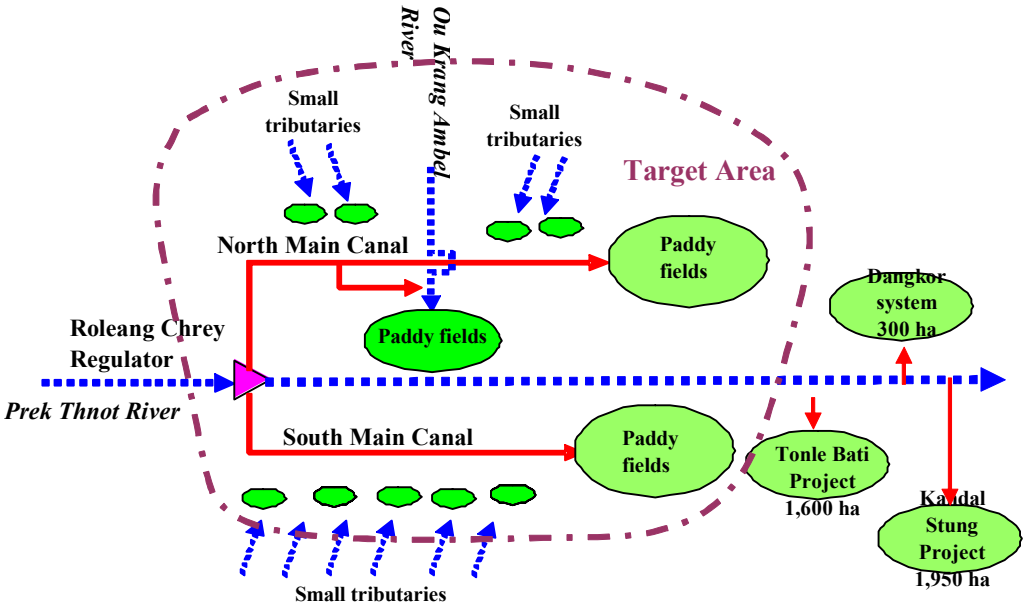
Chapter 6 Water Resources Potential and Drainage Improvement for Agricultural Development

6.1 General

Water availability for the agricultural development for the Target Area is studied without consideration of any new water resources development in the Prek Thnot river basin.

In the Target Area, there are three types of water sources for agriculture: (i) the Prek Thnot River, (ii) the Ou Krang Ambel Tributary and (iii) Small Tributaries. The existing facilities to use these water sources are (i) Roleang Chrey Regulator and Intake Gates, (ii) the North and South Main Canals constructed partially under the Western Phnom Penh Integrated Development Center Project, and (iii) 49 small reservoirs located on small tributaries illustrated as follows:



On the other hand, the present major water users are (i) 85 irrigation systems in the Target Area, including a beneficiary area proposed by the Western Phnom Penh Integrated Development Center Project, and (ii) On-going and proposed irrigation projects downstream of the Target Area to take water from the Prek Thnot River.

Some studies have been made previously for the potential of water resources development of the Prek Thnot River. As a result, these studies have reported a limitation of water resources development in the basin unless a new water resources facility such as a dam is constructed at an upstream site. In this Study, therefore, new reclamation of paddy field in the Target Area is not taken into consideration.

6.2 Water Resources in Target Area

6.2.1 Discharge of Prek Thnot River at Roleang Chrey Regulator

The 5-day dependable discharge of the Prek Thnot River at Roleang Chrey Regulator was estimated as explained in Section 3.5.

6.2.2 Discharge of Ou Krang Ambel River

There is a reservoir in the Ou Krang Ambel River in the Target Area for irrigation purpose. The Ou Krang Ambel River is the largest tributary of the Prek Thnot River flowing in the Target Area, and its catchment area is estimated to be about 453 km^2 at the Ou Krang Ambel Reservoir located along National Road No.4. Two more reservoirs have been constructed for the purpose of irrigation development in the upstream portion of the Ou Krang Ambel River.

Inflow to the Ou Krang Ambel Project thus decreases remarkably. The inflow to the Ou Krang Ambel Reservoir has been estimated through a reservoir simulation considering 2 irrigation projects as follows.

(1) O Sya Irrigation Project

- Location: Mostly upstream of the Ou Krang Ambel River
- Catchment area of the reservoir: 144 km2
- Effective storage of the reservoir: 3,600,000 m3
- Beneficial Area: 730 ha at max.

(2) Chan Tanal Irrigation Project

- Location: between O Sya Irrigation Project and Ou Krang Ambel Irrigation Project
- Catchment area of the reservoir: 124 km^2 (between O Sya and Ou Krang Ambel)
- Effective storage of the reservoir: 3,000,000 m^3
- Beneficial Area: 1,470 ha at max.

The reservoir operation is calculated for each reservoir using the following equation.

$V_i=Q_i-(EV_i+PL_i+Qd_i)+V_{i-1}$

Where, V_i: *Water in the reservoir at time i*

Q_i: *Inflow to reservoir between time i-1 to i*

EV_i: *Evaporation loss from the reservoir between time i-1 to i*

PL_i: *Percolation loss from the reservoir between time i-1 to i*

Qd_i: *Water demand for irrigation to be supplied from the reservoir between time i-1 to i*

V_{i-1} : *Water in the reservoir at time i-1*

In this reservoir operation calculation, the following are assumed:

(a) Inflow to the reservoir is estimated by the dependable discharge of the Ou krang Ambel River at its confluence with the Prek Thnot River in proportion to the catchment area of the reservoir

(b) Evaporation from the reservoir is determined by the Penman-Montieth method (refer to Section 6.4) by use of meteorological data at Phnom Penh Air Port.

(c) Percolation from the reservoir is assumed at 0.2 % of the storage volume referring to the Japanese Guideline (0.05 % of the storage volume), which was adjusted for the soil characteristics in the reservoir and quality of soil compaction work.

(d) Irrigation water demand is estimated similarly with that used for the water balance study (refer to Section 6.4). Other water demands such as domestic use are not taken into account in the calculation considering that those are balanced by the return flow of irrigation water.

As the result of the reservoir operation calculation, dependable inflow to the Ou Krang Ambel Reservoir is calculated as shown in Table 6.2.1.

6.2.3 Small Tributaries

The discharge of the small tributaries can be determined by the dependable discharge of the Prek Thnot River at Peam Khley in proportion to its catchment area and annual rainfall. The catchment area at Peam Khley was calculated at 3,654 km^2. The annual rainfall in the Target

Area is assumed to be about 900 mm per annum from the isohyet map prepared by the Study Team. On the other hand, the catchment size of the majority of water harvesting reservoirs is less than 10 km^2, and this is very small compared with that at Peam Khley. Runoff characteristics in the small catchments and large catchments will be quite different. The large catchment areas like the Prek Thnot River have a base flow mainly due to groundwater. The runoff from a small tributary is only direct runoff caused by heavy rain. To cope with this difference in runoff depending on the size of the catchment area, minimum mean monthly discharge is extracted from monthly mean discharge data as explained in Section 3.5. The moving averages for every 3 months are calculated from these values, and deducted from the dependable discharge at Peam Khley as a base flow.

Estimated Base Flow in the Prek Thnot River at Peam Khley (m^3/sec)

Items	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Minimum	2.4	0.4	0.4	1.5	3.7	3.0	5.3	12.7	69.8	45.6	12.0	2.4
Base Flow	5.6	1.7	0.8	0.6	1.4	2.1	3.0	5.3	22.0	32.0	31.8	15.0

Based on the above result, the discharge of a small tributary is calculated by use of the following equation.

Qr = Qp x 900/1225/3654 x 10 = 0.0020 x Qp

Where,

Qr: discharge of a tributary per 10 km^2 of catchment area

Qp: discharge at Peam Khley after deducting base flow (3,654 km^2)

Dependable 5-day discharge of the tributary per 10 km^2 of catchment area is summarized in Table 6.2.2.

6.3 Water Demand in Target Area

6.3.1 Water Rights

At present, a water law is under preparation, so that water rights are not officially recognized. For the agricultural activities, customary water rights accompanying agricultural land, consisting mainly of paddy fields, are prevailing in the Target Area. This system may not be drastically changed so far as the water law is not enacted.

Farmers sold their land to other private sectors as industrial sites. This has been observed in many scattered places along major roads. This land conversion complicates the water management. The water law should therefore be enacted as soon as possible, especially considering the application of the river basin approach, which might be realized in the future from the viewpoint of effective use of water resources.

6.3.2 On-going and Proposed Irrigation Projects in Downstream Area

(1) Kandaul Stung Irrigation Project

Kandal Stung Irrigation Project is located in the Kandal Stung District of Kandal Province. The project will develop an irrigation system commanding 1,950 ha in net. The construction work was started in September 2005 under the grant aid of the Government of Japan and will be completed by August 2008.

A new diversion weir is under construction to take irrigation water from the Prek Thnot River. Since the project fully depends on the Prek Thnot River, the following irrigation water requirements for the project should be taken into account in the Study.

Summary of Monthly Irrigation Water Requirements of Kandal Stung Irrigation Project (m^3/sec)

Discharge	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Irrigation Water Requirements	0.8	0.7	0.0	0.1	0.8	1.3	2.33	1.0	0.3	0.6	1.3	1.5

Source: Basic Design Report of Kandal Stung Irrigation Project, 2005

(2) Dangkor Irrigation Project

Irrigation water for the Dangkor Irrigation Project is pumped from the left bank of the by-pass channel of the Prek Thnot River immediately upstream of the Tuk Thla Regulator. The project area under the original plan was 300 ha, most of which is not presently irrigated. The irrigation facilities are poor and do not function properly. However, the irrigation water requirements of this project should be taken into consideration in the Study because MOWRAM has a plan to improve this project in the future.

Since no data on irrigation water requirements for the project are available, the requirements have been estimated by applying a similar cropping pattern proposed in the Study. The result is summarized as follows.

Summary of Monthly Irrigation Water Requirements of Dangkor Irrigation Project (m^3/sec)

Discharge	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Irrigation Water Requirements	0.0	0.0	0.0	0.2	0.05	0.05	0.16	0.3	0.18	0.21	0.23	0.03

Source: Study Team

(3) Tonle Bati Irrigation Project

The Tonle Bati Irrigation Project is located in Takeo Province. The project is planned to cover about 1,600 ha excluding the Prek Thnot Reservoir.[1] The proposed water source for the project is the Prek Thnot River. The irrigation water requirements for the project to be considered in the Study are as follows.

Summary of Half-monthly Water Requirements of Tonle Bati Irrigation Project (m^3/sec)

Discharge	January		February		March		April		May		June	
Irrigation Water Requirements	0.95	0.57	0.66	0.64	0	0	0.02	0.05	0.4	0.84	0.91	0.99
Discharge	**July**		**August**		**September**		**October**		**November**		**December**	
Irrigation Water Requirements	1.66	1.42	1.14	0.68	0.34	0.50	0.82	0.64	0.75	0.82	0.98	1.21

Source: Study Team

6.3.3 River Maintenance Flow

The river maintenance flow to the downstream from Roleang Chrey Regulator is determined to be 0.6 m^3/sec, using the result of the Basic Design of the Kandal Stung Irrigation Project in 2005.

6.3.4 Responsible Release Discharge to Downstream Area at Roleang Chrey Regulator

The responsible release discharge to the downstream area at the Roleang Chrey Regulator is estimated by summation of the irrigation water requirements of the Kandal Stung Irrigation Project Dangkor Pump Irrigation Project, the Tonle Bati Irrigation Project and river maintenance flow. The result is given in Table 6.3.1.

[1] *Master Plan Study on the Integrated Agricultural and Rural Development Project in the Suburb of Phnom Penh, Japan International Cooperation Agency, Nippon Koei Co., Ltd., February 1995*

6.3.5 Irrigation Water Requirements in Target Area

6.3.5.1 Introduction of Water Saving Irrigation Method

Net irrigation water requirements are estimated on the condition that the following water saving irrigation method will be introduced for paddy cultivation.

Paddy fields after land preparation and transplanting will not be submerged in water, and are to be supplied with only enough water to keep the soil moisture content at the root depth at not less than 75% of full saturation throughout the total growing period. The paddy field is to be submerged only during a period of 30 days starting at head initiation until the end of flowering. In the calculation, this is converted to a decrease of percolation loss for every 5 days as presented in Table 6.3.2. In this irrigation practice, percolation losses could be reduced by 20% to 25% of total net irrigation water requirements.

6.3.5.2 Calculation Procedure

The irrigation water requirements were estimated based on the following procedures and conditions.

(1) To estimate the Crop Evapotranspiration (ETo), the Penman-Montieth method with the available meteorological data from the Phnom Penh Air Port located near the Target Area is used according to the Guideline for Crop Evapotranspiration, FAO Irrigation and Drainage Paper 56: The calculation was made for every month from 1991 to 2005 except for month with data missing. The annual daily mean Crop Evapotranspiration was calculated at 4.9 mm/day.

Crop Evapotranspiration by the Penman-Montieth Method (mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
4.6	5.3	6.0	6.1	5.5	5.2	4.6	4.9	4.3	4.0	4.4	4.4

(2) To determine the Crop Coefficients of paddy and other crops, reference was made to the above Guideline, and the consumptive use of water for each crop was obtained by multiplying the Crop Evapotranspiration and Crop Coefficients. Based on the cropping calendar proposed, the irrigation water requirements were calculated for every 5 days.

(3) The water requirements for land preparation were determined based on water layer replacement and effective rainfall in the paddy field.

(4) To obtain the field water requirements by summation of consumptive use of water, percolation, land preparation, and water layer replacement; the percolation rate of 8 mm/day was used, based on the field measurements at 9 locations by the Study Team. In this regard, water saving irrigation was proposed in the Study as described in the previous Clause 6.3.5.1.

(5) To calculate the net field water requirements effective rainfall was deducted from the field water requirements. A sample calculation is presented in Table 6.3.3. The calculation is made for several cropping calendars to seek the maximum area that can be irrigated in the rainy season.

(6) Diversion water requirements at each intake site were estimated by taking into account seepage loss, loss from canals and related structures, and operational loss between the intake and the fields. The overall water loss is estimated at 34% of the water flow at the intake.

(7) To calculate a unit diversion water requirement at intake site by multiplying the cropping area factor to the unit diversion water requirement. A sample calculation is shown in Table 6.3.4.

(8) The peak diversion water requirement of the proposed cropping pattern was calculated to be 1.60 lit/sec/ha for Medium Rice early in November. The second largest one is 1.55

lit/sec/ha in the middle of August.

6.4 Water Balance Study

(1) Procedure

The river discharge and water demand were compared in the following manner.

- The 5-day unit diversion requirement calculated in above Sub-section 6.3.5 is compared with the 5-day mean dependable discharge with 80% dependability.
- An irrigation area which meets one 5-day water deficit is tentatively set up
- The cropping calendar which guarantees the largest irrigable area is applied.

Table 6.4.1 shows the most suitable cropping pattern taking into due account the river discharge.

(2) Present Irrigation Area

As for the present irrigation area, no data is available. Therefore, it was assumed based on the currently dominant cropping pattern, irrigation water requirement. As a result of calculation, the present maximum possible irrigation area is estimated to be 6,300 ha with 80% dependable discharge from July to December. Only 500 ha can be completely irrigated in the dry season from May to August.

(3) Probable Maximum Irrigation Area

(a) Probable Maximum Irrigation Area to be supplied from Prek Thnot River

Based on the procedures mentioned above, maximum irrigation area was calculated based on different water sources and different dependability to examine the impact of these factors on probable maximum irrigation area.

Probable Maximum Irrigation Area Commanded by Roleang Chrey Regulator

Dependability	Early rice-1 (ha)	Early rice-2 (ha)	Medium rice (ha)
80% (4 in 5 years)	400	400	5,500
50% (3 in 6 years)	3,500	3,500	13,000
33%(1 in 3 years)	3,600	3,600	18,000

Early rice-1: Cultivated from middle April to early August
Early rice-2: Cultivated from early August to early December
Medium rice: Cultivated from early July to early December

The above areas could be completely included into the Target Area since river maintenance flow and irrigation water requirements for the existing downstream irrigation projects have already been deducted from the available river discharge.

On the other hand, the Western Phnom Penh Integrated Development Center Project is planned to irrigate 24,000 ha from the Prek Thnot River. This command area is located at the eastern part of the Target Area. As can be seen in the above table, this command area could not be irrigated entirely even with 33 % probable river discharge. In addition, there are the existing irrigated paddy fields of about 2,500 ha between the NMC/SMC and this command area, where development priority should be given. From such conditions, it could be said that the full development of the Western Phnom Penh Integrated Development Center Project would require the development of new water resources such as a dam.

(b) Probable Maximum Irrigation Area to be supplied from the Ou' Krang Ambel River

With the same approach, the probable maximum irrigation area from the Ou' Krang Ambel River was calculated as shown below:

Probable maximum Irrigation Area from Ou Krang Ambel River

Dependability	Early rice-1 (ha)	Early rice-2 (ha)	Medium rice (ha)
80% (4 in 5 years)	115	115	430
50% (3 in 6 years)	250	250	700
33%(1 in 3 years)	265	265	1,065

In the above table, no additional water supply from the NMC is taken into account.

(c) Probable Maximum Irrigation Area by Water Harvesting

Similarly, the probable maximum irrigation area by water harvesting is estimated as follows:

Probable maximum Irrigation Area by Water Harvesting (Reservoir)

Dependability	Early rice-1 (ha)	Early rice-2 (ha)	Medium rice (ha)
80% (4 in 5 years)	-	-	600
50% (3 in 6 years)	-	-	1,200
33%(1 in 3 years)	-	-	1,600

6.5 Adoption of Different Dependability

As explained in the previous section, water resources in the Target Area are not adequate for irrigating the whole Target Area. However, parts of NMC and SMC have already been constructed under the Western Phnom Penh Integrated Development Center Project, so that these canals should be used as much as possible. On the other hand, it is hard to immediately set out new water resources development project on the Prek Thnot River due to various problems such as lack of budget, hydrological data and information, and social problems. In consideration of such conditions surrounding the Target Area and to expand the irrigation area as much as possible, it is proposed to classify the beneficial area into two zones of different dependability, namely 80% dependability (4 in 5 years), and 50% dependability (3 in 6 years).

At present and in general, the upstream area of the main irrigation canal could enjoy more opportunity of water use. It seems as though it would be very difficult to change this situation even if a water law is enacted. On the other hand, the downstream area is currently hardly irrigated from the main canal due to less water in the canal and improper canal design. The downstream farmers become in better situation will be improved significantly even with additional water supply of only 50% dependability. In view of these present irrigation situations, it is proposed that the irrigated area of the Target Area should be divided into two areas, i.e., the upstream area with an 80% dependable water supply and the downstream area with a 50% dependable water supply.

Thus, the command areas of NMC and SMC are divided into upstream and downstream areas taking into account topography, location of paddy fields, existing canal layout, and operational activities. The area irrigated by water harvesting is also classified in the same concept. The result of this classification is shown as follows:

Irrigation Area by Different Dependability (Unit; ha)

Name of Canal	Upstream Area with 80% Dependability	Total Area with 50% Dependability	Downstream Area [1/] with 50% Dependability	Design Discharge (m^3/sec)
SMC	3,450	10,200	6,750	16.3
NMC	2,210	3,600	1,390	10.4[2/]
Ou Krang Ambel	-	2,900	2,900	4.6
Sub-total	5,660	16,700	11,040	26.7
Small Tributaries	600	1,200	600	1.9[3/]
Total	6,260	17,900	11,640	28.6

[1/] *Downstream area with 50% dependability= Total area with 50% dependability – Upstream are with 80% dependability*

[2/] *Including 4.6 m3/sec to Ou Krang Ambel System since the system is mainly supplied by the North Main Canal.*

[3/] *A summation of 49 irrigation systems*

6.6 Drainage Improvement Plan

(1) Development Concept

The development concept for drainage improvement is worked out as follows:

(a) Main crop in the Target Area is paddy, and drainage from paddy field is a main target of the drainage development plan.

(b) Small streams are to be utilized for drains as much as possible to minimize construction cost.

(c) An intensive drainage improvement is planned in the limited area, i.e. 14 irrigation systems commanding 620 ha as described in the previous section. An extensive drainage improvement is planned for the remaining areas of Zone-1.

(2) Allowable Flooding Depth, Allowable Inundation Period

Paddy suffers a serious loss if it is submerged at booting stage by flood. The booting stage will start at about 6 days before flowering (heading) which occurs 30 days before harvesting. The height of paddy stem is generally more than 30 cm at the booting stage. The allowable maximum flooding depth and allowable inundation period in the paddy field is planed to be 300 mm and 3 days respectively by making reference with the study by the Ministry of Agriculture, Forestry and Fishery, Japan.

(3) Design Rainfall and Drainage Water Requirement

A maximum daily rainfall and 3 continuous day rainfall are extracted from daily rainfall record at Kampong Speu from 2001 to 2005 as follows:

Annual maximum 1 day rainfall (mm) at Kampong Speu

Year	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
2001				80.9			
2002				111.5			
2003	76.0						
2004					94.9		
2005*1			73.4				

*1 *From May to August*

Annual maximum continuous 3 days rainfall (mm) at Kampong Speu

Year	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.
2001					130.2		
2002				112.9			
2003	115.0						
2004						114.5	
2005*1			80.1				

*1 *From May to August*

A probable rainfall with a 1/5 to 1/10 year return period is applied for planning of drainage system in the paddy field. As shown above, the record length is only 5 years, and difficult to carry out probable analysis by such small number of record. So, the maximum 3 continuous day rainfall is applied in the Study. The unit drainage water requirement is figured out by the following equation.

$q=0.130\times10,000/(3\times86400)$ x 1000 =5

Where,

q : drainage water requirement (lit./sec/ha)

(4) Drainage Canals

Drainage system is composed of field drains, tertiary, secondary, and main drains. Field

drains is planned to be excavated by FWUC together with construction of watercources. A density of tertiary and secondary drains is to be similar with tertiary and secondary irrigation canals. A field drain is planned to be excavated at lowest edge of the field unit which is irrigated by a field irrigation canal. A tertiary drain is planned to be excavated at lowest edge of each tertiary unit. Most of the small tributaries in the Target Area will serve as the secondary drains. However, the tributaries are to be excavated to smoothly flow the drainage water.

Due to the topography in the Target Area, all small tributaries flow into the Prek Thnot river. The Prek Thnot River is to be a main drain in the Target Area.

The excavated material for drains would be used for embankment of irrigation canal for cost saving purpose, provided that its soil characteristics are suitable as embankment material

Chapter 7 Lessons Learned from Pilot Projects and Feedback to Master Plan

7.1 General

In the Master Plan study for the Comprehensive Agricultural Development of Prek Thnot River Basin as mentioned in Chapter 8, four Pilot Projects were proposed, and eventually the following two pilot projects were taken up for implementation under the Study from the viewpoints of "impact to strategic target of Master Plan", "Urgency" and "Farmers' incentive":

- Irrigated Agriculture On-farm Technology Improvement Pilot Project
- Rainfed Agriculture Improvement Pilot Project

These Pilot Projects were implemented from July 2006 to February 2008. In these Pilot Projects, the following activities were conducted:

Pilot Project Activities

Activities	Irrigated Agriculture On-farm Technology Improvement Pilot Project	Rainfed Agriculture Improvement Pilot Project
(1) Participatory Irrigation Management and Development	○	X
(2) Participatory Agriculture Extension	○	○
(3) Experimental Farming Practice Improvement	○	○

Through these activities, lots of lessons learned were obtained, and some of them were fed back to the Master Plan.

In addition, as for "Hydrological Study and Environmental Management Basic Capacity Strengthening", the concerned findings obtained were utilized for feedback to the Master Plan.

7.2 Lessons Learned from Pilot Projects

As mentioned in Volume-IV: Pilot Projects, the lessons learned were arranged based on 6 categories, that is "5 basic strategies" and "others". These lessons learned are listed below, of which the details are shown in Volume-IV: Pilot Projects:

(1) Participatory Irrigation Management and Development Activities

List of Lessons Learned

(a) Strategy-1: Learning from good farmers' practices in Cambodia	
First Year (July 2006 to February 2007)	
	1) Necessity of Development of Water Resource Scarce Areas
	2) Importance of a Quick Plan-Do-See Cycle in Project Operation
	3) Necessity of Empowering Farmers by Confirming Their Behavioral Change
	4) Necessity of Incentives for FWUC Committee Members
	5) Identified Keys for Proper Irrigation Service Fee Collection
Second Year (May 2007 to February 2008)	
	1) Application of Experienced Procedure for ISF Collection in Other Project
(b) Strategy-2: Project operation by united farmers-government-NGO project team	
First Year (July 2006 to February 2007)	
	1) Related Institutions to be involved in the Project Activities
	2) Necessity of Implementing Formal Processes in FWUC Activities
Second Year (May 2007 to February 2008)	
	1) Formation of United Farmer-Government-NGO Project Team to Collect ISF
(c) Strategy-3: Government agencies collaborating in irrigated agriculture related activities	
First Year (July 2006 to February 2007)	

	1) Finding of Proper timing of Integrating FWUC Strengthening Activities and Agricultural Extension Activities
	2) Effectiveness of Utilizing the Existing Social Capital of Local Communities
	3) High Capability of Provincial Government Staffs in Communicating with Local Inhabitants
	4) Necessity of Applying Different Approaches to Empowering FWUC or Irrigation Management Groups in Different Zones
Second Year (May 2007 to February 2008)	
	1) Need of Collaboration of PDOWRAM and PDA for Dissemination of Proper Water Management
	2) Need of Joint Meeting for Creating Coordination between PDOWRAM and PDA
(d) Strategy-5: Introduction of farmer-to-farmer extension	
First Year (July 2006 to February 2007)	
	1) Effectiveness of Group Discussions in Meetings and Training sessions
(f) Others	
First Year (July 2006 to February 2007)	
	1) Importance of Providing Non Formal Education to Farmers
	2) Empowerment of Farmers and Local Government Staff Taking Their Mentality into Account
	3) Proper Use of Scientifically Obtained Data and Collected Data in a Participatory manner
	4) Necessity of Paying Careful Attention to Sustainable Development
	5) Necessity of Proper Understanding of the Necessary Conditions and Requirements for an Active FWUC
	6) Necessity of Understanding the Nature of an FWUC and Providing a Proper amount of Time for Strengthening
	7) Necessity of Improving Administration of an FWUC Prior to Implementing Water Management
	8) Difficulties in Establishing Trans-village Networks for FWUC Activities
	9) Effectiveness of Utilizing Various Village Events in FWUC Activities
	10) Importance of Preparing a Preliminary Landholding Map in FWUC Strengthening
	11) Necessity of Developing a Rapid and Low Cost Preliminary Landholding Map Preparation Method
	12) Necessity of Establishing a Simple Method for Updating a Preliminary Landholding Map
	13) Effectiveness of Introducing FWUC Initiated Training System
	14) Importance of Publicity Information the People of the Activities of an FWUC
	15) Necessity of Providing Technical Information to PDOWRAM
Second Year (May 2007 to February 2008)	
	1) Inadequate Basic Knowledge and Experience of PDOWRAM Staff in Irrigation
	2) High Motivation of PDOWRAM Staff on Raising Knowledge
	3) High Expectation of Downstream Farmers to Proper Water Management
	4) Need of Formation of WUGs on the Canal Basis
	5) Need of Slipping Out of Bad Circularity in FWUC Activity
	6) Application of Collection of ISF at the Village Level
	7) Effect of Involvement of Local Authority
	8) Need of Simple Measuring Device
	9) Need of Discussion focusing on What Farmers Can do by themselves
	10) Need of Further Strengthening the Coordination among Leaders of WUGs and FWUG
	11) Heightening of Awareness of FWUC
	12) Recognition of Importance of PDOWRAM's Role for Supporting FWUC

(2) Participatory Agricultural Extension Activities

List of Lessons Learned

(a) Strategy-1: Learning from good farmers' practices in Cambodia	
Second Year (May 2007 to February 2008)	
	1) Participation of Government Staff in Study Tour Visiting to Successful Project
	2) Difficulty in Dissemination of Proposed Manner against Insect and Mouse Injuries
(b) Strategy-2: Project operation by united farmers-government-NGO project team	
First Year (July 2006 to February 2007)	
	1) Importance of Showing Various Types of Farming Practices in Agricultural Extension
Second Year (May 2007 to February 2008)	
	1) Expectation of Follow-up Works by Government and NGO
(c) Strategy-4: Minimum material and equipment input from farmers	
Second Year (May 2007 to February 2008)	
	1) Effect of Minimum Inputs of Material and Equipment from Farmers
(d) Strategy-5: Introduction of farmer-to-farmer extension	
First Year (July 2006 to February 2007)	
	1) Identified Key Points for Effective Participatory Agricultural Extension
	2) Importance of Sharing Experiences through Lateral Farmers' Networks
	3) Importance of Farmers' Groups in Agricultural Extension and Further Development
Second Year (May 2007 to February 2008)	
	1) High Impact by Presentation of Experienced Farmers
(e) Others	
First Year (July 2006 to February 2007)	
	1) Importance of Farmers' Self-reliance in Improving Farming Practices
	2) Assessment of Ease or Difficulties in Low input SRI Principles by Farmers
	3) Possibility of Applying Similar Extension Processes in All Zones
	4) Necessity of Guiding Farmers toward Flexible Application of New Farming Practices
	5) Necessity of Continuing Activities in the Dry Season
	6) Importance of Testing SRI without Applying New Seeds
	7) Strong Demand of Farmers for Savings Activities
	8) Expected Effect of Savings Activities on Sustainable and Self-reliant Farmers' Groups
	9) Proposed Process of Establishing Farmers Cooperatives in the Future
Second Year (May 2007 to February 2008)	
	1) High Impression by Paddy Cultivation in SRI System and Traditional System at the Same Plot
	2) Effect of Timely Monitoring and Support to Cooperative Farmers

(3) Experimental Farming Practice Improvement Activities

List of Lessons Learned

(a) Strategy-3: Government agencies collaborating in irrigated agriculture related activities	
Second Year (May 2007 to February 2008)	
	1) Need of Collaborative field activities of PDA and PDORAM
(b) Strategy-4: Minimum material and equipment input from farmers	
First Year (July 2006 to February 2007)	
	1) Easy Improvement by Farmers on Identified farming Skills
	2) Need of Improvement on Farming Practices that were identified as being difficult for Farmers
(c) Strategy-5: Introduction of farmer-to-farmer extension	
Second Year (May 2007 to February 2008)	
	1) Difficulty in farmer-to-farmer extension
(d) Others	
First Year (July 2006 to February 2007)	
	1) Necessity of Careful Consideration of Farmers' Financial Condition

	2) Importance of Improving Farming Practices to avoid Uneven Growth in the Plots
	3) Necessity of Introducing Simple Comparison Tests that can be executed by the Farmers
	4) Necessity of Empowering PDA Extension Staff by implementing Learning through Doing
	5) Necessity of Establishing a Practical Extension Systems
Second Year (May 2007 to February 2008)	
	1) Improved Practices Easily Accepted
	2) Dissemination of Improved Farming Practices in Zone-3
	3) Farmers Knowledge on Organic Fertilizer
	4) Effect of Provision of Seed on Seed Replacement
	5) Farmer Operated Trial
	6) Limited Practical Skills of PDA Staff
	7) Weak Field Extension Activities

7.3 Feedback to Master Plan

7.3.1 Basic Approach to Feedback to Master Plan

One of subjects given for execution of the Pilot Projects is to feed back the results of them to the Master Plan. As mentioned previously, lots of valuable lessons learned have been obtained from the activities for the Irrigated Agriculture On-farm Technology Improvement Project and the Rainfed Agriculture Improvement Pilot Project, such as the Participatory Irrigation Management and Development activities, Participatory Agricultural Extension Activities and Experimental Farming Practice Improvement Activities. Thus, the feedback to the Master Plan was conducted using theses lessons learned.

The Master Plan proposed the development objectives and strategies, and 27 projects/studies including the above two Pilot Projects, which were explained by Project Proposal, Implementation Schedule and Project Design Matrix (PDM). As a matter of course, these projects/studies have been planed at master plan level and have been largely different from the Pilot Project in scale and precision. Thus, feedback to the Master Plan would be made only for the substantial matters taking the above into due consideration. This approach was also applied for “Hydrological Study and Environmental Management Basic Capacity Strengthening”.

7.3.2 Feedback to Master Plan from Pilot Projects

Based on the basic approach to feedback to the Master Plan mentioned above, some parts of the development objectives and strategies, and some projects out of 27 projects/studies would be modified. In this section, major modifications only are mentioned hereunder.

7.3.2.1 Irrigation and Drainage

(1) Application of Rotational Irrigation Method along Tertiary Canal

In 3) Water Management for the Main Canal and 4) Water Management for Secondary and Tertiary Canals and Watercourses, (6) Water Management and O&M, 8.6.1 Zone-1 Development, 8.6 Development Objectives and Strategies for Scheme-wise Improvement in Interim Report (1), rotational irrigation method was applied along the main canal. In the participatory irrigation and management activities, rotational irrigation method was conducted by FWUC along tertiary canal. The result was satisfactory and water was distributed to tail end fields. From this experience and considering mitigation of burden to the government, the rotational irrigation should be applied along the tertiary canal. In connection with this change, water supply for each canal should be conducted as follows:

- Main canal: continuous water supply
- Secondary canal: continuous water supply

- Tertiary canal: rotational water supply
- Watercourse: rotational water supply

(2) Need of Support from MAFF on Training of Water Management

Farmers did not show the high interest in water management since they did not precisely know that proper water management closely connected with high crop production. Therefore, dissemination of proper water management should require the support of agriculture expert. From this finding, need of coordination between MOWRAM and MAFF should be added to Development Strategies, (6) Water Management and O&M, 8.6.1 Zone-1 Development, 8.6 Development Objectives and Strategies for Scheme-wise Improvement in Interim Report (1).

(3) Collection Method of ISF

The successful collection of ISF is one of major subjects for the participatory irrigation management and development activities. Before starting these activities, the collection rate of ISF in the Ou Veaeng FWUC was only 10%. After a series of activities such as preparation of necessary materials, establishment of collection procedure, formation of WUGs and training to FWUC, the collection rate of ISF highly attained at 86 %. The paid farmers were 97 % of all farmers concerned. Thus, In 6) collection of ISF, (4) FWUC Formation and Strengthening, 8.6.1 Zone-1 Development, 8.6 Development Objectives and Strategies for Scheme-wise Improvement in Interim Report(1), the following sentences should be added:

“Collection of ISF should be made based on the water request form in which name of farmers, plot area, amount to be paid, kind of crops, and WUG No. should be mentioned. This water request form should be given his finger print, signed by WUG leader and approved by FWUC leader. Each farmer should pay ISF to WUG leader based on this water request form”.

(4) Observation of Rainfall

In (3) Irrigation and Drainage Development, 8.6.3 Zone-3 Development, 8.6 Development Objectives and Strategies for Scheme-wise Improvement in Inteim Report (1), Observation of rainfall should be added. The participatory irrigation management and development activities were carried out for Prey Robong Water Harvesting Irrigation System in the first year, but could not be made satisfactorily because of insufficient water in reservoir due to drought weather condition. In the second year, therefore, Takao and Prey Kijeay Water Harvesting Irrigation Systems were taken up additionally as target sites of participatory irrigation management and development activities after having confirmed farmers that reservoir was filled with rainfall water in the rainy season. But, the reservoirs for these systems had less water in this rainy season. From such unexpected experience and considering recent abnormal weather condition, rainfall should be observed at the catchment area of the respective reservoirs prior to commencement of development. Since this matter is so important, it should be mentioned as one of development strategies.

(5) Multi-use of Reservoir Water

In (3) Irrigation and Drainage Development, 8.6.3 Zone-3 Development, 8.6 Development Objectives and Strategies for Scheme-wise Improvement in Interim Report (1), Multi-use of reservoir should be added. The water harvesting irrigation system was provided with the reservoir to store rainfall water. It was found that the reservoir water was used not only for irrigation, but also for domestic purpose and animal drinking. Therefore, water harvesting irrigation should be planed in consideration of this matter.

(6) Water Supply based on Growing Stages of Paddy

The effective storage capacity of reservoir is limited. Besides, the reservoir generally is

filled with rainfall water around later half of rainy season. Thus, ordinary water supply could not be expected for the water harvesting irrigation system. According to the physiological characteristic of paddy, the following periods require water indispensably:

- About 10 days after transplanting for rooting
- About 10 days at panicle initiation stage around 65 days before harvesting
- About 10 days at flowering/heading stage around 30 days before harvesting

Taking into consideration the storage condition in the reservoir and the physiological characteristic of paddy mentioned above, water supply from the reservoir should be done based on physiological characteristic of paddy. This matter should be mentioned in (6) Water Management and O&M, 8.6.3 Zone-3 Development, 8.6 Development Objectives and Strategies for Scheme-wise Improvement in Interim Report (1).

In connection with this modification, “In Zone-3, the small……..considering this matter” in (5) Project Description, 9.4.7 C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project in Interim Report (1), should be modified as follows:

“In Zone-3, project approach is quite different from Zone-1 since the available water is so limited. Water management and farming practice should also be conducted in different manner with Zone-1. The pilot project activities for Zone-3 should be therefore planed and executed in due consideration of the above."

7.3.2.2 Agriculture

(1) Proposed Farming Practices

The attempts in the verification plots and on-farm water management trial plots indicate that on-farm water management or water saving rice cultivation should be carried out through controlling of water depth at time of irrigation and not through draining of water because on-farm drains are not constructed in irrigated areas.

Further, the detail study on the prevailing post-harvesting practices indicates that the improvement of post-harvest practices will not be possible because of limited availability of threshing machine, needs of transport of rice straw to home yard for feeding cattle and wet field condition after harvest. Therefore, under the current situation, the continuation of current prevailing post-harvest practices should be accepted.

In the finalization of the Master Plan, the proposed farming practices shall be modified in line with the findings stated above.

(2) Agricultural Support Services

The results of the verification tests on upland crops (mungbeans) dictate the intensification of field programs for upland crops (technology development and field demonstration) for the attainment of the target set in the Master Plan.

In the finalization of the Master Plan, the necessity of technology development and field demonstration on upland crops production shall be emphasized.

(3) Cropping Pattern

The adoptability of the cropping patterns was verified through the verification tests in 2006 and 2007. However, further technology development and guidance activities on upland crops cultivation are considered essential for the extension of the introduction of upland crops in the early rainy season in paddy fields as stated earlier.

7.3.2.3 Institutions

(1) Involvement of Commune Chief and Council

For the FWUC activities, it was effective to involve the Commune Chief and Council in addition to the Village Chief. It was sometimes found that farmers showed the obedient attitude for the explanation of the Commune Chief or Commune Council in the meeting. In particular, the request of Commune Chief was so effective to gather farmers to the meeting. From such finding, description of 2) Formation of FWUC, FWUG and WUG Considering Tragic History, (4) FWUC Formation and Strengthening, 8.6.1 Zone-1 Development in Interim Report (1), should add the Commune Chief/Council to Village Chief and VDC.

(2) Strengthening of FWUC for Proper Water Management and O&M

According to the government policy, water management and O&M at tertiary canal level should be carried out by FWUC. However, almost all FWUCs do no have enough capacity to fulfill the proper water management and O&M at tertiary canal level. In the participatory irrigation management and development activities, this was realized keenly. Thus, the following sentence should be added to the Development Strategies, (7) Irrigated Agriculture On-farm Technology Improvement Pilot Project, 8.7 Development Objectives and Strategies for Subject-wise Improvement in Interim Report (1):

- Strengthen FWUC so as to enable the FWUC duties satisfactorily.

(3) Need of WUG Formation for Realization of Proper FWUC Activities

In the participatory irrigation management and development activities, WUGs were formed as the lowest unit in FWUC, to strengthen FWUC activities at on-farm level. WUG should conduct the O&M for watercourse, water management along watercourse, settlement of water conflict occurred at on-farm level and collection of ISF. As the result of formation of WUGs, many watercourses were rehabilitated and/or constructed newly in the pilot project area. In addition, leaders of WUGs played an important role of collection of ISF, so that high collection rate of ISF was achieved. In this sense, WUGs should be added to (iii) Formation and strengthening of FWUC/FWUGs, (7) Project Components, 9.3.1.2 A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project in Interim Report (1).

(4) Coordination between MOWRAM and MAFF Strengthening

In stead of "Project Management Group," Advisory Team consisting of MOWRAM, MAFF, JICA Expert, and JICA Cambodia Office has been established in the Pilot Projects. The establishment of this team has promoted the coordination between MOWRAM and MAFF. Consequently, to promote coordination between MOWRAM and MAFF, it is crucial to hold regular meetings about the progress of the project to exchange the information and the ideas about the project. Expressed in another way, the projects required to be implemented jointly are important for promoting their coordination. This matter would be reflected on the Master Plan.

(5) Provincial Departments Strengthening

The capacity of provincial departments, PDOWRAM and PDA, has been largely developed through the On-the-Job-Training and technical seminars in the Pilot Projects. The Pilot Projects have granted them the good opportunities to utilize the knowledge and technique learned through the Pilot Project during the implementation. Therefore, they have been highly motivated to improve their capacity. It indicates that it is crucial to give the provincial department to practice the attained knowledge and technique in the project implementation to strengthen the provincial departments. This matter would be incorporated into the Master Plan.

7.3.3 Feedback to Master Plan from Hydrological Study

In the Master Plan, one project and one study were proposed as Subject-wise Improvement. These are (i) Hydrological Observation Strengthening Project and (ii) Flood Forecasting and Warning Study, which have been conducted during the second year (May 2006 to February 2007) and the third year (May 2007 to February 2008).

7.3.3.1 Hydrological Observation Strengthening Project

This Project aims to strengthen hydrological data acquisition system for water resources related project. In the Study, 10 rainfall automatic gauging stations and 5 water level automatic gauging stations were established newly. Using these gauging stations, the Study Team has trained the counterpart dispatched from Department of Hydrology and River Works (DHRW), MOWRAM about periodical downloading of data from data loggers, arranging of data collected, analysis of runoff model and flood forecast method analysis. These works have been carried out during the said period, and training to counterpart of DHRW has been trained as planed. Thus, any modification is not required.

7.3.3.2 Flood Forecasting and Warning Study

As for the Flood Forecasting and Warning Study, the actual approach to the study was slightly deviated from the planned one in Interim Report (1). Thus, some modifications are required for it.

(1) Flood Forecasting

The use of runoff model was one of the conceivable methods for flood forecasting. In the study, two options were considered; flood forecasting with water-level and flood forecasting with rainfall. After the study on the both, the use of simple correlation method between rainfall at Kirirom and the water-level at Peam Khley Bridge site has been found appropriate for flood forecasting.

(2) Flood Warning

Regarding the flood warning, the dissemination means are the mass media, such as TV and Radio in the case of flood warning of the Mekong, the Tonle Sap and the Bassac Rivers, but the warning contents are estimated inundation water-level on staff gauges set in villages for the immediacy for local people. This system would be desirable to be applied for the Prek Thnot River basin.

In the case of the Prek Thnot River basin, the inundation water depth is quite different depending on the locations since the area is an undulating plain. Accordingly the staff gauges for flood warning should be set very carefully in consideration of the undulating plain in the area. Besides, the relation between the river water-level and the inundation water-level at the staff gauges should be carefully studied based on the actual experience to be accumulated in coming future.

Regarding the influence to inundation by gate operation of Roleang Chrey Regulator and Kandal Steung Regulator, it has been found that these regulators have no function to retain floods in the upstream side of the regulators. The gates of these regulators should be operated to keep the upstream side water-level at the designated water-level during a flood and finally should be fully opened if the water-level is still rising over the designated water-level.

Based on the actual study, the project digest of flood forecasting and warning study in the draft master plan would be modified as shown in the attached sheet.

7.3.4 Feedback to Master Plan from Environmental Management Basic Capacity Strengthening

Interim Report (2) presented two kinds of environmental activities which were Environmental Management Capacity Development Project and Environmental Management Applied Capacity Development Project.

On this occasion, the design of these two projects related to environment were once again considered to be modified and finalized based on lessons learned from the whole Study activities including technology transfer activities.

7.3.4.1 Environmental Management Capacity Development Project

The Environmental Management Capacity Development Project was planed as supportive project of implementation of the other projects under the Master Plan. The project consisted of 1) case study of EIA/ preparation of draft TOR for EIA, and 2) training for environmental conservation and management planning. Through the Study activities, it was evaluated that the contents of the project were reasonable and appropriate considering of current condition of MOWRAM and MAFF, their requests and needs as the executing agencies of the project.

Though this Project was designed to start from last half of 2006 to 2007, the executing agencies, i.e. MOWRAM and MAFF, had not had any opportunities to organize and implement the project component by themselves during the Study period. In such a situation, some components were conducted through the technology transfer activities under the Study.

The conducted components of the Project under the Study were as follows;

(1) Case Study of EIA/ Preparation of draft TOR

Several times of workshops were conducted to transfer the knowledge about EIA toward counterpart from MOWRAM and MAFF. These activities basically covered main and necessary contents to be trained for the counterparts. Remaining content to be conducted is to prepare the check list of EIA for agricultural practices. In addition, preparation of draft terms of reference (TOR) of EIA study should be conducted once more because the counterparts expressed its difficulty to understand under the Study.

(2) Training for Environmental Conservation and Management Planning

Under the Study, the three-day workshop on environmental management and monitoring was organized toward the staff of MOWRAM, MAFF, PDOWRAM and PDA of the Kampong Speu Province. It was out of planned contents to share the basic concept of environmental management and monitoring just as a first step. Through this activity, it became apparent that both PDOWRAM and PDA were so interested in the environmental management activities and considering the possibilities of start of environmental management activities within their fields.

Through the conducted activities under the Study, it can be said that two components of the project would be effective. Moreover, it became clear that training for environmental conservation and management planning might be beneficial for not only MOWRAM and MAFF but also provincial level of staff.

Taking above mentioned condition into consideration, the Project should be modified the following points;

- Implementation schedule of the component of 1) Case Study of EIA/ Preparation of draft TOR should be modified based on the results of actual implementation under the Study.
- Implementation schedule of the component of 2) Training for Environmental

Conservation and Management Planning should be modified in consideration of b feasible planning of MOWRAM and MAFF.

7.3.4.2 Environmental Management Applied Capacity Development Project

Environmental Management Applied Capacity Development Project was planned to be developed as a second supportive project after the Environmental Management Basic Capacity Development Project in 2012-2015 in order to strengthen applied capabilities of the relevant staff of MOWRAM and MAFF regarding EIA and environmental management through follow-up of the environmental management activities which have been implemented under the Master Plan. The project consisted of 1) monitoring of environmental management activities and 2) implementation of follow-up program.

Basically, it was evaluated that this Project might be effective without any modification of the Project contents (project digest, implementation schedule and project design matrix) in the future.

Chapter 8 Basic Concept of and Approach to Master Plan for Comprehensive Agricultural Development

8.1 Needs for Comprehensive Agricultural Development for Target Area

(1) Shortage of Rice

Agriculture is a mainstay for ensuring the livelihood of the population in the Target Area. Of the cultivated crops, paddy, a main pillar for generating income, is predominant in the area. Paddy, in the Target Area, is produced mostly under rainfed conditions. As a result, its yield and production are low and unstable mainly due to erratic rainfall. Lack of proper farming technology also causes this low yield and production. The average yield of paddy in the area is only 1.8 ton/ha, which is lower than the average of the entire country which is 2.2 ton/ha. The annual total production of rice for each year from 2002-03 to 2004-05 in the area resulted in either a shortage or very small surplus as shown below:

Food Balance of Rice Production from 2002/03 to 2004/05 **Unit: tons**

Province/ District	2002-2003			2003-2004			2004-2005		
	Supply	Demand	Balance	Supply	Demand	Balance	Supply	Demand	Balance
Kampong Speu									
Char Mon	2,807	5,964	-3,157	4,894	6,052	-1,158	2,565	6,085	-3,519
Kong Pisei	5,679	8,239	-2,560	5,618	8,584	-2,965	7,071	8,642	-1,570
Samraong Tong	7,324	19,043	-11,719	14,094	19,139	-5,045	8,092	19,473	-11,381
Kandal									
Kandal Stueng	2,168	2,193	-26	1,679	2,262	-583	2,659	2,313	346
Angk Snuol	7,167	10,219	-3,053	8,640	10,400	-1,760	5,752	10,629	-4,877
Total	**25,145**	**45,659**	**-20,514**	**34,925**	**46,436**	**-11,512**	**26,140**	**47,141**	**-21,001**

Source: Shown in Table 4.7.7

As can be seen in the table, the three districts in Kampong Speu Province, which administratively cover approximately 85% of the Target Area, suffer from a constant shortage of rice, and accordingly are in a crucial situation from the viewpoint of food security. Increase of rice production is given a top priority in the Target Area to attain self-sufficiency in rice production in the area.

(2) Need for Expansion of Irrigated Area together with Timely Input of Agricultural Support Services

The most significant action to increase the agricultural production in the Target Area is to expand the irrigable area as much as possible through water saving irrigation methods and proper water management. It is no doubt that irrigation contributes to stabilizing and increasing the agricultural production. However, there is a limitation in increasing the agricultural production by irrigation only. Timely provision of agricultural support services is needed for further increasing the agricultural production in parallel with the expansion of irrigable area. Thus, it is essential to develop the irrigation systems and agricultural supporting services in a complementary manner.

(3) Need for Promotion of Other Agricultural Sub-sectors for Income Generation

In order to supplement the farm income from crop production, the farmers are keenly tackling the raising of livestock and/or inland fish culture. But these are still far from a satisfactory level at present, mainly due to the lack of adequate technical knowledge and supporting systems. In order to promote these activities and to realize significant income generation, it is necessary to study and apply the appropriate support systems.

(4) Need for Institutional Strengthening

The provincial departments and district offices shall provide technical support, including agricultural support services, to the farmers. On the other hand, the farmers, as the Farmers Water Users Community (FWUC), shall be responsible for water management, operation and maintenance of irrigation facilities at least at the on-farm level. Even in the rainfed areas, the farmers groups are required for targeting the extension services and in the future executing the economic activities. In this sense, institutional strengthening, including capacity building, is prerequisite for the provincial and district staff and farmers, prior to irrigation infrastructure development.

As mentioned above, many issues are concerned with the current low agricultural production in the Target Area. To improve current low agricultural productivity in the Target Area, comprehensive agricultural development is thus essential as the most realistic and achievable approach.

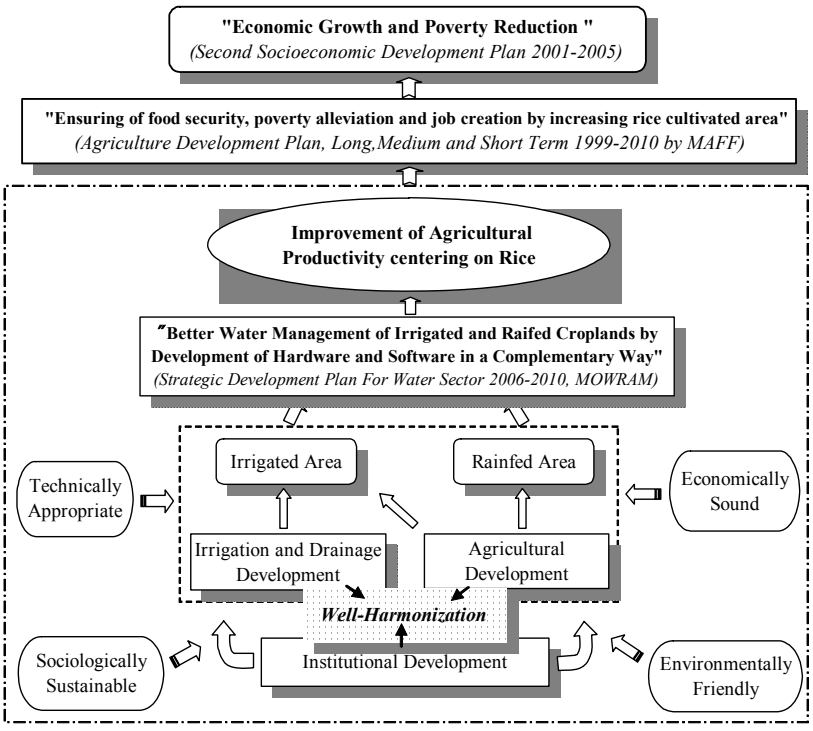
8.2 Objective and Strategy

(1) Objective

Objective of the master plan is to elaborate and indicate the strategies to improve the agricultural productivity in the Target Area by the specific year using appropriately the existing water resources.

(2) Strategy

As the result of review of the government policies, socioeconomic survey, PCM workshop, RRA and site inspection, the JICA study team selected the "***Improvement of Agricultural Productivity centering Rice***" as the strategic target of the master plan, which will be attained by the "***program approach***" in the concept of the "***Well-harmonized Development of Irrigation and Drainage, Agriculture and Institution***". The irrigated area should be harmoniously developed in the three subject fields of irrigation and drainage, agriculture and institutions. The rainfed area where a reliable water source is not available should be developed through a combination of agriculture development and institutional development. This development concept is illustrated as follows:



As can be seen in the above illustration, this concept is supported by four elements: "Technically Appropriate", "Economically Sound", "Sociologically Sustainable" and "Environmentally Friendly".

(1) Technically Appropriate

This element emphasizes the importance of appropriate technologies for irrigation and drainage development and agricultural development. The irrigation system should be planed so as to ensure the proper water management with water saving technology and to expand the irrigable area as much as possible. The drainage system should be planed in a concept of maximum use of natural streams to save the construction cost and allowable water stagnant at growing stage of paddy . The agricultural development should provide the farmers with the appropriate farming technology focusing on introduction of water saving cultivation of paddy like SRI, and improvement of crop yield.

(2) Economically Sound

This element is concerned with the use of limited financial sources. The government and farmers are still facing a severe situation in financial arrangements for agricultural development. The Master plan should be formulated in consideration of the effective use of the limited financial source for its implementation. The proposed projects in the Master plan should therefore be economically sound, and/or be economically attractive for the donors in order to obtain their assistance.

(3) Sociologically Suitable

This element stresses the importance of the farmers' role in comprehensive agricultural development. The Master plan will be worked out taking into consideration farmers not only as the beneficiaries, but also as main actors for comprehensive agricultural development. In this sense, active participation and empowerment of the farmers are indispensable and effective approaches. The sociological aspects should therefore be emphasized in the master plan.

(4) Environmentally Friendly

This element promotes management practices for water and land use that are environmentally sustainable. Well-managed water and land use guarantees good conditions for agricultural production and a sustainable ecological system, which eventually leads to environmentally appropriate living conditions for the farmers.

8.3 Development Scenario

In succession to SEDP II, NSDP presents the development vision of RGC for the 5 years from 2006 to 2010. Various polices/plans have been prepared in harmony with this plan, setting a target year of 2005 and/or 2010. In consideration of consistency with these polices/plans, the situation of available financial sources, and the size of Target Area, the master plan is to be delineated targeting a medium term of the year 2015. The proposed development scenario for the master plan is explained on both a short and medium term basis.

(1) Short Term

The short term is set from 2006 to 2010. "Decentralization" was selected as the focus point for this term. NSDP as well as SEDP II states that decentralization contributes to broader-based economic growth and implementation of more effective and efficient strategy for poverty alleviation. Thus, the government initiated a decentralization process by commencement of operation of newly elected Commune Councils in early 2002, and is proceeding now.

This decentralization policy highly influences the agricultural development, including

irrigation development. The local authorities such as the provincial and district offices should also be more involved in implementation of agricultural development year by year. The more the local departments are involved, the higher their capability must be developed. This means that the technical capacity of local department staff should be increased for smooth execution of the development activities. The comprehensive agricultural development plan in the short term should therefore be mapped out focusing on the mechanisms needed for the local department-oriented approach.

(2) Medium Term

The medium term covers the 10 years from 2006 to 2015. In this term, a focus is put on "privatization". The Action Program for Development of the Agricultural Sector (2001-2010), indicates that it is essential to apply a strategy of working with the private sector as a full partner for agriculture development. Similarly, SEDP II suggests that private sector-led construction of irrigation should be one of the objectives for the medium and long term in irrigation development.

The individual farmers and communities of farmers are included in the category of "the private sector" according to the Strategic Development Plan 2006-2010. There is no doubt that the farmers should be main actors playing an important role to fulfill sustainable agricultural development, although this needs the timely provision of well-planed capacity development for them so that they can successfully perform the duties as the actor. The comprehensive agricultural development plan in the medium term will be thus worked out putting a focus on the farmers' initiative or farmers-oriented approach as the cornerstone of development.

The development scenario mentioned above is illustrated below.

Development Scenario

	Short Time (2006-2010)	Medium Time (2006-2015)
Overall Strategic Target	Improvement of Agricultural Productivity Centering on Rice	
Focus Point in Each Term	**Decentralization** →	→ **Privartization**
Irrigation and Drainage Development		
Strategic Approach	Expansion of the irrigated area through effective use of existing water resources and application of appropriate water management.	
Focused Main Activities	- Improvement of priority/urgent irrigation projects - Execution of proper water management by local department-oriented approach - Execution of O&M of irrigation and drainage facilities by local department-oriented approach	- Improvement of irrigation projects by farmers' participation - Execution of proper water management by farmer-oriented approach - Execution of O&M of irrigation and drainage facilities by farmer-oriented approach
Agricultural Development		
Strategic Approach	Improvement of crop yields through proper farming technology and stengthening of support services, and promotion of inland fishe culture and livestock farming	
Focused Main Activities	- Promotion of agricultural development in the priority/urgent irrigation projects - Agricultural support services by local department-oriented approach	- Farmer initiative agricultural developent in irrigation project areas and raifed areas - Agricultural support services by farmer -oriented approach
Institutional Development		
Strategic Approach	Formation of farmers organization, and capacity development of local department and famers organization	
Focused Main Activities	- Proper financial and administrative arrangement - Strengthening of coordinaton beween MOWRAM and MAFF - Capacity development of local departments - Formation of FWUCs and other required farmers organization - Commencement of capacity development of FWUCs and other required farmers organization	- Formation of FWUCs and other required farmers organization for remaining irrigation projects and rainfed ptrojects - Capacity building of FWUCs and other required farmers organization - Monitoring and evalution of activities of local departments, FWUCs and other required farmers organization

8.4 Zoning of Target Area

8.4.1 Need of Zoning

The Target Area exhibits diversity in terms of water availability and land use. In view of this situation, it is inadvisable to simply apply a uniform development approach plan to such a large area. Instead, zoning of the Target Area is recommendable as an appropriate approach, especially for the crop sub-sector, which is a main income source for farmers in

the Target Area. The master plan for comprehensive agricultural development should be formulated by applying a zone based approach.

8.4.2 Methodology

The zoning map was prepared in the following three steps.

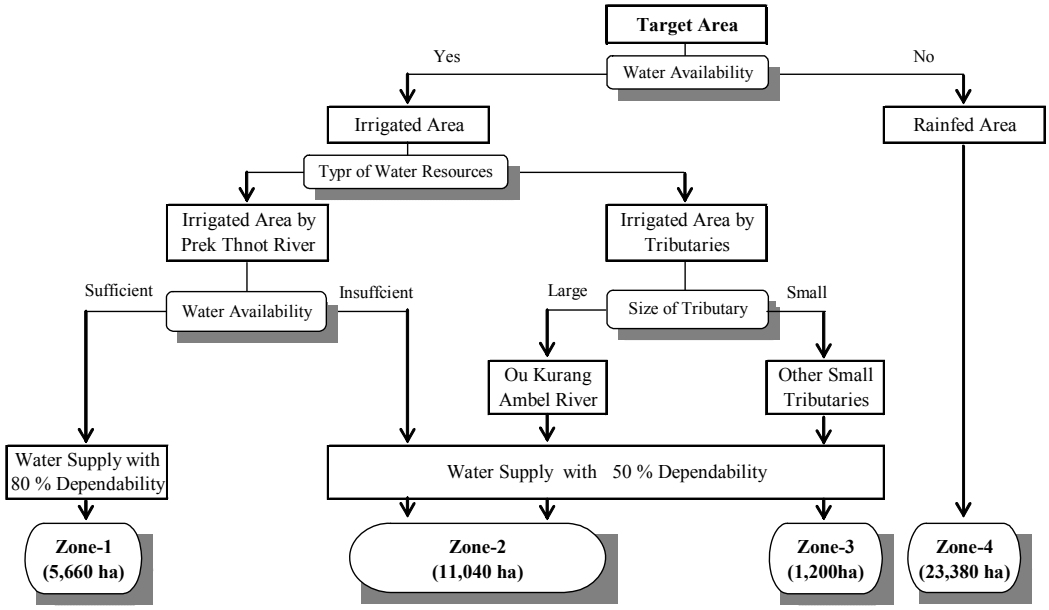
- Preparation of land use assessment map
- Preparation of an assessment map showing the area irrigated by water from the Prek Thnot River and from water harvesting. The area irrigated by the Prek Thnot River is to be divided into two zones showing where water is available with 80% dependablility and 50% dependablity. These dependability calculations consider the maximum use of water from the North Main Canal and the South Main Canal as their excavation has almost been completed.
- Overlaying of these aseessment maps to delineate the rainfed area.

The zoning map which has been prepared in this procedure, is shown in the beginning of this report.

8.4.3 Classified Zones

As the results of zoning, the Target Area was divided into the four zones. The area of each zone, which is a net plan area, is shown below:

Zoning of Target Area



8.5 Framework Formulation for Comprehensive Agricultural Development

8.5.1 Major Causes of Problems/Constraints Identified

As mentioned in Chapters 4 and 5, many problems and constraints for agricultural development were found through the PCM workshop, RRA, socio-economic survey, SWOT analysis and also the site inspection by the JICA study team. These problems and constraints were analyzed and their causes were abstracted. The abstracted major causes have been arranged by classifying them into 3 fields, i.e. agriculture, irrigation and drainage and institutional, which are the pillars supporting the master plan. The results are shown in Table 8.5.1.

Table 8.5.1 Causes to Major Problems/Constraints Identified through Survey and Workshop

	PCM	RRA	Socio-economic Survey	SWOT Analysis	Abstracted Major Causes*
Agriculture	1. No good plans for planting 2. Unfertiled land 3. Use of indigenous knowlidge 4. Lack of quality seeds 5. Lack of technique for rice growing 6. Lack of pesticide 7. Lack of draft animals 8. Inadequate location of rice fields 9. poor soil management 10. Pest/desease of domestic animals	1. High price of fertilizer 2. High price of food 3. Watershed degrdation 4. Low farm income 5. Unstable farm income 6. No agricultural extension services on improved raising practice	1. Insufficient agricultural extension services 2. Lack of quality seeds 3. High price of quality seeds 4. High price of fertilizer 5. High crop lossese due to pest and disease 6. Delayed seed supply 7. Low yield of paddy 8. Poor soil conditions	1.Facing flood anf drought 2. No incorporation of new technique 3. Insufficient support to farmers due to law salary 4. Law technical knowledge of farmers	1. Inappropriate farming practices 2. Insufficient and less coordinated agricultural support services 3. Losses caused by disease and pest for livestock 4. Inappropriate raising practices 5. Seasonal insuffciency of feeds 6. Poor genetic resources/breeds 7. Less developed inland fisheries potentials 8. Limited introduction of fish culture 9. Limited land holding sizes 10. Limitation in income sources 11. Lack of knowledge on agriculture based income generation 12. Limited participation of farmers in servces 13. Limited holding size of livestock 14. Lack of basic knowledge on farming practices under rainfed condition
Irrigation And Drainage	1. Insufficient irrigation systems 2. Drought 3. No maintenance of irrigation systems 4. Natural disaster 5. Improper water allocation	1. Water shortage in the dry season 2. Improper design of canal system 3. No water supply systeme 4. Improper removal of existing irrigation facility 5. Improper location of house 6. Limited water resource 7. Insufficient irrigation system 8. No efficient water management 9. No irrigation extension services 10. No irrigation system	1. Lack of irrigation extension services 2. Irrigation water shortage in rainy season 3. Irrigation water shortage in dry season 4. Insufficient irrigation system	1.Insufficient budget for water resouce development including irrigation system 2. Improper existing irrigation system 3. Insufficient irrigation system 4.Attack of narural disaster 5.No water law	1. Limitation of water resources 2. Poor or lack of of irrigation system 3. Unwareness of necessity of effective water use 4. Lack of basic knowledge on water management 5. Lack of basic knowledge on system maintenance 6. Insufficient water management in irrigation system 7. Insufficient water management at on-farm level 8. Inproper plan and design of irrigation system 9. Insufficient hydro-meteorological data 10. Insufficient communication on flood 11. Deterioration of Roleang Chrey Regulator
Institution		1. Inactive FWUC	1. Insufficient activities of FWUC 2. Less knowledge on FWUC/FWUG	1.Law salary 2.Improoper distribution of work assignment 3.No training program to modernize knowledge 4. No inceptives 5.Lack of physical and financial resources for implementation 6.Low level of officer's expertise 7. Insifficient budget allocation 8.Limitted capacity of accounting, administration and planning 9. Lack of working means 10. Lack of transportation means 11. Small office space 12. Insifficient human resources in rural area	1. Lack or inactivity of FWUC/FWUG 2. Insufficient support of MOWRAM and MAFF to provincial departments 3. Limited capability of provincial departments of MOWRAM and MAFF 4. Poor coordination among stakeholders 5. Lack or less experience in environmental assessment of MOWRAM and MAFF as executing agency. 6. Insufficient experience in plan,, design, construction supervision and O&M works of MOWRAM 7. Limitation of farmers' participation in services

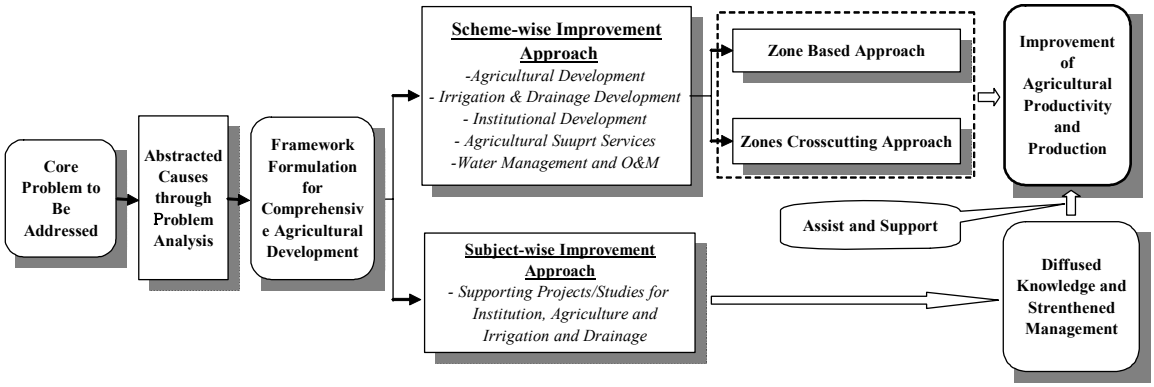
*: *This column shows the major causes abstracted through PCM, RRA, Socio-economic survey, SWOT analysis, and also the site inspection by JICA Study Team.*

8.5.2 Basic Concept

In order to formulate a master plan well fitted to the area conditions, the abstracted causes should guide the preparation of the proposed projects/studies composing the master plan.

As stated in Section 8.2, the master plan program approach should be formulated as an effective way toward attaining the strategic targets. The proposed program approach to a comprehensive agricultural development plan is illustrated below:

Outline of Approach to Comprehensive Agricultural Development



(1) Scheme-wise Improvement

The scheme-wise improvement approach aims at reaping the benefits directly from the projects. The scheme-wise development is divided into the zone based approach and the zone crosscutting approach. In the zone based approach, irrigated agriculture projects for Zones-1 to-3 and rainfed agriculture projects for Zone-4 are formulated aiming at "***improvement of agricultural productivity centering on ric***e" in the Target Area, and eventually contribute to self-sufficiency in rice production in the Target Area. The zone based projects should be implemented through an integrated manner of hardware and software aspects. Thus, the zone based projects should cover the agricultural development, irrigation and drainage improvement, FWUC formation and strengthening, agricultural support services, and water management and O&M strengthening.

In the zone crosscutting approach, development of the livestock sub-sector and fishery sub-sector, which are related to the entire Target Area, are taken up in a comprehensive way. As for the livestock and fishery sub-sectors, their production will be increased by improving the present extensive system without regard to zoning.

In the Target Area, there exist marginal level farmers with limited land holding size although they are not predominant. Income generation for these farmers will also be considered from the viewpoint of poverty alleviation.

(2) Subject-wise Improvement

The subject-wise improvement approach is to support the scheme-wise improvement projects from the technical, institutional, sociological and environmental viewpoints, which is emphasized in Section 8.2. As a result, the subject-wise improvement projects/studies will heighten the effect and sustainability of the scheme-wise improvement projects. In the subject-wise improvement approach, some pilot projects will also be implemented to verify the appropriate technical approach to water management, farming practices and inland fisheries cultivation.

(3) List of Proposed Projects/Studies

As the result of the approaches mentioned above, the projects/studies involved in the master plan are shown below:

List of Scheme-wise Improvement Projects and Subject-wise Improvement Projects

Scheme-wise Improvement		
	Zone Based Projects (Zone-1),	
1	A.1(1)	Irrigated Agricultural Improvement Model Project
2	A.1(2)	Upper North Main Canal Irrigated Agriculture Improvement Project
3	A.1(3)	Upper South Main Canal Irrigated Agriculture Improvement Project
	Zone Based Projects (Zone-2)	
4	A.2(1)	Lower North Main Canal Irrigated Agriculture Improvement Project
5	A.2(2)	Lower South Main Canal Irrigated Agriculture Improvement Project
6	A.2(3)	Ou Krang Ambel Irrigated Agriculture Improvement Project
	Zone Based Project (Zone-3)	
7	A.3(1)	Water Harvesting Irrigated Agriculture Improvement Project
	Zone Based Project (Zone-4)	
8	A.4(1)	Rainfed Agriculture Improvement Project
	Zones Crosscutting Projects	
9	B.1(1)	Roleang Chrey Regulator Gates Urgent Improvement Project
10	B.1(2)	Roleang Chrey Regulator and Intakes Improvement Project
11	B.2(1)	Veterinary Services Strengthening and Livestock Raising Improvement Project
12	B.3(1)	Community Inland Fisheries Development Project
13	B.4(1)	Income Generation Projects for Marginal Farmers
Subject-wise Improvement		
14	C.1(1)	Coordination between MOWRAM and MAFF Stregthening Project
15	C.1(2)	Provincial Departments Strengthening Project
16	C.2(1)	Livestock Sub-sector Development Study
17	C.3(1)	Technical Guidelines Preparation Project
18	C.4(1)	Environmental Management Basic Capacity Development Project
19	C.4(2)	Environmental Management Applied Capacity Development Project
20	C.5(1)	Irrigated Agriculture On-Farm Technology Improvement Pilot Project
21	C.6(1)	Irrigation Facility Maintenance Capacity Strengthening Pilot Project
22	C.7(1)	Rainfed Agriculture Improvement Pilot Project
23	C.8(1)	Community Inland Fisheries Development Pilot Project
24	C.9(1)	River Basin Effective Water Use Awareness Raising Project
25	C.10(1)	Institutional and Agricultural Support Services Strengthening Project
26	C.11(1)	Hydrological Observation Strengthening Project
27	C.11(2)	Flood Forecast and Warning Study

8.5.3 Overall Framework for Comprehensive Agricultural Development

Table 8.5.2 shows the overall framework for comprehensive agricultural development for the Target Area.

Table 8.5.2 Overall Framework for Comprehensive Agricultural Development

Core Problem to Be Addressed	Major Causes abstracted from PCM, RRA, Socio-economic Survey, SWOT and Site Inspection	Approach to Improvement	Proposed Improvement Projects/Studies	Expected Outcome
Unstable and Low Production	**Scheme-wise Improvement**		**Scheme-wise Improvement**	Improvement of Agricultural Productivity Centering on Rice
	Zone-based Approach (Zone 1)		Zone-based Approach (Zone 1)	
	A-1.1 Limitation of water resources	Efficient use of existing water resource	Irrigated Area	
	A-1.2 Poor or lack of irrigation system	Rehabilitation/Improvement/Development of irrigation system	A.1(1) Irrigated Agriculture Improvement Model Project	
	A-1.3 Insufficient water management	Improvement of water management	A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project	
	A-1.4 Inappropriate farming practice	Introduction of improved farming practice	A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project	
	A-1.5 Lack or inactive of FWUC/FWUG	Formation or empowerment of FWUC/FWUG		
	A-1.6 Insufficient and less coordinated agricultural support services	Strengthening & coordination of agricultural support services		
	Zone-based Approach (Zone 2 and 3)		Zone-based Approach (Zone 2)	
	A-2.1 Limitation of water resources	Efficient use of existing water resource	Irrigated Area	
	A-2.2 Poor or lack of irrigation system	Rehabilitation/Improvement/Development of irrigation system	A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project	
	A-2.3 Insufficient water management	Improvement of water management	A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project	
	A-2.4 Inappropriate farming practice	Introduction of improved farming practice	A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project	
	A-2.5 Low land use intensity	Introduction of crop diversification	Zone-based Approach (Zone 3)	
	A-2.6 Lack of or inactive FWUC/FWUG	Formation or empowerment of FWUC/FWUG	Irrigated Area	
	A-2.7 Insufficient and less corrodinated agricultural support services	Strengthening & coordination of agricultural support services	A.3(1) Water Harvesting Irrigated Agriculture Improvement Project	
	Zone-based Approach (Zone 4)		Zone-based Approach (Zone 4)	
	A-4.1 Limitation of water resources	Efficient use of existing water resource	Rainfed Area	
	A-4.2 Inappropriate farming practice	Introduction of improved farming practice	A.4(1) Rainfed Agriculture Improvement Project	
	A-4.3 Lack or inactive of FWUC/FWUG	Formation or empowerment of FWUC/FWUG		
	A-4.4 Insufficien & less corrodinated agricultural support services	Strengthening & coordination of agricultural support services		
	Zones Crosscutting Approach		Zones Crosscutting Approach	
	B-1.1 Deterioration of Roleang Chrey Regulator	Improvement of Roleang Chrey Regulator	B.1(1) Roleang Chrey Gates Urgent Improvement Project	
			B.1(2) Roleang Chrey Regulator and Intakes Improvement Project	
	B-2.1 Losses caused by disease and pest	Strengthening of veterinary services	B.2(1) Veterinary Services Strengthening and Live stock Raising Improvement Project	
	B-2.2 Inappropriate raising practices	Intrpduction of improved raising practices		
	B-3.1 Less development inland fisheries potentials	Introduction of inland fishries in stored water	B.3(1) Community Inland Fisheries Development Project	
	B-3.2 Limited introduction of fish culture	Introduction of small scale fish culture		
Existence of Marginal Level Farmers	B-4.1 Limited land holding size	Introduction of agriculture based income generation methods	B.4(1) Income Generation Projects for Marginal Farmers	Imcome Increase of Marginal Level Farmers
	B-4.2 Limited holding size of livestock			
	B-4.3 Limitation in income sources			
Lack of Fundamental Knowledge and Ineffective Management for Agricultural Development	**Subject-wise Improvement**		**Subject-wise Improvement**	Diffused Fundamental Knowledge and Strengthened Management for Agricultural Development
	C-1.1 Insufficient coordeination between MOWRAM and MAFF	Strengtheing of coordination between MOWRAM and MAFF	C.1(1) Coordination between MOWRAM and MAFF Strengthening Project	
	C-1.2 Limited capability of provincial departments	Strengthening of provincial departments	C.1(2) Provincial Departments Strengthening Project	
	C-2.1 Seasonal insufficiency of feeds	Identification of development potential	C.2(1) Livestock Sub-sector Development Study	
	C-2.2 Poor genetic resources/breeds	Identification of development potential		
	C-3.1 Improper plan and design of irrigation system	Capacity development of technical knowledge on planning and design of irrigation system	C.3(1) Technical Guidelines Preparation Project	
	C-4.1 Lack or less experience in environmental assessment of MAFF and MOWRAM as executing agency	Capacity development of staff of MAFF and MOWRAM on envirionmental asseessment	C.4(1) Environmental Management Basic Capacity Development Project	
			C.4(2) Environmental Management Applied Capacity Development Project	
	C-5.1 Lack of basic knowledge on water management	Establishment of water management system through model project	C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project	
	C-6.1 Lack of basic knowledge on system maintenance	Establishment of maintenanace system through model project	C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project	
	C-7.1 Lack of basic knowledge on farming practice under rainfed condition	Establishment of proper farming practice under rainfed condition	C.7(1) Rainfed Agriculture Improvement Pilot Project	
	C-8.1 Lack of knowledge on agriculture based income generation	Establishment of appropriate agriculture based income generation	C.8(1) Community Inland Fisheries Development Pilot Project	
	C-9.1 Unawareness of necessity of effective water use	Awareness raising of effective water use	C.9(1) River Basin Effective Water Use Awareness Raising Project	
	C-10.1 Insufficient agricultural support services	Establishment of institutional responsible for agricultural productivity improvement and strengthening agricultural support services	C.10(1) Institutional and agricultural Support Services Strengthening Project	
	C-10.2 Less coordinated agricultural support services			
	C-10.3 Limitation of farmers' participation in services			
	C-10.4 Poor coordination among stakeholders			
	C-10.5 Lack or inactivity of FWUC/FWUG			
	C-11.1 Insufficient hydrometeorological data	Strengthened observation system on hydrological data	C.11(1) Hydrological Observation Strengthening Project	
	C-11.2 Insufficient communication on flood	Strengthened pre-information system on flood	C.11(2) Flood Forecasting and Warning Study	

8.6 Development Objectives and Strategies for Scheme-wise Improvement

8.6.1 Zone-1 Development

(1) Development Objectives and Plan

The development objective of Zone-1 is to improve the agricultural productivity by well-harmonized development of agriculture, irrigation and drainage and the relevant institutions. As the targeted indexes, the following are proposed:

Proposed Cropping Pattern and Intensity

The proposed cropping pattern in Zone-1 is illustrated in Figure 8.6.1 and summarized in the following table.

Proposed Cropping Pattern & Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	**Area (Intensity)**	**Crop**	**Area (Intensity)**	**Crop**	**Area (Intensity)**
Early Rice	500ha (9%)	Early Rice	500ha (9%)	Early Rice	1,000ha (18%)
		Medium Rice	5,160ha (91%)	Medium Rice	5,160ha (91%)
Upland Crops	280ha (5%)			Upland Crops	280ha (5%)
Total	780ha (14%)		5,660ha (100%)		6,440ha (114%)

Target Crop Yields

The target crop yields under the development plan are set as shown in Table 8.6.2 and in the following table in comparison with the present yield levels.

Target Yields and Present Yield Levels

Early Rainy Season				Rainy Season			
Crop	**Yield (t/ha)**			**Crop**	**Yield (t/ha)**		
	Target	**Present**	**Increment**		**Target**	**Present**	**Increment**
Early Rice	3.30	2.40	0.90	Early Rice	3.30	-	-
Upland Crops	0.70	0.45	0.25	Medium Rice	3.00	2.10	0.90

Upland crops are represented by mungbeans; medium rice under supplemental irrigation

(2) Agricultural Development

Assumptions on the Present and Without-Project Agricultural Development Conditions

The present and without-project[1] agricultural development conditions in Zone-1 are assumed based on: i) the findings of the present agricultural study, ii) the results of the Irrigation Inventory Survey, iii) the results of the water balance study and iv) the statistical data of SEILA, MAFF and PDAs as shown together with the with-project condition in Table 8.6.1 and as follows;

Assumptions on the Present and Without-Project Agricultural Development Status

Land Use			
Category	**Present/Without-Project**	**With-Project**	**Increment**
Paddy Field	5,710	5,660	-50
Right of Ways	-	50	50
Total	5,710	5,710	0
Irrigation Status			
Irrigated [1/]	500	500	0
Supplementary [2/]	3,490	5,160	1,670
Rainfed	1,720		-1,720
Total	5,710	5,660	-50

[1/]: Irrigated paddy field; irrigation water available for double cropping of rice

[2/]: Supplementary irrigated paddy field in the rainy season; water supply only for rainy season

[1] *Without-project conditions before the functional failure of the Roleang Chery Regulator*

Development Strategies

1) Improvement of productivity and increased production of rice is envisaged through the introduction of: i) a double cropping pattern for early rice to a limited extent and a single cropping of medium rice in the rainy season in the rest of the project area as shown in the proposed cropping pattern illustrated in Figure 8.6.1 and ii) improved farming and irrigation practices formulated on the basis of current farming practices which represent, to a certain extent, the capabilities of farming communities, farming constraints and farmers' expectations,

2) Improvement of productivity and increased production of rice is envisaged through the introduction of improved farming practices supported by the strengthening of agricultural support services employing the farmer participatory concept,

Proposed Farming Practices

The proposed farming practices for rice are presented in Table 8.6.4. Major improvements envisaged from the current prevailing practices are: i) proper land leveling & preparation, ii) use of quality seed, iii) raised nursery beds, iv) planting of young seedlings, v) regular planting, vi) reduced no. of plants per hill, vii) fertilization (increased & timely application including compost or cow dung), viii) shallow irrigation aiming at introduction of water saving cultivation, ix) intensified weeding.

3) Introduction of water saving rice cultivation methods availing the expansion of the areas to be irrigated to the fullest extent possible through the efficient utilization of valuable water resources, and

4) The introduction of upland crop/vegetable production in about 5% of the project area in the early rainy season to increase land use intensity and promote crop diversification.

(3) Irrigation and Drainage Development

Development Strategies

To attain the objective of Zone-1, for irrigation and drainage the following strategies will be employed:

1) Maximum Use of Existing Facilities

In Zone-1, the main canal and secondary canal covering the Zone-1 area were constructed under the Western Phnom Penh Integrated Development Center Project, so that these existing facilities should be used as much as possible, to save construction cost and to continue its development concept.

2) Minimum Rehabilitation/Improvement Works

The existing canals are excavated canals with comparatively large sections as compared with the required discharge. These canals should be rehabilitated and/or improved in the most economical way possible. As for the additional structures, the number should be minimized through the site inspections followed by proper hydrological design.

3) Use of Suitable Borrow Materials for Canal Embankments

Some parts of the existing canals have been constructed using unsuitable soil, like dispersible soil, so that severe soil erosion has occurred. Such portions should be rehabilitated using suitable borrow materials, although the suitable excavated soils should be used for rehabilitation and/or improvement where possible. In addition, sod-facing should be provided for the embankment portion to prevent soil erosion.

4) Application of Gravity Method

The water level in most canals is lower than the ground level of the paddy fields so that irrigation water could not be supplied to the paddy fields by gravity. The portable pump irrigation system limits the irrigation area and produces higher operation cost. In this Study, gravity irrigation systems are planed by raising the water level in the canals through the provision of additional check structures.

5) Appropriate Density of Minor Canals

In order to supply irrigation water to each field from canals smoothly and effectively, the density of minor canals such as tertiary canals and watercourses should be increased, say to 30m/ha.

6) Use of Natural Small Streams and Degraded Area as Drainage

There are many natural small streams and degraded areas in the Zone-1 area. These are to be used as natural drains to minimize cost.

7) Application of Simple Measuring Device

Measuring device is essential for proper water management. Since FWUC has no experience in systematic water management, a simple measuring device should be applied.

(4) FWUC Formation and Strengthening

Development Strategies

Zone-1 is located on the upstream side of the existing North and South Main Canals, and is comparatively blessed with irrigation water. The number of existing FWUC is larger than that in other Zones. However, their activities, such as water management and O & M at the minor canal level, do not reach a satisfactory level. To attain the objective mentioned above, the following strategies should be implemented for FWUC formation and strengthening in Zone-1:

1) Precise Structure and Responsibilities

Presently, the canal system is not completed, so that the responsibilities of the FWUC are not clear although the "Policy for Sustainability of Operation and Maintenance Irrigation System, June 2000" is available. After completion of proper irrigation systems, the following structure and responsibilities are proposed:

Proposed Structure and Responsibilities

In-charge	Canal Level	Responsibilities
Government	Main Canal	Maintenance of Main Canal and control of gates to Secondary Canal
FWUC	-	-
FWUG	Secondary Canal	Maintenance of Secondary Canal and control of gates to Tertiary Canal
Sub-FWUG	Tertiary Canal	Maintenance of Tertiary Canal and control of gates to Watercourse
WUG	Watercourse	Maintenance of Watercourse and control of water distribution to each field

2) Formation of FWUC, FWUG and WUG Considering Tragic History

Formation of FWUC, FWUG, Sub-FWUG and WUG should be carried out carefully keeping the tragic history in mind. The results of various surveys have made it clear that Village Chiefs, Commune Chiefs/Councils and VDC members are playing important roles for smooth formation of the farmer organizations. Village Chiefs, Commune Chiefs/Councils and VDC members are representatives selected from the village people. This is one of the reasons for their success. Formation/strengthening of FWUC, FWUG,Sub-FWUG and WUG should therefore involve them from the beginning stage.

3) Clear Sharing of Roles of FWUC, FWUG and WUG

The proposed roles of FWUC, FWUG and WUG are as follows:

Name of Organization	Membership	Activities
FWUC	• Farmers' representatives from various levels of the irrigation operational system	• Adhering to the decisions made by the steering committee of FWUC
Steering committee of the FWUC	• Leaders of FWUGs • Secretary • Accountant	• Solving water conflicts as a federation of FWUGs • Preparation of Irrigation Service Plan
FWUG	• FWUG members	• Attending general meetings • Execution of O&M of secondary canal system
Steering committee of the FWUG	• Leaders of Sub-FWUGs • Secretary • Accountant	• Preparation of O&M plan of secondary canals • Convening FWUG members for general meetings
Sub-FWUG	• Leaders of WUGs	• Preparation of O&M plan of tertiary canal • Execution of O&M plan of tertiary canals
WUG	• Land owners/tenants whose land	• Discussing and determining the turns

	is located in the irrigated area	of irrigation water use • Removal of sediments and the other obstacles in watercourses • Collection of ISF from WUG members under FWUC

4) Timely Participation of Beneficial Farmers

Participation of beneficial farmers should be made from the design stage in order to ensure their awareness of the project. Canal layout should be determined under the mutual understanding of the government and beneficial farmers through workshops including Village Chiefs, Commune Chiefs/Councils and VDC members.

5) Participation of Beneficiary Farmers at Construction Stage

WUG should construct the watercourses under the technical support of PDOWRAM. This activity should also be undertaken with mutual understanding established through workshop including Village Chiefs, Commune Chiefs/Councils and VDC members.

6) Collection of Irrigation Service Fees

Collection of ISF should be made based on the water request form in which name of farmers, plot area, amount to be paid, kind of crops, and WUG No. should be mentioned. This water request form should be given his finger print, signed by WUG leader and approved by FWUC leader. Each farmer should pay ISF to WUG leader based on this water request form.

(5) Agricultural Support Services

Development Strategies

The agricultural support services require for the promotion of adoption of the proposed farming practices and for attaining the project target cropping patterns, cropping intensity and crop yields at the earliest possible stage are as follows:

Required Agricultural Support Services

Activity	Program Required
Field Extension Programs	Rice: Plot & area demonstration, adaptability test, seed multiplication Upland crops: plot demonstration and adaptability test
Farmer/Farmer's Group Training Programs	Training programs, farmer field schools, study tours, village extension agent training & deployment
Mass Guidance/Workshops	Mass guidance/workshops
Farmer-to-farmer Extension Support [1/]	Farmer-to-farmer extension support
Staff Empowerment	Staff training, study tours

[1/]: *Provision of support for farmer-to-farmer extension by village extension agents*

As shown in the table, the introduction of village extension agents like Village Livestock Agents (VLA) is envisaged as farmer-to-farmer extension providers.

(6) Water Management and O&M

Development Strategies

1) Overall Water Management

The irrigated area in the Target Area is divided into two categories; the upper irrigated area with an 80% dependable water supply and the lower irrigated area with a 50% dependable water supply. Water allocation for these areas should be carried out in the combinations shown in the following table:

Combinations of Water Allocation for Upper and Lower Irrigated Areas

Pattern of Water Supply	Upper Irrigated Area with 80% Dependable Water Supply	Upper Irrigated Area with 50% Dependable Water Supply
Case-1	Guaranteed	Guaranteed
Case-2	Guaranteed	Not Guaranteed
Case-3	Not Guaranteed	Not Guaranteed

2) Need of Close Communication between Government and FWUC

Water management and O&M should be executed in a timely manner keeping the irrigation calendar in mind. This means that responsibilities should be properly allocated by the government and the FWUC. Close communication between both should be implemented accordingly.

3) Need of Support from MAFF

Farmers did not show the high interest in water management since they did not precisely know that proper water management closely connected with high crop production. Therefore, dissemination of proper water management should require the support from MAFF.

4) Water Management for the Main Canal and Secondary Canals

Taking into account the size of command area, existing capacity of main canal, secondary canals and related structures, the continuous water supply method is applied for the main and secondary canals.

5) Water Management for Tertiary Canals and Watercourses

In order to minimize losses and to make timely and even water distribution, a rotational water supply is applied along tertiary canals and watercourses.

6) O&M Cost

Cost responsibility for O&M and emergency repairs of the canals and related structures below main canals should be carried out in the following stepwise manner since the beneficial farmers could not pay them from the beginning.

Share of O&M Cost

Year after completion	Government	Beneficiary Farmers
One	80%	20%
Second	60%	40%
Third	40%	60%
Fourth	20%	80%
After Fifth	0%	100%

8.6.2 Zone-2 Development

(1) Development Objective and Plan

The development objective of Zone-2 is the same with that of Zone-1. However, the targeted indexes are different due to the difference in the availability of water. The following are the proposed target indexes for Zone-2:

1) Proposed Cropping Pattern and Intensity

The proposed cropping pattern in Zone-2 is shown in Table 8.6.2 and Figure 8.6.1 and summarized in the following table.

Proposed Cropping Pattern & Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	Area (Intensity)	Crop	Area (Intensity)	Crop	Area (Intensity)
Early Rice	1,600ha (14%)			Early Rice	1,600ha (14%)
		Medium Rice	11,040ha (100%)	Medium Rice	11,0400ha (100%)
Upland Crops	550ha (5%)			Upland Crops	550ha (5%)
Total	2,150ha (19%)		11,040ha (100%)		13,190ha (119%)

2) Target Crop Yields

The target crop yields under the development plan are set as shown in Table 8.6.2 and the following table in comparison with the present yield levels.

Target Yields and Present Yield Levels

Early Rainy Season				Rainy Season			
	Yield (t/ha)				Yield (t/ha)		
Crop	Target	Present	Increment	Crop	Target	Present	Increment

Early Rice	3.30	-	-	Early Rice	-	-	-
Upland Crops	0.64	0.45	0.19	Medium Rice	2.90	2.10	0.80

Upland crops are represented by mungbeans; medium rice under supplemental irrigation

(2) Agricultural Development

Assumptions on the Present and Without-Project Agricultural Development Conditions

The present and without-project agricultural development conditions in Zone-2 have been assumed similarly to Zone-1 as shown together with the with-project condition in Table 8.6.1 and as follows;

Assumptions on the Present and Without-Project Agricultural Development Status

Land Use			
Category	**Present/Without-Project**	**With-Project**	**Increment**
Paddy Field	11,210	11,040	-1,700
Right of Ways	-	170	170
Total	11,210	11,2100	0
Irrigation Status			
Irrigated [1/]		(1,600) [3/]	(1,600) [3/]
Supplementary [2/]	1,710	11,040	9,330
Rainfed	9,500		-9,500
Total	11,210	11,040	-170

[1/]: *Irrigated paddy field; irrigation water available for double cropping of rice*

[2/]: *Supplementary irrigated paddy field in the rainy season; water supply only for rainy season*

[3/]: *Area irrigable in early rainy season is 3,200ha at 50% dependability; annual irrigated area is assumed to be 1,600ha (50%) for the present planning purpose*

The water balance study indicates the possibility of irrigation water supply to an area of 3,200ha in the early rainy season at 50% dependability. For the present planning purpose, annual irrigable area in this season is assumed to be 50% or 1,600ha as shown in the table.

Development Strategies

The strategies established for the attainment of the said development objectives in Zone-2 are similar to the case of Zone-1 and include:

1) Improvement of productivity and increased production of rice is envisaged by the introduction of: i) early rice to a limited extent in the early rainy season once in 2 years in accordance with the result of the water balance study (irrigable at 50% dependability) and a single cropping of medium rice over the entire area in the rainy season as shown in the proposed cropping pattern illustrated in Figure 8.6.1 and ii) improved farming and irrigation practices,

2) Improvement of productivity and increased production of rice is envisaged through the introduction of improved farming practices supported by the strengthening of agricultural support services to initiate the farmer participatory concept,

> Proposed Farming Practices
>
> The proposed farming practices for rice are presented in Table 8.6.4. Major improvements envisaged from the current prevailing practices are similar to those proposed for Zone-1.

3) Introduction of water saving rice cultivation methods availing expansion of irrigation areas to the greatest extent possible, and

4) Introduction of upland crop/vegetable production in about 5% of the project area in the early rainy season to increase land use intensity and promote crop diversification.

(3) Irrigation and Drainage Development

Development Strategies

The development strategies for Zone-2 are similar to those for Zone-1. However, irrigation supply is less than Zone-1 because irrigation water could not be provided with a 50% dependability although it will be an improvement over the current situation. Application of rotational irrigation is one of the alternatives for the non-guaranteed year from the viewpoint of effective water use.

(4) FWUC Formation and Strengthening

Development Strategies

Zone-2 is also an irrigated agriculture area. Formation and strengthening of FWUC should be carried out in the same manner as Zone-1. However, Zone-2 will face the problems of limited water for irrigation, namely a 50% dependable water supply. Therefore, more careful attention should be paid to the efficient use of irrigation water. Strict rotational irrigation should be applied at the on-farm level under technical support of PDOWRAM. To minimize the conveyance losses in the canals, realization of proper O&M will be one of the important duties for FWUC.

(5) Agricultural Support Services

Development Strategies

The agricultural support services required for the promotion of the proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an early stage are similar to Zone-1 as follows;

Required Agricultural Support Services

Activity	Program Required
Field Extension Programs	Rice: Plot & area demonstration, adaptability test, seed multiplication Upland crops: plot demonstration and adaptability test
Farmer/Farmers' Group Training Programs	Training programs, farmer field schools, study tours, village extension agent training & deployment
Mass Guidance/Workshops	Mass guidance/workshops
Farmer-to-farmer Extension Support [1/]	Farmer-to-farmer extension support
Staff Empowerment	Staff training, study tours

[1/]: Provision of support for farmer-to-farmer extension by village extension agents

(6) Water Management and O&M

Development Strategies

The development strategies for Zone-2 are similar to those for Zone-1. However, as mentioned in "irrigation and drainage development", a rotational irrigation method should be considered for the non-guaranteed years. In order to implement the rotational irrigation successfully, FWUCs are required to maintain good communication among them.

8.6.3 Zone-3 Development

(1) Development Objective and Plan

The development objective of Zone-3 is the same with that of Zone-1. However, the targeted indexes are different due to the more severe water environment. The following are proposed target indexes for Zone-3:

1) Proposed Cropping Pattern and Intensity

The proposed cropping pattern in Zone-3 is shown in Table 8.6.2 and in Figure 8.6.1, and summarized in the following table.

Proposed Cropping Pattern & Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	Area (Intensity)	Crop	Area (Intensity)	Crop	Area (Intensity)
		Medium Rice	1,200ha (100%)	Medium Rice	1,200ha (100%)
Upland Crops	60ha (5%)			Upland Crops	60ha (5%)
Total	60ha (5%)		1,200ha (100%)		1,260ha (105%)

2) Target Crop Yields

The target crop yields under the development plan are set as shown in Table 8.6.2 and the following table in comparison with the present yield levels.

Target Yields and Present Yield Levels

Early Rainy Season	Rainy Season

Crop	Yield (t/ha)			Crop	Yield (t/ha)		
	Target	Present	Increment		Target	Present	Increment
Upland Crops	0.64	0.45	0.19	Medium Rice	2.90	2.10	0.80

Upland crops are represented by mungbeans; medium rice under supplemental irrigation

(2) Agricultural Development

Assumptions on the Present and Without-Project Agricultural Development Conditions

The present and without-project agricultural development conditions in Zone-3 have been assumed in the same manner as Zone-1 and Zone-2 as shown together with the with-project condition in Table 8.6.1 and as follows;

Assumptions on the Present and Without-Project Agricultural Development Status

Land Use			
Category	**Present/Without-Project**	**With-Project**	**Increment**
Paddy Field	1,200	1,200	0
Irrigation Status			
Supplementary [1/]	600	1,200	600
Rainfed	600		-600
Total	1,200	1,200	0

[1/]: Supplementary irrigated paddy field in rainy season; water supply only for rainy season

Development Strategies

The strategies established for the attainment of the said development objectives in Zone-3 are similar to the cases of Zones-1 and -2 and include:

1) Improvement of productivity and increased production of rice is envisaged through the introduction of improved farming and irrigation practices,

> Proposed Farming Practices
>
> The proposed farming practices for early and medium rice are presented in Table 8.6.4. Major improvements envisaged from the current prevailing practices are similar to those proposed for Zones-1 and -2.

2) Improvement of productivity and increased production of rice is envisaged by the strengthening of agricultural support services utilizing the farmer participatory concept,
3) Introduction of water saving rice cultivation methods availing the expansion of the irrigation areas to the greatest extent possible, and
4) Envisaging the introduction of upland crops/vegetable production in about 5% of the project area in the early rainy season to increase land use intensity and promote crop diversification.

(3) Irrigation and Drainage Development

Development Strategy

1) Minimized Investment Cost

Development strategies for Zone-3 are similar to those for Zone-2. However, the benefits accrued from this system are limited, therefore, investment costs should be minimized. To lower the development level is one of the alternatives.

2) Active Application of Farmers Participation

This system is mostly small-scaled, say less than 50 ha. This means that the required irrigation and drainage works would generally be small in size. These works might be completed by farmers if proper technical support is given by the government, therefore farmers participatory should be strengthened.

3) Collection of Rainfall Data

Irrigation in Zone-3 largely depends on rainfall condition. In case of less rainfall, the reservoir could not be filled with rain water, so that water supply could not be successfully made for paddy fields even though the definite irrigation service plan is prepared. Thus, prior collection of rainfall data is essential for irrigation development in Zone-3.

4) Multi-use of Reservoir Water

Reservoir water in Zone-3 is used not only for irrigation, but also for domestic and animal drinking purpose since there are no other suitable water resources nearby. Water use from the reservoir should be therefore planned considering such multi-use of reservoir water.

(4) FWUC Formation and Strengthening

Development Strategy

Zone-3 area is irrigated by water harvesting. Irrigation systems consist of reservoir and small supply canals. Formation and strengthening of FWUC should be carried out in the same manner with in Zone-1. However, irrigation systems in Zone-3 are small-scaled and could mostly be controlled by farmers alone, so that FWUC formation and strengthening should be required.

(5) Agricultural Support Services

Development Strategy

The agricultural support services required for the adoption of the proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an early stage are as follows;

Required Agricultural Support Services

Activity	Program Required
Field Extension Programs	Rice: Plot & area demonstration, adaptability test, seed multiplication Upland crops: plot demonstration and adaptability test
Farmer/Farmers' Group Training Programs	Training programs, farmer field schools, study tours, village extension agent training & deployment
Mass Guidance/Workshops	Mass guidance/workshops
Farmer-to-farmer Extension Support [1/]	Farmer-to-farmer extension support
Staff Empowerment	Staff training, study tours

[1/]: *Provision of support for farmer-to-farmer extension by village extension agents*

(6) Water Management and O&M

Development Strategy

1) Water Supply based on Growing Stages of Paddy

Zone-3 has a limited amount of water available, therefore, irrigation water would only be guaranteed in the rainy season. Hence, water management should be planned in consideration of physiological characteristic of paddy and storage condition of reservoir. According to the physiological characteristic of paddy, the following periods require water indispensably:

- About 10 days after transplanting for rooting
- About 10 days at panicle initiation stage around 65 days before harvesting
- About 10 days at flowering/heading stage around 30 days before harvesting

Since the irrigation facilities are generally small-scaled, O&M for them should be conducted by FWUC under technical support of PDOWRAM.

8.6.4 Zone-4 Development

(1) Development Objective and Plan

The study on the development approaches directed to Zone-4, which consists of rainfed paddy fields, has resulted in ambitious proposals and will present a number of controversial issues. However, for the attainment of the master plan target of improvement of agricultural productivity in the Target Area, the improvement of rainfed agriculture should be duly sought through the integrated interventions of agronomic, extension and farmer organizational approaches. The following are proposed target indexes for Zone-4:

1) Proposed Cropping Pattern and Intensity

The proposed cropping pattern in Zone-4 is shown in Table 8.6.2 and in Figure 8.6.1 and summarized in the following table.

Proposed Cropping Pattern & Intensity

Early Rainy Season		Rainy Season		Annual	
Crop	Area (Intensity)	Crop	Area (Intensity)	Crop	Area (Intensity)
		Medium Rice	23,380ha (100%)	Medium Rice	23,380ha (100%)
Upland Crops	230ha (1%)			Upland Crops	230ha (1%)
Total	230ha (1%)		23,380ha (100%)		23.610ha (101%)

2) Target Crop Yields

The target crop yields under the development plan are set as shown in Table 8.6.2 and the following table in comparison with the without-project yield.

Target Yields and Present Yield Levels

Early Rainy Season				Rainy Season			
Crop	Yield (t/ha)			Crop	Yield (t/ha)		
	Target	Present	Increment		Target	Without [1/]	Increment
Upland Crops	0.45	-	-	Medium Rice	2.00	1.50	0.50

[1/]: Present yield level 1.2 t/ha; *Upland crops represented by mungbeans*

(2) Agricultural Development

Development Strategies

The strategies established for the attainment of the said development objectives in Zone-4 include:

1) Improvement of productivity and increased production of rice is envisaged by the introduction of improved farming practices; in this regard, the expansion of modified SRI in Kampong Speu Province as proposed earlier and the promising results obtained in the SRI fields as shown in Table 8.6.3 indicate the possibility of the attainment of the objectives,

2) Improvement of productivity and increased production of rice supported by the strengthening of

> Proposed Farming Practices
>
> The proposed farming practices are presented in Table 8.6.4. Major improvements from the current prevailing practices envisaged are: i) proper land leveling & preparation, ii) heightening of bound, iii) use of quality seed, iv) raised nursery bed, v) planting of young seedlings, vi) regular planting, vii) reduced no. of plants per hill, viii) fertilization (increased & timely application including compost or cow dung), and ix) intensified weeding. Major improvements from the current prevailing practices envisaged are similar to those proposed for Zone-1 to 3. However, the introduction of the modified SRI disseminated in Kampong Speu, which covers most of the said proposed farming practices, is proposed after further adaptability tests and accommodating site specific requirements in farming practices.

agricultural support services is envisaged (the approach for strengthening includes training and deployment of village agriculture agents),

3) The introduction of upland crop/vegetable production in the early rainy season to a very limited extent in a pilot scale as a trial step for crop diversification in the future,

4) In the present Study, the development intervention is formulated as the "Rainfed Agriculture Improvement Project", and

5) The proposed intervention is the strengthening of agricultural support services in the zone implemented by MAFF/PDA in collaboration with NGOs and supported by experts.

In the present Study, the development intervention is formulated as the "Rainfed Agriculture Improvement Project".

(3) Farmers Organization Formation

Development Strategies

To attain the objective mentioned above, Farmers Organization (FO) should be established in the following manner:

1) Identify the leading farmers is essential for successful extension of agricultural techniques in the villages
2) Extend the techniques to the other farmers in the villages by leading farmers who are trained
3) Form FO at the same time as the start of rainfed agricultural development
4) Do not force the farmers to become members. If farmers do not want to be members, a study tour would be helpful for promotion of FO membership.
5) Promote FO to "Agricultural Cooperatives" under the coordination of MAFF for its sustainability

(4) Agricultural Support Services

Development Strategies

The agricultural support services required for adopting the proposed farming practices and for attaining the project target at an early stage are as follows;

Required Agricultural Support Services

Activity	Program Required
Field Extension Programs	Rice: Plot & area demonstration, adaptability test, seed multiplication Upland crops: plot demonstration and adaptability test
Farmer/Farmers' Group Training Programs	Training programs, farmer field schools, study tours, village extension agent training & deployment
Mass Guidance/Workshops	Mass guidance/workshops
Farmer-farmers' Extension Support [1/]	Farmer-farmers' Extension Support
Staff Empowerment	Staff training, study tours

[1/]: Provision of support for farmer-farmer

Agricultural support services required in the Zone-4 development are similar to those for the other zones, however, intensive and farmer participated deliveries of such services will be essential for the attainment of the target productivity improvement in the zone.

8.6.5 Zone Crosscutting Development

(1) Roleang Chrey Regulator Gates Urgent Improvement

Development Objective

The objective of the improvement is to ensure proper gate operation for irrigation water supply and flood water.

Development Strategies

To carry out the objective mentioned above, the following are to be implemented:

1) Application of minimum repairs as a temporary treatment to maintain proper water abstraction and flood control for the time being
2) Execution of repairs during the rainy season so as not to interfere with the current irrigation water supply

(2) Roleang Chrey Regulator and Intakes Improvement

Development Objective

The objective of the improvement is to stabilize the supply of irrigation water to the main canals by improving the Roleang Chrey Regulator and Intake Gates.

Development Strategies

The Roleang Chrey Regulator and Intakes were constructed about 30 years ago, so that they are now deterorated. As the proposed strategies for improvement work, the following are proposed:

1) Improvement of Roleang Chrey Regulator should be of an extent and quality that will provide for another 50 years of service life.
2) Simultaneously, the two intake structures should be improved.
3) To realize efficient water management, a communication system between the Roleang Chrey Regulator

site and both intake structure sites should be established in as simple a way as possible.

4) Gate operation of the Roleang Chrey Regulator should be made based on the operation manual.

5) A bypass should be provided at the Roleang Chrey Regulator to ensure that the required water for downstream side will be provided.

(3) Veterinary Services Strengthening and Livestock Raising Improvement

Development Objective

The captioned development intervention is formulated with the aim of stabilization of livestock productivity in the Target Area through the improvement of veterinary services and livestock raising practices. For attaining the said objective the development approaches taken are to recruit new Village Livestock Agents (VLAs) or empower existing VLAs in each village as providers of animal health and livestock extension services for strengthening of the same in the Target Area.

Development Strategies

The development strategies of the intervention are to be established considering the basic development directions addressing the problems and constraints of the livestock sub-sector development as follows:

1) Primary development constraints in the sub-sector are animal/poultry losses or the high mortality rate caused by diseases due to insufficient veterinary services coverage and poor livestock raising practices. Strengthening of animal health and extension services through the involvement of farmers in the delivery of services such as the Village Livestock Agent (VLA) as currently introduced in the Target Area are to be implemented for the stabilization of productivity.

2) However, SLPP target districts are excluded from the project area due to similar activities under SLPP.

Scope of Intervention

The main scopes of the intervention are as follows;

Target Area	Chbar Mon (Kampong Speu), Kandal Stueng & Angk Snuol (Kandal)
Target Group	Existing VLAs and VLA candidates in the project target area
Major Project Activities Envisioned	- Training or refresher training of VLA candidates & existing VLAs - Field demonstrations on improved livestock raising

(4) Community Inland Fisheries Development

Development Objective

The development approaches are to be established with the aim of promoting inland fish culture in the water bodies of the Water Harvesting Irrigated Agriculture Improvement Project and with the aim of raising common funds for the FWUC responsible for the O&M of the subject irrigation system.

Development Strategies

The development strategies for the intervention have been established considering the basic development directions addressing problems and constraints for the inland fisheries sub-sector development as follows;

1) For the utilization of valuable existing or newly developed water bodies, the development of community based inland fish culture is envisaged. Target areas for the development are reservoirs for the "Water Harvesting Irrigated Agricultural Improvement Project" of the present Study and the groups of beneficiaries (FWUCs) of irrigation development who are responsible for O&M of the irrigation systems will be the target groups. Returns from the development are to be utilized as a source of funds for the required O&M of the irrigation systems, and

2) Prior to the start of development activities, a detailed inventory survey of the target reservoirs is essential to clarify whether any current water uses, water and fishing rights or other rights do or do not conflict with the present development intervention. □

Scope of Intervention

The main scopes of the intervention are:

Target Reservoirs	49 reservoirs of the Water harvesting Irrigated Agricultural Improvement Project (to be free from flooding throughout a year)
Target Group	FWUCs of the target ponds
Major Project Activities Envisioned	- Technical guidance to the FWUC - Provision of fingerlings, fish nets & boats

(5) Income Generation for Marginal Farmers

Development Objective

Poverty reduction is the primary development goal of Cambodia and the National Poverty Reduction Strategy (NPRS) dictates the improvement of the agricultural sector and the enhancement of assistance to farmers as the backbone of poverty reduction, which could be achieved through the strengthening of the agricultural sector through the improvement of productivity and diversification of farming.

The main objective of this development intervention, enhancement/introduction of income generation activities targeting marginal farmers, is to increase the income of marginal farmers and to improve the level of food security, thereby contributing to human security and reduce vulnerability of the target groups. The project aims to achieve this by promoting income diversification of the target groups.

Development Strategies

The development intervention envisages achieving/approaching the said development objective by employing the extension mechanisms, including utilization of a group oriented approach by forming small farmers' organizations, a "Learning by Doing" concept through the operation of Integrated Farmer Field Schools (IFFS) and provision of credit for improvement of current farming activities or introduction of new farming activities selected by the target groups. The mechanisms have been successfully introduced under SPFS of FAO and such innovative extension approaches through IFFS have demonstrated the importance of participatory and sustained support to farmers in order to stabilize their agricultural production. The development strategies involved in the project include:

1) Target group of the project are poor farmers who belong to the poorest and most vulnerable group in the Target Area. In the present Study, landless farm households, women headed households and farm households with less than 0.1 ha of land are tentatively selected as the target groups. These households are to be formed into a group of farmers sharing a common production interest,
2) Responding to farmers needs, the project envisages introducing participatory community micro-project approaches which could be more responsive to the community's' needs and will be a better and more practical way to solve the problem of the farmers, and
3) The lessons learned from the past similar projects indicate that lack of capital is one of the main constraints to improve rural poor farmers' livelihood and saving and credit activities have played a very important role to sustain the project activities at the grass roots level. The project accommodates credit provision as a core component for sustaining farmers' activities to improve and diversify their farm incomes, and
4) Employment of a participatory extension approach through IFFS.

Scope of Intervention

1) Target Groups

The target groups of the schemes are marginal farmers who are poor and the group most vulnerable to food insecurity in the Target Area and landless households, households with holding size less than 0.1ha and women headed households are tentatively defined as target households (actual target groups are to be selected in the preparatory stage of the project). As similar projects have been implemented in or around the Target Area by SPFS, SEILA and NGOs, the project target groups are tentatively set to be 20% of the said households or 4,200 households as follows;

Estimated Number of Marginal Farmers & Target Groups 1/

Target Households [1/]	Kampong Speu	Kandal	Target Area
Landless Farmers	3,995	2,258	6,253
Households with Holding Size < 0.1ha	1,110	868	1,978
Women Headed Families	8,478	3,539	12,017

Total	13,583	6,665	20,248
Target Groups (±20%;)	2,800	1,400	4,200

1/:Marginal households in the project communes

Source: SEILA Data Base 2004 & Commune Survey on Crops & Livestock, 2003, MAFF

2) Project Components

The project is to be implemented in 2 stages, the preparatory stage and the operation stage. Major components in the operation stage are as follows;

1) PRA at the village level, farmer group (Self-help Group) formation
2) IFFS at target villages,
3) Provision of credit for farm inputs, seedlings, farm tools, fingerlings, animals and poultry etc. depending on schemes selected and beneficiaries' needs,
4) Conceivable candidate schemes,
5) Village Chick & Hen Management Scheme,
6) Fish Culture Scheme in Rice Fields,
7) Fruit Seedling Production Scheme,
8) Small-scale Fish Culture Scheme,
9) Small scale livestock production (pig raising etc.),
10) Fruit production, and
11) Mushroom production with local inputs,

The overall framework of the intervention is illustrated in Figure 8.6.2.

8.7 Development Objectives and Strategies for Subject-wise Improvement

(1) Coordination between MOWRAM and MAFF Strengthening Project

Development Objective

The objective of the project is to strengthen the coordination between MOWRAM and MAFF for efficient and smooth implementation of irrigated agricultural projects.

Development Strategies

Good coordination between MOWRAM and MAFF is indispensable for successful implementation of irrigated agricultural projects. In the current condition, it is hard to say that the coordination between MOWRAM and MAFF is very good. To achieve the objective mentioned above, the following strategy is proposed:

1) Establish a "project management group" consisting of the departments concerned in MOWRAM and MAFF

The project management group will consist of the departments concerned in MOWRAM and MAFF. The project management group would take charge of;

1) Work coordination between MOWRAM and MAFF,
2) Implementing the project until its completion, and
3) Monitoring and evaluation of the project.

It is a little difficult to communicate with each other frequently through e-mails, thus, the following procedure is recommendable:

1) Have regular meetings between MOWRAM and MAFF during the implementation period, and
2) Hold a joint workshop using participatory methods such as PCM to learn and share the present condition of each other, including the present difficulties

Additionally, it will be possible to clarify the project line of responsibility and also realize better

accountability through this procedure.□

(2) Provincial Departments Strengthening Project

Development Objectives

The objective of the project is to strengthen Provincial Departments for efficient and smooth implementation of irrigated and rainfed agricultural projects under the decentralization policy.

Development Strategies

It can be said that the knowledge and skills of the provincial officers in the fields of management and O &M of irrigation systems and new high yielding technology are still limited at PDOWRAMs and PDAs. To attain the objective under such situation, the following strategies should be applied:

1) Increase the opportunities to attend specific technical training courses and study tours to highly motivate the officers.
2) Monitor existing office equipment and the other means for improving availability.
3) Improve communication among the staffs in different offices in Provincial Departments for sharing information including current difficulties and proposals for their solution.

(3) Livestock Sub-sector Development Study

Development Objective

For the enhancement of livestock productivity in the Target Area, the integrated implementation of improvement of genetic resources, development of feed resources and improvement of veterinary services are considered essential. However, the overall investigations on present conditions, development potentials and approaches for development are yet to be made in the Area. The proposed development study aims at formulating an integrated livestock sub-sector development plan in the Target Area for medium and long term development scopes. The long term plan is to be formulated based on the study.

Development Strategies

The development study is to be implemented by a well experienced foreign consultant so as to ensure the quality of outputs and formulation of practical development plans.

Scope of Intervention

The main scopes of the study include: i) identification of present conditions and development constraints & potential and ii) study on integrated livestock development concepts.

(4) Technical Guidelines Preparation Project

Development Objective

The objective of this project is to prepare the irrigation related technical guidelines, such as (i) Irrigation Planning, (ii) Irrigation Design, (iii) Construction Supervision of Irrigation Facilities, and (iv) Irrigation System Operation and Maintenance.

Development Strategies

To attain the objective mentioned above, the following strategies are to be employed:

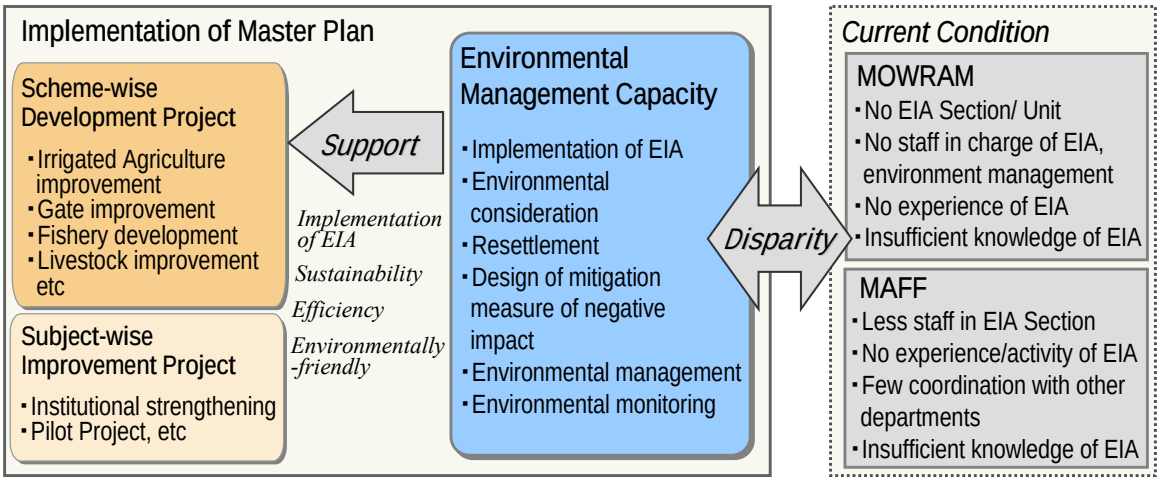
1) Ask users of the guidelines to test the draft guidelines in the field and revise them based on the users' comments.
2) Prepare useful supporting volumes for the guidelines, such as standard design drawings and a check list of planning and design works.
3) Prepare the guidelines in two languages, English and Khmer.

In preparation of the guidelines, special attention should be paid to treatment of dispersive clay soil. The dispersive clay soil is commonly seen in the Target Area and easily eroded by water flow.

(5) Environmental Management Basic Capacity Development

Development Objectives

The objective of the Environmental Management Basic Capacity Development Project is to strengthen basic capabilities of the relevant staff of MOWRAM and MAFF regarding Environmental Impact Assessments (EIA) and environmental management[2]. The strengthened capabilities should support implementation of the master plan from the viewpoint of the environment.



Objectives of the Environmental Management Capacity Development under the master plan

Development Strategies

The development strategies established for the attainment of the said objective include:

1) Basic capacity development for EIA (preparation of terms of reference (TOR) for an EIA study, supervision and monitoring of an EIA study)
2) Basic capacity development for environmental management
3) Establishment of coordination among relevant technical departments and the EIA Section

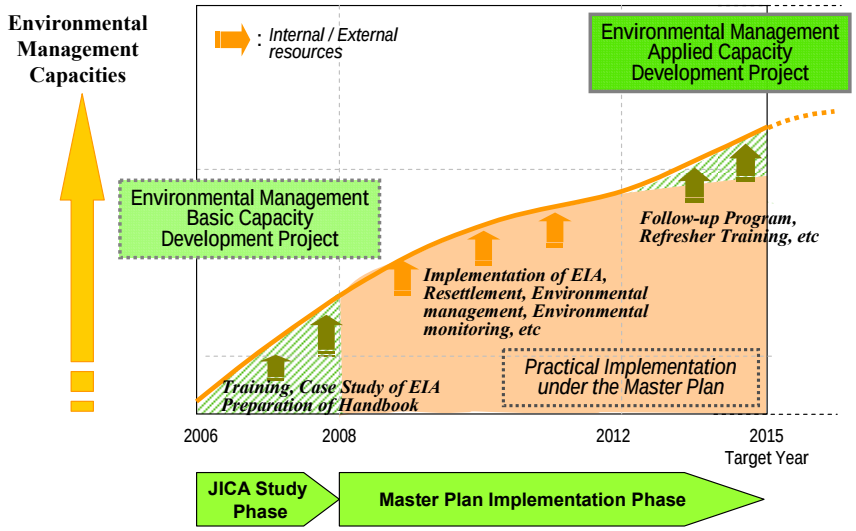
(6) Environmental Management Applied Capacity Development Project

Framework

After the Environmental Management Basic Capacity Development Project, practical implementation of environmental management will need to be conducted for implementation of the scheme-wise development projects under the master plan on a project-by-project basis. As for a project that requires an EIA, EIA staff will gain first hand experience on how to prepare terms of reference for an EIA study, supervise and monitor the EIA study under the implementation of the project. Other projects will require land acquisition and/or involuntary resettlement, both of which are sensitive issues. It is expected that MOWRAM and MAFF will utilize both internal and external resources for support of the environmental management activities on a project-by-project basis.

Following the practical implementation of the environmental management activities under the master plan, the "Environmental Management Applied Capacity Development Project" will be appropriate in the latter phase of the master plan. This aims to follow-up on and reinforce environmental management activities and capabilities of the relevant staff of MOWRAM and MAFF.

[2] *In this section, "Environment" is defined to be composed of two issues; natural environment and social environment.*



Framework of Environmental Management Capacity Development

Development Objective

The objective of the project is to strengthen the applied capabilities of the relevant staff of MOWRAM and MAFF regarding an Environmental Impact Assessment (EIA) and environmental management through follow-up of the environmental management activities which have been implemented under the master plan.

Development Strategies

The development strategies established for the attainment of the said objectives include:

1) Implementation of an effective follow-up program based on the results of a series of activities under the master plan
2) Efficient and effective capacity development for environmental management through the follow-up training

(7) Irrigated Agriculture On-Farm Technology Improvement Pilot Project

Development Objective

The objective of the project is to establish an efficient water use model in an irrigated agriculture area.

Development Strategies

To attain the objective mentioned above, the following strategies are involved

1) Design a pilot project framework that will allow easy dissemination at the post-pilot stage.
2) Conduct project activities with provision of minimum irrigation facilities for water management.
3) Involve irrigation related government agencies (MOWRAM and PDOWRAM) and agriculture related government agencies (MAFF and PDA) together in the activities.
4) Ask farmers to participate in the group activities voluntarily.
5) Strengthen FWUC so as to enable the FWUC duties satisfactorily
6) Improve farming practice at the same time as strengthening of water management.
7) Apply useful local knowledge obtained from successful models in and around the Target Area.
8) Strengthen both the small-scale field water management activities by FWUC.
9) Feed back the results of project activities to the master plan for Comprehensive Agricultural Development.

(8) Irrigation Facility Maintenance Capacity Strengthening Pilot Project

Development Objective

The objective of the project is to establish a good irrigation facility maintenance model in an irrigated

agriculture area.

Development Strategies

To accomplish the objective stated above, the following strategies are employed:

1) Design a pilot project framework that will allow easy dissemination at the post-pilot stage.

2) Conduct project activities with provision of minimum irrigation facilities for water management.

3) Carry out project activities where irrigation water is properly distributed.

4) Ask farmers to participate in the group activities voluntarily.

5) Apply useful local knowledge obtained from successful models in and around the target area.

6) Strengthen both the small-scale facility maintenance activities by FWUC and large-scale facility maintenance by the government.

(9) Rainfed Agriculture Improvement Pilot Project

Development Objective

The objective of the project is to improve the rainfed agriculture productivity and increase the production of rice.

Development Strategies

The development intervention directed to Zone-4, rainfed paddy fields, is an ambitious one. However, the improvement of rainfed agriculture should be sought for the attainment of the master plan target. In the pilot project, practical ways to improve rainfed rice productivity will be examined. The trategies for the pilot project are as follows;

1) Test adoptability of improved rainfed rice production systems, including a system of modified SRI and systems recommended by PDA/CARDI,

2) Verify adoptability of the tested improved rainfed rice production system(s) with participation of farmers (plot demonstration),

3) Organize small-scale farmer groups as target groups of extension services and train selected members as village extension agents,

4) Involve agricultural government agencies (MAFF and PDA) and NGOs having experiences in rainfed rice production activities,

5) Feed back results and findings of the pilot project to the master plan, and.

6) Apply useful local knowledge obtained from successful models in and around the Target Area.

(10) Community Inland Fisheries Development Pilot Project

Development Objective

The objective of the project is to establish an effective and practical model of community inland fisheries operated by FWUC in the target area.

Development Strategies

The possibility of practical community inland fishery will be examined in the pilot project by applying the following strategies.

1) Design a pilot project framework that will allow easy dissemination in the post-pilot stage.

2) Conduct project activities where a community small reservoir is functioning well.

3) Ask farmers to participate in the group activities voluntarily.

4) Introduce fish culture practices at the same time as strengthening of FWUC on water management.

5) Run an inland fishery business by FWUC.

6) Use the income produced by the inland fishery for FWUC activities.

(11) River Basin Effective Water Use Awareness Raising Project

Development Objective

The objective of the project is to raise awareness and knowledge of farmers on efficient water use on the basin basis, by introducing the result of the "Irrigated Agriculture On-farm Technology Improvement pilot project".

Development Strategies

To attain the objective mentioned above, the following strategies are to be taken:

1) Feed back the results of the master plan for Comprehensive Agricultural Development to the farmers and other stakeholders.
2) Make farmers understand the actual situation of the upstream and downstream irrigation areas.
3) Introduce the lessons learned in the "Irrigated Agriculture On-farm Technology Improvement pilot project" to farmers in other areas.
4) Disseminate the necessity and procedures of water saving irrigation using calendars or other material.

(12) Institutional and Agricultural Support Services Strengthening Project

Development Objective

The objective of the present master plan is productivity improvement of both irrigated and rainfed rice to achieve rice sufficiency within the Target Area. From the crop sub-sector development constraints faced in the Target Area, strengthening of agricultural support services and improvement of irrigation water management will be essential in order to ensure the attainment of project targets at an early stage.

The present development intervention is proposed as a technical cooperation project with the objectives of: i) establishment of an institutional set-up responsible for the promotion of agricultural improvement centering on rice in the Target Area at an initial stage of the master plan, ii) development and extension of improved and sustainable farming technologies on rice production to enhance productivity of the primary agriculture activity in the Area, iii) development and extension of irrigation water management and O&M technologies and practices for sustaining the irrigation systems in the Area and iv) formation and empowerment of Farmer Water Users Group (FWUG) and Farmer Water Users Community (FWUC) and other farmers organizations.

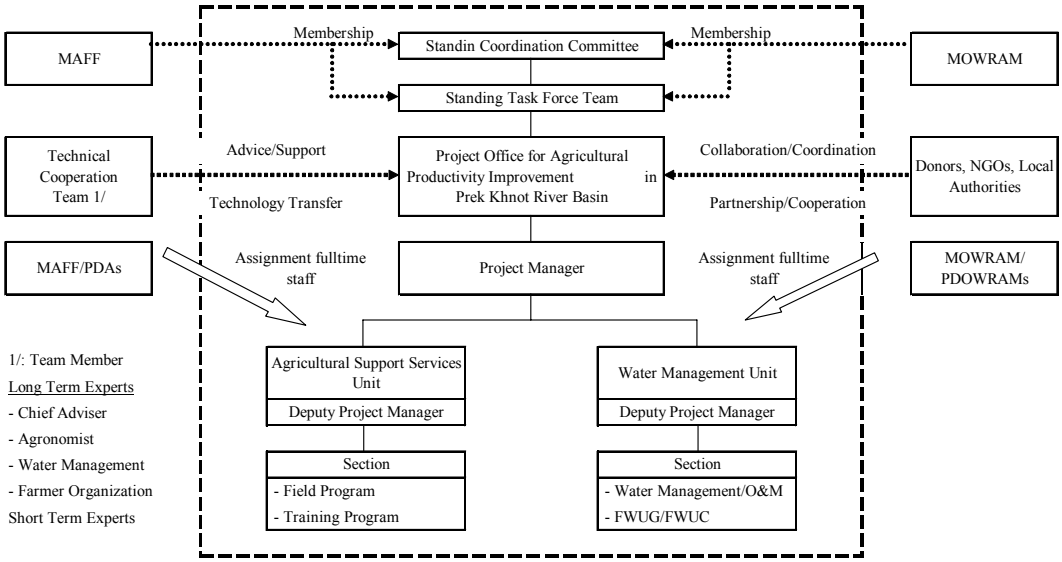
Development Strategies

For the attainment of the objectives stated above, the development strategies for the project are set as follows;

1) The insufficient coordination and collaboration between MAFF and MOWRAM appears to be one of the most serious constraints for the irrigated agricultural development in the Target Area. The development intervention aims at the establishment of coordination and a collaboration body at the central and project levels to tackle such a sustained constraint for the development under the support of the foreign donor, and
2) Establishing the Project Management Unit or Project Office organized by staffs of MAFF/PDA and MOWRAM/PDOWRAM in the Target Area as an organization responsible for the integrated & collaborative activities of MAFF & MOWRAM and project implementation.

Scope of the Intervention

The project is to be formulated as a technical cooperation project for the period of 5 years and the project purpose is to establish an institution responsible for the agricultural productivity improvement, Project Management Unit or Project Office, and to strengthen agricultural support services provided through the Project Office. The envisioned major activities include: i) institutional strengthening, ii) improvement of the irrigated rice production system with farmers participation, iii) improvement of the rainfed rice production system with farmers participation, iv) technology development & extension of upland crops production in early rainy season in paddy fields, v) establishment of village extension agents (VEAs), vi) introduction of proper water management & O&M systems and vii) capacity building of farmers' organizations as discussed in PDM. The proposed organization set-up of the Project Office is as illustrated below.



Proposed Project Organization Set-up

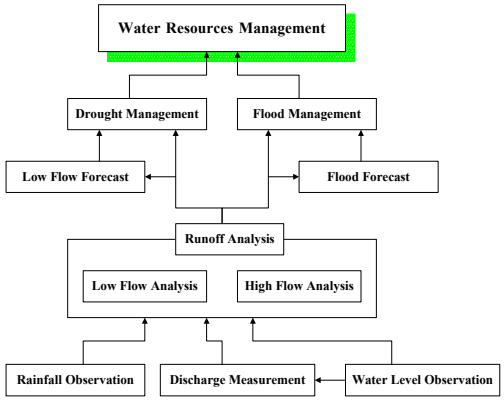
(13) Hydrological Observation Strengthening Project

Development Objective

The objective of the project is to strengthen the system for hydrological data acquisition for water resources related projects.

Development Strategies

The hydrological observations proposed in the present study are composed of rainfall observations, water level observations and discharge measurements for preparation of discharge rating curves in the basin of the Prek Thnot River. The rainfall data to be observed here is the temporal rainfall data and is to be arranged into hourly rainfall, daily rainfall, monthly rainfall and yearly rainfall data. In the same manner, the water level data are to be arranged, through discharge rating curves, into hourly discharge, daily discharge, monthly discharge and yearly runoff amounts.



The collated rainfall and discharge data could be used for low flow analysis and high flow analysis and then the analysis results could be utilized for water resources development planning and flood management planning. The general idea on this is shown briefly to the right:

Therefore the hydrological observation basically contributes to the agricultural development in the Prek Thnot River basin and mitigation of water related hazards in the basin.

(14) Flood Forecasting and Warning Study

Development Objective

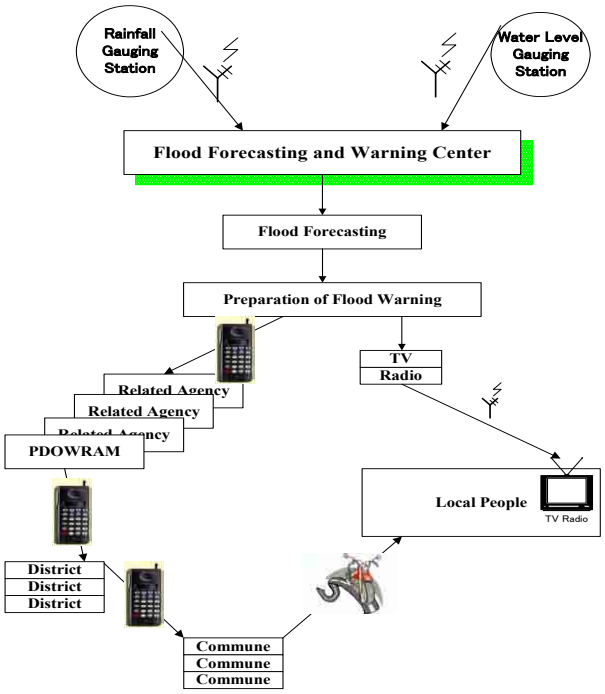
The objective of the study is to prepare a flood forecasting and warning system plan for mitigation of flood damage in the downstream basin of the Prek Thnot River.

Development Strategies

Since the runoff of the Prek Thnot River is very rapid, the sudden rise of the river water level may cause disastrous damage to the people in the flood prone areas. Thus, the preparation of flood forecasting and warning systems in the basin would contribute much to the welfare of the people and to avoid the loss of life. The figure to the right shows one example of a flood forecasting and warning system in the Prek Thnot River basin:

In the core portion of the flood forecasting method, the present plan is that the calculation method should be as simple as possible so that the relevant staff can conduct the flood forecasting works easily. Accordingly a simple correlation method would be first taken into consideration for flood forecasting. And then the multi correlation method using rainfall and water levels would be the second option to be studied. To avoid complicated work for flood forecasting, the application of the Storage Function Method would be the final option to be selected, if the other correlation methods did not give good results.

The present flood forecasting system of the Mekong, the Bassac and the Tonle Sap Rivers would be the good example for preparation of the flood forecasting system of the Prek Thnot River basin.



Chapter 9 Formulation of Master Plan for Comprehensive Agricultural Development

9.1 General

Based on the basic concept of and approach to the master plan, 27 projects/studies have been worked out aiming at improvement of agricultural productivity centering on rice in the Target Area. This chapter presents the project digests of these projects/plans. Attention in their implementation plans is paid to the harmonization of the implementation times of the respective projects/plans because these are in reciprocal relationships that have a bearing on their effects.

As mentioned in Chapter 7, two Pilot Projects; Irrigated Agriculture On-farm Technology Improvement Pilot Project and Rainfed Agriculture Improvement Pilot Project, which are of 27 projects/studies proposed in the master plan, were carried out for about 2 years from July 2007 to February 2008. The substantial results obtained from these Pilot Projects were fed back to the master plan, aiming to formulate it fitted to the local current conditions. Thus, this chapter presents the revised version of the master plan provisionally formulated in the Interim Report (1).

Appendix-K of Volume-VI: Appendixes for master plan, presents the project proposals, implementation schedules, and Project Design Matrix (logical framework) for them aiming at easy understanding by the officials concerned and the donors taking interests in them.

9.2 Program Theory Matrix

As mentioned in Sub-section 8.5.2, the various projects/studies under the Scheme-wise Improvement and Subject-wise Improvement, are proposed aiming to achieve the strategic target; ***improvement of agricultural productivity centering on rice*** in the Target Area.

In order to clarify the relationships within the overall policy, end outcomes, intermediate outcomes, outputs and these projects/studies activities in the framework of the master plan, a logical framework (PTM: Program Theory Matrix) was prepared as shown in Table 9.2.1.

As described in Section 8.2, the master plan is composed of three pillars; agricultural development, irrigation and drainage development and institutional development, and stresses the concept of the well harmonized development of these three pillars. PTM presents this concept visually for easy understanding of the framework of the master plan for Comprehensive Agricultural Development.

Table 9.2.1 Program Theory Matrix for Comprehensive Agricultural Development Plan

Overall Policy	**OP: "Economic Growth and Poverty Reduction"**		
End Outcome	**EO-1:Ensuring of Food Security, Poverty Alleviation and Job Creation by Increasing Rice Cultivation Area (Agricultural Development Plan, Long, Medium and Short Term 1999-2010, MAFF)**		
Intermediate Outcome	**IO-1:Improvement of Agricultural Productivity Centering on Rice**		
Output	**O-1:Better water management of irrigated and rainfed croplands by development of hardware and software in a complementary way (Strategic Development Plan for Water Sector 2006-2010, MOWRAM)**		
	O-1-1: Agricultural Development	**O-1-2: Irrigation & Drainage Development**	**O-1-3: Institutional Development**
	"Improvement of crop yields through proper farming technology and strengthening of extension services, and promotion of inland fish culture and livestock farming"	*"Expansion of the irrigated area through effective use of existing water resources and application of appropriate water management"*	*"Formation of farmers' organization and capacity development of provincial departments and farmers' organization"*
Activities			
(1) Scheme-wise Improvement			
(a) Zone-1			
A.1(1) Irrigated Agriculture Improvement Model Project	○	○	○
A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project	○	○	○
A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project	○	○	○
(b) Zone-2			
A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project	○	○	○
A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project	○	○	○
A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project	○	○	○
(c) Zone-3			
A.3(1) Water Harvesting Irrigated Agriculture Improvement Project	○	○	○
(d) Zone-4			
A.4(1) Rainfed Agricultural Improvement Project	○	—	○
(e) Zones Crosscutting			
B.1(1) Roleang Chrey Regulator Gates Urgent Improvement Project	—	○	—
B.1(2) Roleang Chrey Regulator and Intakes Improvement Projec	—	○	—
B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project	○	—	○
B.3(1) Community Inland Fisheries Development Project	○	—	○
B.4(1) Income Generation Project for Marginal Farmers	○	—	○
(2) Subject-wise Improvement			
C.1(1) Coordination beteeen MOWRAM and MAFF Strengthening Project	—	—	○
C.1(2) Provincial Departments Strengthening Project	—	—	○
C.2(1) Livestock Sub-sector Development Study	○	—	○
C.3(1) Technical Guidelines Preparation Project	—	○	—
C.4(1) Environmental Management Basic Capacity Development Project	—	—	○
C.4(2) Environmental Management Applied Capacity Development Project	—	—	○
C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project	○	○	○
C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project	—	○	○
C.7(1) Rainfed Agriculture Improvement Pilot Project	○	—	○
C.8(1) Community Inland Fisheries Development Pilot Project	○	—	○
C.9(1) River Basin Effective Water Use Awareness Raising Project	—	○	○
C.10(1) Institutional and agricultural Support Services Strengthening Project	○	○	○
C.11(1) Hydrological Observation Strengthening Project	—	○	—
C.11(2) Flood Forecast and Warning Study	○	○	○

9.3 Scheme-wise Improvement

9.3.1 Zone-1 Projects

9.3.1.1 A.1(1) Irrigated Agriculture Improvement Model Project

(1) Title of Project	Irrigated Agriculture Improvement Model Project
(2) Location	District: Chbar Mon, Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims at demonstration of proper water management and increase of rice production in the model area (570ha)by good harmonization of agriculture, irrigation and drainage and institutional development.
(4) Site Description	The South Main Canal (SMC) has been recently constructed by MOWRAM. However, the canal has not been well maintained due to lack of government budget. Further, related structures of secondary and tertiary canals such as turnouts, regulators, and culverts are not sufficiently constructed. Water from SMC is not efficiently delivered to paddy fields because of the above constraints. This poor condition of irrigation facilities must be one of the important reasons for the low agricultural productivity in the area. **South Main Canal and related structures** - SMC recently constructed is about 26 km long. However, its design considerably deviates from the ordinal one. The present canal is designed to maintain the water level lower than adjacent paddy fields. A few water level regulators were constructed, but water level in the secondary or tertiary canals is still lower than the paddy fields. To struggle against this difficulty, many farmers are taking water from the main canal using portable pumps. - Permanent turnouts which divert water from the main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to withdraw water. To solve this problem, some farmers broke canal embankments and buried pipes without proper backfilling. This caused collapse of the canal embankments.

The SMC seriously eroded

A check structure severely deteriorated

Secondary canals and related structures

- Number and length of secondary canals are insufficient.
- Gravity irrigation is unable to be practiced since design water level of the canal is lower than adjacent paddy fields.
- Existing turnouts and check gates are deteriorated.
- Numbers of turnouts and check gates are insufficient.
- Design criteria of secondary and tertiary canals are unclear. This unclear criteria cause poor water management, since some canals command too large an area.

Tertiary canal systems

- Improper layout of tertiary systems causes poor water management.

A check structure recently constructed

An existing tertiary canal

(5) Agricultural Development Plan

The agriculture development plan indicated in comparison with the present condition is as follows;

Agriculture Development Plan (Paddy Production)

	With Project			Present	Increment
	Early Rainy	Rainy Season	Annual	Annual	
Cropped Area	285ha	570ha	855ha	860ha	-5ha
Yield	3.3t/ha	3.0~3.3t/ha	3.0~3.3t/ha	1.5~2.4t/ha	-
Production	941t	1,796t	2,737t	1,892t	845t

At the full development stage, an increase in the production of paddy of some 850 t/year from the present level is aimed at.

(6) Irrigation Development Plan

Water management of the irrigation system will be done by government agencies for major facilities and by FWUCs for minor facilities. As the first step, an on-farm level water management model is planned to be established in the "Irrigated Agriculture On-farm Technology Improvement Pilot Project". For the second step, total irrigation system management from the main canal to on-farm facilities needs to be established by this model project. Implementation of the model project also can demonstrate actual benefits from the irrigation system.

Taking the strong relationship with the above-mentioned pilot project into account, the model project needs to be conducted in an area surrounding the pilot project, which is in the upstream part of the SMC system. It is also necessary that the model project area has proper scale to practice and demonstrate proper water management. The proper size of the model area would be the area operated by several turnouts and a few check structures. Taking these criteria into account, the model project area was finally decided to be the most upstream command area of SMC distributed in Chbar Mon and Samraong Tong districts. Length of SMC and paddy area in the model project area is 7 km and 570 ha respectively. Complete irrigation will be achieved in the entire project area at least four years out of five (80% dependability) in the rainy season.

To introduce river water from the Prek Thnot River to the paddy fields, all canals are proposed to be improved to be able to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned to be provided at the diversion points on the main canal. To avoid the canals obstructing public transportation, culverts or bridges are planned to be provided. Of the 32 km of total length of SMC, the most upstream 7km is proposed to be rehabilitated by the project. Design discharge of SMC is 16.3 m^3/sec.

A participatory approach will be applied in the planning of the tertiary canal system and construction of watercourses. Tertiary canal and watercourse layout will be determined through workshops with farmers in the planning stage. Watercourses will be constructed by the farmers under guidance of the government. Formation and strengthening of FWUCs will also be implemented in parallel.

(7) Project Components

(i) Construction works

- Rehabilitation of SMC from Vat Kruoch Intake Gate for a length of 7 km, including construction of related structures

	- Rehabilitation of existing secondary canals (6.1 km), construction of new secondary canals (1.0 km), and rehabilitation of tertiary canal systems for 570 ha, including related structures and drainage canals - Rehabilitation of 4 water harvesting facilities (ponds) including intake structures and irrigation canal systems (ii) Procurement of O&M (operation and maintenance) equipment (iii) Formation and strengthening of FWUCs/FWUGs/WUGs (iv) Agricultural support services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, and staff empowerment (v) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and operation manual for the facilities - Reinforce organization for O&M of the facilities.
(8) Cost	US$1,679,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	4.5 years
(11) Environmental Management/ Social Consideration	(i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.1.2 A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project

(1) Title of Project	Upper North Main Canal Irrigated Agriculture Improvement Project
(2) Location	District: Chbar Mon, Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims to increase rice production in the upper north area (2,210ha) by improvement of irrigation systems and strengthening of agricultural support services and FWUCs.
(4) Site Description	The construction of the North Main Canal (NMC) was planned in the late 1960s and started in the early 1970s as a part of the Prek Thnot Multi Purpose Project. The construction started from Roleang Chrey Regulator. The construction ceased completely because of war activities. After 1979, the construction was resumed by the Government of Cambodia under assistance of donor countries. Its design, however, deviate considerably from the original design. The most downstream part of NMC has been recently constructed by MOWRAM. However, none of the canals have been well maintained up to now. Further, secondary and tertiary canals, related structures such as turnouts, checks, and culverts are not sufficiently constructed due to lack of budget. Water in NMC is not efficiently delivered to paddy fields at present because of the reasons above. This appears to be one of the important reasons of low agricultural productivity in the area. Farmers excavate canal embankment and bury small pipe intakes in the embankment without compacting soils. This frequently causes collapse of NMC. **NMC and related structures** - NMC is about 25 km in length. However, its design considerably deviates from the original design. The present canal is designed to maintain the water level lower than the adjacent paddy fields. No water level regulator was constructed, so, the water level in the secondary or tertiary canals is also lower than the paddy fields. Pump irrigation is practiced in many places. - The excavated sandy soil is being deposited on both sides of the canal without compaction due to lack of construction budget. The soil, therefore, severely erodes and flows into the canal decreasing flow capacity. - Permanent turnouts which divert water from the main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to take water from NMC. To solve this problem, farmers excavated the canal and buried pipes. They do not properly backfill the canal causing collapse of the canal.

Pump irrigation from main canal due to low water level in the canal

The excavated sandy soils are deposited on the canal bank causing severe erosion

Canal bank collapsed due to water seepage along pipes illegally buried by farmers

Culvert constructed by people blocks main canal

Proper number of turnout to the secondary canal are not provided, and water level in the canal is lower than the paddy fields making gravity irrigation impossible.

Secondary canals and related structures

- The number and length of secondary canals are insufficient for adequate irrigation.
- The water level is designed lower than adjacent paddy fields.
- Turnouts and check gates are insufficient for proper water management.
- At present, definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities are not able to be implemented.

Tertiary canal systems

- The size and number of tertiary canals are insufficient, which interfere the timely and even water distribution.

Reservoirs

- The existing 11 reservoirs in the project area were mostly constructed the late 1970s to collect rainfall. These have been used for irrigation of paddy fields. They are presently deteriorated due to lack of maintenance activities.

(5) Agricultural Development Plan

The agricultural development plan indicated in comparison with the present condition is as follows;

Agricultural Development Plan (Paddy Production)

	With Project			Present	
	Early Rainy	Rainy Season	Annual	Annual	Increment
Cropped Area	215ha	2,210ha	2,425ha	2,445ha	-20ha
Yield	3.3t/ha	3.0 ~ 3.3t/ha	3.0 ~ 3.3t/ha	1.5 ~ 2.4t/ha	-
Production	710t	6,695t	7,405t	4,797t	2,608t

At the full development stage, an increase in the production of paddy of 2,600 t/year from the present level is aimed at.

(6) Irrigation Development Plan

The project is planned to develop irrigated agriculture in 2,210 ha of paddy fields. The project area is scattered along NMC in Chbar Mon and Samraong Tong Districts in Kampong Speu province.

Full irrigation will be achieved in the entire project area at least 4 years out of 5 years (80% dependability) from the viewpoint of water availability in the rainy season.

Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into NMC, and will be finally distributed to paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on NMC. To avoid the canals being obstacles to public transportation, culverts

	or bridges are also planned on the canal. The design discharge of NMC varies from 10.4 m3/sec to 5.8 m3/sec at the end point. All stretches of NMC (32 km) are proposed to be rehabilitated by the project, so that water availability in the downstream area will also be improved. Existing reservoirs are also to be rehabilitated to recover the original designed storage capacity. Those reservoirs are planned to receive irrigation water from NMC and function as regulating ponds to store inflow and regulate outflow to the downstream paddy fields. The project proposes to apply a participatory approach in the planned tertiary canal system and construction of watercourses. Tertiary canal and water course layout will be determined through workshops with farmers in the planning stage. Watercourses will be constructed by the farmers under guidance of the government. Formation and strengthening of FWUC shall be therefore implemented before detailed design work.
(7) Project Components	(i) Construction works - Rehabilitation of NMC from Andong Sla Intake Gate to the end of the canal (32 km) including construction of related structures - Rehabilitation of existing secondary canals (4.9km), construction of new secondary canals (5.2km), and rehabilitation of tertiary canal systems for 2,210 ha, including related structures such as turnouts, checks, culverts and drainage canals - Rehabilitation of 11 water harvesting facilities (reservoirs) including intake structures and irrigation canal systems (ii) Procurement of O&M (operation and maintenance) equipment (iii) Formation and strengthening of FWUC/FWUGs/WUGs (iv) Agricultural support services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment (v) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce organization for O&M of the facility.
(8) Cost	US$11.332,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	5 years
(11) Environmental Management/ Social Considerations	(i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with the stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.1.3 A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project

(1) Title of Project	Upper South Main Canal Irrigated Agricultural Improvement Project
(2) Location	District: Chbar Mon, Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims to increase rice production in the upper south area (2,880ha) by improvement of the irrigation systems and strengthening of agricultural support services and FWUCs
(4) Site Description	The South Main Canal (SMC) has been recently constructed by MOWRAM. However, none of the canals have been well maintained until now due to lack of government budget. Further, secondary and tertiary canals, related structures such as turnouts, regulators, and culverts are not sufficiently constructed. Water in SMC is not efficiently delivered to the paddy fields at present because of the reasons above. This appears to be one of the important reasons of low agricultural productivity in the area. Farmers excavate the canal embankment and bury small pipe intakes in the embankment without compacting soils. This frequently causes collapse of SMC. **SMC and related structures** - SMC of about 26 km in length, has been recently constructed. However, its design considerably deviates from the ordinal irrigation canal design. Because the present canal is designed to maintain the water level lower than the adjacent paddy fields. A few water level regulators were constructed; however, the water level in the secondary or tertiary canals is still lower than the paddy fields. Pump irrigation is practiced in many places.

Water level in the canal is lower than the paddy fields

Breach of bank of SMC due to seepage

- Permanent turnouts which divert water from SMC to secondary and/or tertiary canals are rarely constructed. It makes it difficult for farmers to take water from SMC. To solve this problem, farmers excavated the canal embankment and buried pipes. They do not properly backfill the canal, which causes collapse of canal.

Water level in the subsidiary canal is lower than the paddy fields, which makes gravity irrigation impossible.

Secondary canals and related structures

- The number and length of secondary canals are not sufficient for proper irrigation.
- The water level is designed lower than the adjacent paddy fields.
- Existing turnouts and check gates are deteriorated, and also insufficient for proper water management.
- At present, the definition and classification of the secondary and tertiary canals are not clear, so that some existing secondary canals command so large areas in which proper water management activities are not able to be implemented.

Tertiary canal systems

- The size and number of tertiary systems is insufficient, which leads to improper water management.

Reservoirs

- The existing 4 reservoirs in the project area were mostly constructed in the late 1970s to collect rainfall. These have been used for irrigation of paddy fields. They are deteriorated due to lack of maintenance work.

A reservoir for collecting rain. The dike was severely washed away

An intake structure at a water harvesting reservoir is deteriorated

(5) Agricultural Development Plan

The agricultural development plan indicated in comparison with the present condition is as follows;

Agricultural Development Plan (Paddy Production)

	With Project			Present	
	Early Rainy	Rainy Season	Annual	Annual	Increment
Cropped Area		2,880ha	2,880ha	2,905	-25ha
Yield		3.0t/ha	3.0t/ha	1.5 ~ 2.1t/ha	-
Production		8,640t	8,640t	5,471t	3,169t

At the full development stage, an increase in the production of paddy of some 3,200 t/year from the present level is aimed at.

(6) Irrigation Development Plan

The project is planned to develop irrigated agriculture in 2,880 ha of paddy fields. The project area is scattered along SMC in Chbar Mon and Samraong Tong Districts in Kampong Speu province.

Irrigation will be achieved in the entire project area at least 4 years out of 5 years (80% dependability) from the viewpoint of water availability in the rainy season.

Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into SMC, and will be finally distributed to the paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on SMC. To avoid the canals being an obstacle to public transportation, culverts or bridges are also planned on the canal.

The design discharge of SMC varies from 16.3 m3/sec to 6.6 m3/sec at the end point. Of the total length of 32km, 25 km is proposed to be rehabilitated by the project, so that water availability in the upstream and middle stream area will also be improved.

Existing reservoirs are also to be rehabilitated to recover the original design storage capacity. Those reservoirs are planned to receive irrigation water from SMC, and function as regulating ponds to store inflow and regulate outflow to the downstream paddy fields.

The project proposes to apply a participatory approach in planning the tertiary canal system and construction of watercourses. Tertiary canal and watercourses layout will be determined through workshops with farmers in the planning stage. Watercourses will be constructed by farmers under assist and advice from the

	government. Formation and strengthening of the FWUC shall be implemented in parallel with project implementation.
(7) Project Components	(i) Construction works - Rehabilitation of SMC from station 7 km to station 25 km, including construction of related structures - Rehabilitation of existing secondary canals (9.5 km), construction of new secondary canals (21.3 km), and rehabilitation of tertiary canal systems for 2,880 ha, including related structures such as turnouts, checks, culverts and drainage canals, - Rehabilitation of 4 water harvesting facilities (reservoirs) including intake structures and irrigation canal systems (ii) Procurement of O&M (operation and maintenance) equipment (iii) Formation and strengthening of FWUC/FWUGs/WUGs (iv) Agricultural support services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment (v) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce organization for operation and maintenance of the facilities.
(8) Cost	US$9,871,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	5 years
(11) Environmental Management/ Social Considerations	(i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with the stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.2 Zone-2 Projects

9.3.2.1 A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project

(1) Title of Project	Lower North Main Canal Irrigated Agriculture Improvement Project
(2) Location	District: Angk Snuol, Province: Kandal
(3) Objective of Project	The project aims to increase rice production in the lower north area (1,390ha) by improvement of the irrigation system and strengthening of agricultural support services and FWUCs.
(4) Site Description	The most downstream part of NMC has been constructed recently by MOWRAM. However, the secondary and tertiary canals and related structures are not sufficiently constructed due to lack of budget. Water in NMC is not delivered efficiently to the paddy fields at present due to the reasons mentioned above. This appears to be one of the important reasons for the low agricultural productivity in the area. Farmers bury small pipe intakes in the embankment without compacting the soils. This frequently causes collapse of embankment of NMC. **Secondary canals and related structures** - The number and length of secondary canals are insufficient. - The water level is designed to be lower than the adjacent paddy fields. - At present, the definition and classification of the secondary and tertiary canals is not clear and not precise, so some existing secondary canals command very large areas in which proper water management activities can not be conducted. - Permanent turnouts which divert water from the secondary canals to the tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the canal. - Culverts are not sufficiently provided in the canals causing people difficulty in crossing the canals for daily activities. To solve this, people block the canal by soil burying pipes, which results in a decrease of flow capacity in the canal.

No turnout to the tertiary canal, water level in the canal is lower than the paddy field making gravity irrigation impossible.

Water level in the canal is too low to irrigate by gravity

Tertiary canal systems

- Sizes and number of tertiary systems are insufficient.

(5) Agricultural Development Plan

The agricultural development plan indicated in comparison with the present condition is as follows;

Agricultural Development Plan (Paddy Production)

	With Project			Present	
	Early Rainy	Rainy Season	Annual	Annual	Increment
Cropped Area	200ha	1,390ha	1,590ha	1,400	190ha
Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5 ~ 2.1t/ha	-
Production	660t	3,892t	4,552t	2,430t	2,122t

At the full development stage, an increase in the production of paddy of 2,100 t/year from the present level is aimed at.

(6) Irrigation Development Plan	The project is planned to develop irrigated agriculture in 1,390 ha of paddy fields. The project area is scattered downstream of the NMC in Angk Snuol District in Kandal Province. Supplemental irrigation will be achieved in the entire project area in at least 3 years out of 6 years (50% dependability) from the viewpoint of water availability in the rainy season. Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into NMC, and will be finally distributed to paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on the main canal. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal. Design discharge of 5.8m3/sec will be conveyed to the project area in the peak period. All secondary and tertiary canals are proposed to be rehabilitated by the project, so that water availability in the downstream area will be also improved. The project proposes to apply a participatory approach in planning tertiary canal system and watercourses. Tertiary canal and watercourse layout will be determined through workshops with the farmers. Watercourses will be constructed by the farmers with support from the government. Formation and strengthening of the FWUC shall be implemented before detailed design work.
(7) Project Components	(i) Construction works - Rehabilitation of existing secondary canals (8.6 km), construction of new secondary canals (10.9 km), and rehabilitation of tertiary canal systems for 1,390 ha, including related structures such as turnouts, checks, culverts and drainage canals (ii) Procurement of O&M (operation and maintenance) equipment (iii) Formation and strengthening of FWUC/FWUGs/WUGs (iv) Agricultural support services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment (v) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce organization for O&M of the project facility.
(8) Cost	US$3,190,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	3 years
(11) Environmental Management/ Social Considerations	The following activities are planned; (i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with the stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.2.2 A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project

(1) Title of Project	Lower South Main Canal Irrigated Agricultural Improvement Project
(2) Location	District: Kong Pisei, Kandal Stung, Province: Kampong Speu, Kandal
(3) Objective of Project	The project aims to increase rice production in the lower south area (6,750ha) by improvement of the irrigation system and strengthening of agricultural support services and FWUCs
(4) Site Description	The South Main Canal (SMC) has been recently constructed by MOWRAM. However, none of the canals have been well maintained until now due to lack of government budget. Further, secondary and tertiary canals and related structures such as turnouts, check gates, and culverts are not sufficiently constructed. Water in SMC is not efficiently delivered to the paddy fields at present because of the reasons above. This appears to be one of the important reasons for the low agricultural productivity in the area. Farmers excavate canal the embankment and bury small pipe intakes in the embankment without compacting the soils. This frequently brings about collapse of SMC. **SMC and related structures** - SMC, of about 26 km total length, has been recently constructed. However, its design considerably deviates from the original irrigation canal design. The present canal is designed to maintain the water level lower than adjacent paddy fields. A few water level regulators were constructed; however, the water level in the secondary or tertiary canals is generally still lower than paddy fields. Pump irrigation is practiced in many places.

Secondary canal from SMC, water level is low because the canal was a river before

End structure of SMC

- Permanent turnouts which divert water from the main canal to secondary and tertiary canals are rarely constructed. It makes it difficult for farmers to take water from SMC. To solve this problem, farmers excavated the canal and buried pipes. They do not properly backfill the canal, which causes collapse of the canal.

Water level in the subsidiary canal is lower than the paddy fields, which makes gravity irrigation impossible.

Secondary canals and related structures

- The number and length of secondary canals are not sufficient for proper irrigation.
- The water level is designed lower than the adjacent paddy fields.
- Existing turnouts and regulators are deteriorated, and also insufficient for proper water management.
- At present, the definition and classification of the secondary and tertiary canals are not clear, so that some existing secondary canals command very large areas in which proper water management activities are not able to be implemented.

Tertiary canal systems

- The size and number of tertiary systems is insufficient causing inadequate water management.

Reservoirs

- The existing 5 reservoirs in the project area were mostly constructed in the late 1970s to collect rainfall (water harvesting). These have been used for irrigation of the paddy fields. They are deteriorated due to adverse soil characteristics and lack of maintenance work.

Erosion at dispersive soil embankment

Embankment collapsed due to seepage along buried pipe

(5) Agricultural Development Plan

The agricultural development plan indicated in comparison with the present condition is as follows;

Agricultural Development Plan (Paddy Production)

	With Project			Present	
	Early Rainy	Rainy Season	Annual	Annual	Increment
Cropped Area	1,000ha	6,750ha	7,750ha	6,880ha	870ha
Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5t/ha	-
Production	3,300t	18,900t	22,200t	10,320t	11,880t

At the full development stage, an increase in the production of paddy of 11,900 t/year from the present level is aimed at.

(6) Irrigation Development Plan

The project is planned to develop irrigated agriculture in 6,750 ha of paddy fields. The project area is scattered along the South Main Canal in Kong Pisei District and Kandal Stung District in Kampong Speu province and Kandal Province respectively.

Irrigation will be achieved in the entire project area at least 3 years out of 6 years (50% dependability) from the viewpoint of water availability in the rainy season.

Water is to be diverted from the Prek Thnot River at the Roleang Chrey Regulator where it flows into SMC, and will finally be distributed to the paddy fields through secondary and tertiary canals. To achieve this, all canals are proposed to be rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures such as check structures and turnouts are planned at the diversion points on SMC. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal.

The design discharge of SMC varies from 6.6 m3/sec to 16.3 m3/sec. Out of the 31km total length, 6 km in the downstream part is proposed to be rehabilitated by the project, so that water availability in the upstream and middle stream area will also be improved.

Existing reservoirs are also to be rehabilitated to recover the original design storage capacity. These reservoirs are planned to receive irrigation water from SMC, and function as regulating reservoirs to store inflow and regulate outflow to the downstream paddy field.

The project proposes to apply a participatory approach in the planning of the

	tertiary canal systems and watercourses. Tertiary canal and watercourse layout will be determined through workshops with the farmers in the planning stage. Watercourses will be constructed by the farmers under the assistance and advice of the government. Formation and strengthening of FWUC shall be implemented in parallel with project implementation.
(7) Project Components	(i) EIA Study (ii) Construction works - Rehabilitation of SMC from station 25 km to station 31 km including construction of related structures - Rehabilitation of existing secondary canals (5.8 km), construction of new secondary canals (60.5 km), and rehabilitation of tertiary canal systems for 6,750 ha, including related structures such as turnouts, checks, culverts and drainage canals, - Rehabilitation of 5 water harvesting facilities (reservoirs) including intake structures and irrigation canal systems (iii) Procurement of O&M equipment (iv) Formation and strengthening of FWUC/FWUGs/WUGs (v) Agricultural Support Services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment (vi) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce the organization for the operation and maintenance of the project facility.
(8) Cost	US$15,183,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	5 years
(11) Environmental Management/ Social Considerations	In addition to the EIA Study, the following activities are planned; (i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.2.3 A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project

(1) Title of Project	Ou Krang Ambel Irrigated Agriculture Improvement Project
(2) Location	District: Samraong Tong, Angk Snuol, Province: Kampong Speu, Kandal
(3) Objective of Project	The project aims to increase rice production in the Ou Krang Ambel area (2,900ha) by improvement of the irrigation system and strengthening of agricultural support services and FWUCs.
(4) Site Description	Ou Krang Ambel Reservoir and irrigation system was constructed on the Krang Ambel River to irrigate about 500 ha in the late 1970s. The catchment area of the reservoir was about 450 km^2. Inflow to the reservoir, however, has been decreasing due to further irrigated agriculture development in the upstream. Construction of Ta Hor Canal was also started in the late 1970s from the Prek Thnot River to the beneficial area. A diversion weir was once constructed in the Prek Thnot river, but it was washed away by a flood. To cope with this problem the Government connected a main canal from Ou Krang Ambel Pond with Ta Hor Canal. The Government extended NMC from Roleang Chrey 14 km, and constructed a diversion channel and Tousamn Ang Check Gate to supply irrigation water from the Prek Thnot River to the reservoir. At present, the irrigation area of the reservoir and Ta Hor Canal mostly receive irrigation water from the Prek Thnot River in addition to the flow in the Krang Ambel River.

Tousamn Ang Check Structure to divert water from NMC to Ou Krang Ambel Reservoir.

Ou Krang Ambel Intake Gate, 4 steel slide gates are manually operated

The downstream apron of the Tousamn Ang Check Structure is eroded and requires some modification work to prevent further erosion. The approach road also needs modification to ease ox-drawn cart and motor cycle traffic.

Ou Krang Ambel Intake functions fairly well at present except for leakage from damaged rubber seals.

Ta Hor Canal water level is lower than the paddy field

End of Ta Hor Canal

Ta Hor Canal is deteriorated due to lack of maintenance. The water level in the canal is not enough high for gravity irrigation. Secondary and tertiary canals and related structures such as turnouts, regulators, and culverts are not sufficiently constructed due to lack of budget. This appears to be one of the

important reasons for low agricultural productivity in the area.

Secondary canals and related structures

- The number and length of secondary canals are not sufficient for proper irrigation.
- The water level is designed lower than the adjacent paddy fields.
- At present, the definition and classification of the secondary and tertiary canals is not clear and not precise, so that some existing secondary canals command very large areas in which proper water management activities are not able to be implemented.
- Permanent turnouts which divert water from secondary canals to tertiary canals are rarely constructed. It makes it difficult for farmers to take water from the canal.
- Culverts are not sufficiently provided in the canal, which causes people difficulty in crossing the canal for daily activities. To solve this, people block the canal by burying pipes resulting in a decrease of flow capacity in the canal.

Tertiary canal systems

- The low density of tertiary canals is causing poor water management.

(5) Agricultural Development Plan

The agriculture development plan indicated in comparison with the present condition is as follows;

Agricultural Development Plan (Paddy Production)

	With Project			Present	Increment
	Early Rainy season	Rainy Season	Annual	Annual	
Cropped Area	400ha	2,900ha	3,300ha	2,930ha	370ha
Yield	3.3t/ha	2.8t/ha	2.8 ~ 3.3t/ha	1.5 ~ 2.1t/ha	-
Production	1,320t	8,120t	9,440t	5,091t	4,349t

At the full development stage, an increase in the production of paddy of 4,300 t/year from the present level is aimed at.

(6) Irrigation Development Plan

The project is planned to develop irrigated agriculture in 2,900 ha of paddy fields. The project area is scattered downstream of Ou Krang Ambel Reservoir in Samraong Tong District and Angk Snuol District in Kampong Speu Province and Kandal Province respectively. Supplemental irrigation will be achieved in the entire project area at least 3 years out of 6 years (50% dependability) from the viewpoint of water availability in the rainy season.

Water is to be diverted from the Prek Thnot River at Roleang Chrey Regulator where it flows into NMC, Tousamn Check Gate, and Ou Krang Ambel Reservoir.

To achieve this, the existing canals are proposed to be mostly rehabilitated and improved to maintain proper water level for gravity irrigation. Related structures, such as check structures and turnouts are planned at the diversion points on the main canal. To avoid the canals being obstacles to public transportation, culverts or bridges are also planned on the canal.

A 4.6 m3/sec flow will be conveyed to the project area in the peak period and depending on the river discharge of the Prek Thnot River. All secondary and tertiary canals are proposed to be rehabilitated by the project, so that water availability in the downstream area will be also improved.

The project proposes to apply a participatory approach in planning the tertiary canal systems and watercourses. Tertiary canal and watercourse layout will be determined through workshops with the farmers at the planning stage. Watercourses will be constructed by the farmers with assistance and advice from the government. Formation and strengthening of FWUCs shall be

	implemented before the detailed design work.
(7) Project Components	The followings project components are planned: (i) Construction works - Rehabilitation of the Tousamn Check Gate, Ou Krang Ambel Intake Gate, about 21 km of the Ta Hor Canal , existing secondary canals (11.7 km), construction of new secondary canals (8.3 km), and rehabilitation of tertiary canal systems for 2,900 ha, including related structures such as turnouts, checks, culverts and drainage canals (ii) Procurement of O&M (operation and maintenance) equipment (iii) Formation and strengthening of FWUC/FWUGs/WUGs (iv) Agricultural support services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment (v) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce FWUCs for O&M of the facilities
(8) Cost	US$7,219,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	3 years
(11) Environmental Management/ Social Considerations	The following activities are planned; (i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation (ii) Proper management of construction work (including social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.3 Zone-3 Project

9.3.3.1 A.3(1) Water Harvesting Irrigated Agriculture Improvement Project

(1) Title of Project	Water Harvesting Irrigated Agriculture Improvement Project
(2) Location	District: Chbar Mon, Samraong Tong, Kong Pisei, Angk Snuol Province: Kampong Speu, Kandal
(3) Objective of Project	The project aims to increase rice production in the Zone-3 area (1,200 ha in total) by improvement of the irrigation system, strengthening of agricultural support services and formation of FWUCs
(4) Site Description	There are 49 water harvesting reservoirs in the project area. Those were mostly constructed in the 1970s. Total catchment area of those reservoirs is 181 km2 individually varying from 22km2 to 10 ha. Storage volume is 22,000,000 m3 in total of all reservoirs varying from 10,000 m3 to 4,900,000 m3 at one reservoir. None of the streams that flow into the catchment areas have perennial flow, so they should be classified as water harvesting facilities. All reservoirs have deteriorated due to lack of maintenance. Further, irrigation canals and related structures such as turnouts, division boxes, checks, and culverts are hardly constructed. Water in the reservoirs is not efficiently delivered to the paddy fields at present because of the reasons mentioned above. This appears to be one of the important reasons of low agricultural productivity in the area. **Water Harvesting Reservoirs** - The existing 49 reservoirs in the project area were mostly constructed the late 1970s to collect rainfall (water harvesting) although some of them were recently rehabilitated under SEILA program. These have been used for irrigation of the paddy fields. They are deteriorated due to adverse soil characteristics and lack of maintenance work. - It was found that intake gates had been removed or broken in some systems.
(5) Agricultural Development Plan	The agriculture development plan indicated in comparison with the present condition is as follows;
(6) Irrigation Development Plan	The project is planned to develop irrigated agriculture in 1,200 ha of paddy fields as a whole. The project area is scattered outside of the command areas of SMC and NMC. Irrigation will be achieved in the entire project area with a probability of 3 years out of 6 years (50% dependability) from the viewpoint of available water in the rainy season.

Erosion at dispersive soil embankment

Embankment collapsed due to seepage along buried pipe

Cropping Pattern of Rice

	Cropping Season	Cropped Area	Yield	Production
Without Project	Rainy Season	1,200ha	1.5 ~ 2.1 t/ha	2,160 t
With Project	Rainy Season	1,200ha	2.8 t/ha	3,360 t

At the full development stage, an increase in the production of paddy of 1,200 t/year from the present level is aimed at.

	The existing reservoirs are also to be rehabilitated to recover the original design storage capacity. The project proposes to apply a participatory approach in planning the supply canal system and watercourses. Supply canal and watercourse layout will be determined through workshops with the farmers at the planning stage. Watercourses will be constructed by the farmers with assistance and advice from the government. Formation and strengthening of FWUC shall be implemented in parallel with project implementation.
(7) Project Components	(i) Construction works - Rehabilitation of existing water harvesting facilities (reservoirs) at 49 sites - Rehabilitation of existing supply canals and construction of new supply canals of about 18 km. (ii) Procurement of O&M (operation and maintenance) equipment (iii) Formation and strengthening of FWUC/FWUGs/WUGs (iv) Agricultural Support Services - Field Programs, Farmer/Farmers' Group Training Programs (including training of village extension agents), Mass Guidance & Workshops, staff empowerment (v) Engineering Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce the farmers organization for O&M of the facilities.
(8) Cost	US$7,427,000 including price contingency
(9) Executing Agency	MOWRAM and MAFF
(10) Implementation	6 years
(11) Environmental Management/ Social Considerations	The following activities are planned; (i) Proper procedures for land acquisition/involuntary resettlement - Public meetings with the affected people, discussions with stakeholders, resettlement and compensation (ii) Proper management of construction work (social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, etc) and at the operation phase (management of FWUC/FWUGs/WUGs, water quality, etc)

9.3.4 Zone-4 Project

9.3.4.1 A.4(1) Rainfed Agriculture Improvement Project

<table>
<tr><td>(1) Title of Project</td><td>Rainfed Agriculture Improvement Project</td></tr>
<tr><td>(2) Location</td><td>Zone-4 (rainfed paddy areas) in the Target Area</td></tr>
<tr><td>(3) Objective of Project</td><td>The project aims at the improvement of rainfed agriculture productivity and increased production of rice in Zone-4 in the Target Area</td></tr>
<tr><td>(4) Site Description</td><td>Rainfed paddy growing is the largest land use within the area. The Zone-4 area is estimated at 23,980ha and is extensively distributed in the northern and southern parts of the Target Area located away form the Prek Thnot River. Rainfed paddy fields are solely used for a single cropping of rice in the rainy season, and because of unstable rainfall, traditional farming practices and cultivation of traditional varieties, productivities are limited and unstable.</td></tr>
<tr><td>(5) Project Description</td><td>Improvement of rainfed agriculture should duly be sought through the integrated interventions of agronomic, extension and farmer organizational approaches. The strategies include:
- Improvement of productivity and increased production of rice is envisaged by the introduction of improved farming practices; in this regard, the expansion of low input SRI in Kampong Speu Province and promising results obtained in the SRI fields in 2005 as shown in Table 8.6.3 indicate the possibility for the attainment of the objectives,
- Improvement of productivity and increased production of rice supported by the strengthening of agricultural support services is envisaged, and
- Introduction of upland crops/vegetable production in the early rainy season to a limited pilot scale as a trial crop diversification for the future.
The proposed intervention is the strengthening of agricultural support services in the zone implemented by MAFF/PDA in collaboration with NGOs and supported by the experts. Therefore, the primary scope of the Project is the dissemination of an improved rice production system to the farming communities in Zone-4 through: (i) the strengthening of agricultural support services and (ii) formation and empowerment of farmers/farmers' groups. The agriculture development plan indicated in comparison with the without-project condition is as follows;
Agricultural Development Plan (Paddy Production)
<table><tr><th>Condition</th><th>Cropped Area</th><th>Unit Yield</th><th>Annual Production</th></tr><tr><td>Without-Project</td><td>23,380</td><td>1.5 t/ha</td><td>35,070 t</td></tr><tr><td>With-Project</td><td>23,380</td><td>2.0 t/ha</td><td>46,760 t</td></tr><tr><td>Increment</td><td>0</td><td>0.5 t/ha</td><td>11,690 t</td></tr></table>A production increase of paddy of 11,700 ton/year is targeted under the Project.</td></tr>
<tr><td>(6) Project Components</td><td>- Field programs for demonstration & training
- Farmer/farmers' group training (including training of village extension agents & refresher training of them, and study tours)
- Mass guidance/workshops
- Farmers' group formation & empowerment
- Provision of transportation means to project staffs and village extension agents
- Staff empowerment
- Field guidance & monitoring by PDA/DAO/NGO staffs</td></tr>
<tr><td>(7) Cost</td><td>US$ 2,975,000.including price contingency</td></tr>
<tr><td>(8) Executing Agency</td><td>Department of Agricultural Extension, MAFF</td></tr>
<tr><td>(9) Implementing Agency</td><td>Kampong Speu & Kandal PDA /CARDI/NGO</td></tr>
<tr><td>(10) Implementation</td><td>5 years</td></tr>
<tr><td>(11) Environmental Management/ Social Considerations</td><td>The included activities are explanation of environmental risks at the training (impacts from excess agrochemicals, etc)</td></tr>
</table>

9.3.5 Zone Crosscutting Projects

9.3.5.1 B.1(1) Roleang Chrey Regulator Gates Urgent Improvement Project

(1) Title of Project	Roleang Chrey Regulator Gates Urgent Improvement Project
(2) Location	Kampong Speu Province
(3) Objective of Project	To ensure the proper gate operation for irrigation water supply and flood water control.
(4) Site Description	The Roleang Chrey Regulator was constructed on the Prek Thnot River in 1974, about 100 km upstream from its confluence with the Bassac River. The Roleang Chrey Regulator was originally planned to supply the irrigation water for the left and right riparian areas of 34,000 ha provided that the Prek Thnot Multipurpose Dam was constructed upstream. However, the construction of the Prek Thnot Multipurpose Dam was suspended in 1973 due to political change. At present, the Roleang Chrey Regulator is planned to serve the irrigation water supply to the on-going Western Phnom Penh Integrated Development Center Project commanding 24,000ha in the Target Area. It can be said that the Roleang Chrey Regulator is thus a key structure for agricultural development for the Target Area.   *Temporary Hoisting Wire* *Aged Diesel Generator*
(5) Project Description	The gates and relevant accessories of the Roleang Chrey Regulator are so severely deteriorated that it does not function properly. The urgent recovery of gate function is strongly requested by the government. Thus, the project aims at recovery of gate function by providing the minimum rehabilitation work as a temporary treatment. The required work is to replace the wire ropes and to install a diesel generator with sufficient capacity. It is noted that the project should be implemented early in this Study period. If the project is delayed and the gates malfunction, river water could not be supplied to SMC and NMC. This means that the pilot projects to be conducted in this Study will be greatly interfered with and finally be discontinued.
(6) Project Components	As temporary measures, the following are planned: - Replacement of the counter weight wire rope in all 5 gates. - Installation of one additional diesel generator of 75 kVA as a main source although the existing one is used as an auxiliary electric source - Provision of spare parts such as fuses, magnetic switches and air filters for the diesel generator - Provision of standard maintenance tools such as wrenches, screw drivers, hammers and grease guns
(7) Required Cost	US$ 75,000
(8) Executing Agency	MOWRAM
(9) Implementation	4 months after Notice to Proceed
(10) Environmental Management/ Social Considerations	The following activities are planned; (i) Careful management of construction work (proper management of workers, heavy equipment, waste, etc)

9.3.5.2 B.1(2) Roleang Chrey Regulator and Intakes Improvement Project

(1) Title of Project	Roleang Chrey Regulator and Intakes Improvement Project
(2) Location	Village: Roleang Chrey, Commune: Taing Kruoch, District: Samraong Tong, Province: Kampong Speu
(3) Objective of Project	The project aims to provide a stable supply of water to the main canals by improving the Roleang Chrey Regulator, Andong Sla intake and Vat Kroch Intake.
(4) Site Description	Roleang Chrey Regulator, Andong Sla Intake Gate, and Vat Kroch Intake Gate, and approach channels were constructed as main facilities of the irrigation systems in the Prek Thnot river basin in the early 1970s. The operation of these facilities control and affect irrigation water distribution for about 20,250 ha in Kampong Speu and Kandal provinces. **Roleang Chrey Regulator** - The Regulator has not been well maintained since it was constructed in the early 1970s - Almost all the gate wheels are not able to rotate due to rusting of shafts causing overload to the hoist mechanism, which makes it difficult to operate precisely - Hoist systems are very old - All gates have deteriorated since installation in the early 1970s causing a large amount of water leakage - The downstream apron and river side are severely eroded - A small outlet structure is required to control and release irrigation water and maintenance flow to the downstream **Andong Sla Intake Gate and Vat Kruoch Intake Gate** - These structures have not been well maintained since they were constructed in the early 1970s, - A very large amount of leakage is observed from the gates, - Electric parts such as motors and the control cabinets were removed; the gates are operated by manual cranks. Their operation is limited. - Approach channels need to be rehabilitated to recover the design flow capacity.  *Vat Kruoch Intake Gate*  *leakage at Andong Slat Intake Gate*
(5) Project Description	Roleang Chrey Regulator will supply irrigation and domestic water to the areas served by NMC (6,500ha) and SMC (10,200 ha). It is a linchpin of water utilization in the downstream portions of the Prek Thnot river basin. Should it malfunction, it will directly and severely affect irrigation water supply to all the irrigation systems concerned. All gates and hoisting systems are to be rehabilitated. The downstream apron and

	river side slope are severely eroded due to insufficient length of the apron and side slope protection. The downstream apron and river side slope are to be improved to assure the safety of the structure. The Regulator also has to release water to the downstream for the on-going Kandal Stung Irrigation Project (1,950 ha) and planned Tonle Bati Irrigation Project (1,600 ha). The size of the gates, however, are too large to control the amount of water to the downstream, which will vary from less than 1 m3/sec to about 5 m3/sec from month to month. A structure is to be constructed to assure and control the amount of water released to the downstream. Andong Sla Intake Gate and its approach channels are the first facility of NMC. The gates produce a large amount of leakage, and are not able to be operated adequately at present and need rehabilitation and improvement for modernized irrigation water management. Vat Kruoch Intake Gate and its approach channel are the first facilities of SMC. Appropriate operation is not executed at present due to poor condition of facilities. The project is a key, not only to maintain the present situation, but also to achieve sustainable development of the downstream area of 16,700ha of paddy field as a whole.
(6) Project Components	The following activities are planned: (i) Rehabilitation and Improvement of Roleang Chrey Regulator - Rehabilitation of all gates and hoist systems of the Regulator, - Improvement of the downstream apron and river side slope protection - Construction of a river outlet structure at the right side of the Regulator - Construction of an operators hut (ii) Reconstruction of the Intake Gates - Reconstruction of Andong Sla Intake Gate and Vat Kruoch Intake Gate - Rehabilitation of the approach channels to the Intake Gates - Construction of a power transmission line from the Regulator and Intake Gates (iii) Engineering Support Services - Survey, design, preparation of tender documents, and construction supervision - Prepare operation rules and an operation manual for the facilities - Reinforce the organization for the operation and maintenance of the project facility
(7) Cost	US$4,786,000 including price contingency
(8) Executing Agency	MOWRAM
(9) Implementation	3 years
(10) Environmental Management/ Social Considerations	The following activities are planned; (i) A reconnaissance survey of the natural conditions at the design phase (ii) Proper management of construction work (including social considerations) - A series of public meetings from the design phase, proper management of workers' sanitation, regular watering for unpaved roads, etc (iii) Regular monitoring at the construction phase (watering, sanitation, waste, water flow, etc) and at the operation phase (water quality, etc)

9.3.5.3 B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project

(1) Title of Project	Veterinary Services Strengthening and Livestock Raising Improvement Project
(2) Location	Target Area (Kampong Speu & Kandal Province)
(3) Objective of Project	The project aims at recruiting new Village Livestock Agents (VLAs) or empowering existing VLAs in each village as providers of animal health and livestock extension services.
(4) Site Description	The livestock sub-sector is the primary income source of farmers in the Target Area and draft cattle are primary sources of labor for land preparation and transport of farm products. The average holding sizes of livestock per farm household are: **Beef Cattle** 2.3 / **Milk Cows** 0.7 / **Draft Cattle** 0.9 / **Pigs** 1.0 However, livestock husbandry in the Area is still not very intensive and faces unstable and low productivity. Major constraints for the development of the livestock sub-sector include problems in animal health and raising practices.
(5) Project Description	The project plans to recruit new Village Livestock Agents (VLAs) or empower existing VLAs as providers of animal health and livestock extension services at the village level with the objective of improving livestock productivity through the strengthening of veterinary services and the strengthening of livestock extension services to support improvement of livestock raising practices for farmers. Such veterinary & extension services are to be provided to farmers by the VLAs trained under the Project. Target Area: Chbar Mon, Kandal Stueng, Angk Snuol District Target districts of SLPP are excluded from the Project because similar activities are planned under SLPP. Target Group: Existing VLAs and VLA candidates in the project Target Area Beneficiaries of Project: Farmers in the project Target Area Total No. of target groups: 500 (one from each project village) New VLAs: 400 & existing VLAs: 100
(6) Project Components	Field demonstrations on improved livestock raising at selected villages - 100 villages (± 20% of project villages) - Subject: Pig fattening & chick & hen management (tentative) Field guidance & monitoring by PDA/DAO staffs
(7) Cost	US$ 377,000 including price contingency
(8) Executing Agency	Department of Animal Health & Production, MAFF
(9) Executing Agency	Kampong Speu & Kandal PDA
(10) Implementation	5 years
(11) Environmental Management/ Social Considerations	The following activity is included; (i) Explanation of environmental risks at the training (offensive odors caused by improper management, etc)

9.3.5.4 B.3(1) Community Inland Fisheries Development Project

<table>
<tr><td>(1) Title of Project</td><td>Community Inland Fisheries Development Project</td></tr>
<tr><td>(2) Location</td><td>Ponds/eservoirs used for the Water Harvesting Irrigated Agriculture Improvement Project in the Target Area</td></tr>
<tr><td>(3) Objective of Project</td><td>The Project aims at promoting inland fish culture in the water bodies of the Water Harvesting Irrigated Agriculture Improvement Project. Income from the inland fisheries could be placed in a common fund for the FWUC responsible for the O&M of the subject irrigation system.</td></tr>
<tr><td>(4) Site Description</td><td>The project target ponds/reservoirs are distributed in a scattered way in the Target Area of Kampong Speu. The size of reservoirs expressed by water surface area in the rainy season varies from 0.4 ha to 111 ha.</td></tr>
<tr><td>(5) Project Description</td><td>The Fisheries Office of PDA Kampong Speu has fish breeding facilities with fingerling production capacity of 3 ~ 4 million per year and efforts to introduce freshwater fish culture in the Target Area have been made, although they are still at the threshold level, the existence of 150 small fish reservoirs/ponds in Vosai District (outside of the Target Area) is reported. Freshwater culture in the Area is carried out both in small reservoirs/ponds and rice fields on a micro scale. However, fish culture on a substantial scale in reservoirs/ponds or reservoirs constructed for irrigation purposes have not been established yet in the province.

The Project aims at introduction of such substantial scales of inland fish culture in the water bodies used for irrigation.

In the project, the development of community based inland fish culture is envisaged in the water bodies. Objective areas of the development are reservoirs/ponds for the Water Harvesting Irrigated Agriculture Improvement Projects of the present Study and the groups of beneficiaries (FWUCs) of the irrigation development who are responsible for O&M of the irrigation systems will be the target groups. Returns from the development are to be utilized as a source of funds for O&M of the irrigation systems.

Target reservoirs:

Reservoirs free from flooding throughout the year

Size Distribution of Target Reservoirs: in total 49 reservoirs/ponds
<table>
<tr><th>Mini-scale</th><th>Small-scale</th><th>Medium-scale</th><th>Large-scale</th></tr>
<tr><td>(0.4 – 3.0ha)
5</td><td>(3.6 -10.3ha)
27</td><td>(11.5 – 34.3ha)
14</td><td>(57.6–111.4ha)
3</td></tr>
</table>
</td></tr>
<tr><td>(6) Project Components</td><td>- Initial technical guidance
- Provision of fingerlings
- Provision of fish nets & boats
- Periodical field guidance by PDA/DAO staffs</td></tr>
<tr><td>(7) Required Cost</td><td>US$ 413,000 including price contingency</td></tr>
<tr><td>(8) Executing Agency</td><td>Department of Fisheries, MAFF</td></tr>
<tr><td>(9) Implementation</td><td>5 years with 1 year pilot operation</td></tr>
<tr><td>(10) Environmental Management/ Social Considerations</td><td>The following activities are planned;
- Reconnaissance survey of the natural conditions, including aqua-diversity and careful selection of fish as fingerlings at the design phase
- Careful site selection at the design phase
- Regular monitoring of the reservoir/pond environment and management condition</td></tr>
</table>

9.3.5.5 B.4(1) Income Generation Project for Marginal Farmers

(1) Title of Project	Income Generation Project for Marginal Farmers
(2) Location	Target Area (Kampong Speu & Kandal Province)
(3) Objective of Project	The main objective of this development intervention, enhancement/introduction of income generation activities targeting marginal farmers, is to increase the income of marginal farmers and to improve the level of food security, thereby contributing to human security and reducing the vulnerability of the target groups. The project aims to achieve this by promoting the income diversification of the target groups.
(4) Project Description	Poverty reduction is the primary development goal of Cambodia and the NPRS dictates the improvement of the agricultural sector and the enhancement of assistance to farmers as the backbone of poverty reduction. Target Groups: 4,200 households Target groups of the schemes are marginal farmers who are poor and the most vulnerable group for food insecurity in the Target Area and landless households, households with holding size less than 0.1ha and women headed households are tentatively defined as target households. As similar projects have been implemented in or around the Target Area by SPFS, SEILA and NGOs, the project target groups are tentatively set to be 20% of the said households or 4,200 households (actual target groups are to be selected in the preparatory stage of the project).
(5) Project Components	Preparatory Stage - Inventory survey (selection of target groups and villages) - Preparation of Annual Work Plan - Preparation of scheme lists & guidelines - Field staffs (PDA/DAO/NGOs staffs) training; trainer training Project Operation Stage - PRA at village level - Farmers' group (Self-help Group) formation of members having similar intentions or preference toward income generating activities - Membership: 30 members & 3 sub-groups of 10 members - Board members: President, vice president & treasurer - Selection of a scheme to be introduced by a group - Training program for board members - IFFS (Integrated Farmer Field School) curriculum development - IFFS (including a study plot/scheme operation) at target villages - Provision of credit for farm inputs, seedlings, farm tools, fingerlings, animals and poultry etc. depending on schemes selected and beneficiaries' needs - Credit amount US$ ±50/member (depending on schemes selected), - Credit provision & revolving arrangements - Monitoring & evaluation Conceivable Candidate Schemes - Village Chick & Hen Management Scheme - Fish Culture Scheme in Rice Fields - Fruit Seedling Production Scheme Small scale aquaculture - Small-scale Fish Culture Scheme - Small scale livestock production - Fruit production - Mushroom production with local inputs
(6) Cost	US$ 679,000 including price contingency
(7) Executing Agency	Department of Fisheries, Animal Health & Production, and Extension, MAFF in collaboration with Kampong Speu & Kandal PDA, NGOs and other organizations
(8) Implementation	5 years (Preparatory Stage: 1 year, Operation Stage: 4 years)

9.4 Subject-wise Improvement

9.4.1 C.1(1) Coordination between MOWRAM and MAFF Strengthening Project

(1) Title of Project	Coordination between MOWRAM and MAFF Strengthening Project
(2) Location	Phnom Penh (MOWRAM or/and MAFF)
(3) Objective of Project	To strengthen the coordination between MOWRAM and MAFF for efficient and smooth implementation of irrigated agriculture projects
(4) Site Description	Office buildings located in Phnom Penh
(5) Project Description	It is important to improve the coordination between MOWRAM and MAFF for effective execution of the projects/ implementation of the action plans for irrigated agriculture. In a current condition, it is hard to say the coordination between MOWRAM and MAFF goes very well. Some donors are confused and embarrassed to execute irrigated agriculture projects because both Ministries are required to involve in. Some of the staffs in MAFF are aware of this condition and raise the alarm. In order to improve this condition, it is proposed to establish a "Project Management Group (PMG)" or "Advisory Team" consisting of MOWRAM and PDOWRAM.
(6) Project Components	The following activities are planned: - To hold a participatory workshop. - To organize a Project Management Group/ Advisory Team for implementation of an irrigated agriculture project. - To have regular meetings to exchange the information and the ideas about the irrigated agriculture project. - To monitor and evaluate the irrigated agriculture project jointly. - To publish quarterly reports about the irrigated agriculture project. - To do PR activities of a Project Management Group/ Advisory Team. - To monitor and evaluate the Coordination between MOWRAM and MAFF Strengthening Project.
(7) Cost	US$ 98,000 including price contingency
(8) Executing Agency	MOWRAM and MAFF
(9) Implementation	12 months

9.4.2 C.1(2) Provincial Departments Strengthening Project

(1) Title of Project	Provincial Departments Strengthening Project
(2) Location	Kampong Speu Province and Kandal Province
(3) Objective of Project	To strengthen Provincial Departments for efficient and smooth implementation of irrigated agriculture projects
(4) Site Description	Irrigated farmland and Provincial Department offices in Kampong Speu Province and Kandal Province
(5) Project Description	It can be said that the knowledge and skills of the provincial officers in the fields; planning, designing, and management and O &M of irrigation systems and new high yielding technology are still limited at PDOWRAMs and PDAs. It is said that about 50% of the officers lack the incentives to work due to low salary; however, it is true that there are some officers that are highly motivated but have not developed their potentials.
(6) Project Component	- To hold a participatory workshop on strengths, weaknesses, opportunities, and threats.

	- To seize the opportunities of the training courses, the study tours, and the On-the-Job-Training during the implementation of an irrigated agriculture/ a rainfed agriculture project. - To have technical awards for attained technique and knowledge through the implementation of irrigated agriculture / a rainfed agriculture project. - To have inter-departments/ offices meetings regularly to exchange the information and the ideas about the irrigated agriculture project/ the rainfed agriculture project. - To monitor and evaluate the Provincial Departments Strengthening Project.
(7) Cost	US$ 330,000 including price contingency
(8) Executing Agency	Kampong Speu and Kandal PDOWRAMs and PDAs
(9) Implementation	12 months

9.4.3 C.2(1) Livestock Sub-sector Development Study

(1) Title of Project	Livestock Sub-sector Development Study
(2) Location	Target Area (Kampong Speu & Kandal Province)
(3) Objective of Project	The Study aims at the formulation of an integrated livestock sub-sector development plan in the Target Area for medium and long term development scopes.
(4) Site Description	The livestock sub-sector is the primary income source of farmers in the Target Area and draft cattle are the primary sources of labor for land preparation and transport of farm products. The average holding sizes of livestock per farm household are shown in the right table. However, livestock husbandry in the Target Area is still not very intensive and faces unstable and low productivity. Major constraints include problems in animal health and raising practices. Other constraints are the lack of a comprehensive study on livestock development potential in the environment of the Target Area, including investigations on improvement of genetic resources and feed supply conditions as well as animal health issues. Cattle 2.3 Cow 0.7 Draft Cattle 0.9 Pig 1.0
(5) Project Description	For the enhancement of livestock productivity in the Target Area, the integrated implementation of improvement of genetic resources, development of feed resources and improvement of veterinary services are considered essential. As the sub-sector is a main income source of the farming communities, the development of the sub-sector will be a primary target sub-sector in the long term agricultural development in the Target Area. However, the overall investigations and study on present conditions, development potentials, approach for development and formulation of the integrated development plan are yet to be made. To tackle the said weaknesses in the sub-sector, the Study aims at executing a development study for the formulation of an integrated livestock sub-sector development plan in the Target Area for medium and long term development scopes.
(6) Scope of the Study	- Identification of present conditions (livestock population, genetic resources, feed resources, production, raising practices & systems, diseases, marketing, processing, support systems & activities, the private sector etc.) - Identification of development constraints & potential - Study of integrated livestock development concepts - Formulation of integrated development plan - Technology transfer - Workshops & seminars - Cost estimate & project evaluation
(7) Cost	US$ 1,551,000 including price contingency
(8) Executing Agency	Department of Animal Health & Production, MAFF
(9) Implementation	12 months

9.4.4 C.3(1) Technical Guidelines Preparation Project

(1) Title of Project	Technical Guidelines Preparation Project
(2) Location	Irrigation areas in Zones-1, 2 and 3
(3) Objective of Project	The project aims at preparation of irrigation related technical guidelines such as (i) Irrigation Planning, (ii) Irrigation Design, (iii) Construction Supervision of Irrigation Facilities, and (iv) Irrigation System Operation and Maintenance.
(4) Site Description	In the Target Area, it is observed that some irrigation facilities are not planned or designed properly. This hinders proper function of irrigation facilities and proper water distribution. In addition, dispersive clay soil, which is commonly distributed in the Target Area, has caused problems in irrigation facilities. Canal embankments constructed of such soil were heavily eroded and damaged by water flow. However, it is unavoidable to use the dispersive clay soil as embankment material since it is very costly to bring in other types of soil from very far away. Scientific reasoning and the mechanism of the erosion is not clarified due to lack of basic data.  *A type of damaged canal embankment constructed by dispersive clay soil*
(5) Project Description	The project activity includes preparation of technical guidelines on irrigation planning, design, construction, operation and maintenance by foreign senior irrigation specialists. Standard drawings of irrigation facilities and a check list of works will support the guidelines. The guidelines should be able to be applied to all irrigation projects in the country. This means that the guidelines show only general procedures of planning and design. It should be stressed that planning concepts or design criteria need to be prepared for each irrigation project referring to the guidelines' procedures. As described above, special consideration on dispersive clay soil is required in preparation of the guidelines. Data collection and analysis of the soil in laboratories and on site is required. After collection of such basic data, proper measures for using dispersive clay soil as embankment material will be developed by senior foreign soil mechanical engineers. The effectiveness of such methods needs to be confirmed by experimental construction on site. The procedures developed for treatment of dispersive clay soil will be described in the guidelines. In addition, appropriate irrigation method will be mentioned in the guidelines considering the results of Pilot Projects. The guidelines should be prepared in both the English and Khmer languages. The guidelines also need to be prepared by a participatory approach. The effectiveness of the draft guidelines need to be checked by PDOWRAM irrigation engineers in actual irrigation development as much as possible. Based on findings in such trial usage of the guidelines, they should be revised.
(6) Project Components	- Development of proper measures for use of dispersive clay soil for embankment - Preparation of irrigation planning / design / construction supervision / operation and maintenance guidelines - Distribution of prepared guidelines - Dissemination activity on proper guidelines usage by MOWRAM
(7) Required Cost	US$ 1,725,000 including price contingency
(8) Executing Agency	MOWRAM and PDOWRAM
(9) Implementation	2.5 years

9.4.5 C.4(1) Environmental Management Basic Capacity Development Project

(1) Title of Project	Environmental Management Basic Capacity Development Project
(2) Location	In and around Target Area
(3) Objective of Project	To strength basic capabilities of the relevant staff of MOWRAM and MAFF regarding EIA and environmental management
(4) Project Description	This is the supportive project of implementation of the other projects under the master plan. One of the projects requires environmental impact assessment (EIA) study under the RGC sub-decree, while some others require proper environmental management. This signifies that environmental management capacity is required in order to identify proper environmental management measure for avoidance and/or mitigation of negative impact caused by agricultural practice and sustain the effectiveness of the project with environmentally-friendly approach. On the other hand, both MOWRAM and MAFF have few experiences and knowledge about environmental management for agricultural practice, especially for EIA study. In order to strength their capabilities, two components of activities are proposed in this project, namely, (i) Case study of EIA and preparation of draft TOR, (ii) Training for environmental conservation and management planning. Implementation of the project requires technical support from Ministry of Environment and environmental consultants.   *Images of Workshop/Discussion*
(5) Project Component	1. Case Study of EIA/ Preparation of draft TOR - To conduct case study of EIA as a training (including site visit) - To prepare the check list of EIA for agricultural practices. - To be trained for preparation of draft terms of reference (TOR) of EIA study toward the project that requires EIA study. 2. Training for Environmental Conservation and Management Planning - To clarify causes and mechanisms of the environmental issues related to agricultural practice through discussion among the relevant staff including technical section. - To identify proper management technology/measure for avoidance and/or mitigation of negative impact caused by agricultural practice through discussion among the relevant staff - To summarize those results as "Environmental mitigation sample paper for agricultural practice (tentative)".
(6) Required Cost	US$ 70,000
(7) Executing Agency	MAFF (Office of EIA, Department of Planning and Statistics), MOWRAM (Staff in charge of EIA)
(8) Implementation	2-3 months

9.4.6 C.4(2) Environmental Management Applied Capacity Development Project

(1) Title of Project	Environmental Management Applied Capacity Development Project
(2) Location	In and around the Target Area
(3) Objective of Project	To follow-up environmental management activities and to redeem capabilities of the relevant staff of MOWRAM and MAFF.
(4) Project Description	After the Environmental Management Basic Capacity Development Project, practical implementation of environmental management including EIA study will require to be conducted for implementation of the projects under the master plan on a project-by-project basis. Following the practical implementation under the master plan, "Environmental Management Applied Capacity Development Project" will be conducted at the latter phase of the master plan. This aims to follow-up environmental management activities and capabilities of the relevant staff of MOWRAM and MAFF. For that, this project consists of two components; i.e. (i) Monitoring of Environmental Management Activities, and (ii) Implementation of Follow-up Program. As a first step, external monitoring of the environmental management activities will be conducted with the relevant staff of MOWRAM and MAFF. Based on the results of monitoring including discussion and evaluation among stakeholders, components of the follow-up program including training course will be built up. After that, the follow-up program will be implemented with the relevant staff of MOWRAM and MAFF. As for the follow-up training, the course will focus on the issues to be reinforced toward the relevant staff efficiently. Under the training, the practical paper for "Case Studies of Environmental Management Measures" and the check list for EIA Study which have been published at Environmental Management Basic Capacity Development Project will be modified based on the practical activities. These follow-up will help the capacity more strengthen and sustain the projects under the master plan with environmentally-friendly approach. Implementation of the project requires technical support from Ministry of Environment and environmental consultants.  *Images of Monitoring/ Training*
(5) Project Component	1. Monitoring of Environmental Management Activities - To monitor and review environmental activities with external experts - To make clear the condition of environmental management - To formulate the follow-up program including the follow-up training course in order to redeem both environmental management activities and skills. 2. Implementation of Follow-up Program - To conduct the follow-up training toward the relevant staff - To conduct the follow-up activities - To modify the check list for EIA and the practical paper for "Case Studies of Environmental Management Measures" to be more practical.
(6) Required Cost	US$ 520,000 including price contingency
(7) Executing Agency	MAFF (Office of EIA, Department of Planning and Statistics), MOWRAM (Staff in charge of EIA)
(8) Implementation	4 years

9.4.7 C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project

(1) Title of Project	Irrigated Agriculture On-farm Technology Improvement Pilot Project
(2) Location	Upstream of the irrigation system where the efficient water use is most probable. Zone-1: A tertiary block in Kandal Dom commune which is within the upstream command area of SMC. Zone-3: Standard water harvesting irrigation systems will be selected.
(3) Objective of Project	The project aims at establishment of on-farm level efficient water use models in irrigated agriculture areas.
(4) Site Description	Hydrological analysis in the master plan study concluded that water resources were so limited for agricultural development of the Target Area. Thus, the necessity of efficient irrigation water use is emphasized in the master plan. However, in the Target Area, proper irrigation water management is not practiced. The reasons for this improper water management are (i) hardware constraints (such as insufficient provision of irrigation facilities) and (ii) software constraints (such as lack of water distribution schedules). In some advanced areas, secondary canals, tertiary canals and structures on the secondary canals are currently in existence but water is not used efficiently due to insufficient on-farm facilities and software constraints. The photo on the right shows an advanced area in Kandal Dom commune located upstream of SMC.  *Turnout Structure on Secondary Canal (RS-3) to Tertiary Canal (RT-2)*
(5) Project Description	The government's responsibility is to operate the major irrigation system, and the FWUCs' responsibility is to operate the minor systems, say on-farm system. However, no on-farm irrigation block in the Target Area is using irrigation water efficiently, so that it is essential to establish a model of efficient water use. As the first step of improvement, on-farm level improvement is required. Efficient water use could be achieved by collaboration with (i) FWUCs/FWUGs/WUGs and (ii) the government. The project plans to increase the water management capabilities of all the stakeholders at the same time. It is expected that such simultaneous capacity development will make the involved stakeholders realize their responsibilities. If the project activities start without proper irrigation facilities, farmers in the area will be discouraged regarding the project activities. The pilot project areas need to be selected considering this matter. If there could not find proper pilot project area from this viewpoint, minimum facilities should be constructed for smooth execution of proper water management activities. In Zone-3, project approach is quite different from Zone-1 since the available water is so limited. Water management and farming practice should also be conducted in different manner with Zone-1. The Pilot Project activities should be therefore planned and executed in due consideration of the above. The Pilot Project site will be selected considering that the small reservoir functions well for irrigation water supply subject to no provision of additional facilities. The project activity also includes introduction of improved farming practice in irrigated agricultural land. Introduction of improved farming practice could increase rice yield and encourage farmers to join project activities since only water management could not give ant incentive to farmers. The effect of the pilot project will be disseminated to the outer areas of the pilot project by implementing the "Irrigated Agriculture Improvement Model Project" after the pilot project.
(6) Project Components	The following practices will be conducted for Zone-1

	- Preliminary landholding map preparation - Water use map preparation - Water loss identification and minimization - FWUC sub-group establishmentt - FWUC administration improvement. - Proper irrigation water use education - Irrigation service plan preparation - On-farm irrigation facility construction - Watercourse construction/rehabilitation - Water management training - FWUC meeting building construction The following practices will be conducted for Zone-3 - Preliminary landholding map preparation - Water use map preparation - FWUC establishment - Reservoir capacity clarification - Irrigation service plan preparation - Water management training The following practices will be conducted for Zone-1 and Zone-3 - Farmer-to farmer low input SRI extension - Farmers' group strengthening - Experimental trial of improved farming practice - Execution of small scale adaptability tests for planting method, field level water management, fertilizer trail, variety trial, and upland crop cultivation trail
(7) Cost	US$ 800,000 (including cost for additional on-farm facilities)
(8) Executing Agency	MOWRAM, MAFF, PDOWRAM, and PDA
(9) Implementation	2 years

9.4.8 C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project

(1) Title of Project	Irrigation Facility Maintenance Capacity Strengthening Pilot Project
(2) Location	Model project areas in Zones-1, 2 and 3. For Zones-1 and 2, the model project areas will be tertiary blocks. For Zone-3, the model area will be an area which has a small reservoir/pond.
(3) Objective of Project	The objective of the project is to establish a good model for irrigation facility maintenance in an irrigated agricultural area.
(4) Site Description	FWUCs are not formed for entire irrigated agricultural area in the Target Area. Even the existing FWUCs are not active and incomplete. Some FWUCs only are collecting ISF for O&M of irrigation facilities but collection rate is still low. Reasons for this inactivity are (i) insufficient water, mainly in the dry season when farmers really need the water, and (ii) less irrigation facility, especially for on-farm facility.  *A Sample of irrigation area with no provision of on-farm facility*
(5) Project Description	The project activities need to be executed in irrigated agricultural areas which have proper irrigation facilities to control and measure irrigation water. In Zone-3, the small reservoir supplying water to the irrigation area needs to function well. For this, it is indispensable to observe rainfall in advance, to clarify the storage condition of reservoir. If there are no proper irrigation facilities in the Target Area, such facilities should be constructed during the activities. It is also necessary that water is properly distributed to the fields by proper irrigation facilities. If activities start without proper irrigation facilities, farmers in the Target Area will be discouraged regarding the project activities. The project activity is mainly strengthening of FWUC/FWUGs/WUGs, since maintenance of on-farm irrigation facilities should be done by FWUC, FWUGs and WUGs. To maintain such facilities, ISF should be collected from water users and properly saved. Next, long-term rehabilitation plans for the facilities need to be prepared. Saved funds need to be made available for repairing and maintaining on-farm facilities. The long-term rehabilitation plan for the facilities needs to be revised based on the results of such rehabilitation works to reflect the lessons learned. Proper attention of the FWUC leaders should be given to collection and usage of ISF. The projects also include procedures for acquiring budgets/funds for annual maintenance and periodic replacements (for gates, etc.) by a responsible government agency.
(6) Project Components	- Problem analysis of selected FWUCs and FWUGs - Awareness raising campaign on the importance of facility maintenance - Preparation of a long-term rehabilitation plan by the FWUCs - Establishment of local rules of the FWUCs/FWUGs/WUGs on ISFcollection - Preparation of a long-term rehabilitation plan for major facilities by a responsible government agency - Setting procedure for acquisition of maintenance budgets/funds for large-scale irrigation facilities by a responsible government agency
(7) Cost	US$ 909,000
(8) Executing Agency	MOWRAM and PDOWRAM
(9) Implementation	2.5 years

9.4.9 C.7(1) Rainfed Agriculture Improvement Pilot Project

(1) Title of Project	Rainfed Agriculture Improvement Pilot Project
(2) Location	Zone-4 (rainfed paddy areas) of Target Area
(3) Objective of Project	The project aims at development of an improved rainfed rice cultivation system.
(4) Site Description	Rainfed paddy cultivation occupies the largest land within the Target Area. The Zone-4 area is estimated at 23,980ha and its extensive distributions are found in the Target Area located away form the Prek Thnot River. Rainfed paddy fields are solely used for a single cropping of rice in the rainy season, and unstable rainfall distribution and traditional farming practices bring about unstable and low productivity of paddy.
(5) Project Description	For the attainment of the target of improvement of agricultural productivity in the Target Area, the improvement of rainfed agriculture should be sought through the integrated interventions of agronomic, extension and farmers' organizational approaches. The strategies established in the master plan include: (a) Improvement of rice productivity is envisaged by the introduction of improved farming practices; in this regard, the expansion of low input SRI in Kampong Speu Province and promising results obtained in such fields in 2005 indicate the possibility for the attainment of the target, and (b) Improvement of rice productivity supported by the strengthening of agricultural support services is envisaged.  *Modified SRI Field (rainfed) Medium Variety/Riang Chery*  *CARDI Demonstration Plot (rainfed) Early Variety/Sen Pidao* The development approaches taken under the project include: - To test/verify the adoptability of improved rainfed rice farming practices, - To organize small-scale farmers' groups as target groups of extension services and train selected members as village extension agents, - To implement agricultural support programs including demonstrations, farmers' training, workshops, study tours and farmers' field days, - To involve agricultural government agencies (MAFF/CARDI and PDA) and NGOs having experience in rainfed rice cultivation activities and to the promote collaborative activities of such institutions, - Feed back the results and findings of the project to the master plan, and - Apply useful local knowledge obtained from the successful models.
(6) Project Components	- Development of improved rainfed rice farming practice including a system of low input SRI, - Verification of adoptability of the tested or developed improved rainfed rice farming practice with the participation of the farmers (plot demonstrations), - Organize small-scale farmers' groups as target groups of extension services and train selected members as village extension agents, and - Support implementation of agricultural support programs by PDA/DAO. After completion of the pilot project, the results and findings obtained should be disseminated in the remaining Zone-4 area by implementing the "Rainfed Agriculture Improvement Project" and "Institutional and Agricultural Support

	Services Strengthening Project" as proposed in the master plan.
(7) Cost	US$ 100,000
(8) Executing Agency	MAFF, PDA in collaboration with NGOs
(9)Implementation	2 years

9.4.10 C.8(1) Community Inland Fisheries Development Pilot Project

(1) Title of Project	Community Inland Fisheries Development Pilot Project
(2) Location	Model project area in Zone-3: the model project area should have small reservoirs for irrigation or natural ponds in good condition. The reservoirs/ponds are also required to be free of flooding throughout the year.
(3) Objective of Project	The project aims at establishment of a productive community inland fishery model.
(4) Site Description	There are many small reservoirs/ponds on small tributaries in and around the Target Area. The man-made reservoirs/ponds are normally constructed for irrigation purposes. However, most of the reservoirs are shallow and thus storage capacity is generally small. The reservoirs/ponds are filled with water but dry in the dry season due to their small storage capacity.  *A type of small reservoir for irrigation in the Target Area*  *Another type of small reservoir for irrigation in the Target Area*
(5) Project Description	There is a possibility to promote inland fish culture in small reservoirs/ponds in the rainy season. But, water availability should be carefully checked before starting the promotion. Since river flow data for small tributaries are not available, proper procedure for selecting the sites should be developed. Also farmers' willingness to accept introduction of community inland fishery should be confirmed. For these purposes, the execution of a Pilot Project on community inland fishery development is required. Since the main purpose of storing water in the reservoirs/ponds is not inland fishery but irrigation, inland fishery activities should be cooperated well with the irrigation activities. In this connection, the organization responsible for O&M of the reservoir/pond for irrigation purpose, FWUC, will be selected as the target group of the project. Income obtained from the inland fishery production could be used as a fund to pay for O&M of the irrigation facilities.
(6) Project Components	- Provision of fingerlings, fertilizers, fishing gear and fishing boats for initial set up - Organize seminars on introduction of inland fishery - Provision of field guidance - Preparation of a field extension manual
(7) Required Cost	US$ 110,000
(8) Executing Agency	PDA and DAO
(9) Implementation	2 years
(10) Environmental Management/ Social Considerations	(i) Careful selection of site and fish as fingerlings at the design phase (ii) Explanation of environmental risks (iii) Regular monitoring of the environmental and management condition of the reservoirs

9.4.11 C.9(1) River Basin Effective Water Use Awareness Raising Project

(1) Title of Project	River Basin Effective Water Use Awareness Raising Project
(2) Location	The Prek Thnot river basin. Especially the irrigated areas in Zones-1, 2 and 3 (First priority: Zone-1: Second priority: Zone-2: Third priority: Zone-3)
(3) Objective of Project	The objective of the project is to raise the awareness and knowledge of the farmers in the river basin on efficient water use by introducing them to the results of the "Irrigated Agriculture On-farm Technology Improvement Pilot Project".
(4) Site Description	(River basin) According to the hydrological analysis in the master plan, water resources of the Prek Thnot river are revealed to be very limited. This means that such limited water resources should be used effectively with proper river basin level water management. Even now, it is obvious that there are many water users in the upstream of the Prek Thnot river. Since the hydrological model applied in the master plan considered such water users in the model, it can be said that the model is accurate for the present. However, the model might not be accurate in the future if the upstream situation changes. It is said by some government officers that deforestation is progressing in the upstream area of the Prek Thnot river basin. It is also feared that reclamation of the upstream area makes people in the upstream area take more water from Prek Thnot river.  *Situation of upstream area of Prek Thnot river* (Downstream irrigation area) The participatory survey conducted in the master plan study shows that farmers' knowledge on irrigation in the Target Area is limited. Water is not distributed properly and irrigation service fees are not being paid by the users. Most of the farmers seem to misunderstand the necessity of such important activities. The reasons for this insufficient knowledge might be that (i) farmers are discouraged by poor water delivery from the irrigation system, (ii) farmers are not aware of the importance of proper operation and maintenance of irrigation systems, and (iii) farmers do not understand or were not instructed on how to operate the irrigation systems properly.  *A Sample of Secondary Canal not Operated Properly basin*
(5) Project Description	The project is composed of two stages: <u>Stage-1 (River Basin Water Use Study)</u> In the master plan, water availability at Roleang Chrey regulator was estimated by hydrological model analysis. However, the current model will not be fitted if the situation of the upstream area changes in the future. In this connection, a river basin water use study is required. Water users of the Prek Thnot river need to be surveyed and listed periodically (at least every five years). When new water users

	are found, water allocation rules should be determined that will be fait to both the new water users and existing water users. Another objective of the study is to transfer technology to MOWRAM staff on how to conduct river basin water use studies. It is planned that the study will be executed on a project basis the first time (five years after the master plan formulation) and all the technical skills will be transferred to MOWRAM officials in that study period. Each of the following studies will be routinely conducted by MOWRAM every five years. <u>Stage-2 (Awareness Raising Campaign)</u> The project aims at creating mutual understanding among the stakeholders that are related to the irrigation systems. In this regard, upstream farmers play a key role in saving water. The upstream farmers should understand how severe the downstream situation is. Downstream farmers should also understand that the upstream farmers understand that the situation is severe and that the downstream farmers need to start to take action. These kinds of discussions should be entered into by the farmers themselves in the basin level conferences. It is also important that irrigation farmers keep the importance of water saving in their minds and take action for it. To encourage them to take action, dissemination material should be distributed to them. Distribution of calendars with water management schedules might be a good dissemination material for farmers. In addition, various other types of dissemination materials need to be distributed to them after confirming their effects. To motivate the farmers to take action, it is important to introduce the possibility of irrigated agriculture as practiced by farmers in the Target Area. Status and effects of the "Irrigated Agriculture On-farm Technology Improvement Pilot Project" need to be introduced to the farmers in the other areas. It is also important that the government should prepare a legal water rights system or a water law urgently.
(6) Project Components	<u>Stage-1 (River Basin Water Use Study)</u> - Acquisition of satellite images of the river basin - Inventory survey of water users in the river basin - River basin vegetation analysis by remote sensing technology - Propose proper water allocations between water users, if required - Propose proper measures for mitigating the effects of deforestation, if required <u>Stage-2 (Awareness Raising Campaign)</u> - Organize seminars on efficient water use at the government level - Organize awareness raising seminars on efficient water use - Establish study tours on efficient water use - Distribute dissemination material to irrigation farmers - Organize basin level conferences on efficient water use with stakeholders related to irrigation in the Target Area
(7) Cost	US$ 633,000 including price contingency
(8) Executing Agency	MOWRAM, MAFS, PDOWRAM and PDA
(9) Implementation	3 years

9.4.12 C.10(1) Institutional and Agricultural Support Services Strengthening Project

(1) Title of Project	Institutional and Agricultural Support Services Strengthening Project
(2) Location	The Target Area (Kampong Speu & Kandal Province)
(3) Objective of Project	The present project is proposed as a technical cooperation project with the objectives of: (i) establishment of an institutional set-up responsible for the promotion of agricultural improvement centering on rice in the Target Area at the initial stage of the master plan, (ii) development and extension of improved and sustainable farming technologies on rice production to enhance productivity of the primary agricultural activity in the Area, (iii) development and extension of irrigation water management and O&M technologies and practices for sustaining the irrigation systems in the Target Area and (iv) formation and empowerment of FWUGs, FWUCs, WUGs and other farmers' organizations.
(4) Site Description	The subject project areas are the irrigated and rainfed paddy fields in the Target Area for the master plan.
(5) Project Description	For the attainment of the objectives stated above, the development strategies of the Project have been set as follows; - The insufficient coordination and collaboration between MAFF and MOWRAM appears to be one of the most crucial constraints for the irrigated agricultural development in the Target Area. This Project aims at the establishment of a coordination and collaboration body at the central and project level to tackle such sustained constraints for the development. The project envisages attaining the well coordinated implementation of the Project under the support of the foreign donors, - The Project Management Unit or Project Office organized by staffs of MAFF/PDA and MOWRAM/PDOWRAM should be established in the Target Area as an institute responsible for the integrated & collaborative activities of MAFF & MOWRAM and project implementation, - This project has been formulated with five main components of activities including: (i) institutional strengthening, (ii) improvement of irrigated & rainfed rice production systems with farmers' participation, (iii) establishment of village extension agents (VEAs), (iv) introduction of proper water management & O&M systems and (v) capacity building of farmers' organizations (FWUG/FWUCs/WUGs & other organizations).
(6) Project Components	The project is formulated as a technical cooperation project for the period of 5 years and the project purpose is to establish an institution responsible for the agricultural productivity improvement, Project Management Unit or Project Office, and to strengthen agricultural support services provided through the Project Office. The project's major activities include: (i) institutional strengthening, (ii) improvement of irrigated rice production systems with farmers' participation, (iii) improvement of rainfed rice production systems with farmers' participation, (iv) technical development & extension of upland crops production in paddy fields in early rainy season, (v) establishment of village extension agents (VEAs), (vi) Introduction of proper water management & O&M systems and (vii) capacity building of farmers' organizations as discussed in PDM.
(7) Cost	US$ 2,928,000 including price contingency
(8) Executing Agency	MAFF & MOWRAM
(9) Implementation	6 years

9.4.13 C.11(1) Hydrological Observation Strengthening Project

(1) Title of Project	Hydrological Observation Strengthening Project
(2) Location	Kampong Speu Province
(3) Objective of Project	To strengthen the hydrological data acquisition system for water resources
(4) Site Description	In the past, there was only one automatic rainfall gauging station in the Prek Thnot river basin, which was situated at the Kampong Speu PDOWRAM. Now 10 rainfall automatic gauging stations and 5 water level automatic gauging stations have been established in the basin. From these automatic gauging stations, necessary hourly data on rainfall and water level can be obtained.
(5) Project Description	All the data are to be stored in a data logger and periodic downloading of the data from the data logger will now be required. By downloading and arranging the data, necessary hourly rainfall and water level data become available for analyzing the runoff model and flood forecasting method analysis. In addition, the discharge measurements are needed for preparation of discharge rating curves at the water level gauging stations. The project includes, not only installation of hydrological equipment, but also training of the MOWRAM staff concerned.
(6) Project Components	- Continuation of discharge measurements. - Battery changes, data downloading, and arrangement of downloaded data files by pivotal staff of DHRW under MOWRAM.
(7) Required Cost	US$ 53,000
(8) Executing Agency	MOWRAM
(9) Implementation	2 years

9.4.14 C.11(2) Flood Forecasting and Warning Study

(1) Title of Project	Flood Forecasting and Warning Study
(2) Location	Kampong Speu Province
(3) Objective of Project	To prepare a flood forecasting and warning system plan for mitigation of flood damage in the downstream basin of the Prek Thnot river
(4) Site Description	In the Prek Thnot River downstream basin, flooding has often occurred and brought damage to the people in the area. Since the Prek Thnot River basin has a rather high mountainous area, the runoff is very rapid compared with those of the Mekong and the Bassac Rivers. Due to the absence of a flood forecasting and warning system, the people have been suffering from the sudden inundation in the area.
(5) Project Description	Now that the hydrological observation system has been established in the basin, hydrological analysis of the Prek Thnot river basin will soon be possible based on the data collected by the observation system. Based on the hydrological analysis, it will be possible to make flood forecasts in the basin. And based on the flood forecasts, a flood warning could be given to the people in the basin and the flood damage to the people could be mitigated.
(6) Project Components	- Data arrangement of rainfall and water level in the basin - Preparation of runoff and inundation models - Analysis of relationships between water level upstream, rainfall in the upstream basin, and the water level in the downstream reaches and the inundation area. - Analysis of hydrological impact to the downstream basin of the Prek Thnot River on gate operation of the Roleang Chrey regulator and Kandal Stueng regulator.
(7) Cost	US$ 120,000
(8) Executing Agency	MOWRAM
(9) Implementation	3.5 months

9.5 Implementation Plans for Short - Medium Terms

9.5.1 Concept of Implementation Plans

The master plan will be implemented over 10 years from 2006 to 2015, which is proposed in Section 8.3. Twenty seven projects/studies are proposed and will be implemented over the 10 years in the following concept:

- Out of 10 years, the first 5 years from 2006 to 2010 will focus on the "decentralization", and the latter 5 years from 2010 to 2015 on "privatization" although it should be actually started from 2006. Thus, the proposed projects/studies will be implemented with these focus points in mind.
- Out of the 27 proposed projects/studies, some pilot projects are to be undertaken as bridgeheads to obtain and reflect the lessons learnt upon the subsequent large scaled irrigated and/or rainfed agriculture improvement projects. Thus, pilot projects should be implemented at an early stage.
- As mentioned frequently, an integrated approach to hardware and software is essential for achieving the target as planed. This matter should also be taken into consideration in preparation of the implementation plans.
- In improvement of irrigated agriculture, implementation should proceed from upstream to downstream to ensure the project benefits will accrue as soon as possible. This procedure should be introduced into the implementation plans.

9.5.2 Implementation Plans

Based on the concept for preparation of the implementation plans mentioned above, the implementation plans for the 27 proposed projects/studies will be worked out. The elaborated implementation plans are given in Table 9.5.1.

9.6 Required Cost for Implementation

9.6.1 Project Cost

(1) Basic Conditions and Assumptions

The project cost for the 27 projects/studies was estimated using the following conditions and assumption:

(a) The cost estimate refers to the prices as of January 2006.

(b) Unit prices of labor, construction materials, engineering works, etc., were collected from MOWRAM and the market.

(c) Construction is to be undertaken on a contract basis, and bidding of contractors is to be done based on the work volume and technical requirements.

(d) Project cost comprises i) direct construction cost, ii) administration cost, iii) engineering service cost, iv) agricultural support service cost v) cost of formation and strengthening FWUC/FWUGs/WUGs, vi) O&M equipment and viii) contingencies

(e) Administration cost is 10% of direct construction cost.

(f) The cost of O&M equipment is 1% of direct construction cost.

(g) Contingencies comprise physical contingency and price escalation. The physical contingency is 10% of the Project cost.

(h) Price escalation is evaluated based upon 2.5% per annum for the foreign currency portion and 7.5% per annum for the local currency portion.

(i) The institutional development cost includes the cost for training, extension, and other support services identified in the support programs.

(j) The conversion rate is assumed at US$ 1.0 = Riel 4,070 (as of January 2006).

Table 9.5.1 Implementation Plan for Short and Medium Terms

No.	Code No.	Proposed Improvement Projects/Studies / Name of Projects/Studies	Short Term / Medium Term																																					
			2006				2007				2008				2009				2010				2011				2012				2013				2014				2015			
			I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Scheme-wise Improvement																																									
		Zone -based Approach (Zone-1)																																							
1	A.1(1)	Irrigated Agriculture Impovement Model Project																																							
2	A.1(2)	Upper North Main Canal Irrigated Agriculture Improvement Project																																							
3	A.1(3)	Upper South Main Canal Irrigated Agriculture Improvement Project																																							
		Zone -based Approach (Zone-2)																																							
4	A.2(1)	Lower North Main Canal Irrigated Agriculture Improvement Project																																							
5	A.2(2)	Lower South Main Canal Irrigated Agriculture Improvement Project																																							
6	A.2(3)	Ou Krang Ambel Irrigated Agriculture Improvement Project																																							
		Zone -based Approach (Zone-3)																																							
7	A.3(1)	Water Harvesting Irrigated Agriculture Improvement Project																																							
8		Zone -based Approach (Zone-4)																																							
	A.4(1)	Rainfed Agriculture Improvement Project																																							
		Zones Crosscutting Approch																																							
9	B.1(1)	Roleang Chrey Gates Urgent Improvement Project																																							
10	B.1(2)	Roleang Chrey Regulator and Intakes Improvement Project																																							
11	B.2(1)	Veterinary Services Strengthening and Livestock Raising Improvement Project																																							
12	B.3(1)	Community Inland Fisheries Development Project																																							
13	B.4(1)	Income Generation Project for Marginal Farmers																																							
Subject-wise Improvement																																								
14	C.1(1)	Coordination between MOWRAM and MAFF Strengthening Project																																							
15	C.1(2)	Provincial Departments Strengthening Project																																							
16	C.2(1)	Livestock Sub-sector Development Study																																							
17	C.3(1)	Technical Guidelines Preparation Project																																							
18	C.4(1)	Environmental Management Basic Capacity Development Project																																							
19	C.4(2)	Environmental Management Applied Capacity Development Project																																							
20	C.5(1)	Irrigated Agriculture On-farm Technology Improvement Pilot Project																																							
21	C.6(1)	Irrigation Facility Maintenance Capacity Strengthening Pilot Project																																							
22	C.7(1)	Rainfed Agriculture Improvement Pilot Project																																							
23	C.8(1)	Community Inland Fisheries Development Pilot Project																																							
24	C.9(1)	River Basin Effective Water Use Awareness Raising Project																																							
25	C.10(1)	Institutional and Agricultural Support Services Strengthening Project																																							
26	C.11(1)	Hydrological Observation Strengthening Project																																							
27	C.11(2)	Flood Forecasting and Warning Study																																							

(2) Project Cost

Based on the basic conditions and assumptions, the project cost including price contingency is estimated at US$ 75,153,000, of which the annual disbursement is given below:

Project Cost

(Unit:US$000)

Projects/Studies	Total Cost	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
(1) Scheme-wise Improvement											
(a) Zone-1											
A.1(1) Irrigated Agriculture Improvement Model Project	1, 679				737	917	10	11	4		
A.1(2) Upper North Main Canal Irrigated Agriculture Improvement Project	11, 332						710	2, 732	5, 453	2, 187	250
A.1(3) Upper South Main Canal Irrigated Agriculture Improvement Project	9, 871						549	2, 103	4, 467	2, 397	355
(b) Zone-2											
A.2(1) Lower North Main Canal Irrigated Agriculture Improvement Project	3, 190							965	1, 554	671	
A.2(2) Lower South Main Canal Irrigated Agriculture Improvement Project	15, 183						3, 040	4, 728	3, 152	2, 249	2, 014
A.2(3) Ou Krang Ambel Irrigated Agriculture Improvement Project	7, 219							3, 038	3, 590	591	
(c) Zone-3											
A.3(1) Water Harvesting Irrigated Agriculture Improvement Project	7, 427					129	1, 447	2, 160	2, 117	832	742
(d) Zone-4											
A.4(1) Rainfed Agricultural Improvement Project	2, 975				595	595	595	595	595		
(e) Zones Crosscutting											
B.1(1) Roleang Chrey Regulator Gates Urgent Improvement Project	75	75									
B.1(2) Roleang Chrey Regulator and Intakes Improvement Projec	4, 786				382	2, 710	1, 694				
B.2(1) Veterinary Services Strengthening and Livestock Raising Improvement Project	377				76	75	75	75	76		
B.3(1) Community Inland Fisheries Development Project	413						79	79	81	84	90
B.4(1) Income Generation Project for Marginal Farmers	679				91	108	149	166	165		
Sub-total	65, 206				1, 881	4, 534	8, 348	16, 652	21, 254	9, 011	3, 451
(2) Subject-wise Improvement											
C.1(1) Coordination beteeen MOWRAM and MAFF Strengthening Project	98				98						
C.1(2) Provincial Departments Strengthening Project	330				330						
C.2(1) Livestock Sub-sector Development Study	1, 551				1, 551						
C.3(1) Technical Guidelines Preparation Project	1, 725				690	863	172				
C.4(1) Environmental Management Basic Capacity Development Project	70	35	35								
C.4(2) Environmental Management Applied Capacity Development Project	520							156	104	104	156
C.5(1) Irrigated Agriculture On-farm Technology Improvement Pilot Project	800	300	400	100							
C.6(1) Irrigation Facility Maintenance Capacity Strengthening Pilot Project	909				345	460	104				
C.7(1) Rainfed Agriculture Improvement Pilot Project	100	45	45	10							
C.8(1) Community Inland Fisheries Development Pilot Project	110				50	60					
C.9(1) River Basin Effective Water Use Awareness Raising Project	633				253	316	64				
C.10(1) Institutional and agricultural Support Services Strengthening Project	2, 928					293	586	586	586	586	291
C.11(1) Hydrological Observation Strengthening Project	53	26	27								
C.11(2) Flood Forecasting and Warning Study	120		120								
Sub-total	9,947	406	627	110	3,317	1,992	926	742	690	690	447
Total	75,153	406	627	110	5,198	6,526	9,274	17,394	21,944	9,701	3,898

(3) Cost for the Eight Scheme-wise Improvement Projects

The costs for implementation of each project are summarized below.

Cost for Eight Scheme-wise Improvement Project (Unit:Thousand US Dollar)

Item	RC	UNMC	USMC	Model	O' Krang	LNMC	LSMC	WH	Total
(1) Direct Construction Cost									
1) Regulator & Intakes	3,259	−	−	−	−	−	−	−	3,259
2) Main Canal	−	5,681	4,188	832	2,900	−	1,025	−	14,626
3) Secondary, tertiary canals	−	819	1,511	263	1,266	1,817	7,795	124	13,595
4) Water harvesting	−	433	311	−	252	−	599	4,570	6,165
(2) O&M equipment	30	63	55	10	40	17	86	43	344
Sub-total	3,289	6,996	6,065	1,105	4,458	1,834	9,505	4,737	37,989
(3) Engineering service cost	403	771	628	171	474	308	875	471	4,101
(4) Formation and strengthening FWUC	−	51	65	25	59	26	114	16	356
(5) Agricultural support services	−	42	54	23	49	24	113	8	313
Sub-total Σ((1) - (5))	3,692	7,860	6,812	1,324	5,040	2,192	10,607	5,232	42,759
(6) Physical contingency	369	786	681	132	504	219	1,061	523	4,275
	4,061	8,646	7,493	1,456	5,544	2,411	11,668	5,755	47,034
(7) Price Contingency	725	2,686	2,378	223	1,675	779	3,515	1,672	13,653
Total	4,786	11,332	9,871	1,679	7,219	3,190	15,183	7,427	60,687

RC : Roleang Chrey Regulator and Intake Improvement Project
UNMC : Upper North Main Canal Irrigated Agricultural Improvement Project
USMC : Upper South Main Canal Irrigated Agricultural Improvement Project
Model : Irrigated Agricultural Improvement Model Project
O'Krang : Ou Krang Ambel Irrigated Agricultural Improvement Project
LNMC : Lower North Main Canal Irrigated Agricultural Improvement Project
LSMC : Lower South Main Canal Irrigated Agricultural Improvement Project
WH : Water Harvesting Irrigated Agriculture Improvement Project

Annual Disburesement Schedule of Eight Projects (Unit:1000 US$)

Project	2009	2010	2011	2012	2013	2014	2015	Total
RC	382	2,710	1,694					4,786
UNMC			710	2,732	5,453	2,187	250	11,332
USMC			549	2,103	4,467	2,397	355	9,871
Model	737	917	10	11	4			1,679
O'Krang				3,038	3,590	591		7,219
LNMC				965	1,554	671		3,190
LSMC			3,040	4,728	3,152	2,249	2,014	15,183
WH		129	1,447	2,161	2,117	832	741	7,427
Total	1,119	3,756	7,450	15,738	20,337	8,927	3,360	60,687

9.7 Project Evaluation

9.7.1 General

The objectives of the master plan evaluation are to determine the economic viability of the conceived projects using EIRR and the effects on the farmers' economy applying farm budget analysis in order to assure the viability of the projects selected for further detailed study, i.e. a feasibility study.

The analysis and discussion in this section focuses on the economic viability of the selected projects. Since each project has various aspects that should be taken into consideration when comparing it with the others, looking at them from all angles, including economic viability, is to be carried out continuously by the Study Team.

For the master plan, more than twenty different projects were conceived, consisting of (1) Scheme-wise Improvement Projects based on the zoning mentioned previously, coupled with zone crosscutting activities, and (2) Subject-wise Improvement Projects that address particular issues, aspects and sub-sectors.

The economic evaluation was conducted on a total of 9 selected projects from the Scheme-wise Improvement Project category. However, because there are close hydrological relationships between them, it was considered appropriate to evaluate the set of projects together where appropriate, rather than separately evaluating projects singly.

The list of 9 evaluated projects is shown in the following table.

Evaluated Projects for each Zone

Zones	No.	Code	Description	Command Area (ha)
Zone Crosscutting	1.	RC	Roleang Chrey Regulator and Intakes Improvement Project	16,700
Zone-1	2.	IAIMP	Irrigated Agriculture Improvement Model Project (IAIMP)	570
	3.	UNMC	Upper North Main Canal Irrigated Agriculture Improvement Project	2,210
	4.	USMC	Upper South Main Canal Irrigated Agriculture Improvement Project	2,880
Zone-2	5.	LNMC	Lower North Main Canal Irrigated Agriculture Improvement Project	1,390
	6.	LSMC	Lower South Main Canal Irrigated Agriculture Improvement Project	6,750
	7.	-	Ou Krang Ambel Irrigated Agriculture Improvement Project	2,900
Zone-3	8.	-	Water Harvesting Irrigated Agriculture Improvement Project	1,200
Zone-4	9.	-	Rainfed Agriculture Improvement Project	23,380

Some explanations regarding the relationships between the above-listed projects are;

(1) The Roleang Chrey Regulator and Intakes are situated at the upper-most portion of the Prek Thnot River in the Target Area, and is the key structure for all connected irrigation schemes in the down stream. All these connected schemes (No. 2 to 7 in the above table) are assuming the improvement of Roleang Chrey Regulator and Intakes, as a precondition for their own improvement.

(2) The Irrigated Agriculture Improvement Model Project (IAIMP) and Upper South Main Canal (USMC) Irrigated Agriculture Improvement Project in Zone-1, and the Lower South Main Canal (LSMC) Irrigated Agriculture Improvement Project in Zone-2, are connected by SMC running through them from upstream to downstream. As it is easily be understood, improvements of the schemes situated downstream will require the prior improvement of the other scheme(s) upstream.

(3) Likewise, the Upper North Main Canal (UNMC) in Zone-1, and the Lower North Main Canal (LNMC) and Ou Krang Ambel Irrigation in Zone-2 are connected; however, the Ou Krang Ambel only connects UNMC with a branch canal., While improvement of UNMC will be a precondition for the improvement of LNMC in this set of projects, improvement of UNMC is not a precondition for the Ou Krang Ambel improvement because UNMC is currently supplying adequate water to the Ou Krang Ambel irrigation scheme.

Taking the above situation into consideration, an economic evaluation was conducted for the 9 Project Implementation Scenarios as listed following.

1) Roleang Chrey (RC) Regulator and Intakes Improvement Project

Taking the implementation of 1) RC as a precondition for the NMC area;

2) RC + UNMC,

3) RC + Ou Krang Ambel, and

4) RC + UNMC + Ou Krang Ambel + LNMC.

Likewise, for the SMC area;

5) RC + IAIMP,

6) RC + IAIMP + USMC, and

7) RC + IAIMP + USMC + LSMC.

Separately from the above, two more projects for Zones-3 and 4 were analysed. They are;

8) Water Harvesting Irrigated Agriculture Improvement Project, and

9) Rainfed Agriculture Improvement Project.

9.7.2 Economic Evaluations

(1) Evaluation Procedures

All prices for the master plan Evaluation were expressed in constant prices as of January 2006, applying the official exchange rate of USD 1.0 = Riel 4,070. The economic life of the projects is assumed to be 50 years beginning from year 2009, the proposed year for commencement of construction.

Economic farm gate prices of traded agricultural inputs and outputs were based on their export and import parity prices derived from the World Bank Commodity Price Forecasts as of October 2005. A standard conversion factor (SCF) of 0.98 and a shadow wage rate (SWR) of 0.48 were applied for the adjustment of prices and labor costs reflecting the market distortion. Transfer payments such as taxes, duties, subsidies, interest, etc., were excluded in estimating the economic costs and benefits. Financial construction costs were converted into economic values using the construction conversion factors (CCFs).

(2) Economic Benefits

Irrigation and drainage benefits will accrue from the increase in cropping areas and also the increase in productivity of target crops comprising paddy, and upland crops such as mungbeans, and vegetables. The economic benefits were estimated as the increase of net production value between the future "with" and present "without" project conditions.

The irrigation and drainage benefits (increase of net production value) of the respective projects were estimated as follows.

Economic Irrigation and Drainage Benefit of the 9 Evaluated Projects

Zones	No.	Code	Project Area (ha)	Cropping Intensity (%)		Net Production Value (Riel, Million)		
				Without Project	With Project	Without Project	With Project	Increment
Zone Cross-cutting	1.	RC	16,700	*104	*118	7,677.2	9,271.0	1,593.8
Zone-1	2.	IAIMP	570	155	155	622.7	1019.0	375.7
	3.	UNMC	2,210	111	115	1,544.9	2,703.8	1,158.9
	4.	USMC	2,880	100	105	1,730.7	3,124.4	1,393.7
Zone-2	5.	LNMC	1,390	101	119	757.8	1,689.8	984.4
	6.	LSMC	6,750	101	120	3,200.4	8,533.7	5,333.3
	7.	Ou Krang Ambel	2,900	101	119	1,601.6	3,637.5	2,035.9
Zone-3	8.	Water Harvest	1200	101	105	680.9	1252.0	571.1
Zone-4	9.	Rainfed	23,380	100	101	10,708.0	15342.8	4,634.8

** Weighted average of Project No. 2 to 7 in above table.*

In the above table, RC is assuming complete malfunctioning of the gate from 2007 which requires the urgent improvement if no repairs are done. Its present status is judged quite serious and that there is a very high probability that the gates will become inoperable before long. Thereby, net production values for RC 'without' and 'with' in the above table mean 'no action taken' for the former, and 'action taken' for the latter. In other words, RC is the project that will maintain the present production level in all the connected command areas and prevent the water supply from deteriorating. RC can prevent the losses that will occur if no action is taken.

Existing farmlands will be acquired and used for the construction of irrigation and drainage facilities. The agricultural production that will be foregone due to this accumulation of land is defined as the annual net production value without project was counted as a negative benefit in the evaluation.

(3) Economic Cost

The economic construction cost was classified into (i) preparatory works, (ii) direct construction, (iii) O&M equipment, (iv) agricultural support activities, (v) formation and strengthening of the FWUC, (vi) administration, (vii) engineering services, and (viii) physical contingencies. The economic project investment cost was estimated by applying relevant conversion factors to the components of foreign financial and local currency cost comprising equipment, material and labor. The total economic project cost was estimated as follows.

Economic Investment Cost

Zones	No.	Project name/Code	Project Area (ha)	Investment Cost (Riel, Million)	Cost Per ha (Riel '000)
Zone Crosscutting	1.	RC	*16,700	14,542	871
Zone-1	2.	IAIMP	570	5,181	9,089
	3.	UNMC	2,210	30,696	13,889
	4.	USMC	2,880	26,581	9,229
Zone-2	5.	LNMC	1,390	8,598	6,185
	6.	LSMC	6,750	41,163	6,098
	7.	Ou Krang Ambel	2,900	19,665	6,781
Zone-3	8.	Water Harvest	1200	18,814	15,678
Zone-4	9.	Rainfed	23,380	10,616	454

** Project area for RC is the sum of Projects No. 2 to 7 in the above table.*

The financial O&M cost and replacement cost were converted into economic value by applying relevant conversion factors to the components of foreign financial and local currency costs, in the same way as the project investment costs.

The financial O&M cost and replacement cost were converted into economic value by applying relevant conversion factors to the components of foreign financial and local currency costs, in the same way as the project investment costs.

(4) Economic Evaluation

The economic cost and benefit stream comprising (i) the cost of project investment, O&M and replacement, and (ii) irrigation and drainage, and negative benefit was prepared for the economic life of the respective projects and sets of projects. The economic internal rate of return (EIRR) and other indicators were calculated and summarized as follows.

Economic Irrigation and Drainage Benefit of 9 Evaluated Projects' Implementation Scenarios

Evaluated Projects/Sets of Projects		EIRR (%)	NPV in Million Riel (7% discount rate)			
			Benefit	Cost	B-C	B/C
1.	RC	13.6	21,996	15,560	6,436	1.4
2.	RC + UNMC	4.7	31,216	39,149	-7,933	0.8
3.	RC + Ou Krang Ambel	9.4	38,098	30,715	7,383	1.2
4.	RC + UNMC + Ou Krang Ambel + LNMC	6.2	55,367	60,785	-5,418	0.9
5.	RC + IAIMP	10.6	26,232	20,513	5,719	1.3
6.	RC + IAIMP + USMC	6.2	37,430	40,637	-3,207	0.9
7.	RC + IAIMP + USMC + LSMC	7.4	73,866	70,414	3,472	1.0
8.	Water Harvest	0.4	5,216	15,766	-10,550	0.3
9.	Rainfed	17.6	35,032	8,762	26,270	4.0

Some notes on the economic evaluation results shown in above table are as follows:

(a) The benefit achieved by RC is the benefit derived from preventing the complete malfunctioning of the regulator from occurring. In other words, the benefit of preventing the impending crop losses. Most other projects (No. 2 to 7 in the above table) are assuming the prior (or parallel) implementation of RC as a precondition.

(b) Water harvesting irrigation improvement in Zone-3 did not show a good result. Although this is the result of evaluating 49 small reservoir schemes in aggregate, another evaluation conducted for 5 considerably better cost performance small reservoir schemes showed a high figure (EIRR 15.5%). This indicates the needs for selective implementation of the small reservoir schemes in this group.

(c) Rainfed agriculture improvement in Zone-4 performed well in the above evaluation. However, it should be noted here that this achievement is based on the assumption in which the regional level extension officers will continuously perform well in the post-project period and assuming the full-fledged adoption of the introduced technology by a significant portion of the farmers in the area.

9.7.3 Financial Evaluation

The economic analysis of typical farms on net returns from paddy fields under the present and 'with-project' condition was made for the financial analyses of irrigated and rainfed agriculture improvement plans. The assumptions involved in the analyses are as follows;

Assumptions for Farm Economic Analyses

Typical Farms	Holding size of paddy field: 0.7 ha per farm household
Subject of Analysis	Net return from paddy field under present & with-project condition
With-project & Present Farm Net Return from Paddy Field	With-project & present crop budgets are applied for estimation

The results of the analyses are presented in Table 9.7.1 and summarized in the following table.

Results of Farm Economic Analyses (unit: Riel)

Zone/Project	1. Present Net Return from Paddy Field per Farm	2. With-project Net Return from Paddy Field per Farm	Increment per Farm (2 – 1)
Zone-1			
- IAIMP	786,000	1,133,000	347,000
- UNMC	514,000	822,000	308,000
- USMC	446,000	746,000	299,000
Zone-2	385,000	830,000	445,000
Zone-3	433,000	732,000	299,000
Zone-4	234,000	470,000	236,000

As shown in the tables, the anticipated increase in the net return from the paddy fields under the with-project condition are estimated to be in the range of Riel 299,000 to Riel 445,000 from the present levels in the irrigated agricultural improvement projects and the increase in the net return in the rainfed agriculture improvement project in Zone-4 is estimated at Riel 236,000.

9.7.4 Overall Agricultural Development Features under Master Plan

(1) Overall Agricultural Development Features

The overall crop sub-sector agricultural development features of the master plan are presented in the following table.

Overall Agricultural Development Features under the Master Plan

Zone	Annual Paddy Production [1/]	Without Project	With Project	Increment	
				Area/Prod.	% [2/]
Zone-1	Cropped Area (ha)	6,210	6,160	-50	-
	Production (ton)	12,159	18,780	6,621	54
Zone-2	Cropped Area (ha)	11,210	12,640	1,430	13
	Production (ton)	17,841	36,192	18,351	103
Zone-3	Cropped Area (ha)	1,200	1,200	0	-
	Production (ton)	2,160	3,360	1,200	56
Zone-4	Cropped Area (ha)	23,380	23,380	0	-
	Production (ton)	35,070	46,760	11,690	33
Overall	Cropped Area (ha)	42,000	43,380	1,380	3
	Production (ton)	67,230	105,092	37,862	56

[1/]: Cropped area & production of paddy *[2/]: Increment in % to without-project*

As indicated in the table, the characteristic of the present crop sub-sector master plan is defined as production increases of paddy of about 38,000 ton that are realized through the productivity improvement of paddy with no major increase in cropped areas as envisaged in the objective of the Plan. Such productivity improvement is attributed to the improvement of the irrigation status in Zone-1, Zone-2 and Zone-3 with an increase of supplementary irrigated area of 11,600 ha and it is envisaged that this will be obtained through improvement of the rice production system in Zone-4. Major features of the master plan are as tabulated below.

Major Features of Master Plan

Feature	Present/Without	With	Increment
Irrigated Field (ha) 1/	500	500	0
Supplementary Irrigated Field (ha)	5,800	17,400	11,600
Rainfed Field (ha)	35,200	23,380	-11,820
Overall Paddy Yield (ton/ha)	1.6	2.4	0.8

1/: Irrigated field by 80% dependability

(2) Food Balance

The future food balance of rice in the Target Area under the master plan (with-project condition) and the without-project condition was examined with the following assumptions.

Assumptions for Food Balance Study in the Target Area

With-project Condition	The irrigated and rainfed agriculture improvement plans in the master plan are implemented as scheduled. Full development in terms of production is attained in 2019.
Without-project Condition	No change in rice production level in the Area from the present level is assumed in future.
Estimation of Rice Requirements	Annual per capita consumption of rice: 143 kg & seed requirement & post harvest losses of 13% as indicated in Table 9.7.2

The result of the study is indicated in Table 9.7.2 and summarized below.

Food Balance Study in the Target Area

Year		Rice Sufficiency Rate	
		With-project	Present/Without-project
2005	Present Status	-	68%
2015	Final Year of Medium Term 1/	93%	55%
2020	Full Development year 2/	93%	50%

1/: Final year of the Master Plan period

2/: Full development stage of the agricultural improvement plans is attained

As shown in the tables, self-sufficiency in rice in the Target Area, the basic target envisaged in the master plan, is nearly attained in 2015 in the final year of the master plan, which is markedly compared with the same of 55% under the present/without-project condition.

Chapter 10 Environmental Assessment

10.1 Environmentally Related Laws and Regulations in Cambodia

10.1.1 General

Relevant environmental laws and regulations in Cambodia are listed in the following table. The laws prescribe responsibilities of specific agencies and means of managing natural and cultural protected areas, prescribe EIA procedures, and set out standards and criteria for water and air pollution and solid waste management.

The Law on Environmental Protection and Natural Resources Management (LEPNRM) enacted in 1996 was a fundamental legislation focusing on protection, conservation and management of natural environments for sustainable development. The LEPNRM stipulates (i) development of a national and regional environmental plan, (ii) environmental impact assessment, (iii) natural resources management, (iv) environmental protection, (v) monitoring and inspection, and (vi) public participation and information disclosure.

In order to ensure the contents of LEPNRM, the following sub-decrees were issued.

- Sub-decree on the Environmental Impact Assessment Process (1999),
- Sub-decree on Water Pollution Control (1999),
- Sub-decree on Solid Waste Management (1999),
- Sub-decree on Air and Noise Pollution Control (2000).

As for natural resource protection, which is one of the key aspects of the environment, various legislations and declarations were enacted. These include; the Decree on Creation and Designation of Protected Areas in 1993 and LEPNRM in 1996 and the Law on the Protection of Cultural Heritage. The Decree on Creation and Designation of Protected Areas in 1993 designates the country's protected areas under 4 categories, which correspond to international classifications, namely National Parks, Wildlife Sanctuaries, Protected Landscapes, and Multiple Use Management Areas.

As for the law related to land, the Land Law was promulgated in 2001. It was a revision of the Land Law of 1992.

Environmentally related Legislation and Laws

Title	Provisions
Basic Law	
Law on Environmental Protection and Natural Resources Management (1996)	- Development of national and regional environmental plans; environmental impact assessments; natural resources management; environmental protection; monitoring and inspection; public participation and information disclosure; environmental endowment funds; and penalties.
Institution	
Sub-decree on Organization and Functions of Ministry of Environment (1997)	- A National Environmental Plan and Regional Environmental Plans are required to be drawn up, reviewed and revised once every five years. - The functions and the structure of the MOE and the function of each of the seven departments - Each provincial level authority and district is to establish a department of environment and a district agency of environment respectively.
Declaration on the Organization of the Provincial and Municipal Environment Department (1999)	- Provincial and municipal responsibilities in environmental management. - Illegal activities carried out in national protected areas, inspection and monitoring of pollution sources, environmental education programs and data management.

Title	Provisions
EIA	
Sub-decree on the Environmental Impact Assessment Process (1999)	- The project owner shall conduct an IEIA for a project to determine if an EIA is required. If the project requires a full-scale EIA report as determined by the MOE, the project sponsor shall conduct and submit the EIA report. - MOE has the responsibility to evaluate and review the IEIA/EIA reports.
Guideline for conducting Environmental Impact Assessment Report (Draft)	- The project's owners should prepare an EIA report with at least the following contents; 1) Project summary, 2) Introduction, 3) Purpose of the Project, 4) Project Description, 5) Description of Environmental Resources, 6) Public Participation, 7) Environmental Impact Analysis, 8) Environmental Impact Mitigation Measures, 9) Economic Analysis and the Environmental Value, 10) Environmental Management Plan, 11) Institutional Capacity, 12) Conclusions and Recommendations, 13) References.
Protected Area	
Decree on Creation and Designation of Protected Areas (1993)	- National protected areas, which are managed and supervised for the development and protection of natural areas by the Secretariat of Environment, are classified into four categories; 1) National parks, 2) Wildlife sanctuaries, 3) Protected landscapes, and 4) Multiple use areas.
Declaration No.1033 on Protected Areas (1994)	- Prohibited activities include hunting, deforestation, exploitation of minerals, water pollution activities within the protected areas.
Land	
Land Law (2001)	- Some provisions relevant to land ownership and property rights, land acquisition for public works, resettlement aspects and a legal requirement for compensation for land lost
Others	
Sub-decree on Water Pollution Control (1999)	- Standard for effluent discharge from any source of pollution and public water was stipulated. - MOE has responsibility for monitoring of the pollution sources and the situation of the water pollution in public water bodies.
Sub-decree on Solid Waste Management (1999)	- MOE shall establish guidelines on household waste management and hazardous waste management. - The authorities of the provinces and cities shall establish the waste management plan and have the responsibility for the collection, transport, storage, recycling, minimizing and dumping of waste.
Sub-decree on Air and Noise Pollution Control (2000)	- Maximum allowable concentration of hazardous substances in ambient air; maximum allowable standard of pollution substance for immobile sources in the ambient air; ambient air quality standard; and maximum permitted noise level in public areas.

Source; MOE, MOWRAM

The first National Environmental Action Plan for 1998-2002 was prepared by MOE with assistance of the World Bank, UNDP, FAO, UNESCO, and USAID. The plan focuses on the six priority themes, i.e.; (i) forest policy, (ii) fisheries and floodplain agriculture in the Tonle Sap region, (iii) coastal fisheries, (iv) biodiversity and protected areas, (v) energy development and the environment, and (vi) urban waste management. At the moment, the plan has not been revised by MOE.

10.1.2 Environmental Impact Assessment Approval Process

The Sub-decree on the Environmental Impact Assessment (EIA) process enacted in 1999 defines the types of projects for which an EIA is required, together with the EIA approval process. According to the sub-decree, a project owner who plans to develop and/or rehabilitate an irrigation system with a service area of more than 5,000 ha requires approval of the EIA from MOE. Other types of agricultural projects, which require the EIA approval under the Sub-decree on EIA process, are shown in the following table.

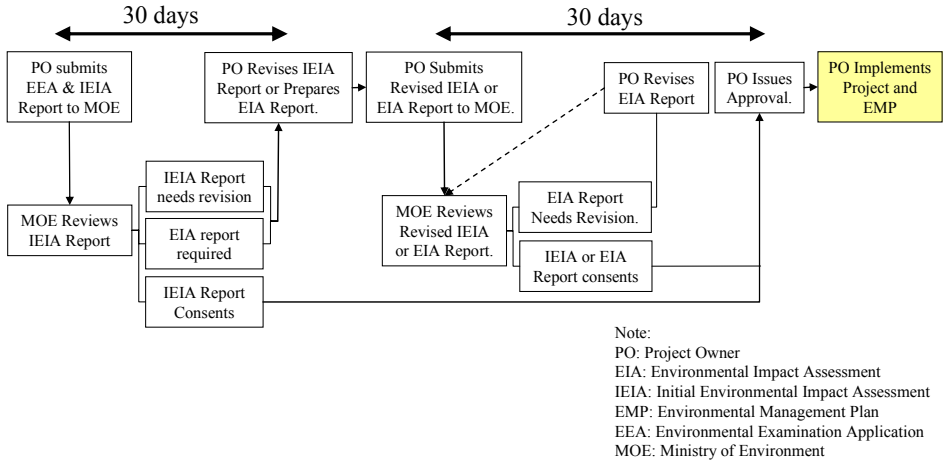
The outline of the EIA approval process is summarized below;

- The Project Owner shall prepare the Initial Environmental Impact Assessment (IEIA) report through investigation of the existing environmental condition, and identification of the magnitude and extent of environmental impacts.
- The Project Owner shall submit the IEIA report with an Environmental Examination Application (EEA) and a pre-feasibility study report to MOE. The IEIA report is required to describe the initial level of environmental examination.
- MOE shall review the IEIA report and determine whether (i) IEIA is approved, (ii) IEIA should be revised, or (iii) a full Environmental Impact Assessment is required with detailed examinations. The result of the review by MOE shall be presented to the Project Owner within 30 days after the submission of the IEIA report.
- The Project Owner, who is informed of a revision to IEIA or of the requirement for the preparation of a full EIA from MOE, shall revise/prepare the required report and submit it to MOE.
- MOE shall review and examine the IEIA/EIA report, and notify the Project Owner of comments or suggestions, if any, within 30 days from submission. The Project Owner can receive the consent of MOE on implementation of the project after any required revision of the EIA report.

Agricultural Sector's Projects Requiring an IEIA in Cambodia

Type and Activities of Projects	Size / Capacity
1. Agriculture	
1) Concession forest	≧10,000 ha
2) Logging	≧500 ha
3) Land covered by forest	≧500 ha
4) Agricultural and agro-industrial land	≧10,000 ha
5) Flooded and coastal forests	All sizes
6) Irrigation systems	≧5,000 ha
7) Drainage systems	≧5,000 ha
8) Fishing ports	All sizes
2. Projects Related to Agriculture	
1) Food processing and canned goods	≧500 ton/year
2) Rice mills and cereal grains	≧3,000 ton/year
3) Chemical fertilizer plants	≧10,000 ton/year
4) Pesticide industry	All sizes
5) Animals food processing	≧10,000 ton/year

Source: Sub-decree on Environmental Impact Assessment Process, 1999



EIA Approval Process

Source: Sub-decree on Environmental Impact Assessment Process, 1999

The guideline for conducting an EIA Report, which is being drafted, stipulates the minimum contents of EIA report as shown below. According to the Department of EIA in MOE, these contents are also adapted to the IEIA report.

Contents of EIA

1. Project Summary
2. Introduction
- Type, size, and location of the project
- Background of the project's location
- Assurances that it falls within the framework of national and international laws and legislation standards.

3. Propose of the Project
4. Project Description
- Briefing alternatives (size, location, timeframe and sources of labor forces, etc)
- The production process (source and quantity of raw materials to be used, etc)
- Machinery required to run the project
- Methodologies of waste disposal in order to determine any environmental impacts
- Description of the quantity and quality of solid and liquid waste to be disposed and discharged, sources of noise and vibration resulting from this project (construction, operation), emission of particles into the atmosphere
- Project planning

5. Description of Environmental Resources
5.1 Physical resources (Air, Water, Land, etc)
5.2 Ecological resources (Bio-diversity, Fauna, Flora, Forest, etc)
5.3 Socio-economical resources (Population and their settlement, Infrastructure, Land use, Public health and welfare, Economic Condition, Custom, Tradition and Ethnic group, etc)

6. Public Participation
- Local authorities and institutions involved, Opinion of the public towards the development project, Consultation, Company interpretation, etc

7. Environmental Impact Analysis
7.1 Methodologies to identify the scope of the environmental impacts (using the matrix table)
7.2 Environmental impacts during project construction
7.3 Environmental impacts during project operation
7.4 Environmental impacts after the project abandonment or closure stage
7.5 The extent and kinds of significant accumulative environmental impacts

8. Environmental Impact Mitigation Measures
9. Economical Analysis and the Environmental Value
- Benefits of the project compared to the value or cost of the local environmental damages.

10. Environmental Management Plan
- Environmental Protection Measures,
- Environmental Monitoring Program,
- Training program, etc

11. Institutional capacity
- Organizational structure, budget, schedule, staff skills, methodological tools and equipment, etc.

12. Conclusions and Recommendations
13. Reference

In the sub-decree on the EIA process, the information disclosure process is not mentioned. However in the draft guideline, it is stipulated that all opinions given by the public, including local authorities and institutions involved in the EIA process, should be addressed for all factors that can contribute to the decision making process.

If the project cost is less than US$2,000,000, the responsibility for review, recommendation and approval of IEIA/EIA has been stipulated to be the authorized Provincial Department of

Environment, while for projects more than US$2,000,000 the report must be submitted to MOE for review and approval.

10.1.3 Relevant Pollution Standards

(1) Water Quality Standard

The Sub-Decree on Water Pollution Control enacted in 1999 prescribes effluent discharge permits, maximum allowable level of effluent waste water to be discharged to public water, water quality standard in public water bodies, such as rivers, lakes and reservoirs and coastal water, and bio-diversity conservation and water quality standards in public water bodies for public health protection. The following table shows the water quality standard for rivers, lakes and reservoirs for bio-diversity conservation.

Water Quality Standard in Public Water bodies for Bio-Diversity Conservation

No	Parameters	Unit	Standard Value
Rivers			
1	pH		6.5 - 8.5
2	BOD	mg/l	1 - 10
3	Suspended Solids	mg/l	25 – 100
4	Dissolved Oxygen	mg/l	2.0 – 7.5
5	Coliform	MPN/100ml	< 5,000
Lakes and Reservoirs			
1	pH		6.5 – 8.5
2	COD	mg/l	1 – 8
3	Suspended Solids	mg/l	1 – 15
4	Dissolved Oxygen	mg/l	2.0 – 7.5
5	Coliform	MPN/100ml	< 1,000
6	Total Nitrogen	mg/l	0.1 – 0.6
7	Total Phosphorus	mg/l	0.005 – 0.05

Source; Annex 4 of Sub-decree on Water Pollution Control

(2) Noise Standard

Maximum permitted noise levels in public areas are described in the Sub Decree on Air and Noise Control enacted in 2000 as shown below.

Maximum Permitted Noise Level in Public and Residential Areas (dB(A))

No	Area	Period of time		
		From 6 am To 6 pm	From 6 pm To 10 pm	From 10 pm To 6 am
1	Quiet Areas, Hospitals, Libraries, Schools, Kindergartens	45	40	35
2	Residential Area, Hotels, Administration offices, Houses	60	50	45
3	Commercial and service area and mix	70	65	50
4	Small industrial factories, intermingling in residential areas	75	70	50

Source; Annex 6 of Sub decree on air and noise pollution

10.1.4 Legal Framework on Land Issues, Resettlement and Compensation

(1) Land Law of 2001

In 2001, RGC enacted the Land Law which has replaced the former Land Law of 1992. The law contains some provisions relevant to land ownership and property rights, land acquisition for public works, resettlement aspects and a legal requirement for compensation for land loss. The Land Law stipulates that private land may only be compulsorily acquired by the State for reasons of public interest and the land owner must be properly compensated in advance. The land law also stipulates which types of land fall within the public domain of the State including (i) those of a natural origin, such as forests, (ii) water, natural lakes, banks of

navigable and floatable rivers and seashores, and (iii) natural reserves protected by the law.

(2) Resettlement Policy and Guideline

No resettlement policy or guideline has been enacted in Cambodia yet. The draft national policy and guidelines are being prepared as a consultative document under the assistance of the Asian Development Bank (ADB). According to ADB, the policy is in line with the ADB Guidelines on resettlement and affirms that affected people will be fully compensated for all assets lost as a result of a project, regardless of whether the affected people have formal title to the land that they occupy and use.

(3) Inter-ministerial Resettlement Committee (IRC)

The Inter-Ministerial Resettlement Committee (IRC) was established on an ad-hoc basis in 1997. Currently, the IRC is responsible for determination of entitlements, land values and appropriate compensations through detailed surveys and public consultations. The membership of the IRC is comprised of the Ministry of Economy and Finance as a chairperson, executing agency and other concerned ministries.

Box 12.1 Case Example of Resettlement

Resettlement Implementation under the Stung Chinit Irrigation and Rural Infrastructure Project (MOWRAM, MRD, ADB), 1996-

MOWRAM, jointly with the Ministry of Rural Development (MRD), have been implementing Stung Chinit Irrigation and Rural Infrastructure Project in Kompong Thom Province supported by ADB. The project involves the rehabilitation of the Stung Chinit irrigation scheme and the development of its surrounding rural infrastructure. Under the project, land acquisition and involuntary resettlement have been required.

After the project was approved to be implemented, MOWRAM and MRD supported by ADB prepared a draft Resettlement Plan (RP) and submitted it to the Inter-ministerial Resettlement Committee (IRC). The preparation of the draft RP involved a survey on the potential losses through interviews, consultation and discussion with the affected people. The draft RP also provided a methodology and provisional cost for resettlement, including compensation, transport allowance, and supportive program for the affected people.

In reaction to the draft RP submitted, the IRC also conducted a detailed measurement survey in order to determine the value of losses through consultation with village and commune leaders, and a record of recent land transactions. Following that, RP was finalized among concerned organizations, including the IRC, MOWRAM and MRD. After that, the project started to conduct resettlement and began paying compensation with continuous dialogue among concerned organizations, including the affected people. A support program for the affected people included training for income generation skill enhancement, agricultural extension service, and so on.

(4) Other Related Regulations

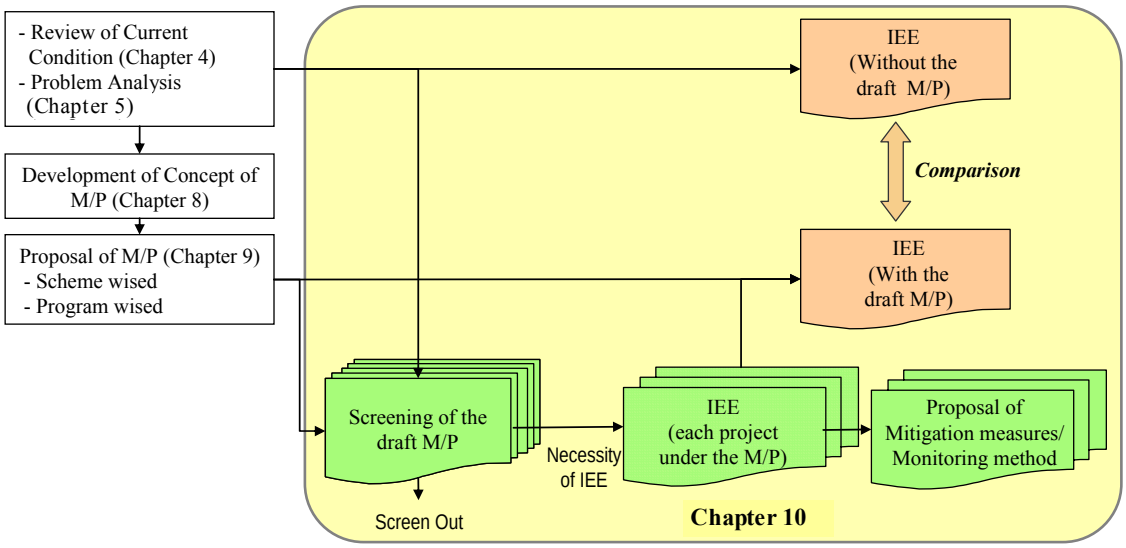
The Law on Water Resources Management stipulates that the beds and banks of rivers, streams, lakes, canals, storage tanks, and reservoirs are owned by the State.

10.2 Initial Environmental Examination for Master Plan

As described in Chapter 9, the Master plan for Comprehensive Agricultural Development was formulated in the first year of the Study. The main objectives of the initial environmental examination (IEE) are to identify potential negative environmental impacts caused by implementation of the Master plan and to suggest mitigation measures and monitoring methods in order to avoid and/or mitigate negative impacts as much as possible.

The framework of IEE study in this section is shown in the following figure. After the screening of the Master plan, IEEs are implemented for the selected projects which need to be examined. The potential impacts are examined based on the available information collected and proposed project contents. In addition, the mitigation measures and monitoring methods

are preliminarily proposed. On the other hand, the impacts that would result without implementation of any of the projects of the Master plan was also examined based on the socio-economic framework that would result without the master plan. The result is compared with the impacts that would result with implementation of all projects of the master plan.



Framework of IEE for Master Plan Study

10.2.1 Screening of Master Plan

Among various projects in the master plan, the projects associated with training, institutional strengthening programs and pilot based demonstrations can be screened out in the initial examination, since no or negligible impact is expected to occur. Therefore the projects as shown below are examined hereinafter.

Results of Screening of Projects

S.N.	Project Name	Screening*	Remarks
Scheme-wise Improvement			
	Zone-1 Projects		
A.1(1)	Irrigated Agriculture Improvement Model Project	IEE	
A.1(2)	Upper North Main Canal Irrigation Agriculture Improvement Project	IEE	
A.1(3)	Upper South Main Canal Irrigation Agriculture Improvement Project	IEE	
	Zone-2 Projects		
A.2(1)	Lower North Main Canal Irrigated Agriculture Improvement Project	IEE	
A.2(2)	Lower South Main Canal Irrigated Agriculture Improvement Project	IEE	EIA study required
A.2(3)	Ou krang Ambel Irrigated Agriculture Improvement Project	IEE	
	Zone-3 Project		
A.3(1)	Water Harvesting Irrigated Agriculture Improvement Project	IEE	
	Zone-4 Project		
A.4(1)	Rainfed Agriculture Development Project	Sc. Out	Training, formulation of farmers' groups.
	Zones Cross-cutting Projects		
B.1(1)	Roleang Chrey Regulator Gates Urgent Improvement Project	Sc. Out	Temporary construction with small scale and short duration

S.N.	Project Name	Screening*	Remarks
B.1(2)	Roleang Chrey Regulator and Intakes Improvement Project	IEE	
B.2(1)	Veterinary Services Strengthening and Livestock Raising Improvement Project	Sc. Out	Training and demonstration
B.3(1)	Community Inland Fisheries Development Project	IEE	
B.4(1)	Income Generation Projects for Marginal Farmers	Sc. Out	Training and demonstration
Subject-wise Development			
C.1(1)	Coordination between MOWRAM and MAFF Strengthening Project	Sc. Out	Institutional strengthening program
C.1(2)	Provincial Departments Strengthening Project	Sc. Out	Institutional strengthening program
C.2(1)	Livestock Sub-sector Development Study	Sc. Out	Study of livestock subsector
C.3(1)	Technical Guidelines Preparation Project	Sc. Out	Preparation of guideline
C.4(1)	Environmental Management Basic Capacity Development Project	Sc. Out	Training
C.4(2)	Environmental Management Applied Capacity Development Project	Sc. Out	Training & environmental management
C.5(1)	Irrigated Agriculture On-farm Technology Improvement Pilot Project	Sc. Out	Training and demonstration (pilot)
C.6(1)	Irrigation Facility Maintenance Capacity Strengthening Pilot Project	Sc. Out	Training and demonstration (pilot)
C.7(1)	Rainfed Agriculture Improvement Pilot Project	Sc. Out	Training and demonstration (pilot)
C.8(1)	Income Generation Pilot Project for Marginal Farmers	Sc. Out	Training and demonstration (pilot)
C.9(1)	River Basin Effective Water Use Awareness Raising Project	Sc. Out	Awareness raising program
C.10(1)	Institutional and Agricultural Support Services Strengthening Project	Sc. Out	Institutional strengthening program
C.11(1)	Hydrological Observation Strengthening Project	Sc. Out	Training
C.11(2)	Flood Forecast and Warning Study	Sc. Out	Examination

Note Screening result is categorized into two groups; i) project needs IEE (which is stated "IEE" in the table), and ii) project is screened-out and no IEE is required (which is indicated as "Sc. Out")*

10.2.2 Result of Initial Environmental Examination

10.2.2.1 Result of Examination by Impact Matrix

After the screening, IEEs are implemented for the relevant projects based on the available data and information in terms of the existing environmental and social conditions in and around the project area. The summary of the examination results by impact matrix is shown below.

Results of IEEs for Master Plan

Activity / Potential Impact		Zone 1			Zone 2			Zone 3	Cross-cutting	
		A.1(1)	A.1(2)	A.1(3)	A.2(1)	A.2(2)	A.2(3)	A.3(1)	B.1(2)	B.3(1)
Social Environment										
1	Involuntary Resettlement	--/D	--/D	--/D	--/D	--/D	--/D	--/D	*	*
2	Local economy	++/C	++/B	++/B	++/C	++/A	++/B	++/C	++/A	++/C
3	Land use and utilization of local resources	--/C	--/C	--/B	--/C	--/C	--/C	--/B	*	++/C
4	Social institutions	++/C	++/B	++/B	++/C	++/B	++/B	++/B	*	++/B
5	Existing social infrastructures and services	++/C	++/A	++/A	++/C	++/A	++/B	++/B	++/A	++/B
6	The poor, indigenous and ethnic people	*	*	*	*	*	*	*	*	*
7	Misdistribution of benefits and damage	*	*	*	*	*	*	*	*	*
8	Cultural heritage	*	*	*	*	*	*	*	*	*
9	Local conflicts of interest	--/C	--/C	--/C	--/C	--/C	--/C	--/C	*	--/C

10	Water Usage	++/B	++/A	++/A	++/B	++/A	++/B	++/B	++/A	=/B
11	Sanitation	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C
12	Hazards (Risk), Infectious diseases	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C
Natural Environment										
13	Topography and Geographical features	*	*	*	*	*	*	*	*	*
14	Soil Erosion	*	*	*	*	*	*	*	*	*
15	Groundwater	*	*	*	*	*	*	*	*	*
16	Hydrological Situation (Hydraulic)	*	=/C	=/C	*	=/C	*	*	=/B	*
17	Flora, Fauna and Biodiversity	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C
18	Meteorology	*	*	*	*	*	*	*	*	*
19	Landscape	*	*	*	*	*	*	*	*	*
20	Global Warming	*	*	*	*	*	*	*	*	*
Pollution										
21	Air Pollution	--/C	--/C	--/C	--/C	--/B	--/C	--/C	--/C	*
22	Water Pollution	--/C	--/B	--/B	--/C	--/B	--/C	--/C	--/C	--/C
23	Soil Contamination	--/C	--/C	--/C	--/C	--/C	--/C	--/C	*	--/C
24	Waste	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	*
25	Noise and Vibration	--/C	--/C	--/C	--/C	--/B	--/C	--/C	--/C	*
26	Ground Subsidence	*	*	*	*	*	*	*	*	*
27	Offensive Odor	*	*	*	*	*	*	*	*	--/C
28	Bottom sediment	*	*	*	*	*	*	*	*	*
29	Accidents	--/C	--/C	--/C	--/C	--/C	--/C	--/C	--/C	*

Note) --/B: Left-hand side of each cell represents the direction of impact,
right-hand side represents the magnitude of impact.
++: Positive impact --: Negative Impact =: Neutral Impact
*A: relatively significant impact, B: relatively medium-size impact, C: relative small impact, D: :unknown as of now, *: No impact or no corresponding impact*

10.2.2.2 Potential Negative Impacts

The summarized results of potential negative impacts to be noted are shown below.

(1) Social Environment

(a) Land Acquisition/ Involuntary Resettlement (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1))

Rehabilitation by widening and expansion of the canals under the A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), and A.3(1) will require land acquisition and might cause involuntary resettlement. The magnitude of land acquisition and/or involuntary resettlement will be relatively small because the main activities are rehabilitation of existing canals and reservoirs, and the facilities and structures to be newly constructed will be small in size and limited in number. However, because land acquisition and involuntary resettlement are so sensitive issues, conflict among the people and project owner may occur if the project owner doesn't take a proper approach toward this issue.

(b) Inflow of Workers at Construction Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.1(2))

Deterioration of sanitation conditions and increased risk of diseases are expected at the construction phase due to the inflow of workers from outside. In addition, the people in the Target Area are not familiar with workers coming in from other areas. These characteristics have sometimes brought local conflicts among the people and the workers, or diseases like AIDS/HIV in epidemics. Especially for A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), and B.1(2) where the construction duration is more than two years this matter should be taken care of more carefully.

(c) Limitation of Water Usage in the Construction Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1))

In the construction phase, water in the canals and/or reservoirs should be drained and dried up in order to rehabilitate the base of the facilities. This will limit water usage from the canals and/or reservoirs for domestic use, agricultural activities and also fishery activities. Limitation of water availability should be an issue of great concern for the surrounding people.

(d) Local Conflicts at Operation Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.3(1))

A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1) and B.3(1) include formation and strengthening of FWUCs/FWUGs/WUGs for appropriate management of the canals and/or reservoirs. If FWUCs/FWUGs/WUGs fail to be trained and manage the canals and/or reservoirs properly, local conflict among the FWUCs/FWUG/WUGs members in the operation phase can happen easily because of water usage. As for B.3(1), there are assumed to be two kinds of negative impacts: i.e. i) local conflicts among the FWUCs/FWUGs/WUGs members caused by improper management of the fishery, and ii) local conflicts between FWUCs/FWUGs/WUGs and other people caused by limitation of domestic use of water from the reservoirs because of the fishery.

(2) Natural Environment

(a) Change of Fish habitat in the Construction and Operation Phases (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.3(1))

Any potential impact to fish populations from the project would be most likely to result from the projects A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), and B.3(1) which entail blocking fish migrations in the construction phase, because water in the canals and/or ponds will be drained or limited. But construction during the dry season would reduce negative impacts on fish populations, because large portions of the canals and shallow ponds usually dry up during the dry season under normal circumstances. During the operation phase, expansion of water bodies in canals and ponds will play a positive role for new fishery resources which provide opportunities from the fishery for local people. In addition, because of efficient management of water after the rehabilitation of the canals, the surface water volume in the Prek Thnot River will also increase beyond the current condition. However as for the canals, the structure of the canals should be considered to ensure a viable fish habitat.

At the same time, the existing water bodies for fish habitat in the Target Area, such as rivers, streams, and small swamps, could be damaged by water quality contamination mainly due to increased fertilizer use.

As for D-2, the bio-diversity of the reservoirs and surrounding water environment which are connected to the ponds might be changed by releasing fingerlings and water pollution if any.

(b) Change of Bio-diversity (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.1(2), B.3(1))

To date, no study has been made for the wildlife, including birds, frequenting the canals and/or reservoirs. In addition, it is not known which species predominate, nor if any wildlife are sensitive to muddy water, or the noise and vibration resulting from construction. Because some biodiversity might be spread out, any major disturbance such as disruption of nesting or feeding grounds caused by these projects is considered unlikely.

(3) Pollution

(a) Pollution caused by Construction Work (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.1(2))

Because most of the projects are simply rehabilitation of the existing canals, gates and/or reservoirs, and the new construction scale is not large, significant negative impacts are not expected with proper management in the construction phase. However, the following negative impacts are expected; (i) air pollution caused by spread of dust from unpaved roads and emission of exhaust gas from the construction vehicles and heavy equipment, (ii) water

contamination (low pH-water) triggered by the concrete works, (iii) noise and vibration caused by movement of heavy equipment, and (iv) generation of construction waste such as surplus soil, old equipment and waste generated by the workers.

(b) Pollution caused by Fertilizer in the Operation Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.3(1))

According to the socio-economic survey, most farmers tend to increase the dosage of fertilizers to improve farm productivity after the stabilization of the water supply. Therefore, after the project begins to operate with the rehabilitated canals and/or reservoirs, an increase in the dosage of fertilizers for agricultural activities is expected. This might result in an increase of the nutrient load or chemical contamination in both land and drainage water which could affect the downstream aquatic-diversity. The water quality contamination could affect drinking water resources for the local people, and fish habitat.

As for B.3(1), improper management of the reservoirs by FWUCs/FWUGs, such as over usage of fertilizer for the fishery, may affect water quality in the reservoirs. This might lead to the spread of ill health to the people who utilize the water of the reservoirs for domestic uses.

10.2.2.3 Proposed Mitigation Measures and Monitoring Framework

In order to avoid and/or mitigate the potential negative impacts caused by the project, the following mitigation measures and monitoring framework are preliminarily proposed. The planning of proper and timely measures for avoidance and/or mitigation of the negative impacts should be required.

(1) Social Environment

(a) Land Acquisition/ Involuntary Resettlement (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1))

Land acquisition and/or involuntary resettlement should be conducted very carefully from the design phase, because of the great sensitivity of the issue. Not only for land owners, but also for land users, who illegally use state-owned lands like reservoirs and canals, appropriate support should be given and assistance to a certain extent in order not to lower their living standard. Stage wise discussions on design of the canal lay-out, compensation measures, support programs and so on with the local people should be conducted in order to obtain a consensus of the affected people. In addition, proper compensation and support programs, which include support for adaptation of their lives in the new lands and training to increase their skills for earning money, should be implemented for the affected people in cooperation with the Resettlement Unit of MOWRAM and the Inter-ministerial Resettlement Committee (IRC).

(b) Inflow of Workers in the Construction Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.1(2))

It is necessary to improve the sanitary condition of workers such as providing a proper arrangement of accommodation, installation of toilets and proper water supply. Implementation of an education program for the workers and their periodical patrol should be conducted in order to avoid both occurrence of local conflicts and epidemics of diseases.

On the other hand, a series of public meetings for the surrounding people should be valuable in order to explain noteworthy points of the construction work and its schedule.

(c) Limitation of Water Usage in the Construction Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1))

It is important to conduct stakeholder meetings in the design phase in order to discuss and get consensus for the construction works and schedule among the relevant people, especially those who utilize water from the canals and/or reservoirs for both domestic use and agricultural activities. At that time, the following issues are also to be taken into consideration;

(i) participatory meetings should be conducted in order for people to express their opinions without any pressures, (ii) all relevant stakeholders should be invited, including vulnerable groups like poverty groups, and (iii) not only paddy field schedules, but also fishery timing should be considered in a comprehensive way.

Meetings with stakeholders should be conducted regularly in order to inform them of the construction schedule and collect their opinion during the construction phase.

(d) Local Conflicts in the Operation Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.3(1))

In order to avoid local conflicts among the FWUCs/FWUGs/WUGs, the following measures are proposed; (i) implementation of a series of trainings for improvement of management capacities of FWUCs/FWUGs/WUGs, (ii) request periodic meetings among the FWUCs/FWUGs/WUGs members in order to obtain consensus among the members for proper management, (iii) introduction of a periodic patrol system for water (fish) management among the members, and (iv) refresher training for the target people.

As for monitoring measures, regular visits to FWUGs/FWUGs/WUGs to monitor their management condition should be conducted by MOWRAM and/or PDOWRAM.

(2) Natural Environment

(a) Change of Fish habitat in the Construction and Operation Phases (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.3(1))

The construction schedule should be prepared considering the spawning and fishing seasons as much as possible. In addition, the following measures would be valuable to ensure fish habitat in the operation phase; (i) designing structures which allow fish passage to the maximum extent possible, and (ii) operating any new infrastructure in such a way as to allow fish passage at the time of major migrations.

On the other hand, proper management of fertilizer usage by farmers should be taught to the target people through appropriate training courses.

As for B.3(1), it is necessary to conduct research regarding the existing species of fish in the reservoirs in the design phase in order to utilize the indigenous species as fingerlings. In addition, periodic monitoring of the reservoirs as fish habitat should be conducted by the Department of Fisheries, MAFF.

(b) Change of Bio-diversity (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.1(2), B.3(1))

A reconnaissance survey and/or interviews with the local people around the project area in the design phase would be effective so that any important species that may be particularly disturbed by construction can be identified and mitigation measures devised.

(3) Pollution

(a) Pollution caused by Construction Work (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.1(2))

The following mitigation measures should be conducted; (i) regular sprinkling of unpaved roads, (ii) minimization of idling of construction vehicles, (iii) installation of an adequate treatment system for low pH-water, (iv) limitation of construction time with consensus among the surrounding people. As for waste generation, the following measures are proposed; (i) effective utilization of surplus soil in and around the project area, (ii) establishment of soil disposal sites far from residence areas or rivers, and (iii) an educational program for workers for reduction of waste generation.

In addition, regular monitoring to check the management of construction work should be done by MOWRAM.

(b) Pollution caused by Fertilizer in the Operation Phase (A.1(1), A.1(2), A.1(3), A.2(1), A.2(2), A.2(3), A.3(1), B.3(1))

In order to mitigate any possible increase in the dosage of fertilizers, the following measures are proposed; (i) implementation of support programs for appropriate agricultural management for the target people in the operation phase, (ii) introduction of organic fertilizer, (iii) introduction of a check system among the FWUCs/FWUGs/WUGs members, and (iv) implementation of refresher training after a few months/years for the target people. As for B.3(1), FWUCs/FWUGs/WUGs which manage the reservoirs/ponds should be trained in O&M of the ponds, including monitoring of water quality.

Proposed monitoring activities are as follows; (i) regular monitoring by visiting the target people and/or FWUCs/FWUGs/WUGs members for interviews, (ii) regular water quality monitoring.

10.2. 3 Comparison between With and Without Master Plan

The following table shows the supposed conditions under the "Without the master plan" case compared with the "With the master plan" case. One of the important assumptions without the master plan is that the Roleang Chrey Regulator will not be able to continue to work and will fail to operate properly by 2008. It is noted that in the case of "with the master plan", mitigation measures are assumed to be implemented properly under the master plan implementation.

Condition without the Master Plan and with the Master Plan

Item	Without the Master Plan	With the Master Plan
Water Availability	- No/ very little water in NMC and SMC because of damage of Roleang Chrey Regulator and no rehabilitation of canals. - No improvement in Zones-3 and- 4.	- Proper management of Roleang Chrey Regulator gates. - Rehabilitation of upper north/south main canals and extension of lower north/south main canals. - Rehabilitation of ponds/reservoirs in Zone-3.
Agriculture	- Decrease of agricultural productivity in Zones-1and-2. - No improvement of agricultural productivity in Zones-3 and- 4.	- Increase of agricultural productivity in Zones -1 to -4.
Fishery	- Decrease of fishery because of water shortage.	- Improvement of fishery in Zones-1 to -3.
Society	- Improper management of local resources, including water and fishery.	- Land acquisition and/or involuntary resettlement caused by master plan - Proper management of local resources like water and fish through strengthening of local committees, including FWUCs/FWUGs/WUGs.

(1) Examination of the Condition without the master plan

The following table shows potential negative impacts without implementation of the master plan.

Potential Negative Impacts without Master Plan

Potential Impacts	Impact cause/ severity
Social environment	
Water usage	Water availability may be reduced or become close to zero. Especially in Zones-1 and-2, because of breakdown of the Roleang Chrey Regulator gates, no water would come through NMC/SMC. Because the people along the canal use canal water for domestic purposes, they would have to find another source of water. In addition, this results in the reduction or abandonment of agricultural activities and/or fishery.

Potential Impacts	Impact cause/ severity
Local economy	Because of the shortage of water, agricultural activities, especially paddy fields and fishery may be drastically scaled down. People would have to go to the town or factory for earning money.
Local conflicts	Because water availability will be reduced further, the local conflicts caused by water usage may occur more seriously among the people. In addition, lack of proper support for FWUCs/FWUGs/WUGs for management of canals and/or reservoirs may cause conflicts among the members. Those conflicts may negatively affect the village environment.
Pollution	
Water Pollution and soil contamination caused by inappropriate usage of agrochemicals	No proper management of agriculture along with a shortage of water will increase farm inputs such as agrochemicals to the agricultural fields. This may result in nutrient load or chemical contamination in connected water and affect water quality and soil contamination. Contamination of water will degrade the suitability of drinking water resources and fish habitat.

(2) Examination of the Condition with the Master Plan

On the other hand, the following table shows the potential negative impacts with implementation of the master plan. As described above, the projects of the master plan are assumed to be implemented with appropriate environmental management activities in order to avoid and/or mitigate the negative impacts.

Potential Negative Impacts with the Master Plan

Potential Impacts	Impact cause/ severity
Pollution	
Air pollution, water pollution, waste generation, noise and vibration in the construction phase	In the construction phase, not significant but small impacts on air quality, water quality, noise and vibration will be expected. In addition, waste from construction will be generated but not on a huge-scale.

(3) Results of Comparison

The following table shows the comparison of potential impacts between with and without the master plan. Compared to the "without the master plan" case, it is expected that the master plan as proposed will raise or increase positive impacts related to water usage, economic activities, including agriculture and fishery, local society, and land use condition, and decrease of risk of hazards and water pollution.

Comparison between With and Without Master Plan

	Activity / Potential Impact	Without Master Plan	With Master Plan
	Social Environment		
1	Involuntary Resettlement	*	--/D
2	Local economy (employment, livelihood etc)	--/A	++/A
3	Land use and utilization of local resources	--/A	++/B
4	Social institutions	--/B	++/A
5	Existing social infrastructures and services	--/A	++/A
6	The poor, indigenous and ethnic people	--/A	*
7	Misdistribution of costs and benefits	--/B	*
8	Cultural heritage	*	*
9	Local conflicts of interest	--/A	*
10	Water Usage	--/A	++/A
11	Sanitation	--/B	=/C
12	Hazards (Risk), Infectious diseases	--/A	*
	Natural Environment		
13	Topography and Geographical features	*	*

Potential Impact \ Activity		Without Master Plan	With Master Plan
14	Soil Erosion	*	*
15	Groundwater	*	*
16	Hydrological Situation (Hydraulic)	=/B	=/B
17	Flora, Fauna and Biodiversity	*	*
18	Meteorology	*	*
19	Landscape	*	*
20	Global Warming	*	*
	Pollution		
21	Air Pollution	*	--/C
22	Water Pollution	--/A	--/C
23	Soil Contamination	--/A	--/C
24	Waste	*	--/C
25	Noise and Vibration	*	--/C
26	Ground Subsidence	*	*
27	Offensive Odor	*	*
28	Bottom sediment	--/C	*
29	Accidents	*	--/C

Note) --/B: Left hand side of each cell represents the direction of impact;
right-hand side represents the magnitude of impact.
++: Positive impact --: Negative Impact =: Neutral Impact
A: relatively significant impact, B: relatively medium-size impact, C: relative small impact, D: :unknown as of now
*: No impact or no corresponding impact

10.2. 4 Conclusions

The IEE study for the Master Plan concludes as follows;

- The master plan overall would have benefits for the social environment and is judged to be acceptable from an environmental viewpoint.
- Some of likely negative impacts on both the social and natural environment were pointed out through the IEE study. However, the magnitude of negative impacts is not serious and most of them can be avoided/ mitigated by the proposed countermeasures.
- Various projects are directly related to the local people. Therefore, it is important to consider how to involve those people into the projects, including venue, time, methods, invitees and discussion contents. Especially for land acquisition and/or involuntary resettlement, a careful approach should be taken.

Chapter 11 Conclusions and Recommendations

11.1 Conclusions

The master plan presents the framework and strategies for comprehensive agricultural development for the Target Area with the target year of 2015, aiming to contribute to creation of an enabling and conducive environment for improving the currently unstable and low agricultural production.

In order to achieve this aim, the Study Team selected the "Improvement of Agricultural Productivity Centering on Rice" as the strategic target of the master plan, which will be attained by the program approach consisting of a Scheme-wise Improvement Approach and a Subject-wise Improvement Approach, and will prepare an implementation plan targeting the year 2015. The Scheme-wise Improvement Approach consists of 13 projects, and the Subject-wise Improvement Approach includes 14 projects/studies.

These projects/studies are grouped by implementation horizon, namely Short Term (2006-2010) and Medium Term (by 2015), taking into account the focus points of "decentralization" and "privatization", respectively.

It is expected that completion of the proposed projects under the Scheme-wise Improvement Approach supported by the Subject-wise Improvement Approach will increase the rice production from the current 46,950 tons to 105,092 tons by 2015. This increase would almost meet the rice requirements of the people in the area in 2015, provided that the inter-ministerial coordination between MOWRAM and MAFF is successfully executed. This increase would result in an increase in the farm income of typical farmers. The income increase per farm would range from Riel 236,000 to Riel 445,000, which is about 1.5 to 2.0 times the present income. From these impacts, it can be seen that investment in the implementation of the proposed Scheme-wise Improvement Approach supported by the Subject-wise Improvement Approach would be in best interests of the region.

Taking into consideration these contributions and the progress of the on-going West Phnom Penh Integrated Development Center Project covering most of the Target Area, it is concluded that the master plan should be implemented as planned.

11.2 Recommendations

(1) Arrangement of Financial Resources for Master Plan Implementation

The inadequate financial resources available can become one of the major constraints which may hinder the smooth implementation of the master plan. According to the cost estimate, the implementation of the master plan will require US$ 75,153,000 over the 10 years from 2006 to 2015. It is essential to ensure this amount in a timely manner for the smooth implementation of the master plan. It is therefore recommended that MOWRAM and MAFF should arrange the necessary budget for the master plan implementation.

(2) Need of Urgent Improvement of Roleang Chrey Regulator and Intakes

The Roleang Chrey Regulator is a key structure for irrigated agriculture development in the Target Area. However, the Roleang Chrey Regulator is now severely deteriorated as it was constructed in 1974 and has not had proper maintenance. If the Roleang Chrey Regulator malfunctions, irrigation water could not be properly delivered to the fields. In addition, flood control would be impossible, so that upstream areas might be inundated. In order to avoid such undesirable situations, it is recommended that the Roleang Chrey Regulator should be improved urgently.

In connection with the improvement of the Roleang Chrey Regulator, it is also recommended to improve the intake structures for the NMC and the SMC because these are deteriorated due to the same reason as the Roleang Chrey Regulator.

(3) Need of Inter-ministerial Coordination between MOWRAM and MAFF

Irrigation is an effective resource to provide stability in and increase of agricultural production. There is no doubt that irrigation is directly linked with the stability of agricultural production and that irrigation can become a major factor for creating a physiologically suitable environment for enhancing agricultural production. However, irrigation alone can not produce a remarkable increase in agricultural production without support from other sub-sectors such as agricultural inputs and extension services belonging to MAFF. It is therefore recommended that irrigated agriculture development should be made under close inter-ministerial coordination between MOWRAM and MAFF.

(4) Need of Strengthening of Environmental Management for Executing Agencies

As for irrigated agricultural development, the executing agencies, such as MOWRAM and MAFF are required to identify appropriate environmental management measures for avoiding and mitigating any negative impacts caused by agricultural practice and to sustain the effectiveness of the project with an environmentally friendly approach. However, MOWRAM and MAFF have little experience or knowledge in environmental management for agricultural practice, especially for executing an EIA study. Taking it into consideration that many irrigated agriculture development projects should be planned and implemented in the future, it is recommended that the capability for environmental management in MOWRAM and MAFF should be strengthened.

(5) Need of Monitoring of the Implementation of the Master Plan

The master plan proposes 27 projects/studies which will be carried out by 2015. These projects/studies have close relationships with each other. The implementation order of each project/study should be conducted carefully. In order to grasp the actual progress of them accurately, monitoring is essential. Based on the results of the monitoring, the master plan should be updated as required.

(6) Need of Study on New Water Resource Development

The implementation of the master plan will contribute to attainment of self-sufficiency in rice production in the target year 2015. However, the increasing population pressure will make the self-sufficiency rate worse after 2015. In the master plan, the existing water resources are used effectively and there is no room for more development. To cope with this situation, it is recommended that MOWRAM keep in mind the need for a study on new water resource development at in the foreseeable future.

(7) Need of Strengthening of Provincial Authority for Technical and Financial Aspects

Through the implementation of pilot projects, it was keenly felt that the provincial authority such as PDOWRAM and PDA played a so important role for agricultural development. The provincial authority should always contact with the farmers and understand their minds and problems envisaged. It is no exaggeration to say that the successful agricultural development could not be attained without support of provincial authority. However, it is current situation that local authority suffers from insufficient budget and less opportunity on raising his staff capability. From this finding, it is recommended that MOWRAM and MAFF should strengthen the provincial authority for technical and financial aspects, which is duly coincided with the decentralization policy held up by the government.

(8) Need of Timely Updating of Master Plan

The master plan provides the overall framework and strategies for comprehensive agricultural development toward the year 2015, which are based on the super-ordinate national and sectoral policies. These policies will be renewed every five years. On the other hand, the socio-economic conditions related to the formulation of the master plan are also changed as the Cambodian economy advances. Taking into due consideration such situations surrounding the master plan, it is recommended that the master plan should be updated at least every five years. If the actual progress of scheme-wise improvement and subject-wise improvement are

judged to be not satisfactory as the results of monitoring mentioned above, the master plan should be timely updated without waiting five-yearly review.

Tables

Table 2.1.1 Socio-Economic Indicators of Cambodia

1	GDP in Riel (Billion: 2005)	21,812
	GDP in US$ (Million: 2005)	5,330
	GDP Growth Rate (2000-2005 average)	7.8%
2	GDP per Capita in US$ (2005)	385
	GDP per Capita Growth Rate (2005)	9.0%
3	GDP by Sector (2005)	
	Agriculture	31.4%
	Industry	27.0%
	Service	36.2%
4	Balance of Trade (2005)	
	Export (US$ Million)	2,910
	Import (US$ Million)	3,928
5	Population	
	National (2005)	13.8 Million 1)
	Phnom Penh (2005)	1,243,506
	Kampong Speu Province (2005)	729,552
	Kandal Province (2005)	1,242,506
6	Population Density (persons/km2)	
	National (2006)	82 1)
	Phnom Penh (2006)	4,969 1)
	Kampong Speu Province (2006)	110 1)
	Kandal Province (2006)	374
7	Population Growth (2005)	1.9%
8	Population Below Poverty Line (2004)	28.0%
9	Total Number of Households (2004)	
	National (1998)	2,188,663
	Phnom Penh (1998)	173,678
	Kampong Speu Province (1998)	115,728
	Kandal Province (1998)	206,189
10	Inflation Rate (2005)	6.7%
11	Unemployment Rate (2001)	1.8%
12	Exchange Rate to US$	
	2002	3,920
	2003	3,980
	2004	4,023
	2005	4,107

Source: Statistical Yearbook 2006, National Institute of Statistic, Ministry of Planning

1) Projection from 1998 General Population Census of Cambodi1

Table 3.5.1 Dependable 5-day Discharge at Peam Khley

Probable monthly mean discharge at Peam Khley — MCM

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
80 % dependability	8.8	3.0	4.2	7.8	16.6	24.3	71.3	133.2	193.7	274.2	55.7	22.9
50 % dependability	8.9	3.2	4.2	10.3	35.3	44.3	116.7	160.0	229.1	383.6	110.7	22.9

Distribution pattern of 5-day mean discharge in every month by actual data between 1997 and 2005

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	112.5%	109.3%	78.4%	45.4%	75.9%	68.2%	73.9%	132.9%	99.2%	98.1%	231.0%	196.2%
06-10	117.3%	105.7%	83.5%	51.4%	66.4%	159.9%	149.6%	149.8%	83.4%	102.6%	151.6%	211.7%
11-15	116.1%	98.5%	106.9%	66.3%	55.2%	74.8%	73.7%	62.4%	53.1%	108.0%	79.9%	50.5%
16-20	116.7%	86.4%	121.6%	101.5%	116.8%	85.4%	81.0%	57.5%	75.6%	131.0%	68.3%	34.1%
21-25	77.2%	91.5%	118.8%	183.5%	217.1%	94.3%	61.3%	92.4%	110.6%	79.0%	43.6%	66.4%
26-end	60.1%	108.7%	90.7%	151.8%	68.5%	117.4%	160.5%	105.0%	178.0%	81.3%	25.7%	41.0%

80 % Dependable 5-day mean discharge — MCM

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	9.9	3.3	3.3	3.5	12.6	16.6	52.7	177.0	192.2	269.1	128.8	44.9
06-10	10.3	3.2	3.5	4.0	11.0	38.8	106.8	199.5	161.7	281.3	84.5	48.5
11-15	10.2	3.0	4.5	5.2	9.2	18.2	52.5	83.1	102.8	296.1	44.5	11.6
16-20	10.2	2.6	5.1	7.9	19.4	20.7	57.8	76.5	146.5	359.2	38.1	7.8
21-25	6.8	2.7	5.0	14.3	36.0	22.9	43.7	123.0	214.3	216.5	24.3	15.2
26-end	5.3	3.3	3.8	11.8	11.4	28.5	114.5	139.8	344.9	223.0	14.3	9.4

50 % Dependable 5-day mean discharge — MCM

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	10.0	3.4	3.3	4.7	26.8	30.2	86.2	212.6	227.3	376.4	255.7	44.9
06-10	10.4	3.3	3.5	5.3	23.5	70.9	174.6	239.6	191.2	393.6	167.8	48.5
11-15	10.3	3.1	4.5	6.8	19.5	33.1	85.9	99.9	121.6	414.2	88.5	11.6
16-20	10.4	2.7	5.1	10.5	41.2	37.8	94.5	91.9	173.3	502.6	75.6	7.8
21-25	6.9	2.9	5.0	18.9	76.7	41.8	71.5	147.8	253.4	302.9	48.2	15.2
26-end	5.4	3.4	3.8	15.6	24.2	52.0	187.2	167.9	407.9	311.9	28.4	9.4

Table 3.5.2 Dependable 5-day Mean Discharge at Roleang Chrey

80 % Dependable 5-day mean discharge — MCM

5-day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	10.6	3.5	3.5	3.8	13.5	17.7	56.4	189.4	205.6	287.9	137.8	48.1
06-10	11.0	3.4	3.8	4.3	11.8	41.6	114.2	213.5	173.0	301.0	90.4	51.9
11-15	10.9	3.2	4.8	5.5	9.8	19.4	56.2	89.0	110.0	316.8	47.7	12.4
16-20	11.0	2.8	5.5	8.5	20.7	22.2	61.8	81.9	156.8	384.4	40.7	8.4
21-25	7.3	2.9	5.3	15.3	38.6	24.5	46.8	131.6	229.3	231.7	26.0	16.3
26-end	5.6	3.5	4.1	12.7	12.2	30.5	122.5	149.6	369.0	238.6	15.3	10.1

50 % Dependable 5-day mean discharge — MCM

5-day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	10.7	3.7	3.5	5.0	28.7	32.3	92.3	227.5	243.2	402.8	273.6	48.1
06-10	11.2	3.6	3.8	5.7	25.1	75.8	186.8	256.4	204.6	421.1	179.5	51.9
11-15	11.1	3.3	4.8	7.3	20.8	35.5	91.9	106.9	130.1	443.2	94.7	12.4
16-20	11.1	2.9	5.5	11.2	44.1	40.5	101.1	98.3	185.4	537.7	80.8	8.4
21-25	7.4	3.1	5.3	20.2	82.0	44.7	76.5	158.1	271.1	324.1	51.6	16.3
26-end	5.7	3.7	4.1	16.7	25.9	55.7	200.3	179.7	436.4	333.8	30.4	10.1

Table 4.2.1 Detailed Administrative Information for Target Area

Province	District	Commune	No. of Villages	No.of Familiies	Population	Average Familiy Size	Working Population
1.Kampong Speu	1.Chabar Mon	1. Chabar Mon	13	1,456	7,781	5.3	4,648
		2.kandaol Dom	10	1,397	7,173	5.1	4,301
		3.Roka Thum	12	2,658	13,876	5.2	8,956
		4.Sopoar Tep	10	1,132	6,071	5.4	3,556
		5.Svay Kravan	11	1,367	7,648	5.6	4,816
	Sub-total	**5**	**56**	**8,010**	**42,549**	**5.3**	**26,277**
	2.Kong Pisei	1.Angk Popel	13	987	5,478	5.6	3,043
		2.Preah Nipean	27	2,131	11,730	5.5	6,331
		3.Roka Kaoh	12	1,222	6,632	5.4	3,398
		4.Veal	22	1,535	8,537	5.6	5,039
		5.Chongruk	25	2,341	12,603	5.4	7,507
		6.Pechr Muni	13	1,806	9,737	5.4	5,377
		7.Prey Nheat	12	1,099	5,714	5.2	3,539
		8.Tuek L'ak	25	986	4,791	4.9	2,560
	Sub-total	**8**	**149**	**12,107**	**65,222**	**5.4**	**34,234**
	3.Samraong Tong	1.Roleang Chak	19	1,470	7,957	5.4	4,550
		2.Kahaeng	15	1,324	6,808	5.1	3,953
		3.Roleang Kreul	26	2,039	11,751	5.8	7,092
		4.Saen Dei	21	1,995	11,156	5.6	6,298
		5.Tang Krouch	20	1,500	7,416	4.9	4,137
		6.Trapeang Kong	29	2,602	14,090	5.4	8,476
		7.Voa sa	23	2,424	12,659	5.2	7,353
		8.Khtum Krang	17	1,318	6,733	5.1	3,736
		9.Krang Ampil	15	1,430	8,286	5.8	4,828
		10.Pneay	19	2,025	10,991	5.4	6,265
		11.Samraong Tong	18	1,161	6,033	5.2	3,511
		12.Sambour	18	1,391	7,402	5.3	4,301
		13.Skuh	21	1,881	9,896	5.3	6,020
		14.Thommoda Ar	21	1,801	9,266	5.1	5,066
		15.Tumpoar Meas	13	1,116	5,729	5.1	3,177
	Sub-total	**15**	**295**	**25,477**	**136,173**	**5.3**	**78,763**
	Total	**28**	**500**	**45,594**	**243,944**	**5.4**	**139,274**
2.Kandal	1.Kandal Stueng	1.Daeum Rues	14	1,669	7,970	4.8	4,719
		2.Roka	7	618	3,089	5.0	1,697
		3.Roleang Kaen	11	1,031	5,116	5.0	3,196
	Sub-total	**3**	**32**	**3,318**	**16,175**	**4.9**	**9,612**
	2.Angk Snuol	1.Baek Chan	21	1,845	9,303	5.0	5,804
		2.Boeng Thum	16	1,166	5,903	5.1	3,397
		3.Chhak Ch. Neang	10	616	3,492	5.7	2,068
		4.Damnak Ampil	10	863	4,690	5.4	2,776
		5.Kantaok	17	1,732	10,087	5.8	6,194
		6.Kamboul	18	1,149	6,336	5.5	3,949
		7.Krang Mkak	15	796	4,398	5.5	2,752
		8.Lumhach	20	1,334	7,154	5.4	4,292
		9.Peuk	19	1,210	6,552	5.4	4,030
		10.Prey Puok	23	1,272	6,945	5.5	4,316
		11.Ovlaok	14	631	3,464	5.5	2,129
		12.Samraong Leu	28	1,362	8,235	6.0	5,118
		13.Snao	18	698	4,106	5.9	2,465
	Sub-total	**13**	**229**	**14,674**	**80,665**	**5.5**	**49,290**
	Total	**16**	**261**	**17,992**	**96,840**	**5.4**	**58,902**
	Grand Total	**44**	**761**	**63,586**	**340,784**	**5.4**	**198,176**

Source: SEILA Commune Data Base 2004

Table 4.6.1 On-going Donors' Projects for Agricultural and Water Sector in Kampong Speu and Kandal Provinces (1/3)

Donor Agency	Project Title	Executing Agency	Approx. Amount	Provincces	Objectives/Scope of Works	Period
I. Agriculture Sector						
1 AusAID	Cambodia Australia Agricultural Extension Project Phase II (CAAEP II)	MAFF	US$12.11million	Kandal Kanpong Speu	To assist the RGC to achieve its development goals by improving access to agricultural knowledge. To increase household cash incomes by further developing a sustainable direct-oriented extension system with the DAE of MAFF as a focal point for coordinating and facilitating all extension service providers in Cambodia. Further objectives are as follows: - Building the capacity of DAE to act as a focal point for coordinating and facilitating all extension service providers in Canbodia. - Working towards a government extension system focused at the district leveland utilizing agro-ecosysytems analysis to identify local extension priorities. - Providing training to government extension staff at national, provincial and district levels. - Collecting and analysing information to establish extension priorities. - Strengthening capacity of MAFF to deliver extension at provincial and district levels. - Establishing an effective M&E system to improve decision making and extension strategies over time.	March 2002-March 2006
2 AusAID	Agriculture Quality Improvement Project (AQIP)	MAFF, PDAFF, PDWVA,MOC, MRD	US$11.93 million	Kandal	To support economic growth in Cambodia by providing high quality services in rice production, rivce post harvest technology and fruit and vegetable marketing which contribute to a secure food supply, increased agricultural output and add value on a sustainable and cost effective basis. To improve food security and cash income for farm households to take them beyond their current levels of marginal subsistence in selected districts of selected provinces. Further objectives are as follows: - Establishing seed grower associations and commercial seed companies in each of the four provinces. - Producing high quality rice seed. - Developing institutional capacity at provincial level in relation to seed inspection, crop production monitoring, post harvest technology transfer, training provision. - Developing institutional capacity at provincial level in Rehabilitating selected irrigation infrasructures.	August 2000-August 2006

Table 4.6.1 On-going Donors' Projects for Agricultural and Water Sector in Kampong Speu and Kandal Provinces (2/3)

Donor Agency	Project Title	Executing Agency	Approx. Amount	Provincces	Objectives/Scope of Works	Period
3 AusAID	CARDI Assistance Project (CARDI AP)	MAFF, CARDI	US$4.56 million	Whole Country	To assist CARDI in achieving sustainable management of its personnel, finances and physical resources to deliver its mandate according to national priorities for food security, poverty reduction and natural resource management. The project has four components, the titles and objectives of which are: - Governance: CARDI operating as a semi-autonomous (financial and administration) research institution. - Corporate Development: CARDI management and staff implementing research and development projects as required by government and commercial interests. - Service Delivery: Promotion of CARDI as the preferred provider of agricultural research services for government, joint venture partners and contracted services. - Project Management: Delivery of all inputs in a timely and cost effective manner.	September 2002 - December 2006
4 EU	Smallholder Livestock Production Programme (SLPP)	MAFF	US$ 6 million	Kanpong Speu	To reduce poverty and food insecurity in rural areas by increasing the rate of growth of livstock GDP. The project activities are as follows: - Institutional capacity building of DAPH - Improved rural animal health services through training, certification, and expansion of Village Animal Health Workers - Introduction and implementation of a national system of animal disease surveillance and monitoring - Improved animal health through demonstration and extension services - Improved livestock feed regimes - Linking producers with local markets - Improved meat processing, storage and marketing	April 2005 - March 2010
5 JICA	Feasibility Study on Establishment of Open Paddy Market	MOC, MAFF	-	Kandal	To prove the validity of open paddy market in terms of: - Reasonalbe price formation of rice, - Stability of supply provision through information of price and others concerning to rice in each province, - quality improvement of rice , and - improvement of condition for intraregional commercial transaction.	2003- 2006

Table 4.6.1 On-going Donors' Projects for Agricultural and Water Sector in Kampong Speu and Kandal Provinces (3/3)

Donor Agency	Project Title	Executing Agency	Approx. Amount	Provincces	Objectives/Scope of Works	Period
6 JICA	Feshwater Aquaculture Aquaculture Improvement and Extension Project	MAFF	US$4.8 million	Kanpong Speu	To achieve the increase in aquaculture production in target areas including Kampong Spue, small-scale aquaculture technologies are largely extended. Major outputs are as follows: - Seed producing farmers are trained among existing , small-scale fish farmers by improving their aquaculture technologies. - Small-scale aquaculture technologies and its extension methods are improved. - Aquacutlture-related activities to benefit the poorest landless farmers are promoted. - An aquaculture extension network in rural are is developed.	2005-2009
II Water Sector						
1 AFD/ADB Cofinance	Northwest Irrigation Sector Project	MOWRAM, MAFF, MLMPUC	US$18.6 million	Kandal	To support government effort to reduce poverty in selected northwest rural areas through enhanced agricultural production thereby alleviating food insecurity and improving farmning household incomes. To establish rehabilitated and sustainability operate small to medium-scale irrigation schemes and other water-control infrastructure within the studied priority river basins. Further objectives are as follows: - Regulatory framework for refined Irrigation Management Transfer(IMT) policy with MOWRAM/PDOWRAM capacity building, - 35,000 ha of irrigated (16,000 ha) and flood spreading/ recession (19.000ha) agriculture in 10-12 rehabilitated schemes increased rice productivity to 3.5 t/ha and diversified agricultural production where appropriate, - Structures and canals in all rehabilitated schemes operated and maintained by stakeholders (MOWRAM/FWUCs), - Provincisl and district extension staff and local extension terms with improved technical extension skills, - Diversified and intensified agricultural production activities undertaken.	2004 - 2009
2 JICA	Technical Service for Irrigation System Project	MOWRAM	US$ 8 million	Kandal	To improve the technical capacity of the engineers and technicians of MOWRAM and PDOWARAM in the fields of surcey, planning, design, construction management, and water management with participation of farmkers in irrigation systems.	2001 - 2006

Table 4.7.1 Agro-demographic Features of the Project Communes - 1/2

Province/District	Commune	Type	No. of Households	No. of Families	Population				Working Population				Crop Producing Households (% to Total Households)		None Crop Producing Household (% to Total Households)		Landless Households	Households with Less Than 10a	(% to Crop Producing Household)	Households with More Than 3ha	(% to Crop Producing Household)	Irrigated Area (ha)	Irrigated Area per Crop Producing Household (ha)
					Male	Female	Total	Average Family Size	Male	Female	Total	Average per Family	No.	%	No.	%	No.	No.	%	No.	%		
		1/	2/	1/	1/	1/	1/	1/	1/	1/	1/	1/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/
Kampong Speu																							
Chbar Mon	Chbar Mon	Urban	1,415	1,456	3,705	4,076	7,781	5.3	2,190	2,458	4,648	3.2	922	65	493	35	493	22	2	1	0	109	0.12
	Kandaol Dom	Urban	1,382	1,397	3,412	3,761	7,173	5.1	2,080	2,221	4,301	3.1	978	71	404	29	404	30	3	-	-	362	0.37
	Roka Thum	Urban	2,595	2,658	6,819	7,057	13,876	5.2	4,363	4,593	8,956	3.4	1,512	58	1,083	42	1,083	180	12	5	0	222	0.15
	Sopoar Tep	Urban	1,154	1,132	2,950	3,121	6,071	5.4	1,723	1,833	3,556	3.1	890	77	264	23	264	100	11	-	-	136	0.15
	Svay Kravan	Urban	1,357	1,367	3,616	4,032	7,648	5.6	2,216	2,600	4,816	3.5	1,050	77	307	23	307	90	9	-	-	456	0.43
District/Project Communes Total		Urban	**7,903**	**8,010**	**20,502**	**22,047**	**42,549**	**5.3**	**12,572**	**13,705**	**26,277**	**3.3**	**5,352**	**68**	**2,551**	**32**	**2,551**	**422**	**8**	**6**	**0**	**1,285**	**0.24**
Kong Pisei	Angk Popel	Rural	959	987	2,620	2,858	5,478	5.6	1,464	1,579	3,043	3.1	952	99	7	1	7	12	1	-	-	4	0.00
	Preah Nipean	Rural	2,080	2,131	5,691	6,039	11,730	5.5	3,043	3,288	6,331	3.0	1,775	85	305	15	305	486	27	247	14	22	0.01
	Roka Kaoh	Rural	1,197	1,222	3,202	3,430	6,632	5.4	1,638	1,760	3,398	2.8	1,065	89	132	11	132	-	-	-	-	14	0.01
	Veal	Rural	1,482	1,535	4,012	4,525	8,537	5.6	2,336	2,703	5,039	3.3	1,471	99	11	1	11	24	2	51	3	13	0.01
	Chongruk	Rural	2,284	2,341	6,170	6,433	12,603	5.4	3,536	3,971	7,507	3.2	2,241	98	43	2	43	24	1	-	-	500	0.22
	Prey Nheat	Rural	1,685	1,806	4,616	5,121	9,737	5.4	2,469	2,908	5,377	3.0	1,592	94	93	6	93	29	2	-	-	4	0.00
	Pechr Muni	Rural	975	986	2,264	2,527	4,791	4.9	1,184	1,376	2,560	2.6	975	100	-	-	-	34	3	-	-	42	0.04
	Tuek L'ak	Rural	1,072	1,099	2,749	2,965	5,714	5.2	1,653	1,886	3,539	3.2	1,031	96	41	4	41	61	6	-	-	12	0.01
Project Communes Total		Rural	**11,734**	**12,107**	**31,324**	**33,898**	**65,222**	**5.4**	**16,139**	**18,095**	**34,234**	**2.8**	**11,102**	**95**	**632**	**5**	**632**	**670**	**6**	**298**	**3**	**611**	**0.06**
District Total			20,715	21,371	54,568	58,846	113,414	5.3	30,592	34,060	64,652	3.0	19,347	93	1,368	7	2,281	1,156	6	329	2	768	0.04
Samraong Tong	Roleang Chak	Rural	1,479	1,470	3,796	4,161	7,957	5.4	2,148	2,402	4,550	3.1	1,479	100	-	-	-	-	-	-	-	187	0.13
	Kahaeng	Rural	1,309	1,324	3,316	3,492	6,808	5.1	1,890	2,063	3,953	3.0	1,244	95	65	5	65	-	-	-	-	120	0.10
	Roleang Kreul	Rural	2,005	2,039	5,876	5,875	11,751	5.8	3,443	3,649	7,092	3.5	2,005	100	-	-	-	-	-	-	-	412	0.21
	Saen Dei	Rural	1,982	1,995	5,469	5,687	11,156	5.6	3,065	3,233	6,298	3.2	1,982	100	-	-	-	-	-	-	-	244	0.12
	Tang Krouch	Rural	1,429	1,500	3,499	3,917	7,416	4.9	1,876	2,261	4,137	2.8	1,429	100	-	-	-	-	-	-	-	-	-
	Trapeang Kong	Rural	2,550	2,602	6,963	7,127	14,090	5.4	4,158	4,318	8,476	3.3	2,112	83	438	17	438	18	1	13	1	410	0.19
	Voa Sa	Rural	2,322	2,424	5,989	6,670	12,659	5.2	3,436	3,917	7,353	3.0	2,013	87	309	13	309	-	-	45	2	626	0.31
	Khtum Krang	Rural	1,288	1,318	3,289	3,444	6,733	5.1	1,803	1,933	3,736	2.8	1,288	100	-	-	-	-	-	-	-	120	0.09
	Krang Ampil	Rural	1,406	1,430	4,097	4,189	8,286	5.8	2,345	2,483	4,828	3.4	1,406	100	-	-	-	-	-	-	-	20	0.01
	Pneay	Rural	1,967	2,025	5,273	5,718	10,991	5.4	2,977	3,288	6,265	3.1	1,967	100	-	-	-	-	-	-	-	169	0.09
	Samraong Tong	Rural	1,106	1,161	2,956	3,077	6,033	5.2	1,695	1,816	3,511	3.0	1,106	100	-	-	-	-	-	-	-	-	-
	Sambour	Rural	1,362	1,391	3,578	3,824	7,402	5.3	2,057	2,244	4,301	3.1	1,362	100	-	-	-	-	-	-	-	-	-
	Skuh	Rural	1,768	1,881	4,752	5,144	9,896	5.3	2,903	3,117	6,020	3.2	1,768	100	-	-	-	-	-	-	-	-	-
	Thommoda Ar	Rural	1,779	1,801	4,395	4,871	9,266	5.1	2,370	2,696	5,066	2.8	1,779	100	-	-	-	-	-	-	-	-	-
	Tumpoar Meas	Rural	1,052	1,116	2,844	2,885	5,729	5.1	1,547	1,630	3,177	2.8	1,052	100	-	-	-	-	-	-	-	120	0.11
District/Project Communes Total		Rural	**24,804**	**25,477**	**66,092**	**70,081**	**136,173**	**5.3**	**37,713**	**41,050**	**78,763**	**3.1**	**23,992**	**97**	**812**	**3**	**812**	**18**	**0**	**58**	**0**	**2,428**	**0.10**
Project Communes in Kp. Speu		Rural/Urban	**44,441**	**45,594**	**117,918**	**126,026**	**243,944**	**5.4**	**66,424**	**72,850**	**139,274**	**3.1**	**40,446**	**91**	**3,995**	**9**	**3,995**	**1,110**	**3**	**362**	**1**	**4,324**	**0.11**
Province Total				132,618	333,335	357,628	690,963	5	188,717	208,246	396,963	3											

Table 4.7.1 Agro-demographic Features of the Project Communes - 2/2

Province/District	Commune	Type	No. of Households	No. of Families	Population				Working Population				Crop Producing Households (% to Total Households)		None Crop Producing Household (% to Total Households)		Landless Households	Households with Less Than 10a	(% to Crop Producing Household)	Households with More Than 3ha	(% to Crop Producing Household)	Irrigated Area (ha)	Irrigated Area per Crop Producing Household (ha)
					Male	Female	Total	Average Family Size	Male	Female	Total	Average per Family	No.	%	No.	%	No.	No.	%	No.	%		
		1/	2/	1/	1/	1/	1/	1/	1/	1/	1/	1/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/	2/
Kandal																							
Kandal Stueng	Daeum Rues	Rural	1,636	1,669	3,850	4,120	7,970	4.8	2,233	2,486	4,719	2.8	1,580	97	56	3	56	-	-	-	-	578	0.37
	Roka	Rural	620	618	1,433	1,656	3,089	5.0	790	907	1,697	2.7	610	98	10	2	10	30	5	-	-	270	0.44
	Roleang Kaen	Rural	1,029	1,031	2,437	2,679	5,116	5.0	1,477	1,719	3,196	3.1	1,014	99	15	1	15	6	1	-	-	316	0.31
Project Communes Total		Rural	**3,285**	**3,318**	**7,720**	**8,455**	**16,175**	**4.9**	**4,500**	**5,112**	**9,612**	**2.9**	**3,204**	**98**	**81**	**2**	**81**	**36**	**1**	**-**	**-**	**1,164**	**0.36**
District Total			18,617	19,143	44,011	48,844	92,855	5	26,270	30,291	56,561	3	16,041	86	2,576	14	2,576	**293**	2	**72**	0	**7,816**	**0.49**
Angk Snuol	Baek Chan	Rural	1,785	1,845	4,422	4,881	9,303	5.0	2,741	3,063	5,804	3.1	962	54	823	46	823	25	3	-	-	-	-
	Boeng Thum	Rural	1,142	1,166	2,830	3,073	5,903	5.1	1,585	1,812	3,397	2.9	1,023	90	119	10	119	5	0	9	1	150	0.15
	Chhak Ch. Neang	Rural	607	616	1,750	1,742	3,492	5.7	1,024	1,044	2,068	3.4	553	91	54	9	54	116	21	7	1	-	-
	Damnak Ampil	Rural	872	863	2,285	2,405	4,690	5.4	1,344	1,432	2,776	3.2	541	62	331	38	331	-	-	-	-	-	-
	Kantaok	Rural	1,702	1,732	4,899	5,188	10,087	5.8	2,867	3,327	6,194	3.6	1,532	90	170	10	170	340	22	510	33	-	-
	Kamboul	Rural	1,145	1,149	3,077	3,259	6,336	5.5	1,822	2,127	3,949	3.4	943	82	202	18	202	-	-	-	-	-	-
	Krang Mkak	Rural	781	796	2,064	2,334	4,398	5.5	1,287	1,465	2,752	3.5	781	100	-	-	-	47	6	1	0	449	0.57
	Lumhach	Rural	1,319	1,334	3,438	3,716	7,154	5.4	2,003	2,289	4,292	3.2	1,319	100	-	-	-	24	2	-	-	50	0.04
	Peuk	Rural	1,208	1,210	3,128	3,424	6,552	5.4	1,923	2,107	4,030	3.3	884	73	324	27	324	78	9	-	-	-	-
	Prey Puok	Rural	1,225	1,272	3,300	3,645	6,945	5.5	1,993	2,323	4,316	3.4	1,131	92	94	8	94	20	2	4	0	247	0.22
	Ovlaok	Rural	618	631	1,627	1,837	3,464	5.5	980	1,149	2,129	3.4	618	100	-	-	-	10	2	-	-	-	-
	Samraong Leu	Rural	1,288	1,362	4,041	4,194	8,235	6.0	2,475	2,643	5,118	3.8	1,248	97	40	3	40	131	10	-	-	-	-
	Snao	Rural	682	698	1,954	2,152	4,106	5.9	1,172	1,293	2,465	3.5	662	97	20	3	20	36	5	5	1	-	-
Project Communes Total		Rural	**14,374**	**14,674**	**38,815**	**41,850**	**80,665**	**5.5**	**23,216**	**26,074**	**49,290**	**3.4**	**12,197**	**85**	**2,177**	**15**	**2,177**	**832**	**7**	**536**	**4**	**896**	**0.07**
District Total			18,116	18,996	50,727	54,816	105,543	5.6	30,266	34,078	64,344	3.4	15,939	88	2,177	12	2,177	832	5	536	3	**941**	**0.06**
Project Communes in Kandal		Rural	**17,659**	**17,992**	**46,535**	**50,305**	**96,840**	**5.4**	**27,716**	**31,186**	**58,902**	**3.3**	**15,401**	**87**	**2,258**	**13**	**2,258**	**868**	**6**	**536**	**3**	**2,060**	**0.13**
Province Total			127,526	229,263	572,277	613,514	1,185,791	5.2	339,144	371,718	710,862	3.1											
Overall Project Communes		Rural/Urban	**62,100**	**63,586**	**164,453**	**176,331**	**340,784**	**5.4**	**94,140**	**104,036**	**198,176**	**3.1**	**55,847**	**90**	**6,253**	**10**	**6,253**	**1,978**	**4**	**898**	**2**	**6,384**	**0.11**

1/: Source: SEILA Commune Data Base,2004 2/: Source: Commune Survey on Crops & Livestock, 2003, Statistic Office, MAFF

Table 4.7.2 Improved Rice Varieties Released by CARDI and Common Varieties Grown in Target Area

Major Improved Varieties Released by CARDI 1/							
Variety	Year Released	Adaptability	Photoperiod Sensitivity	Growth Period (days) or Flowering Date	Yield Level (ton/ha)	Resistance to BPH	Aroma
Early Rice							
IR 66 2/	1990	IRR/RFL	none	105 ~ 115 days	4.0 ~ 6.5	MS	none
Sen Pido 2/		IRR/RFL	none	105 ~ 115 days	4.0 ~ 6.5	MS	aromatic
IR 72	1990	IRR/RFL	none	110 ~ 120 days	3.5 ~ 6.0	S	none
IR 36		IRR/RFL	none	110 ~ 120 days	3.5 ~ 6.0	MR	none
Kru	1990	IRR/RFL	none	110 ~ 115 days	3.5 ~ 6.0		none
IR Kesar	1993	IRR/RFL	none	105 ~ 120 days	4.0 ~ 6.0	MR	none
Medium Rice							
Riang Chey	1999	IRR/RFL	sensitive	Nov. 5 - 11	3.5 ~ 5.5	MS	none
CAR 11	1997	IRR/RFL	sensitive	Nov. 5 - 11	2.5 ~ 4.5	S	none
CAR 3	1995	IRR/RFL	sensitive	Oct. 30 - Nov. 7	2.5 ~ 4.5	HS	none
Santepheap 1	1992	RFL	none	130 ~ 140 days	4.0 ~ 6.0	MS	none
Santepheap 2	1992	RFL	none	130 ~ 140 days	4.0 ~ 6.0	MS	none
Santepheap 3 2/	1992	RFL	none	140 ~ 145 days	4.0 ~ 6.5	S	none
Late Rice							
CAR 4	1995	RFL	highly sensitive	Nov. 8 - 15	2.5 ~ 5.0	MS	none
CAR 6	1995	RFL	highly sensitive	Nov. 9 - 16	2.5 ~ 5.0	S	none
Aromatic Rice							
Pkha Rumduoul 2/	1999	IRR/RFL	sensitive	Oct. 30 - Nov. 7	3.5 ~ 5.5	S	aromatic
Pkha Rumchek	1999	IRR/RFL	sensitive	Oct. 25 - Nov. 1	3.0 ~ 5.0	MS	aromatic

Rice Varieties Common in the Target Area			
Early Rice	Medium Rice	Late Rice	Aromatic Rice
IR 66	Chamar Prom	Kantom	Neang Malis 3/
IR 36	Ranchey	Kul	Somaly
Sen Pido	Pram Bei Kuo	Phkar Sdao	Phka Knhei
Lom Angthash	Chamar La Lit	Pkar Phnao	
Chrocchap	Chrom Peak Pdao	Phkar Slar	
Kra Ngok Pum	Masari	Khpor Donng	
	Mlis Kraoup	Bei Kan Tom	
		Neang Menh	

Note: IRR: irrigated field RFL: rainfed lowland BPH: brown plant hopper
HS: highly susceptible S: susceptible MS: moderately susceptible
MR: Moderatelt resistant

1/: Rice Varieties Released by the Varietal Recommendation Committee of Cambodia, CARDI, 2001 & CARDI

2/: Variety recommended by CARDI

3/: Variety for contract growing with Angkor Kasekam Roongroeung Co. Ltd.

Table 4.7.3 Rice Production Features in the Project Communes from 2002 to 2004 (SEILA Data Base)

Province/District	Commune	Paddy Field (ha)				Rainfed Rice Cropped Area Rainy Season (ha)				Supplementary Irrigated Cropped Area of Rice, Rainy Season (ha)				Rice Cropped Area, Rainy Season (ha)	Cropping Intensity of Rainy Season Rice (%)	Fully Irrigated Rice Cropped Area Dry Season (ha)				Cropping Intensity of Rice, Dry Season (%)	Annual Rice Cropped Area (ha)	Annual Cropping Intensity of Rice (%)
		2002	2003	2004	Avg	2002	2003	2004	Avg	2002	2003	2004	Avg.	Average	Average	2002	2003	2004	Average	Average	Average	Average
Kampong Speu	Chbar Mon			807	807		730		730					730	90		53		53	7	783	97
Chbar Mon	Kandaol Dom			546	546		567		567					567	104		64		64	12	631	116
	Roka Thum			510	510		522		522	Included in rainfed rice cropped area				522	102		62		62	12	584	115
	Sopoar Tep			357	357		361		361					361	101		45		45	13	406	114
	Svay Kravar			521	521		538		538					538	103		6		6	1	544	104
Communes in the Target Area				2,741	2,741		2,718		2,718					2,718	99		230		230	8	2,948	108
Kong Pisei	Angk Popel	956	1,381	1,382	1,240	956	804	1,382	1,047	0	0	0	0	1,047	84	0	0	0	0	0	1,047	84
	Preah Nipean	1,436	1,436	1,436	1,436	1,436	1,436	1,095	1,322	0	0	341	114	1,436	100	0	19	19	13	1	1,449	101
	Roka Kaoh	980	1,630	980	1,197	980	1,630	860	1,157	0	0	120	40	1,197	100	5	15	61	27	2	1,224	102
	Veal	1,029	1,029	1,029	1,029	1,029	1,029	709	922	0	0	320	107	1,029	100	0	0	0	0	0	1,029	100
	Chongruk	1,619	1,619	1,619	1,619	1,619	1,119	1,619	1,453	500	500	0	333	1,786	110	200	210	250	220	14	2,006	124
	Prey Nheat	1,229	1,229	1,229	1,229	1,229	1,229	1,229	1,229	0	0	0	0	1,229	100	0	0	0	0	0	1,229	100
	Pechr Muni	500	552	500	517	460	500	448	469	40	52	52	48	517	100	40	23	0	21	4	538	104
	Tuek L'ak	782	782	782	782	782	582	762	709	0	200	20	73	782	100	0	0	0	0	0	782	100
Communes in the Target Area		8,531	9,658	8,957	9,049	8,491	8,329	8,104	8,308	540	752	853	715	9,023	100	245	267	330	281	3	9,304	103
Samraong Tong	Roleang Chak	740	740	740	740	417	244	292	318	323	496	448	422	740	100	0	85	20	35	5	775	105
	Kahaeng	703	703	703	703	583	306	429	439	120	397	274	264	703	100	40	47	45	44	6	747	106
	Roleang Kreul	1,033	1,033	1,045	1,037	1,033	1,033	1,045	1,037	0	0	0	0	1,037	100	0	0	0	0	0	1,037	100
	Saen Dei	1,110	1,110	1,110	1,110	1,110	1,089	867	1,022	0	21	243	88	1,110	100	0	0	243	81	7	1,191	107
	Tang Krouch	1,235	1,235	1,276	1,249	1,186	1,086	1,160	1,144	149	149	116	138	1,282	103	0	100	0	33	3	1,315	105
	Trapeang Kong	1,241	1,165	1,365	1,257	730	863	1,046	880	314	302	319	312	1,191	95	10	232	232	158	13	1,349	107
	Voa Sa	1,023	999	1,001	1,008	943	901	746	863	0	98	255	118	981	97	0	55	112	56	6	1,037	103
	Khtum Krang	1,343	1,738	1,738	1,606	1,292	1,738	1,738	1,589	31	0	0	10	1,600	100	3	22	0	8	1	1,608	100
	Krang Ampil	1,457	1,457	1,457	1,457	427	427	1,417	757	1,030	1,030	40	700	1,457	100	0	0	0	0	0	1,457	100
	Pneay	154	1,505	1,505	1,055	154	1,200	1,155	836	0	305	350	218	1,055	100	0	0	0	0	0	1,055	100
	Samraong Tong	833	826	826	828	833	826	649	769	0	0	177	59	828	100	0	0	0	0	0	828	100
	Sambour	941	941	941	941	941	941	941	941	0	0	0	0	941	100	0	0	0	0	0	941	100
	Skuh	1,289	1,357	1,357	1,334	1,283	1,357	1,343	1,328	0	0	14	5	1,332	100	3	10	0	4	0	1,337	100
	Thommoda Ai	1,479	1,479	1,479	1,479	1,479	1,479	1,479	1,479	0	0	0	0	1,479	100	0	0	0	0	0	1,479	100
	Tumpoar Meas	750	1,280	1,280	1,103	750	1,280	1,280	1,103	0	0	0	0	1,103	100	0	0	0	0	0	1,103	100
Communes in the Target Area		15,331	17,568	17,823	16,907	13,161	14,770	15,587	14,506	1,967	2,798	2,236	2,334	16,840	100	56	551	652	420	2	17,259	102
Kandal	Daeum Rues	1,030	1,030	1,030	1,030	148	1,030	1,030	736	852	0	0	284	1,020	99	48	0	0	16	2	1,036	101
Kandal Stueng	Roka	416	416	416	416	16	136	136	96	400	280	280	320	416	100	0	0	0	0	0	416	100
	Roleang Kaen	512	512	512	512	262	75	75	137	250	437	437	375	512	100	0	0	0	0	0	512	100
Communes in the Target Area		1,958	1,958	1,958	1,958	426	1,241	1,241	969	1,502	717	717	979	1,948	99	48	0	0	16	1	1,964	100
Angk Snuol	Baek Chan	543	543	543	543	491	543	543	526	0	0	0	0	526	97	0	0	0	0	0	526	97
	Boeng Thum	720	720	720	720	600	136	136	291	120	584	584	429	720	100	60	40	40	47	6	767	106
	Chhak Chheu Ne	465	403	403	424	410	403	403	405	0	0	0	0	405	96	0	0	0	0	0	405	96
	Damnak Ampil	385	385	385	385	385	385	215	328	0	0	171	57	385	100	0	0	0	0	0	385	100
	Kantaok	750	750	750	750	750	750	750	750	0	0	0	0	750	100	0	0	0	0	0	750	100
	Kamboul	790	790	795	792	790	790	795	792	0	0	0	0	792	100	0	0	0	0	0	792	100
	Krang Mkak	640	640	640	640	425	640	640	568	215	0	0	72	640	100	425	0	0	142	22	782	122
	Lumhach	785	785	785	785	785	110	110	335	0	675	675	450	785	100	0	0	0	0	0	785	100
	Peuk	577	468	577	540	577	468	577	540	0	0	0	0	540	100	0	0	0	0	0	540	100
	Prey Puok	871	577	871	773	871	577	375	608	0	0	465	155	763	99	0	0	4	1	0	764	99
	Ovlaok	468	871	468	602	293	505	468	422	175	354	0	176	598	99	0	71	0	24	4	622	103
	Samraong Leu	780	781	780	780	780	781	780	780	0	0	0	0	780	100	0	0	0	0	0	780	100
	Snao	492	492	492	492	492	492	492	492	0	0	0	0	492	100	0	0	0	0	0	492	100
Communes in the Target Area		8,266	8,204	8,209	8,226	7,649	6,579	6,284	6,837	510	1,613	1,895	1,339	8,176	99	485	111	44	213	3	8,390	102
Communes in Target Area Total		34,086	37,388	39,688	38,881	29,727	33,637	31,215	33,338	4,519	5,880	5,701	5,367	38,705	100	834	1,159	1,026	1,160	3	39,865	103

Source: SEILA Commune Data Base, 2002, 2003 & 2004 except for Chbar Mon; Chabar Mon data from DAO Chbar Mon & Commune Survey on Crops & Livestock, 2003, Statistic Office, MAFF

Table 4.7.4 Rice Production in the Project Communes

Project Communes	Year	Rainy Season Rice					Dry Season Rice				
		Cultivated Area (ha)	Harvested Area (ha)	Yield to Harvested Area (t/ha)	Yield to Cropped Area (t/ha)	Production (ton)	Cultivated Area (ha)	Harvested Area (ha)	Yield to Harvested Area (t/ha)	Yield to Cropped Area (t/ha)	Production (ton)
Project Communes in Chbar Mon District	2003-2004	2,718	2,718	3.0	3.0	8,171	230	230	2.7	2.7	618
	2004-2005	2,313	1,762	2.4	1.8	4,220	173	148	2.6	2.2	387
	Average	2,516	2,240	2.8	2.5	6,196	202	189	2.7	2.5	503
Project Communes in Kong Pisei District	2003-2004	7,988	7,712	1.3	1.3	10,070	14	14	1.4		20
	2004-2005	7,837	6,501	2.0	1.6	12,700	0	0			0
	Average	7,912	7,107	1.6	1.4	11,385	7	7	1.4		10
Project Communes in Samraong Tong Dist.	2003-2004	17,431	17,264	1.4	1.4	24,961	172	159	2.2	2.0	351
	2004-2005	14,810	6,859	2.1	1.0	14,186	123	108	3.2	2.8	347
	Average	16,121	12,062	1.6	1.2	19,574	148	134	2.6	2.4	349
Project Communes in Kapong Speu Province	2003-2004	28,137	27,694	1.6	1.5	43,202	416	403	2.5	2.4	989
	2004-2005	24,960	15,122	2.1	1.2	31,106	296	256	2.9	2.5	734
	Average	26,548	21,408	1.7	1.4	37,154	356	330	2.6	2.4	862
Project Communes in Kandal Stueng Dist.	2000-2001	2,119	1,482	2.3	1.6	3,452	380	380	2.8	2.8	1,048
	2001-2002	2,042	1,789	1.8	1.6	3,221	73	73	2.2	2.2	159
	2002-2003	1,967	1,967	1.8	1.8	3,582	115	115	2.7	2.7	311
	2003-2004	2,171	1,461	1.9	1.3	2,835	82	82	2.2	2.2	180
	2004-2005	2,071	1,937	2.5	2.3	4,776	0	0			0
	Average	2,075	1,675	2.0	1.6	3,273	163	163	2.6	2.6	425
Project Communes in Angk Snuol District	2000-2001	7,654	7,488	2.1	2.0	15,390	151	151	3.5	3.5	530
	2001-2002	7,551	7,352	1.7	1.7	12,589	59	59	3.3	3.3	197
	2002-2003	6,963	6,963	1.8	1.8	12,853	6	6	3.0	3.0	18
	2003-2004	7,794	7,794	2.0	2.0	15,443	30	30	2.5	2.5	75
	2004-2005	7,201	4,757	2.2	1.4	10,330	0	0			0
	Average	7,433	6,871	1.9	1.8	13,321	49	49	3.3	3.3	164
Project Communes in Kandal Province	2000-2001	9,773	8,970	2.1	1.9	18,842	531	531	3.0	3.0	1,578
	2001-2002	9,593	9,141	1.7	1.6	15,810	132	132	2.7	2.7	356
	2002-2003	8,930	8,930	1.8	1.8	16,435	121	121	2.7	2.7	329
	2003-2004	9,965	9,255	2.0	1.8	18,278	112	112	2.3	2.3	255
	2004-2005	9,272	6,694	2.3	1.6	15,106	0	0			0
	Average	9,565	9,074	1.9	1.8	17,341	224	224	2.8	2.8	630
Overall Project Communes	2003-2004	**38,102**	**36,949**	**1.7**	**1.6**	**61,480**	**528**	**515**	**2.4**	**2.4**	**1,244**
	2004-2005	**34,232**	**21,816**	**2.1**	**1.3**	**46,212**	**296**	**256**	**2.9**	**2.5**	**734**
	Average	**36,167**	**29,383**	**1.8**	**1.5**	**53,846**	**412**	**386**	**2.6**	**2.4**	**989**

Source:

Kampong Speu 2003-2004: Commune Survey on Crops & Livestock, 2003, Statistic Office, MAFF; 2004-2005: PDA Kampong Speu

Kandal PDA Kandal

Table 4.7.5 Crop Losses of Rice in the Project Communes

Project Communes	Year	Rainy Season Rice									Dry Season Rice					
		Cultivated Area (ha)	Completely Destroyed by (Ha & %)							Harvested Area (ha)	Cultivated Area (ha)	Completely Destroyed by (Ha & %				Harvested Area (ha)
			Flood		Draught		Insect & Others	Total				Draught	Insect & Others	Total		
			ha	%	ha	%	ha	ha	%			ha	ha	ha	%	
Project Communes in Chbar Mon District	2003-2004	2,718	0		0		0	0		2,718	230	0	0	0		230
	2004-2005	2,313	0		551	24	0	551	24	1,762	173	0	0	25	14	148
	Average	2,516	0		276	11	0	276	11	2,240	202	0	0	13	6	189
Project Communes in Kong Pisei District	2003-2004	7,988	0		276	3	0	276	3	7,712	14	0	0	0		14
	2004-2005	7,837	0		1,336	17	0	1,336	17	6,501	0	0	0	0		0
	Average	7,912	0		806	10	0	806	10	7,107	7	0	0	0		7
Project Communes in Samraong Tong Dist.	2003-2004	17,431	0	0	19	0	148	167	1	17,264	172	0	13	13	8	159
	2004-2005	14,810	0	0	7,951	54	0	7,951	54	6,859	123	0	0	15	12	108
	Average	16,121	0	0	3,985	25	74	4,059	25	12,062	148	0	7	14	9	134
Project Communes in Kampung Speu Province	2003-2004	28,137	0	0	295	1	148	443	2	27,694	416	0	13	13	3	403
	2004-2005	24,960	0	0	9,838	39	0	9,838	39	15,122	296	0	0	40	14	256
	Average	26,548	0	0	5,066	19	74	5,140	19	21,408	356	0	7	27	7	330
Project Communes in Kandal Stueng Dist.	2000-2001	2,119	637	30	0	0	0	637	30	1,482	380	0	0	0		380
	2001-2002	2,042	253	12	0	0	0	253	12	1,789	73	0	0	0		73
	2002-2003	1,967	0		0	0	0	0		1,967	115	0	0	0		115
	2003-2004	2,171	710	33	0	0	0	710	33	1,461	82	0	0	0		82
	2004-2005	2,071	0		134	6	0	134	6	1,937	0			0		0
	Average	2,074	320	15	27	1	0	347	17	1,727	130			0		130
Project Communes in Angk Snuol Dist.	2000-2001	7,654	166	2	0	0	0	166	2	7,488	151	0	0	0	0	151
	2001-2002	7,551	0	0	199	3	0	199	3	7,352	59	0	0	0	0	59
	2002-2003	6,963	0	0	0	0	0	0	0	6,963	6	0	0	0	0	6
	2003-2004	7,794	0	0	0	0	0	0	0	7,794	30	0	0	0	0	30
	2004-2005	7,201	0	0	2,444	34	0	2,444	34	4,757	0	0	0	0		0
	Average	7,433	33	0	529	7	0	562	8	6,871	49			0	0	49
Project Communes in Kandal Province	2000-2001	9,773	803	8	0	0	0	803	8	8,970	531	0	0	0	0	531
	2001-2002	9,593	253	3	199	2	0	452	5	9,141	132	0	0	0	0	132
	2002-2003	8,930	0	0	0	0	0	0	0	8,930	121	0	0	0	0	121
	2003-2004	9,965	710	7	0	0	0	710	7	9,255	112	0	0	0	0	112
	2004-2005	9,272	0	0	2,578	28	0	2,578	28	6,694	0	0	0	0		0
	Average	9,507	353	4	555	6	0	909	10	8,598	179	0	0	0	0	179
Overall Project Communes	2003-2004	38,102	710	2	295	1	148	1,153	3	36,949	528	0	13	13	2	515
	2004-2005 1/	34,232	0	0	12,416	36	0	12,416	36	21,816	296	0	0	40	14	256

Source:
Kampong Speu 2003-2004: Commune Survey on Crops & Livestock, 2003, Statistic Office, MAFF; 2004-2005: PDA Kampong Speu
Kandal PDA Kandal

Table 4.7.6 Prevailing Farming Practices of Rice

Farming Practices	Irrigated Field	Rainfed Field
Major rice varieties	Early Variety: IR 66, Sen Pidao Ire 36, Kra Ngokpum	Medium Variety Chamar Prom, Riang Chey, Masari, Neang Malis
	Medium Variety Chmaprom, Riang Chey Masari, Neang Mleas	Late Variety: CAR 4, CAR 5 Krahom
	Late Variety: CAR 4, CAR 5, krahom	
Seeding rate (kg/ha)	Kampung Speu 45 ~ 60 kg/ha Kandal 80 ~ 100 kg/ha	Kampung Speu 45 ~ 60 kg/ha Kandal 80 ~ 100 kg/ha
Land preparation	Draft animal	Draft animal
Planting method	Transplanting	Transplanting
Planting distance	Kampung Speu 20 x 20 cm (random) Kandal 15 x 20 cm (random) Random planting prevailing	Kampung Speu 30 x 30 cm (random) Kandal 15 x 20 cm (random) Random planting prevailing
Age of seedling	30 days (or more depending on water availability in a field)	30 to 60 days (or more depending on water availability in a field)
Fertilization		
1st application	Timing: at time of land preparation	Timing: at time of land preparation
- Urea (kg/ha)	Limited	Limited
- DAP (kg/ha)	75 ~ 100 kg/ha	50 ~ 75 kg/ha
- KCl (kg/ha)	Not applied	Not applied
- Compost	Applied by farmer holding cattle	Applied by farmer holding cattle
2nd application	Timing: flowering stage or 1 ~ 1.5 month after planting	Timing: flowering stage or 1 ~ 1.5 month after planting
- Urea (kg/ha)	75 ~ 100 kg/ha	50 ~ 75 kg/ha
Agro-chemical spray	Application limited (Trebong etc.)	Application limited (Trebong etc.)
Manual weeding	3 times per a cropping season	3 times per a cropping season
Harvesting	Manual	Manual
Threshing	Manual in a field Use of thresher limited	Manual in a fiel 2. Pedal thresher Use of thresher limited
Drying	Sun drying in home yard after threshing	Sun drying in home yard after threshing
Yield Level: rainy season		
Range	Kampung Speu 2.0 ~ 5.0 ton/ha Kandal 1.8 ~ 4.0 ton/ha	Kampung Speu 1.5 ~ 2.5 ton/ha Kandal 1.8 ~ 4.0 ton/ha
Yield Level: dry season		
Range	Kampung Speu 2.0 ~ 6.0 ton/ha Kandal 2.0 ~ 5.5 ton/ha	

Source: PDA Kampung Speu & Kandal

Table 4.7.7 Food Balance Sheet for 2002/03 to 2004/05 in the Project Communes

Project Communes	Year	Population	Annual Paddy Production (ton)	13% for Seed & Post-harvest Losses)	Paddy for Consumption (ton)	Converted into Milled Rice (64%)	Rice Requirement for Food (ton)	Food Balance: Surplus or Deficit (ton)
Project Communes in Chbar Mon District	2002-2003	41,708	5,042	655	4,387	2,807	5,964	-3,157
	2003-2004	42,322	8,789	1,143	7,646	4,894	6,052	-1,158
	2004-2005	42,549	4,607	599	4,008	2,565	6,085	-3,519
	Average		6,146				6,034	-2,612
Project Communes in Kong Pisei District	2002-2003 1/	57,617	10,200	1,326	8,874	5,679	8,239	-2,560
	2003-2004	60,025	10,090	1,312	8,778	5,618	8,584	-2,965
	2004-2005	60,431	12,700	1,651	11,049	7,071	8,642	-1,570
	Average		10,997				8,488	-2,365
Project Communes in Samraong Tong Dist.	2002-2003	133,168	13,154	1,710	11,444	7,324	19,043	-11,719
	2003-2004	133,838	25,312	3,291	22,021	14,094	19,139	-5,045
	2004-2005	136,173	14,533	1,889	12,644	8,092	19,473	-11,381
	Average		17,666				19,218	-9,382
Project Communes in Kampung Speu Province	2002-2003	232,493	28,396	3,691	24,705	15,811	33,246	-17,436
	2003-2004	236,185	44,191	5,745	38,446	24,606	33,774	-9,169
	2004-2005	239,153	31,840	4,139	27,701	17,729	34,199	-16,470
	Average		34,809				33,740	-14,358
Project Communes in Kandal Stueng Dist.	2002-2003	15,339	3,893	506	3,387	2,168	2,193	-26
	2003-2004	15,815	3,015	392	2,623	1,679	2,262	-583
	2004-2005	16,175	4,776	621	4,155	2,659	2,313	346
	Average		3,895				2,256	-87
Project Communes in Angk Snuol Dist.	2002-2003	71,465	12,871	1,673	11,198	7,167	10,219	-3,053
	2003-2004	72,730	15,518	2,017	13,501	8,640	10,400	-1,760
	2004-2005	74,329	10,330	1,343	8,987	5,752	10,629	-4,877
	Average		12,906				10,416	-3,230
Project Communes in Kandal Province	2002-2003	86,804	16,764	2,179	14,585	9,334	12,413	-3,079
	2003-2004	88,545	18,533	2,409	16,124	10,319	12,662	-2,343
	2004-2005	90,504	15,106	1,964	13,142	8,411	12,942	-4,531
	Average		16,801				12,672	-3,318
Overall Project Communes	2002-2003	319,297	45,160	5,871	39,289	25,145	45,659	-20,514
	2003-2004	324,730	62,724	8,154	54,570	34,925	46,436	-11,512
	2004-2005	329,657	46,946	6,103	40,843	26,140	47,141	-21,001
	Average		51,610			28,736	46,412	-17,676

Source:

Kampong Speu 2002-2003 & 2004-2005: PDA ; 2003-2004: Commune Survey on Crops & Livestock, 2003, Statistic Office,

Kong Pisei: 2002-2003 estimated --- rice field in target area 8,500 ha x average yield in the district 1.2 = 10,20

Kandal 2002-2003, 2003-2004,2004-2005, PDA Kandal

Population: 2002-2003, 2003-2004 & 2004-2005 based on SEILA Data Base, 2002, 2003 & 2004, respectively

Table 4.7.8 Livestock Population and Holding Status by Commune in Target Area in 2003

Unit: head/bird/ha

Province/ District/Commune	No. of Farm Households 1/ 2/	Cattle		Cow		Draught Cattle		Buffalo Total 2/	Draught Buffaloes 2/	Pig Total		Pig (female) 2/	Poultry		No. of Families 3/	No. & Proportion of Families with Cattle & Buffalo 3/		No. & Proportion of Families with Pig 3/		Works Done by Draught Animal (ha) 4/	No. of Ox & Horse Cart 3/
		Population 2/	Average Holding per Farm 2/	Population 2/	Average Holding per Farm 2/	Population 2/	Average Holding per Farm 2/			Population 2/	Average Holding per Farm 2/		Population 2/	Average Holding per Farm 2/		No.	%	No.	%		
Kampong Speu																					
Project Communes in Chbar Mon	5,352	7,290	1.4	2,357	0.4	2,649	0.5	0	0	6,415	1.2	617	194,821	36.4	8,010	-		-		3,062	-
Project Communes in Kong Pisei	10,127	23,615	2.3	7,941	0.8	12,132	1.2	8	4	16,068	1.6	314	54,416	5.4	11,121	8,934	80	4,362	39		4,616
Project Communes in Samraong Tong	23,992	65,747	2.7	20,757	0.9	24,789	1.0	26	24	19,829	0.8	2,107	128,647	5.4	25,477	19,767	78	6,528	26	25,212	11,574
Project Communes in Kampung Speu	39,471	96,652	2.4	31,055	0.8	39,570	1.0	34	28	42,312	1.1	3,038	377,884	9.6	44,608	28,701	64	10,890	24		16,190
Kandal																					
Project Communes in Kandal Stueng	3,204	4,986	1.6	747	0.2	1,466	0.5	0	0	1,797	0.6	178	6,247	1.9	3,318	2,241	68	1,240	37		869
Project Communes in Angk Sunuol	11,254	21,798	1.9	8,603	0.8	7,677	0.7	0	0	7,297	0.6	193	51,114	4.5	13,525	7,921	59	3,730	28		3,959
Project Communes in Kandal	14,458	26,784	1.9	9,350	0.6	9,143	0.6	0	0	9,094	0.6	371	57,361	4.0	16,843	10,162	60	4,970	30		4,828
Overall Project Communes	53,929	123,436	2.3	40,405	0.7	48,713	0.9	34	28	51,406	1.0	3,409	435,245	8.1	61,451	38,863	63	15,860	26		21,018

1/: Assumed to be equal to No. of crop growing households
2/: Source: Commune Survey on Crops & Livestock, 2003, Statistic Office, MAFF
3/: Source: SEILA Commune Data Base,2004
4/: Land preparation works done by draught animals in 2004; Source: PDA Kampong Speu

Table 4.7.9 Summary Results of Socio-economic Survey (Land Use and Cropped Area, Cropping Intensity, Production, Unit Yield & Marketing Volume of Paddy by Category of Land) 1/

Item	Land Use (ha)								Cropped Area of Paddy (ha)					Cropping Intensity of Paddy (%)					Paddy Production (kg)				Paddy Yield (kg/ha)				Marketed Volume of Paddy (kg & %)				
	Paddy Field					Upland Field for Field Crop	Upland Field for Tree Crop	Total Farm Land	Irrigated Paddy					Irrigated Field					Irrigated Paddy				Irrigated Paddy				Irrigated Paddy				
	Irrigated Field	Supplementary Irrigated Field	Irrigated Field Total	Rainfed Field	Total Paddy Field				Rainy Season	Dry season I	Total	Rainfed Paddy	Total	Rainy Season	Dry Season	Annual	Rainfed Field	Overall	Rainy Season	Dry Season	Rainfed Paddy	Total Production	Rainy Season	Dry Season	Average	Rainfed Paddy	Rainy Season	Dry Season	Rainfed Paddy	Total	Proportion to Total Production
Category	Category 1: Fully Irrigated Rice Field																														
Total	19.3	17.4	36.7	10.1	46.8	5.5	2.8	55.0	35.0	20.7	55.7	9.1	64.8	95	56	152	90	138	68,690	46,100	18,260	133,050	1,964	2,225	2,061	2,011	23,090	23,950	2,750	49,790	37
No. of Respondent	40	25	49	26	49	19	12	49	49	40	49	26	49	49	49	49	26	49	49	39	25	49	49	40	49	26	33	31	8	49	49
Per Respondent	0.48	0.70	0.75	0.39	0.96	0.29	0.23	1.12	0.71	0.52	1.14	0.35	1.32						1,402	1,182	730	2,715	40	56	42	77	700	773	344	1,016	37
Per Sample (50 samples)	0.39	0.35	0.73	0.20	0.94	0.11	0.06	1.10	0.70	0.41	1.11	0.18	1.30	95	44	152	90	138	1,374	922	365	2,661	39	44	41	40	462	479	55	996	37
Category	Category 2: Supplementary Irrigated Rice Field (large irrigation system)																														
Total	15.62	17.29	32.91	5.43	38.34	3.73	2.70	44.77	33.19	1.03	34.22	5.43	39.65	101	3	104	100	103	83,330	5,280	7,675	96,285	2,511	5,126	2,589	1,413	18,876	2,500	1,900	23,276	24
No. of Respondent	27	33	47	20	47	13	8	47	47	4	47	20	47	47	47	47	20	47	47	5	17	47	47	4	47	20	24	1	4	47	47
Per Respondent	0.58	0.52	0.70	0.27	0.82	0.29	0.34	0.95	0.71	0.26	0.73	0.27	0.84						1,773	1,056	451	2,049	53	1,282	55	71	787	2,500	475	495	24
Per Sample (50 samples)	0.31	0.35	0.66	0.11	0.77	0.07	0.05	0.90	0.66	0.02	0.68	0.11	0.79	101	3	104	100	103	1,667	106	154	1,926	50	103	52	28	378	50	38	466	24
Category	Category 3: Supplementary Irrigated Rice Field (small irrigation system)																														
Total	0.44	24.03	24.47	35.17	59.64	11.59	1.34	72.57	24.47	1.40	25.87	31.32	57.19	100	6	106	89	96	47,090	4,140	35,185	86,415	1,924	2,957	1,980	1,123	14,570	1,970	15,350	31,890	37
No. of Respondent	3	44	47	37	47	24	9	47	45	2	47	37	47	45	45	45	37	47	43	3	26	47	45	2	45	37	16	2	10	47	43
Per Respondent	0.15	0.55	0.52	0.95	1.27	0.48	0.15	1.54	0.54	0.70	0.55	0.85	1.22						1,095	1,380	1,353	1,839	43	1,479	44	30	911	985	1,535	679	37
Per Sample (50 samples)	0.01	0.48	0.49	0.70	1.19	0.23	0.03	1.45	0.49	0.03	0.52	0.63	1.14	100	2	106	89	96	942	83	704	1,728	38	59	40	22	291	39	307	638	37
Category	Category 4: Rainfed Rice Field																														
Total	0	0	0	48.13	48.13	7.84	2.12	58.09	1.00	0	0	36.83	36.83	-	-	-	77	77	-	-	37,412	37,412	-	-	-	1,016	-	-	13,200	13,200	35
No. of Respondent	0	0	0	41	41	18	9	41	0	0	0	41	41	-	-	-	41	41	-	-	41	41	-	-	-	41	-	-	13	41	41
Per Respondent				1.17	1.17	0.44	0.24	1.42				0.90	0.90	-	-	-			-	-	912	912	-	-	-	25	-	-	1,015	322	35
Per Sample (50 samples)	0	0	0	0.96	0.96	0.16	0.04	1.16	0.02	0	0	0.74	0.74	-	-	-	77	77	-	-	748	748	-	-	-	20	-	-	264	264	35
Category	Overall																														
Total	35	59	94	99	193	29	9	230	94	23	116	83	198	100	25	123	84	103	199,110	55,520	98,532	353,162	2,126	2,398	2,199	1,192	58,686	28,920	33,200	120,806	34
No. of Respondent	70	102	143	124	184	74	38	184	141	46	143	124	184	141	141	141	124	184	139	47	109	184	141	46	141	124	73	34	35	184	-
Per Respondent	0.51	0.58	0.66	0.80	1.05	0.39	0.23	1.25	0.66	0.50	0.81	0.67	1.08						1,432	1,181	904	1,919	15	52	16	10	804	851	949	657	34
Per Sample (200 samples)	0.18	0.29	0.47	0.49	0.96	0.14	0.04	1.15	0.47	0.12	0.58	0.41	0.99	100	12	123	84	103	996	278	493	1,766	11	12	11	6	293	145	166	604	34

1/: Results of the Socio-economic Survey conducted by the JICA Study Team, 2005
Note: Sample No. per category 50; total 200 samples

Table 4.11.1 Current Functions of Technical Offices of PDA

Office	Functions	Major Projects by Donors	
		Kampung Speu	Kandal
Agronomy Office	- Trial & technical development - Plant protection (implementation of IPM program) - Seed production (currently not implemented) - Production statistics	- APIP (IPM) - CDA (RFV) - WVC (IPM) - LWF (IPM)	- APIP (IPM) - FAO (IPM)
Agricultural Extension	- Field extension activities through AEWs - Farmer training activities - AEA - Pilot operation of EPP	- CAAEP II - SEILA - SLPP - LWS - World Vision	- CAAEP II - SEILA
Animal Health & Production	- Technology development/improvement - Extension & farmer training (livestock sub-sector) - Animal health, quarantine & veterinary activities	- UNICEF - SEILA - SLPP - LWS - World Vision	- SEILA - World Vision - LWS - VSS
Fisheries	- Production of fish fries & fingerings - Fish culture - Organization of fishery community - Control of fishing season & lots - Release fingerings in natural water areas	- JICA - SEILA	- SEILA - MRC
Agricultural Machinery	- No activities being taken in principle, no farm machinery possessed		
Agro-industry	- Newly established office, no activity reported		
Planning & Finance	- Planning & agricultural statistic - Accounting		
DAO	- Statistic data collection - Extension activities (project activities in collaboration with PDA) - Animal vaccination	- PDA project activities	- PDA project activities

Source: Kampung Speu & Kandal PDA

Table 5.3.1 Information Summary of Natural and Social Resources (Zone-1) (1/2)

Province	**Kampong Speu**		
District	**Samraong Tong**		
Commune	**Kahaeng**		
Village	**Ou Veaeng**	**Tumpung**	**Kahaeng**
Physical layout and Natural resources: a) Village boundary	Adjacent to La Village (Northern and eastern sides)	Bordered on the north by Roleang Chrey south by Kouk Rumlich west by Krang Spueu and Odongk east by Kahaeng and Roleang Chrey Villages	Bordered on the north by Thmei northern west by Okontrom south by Pongro east by Khvan Villages
b) Nos. of households (# of landless household) (♀: # of female-headed household)	92 (13) (♀almost 30)	133 (15) (N.A.)	92 (0) (♀24)
c) Kinship	All villagers are relatives except 1 newcomer.	N.A.	Some are relatives, and the others are not.
d) Household distribution	Along National Road # 4, village main roads	Mainly along the road to Roleang Chhuk Pagoda, village main roads, the Prek Thnot River	A village main road, the Prek Thnot River
e) Nos. of (administrative) Groups/ *Kromtee*	N.A.	5	5
f) Main road	National Road # 4	National Road # 4, ruined rail ways	National Road # 4, ruined rail ways
g) Main bridge	Ou Veaeng Bridge	None	2 bridges
h) Water resources for agricultural use	South Roleang Chrey main canal, Ou Veaeng secondary canals, Ou Veaeng reservoir, Village common ponds	South and North Roleang Chrey main canals, secondary canals, Roleang Chrey water gate, the Prek Thnot river	The Prek Thnot river, Ou Veaeng canal, Ou Veaeng secondary canals, Ou Veaeng reservoir, Roleang Chrey water gate
i) Water resources for drinking	Rainwater, wells (of which two are donated by UNICEF), canal	Rainwater, wells (of which two are donated by Children's Right Program, one is donated by UNICEF), canals	Rainwater, the Prek Thnot river (must be boiled)
j) Water resources for domestic use	Canals, wells	Canals, wells	Prek Thnot river

Table 5.3.1 Information Summary of Natural and Social Resources (Zone-1) (2/2)

k) Village Common land	Forestry (managed by MAFF), pasture	Not mentioned	Not mentioned
l) Total cropland/ Average farmland holding size	55 ha (rice)/ 0.7ha/HH	54 ha (total)/ 0.45ha/HH	52 ha (rice)/ 0.56/HH
m) Markets nearby	Kg Speu Market, a rice miller	Not on the map	Not on the map
Social resources: a) Schools nearby	Primary and secondary school (in the village)	Roleang Chhuk primary and secondary schools (in the village)	Primary and secondary schools
b) Religious facility	Roleang Chnot Pagoda (2km) Christian church	Roleang Chhuk Pagoda	Pagoda (between primary and secondary schools)
c) Medical institution	Kahaeng-Tang Commune Health Center (200m)	Kahaeng Commune Health Center	Kahaeng Commune Health Center
d) Electricity (transmission network)	None (but in the plan)	None	None
e) Transportation means	Motor bike, bicycle, motorbike taxi, *remorque-moto**, oxcart	Motor bike, bicycle, motorbike taxi, *remorque-moto*, oxcart	Motor bike, bicycle, motorbike taxi, *remorque-moto*, oxcart
f) Communication infrastructure	No telephone line	No telephone line	No telephone line
g) Public agency nearby (besides health center or/and schools)	Commune office, Police station	Military base	(Village Public Center)

Note: * *remorque-moto* is a large trailer hitched to a motorbike

Table 5.3.2 Information Summary of Natural and Social Resources (Zone-2) (1/2)

Province	**Kampong Speu**		
District	**Kong Pisei**		
Commune	**Preah Nipean**		
Village	**Sala Kruos**	**Boeng Chram Tboung**	**Sayav**
Physical layout and Natural resources: a) Village boundary	Bordered on the south and west by Srang Village east by Prey Chor Village and Kandal Province	Bordered on the north by Prey Thkov south by Damnak Mean Chey west and south by Chamkar Sbov east by Dot Kambaor Villages	Bordered on the north and northwest by Trapeang Sla southwest by Dot Kambaor south by Pheansa southeast and east by Prey Totueng Villages
b) Nos. of households (# of landless household) (♀: # of female-headed household)	64 (6) (♀10)	40 (5) (♀2)	99 (6) (♀7)
c) Kinship	All villagers are relatives except 1 newcomer.	N.A.	Some are relatives, and the others are not.
d) Household distribution	Mainly along Village Road # 1 and # 2	Mainly along village roads	Along with village roads
e) Nos. of (administrative) Groups/ *Kromtee*	2	3	4
f) Main road	National Road # 3, National Road # 4, Road # 51, Provincial Road to Kg Speu	Provincial Road to Kg Speu	National Road # 3
g) Main bridge	2	Not on the map	Not on the map
h) Water resources for agricultural use	Canals, reservoir built in 1986	Natural big ponds, small ponds, canals conducted from the big pond (*chram*)	5 big ponds, canals conducted from the ponds
i) Water resources for drinking	Rainwater, wells (donated by UNICEF), big ponds, canals	Rainwater, 9 wells	Rainwater, 20a pond, the other ponds, purchased water, wells (dug by Social Fund, one for the public use)
j) Water resources for domestic use	Wells (donated by Social Fund)	Rainwater, 9 wells, the big pond (*chram*)	Big ponds, the public well

Table 5.3.2 Information Summary of Natural and Social Resources (Zone-2) (2/2)

k) Village Common land	Pasture	Not mentioned	Not mentioned
l) Total cropland/ Average farmland holding size	Rice: 41ha, vegetables 50ha (120ha in total)/ 0.7ha/HH	N.A./ N.A.	N.A./ 0.8ha/HH
m) Markets nearby	Angkor Market A market	Prey Totueng Market	Prey Totueng Market
Social resources: a) Schools nearby	Primary and secondary schools (in the village)	Primary school (in Prey Thkov village)	Primary school (in Trapeang Sla village)
b) Religious facility	Preah Nipean Pagoda (in Prey Chor Village)	Pagoda	Pagodas (one in Prey Totueng Village, one in Trapeang Sla Village)
c) Medical institution	Not on the map (Preah Nipean Commune Health Center)	Preah Nipean Commune Health Center	Preah Nipean Commune Health Center
d) Electricity (transmission network)	None	None	None
e) Transportation means	Oxcart (in the village), *remorque-moto*, (out of the village)	Motor bike, bicycle, motorbike taxi, *remorque-moto* to Takeo, oxcart (for farming), operating railway from PP to Kg Som	Motor bike, bicycle, motorbike taxi, *remorque-moto* for commuting garment factories, operating railway and its station on the way from PP to Kg Som
f) Communication infrastructure	No telephone line (4 mobile phone holders in the village, public mobile phones in the other village)	No telephone line (4 mobile phone holders in the village)	No telephone line (7 mobile phone holders in the village)
g) Public agency nearby (besides health center or/and schools)	Village Public Center Village Accommodation Center	None	None

Table 5.3.3 Information Summary of Natural and Social Resources (Zone-3) (1/2)

Province	**Kampong Speu**		
District	**Samraong Tong**		
Commune	**Pneay**		
Village	**Beng**	**Angkor Chea**	**Sampov Ngo**
Physical layout and Natural resources: a) Village boundary	Bordered on the northwest by Sampov Ngo northeast by Angkor Chea southwest by Chamkar Bos southeast by Krang Pongro east by Samraong Tong Villages	Bordered on the northwest by Sampov Ngo south by Krang Pongro west by Beng east by Samraong Tong Villages	Bordered on the northwest by Ou Kraom northeast by Krang Ta Roatn south by Chamkar Bos west by Pneay east by Angkor Chea Villages
b) Nos. of households (# of landless household) (♀: # of female-headed household)	107 (20) (♀23)	70 (5) (♀5)	65 (4) (♀16)
c) Kinship	Some are relatives, and the others are not.	Some are relatives, and the others are not.	Some are relatives, and the others are not.
d) Household distribution	Mainly along village roads	Along village roads	Along Village Road #1, #2, #3, a village truck road
e) Nos. of (administrative) Groups/ *Kromtee*	4	2	4
f) Main road	National Road # 4	National Road # 4	National Road # 4
g) Main bridge	Not on the map	2	3
h) Water resources for agricultural use	Canals, streams, Chamkar reservoir (controlled by the water gate repaired by PRASAC in 2003), a reservoir (controlled by the water gate constructed by World Vision), a big ponds	Chamkar Thnol reservoir, Roleang Chrey reservoir, Chang Teak stream, canals	Rainfall, canals conduced from Chamkar Thnol reservoir (only in the rainy season), 2 small ponds, big ponds
i) Water resources for drinking	Rainwater, the pond near Te Kanaram pagoda and the well near a primary school, wells	Rainwater, public wells (donated by UNICEF), canals conduced from Roleang Chrey reservoir	Rainwater, 2 small and 2 big ponds
j) Water resources for domestic use	Canals	Canals conduced from Roleang Chrey reservoir, temporary wells near the canals	Wells (donated by UNICEF), individual wells (out of 2 are not available for the villagers)
k) Village Common land	Not mentioned	Not mentioned	Not mentioned

Table 5.3.3 Information Summary of Natural and Social Resources (Zone-3) (2/2)

l) Total cropland/ Average farmland holding size	Rice: 65ha, vegetables (+ residential area): 3ha (68ha in total)/ 0.4ha/HH	Rice: 37ha/ 0.5ha/HH	Rice: 79ha (85ha in total) / 0.5ha/HH
m) Markets nearby	Chambak Market Kg Speu Market	Kg Speu Market	Kg Speu Market
Social resources: a) Schools nearby	Kindergarten, primary school (in the village) Not on the map but; Secondary/ Junior high school (2km away from the village) High school (8km away from the village)	Kindergarten, primary and secondary/ junior high schools (in Beng Village)	Kindergarten, Trapeang Chhuk primary and secondary/ junior high schools (in Chamkar Bos Village), Te Knaram school (nearby Te Knaram Pagoda)
b) Religious facility	Te Knaram Pagoda (in the village)	Trapeang Chhuk Pagoda, the other pagoda	Trapeang Chhuk Pagoda, Te Knaram Pagoda
c) Medical institution	Pneay Commune Health Center (in Sampov Ngo Village)	Pneay Commune Health Center (in Sampov Ngo Village)	Pneay Commune Health Center (in Krang Snuol Village)
d) Electricity (transmission network)	None	None	None
e) Transportation means	*Remorque-moto*, motorbike taxi, car taxi, truck (for going out from the village), bike, motorbike	Motorbike, motorbike taxi, *Remorque-moto*, truck	Bike, motorbike, motorbike taxi, car, *Remorque-moto*
f) Communication infrastructure	No telephone line (5 mobile phone holders in the village, out of 1 is a public mobile phone)	No telephone line (4 mobile phone holders in the village, all of them are used as a public mobile phone)	No telephone line (Mobile phone holders: 5% in the village)
g) Public agency nearby (besides health center or/and schools)	Village Public Center	Commune office Village Public Center	Commune office

Table 5.3.4 Information Summary of Natural and Social Resources (Zone-4) (1/2)

Province	Kandal		
District	**Angk Snuol**		
Commune	**Peuk**		
Village	**Chamkar Trach**	**Tuol Tnaot**	**Angk Samnang**
Physical layout and Natural resources: a) Village boundary	Bordered on the north by Tuol Tnaot west by Troyueng Villages	Bordered on the north by Trapeang Chhuk south by Chamkar Trach southwest by Troyueng west by Trapeang Chhuk east by Angk Samnang Villages	Bordered on the north by Kandal, Trapeang Tuol and Prey Rueng northeast by Trapeang Krasang, Trapeang Sopoar and Khla Koun southeast by Prey Tumpung Villages west by Trapeang Chhuk
b) Nos. of households (# of landless household) (♀: # of female-headed household)	25 (3) (♀N.A.)	42 (7) (♀N.A.)	45 (5) (♀N.A.) Note: including 2 immigrants from Thailand
c) Kinship	Some are relatives, and the others are not.	Some are relatives, and the others are not.	Some are relatives, and the others are not.
d) Household distribution	Mainly along a village road	Mainly along two village roads	Mainly along with a village road, village truck paths
e) Nos. of (administrative) Groups/ *Kromtee*	N.A.	N.A.	3
f) Main road	National Road # 4	National Road # 4, the road constructed in the Pol Pot era to Kg Speu	National Road # 4, the road constructed for railways in the Pol Pot era is used as cattle and motorbike path
g) Main bridge	Not on the map	Not on the map	1
h) Water resources for agricultural use	Rainfall (in the future; the canals conduced from a reservoir nearby projected by Inter-Ministerial Project)	Rainfall (the ruined canals constructed in the Pol Pot era are used for oxcart paths)	Rainfall, shallow canals (only in rainy season)
i) Water resources for drinking	Rainwater, wells, ponds, purchased water	Rainfall, 5 wells (out of two are public and donated by UNICEF), the pond near the pagoda	Rainfall, big ponds, a pond belonged to Village Chief, the pond belonged to Chambok pagoda, purchased water

Table 5.3.4 Information Summary of Natural and Social Resources (Zone-4) (2/2)

j) Water resources for domestic use	Wells	Wells, the pond near the pagoda	Big ponds, a pond belonged to Village Chief
k) Village Common land	Not mentioned	Not mentioned	Chinese cemetery was.
l) Total cropland/ Average farmland holding size	Rice: 18ha (in total 41ha)/ 0.8ha/HH	Rice: 25ha/ 0.67ha/HH	Rice: 27ha (in total 39ha)/ 0.67ha/HH
m) Markets nearby	Angk Snuol Market	Angk Snuol Market	Angkor Kashikan Co. Ltd.,
Social resources: a) Schools nearby	Primary school	Primary school	Primary school near Chambok pagoda
b) Religious facility	Pagoda (near primary school)	Pagoda (near primary school), Korean Catholic Church	Chambok pagoda
c) Medical institution	Peuk Commune Health Center (on the map), a private clinic (near Angk Snuol market)	Peuk Commune Health Center (on the map), a private clinic (near Angk Snuol market)	Angk Snuol Commune Health Center
d) Electricity (transmission network)	None	None	None
e) Transportation means	*Remorque-moto*, motorbike taxi, bike, motorbike	*Remorque-moto*, motorbike taxi, bike, motorbike, truck	Motorbike taxi, motorbike, bike, *Remorque-moto*
f) Communication infrastructure	No telephone line (4 mobile phone holders in the village)	No telephone line (more than 10 mobile phone holders in the village)	No telephone line (more than 8 mobile phone holders in the village)
g) Public agency nearby (besides health center or/and schools)	Commune office	Commune office	None

Table 5.3.5 Condition of FWUC/ FWUG by Village

	Year of Establishment	Water Charge	Current Condition
Zone-1 i) Ou Veaeng	N.A.	• Pumping: R 10,000/ha • Intake: R 30,000/ha	• Members of FWUC are those who have farmland and pay water charge • FWUC functions well
ii) Tumpung	N.A.	N.A.	• Head of FWUC lives in the village • FWUG is at a preparing stage • Nobody pays water charge because the farmers think gravity irrigation is better, but level of paddy fields is lower than water level of canals
iii) Kahaeng	N.A.	• R 200/a from the farmers who used water	• 92 farmers are members of FWUC • FWUC covers 4 Communes; Chbar Mon, Kahaeng, Roleang Chak, and Svay Kravan • Chief and deputy chief live in the village • Not all of the members paid water charge willingly in 2003 • FWUC provides sufficient water for cultivation
Zone-2 i) Sala Kruos	Preparing from August 2005	N.A.	• FWUG is at a preparing stage • Irrigation water is insufficient
ii) Boeng Chram Tboung	Instruction from PDOWRAM in September 2005	N.A.	• The village got the instruction of forming FWUG in September 2005
iii) Sayav	2004	N.A.	• There is no record of activities
Zone-3 i) Beng	2003	Free of Charge	• FWUG was established in 2003 • There are not water distribution facilities because the government removed gates for transferring water to Kandal Province when it repaired canals • Water distribution has been customarily practiced.
ii) Angkor Chea	1998	N.A.	• The villagers had requested the person in charge to open gates; however, they had been closed occasionally when they had needed irrigation water.
iii) Sampov Ngo	N.A.	• There are 3 types; Sampov Ngo Village is classified into Type 3 and water charge is R 10,000/ha	• FWUC covers 2 Communes; Kong Pisei and Samraong Tong • FWUC functions • FWUC manages water of Chamkar Thnol reservoir • Water charge is determined based on the distance from the reservoir
Zone-4 i) Chamkar Trach			
ii) Tuol Tnaot	N.A.	N.A.	• Deputy chief of FWUC lives in the village
iii) Angk Samnang			

Table 6.2.1 Dependable Inflow to Ou Krang Ambel Reservoir from Catchment Area

(including spillout from upstream pond)

80 % dependable 5-day mean discharge (unit; m3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1-5	0.43	0.16	0.14	0.16	0.55	0.74	2.28	7.66	8.60	11.75	5.76	1.95
6-10	0.45	0.15	0.15	0.18	0.48	1.74	4.62	8.64	7.23	12.18	3.78	2.10
11-15	0.44	0.14	0.19	0.23	0.40	0.81	2.28	3.60	4.60	12.82	1.99	0.50
16-20	0.44	0.12	0.22	0.35	0.84	0.93	2.50	3.31	6.56	16.27	1.70	0.34
21-25	0.29	0.13	0.22	0.64	1.56	1.02	1.89	5.33	9.59	9.38	1.09	0.66
26-end	0.23	0.16	0.17	0.53	0.49	1.28	4.96	6.05	15.43	9.66	0.64	0.41

50 % dependable 5-day mean discharge (unit; m3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1-5	0.43	0.17	0.14	0.21	1.16	1.35	3.74	9.21	10.17	20.60	11.45	1.95
6-10	0.45	0.16	0.15	0.24	1.02	3.17	7.56	10.38	8.56	22.32	7.51	2.10
11-15	0.45	0.15	0.19	0.31	0.84	1.48	3.72	4.33	5.44	23.82	3.96	0.50
16-20	0.45	0.13	0.22	0.47	1.79	1.69	4.09	3.98	7.75	30.86	3.38	0.34
21-25	0.30	0.14	0.22	0.85	3.32	1.87	3.10	6.40	11.34	20.72	2.16	0.66
26-end	0.23	0.16	0.17	0.70	1.05	2.33	8.11	7.27	19.22	15.24	1.27	0.41

Table 6.2.2 Dependable Discharge of Tributary at 10 km2

80 % dependable mean 5-day discharge (Unit; m3/sec)

5-day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	0.000	0.000	0.000	0.002	0.007	0.009	0.034	0.122	0.105	0.138	0.036	0.004
06-10	0.000	0.000	0.001	0.002	0.005	0.026	0.074	0.139	0.081	0.147	0.001	0.006
11-15	0.000	0.000	0.002	0.003	0.004	0.010	0.033	0.052	0.036	0.158	0.000	0.000
16-20	0.000	0.000	0.002	0.005	0.012	0.012	0.037	0.047	0.069	0.205	0.000	0.000
21-25	0.000	0.000	0.002	0.010	0.024	0.014	0.027	0.082	0.122	0.098	0.000	0.000
26-end	0.000	0.000	0.001	0.008	0.006	0.018	0.080	0.094	0.223	0.103	0.000	0.000

50 % dependable mean 5-day discharge (Unit; m3/sec)

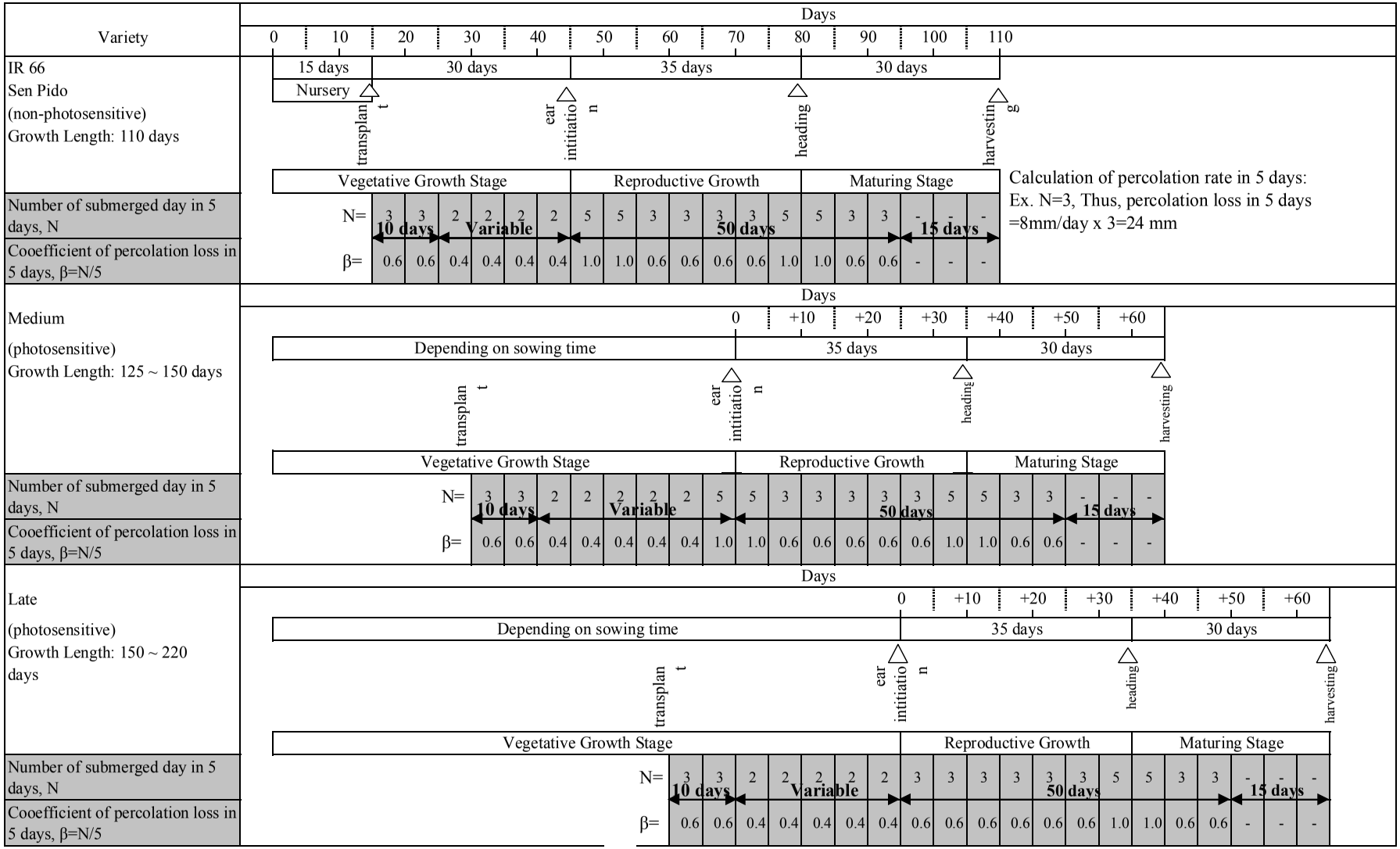
5-day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
01-5	0.000	0.000	0.000	0.002	0.017	0.019	0.059	0.149	0.132	0.218	0.134	0.004
06-10	0.000	0.000	0.001	0.003	0.015	0.051	0.125	0.169	0.104	0.231	0.066	0.006
11-15	0.000	0.000	0.002	0.004	0.012	0.021	0.058	0.064	0.050	0.247	0.004	0.000
16-20	0.000	0.000	0.002	0.007	0.028	0.025	0.065	0.058	0.090	0.313	0.000	0.000
21-25	0.000	0.000	0.002	0.013	0.055	0.028	0.048	0.100	0.152	0.163	0.000	0.000
26-end	0.000	0.000	0.001	0.011	0.015	0.036	0.134	0.115	0.272	0.170	0.000	0.000

Table 6.3.1 Responsible Release Discharge from Roleang Chrey to Downstream

(unit; m3/sec)

DAY	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1-5	2.4	2.0	0.6	0.7	1.8	2.9	4.7	3.0	1.4	2.2	3.0	3.2
6-10	2.4	2.0	0.6	0.7	1.8	2.9	4.7	3.0	1.4	2.2	2.9	3.1
11-15	2.4	2.0	0.6	0.7	1.8	2.9	4.7	3.0	1.4	2.2	2.9	3.1
16-20	2.0	1.9	0.6	0.8	2.3	2.9	4.5	2.6	1.6	2.1	2.9	3.3
21-25	2.0	1.9	0.6	0.8	2.3	2.9	4.6	2.6	1.6	2.1	2.9	3.3
26-end	2.0	1.9	0.6	0.8	2.3	2.9	4.6	2.6	1.6	2.1	2.9	3.3

Table 6.3.2 Growth Characteristics of Rice in Cambodia and Proposed Water Submergence



Source: - Growth characteristics obtained from CARDI
- Proposed water submergence made by Study Team

Table 6.3.3 Irrigation Water Requirement for Early Rice by Transplanting

Item		Apr						May						Jun						Jul						Aug			
		1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20	21-25	26-30	1-5	6-10	11-15	16-20	21-25	26-31	1-5	6-10	11-15	16-20
ETo	(mm/day)	6.0	6.0	6.0	6.0	6.0	6.0	5.6	5.6	5.6	5.6	5.6	5.6	5.2	5.2	5.2	5.2	5.2	5.2	4.6	4.6	4.6	4.6	4.6	4.6	4.7	4.7	4.7	4.7
Percolation, P	(mm/day)	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
After transplanting, β		0.6	0.6																										
In vegetation, β				0.4	0.4	0.4																							
In reproductive, β							1.0	1.0	0.6	0.6	0.6	0.6	1.0	1.0															
In maturing, β															0.6	0.6	-	-	-										
Effective Rain, ER	(mm/day)	0.6	0.6	0.6	0.6	0.6	0.6	2.3	2.3	2.3	2.3	2.3	1.9	1.6	1.6	1.6	1.6	1.6	1.6	1.9	1.9	1.9	1.9	1.9	1.6	2.0	2.0	2.0	2.0
Overall Irrigation efficiency	66%																												
1st block																													
Land preparation, LP	(mm/day)	7.4	10.9	14.4	17.8																								
Percolation, P×β	(mm/day)					4.8	4.8	3.2	3.2	3.2	8.0	8.0	4.8	4.8	4.8	4.8	8.0	8.0	4.8	4.8	0.0	0.0	0.0						
Crop coefficient, Kc						1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.00	0.00	0.00						
Consumptive use, ETo×Kc + P×β	(mm/day)					11.4	11.4	9.4	9.4	9.4	13.9	13.9	10.7	10.2	10.2	10.2	13.4	12.9	9.7	9.2	0.0	0.0	0.0						
FW=ETc + P - ER	(mm/day)					10.8	10.8	7.0	7.0	7.0	11.6	11.6	8.8	8.6	8.6	8.6	11.8	11.3	8.1	7.2	0.0	0.0	0.0						
Net field water req FW +LP	(mm/day)	7.4	10.9	14.4	17.8	10.8	10.8	7.0	7.0	7.0	11.6	11.6	8.8	8.6	8.6	8.6	11.8	11.3	8.1	7.2	0.0	0.0	0.0						
Unit diversion water requirement	(mm/day)	11.2	16.5	21.7	27.0	16.3	16.3	10.7	10.7	10.7	17.5	17.5	13.3	13.1	13.1	13.1	17.9	17.1	12.3	11.0	0.0	0.0	0.0						
Unit diversion water requirement	(l /sec/ha)	1.29	1.90	2.52	3.13	1.89	1.89	1.24	1.24	1.24	2.03	2.03	1.53	1.51	1.51	1.51	2.07	1.98	1.42	1.27	0.00	0.00	0.00						
2nd block																													
Land preparation, LP	(mm/day)		7.4	10.9	14.4	17.8																							
Percolation, P×β	(mm/day)						4.8	4.8	3.2	3.2	3.2	8.0	8.0	4.8	4.8	4.8	4.8	8.0	8.0	4.8	4.8	0.0	0.0	0.0						
Crop coefficient, Kc							1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.00	0.00	0.00						
Consumptive use, ETo×Kc + P×β	(mm/day)						11.4	11.0	9.4	9.4	9.4	13.9	13.9	10.2	10.2	10.2	10.2	13.4	12.9	9.2	9.2	0.0	0.0	0.0						
FW=ETc + P - ER	(mm/day)						10.8	8.6	7.0	7.0	7.0	11.6	12.0	8.6	8.6	8.6	8.6	11.8	11.3	7.2	7.2	0.0	0.0	0.0						
Net field water req FW +LP	(mm/day)		7.4	10.9	14.4	17.8	10.8	8.6	7.0	7.0	7.0	11.6	12.0	8.6	8.6	8.6	8.6	11.8	11.3	7.2	7.2	0.0	0.0	0.0						
Unit diversion water requirement	(mm/day)		11.2	16.5	21.7	27.0	16.3	13.1	10.7	10.7	10.7	17.5	18.1	13.1	13.1	13.1	13.1	17.9	17.1	11.0	11.0	0.0	0.0	0.0						
Unit diversion water requirement	(l /sec/ha)		1.29	1.90	2.52	3.13	1.89	1.52	1.24	1.24	1.24	2.03	2.10	1.51	1.51	1.51	1.51	2.07	1.98	1.27	1.27	0.00	0.00	0.00						
3rd block																													
Land preparation, LP	(mm/day)			7.4	10.9	14.4	17.8																						
Percolation, P×β	(mm/day)							4.8	4.8	3.2	3.2	3.2	8.0	8.0	4.8	4.8	4.8	4.8	8.0	8.0	4.8	4.8	0.0	0.0	0.0				
Crop coefficient, Kc								1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.00	0.00	0.00				
Consumptive use, ETo×Kc + P×β	(mm/day)							11.0	11.0	9.4	9.4	9.4	13.9	13.4	10.2	10.2	10.2	10.2	13.4	12.4	9.2	9.2	0.0	0.0	0.0				
FW=ETc + P - ER	(mm/day)							8.6	8.6	7.0	7.0	7.0	12.0	11.8	8.6	8.6	8.6	8.6	11.8	10.4	7.2	7.2	0.0	0.0	0.0				
Net field water req FW +LP	(mm/day)			7.4	10.9	14.4	17.8	8.6	8.6	7.0	7.0	7.0	12.0	11.8	8.6	8.6	8.6	8.6	11.8	10.4	7.2	7.2	0.0	0.0	0.0				
Unit diversion water requirement	(mm/day)			11.2	16.5	21.7	27.0	13.1	13.1	10.7	10.7	10.7	18.1	17.9	13.1	13.1	13.1	13.1	17.9	15.8	11.0	11.0	0.0	0.0	0.0				
Unit diversion water requirement	(l /sec/ha)			1.29	1.90	2.52	3.13	1.52	1.52	1.24	1.24	1.24	2.10	2.07	1.51	1.51	1.51	1.51	2.07	1.83	1.27	1.27	0.00	0.00	0.00				
4th block																													
Land preparation, LP	(mm/day)				7.4	10.9	14.4	16.0																					
Percolation, P×β	(mm/day)								4.8	4.8	3.2	3.2	3.2	8.0	8.0	4.8	4.8	4.8	4.8	8.0	8.0	4.8	4.8	0.0	0.0	0.0			
Crop coefficient, Kc									1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.00	0.00	0.00			
Consumptive use, ETo×Kc + P×β	(mm/day)								11.0	11.0	9.4	9.4	9.4	13.4	13.4	10.2	10.2	10.2	10.2	12.8	12.4	9.2	9.2	0.0	0.0	0.0			
FW=ETc + P - ER	(mm/day)								8.6	8.6	7.0	7.0	7.4	11.8	11.8	8.6	8.6	8.6	8.6	10.9	10.4	7.2	7.2	0.0	0.0	0.0			
Net field water req FW +LP	(mm/day)				7.4	10.9	14.4	16.0	8.6	8.6	7.0	7.0	7.4	11.8	11.8	8.6	8.6	8.6	8.6	10.9	10.4	7.2	7.2	0.0	0.0	0.0			
Unit diversion water requirement	(mm/day)				11.2	16.5	21.7	24.2	13.1	13.1	10.7	10.7	11.3	17.9	17.9	13.1	13.1	13.1	13.1	16.5	15.8	11.0	11.0	0.0	0.0	0.0			
Unit diversion water requirement	(l /sec/ha)				1.29	1.90	2.52	2.80	1.52	1.52	1.24	1.24	1.30	2.07	2.07	1.51	1.51	1.51	1.51	1.91	1.83	1.27	1.27	0.00	0.00	0.00			
5th block																													
Land preparation, LP	(mm/day)					7.4	10.9	13.0	16.0																				
Percolation, P×β	(mm/day)									4.8	4.8	3.2	3.2	3.2	8.0	8.0	4.8	4.8	4.8	4.8	8.0	8.0	4.8	4.8	0.0	0.0	0.0		
Crop coefficient, Kc										1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.00	0.00	0.00		
Consumptive use, ETo×Kc + P×β	(mm/day)									11.0	11.0	9.4	9.4	8.9	13.4	13.4	10.2	10.2	10.2	9.6	12.8	12.4	9.2	9.2	0.0	0.0	0.0		
FW=ETc + P - ER	(mm/day)									8.6	8.6	7.0	7.4	7.3	11.8	11.8	8.6	8.6	8.6	7.7	10.9	10.4	7.2	7.2	0.0	0.0	0.0		
Net field water req FW +LP	(mm/day)					7.4	10.9	13.0	16.0	8.6	8.6	7.0	7.4	7.3	11.8	11.8	8.6	8.6	8.6	7.7	10.9	10.4	7.2	7.2	0.0	0.0	0.0		
Unit diversion water requirement	(mm/day)					11.2	16.5	19.7	24.2	13.1	13.1	10.7	11.3	11.0	17.9	17.9	13.1	13.1	13.1	11.6	16.5	15.8	11.0	11.0	0.0	0.0	0.0		
Unit diversion water requirement	(l /sec/ha)					1.29	1.90	2.28	2.80	1.52	1.52	1.24	1.30	1.28	2.07	2.07	1.51	1.51	1.51	1.35	1.91	1.83	1.27	1.27	0.00	0.00	0.00		
6th block																													
Land preparation, LP	(mm/day)						7.4	10.0	13.0	16.0																			
Percolation, P×β	(mm/day)										4.8	4.8	3.2	3.2	3.2	8.0	8.0	4.8	4.8	4.8	4.8	8.0	8.0	4.8	4.8	0.0	0.0	0.0	
Crop coefficient, Kc											1.10	1.10	1.10	1.10	1.10	1.05	1.05	1.05	1.05	1.05	1.05	1.05	0.95	0.95	0.95	0.00	0.00	0.00	
Consumptive use, ETo×Kc + P×β	(mm/day)										11.0	11.0	9.4	8.9	8.9	13.4	13.4	10.2	10.2	9.6	9.6	12.8	12.4	9.2	9.2	0.0	0.0	0.0	
FW=ETc + P - ER	(mm/day)										8.6	8.6	7.4	7.3	7.3	11.8	11.8	8.6	8.6	7.7	7.7	10.9	10.4	7.2	7.6	0.0	0.0	0.0	
Net field water req FW +LP	(mm/day)						7.4	10.0	13.0	16.0	8.6	8.6	7.4	7.3	7.3	11.8	11.8	8.6	8.6	7.7	7.7	10.9	10.4	7.2	7.6	0.0	0.0	0.0	
Unit diversion water requirement	(mm/day)						11.2	15.2	19.7	24.2	13.1	13.1	11.3	11.0	11.0	17.9	17.9	13.1	13.1	11.6	11.6	16.5	15.8	11.0	11.4	0.0	0.0	0.0	
Unit diversion water requirement	(l /sec/ha)						1.29	1.76	2.28	2.80	1.52	1.52	1.30	1.28	1.28	2.07	2.07	1.51	1.51	1.35	1.35	1.91	1.83	1.27	1.32	0.00	0.00	0.00	

Table 6.3.4 Calculation of Unit and Total Diversion Water Requirement

(Sample)

Early Paddy (April - July) Cropping Area (ha)= 2,700

Month/5-day		Area factor 0.11	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.11	1.00	m3/sec
Jan	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Feb	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Mar	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Apr	1-5	0.14									0.14	0.4
	6-10	0.21	0.14								0.35	0.9
	11-15	0.28	0.21	0.14							0.63	1.7
	16-20	0.34	0.28	0.21	0.14						0.97	2.6
	21-25	0.21	0.34	0.28	0.21	0.15					1.19	3.2
	26-end	0.21	0.21	0.34	0.28	0.23	0.14				1.41	3.8
May	1-5	0.14	0.17	0.17	0.31	0.27	0.19	0.14			1.38	3.7
	6-10	0.14	0.14	0.17	0.17	0.34	0.25	0.19	0.14		1.52	4.1
	11-15	0.14	0.14	0.14	0.17	0.18	0.31	0.25	0.19	0.14	1.64	4.4
	16-20	0.22	0.14	0.14	0.14	0.18	0.17	0.31	0.25	0.19	1.73	4.7
	21-25	0.22	0.22	0.14	0.14	0.15	0.17	0.17	0.31	0.25	1.76	4.7
	26-end	0.17	0.23	0.23	0.14	0.16	0.14	0.17	0.17	0.31	1.74	4.7
Jun	1-5	0.17	0.17	0.23	0.23	0.15	0.14	0.14	0.17	0.17	1.57	4.2
	6-10	0.17	0.17	0.17	0.23	0.25	0.14	0.14	0.14	0.17	1.57	4.2
	11-15	0.17	0.17	0.17	0.17	0.25	0.23	0.14	0.14	0.14	1.56	4.2
	16-20	0.23	0.17	0.17	0.17	0.18	0.23	0.23	0.14	0.14	1.65	4.4
	21-25	0.22	0.23	0.17	0.17	0.18	0.17	0.23	0.23	0.14	1.72	4.7
	26-end	0.16	0.22	0.23	0.17	0.18	0.17	0.17	0.23	0.23	1.74	4.7
Jul	1-5	0.14	0.14	0.20	0.21	0.16	0.15	0.15	0.15	0.21	1.51	4.1
	6-10		0.14	0.14	0.20	0.23	0.15	0.15	0.15	0.15	1.30	3.5
	11-15			0.14	0.14	0.22	0.21	0.15	0.15	0.15	1.15	3.1
	16-20				0.14	0.15	0.20	0.21	0.15	0.15	1.00	2.7
	21-25					0.15	0.14	0.20	0.21	0.15	0.85	2.3
	26-end						0.15	0.15	0.21	0.22	0.71	1.9
Aug	1-5							0.14	0.14	0.20	0.48	1.3
	6-10								0.14	0.14	0.28	0.8
	11-15									0.14	0.14	0.4
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Sep	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Oct	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Nov	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Dec	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Max											1.76	4.7

Upland crops (April to July) Cropping Area (ha)= 0

Month/5-day		Area factor 0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	1.00	m3/sec
Jan	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Feb	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Mar	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Apr	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
May	1-5	0.04												0.04	0.0
	6-10		0.04											0.04	0.0
	11-15	0.00		0.04										0.04	0.0
	16-20	0.00	0.00		0.04									0.04	0.0
	21-25	0.00	0.00	0.00		0.04								0.05	0.0
	26-end	0.00	0.00	0.00	0.00		0.04							0.05	0.0
Jun	1-5	0.04	0.02	0.02	0.02	0.03	0.02	0.06						0.22	0.0
	6-10	0.04	0.04	0.02	0.02	0.03	0.03	0.02	0.06					0.26	0.0
	11-15	0.04	0.04	0.04	0.02	0.03	0.03	0.03	0.02	0.06				0.29	0.0
	16-20	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.06			0.34	0.0
	21-25	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.06		0.39	0.0
	26-end	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.06	0.44	0.0
Jul	1-5	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.00	0.00	0.00	0.00		0.16	0.0
	6-10	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.00	0.00	0.00	0.00	0.19	0.0
	11-15	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.22	0.0
	16-20		0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.22	0.0
	21-25			0.03	0.03	0.04	0.03	0.03	0.03	0.01	0.01	0.01	0.00	0.22	0.0
	26-end				0.03	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.01	0.22	0.0
Aug	1-5					0.05	0.05	0.05	0.04	0.03	0.03	0.03	0.03	0.30	0.0
	6-10						0.05	0.05	0.05	0.03	0.03	0.03	0.03	0.27	0.0
	11-15							0.05	0.05	0.04	0.03	0.03	0.03	0.24	0.0
	16-20								0.05	0.04	0.04	0.03	0.03	0.20	0.0
	21-25									0.04	0.04	0.04	0.03	0.16	0.0
	26-end										0.04	0.04	0.04	0.13	0.0
Sep	1-5											0.01	0.01	0.03	0.0
	6-10												0.01	0.01	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Oct	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Nov	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Dec	1-5													0.00	0.0
	6-10													0.00	0.0
	11-15													0.00	0.0
	16-20													0.00	0.0
	21-25													0.00	0.0
	26-end													0.00	0.0
Max														0.44	0.0

Medium paddy (Agust - December) Cropping Area (ha)= 7,500

Month/5-day		Area factor 0.11	0.11	0.11	0.11	0.12	0.11	0.11	0.11	0.11	1.00	m3/sec
Jan	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Feb	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Mar	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Apr	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
May	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Jun	1-5										0.00	0.0
	6-10										0.00	0.0
	11-15										0.00	0.0
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Jul	1-5	0.14									0.14	1.0
	6-10	0.19	0.14								0.32	2.4
	11-15	0.24	0.19	0.14							0.57	4.3
	16-20	0.30	0.24	0.19	0.14						0.86	6.5
	21-25	0.15	0.30	0.24	0.19	0.15					1.03	7.7
	26-end	0.16	0.16	0.30	0.25	0.21	0.14				1.21	9.1
Aug	1-5	0.12	0.15	0.15	0.30	0.26	0.19	0.14			1.31	9.8
	6-10	0.12	0.12	0.15	0.15	0.32	0.24	0.19	0.14		1.44	10.8
	11-15	0.12	0.12	0.12	0.15	0.17	0.30	0.24	0.19	0.14	1.55	11.6
	16-20	0.12	0.12	0.12	0.12	0.17	0.15	0.30	0.24	0.19	1.53	11.5
	21-25	0.12	0.12	0.12	0.12	0.13	0.15	0.15	0.30	0.24	1.47	11.0
	26-end	0.13	0.13	0.13	0.13	0.14	0.13	0.16	0.16	0.30	1.40	10.5
Sep	1-5	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.11	0.11	0.81	6.0
	6-10	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.11	0.77	5.8
	11-15	0.08	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.74	5.5
	16-20	0.17	0.08	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.82	6.2
	21-25	0.17	0.17	0.08	0.08	0.09	0.08	0.08	0.08	0.08	0.91	6.8
	26-end	0.11	0.17	0.17	0.08	0.08	0.08	0.08	0.08	0.08	0.94	7.0
Oct	1-5	0.10	0.10	0.16	0.16	0.07	0.07	0.07	0.07	0.07	0.87	6.5
	6-10	0.10	0.10	0.10	0.16	0.17	0.07	0.07	0.07	0.07	0.91	6.8
	11-15	0.10	0.10	0.10	0.10	0.17	0.16	0.07	0.07	0.07	0.93	7.0
	16-20	0.16	0.10	0.10	0.10	0.11	0.16	0.16	0.07	0.07	1.02	7.6
	21-25	0.15	0.16	0.10	0.10	0.11	0.10	0.16	0.16	0.07	1.10	8.3
	26-end	0.10	0.16	0.17	0.11	0.12	0.11	0.11	0.17	0.17	1.24	9.3
Nov	1-5	0.15	0.15	0.21	0.22	0.17	0.16	0.16	0.16	0.22	1.60	12.0
	6-10		0.15	0.15	0.21	0.24	0.16	0.16	0.16	0.16	1.39	10.4
	11-15			0.15	0.15	0.23	0.22	0.16	0.16	0.16	1.23	9.2
	16-20				0.15	0.16	0.21	0.22	0.16	0.16	1.06	8.0
	21-25					0.16	0.15	0.21	0.22	0.16	0.91	6.8
	26-end						0.15	0.15	0.21	0.22	0.73	5.5
Dec	1-5							0.17	0.17	0.24	0.58	4.4
	6-10								0.17	0.17	0.35	2.6
	11-15									0.17	0.17	1.3
	16-20										0.00	0.0
	21-25										0.00	0.0
	26-end										0.00	0.0
Max											1.60	12.0

Early paddy (2) Cropping Area (ha)= 2,700

Month/5-day		Area factor 0.17	0.17	0.17	0.17	0.16	0.16	1.00	m3/sec	Total Div. Req. m3/sec
Jan	1-5							0.00	0.0	0.0
	6-10							0.00	0.0	0.0
	11-15							0.00	0.0	0.0
	16-20							0.00	0.0	0.0
	21-25							0.00	0.0	0.0
	26-end							0.00	0.0	0.0
Feb	1-5							0.00	0.0	0.0
	6-10							0.00	0.0	0.0
	11-15							0.00	0.0	0.0
	16-20							0.00	0.0	0.0
	21-25							0.00	0.0	0.0
	26-end							0.00	0.0	0.0
Mar	1-5							0.00	0.0	0.0
	6-10							0.00	0.0	0.0
	11-15							0.00	0.0	0.0
	16-20							0.00	0.0	0.0
	21-25							0.00	0.0	0.0
	26-end							0.00	0.0	0.0
Apr	1-5							0.00	0.0	0.4
	6-10							0.00	0.0	0.9
	11-15							0.00	0.0	1.7
	16-20							0.00	0.0	2.6
	21-25							0.00	0.0	3.2
	26-end							0.00	0.0	3.8
May	1-5							0.00	0.0	3.7
	6-10							0.00	0.0	4.1
	11-15							0.00	0.0	4.4
	16-20							0.00	0.0	4.7
	21-25							0.00	0.0	4.7
	26-end							0.00	0.0	4.7
Jun	1-5							0.00	0.0	4.2
	6-10							0.00	0.0	4.2
	11-15							0.00	0.0	4.2
	16-20							0.00	0.0	4.4
	21-25							0.00	0.0	4.7
	26-end							0.00	0.0	4.7
Jul	1-5							0.00	0.0	5.1
	6-10							0.00	0.0	5.9
	11-15							0.00	0.0	7.4
	16-20							0.00	0.0	9.2
	21-25							0.00	0.0	10.0
	26-end							0.00	0.0	11.0
Aug	1-5	0.21						0.21	0.6	11.7
	6-10	0.29	0.21					0.50	1.4	12.9
	11-15	0.37	0.29	0.21				0.88	2.4	14.4
	16-20	0.46	0.37	0.29	0.21			1.33	3.6	15.1
	21-25	0.24	0.46	0.37	0.29	0.20		1.56	4.2	15.2
	26-end	0.25	0.25	0.47	0.38	0.28	0.20	1.82	4.9	15.4
Sep	1-5	0.13	0.17	0.17	0.40	0.32	0.25	1.44	3.9	9.9
	6-10	0.13	0.13	0.17	0.17	0.38	0.32	1.30	3.5	9.3
	11-15	0.13	0.13	0.13	0.17	0.16	0.38	1.10	3.0	8.5
	16-20	0.26	0.13	0.13	0.13	0.16	0.16	0.97	2.6	8.8
	21-25	0.26	0.26	0.13	0.13	0.12	0.16	1.06	2.9	9.7
	26-end	0.17	0.26	0.26	0.13	0.12	0.12	1.06	2.9	9.9
Oct	1-5	0.15	0.15	0.25	0.25	0.10	0.10	1.00	2.7	9.2
	6-10	0.15	0.15	0.15	0.25	0.23	0.10	1.04	2.8	9.6
	11-15	0.15	0.15	0.15	0.15	0.23	0.23	1.07	2.9	9.9
	16-20	0.25	0.15	0.15	0.15	0.14	0.23	1.08	2.9	10.5
	21-25	0.24	0.25	0.15	0.15	0.14	0.14	1.07	2.9	11.1
	26-end	0.16	0.25	0.27	0.17	0.16	0.16	1.17	3.2	12.4
Nov	1-5	0.23	0.23	0.33	0.34	0.23	0.23	1.60	4.3	16.3
	6-10		0.23	0.23	0.33	0.32	0.23	1.34	3.6	14.0
	11-15			0.23	0.23	0.31	0.32	1.09	3.0	12.2
	16-20				0.23	0.22	0.31	0.76	2.1	10.0
	21-25					0.22	0.22	0.44	1.2	8.0
	26-end						0.22	0.22	0.6	6.1
Dec	1-5							0.00	0.0	4.4
	6-10							0.00	0.0	2.6
	11-15							0.00	0.0	1.3
	16-20							0.00	0.0	0.0
	21-25							0.00	0.0	0.0
	26-end							0.00	0.0	0.0
Max								1.82	4.9	16.3

Table 6.4.1 Proposed Cropping Pattern by Different Water Sources

Result of water balance calculation

Subject Area/Pattern	Jan	Feb	Mar	Apr	May	June	July	Aug.	Sept.	Oct	Nov	Dec	Jan	Feb	Remarks
by Prek Thnot River {(Fully) Irrigated Rice Field} Pattern: A Double Cropping of Irrigated Rice Early variety - medium variety Upland crops: 5 ~ 10 %	**Current prevailing pattern** **1st priority pattern by PDA Kp. Speu**				Early Rice-1 400 ha by 80% dependable discharge 3,500 ha by 50% dependable discharge Upland Crops					Early Rice-2 400 ha by 80% 3,500 ha by 50% Medium Variety 5,500 ha by 80% 13,000 ha by 50%					Early: IR 66 or Sen Pidao: 110 days Seedling: 20 days Medium: 140 days Seedling: 20 days (20~25) Staggering period: 1 month Duration between 2 crops: 20 days
by Ou Krang Ambel River {(Fully) Irrigated Rice Field} Pattern: A Double Cropping of Irrigated Rice Early variety - medium variety Upland crops: 5 ~ 10 %					Early Rice-1 115 ha by 80% dependable discharge 250 ha by 50% dependable discharge Upland Crops					Early Rice-2 115 ha by 80% 250 ha by 50% Medium Variety 430 ha by 80% 700 ha by 50%					Early: IR 66 or Sen Pidao: 110 days Seedling: 20 days Medium: 140 days Seedling: 20 days (20~25) Staggering period: 1 month Duration between 2 crops: 20 days
					Early Rice-1 500 ha by 80% dependable discharge 3,750 ha by 50% dependable discharge Medium Variety 5,900 ha by 80% 13,700 ha by 50%					Early Rice-2 500 ha by 80% dependable discharge 3,750 ha by 50% dependable discharge					
by Small Tributaries (Water Harvesting) (Supplementary Irrigated Rice Field) Pattern: C Single Cropping of Irrigated Rice Medium variety Rainfed upland crops: 5 ~ 10 %						Upland Crops		Medium Variety 600 ha by 80% dependable discharge 1,200 ha by 80% dependable discharge							Medium: 140 days Seedling: 20 days (20~25) Early: IR 66 or Sen Pidao: 110 days Seedling: 20 days Staggering period: 1 month Early variety: area free from inundation

Table 8.6.1 Present/Without-Project Condition Assumed and With-Project Conditions 1/

1. Land Use

Zone	Present/ Without-Project		With-Project					
	Paddy Field		Paddy Field		Right of Ways		Total	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Zone-1	5,710	14	5,660	14	50	23	5,710	14
Zone-2	11,210	27	11,040	27	170	77	11,210	27
Zone-3	1,200	3	1,200	3			1,200	3
Zone-4	23,380	56	23,380	57			23,380	56
Total	41,500	100	41,280	100	220	100	41,500	100

Zone-1: Irrigated by Prek Thnot River by 80% dependability
Zone-2: Irrigated by Prek Thnot River by 50% dependability
Zone-3: Irrigated by Water Harvesting
Zone-4: Rainfed Paddy Field

2. Irrigation Status

Zone	1. Present/Without-Project							
	Irrigated Paddy Field 2/		Supplementary Irrigated 3/		Rainfed Paddy Field		Total	
	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Zone-1	500	9	3,490	61	1,720	30	5,710	100
Zone-2			1,710	15	9,500	85	11,210	100
Zone-3			600	50	600	50	1,200	100
Zone-4					23,380	100	23,380	100
Total	500	1	5,800	14	35,200	85	41,500	100
	2. With-Project Condition							
	Irrigated Paddy Field 2/		Supplementary Irrigated 3/		Rainfed Paddy Field		Total	
Zone	Area (ha)	%	Area (ha)	%	Area (ha)	%	Area (ha)	%
Zone-1	500	9	5,160	91			5,660	100
Zone-2 4/	(3,200)		11,040	100			11,040	100
Zone-3			1,200	100			1,200	100
Zone-4					23,380	100	23,380	100
Total	500	1	17,400	42	23,380	57	41,280	100
Increment (2 - 1)								
	Irrigated Paddy Field 2/		Supplementary Irrigated 3/		Rainfed Paddy Field		Total	
Zone	Area (ha)		Area (ha)		Area (ha)		Area (ha)	
Zone-1	0		1,670		-1,720		-50	
Zone-2			9,330		-9,500		-170	
Zone-3			600		-600		0	
Zone-4			0		0		0	
Total	0		11,600		-11,820		-220	

1/: Without-project conditions prior to the functional failure of the Roleang Chery Regulator

2/: Irrigated paddy field; irrigation water available for double cropping of rice

3/: Supplementary irrigated field in rainy season; irrigation water supply only for single cropping of rice in rainy season
Zone - 1 by 80% dependability & Zone - 2 & 3 by 50% dependability

4/: In Zone-2, irrigation for early rainy season rice in 3,200 ha & for rainy season rice in 11,040 ha possible
by 50% dependability

Table 8.6.2 Agricultural Development Plan by Zone

Zone-1: Total Irrigation Area 5,660ha

Crops/Cropping Season	I. Without Project 1/ Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	II. With Project Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	Increment (II - I) Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)
Early Rainy Season Rice												
- Early Variety (HYV)	500	9	2.40	1,200	500	9	3.30	1,650	0	0	0.9	450
Rainy Season Rice												
- Early Variety (HYV)					500	9	3.30	1,650	500	9		1,650
- Medium Variety (irrigated)	3,990	70	2.10	8,379	5,160	91	3.00	15,480	1,170	21	0.9	7,101
- Medium Variety (rainfed)	1,720	30	1.50	2,580					-1,720	-30		-2,580
Sub-total	5,710	100	1.92	10,959	5,660	100	3.03	17,130	-50	0	1.1	6,171
Annual Paddy	6,210	109	1.96	12,159	6,160	109	3.05	18,780	-50	0	1.1	6,621
Upland Crop	54	0.9	0.45	24	250	4.4	0.70	175	196	3	0.3	151
Vegetable	6	0.1	9.25	56	30	0.5	9.25	278	24	0	0	222
Upland Crops/Vegetables Total	60	1		80	280	5		453	220	4		373
Total	6,270	110	-	-	6,440	114	-	-	170	4	-	-

Zone-2: Total Irrigation Area 11,040ha

Crops/Cropping Season	I. Without Project 1/ Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	II. With Project Cropped Area (ha) /1	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	Increment (II - I) Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)
Early Rainy Season Rice												
- Early Variety (HYV)					1,600	14	3.30	5,280	1,600	14		5,280
Rainy Season Rice												
- Early Variety (HYV)												
- Medium Variety (irrigated)	1,710	15	2.10	3,591	11,040	100	2.80	30,912	9,330	85	0.7	27,321
- Medium Variety (rainfed)	9,500	85	1.50	14,250					-9,500	-85		-14,250
Sub-total	11,210	100	1.59	17,841	11,040	100	2.80	30,912	-170	0	1.2	13,071
Annual Paddy	11,210	100	1.59	17,841	12,640	114	2.86	36,192	1,430	14	1.3	18,351
Upland Crop	100	0.9	0.45	45	495	4	0.70	347	395	4	0.3	302
Vegetable	10	0.1	9.25	93	55	0	9.25	509	45	0	0	416
Upland Crops/Vegetables Total	110	1		138	550	5		855	440	4		718
Total	11,320	101	-	-	13,190	119	-	-	1,870	18	-	-

1/: Early Rainy Season: 3,200 ha can be irrigated by 50% dependability; average annual irrigated area estimated at 1,600ha for benefit evaluation purpose

Zone-3: Total Irrigation Area 1,200ha

Crops/Cropping Season	I. Without Project 1/ Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	II. With Project Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	Increment (II - I) Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)
Rainy Season Rice												
- Medium Variety (irrigated)	600	50	2.10	1,260	1,200	100	2.80	3,360	600	50	0.7	2,100
- Medium Variety (rainfed)	600	50	1.50	900					-600	-50		-900
Annual Paddy	1,200	100	1.80	2,160	1,200	100	2.80	3,360	0	0	1.0	1,200
Upland Crop	10	2	0.45	5	54	5	0.70	38	44	3	0.3	33
Vegetable					6	1	9.25	56	6	1		56
Upland Crops/Vegetables Total	10	2		5	60	5		93	50	3		89
Total	1,210	102	-	-	1,260	105	-	-	50	3	-	-

Zone-4: Total Subject Area 23,380ha

Crops/Cropping Season	I. Without Project 1/ Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	II. With Project Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	Increment (II - I) Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)
Rainy Season Rice												
- Medium Variety (rainfed)	23,380	100	1.50	35,070	23,380	100	2.00	46,760	0	0	0.5	11,690
Annual Paddy	23,380	100	1.50	35,070	23,380	100	2.00	46,760	0	0	0.5	11,690
Upland Crop					230	1	0.45	104	230	1	0.5	104
Vegetable									0	0		0
Upland Crops/Vegetables Total	0	0			230	1		104	230	1		104
Total	23,380	100	-	-	23,610	101	-	-	230	1	-	-

Overall: Overall Subject Area 41,280ha

Crops/Cropping Season	I. Without Project 1/ Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	II. With Project Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)	Increment (II - I) Cropped Area (ha)	Cropping Intensity (%)	Paddy Yield (ton)	Production (ton)
Early Rainy Season Rice												
- Early Variety (HYV)	500	1.2	2.4	1,200	2,100	5	3.3	6,930	1,600	4	0.9	5,730
Rainy Season Rice												
- Early Variety (HYV)	0			0	500	1	3.3	1,650	500	1		1,650
- Medium Variety (irrigated)	6,300	15	2.1	13,230	17,400	42	2.9	49,752	11,100	27	0.8	36,522
- Medium Variety (rainfed)	35,200	85	1.5	52,800	23,380	57	2.0	46,760	-11,820	-28	0.5	-6,040
Sub-total	41,500	100	1.6	66,030	41,280	100	2.4	98,162	-220	0	0.8	32,132
Annual Paddy	42,000	101	1.6	67,230	43,380	105	2.4	105,092	1,380	4	0.8	37,862
Upland Crop	164	0	0.45	74	1,029	2	0.64	663	865	2	0.2	589
Vegetable	16	0	9.25	148	91	0	9.25	842	75	0	0	694
Upland Crops/Vegetables Total	180	0		222	1,120	3		1,505	940	2		1,283
Total	42,180	102		-	44,500	108	-	-	2,320	6	-	-

1/: Without-project conditions before the functional failure of the Roleang Chery Regulator

Table 8.6.3 Yield Estimation for With & Without-Project Conditions

1. Statistic Data: Paddy Yields in Project Communes

Province	Average Paddy Yield (ton/ha)				Remarks
	To Cropped Area		To Harvested Area		
	Rainy Season	Dry Season	Rainy Season	Dry Season	
Kampung Speu	1.4	2.4	1.7	2.6	1/
Kandal	1.8	2.8	1.9	2.8	2/
All Communes	1.6	2.4	1.7	2.4	3/

1/: Average of 2003/04 - 2004/05 2/: Average of 2000/01 - 2003/04 3/: 2003/04

Source: Kampung Speu: 2003-04: Commune Survey on Crops & Livestock, 2003, Statistic Office, MAFF; 2004-05: PDA
Kandal: PDA Kandal

2. SEILA Data Base: Paddy Yields in Project Communes

Province	2002	2003	2004	Remarks
	Rainy Season	Rainy Season	Rainy Season	
Kampung Speu	1.02	1.59	0.53	Severe draught occur in the Target Area in 2004/05 cropping season
Kandal	1.80	1.54	0.99	
All Communes	1.24	1.57	0.67	

3. Results of Socio-economic Survey: Average yield 1/

Zone	Paddy Yield (ton/ha)		Irrigation Status	Remarks
	Rainy Season Local Variety 2/	Dry Season Improved Variety		
Zone-1	3/ 2.13	2.40	Irrigated field	No. of respondents: 46
Zone-2		-	Supplemental irrigation in rainy season	No. of respondents: 141
Zone-3		-		
Zone-4	1.19	-	Rainfed field	No. of respondents: 124
Overall Average 4/	1.69	-		No. of respondents: 182

1/: Results of Socio-economic Survey conducted by the JICA Study Team
2/: No differentiation into irrigated & rainfed paddy is made
3/: Assumed yield level is similar among the categories, since irrigation conditions in rainy season similar in Category 1 to 3 are similar
4/: Note that overall average yield is nearly equal to the average yield in all communes in the statistics above

4. Results of Socio-economic Survey: Yield Distribution 1/

Irrigation Category	Paddy Yield (ton/ha)		Irrigation Status	Remarks
	Rainy Season Local Variety	Dry Season Improved Variety		
Category 1	0.7 ~ 6.0	0 ~ 6.0	Fully irrigated field	No. of respondents: 46
Category 2	1.1 ~ 6.0	-	Supplemental irrigation in rainy season	No. of respondents: 141
Category 3	0 ~ 5.4	-		
Category 4	0.03 ~ 4.0	-	Rainfed field	No. of respondents: 124
Overall Average	0 ~ 6.0			No. of respondents: 182

1/: Results of Socio-economic Survey conducted by the JICA Study Team

5. Yield Estimated by PDAs

Province	Management Condition	Irrigated Paddy		Rainfed Paddy
		Rainy Season	Dry Season	Rainy Season
Kampung Speu	Well managed paddy field	5.0	6.0	2.5
	Poorly managed paddy field	2.0	3.0	1.5
	Average of the two	2.0 ~ 5.0	4.5	1.5 ~ 2.5
Kandal	Well managed paddy field	4.0	5.5	4.0
	Poorly managed paddy field	1.8	2.0	1.8
	Average of the two	2.5	3.0	2.5

6. Modified SRI Results in Kampung Speu in 2005/06 Cropping Season

No. of District	No. of Village	No. of Farmers	Total Area	Yield
5	179	2,800	1,340	Estimated at > 2.5 1/

1/: Estimated by PDAs

7. Demonstration Results of CARDI Conducted in Rainfed Fields in 2005/06 Rainy Season: 5 plots in each province

Location	Yield Range	Full Practices 1/	Location	Yield Range	Full Practices 1/
Kampung Speu	1.77 ~ 3.00 t/ha	3.00 t/ha	Kampung Speu	1.68 ~ 3.16 t/ha	3.16 t/ha

1/: Yield in plot with full recommended practices of seed quality, fertilizer, pest management, land leveling

8. Estimated Yield Levels of Paddy in the Target Area under With and Without-Project

On the basis of the statistic data & results of the Socio-economic Survey, the With & Without-Project paddy yield level in the Target Area estimated as follows:

Estimated Current Yield Levels in the Target Area

	Zone-1				Zone-2				Zone-3	Zone-4
	Early Rainy Season		Rainy Season		Early Rainy Season		Rainy Season		Wet Season	Wet Season
	HYV	Medium	HYV	Medium	HYV	Medium	HYV	Medium	Medium	Medium
Present	2.40			2.10				2.10	2.10	1.20
Without Project	2.40			2.10				2.10	2.10	1.50
With Project	3.30		3.30	3.00	3.30			2.80	2.50	2.00

1/: Yield improvement assumed through the expansion of modified SRI in rainfed Area

Table 8.6.4 Proposed Farming Practices of Rice

Farming Practices	Irrigated Field	Rainfed Field
Major rice varieties	Early Variety: Sen Pidao, IR 66 Medium Variety Phka Rumduol, Riang Chey, Santepheap 3	Medium Variety Phka Rumduol, Riang Chey, Other local varieties
Seeding rate (kg/ha)	30 ~ 40 kg/ha	30 ~ 40 kg/ha
Land preparation	Draft animal: 2 plow + 2 harrow	Draft animal: 2 plow + 2 harrow
Planting method	Transplanting	Transplanting
Planting distance	Depending on soil conditions & variety 20 x 20 cm (regular or line planting) 25 x 25 cm (regular or line planting)	Depending on soil conditions 25 x 25 cm (regular or line planting) 30 x 30 cm (regular or line planting)
No. of Plants/Hill	2~3 plants/hill (or less)	2~3 plants/hill (or less)
Age of seedling	Early Variety: ± 20 days (or less) Medium Variety ± 25 days (or less)	20 ~ 30 days (or less)
Fertilization		
1st application	Timing: at time of land preparation	Timing: at time of land preparation
- Urea (kg/ha)	45 ~ 50 kg/ha	20 ~ 40kg/ha
- DAP (kg/ha)	110 ~ 115kg/ha	50 ~ 60 kg/ha
- KCl (kg/ha)	40 ~ 60 kg/ha	30 ~ 40 kg/ha
- Compost	> 1.0 ton/ha depending on availability	> 1.0 ton/ha depending on availability
2nd application	Timing: 30 ~ 45 days after transplanting	Timing: 30 ~ 45 days after transplanting
- Urea (kg/ha)	60 ~ 65 kg/ha	20 ~ 40kg/ha
Agro-chemical spray	When necessary	When necessary
Manual weeding	3 times per a cropping season	3 times per a cropping season
Harvesting	Manual	Manual
Threshing	Pedal or engine thresher	Pedal or engine thresher
Drying	Sun drying in home yard after threshing	Sun drying in home yard after threshing
Yield Level: rainy season	Well managed > 3.5 ton/ha Poorly managed 2.5 ~ 3.0 ton/ha Average 3.0 ~ 3.5 ton/ha	Well managed > 2.5 ton/ha Poorly managed 1.5 ~ 2.5 ton/ha Average 2.5 ton/ha
Yield Level: dry season	Well managed > 3.5 ton/ha Poorly managed 2.5 ~ 3.0 ton/ha Average 3.0 ~ 3.5 ton/ha	(normal year)

Source: Prepared based on recommendations of CARDI & PDA Kampung Speu & Kandal

Table 9.7.1 Farm Economic Analysis of Typical Farms

	Items	Zone-1 1/									Zone-2			Zone-3			Zone-4		
		Model Project			Upper North Main Canal			Upper South Main Canal											
		With	Present	Increment	With	Present	Increment	With	Present	Increment	With	Present	Increment	With	Present	Increment	With	Present	Increment
Typical Farm	Holding Size of Paddy Field (ha)																		
	- Irrigated Field	0.70	0.35	0.35	0.07	0.07	0						0.00						
	- Supplementary Irrigated Field		0.35	-0.35	0.63	0.42	0.21	0.70	0.45	0.25	0.70	0.11	0.59	0.70	0.35	0.35			
	- Rainfed Field					0.21	-0.21		0.25	-0.25		0.59	-0.59		0.35	-0.35	0.70	0.70	0
	Total	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0	0.70	0.70	0
Net Return from Paddy Field																			
1. Cropped Area (ha)																			
	- Early Rainy Season																		
	Early Rice	0.35	0.35	0	0.07	0.07	0				0.10		0.10						
	- Rainy Season																		
	Early Rice	0.35		0.35	0.07		0.07												
	Medium Rice (irrigated)	0.35	0.70	-0.35	0.63	0.49	0.14	0.70	0.45	0.25	0.70	0.11	0.59	0.70	0.35	0.35			
	Medium Rice (rainfed)					0.21	-0.21		0.25	-0.25		0.59	-0.59		0.35	-0.35	0.70	0.70	0
	Total	1.05	1.05	0	0.77	0.77	0	0.70	0.70	0	0.80	0.70	0.10	0.70	0.70	0	0.70	0.70	0
	- Upland Crops/Vegetable	0.04	0.04	0	0.03	0.01	0.02	0.03		0.03	0.03	0.01	0.02	0.04	0.01	0.03	0.01		0.01
2. Net Return per Ha (Riel 1,000)																			
	- Early Rainy Season																		
	Early Rice	1,058	754	304	1,058	754	304				1,058								
	- Rainy Season																		
	Early Rice	1,058			1,058														
	Medium Rice (irrigated)	1,032	709	323	1,032	709	323	1,032	709	323	1,001	709	292	1,001	709	292			
	Medium Rice (rainfed)					509			509			509			509		663	334	329
	- Upland Crops/Vegetable 1/	778	651	127	778	651	127	778			778	651	127	778	651	127	558		
3. Net Return per Farm (Riel 1,000)																			
	- Early Rainy Season																		
	Early Rice	370	264	106	74	53	21	0	0	0	106	0	106	0	0	0	0	0	0
	- Rainy Season																		
	Early Rice	370	0	370	74	0	74	0	0	0	0	0	0	0	0	0	0	0	0
	Medium Rice (irrigated)	361	496	-135	650	347	303	722	319	403	701	78	623	701	248	453	0	0	0
	Medium Rice (rainfed)	0	0	0	0	107	-107	0	127	-127	0	300	-300	0	178	-178	464	234	230
	- Upland Crops/Vegetable 1/	31	26	5	23	7	17	23	0	23	23	7	17	31	7	25	6	0	6
Net Return per Farm (Riel 1,000)		**1,133**	**786**	**347**	**822**	**514**	**308**	**746**	**446**	**299**	**830**	**385**	**445**	**732**	**433**	**299**	**470**	**234**	**236**

1/: Weighted average of upland crops & vegetables

Table 9.7.2 Food Balance for Rice in Target Area: Future With- and Without-Project

Year	Projected Population in Target Area	Milled Rice Requirement (ton) 3/	Converted into Paddy (ton) 4/	Seed & Post-harvest Losses (ton) 5/	Annual Paddy Production Required (ton)	Present/Without-Project 1/			With-Project 2/		
						Current Without-Paddy (ton)	Deficit/Surplus of Paddy (ton)	Food Sufficiency %	With-Project Paddy (ton)	Deficit/Surplus of Paddy (ton)	Food Sufficiency %
2004	316,449	45,252	70,707	10,565	81,272						
2005	322,706	46,147	72,105	10,774	82,879	56,670	-26,209	68			
2006	329,210	47,077	73,558	10,991	84,549	56,670	-27,879	67			
2007	335,947	48,040	75,063	11,216	86,280	56,670	-29,610	66			
2008	342,936	49,040	76,625	11,450	88,074	56,670	-31,404	64	57,801	-30,274	66
2009	350,167	50,074	78,240	11,691	89,931	56,670	-33,261	63	57,801	-32,131	64
2010	357,658	51,145	79,914	11,941	91,855	56,670	-35,185	62	68,310	-23,546	74
2011	365,359	52,246	81,635	12,198	93,833	56,670	-37,163	60	73,564	-20,269	78
2012	373,277	53,379	83,404	12,463	95,867	56,670	-39,197	59	73,564	-22,302	77
2013	381,380	54,537	85,215	12,733	97,948	56,670	-41,278	58	78,819	-19,129	80
2014	389,662	55,722	87,065	13,010	100,075	56,670	-43,405	57	84,074	-16,001	84
2015	**398,099**	**56,928**	**88,950**	**13,291**	**102,242**	**56,670**	**-45,572**	**55**	**94,583**	**-7,659**	**93**
2016	406,694	58,157	90,871	13,578	104,449	56,670	-47,779	54	99,837	-4,612	96
2017	415,448	59,409	92,827	13,871	106,697	56,670	-50,027	53	102,990	-3,707	97
2018	424,209	60,662	94,784	14,163	108,947	56,670	-52,277	52	104,041	-4,906	95
2019	432,915	61,907	96,729	14,454	111,183	56,670	-54,513	51	105,092	-6,091	95
2020	**441,610**	**63,150**	**98,672**	**14,744**	**113,416**	**56,670**	**-56,746**	**50**	**105,092**	**-8,324**	**93**

1/: No change in rice production level in the Area is assumed in future

2/: The irrigated and rainfed agriculture improvement plans proposed in the Master Plan are implemented as scheduled in the implementation plan. The full development stage of the plans is attained in 2020.

3/: Annual per capita consumption of rice = 143 kg

4/: Milled rice / 0.64 (milled rice = 64% x paddy)

5/: 13% of paddy production

6/: Proportionf of annual production volumes to the target production are estimated as follows;

2008	*2009*	*2010*	*2011*	*2012*	*2013*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019/20*
55%	*55%*	*65%*	*70%*	*70%*	*75%*	*80%*	*90%*	*95%*	*98%*	*99%*	*100%*

Note: The target production production volume is 105,092 tons