Appendix-C
Agriculture

BASIN-WIDE BASIC IRRIGATION AND DRAINAGE MASTER PLAN STUDY
IN
THE KINGDOM OF CAMBODIA

FINAL REPORT

APPENDIX-C AGRICULTURE

Table of Contents

List of Tables

List of Figures

Attachment

CHAPTER C1 PRESENT CONDITIONS

C1.1 Battambang River Basin

C1.1.1 Soils

(1) Methodology

For investigating properties of the major soils distributed in the basin, soil profile observations and laboratory analyses of soil samples taken from the 6 representative profiles were conducted under the present Study. The results and findings of the survey were made use of as the principal information for the land suitability classification.

For the selection of the representative soils in the basin and the selection of target areas for the profile description and soil sampling, the soil maps prepared under the Tonle Sap Stabilization Project, ADB, 2006 were used as the base soil maps. The maps were drawn by compiling the original soil maps prepared by MRC. The original maps are prepared by classifying soils at a soil sub-unit level applying the FAO/UNESCO soil classification system. Soil test pits were excavated in the target areas after the confirmation of the distribution of the subject representative soils. At the test pit sites, soil profile description and soil sampling were made. The profile descriptions of representative soils are presented in Attachment C-1. The soil laboratory tests were carried out on the following properties.

Soil Properties for Laboratory Analysis

Soil Properties	
pH (H2O & KCl)	Total Phosphate (T-P)
Electric Conductivity (EC)	Available Phosphate (Av.-P)
Total Nitrogen (T-N)	Exchangeable Cations (Ca, Mg, K, Na)
Total Carbon (T-C)	Cation Exchangeable Capacity (CEC)
C/N Ratio	Particle Size Analysis

(2) Soil Distribution and Characteristics

The soils distributed in the basin are classified at soil sub-unit level following the FAO/UNESCO classification system into 10 soil types (sub-units) as shown in Figure C1-1 and in the following table.

Soil Distribution in the Basin

Soil Sub-unit	Distribution (ha)	Distribution (%)	Soil Sub-unit	Distribution (ha)	Distribution (%)
Gleyic Acrisol (ACg)	68,230	11	Eutric Cambisol (CMe)	49,840	8
Gleyic Luvisol (LVg)	120,710	20	Dystric Leptosol (LPd)	60,770	10
Eutric Fluvisol (FLe)	7,010	1	Eutric Leptosol (LPe)	39,420	7
Dystric Gleysol (GLd)	149,420	25	LPd/CMd 1/	600	-
Dystric Cambisol (CMd)	11,920	2	CMe/LPe 1/	97,380	16
			Total	605,300	100

1/ soil associations of Dystric Cambisol/Dystric Leptosol & Eutric Cambisol/Eutric Leptosol

The River basin is characterized by the distribution of finer textured soils and most of the soils distributed in the lower and upper basin have fine textured solums (LiC ~ HC). However, textures of the soils distributed in the piedmont areas vary from medium to fine. The dominant

soil distributed in the paddy fields of the basin is Gleyic Luvisol followed by Gleyic Acrisol.

Distributions and characteristics of the soils are discussed in the following sections. The results of the soil analysis are presented in Table C1-1.

(a) Gleyic Acrisol (mapping symbol: ACg)

The soil is distributed in the piedmont areas of the middle basin. Most lands distributed with this soil are under forest, shrub and grass cover and agricultural activities in the areas are rather limited. Its distribution accounts for 68,230 ha or 11% of the basin.

The soil has medium to fine textured surface layer (SL~LiC) underlain with finer textured sub soils (LiC to HC). In medium textured soils, surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The medium textured soils are very friable when moist and quite easy to crash by fingers. The effective depth of the soils is deep and no plinthite layer is encountered.

The surface soils of the representative profiles have acid reaction (pH) and low to moderate soil fertility judged from moderate total nitrogen, moderate to low cation exchange capacity (CEC) and high exchangeable potassium.

(b) Gleyic Luvisol (mapping symbol: LVg)

The soil is mostly distributed in low land areas of the middle basin. Its distribution accounts for 120,710 ha or 20 % of the basin. Lands distributed with the soil are almost exclusively used for rice cultivation, mainly under direct sowing system.

The soil has fine textured layers in the entire profile (LiC~HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to high soil fertility, judged from moderate total nitrogen, moderate to high cation exchange capacity (CEC) and high exchangeable potassium.

(c) Eutric Fluvisol (mapping symbol: FLe)

The distribution of the soil is limitedly found along the Sangker River and the lands distributed with the soils are almost entirely used as paddy field or for garden crop cultivation. Its distribution accounts for 7,010 ha or 1 % of the basin. The soil has fine textured layers in the entire profile and the effective soil depth is deep.

(d) Dystric Gleysol (mapping symbol: GLd)

The soil is most extensively distributed in the basin and found in the seasonally inundated lowland areas along the Tone Sap Lake. The lands distributed with the soil are mostly covered with flooded shrub or grassland. Its distribution accounts for 149,420 ha or 25 % of the basin.

The soil has fine textured layers in the entire profile (SiC~HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to high soil fertility, judged from moderate to high total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(e) Dystric Cambisol (mapping symbol: CMd)

The distribution of the soil is limited in the basin and currently used for paddy fields or left

under shrub cover. Its distribution accounts for 11,920 ha or 2 % of the basin.

The texture of the soil depending on location and varies from coarse to fine textured (LS to HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, moderate to low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

(f) Eutric Cambisol (mapping symbol: CMe)

The distribution of the soil is restricted in the mountain areas in the basin and lands distributed with the soil are covered with forest. The soil is fertile derived from basalt or lime stone. Its distribution accounts for 49,840 ha or 8 % of the basin.

The texture of the soil is fine in the entire solum (HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to high soil fertility, judged from high total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(g) Dystric Leptosol (mapping symbol: LPd)

The distribution of the soil is restricted in the mountain areas in the southern end of the basin and lands distributed with the soil are covered with forest. Its distribution accounts for 60,770 ha or 10 % of the basin.

The texture of the soils is medium to fine. The effective soil depth is depending on location, however, the depth is generally shallow underlain with bed rocks. The surface soils of the representative profiles have acid to neutral reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

(h) Eutric Leptosol (mapping symbol: LPe)

The distribution of the soil is restricted in the mountain areas in the western end of the basin and lands distributed with the soil are covered with forest. Its distribution accounts for 39,420 ha or 7% of the basin.

(i) Dystric Leptsol/Dystric Cambisol (mapping symbol: LPd/CMd)

The soil association of Dystric Leptsol and Dystric Cambisol is found extremely limitedly in the mountain areas of the basin. Its distribution accounts for 600 ha of the basin.

(j) Eutric Leptsol/Eutric Cambisol (mapping symbol: LPe/CMe)

The soil association of Eutric Leptsol and Eutric Cambisol is found in the mountain areas in the western reach of the basin. Land distributed with the soil is left unused under forest cover. Lands distributed with this association might have moderate to high soil fertility. Its distribution accounts for 97,380 ha or 16% of the basin.

C1.1.2 Land Suitability

(1) Methodology

The land suitability classification for rice and upland crops production has been made by

applying the method proposed in the Framework for Land Evaluation (FAO, 1976).

For the classification, 3 land characteristics for classification in case of rice and 4 land characteristics in case of upland crops are applied as shown in Table C1-2 and as follows;

Factors & Land Characteristics Selected for Land Suitability Classification

Factors for Classification	Land Characteristics for Classification	
	Rice	Upland Crops
Soil	Effective Soil Depth (e)	Effective Soil Depth (e)
	Upper Soil Texture/0-60cm (t)	Top Soil Texture/0-30cm (t)
	CEC/0-30cm (c)	CEC/0-30cm (c)
		pH/0-30cm (p)

For the land suitability assessment, land characteristics are evaluated into 3 to 5 criteria by assessing degrees of limitations for rice and upland crops production. The criteria applied for the present preliminary land suitability classification are set up as shown in Table C1-2. The structure of the suitability classification employed is as follows;.

Structure of Suitability Classification

Class (Sub-class)	Description
S1: Highly Suitable	Subject soil or land characteristics present no significant limitations for a given use
S2: Moderately Suitable (S2t, S2f, S2s etc.)	Subject soil or land characteristics present moderately severe limitations for a given use
S3: Marginally Suitable (S3e, S3f, S3i etc.)	Subject soil or land characteristics present substantially severe limitations for a given use
S4: Conditionally Suitable	Suitability class categorized for farm land (rice fields & upland fields) distributed with sandy soils; Existing rice/upland fields distributed with sandy soils are classified into S4 because land use conversion to other productive agricultural use not conceived.
N: Not Suitable	Subject soil or land characteristics present limitations so severe as to preclude successful sustained use of the land in the given manner.

(2) Suitability Classification

Aiming at examining suitability of the lands in the basin for rice and upland crops cultivation, the land suitability classification has been made based on the criteria set for soil related land characteristics. The results of the classification are presented in Table C1-3 and C1-4 in detail and C1-5 in a summarized manner and as shown below.

Land Suitability Classification for Rice Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)	Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)
Gleyic Acrisol	S3c	68,230	11	Eutric Cambisol	S2tc	49,840	8
Gleyic Luvisol	S2tc	120,710	20	Dystric Leptosol	S2tc/S3t/N	60,770	10
Eutric Fluvisol	S2	7,010	1	Eutric Leptosol	S2 - N	39,420	7
Dystric Gleysol	S2tc	149,420	25	LPd/CMd 1/	S2 – N	600	-
Dystric Cambisol	S2tc/S3t	11,920	2	CMe/LPe 1/	S2 - N	97,380	16
				Total		605,300	100

1/ soil associations of Dystric Cambisol/Dystric Leptosol & Eutric Cambisol/Eutric Leptosol

As shown in the table, 54% of the lands in the basin distributed with Gleyic Luvisol, Dystric Gleysol, Eutric Fluvisol and Eutric Cambisol are classified as moderately suitable (S2) for rice production and 13% of the lands are moderately suitable (S2) or marginally suitable (S3)

depending primarily on surface soil texture and/or top soil CEC. However, 33% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth of lands, therefore, depending on locations.

Land Suitability Classification for Upland Crops Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)	Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)
Gleyic Acrisol	S3c/S3tc	68,230	11	Eutric Cambisol	S3t	49,840	8
Gleyic Luvisol	S3t	120,710	20	Dystric Leptosol	S2cp/S3t/N	60,770	10
Eutric Fluvisol	S2	7,010	1	Eutric Leptosol	S2 ~ N	39,420	7
Dystric Gleysol	S3t	149,420	25	LPd/CMd 1/	S2 ~ N	600	-
Dystric Cambisol	S3t	11,920	2	CMe/LPe 1/	S2 ~ N	97,380	16
				Total		605,300	100

1/ soil associations of Dystric Cambisol/Dystric Leptosol & Eutric Cambisol/Eutric Leptosol

As shown in the table, 67% of the lands in the basin are classified as marginally suitable (S3) or moderately suitable (S2) for upland crops production with major limitations of surface soil texture and/or top soil CEC. However, the remaining 33% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth of lands, therefore, depending on locations.

C1.1.3 Present Land Use

(1) Methodology

The present land use of the river basin was studied by using the land use maps prepared under the Study on the Establishment of GIS Base Data for the Kingdom of Cambodia, 2001 ~ 2003, carried out by JICA. The original maps were prepared at a scale of 1/100,000 and the present land uses of the basin are categorized into 28 land use categories. In the present Study, the number of land use categories was simplified into 13 categories by combining similar land use categories in the original maps. The simplified land use maps were prepared at a scale of 1/100,000 and reduced to A4 size for reporting purpose as shown in Figure C1-2.

(2) Present Land Use

The land uses of the basin are characterized by forest (41% of the basin) in the south -eastern mountain areas, paddy field (15%) in the middle to lower basin and flooded shrub/forest (17%) extended in flooded plain along the Tonle Sap Lake. The total agricultural land is rather limited compared with Moung Ruessei and Boribo River Basins occupying some 118,700 ha or 20% of the basin. Other major land uses include grass land of different types and shrub land. The present land use of the basin is presented in Figure C1-2 and summarized below.

Present Land Use of the River Basin (Gross Area)

Land Use Category	Area (ha)	(%)	Land Use Category	Area (ha)	(%)
Paddy Field	92,710	15	Forest	250,910	41
Field Crop Land	7,020	1	Flooded Grass Land 1/	27,800	5
Garden Crop Land	15,990	3	Flooded Shrub/Forest	104,740	17
Grassland	51,700	9	Others 2/	8,010	1
Shrubland	46,420	8	**Total**	**605,300**	**100**

1/ : flooded grass land/marsh/swamp ; 2/:including watersurfac/ built-up area etc . Source: JICA Study Team

The descriptions of major land use categories are briefed as follows;

(a) Paddy Field

Paddy field occupies 92,710ha or 15% of the basin extending in the middle to lower basin. Most of paddy fields in the basin are rainfed fields and the same located in the irrigated systems are estimated at some 22,000 ha or 24% of the total according to the Inventory Survey conducted by JICA in 2006. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields and fields under rainfed conditions as is the case in the other basins. Prevailing rice cultivation method is direct sowing and prevailing cropping pattern is a single cropping of rice in wet season. Area under receding or floating rice cultivation is limited to 270 ha in the basin.

(b) Field Crop Land

Field crop land is extremely limited in extent to 7,020 ha or 1.2% of the basin and is almost exclusively found along small valleys in the mounting areas. Major crops cultivated in the land include corn, beans and cassava in wet season. Field crop lands in the basin in Pilin province and in the border area of Battambang and Pilin provinces distributed with fertile Cambisol have been developed for commercial scale upland crops cultivation.

(c) Garden Crop Land

The extent of this category of land accounts for 15,990 ha or 3% of the basin. The land category includes two sub-categories of garden crop field and village garden crop field. The distributions of these are mostly found along the Sangker River and other rivers having access to water resources. Over 60% of this category of land is the village garden crop field. Major crops cultivated in these lands are vegetables and some upland crops mainly in dry season.

(d) Forest

This category of land occupies the largest land surface of 250,910 ha or 41% of the basin and extends in the south-eastern mountain areas in the basin. The category of land includes 6 sub-categories of forest. Major ones are evergreen broad leafed forest, deciduous forest and mixed forest of evergreen and deciduous forest.

(e) Flooded Shrub/Forest

This category of land extended widely in the lowland areas up to the Tonle Sap Lake. The land category is composed of flooded shrub land and flooded forest. However, the former accounts for 98% of this category and the later is limited in extent in the basin.

C1.1.4 Agro-demography and Land Holding

Some agro-demographic and land holding features in the basin identified based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented in Table C1-6 and summarized in the following table.

Agro-demographic Features in the Basin in 2003

Items	Features
No. of Households (total)	95,952
No. of Farm Households (No. of crop producing households)	73,288
% of Farm Households to Total Households	76 %
%. of None Farm Households (No. of none crop producing households)	24 %
% of Farm Households Producing Rice	74 %
Total Population (in 2005, SEILA Data Vase)	351,176
Average Family Size (in 2005, SEILA Data Vase)	4.5

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

When assuming that number of farm households is accounted by number of crop producing households, farm households in the basin is calculated at 76% of the total households and none-farm households are estimated at 24%. Only 74% of the farm households (crop producing households) are producing rice. Average family size is 4.5 members.

The access to data/information on land tenure was rather limited in the present Study. However, the Commune Survey, MAFF provides some information on the land tenure and holding statuses as shown in Table C1-6 and summarized in the following table.

Land Holding Features of the Communes in the Basin in 2003

Indicator	Features
No. of None Farm Households (No. of none crop producing households)	22,664
No. of Landless Households	23,095
No. of Landless Households - No. of None Farm Households	431
Wet Season Rice Cropped Area in 2003	103,074 ha
No. of Households Producing Wet Season Rice in 2003	54,075
Rice Cropped Area per Farm Household in Wet Season (2003)	1.9 ha
%. of Farm Households with Holding Size Less Than 10a	10 %
% of Farm Households with Holding Size More Than 3ha	28 %
% of Landless Households	32%

Source: Commune Survey on Crops & Livestock, 2003, MAFF

As shown in the table, almost all the farm households in the basin appear to have some farmland and, from the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at 1.9ha. Proportion of land holding households having less than 0.1ha is calculated at 10% and the same of more than 3ha is at 32%.

The number of landless households calculated at 32% of the total households is nearly equal to the number of none crop producing households. Therefore, the landless figure might represent non-farm households domiciling in the basin, especially in urban areas and number of landless farm households might be limited.

C.1.1.5 Rice Production

(1) General

Rice production is the most important agricultural activities in the basin and farm households cultivated wet season rice in 2003 account for 74% of their total. Rice production in the basin is characterized by low and unstable productivity under rainfed conditions, although most of the paddy fields are distributed with Gleyic Luvisol evaluated as moderately suitable for rice cultivation. Further, the same is characterized by a single cropping of rice in wet season under extensive direct sowing method in large size plots. Rice cultivation in dry season is extremely

limited at less than 1% of annual cropped area and the same in early wet season is limited further. Such off-season cultivation is practiced in some irrigated fields and recession paddy fields. Floating/deep water rice cultivation area was some 14,000 ha in 2003 and is practiced in low lying seasonally inundated areas.

Even in irrigated fields, the cultivation is mostly carried out under nearly rainfed conditions because of unstable and limited water supply. Further, prolonged rice cultivation season continuing form May to January with the cultivation of rice varieties of different growth durations of early to late and traditional farming practices adapted to the agro-climatic conditions are other characteristic of the rice production in the basin.

(2) Cropping Season and Variety

Rice cropping seasons in the basin consists of: i) wet season rice grown from May/June to December/January both in rainfed and irrigated area and ii) dry season rice cultivated from February/March to May/June in irrigated area. In addition, recession rice cultivation generally carried out from November/December to February/March.

In the basin, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Traditional local varieties other than those selected by CARDI are called by local names and same varieties might be named differently depending on locations. Currently cultivated traditional local varieties appear to have been selected by farmers in the past and have some characteristics suited to local agro-climatic conditions such as drought tolerance and tolerance to inundation. Major varieties grown in the basin are as follows;

Major Varieties Grown in the Basin

Season	Growth Duration	Variety
Wet Season	Medium	Riang Chey, Phka Khnei, Phka. Rumdoul, Phka Mulis
	Late	CAR 4, CAR 6, Niang Meng, Neang Khum
Dry Season	Early	IR 66, Sen Pidao (promising variety)

(3) Cropping Calendar and Pattern

The prevailing cropping calendar in the basin is depending on planting method and varieties grown as shown in the following table.

Prevailing Cropping Calendar

Season	Planting Method	Duration	Cropping Calendar
Wet Season	Direct Sowing	Early	Sowing – Harvest: May/June – Aug.
		Medium	Sowing – Harvest: May/June – Nov./Dec.
		Late	Sowing – Harvest: May/June – Dec./Jan.
	Transplanting	Early	Transplanting – Harvest: June – Aug.
		Medium	Transplanting – Harvest: July/Aug. – Nov./Dec.
		Late	Transplanting – Harvest: July/Aug. – Dec./Jan.
Dry Season	Direct Sowing	Early	Feb/Mar. – May/June
	Transplanting	Early	Feb/Mar. – May/June

A single cropping of wet season rice is an almost exclusive cropping pattern both in irrigated and rainfed paddy fields as areas under double cropping of rice is extremely limited and no other crops than rice is cultivated. Accordingly, copping patterns in the basin are summarized as shown in the following table.

Prevailing Cropping Patterns

Field	Cropping Pattern	Note
Irrigated Field	Single cropping of wet season rice	Almost exclusive pattern
	Double cropping of wet season rice + dry season rice	Very limited pattern
Rainfed Field	Single cropping of wet season rice	Exclusive pattern
Recession Field	Single cropping of dry season rice	Only in recession field

(4) Cropped Area and Production

(a) Cropped Area and Cropping Intensity

Cropped area and cropping intensity of rice in the basin communes[1] are roughly estimated based on the crop statistic of MAFF and PDAs and by assuming that wet season cropped areas is equal to total areas of paddy fields as shown Table C1-7 and summarized below.

Cropped Area & Cropping Intensity of Rice 1/

Cropping Season	Cropped Area	Intensity
Wet Season	99,405 ha	100 %
Dry Season	520 ha	0.5 %
Annual	99,925 ha	101 %

1/: Roughly estimated figures *Source: Crop Statistics of PDA &MAFF*

As shown in the table, the overall cropping intensity of rice in the paddy fields in the basin communes is estimated at 100% in wet season, only at 0.5 % in dry season and 101 % annually.

(b) Paddy Yield and Production

Yield and production of paddy in the basin communes are estimated on the basis of the statistic data of MAFF and PDAs and SEILA Data Base as shown in Table C1-7 and C1-8 and as summarized in the following table.

Rice Yield & Production in the Basin 1/

Source	Season	Average Paddy Yield to:		Production
		Cropped Area	Harvested Area	
PDA/MAFF Statistics	Wet Season	1.8	1.8	178,000 ton
	Dry Season	2.8	2.9	1,500 ton
	Annual			179,500 ton
SEILA data base	Wet Season	1.3	-	
	Dry Season	1.6	-	

1/: Figures of the basin communes *Source: PDA/MAFF & SEILA*

Some differences in paddy yield levels between the data sources are noticed as shown in the tables. On the basis of such information, current yield levels of paddy under rainfed conditions in the basin are estimated at around 1.0 ton/ha in direct sowing and 1.5 ton/ha in transplanting in wet season. In fully irrigated fields, yield levels are higher than those figures, however, the area extent of fully irrigated fields is extremely limited in the basin. Annual production of rice in the basin communes is estimated at around 180,000 tons.

[1] Communes wholly or partly located in the basin

(5) Prevailing Farming Practices

Specific features of rice farming practices in the basin are:

- Prevailing of direct sowing method under dry land condition (83%) to transplanting method (17%) for planting, due partly to large land holding size of paddy field per farm family as shown in Table C1-9,
- Prevailing of mechanical land preparation (79%) to land preparation by draft animal (21%) as shown in Table C1-9,
- High seeding rate in direct sowing (120 to 150 kg/ha), partly aiming at suppressing weed growth by sowing densely, and
- 3rd plowing carried out in August (about 90 days after germination) in direct sowing fields for weed control purpose.

(6) Food Balance

The food balance of rice in the basin was examined by applying the method adopted in the food balance sheet of MAFF. The result indicates surplus of some 50,000 tons of milled rice in the basin communes as shown below.

Food Balance of Rice in the Basin 1/

Population in 2005	Milled Rice for Consumption 2/	Rice Requirement	Balance
351,176	100,031	50,218	49,813

1/: Population in 2005 (SEILA) & crop statistics of PDA & MAFF

2/: (production – 13 0of post-harvest losses & seed requirements) x milling recovery rate (64%)

(7) Weaknesses of Rice Production in the Basin

Aiming at over viewing rice production in the basin, the weaknesses on the same are enumerated in the followings.

- Unstable and low productivity of rice primarily attributed to limited and unstable availability of water and unstable rainfall distribution,
- Rainfed rice cultivation with poor and unstable productivity remaining as a mainstay in farming activities,
- Prevailing of extensive direct sowing which are characterized by high seeding rate to suppress weed growth and 3rd plowing in August to reduce plant population,
- Prevailing farming practices characterized by use of traditional varieties, continuous use of self produced seeds, high seeding rate, aged seedlings, random planting, limited application of fertilizer, inadequate post-harvest practices, etc.,
- Single cropping of rice and annual low land use intensity at nearly 100%, and
- Farmers preference for medium or late traditional varieties resulted in prolonged cropping season.

(8) Rice Cultivation in Irrigation Systems

The results of the Survey on the Irrigation System Inventory for the river basins of

Battambang, Dauntri, Pursat, Boribo and Remaining Part of Prek Thnot, 2006, JICA (herein after called the Inventory Survey) indicate existence of 88 irrigation systems in the basin. Prevailing cropping calendar & pattern and cropping intensity are presented in Table C1-10 and C1-11 and summarized below.

Agricultural Features of Irrigation Systems in the Basin

Item	Agricultural Features of Irrigation Systems
No. of Irrigation Systems	Sangker Dist: 29; Banan Dist.: 21; Ratanak Mondoul: 10 Aek Phnum: 16; Battambang: 3; Khs Krolor: 7 Moung Ruessei: 2; Total: 88 systems
Area of Irrigated Paddy Fields	21,604 ha (including recession fields of 78ha)
Rice Cropped Area & Intensity	Wet season: 21,259 ha & intensity 98%
	Dry season: 707 ha & intensity 3% (including recession rice)
	Early wet season: 5 ha & intensity 0.02%
	Annual: 21,967 ha & intensity 102%
Yield information reported	2.2 ton/ha in wet season in supplemental irrigation fields, 3.1 ton/ha in dry season & 1.0-1.2 ton/ha in rainfed fields.

Source: The Inventory Survey report

Paddy fields in the command areas of the irrigation systems in the basin account for about 24% of the total paddy fields. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins.

Other major agronomic features in the systems identified from the Inventory Survey report are enumerated as follows;

Cropping Calendar & Variety

- Exclusive cropping calendar (from sowing in field or nursery to harvest) is May/June to December/January. Varieties grown are medium/late varieties in wet season and early variety in dry & early wet season.

Cropping Pattern & Intensity

- Single cropping of wet season rice is exclusive pattern and number of systems where double cropping of rice is carried out is only 11 systems among 88 systems,
- No other crops than rice is cultivated in paddy fields in the systems, and
- Cropping intensities of individual systems are in the range of 100 to 200%, which obtained in a system of irrigation area of only 20ha; and overall intensity as a whole is only 102%.

Planting Methods

- Direct sowing is prevailing method as is the case in the whole basin.

Yield Levels

- Yield levels reported in the supplementary survey conducted by the Study Team are 2.2 ton/ha in wet season in supplemental irrigation fields, 3.1 ton/ha in dry season in fully irrigated field and 1.0 to 1.2 ton/ha in rainfed fields.

C.1.1.6 Production of Other Crops

The land use study in the basin indicates some 7,000ha of field crops land and 16,000ha (both in gross) of garden crops land in the basin. Productions of other crops such as upland crops, vegetables and fruits are carried out in such lands. Annual cropped areas of upland crops are estimated at 21,900 ha or about 22 % of annual rice cropped area of 99,600 ha as shown in Table C1-12 and summarized in the following table.

Cropped Area of Major Upland Crops in the Basin

Crops	Area (ha)	(%)	Crops	Area (ha)	(%)
Corn	8,653	40	Cassava	3,037	14
Soybeans	3,763	17	Sweet Potato	66	-
Mungbeans	2,781	13	Sesame	2,296	10
Groundnut	1,298	6	Total	21,893	100

Source: PDA Battambang

As shown in the table, major upland crop is corn followed by soybeans, cassava, mungbeans and sesame. Major producing districts of such crops are Ratanak Mondoul of Battambang and Pilin. Cultivation of upland crops in paddy fields are seldom practiced in the basin although a negligible extent of mungbeans withering in paddy fields was observed in field visits. Further, cultivation of upland crops after harvesting of paddy in dry season is also limitedly observed.

Annual cropped area of vegetables is estimated at around 1,100ha in the basin as shown in Table C1-13. Major vegetables include morning glory, Chinese cabbage, other leaf vegetables, string beans, tomato and cucumber. Major cropped areas of vegetables are farm lands (home garden) in villages and river levees having access to water sources for watering categorized as garden crops lands in the present land use. Major cropping season of vegetables is wet season accounting for 65% of annual cropped area. Dry season cultivation is practiced primarily under pump irrigation or manual watering.

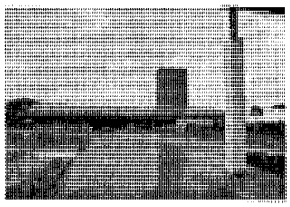
Major fruit trees found in the Area are orange, banana, coconut and mango, although the planted area as a whole is estimated to be limited at some 2,700ha as shown in Table C1-14. Battambang Province is famous for its orange production and planted area is estimated at about 700ha.

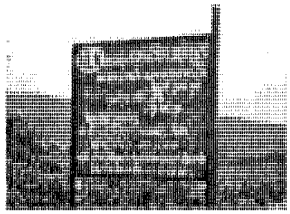
In the western border areas with Thailand, in Ratanak Mondoul District of Battambang and Pilin District of the river basin and other border districts, upland crops cultivation of substantial scales are carried out and several large scale marketing facilities are in operation as the collection & distribution centers in a producing area. Major findings of the field visit by the Study Team are as follows;

- Fertile Cambisol derived from basalt and/or calcareous rock is distributed and high productivity of upland crops is attained without fertilization. No specific soil conservation measures are employed and soil degradation due to erosion is slated.

- Prevailing cropping patterns are corn followed by beans and a single cropping of cassava.

- In cultivation of upland crops, local collectors/middlemen play important roles by providing tractor hiring services for land preparation and even for planting. Such services are generally provided without any obligation for marketing of products.





- In the producing area, construction of large scale collection & distribution facilities with drying facilities started from 2004. Such facilities are in operation, 3 in Battambang border districts and 2 in Pilin district. Further, in Ratanak Mondoul District of Battambang, a border district in the basin, a large scale collection & distribution center construction project was ranched.

- Main marketing channel is as follows;

  Farmer ⇒ Local Collector ⇒ Collection & Distribution Center ⇒ Trader/Wholesaler

  However, direct marketing from collector/large scale farmer to trader from Phnom Penh or Thailand is also carried out.

C1.1.7 Farm Machinery and Equipment

The inventory on farm machinery and equipment in the districts located in the basin is presented in the following table.

Inventory of Farm Machinery in the Basin Districts in 2006

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Heavy
416	4,075	3,963	281	345	92

Source: Department of Agricultural Machinery, MAFF

Mechanical land preparation works for rice cultivation are predominant practices (79% of total) in the basin. The number of rice mills appears to be more than sufficient for milling demand because marketing of paddy is commonly carried out in the form of unhusked rice.

C1.1.8 Livestock

Livestock sub-sector is an important agricultural activity for farm economy and provides an essential source of draft power and manure for farming in the basin. Accordingly, a number of animals and poultry are raised in the basin and majority of farm families hold some kind of animals as shown in Table C1-15 and as summarized below.

Livestock Population & Holding Status in the Basin in 2003

Item	Cattle	Cow	Draft Cattle	Buffalo	Pig
Population	60,599	21,549	24,246	2,020	26,060
Holding Size/Family	1.2	0.4	0.5	0	0.5

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the table, an average holding size of cattle, cow, draft cattle and pig in 2003 is calculated at 1.2, 0.4, 0.5, 0 and 0.5 heads per farm household, respectively, equivalent to animal units of 1.2 in total. The holding size of poultry is calculated at 4.5 per farm. However, as the statistic figures include livestock & poultry hold by commercial farms, an actual holding size per farm might be lower than the said estimates. Distribution of animal population is high in Banan and Ratanak Mondoul compared with other districts in the basin.

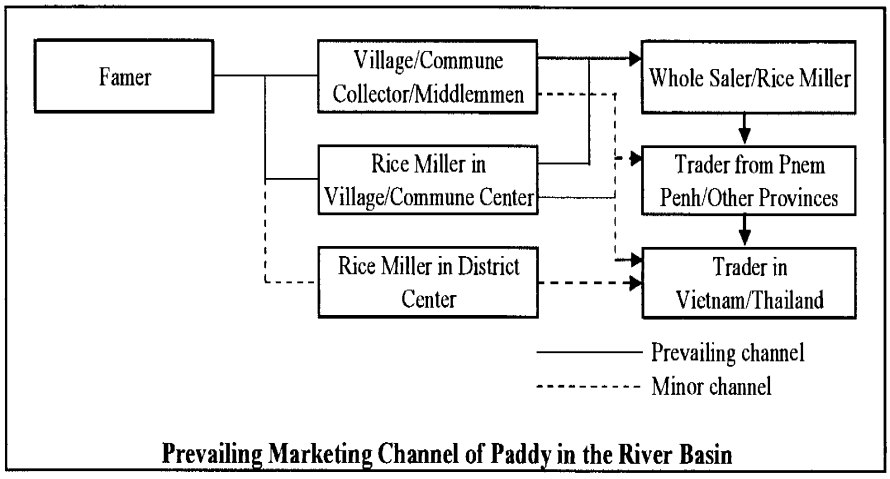
Land preparation for paddy cultivation is mostly done by using hand tractor or 4 wheel tractor

in the basin (about 70%) and the use of draft animals for the purpose will become less common in the future.

C1.1.9 Marketing

There is a high concentration of rice mills in and around Battambang city and along the Road No. 5 and some of these mills have considerable storage capacities. A large-scale modern mill was recently constructed in the city.

From food balance calculation, annual marketing of some 50,000 tons of paddy by producers (farmers) are estimated in the river basin. The prevailing marketing channels of paddy in the basin identified through the Socio-economic Survey, information provided by PDA and field survey by the Study Team are illustrated in the following figure.



Prevailing Marketing Channel of Paddy in the River Basin

Because of limited market volume by individual farmers, farmers have little bargaining power in price setting. Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy. In the same Survey, no serious constraint for market destination is reported.

The general marketing channel of upland crops in Battambang Province is reported by MAFF (Report on Agricultural Marketing System and Market Potential, Agricultural Marketing Office, MAFF, 200) as follows;

Farmers	⇨	Village/Commune Level Collectors	⇨	Traders	⇨	Wholesalers

C1.1.10 Agricultural Support Services

(1) Institutions

The government institutions involved in agricultural support services include MAFF at central level and Provincial Department of Agriculture (PDA) at province level. Because of the decentralization policy in the country, government sector providers of such services at the river basin level are PDA Battambang and Pilin. The organization structure of the PDA Battambang is shown in Figure C1-3.

PDA is a provincial level agricultural agency under the provincial government and is an

agency responsible for agricultural development and provision of agricultural supporting services at province, district, commune and village levels. As shown in Figure C1-3, PDA Battambang is composed of 7 technical offices and two planning/administrative offices. Total number of staffs including district level staffs is 364 (skilled 280 & unskilled 84).

Major functions of Agronomy Office include technology development, seed production and plant protection and the same of Extension Office are provision of extension services and human resources development. Animal Health Office has functions of provision of veterinary services, technology development and extension services. The Agronomy Office has 4 Experimental Station at district level, where experimental and seed production activities are carried out, but to a limited extent. PDA has its branch offices at district level called District Agricultural Office (DAO) and 8 DAOs are deployed in the basin.

The institutional set-up of the agricultural research and technology development activities in Cambodia is composed of the central institute for crop sector research (Cambodian Agricultural Research and Development Institute/CARDI) and the state farms and experimental stations belong to DAALI of MAFF.

A number of international and bilateral cooperation organizations and NGOs are involved in agricultural sector support activities in and around the basin. Major activities of the international organizations include JICA, FAO, EU and CIDA. NGOs having activities include World Vision, Help-Age and Care International.

(2) Current Support Activities

Current major agricultural support activities are BRAND (agricultural extension & farming system improvement activities) by JICA and ECOSORN (wide range activities including crop & livestock sub-sector) by EU. In addition, agricultural support activities under NCCD are also implemented by PDA in the basin.

C1.1.11 Rural Credit

Formal banking financial system for farm credit is limited in Cambodia and Micro Finance Institutions (MFI), ACLEDA Bank and some NGOs are the only formal operators providing credit services in rural areas. Currently, there exist 17 licensed MFIs, 26 registered rural credit operators (mostly NGOs) and around 60 unregistered NGOs freely operating credit services. [2] Among those, major operator in the river basin is ACLEDA Bank. The numbers of branch (province level) and sub-branch offices (district level) of it operated in the basin are as follows;

Deployment of Branch & Sub-branch Offices of ACLEDA

Institute	Branch Offices	Sub-branch Offices
ACLEDA	2	6

Source: ACLED Bank Plc

Some terms and conditions of ACLEDA Bank for farm credit or micro credit for individual are as shown in the following table.

[2] Microfinance of Cambodia, 2007, National Bank of Cambodia

Terms & Conditions for Farm Credit for Individual of ACLEDA Bank and AMRET

Institute	Credit period & interest rate		Conditions
ACLEDA	6 months < R.400,000; 3.25%/month	12 months R.400,000 – 6million; 3.5%/month	Provision of collateral &

Source: ACLED Bank Plc

Further, several NGOs are providing micro credit services in the river basin. However, non-institutional credit providers such as money lenders, rice miller, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

According to Cambodia Agriculture Development Report, 2006, EIC, the current statuses of rural credit in the country are accessed as follows;

- Even with rapid expansion of microfinance activity, many rural households still have no access to formal loans. The installment payment system required by many MFIs is not quite suitable to rural livelihoods where most people only earn money after harvest. This mismatch has led some farmers to turn to informal lenders instead even if they have to pay higher interest rates.
- Future prospects look good as banks and MFIs are cutting cost through learning by doing and economy of scale. Interest rates on loans will continue to decline along with expansion of outreach. However, the pace of the progress will depend on support from the government in terms of infrastructure development, macroeconomic stability and on the government's ability in playing its role as a regulator.
- There is not much room for the government to intervene as the private sector is already doing a good job in serving the rural poor. What the government should do is to reduce the operational cost through providing better infrastructure, maintain macro-economic stability and promote local saving.

The results of the Socio-economic Survey on farm credit are presented below.

Results of Socio-economic Survey on Farm Credit

Enquiry	Proportion by Reponses	Respondents No.
Access to farm credit	Easy: 25%; difficult: 14%, not received: 61%	110
Amount of credit	Sufficient: 30%; insufficient: 26%; not received: 44%	66
Timing of provision	In time: 21%; delayed: 15%; not received: 64%	110
Procedures for credit application	Easy: 7%; difficult: 25%, not received: 68%	110

Source: Socio-economic Survey in the Project Area by the JICA Study team, 2007

C1.1.12 Capacity to Pay

For the estimation of the current capacity-to-pay, farm economic analysis of preliminary nature on a typical farm was made based on the results of the Socio-economic Survey and the crop budget analysis (Table C1-16) on the current paddy production.

(1) Typical Farm

Majority of paddy fields in the river basin are categorized into rainfed paddy fields or fields nearly under rainfed conditions. Accordingly, farm family having rainfed paddy fields or fields nearly under rainfed conditions in irrigation systems was selected as a typical farm for the present farm economic analysis.

On the basis of the average holding size of paddy fields per farm family estimated in the section C1.1.4, the typical farm for the present farm economic analysis is defined as follows;

Typical Farm

Irrigation Status	Holding Size 1/
Rainfed paddy field or fields nearly under rainfed conditions in irrigation systems	2.0 ha/family

1/: holding size of paddy field assumed

(2) Present Capacity to Pay

The present farm economy of the typical farms are estimated based on the results of the Socio-economic Survey and the crop budget as shown in Table C1-17 and as below.

Present Farm Economy

Item		Amount (1000 Riel)
Gross Incomes	Rice Production 1/	1,120
	Other Farm Income	811
	Non-farm Income	1,668
	Total Income	3,599
Expenditures	Production Costs of Farm Products	1,209
	Other Expenditures	2,278
	Total Expenditures	3,487
Net Surplus		112

1/: Direct sowing assumed *Source: JICA Study Team*

As shown in the table, the current net surplus (capacity to pay) is estimated at a marginal level of Riel 112,000 (US$ 27) or 3% of the total gross incomes of the typical farm.

C1.1.13 Results of Socio-economic Survey

Under the present Study, the agro-economic survey aiming at identifying problems and constraints for irrigated farming, activities implemented for improvement of rice productivity by farmers and expectations for improvement of farming activities have been carried out under the Socio-economic Survey conducted in the Study. The target irrigation systems of the Survey were Thamat Pong, Vat Balat and Bot Sala in Sang Ker District.

The results indicate that farmers expectations for farming and irrigation are **productivity improvement of wet season rice** and **adequate irrigation water supply in wet season**.

The major findings obtained through the survey are presented in are presented in a narrative manner in Table C1-18. Major issues are discussed in the followings.

(1) Farming Constraints and Improvement Measures

Major agronomic and farm management constraints responded by sample farmers and assessed by weighted scoring method are low yield followed by crop losses due to pest & disease and weed problem as shown in the following table.

Farming Constraints (agronomy/farm management) in Order of Seriousness

Agronomic & Farm Management Constraints	Total Score	Rating 1/	
Low yield	193	1	Most serious
Crop losses due to pest & disease	100	2	2nd serious
Weed problem	82	3	3rd serious

1/: See Table C1-18. *Source: Socio-economic Survey by the JICA Study team, 2007*

Major physical constraints responded by sample farmers assessed similarly are irrigation water shortage in wet season followed by irrigation water shortage in dry season as follows;

Farming Constraints (physical) in Order of Seriousness

Physical Constraints	Total Score	Rating 1/	
Irrigation water shortage in wet season	281	1	Most serious
Irrigation water shortage in dry season	95	2	2nd serious
Inundation/flooding	25	3	3rd serious

1/: See Table C1-18. *Source: Socio-economic Survey by the JICA Study team, 2007*

Major marketing constraints responded by sample farmers are assessed similarly are unstable market prices of paddy/rice followed by low market prices of paddy/rice as follows;

Marketing Constraints in Order of Seriousness

Marketing Constraints	Total Score	Rating 1/	
Unstable market prices of paddy/rice	245	1	Most serious
Low market prices of paddy/rice	128	2	2nd serious
Unstable market prices of other crops	56	3	3rd serious

1/: See Table C1-18 *Source: Socio-economic Survey by the JICA Study team, 2007*

Activities or practices to improve rice productivity implemented in the past 3 years by sample farmers include increased fertilizer doses, use of quality seed and application of compost/manure as follows;

Activities/Practices to Improve Rice Productivity Implemented

Activities/Practices Implemented	No. of Respondents	Proportion (%)
Increased fertilizer doses	90	20
Used of quality seed (high yielding variety)	54	12
Applied of compost/manure	53	12
Used of quality seed (local variety)	52	12

Source: Socio-economic Survey by the JICA Study team, 2007

Activities necessary to improve rice productivity raised by sample farmers and assessed by weighted scoring method are: i) improvement of farming practices, ii) use of quality seed (high yielding variety) and iii) use of quality seed (local variety) as follows;

Necessary Activities to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Improvement of farming practices	268	1	Most required
Use of quality seed (high yielding variety)	186	2	2nd required
Used of quality seed (local variety)	139	3	3rd required

1/: See Table C1-18 *Source: Socio-economic Survey by the JICA Study team, 2007*

Physical works necessary to improve rice productivity raised by sample farmers and assessed similarly are: i) most required: irrigation water supply for wet season, ii) 2nd most required: irrigation water supply for dry season and iii) 3rd most required: drainage improvement as shown in the following table.

Necessary Physical Works to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Irrigation water supply for wet season	299	1	Most required
Irrigation water supply for dry season	131	2	2nd required

1/: See Table C1-18. *Source: Socio-economic Survey by the JICA Study team, 2007*

(2) Expectations for Improvement of Farming

Farmers expectations for improvement of farming conditions (agronomic/farm management) raised by the respondents and assessed similarly are: i) most expected: productivity improvement of wet season rice, ii) 2nd most expected: productivity improvement of field crops and iii) 3rd most expected: productivity increase of dry season rice as follows;

Expectations for Improvement: Farming (agronomic & farm management)

Expectation for Improvement	Total Score	Rating 1/	
Productivity improvement of wet season rice	308	1	Most expected
Productivity improvement of field crops	85	2	2nd expected
Productivity improvement of dry season rice	83	3	3rd expected

1/: See Table C1-18 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for farming system to be adopted assessed similarly are: i) most expected: double cropping of rice; ii) 2nd most expected: multiple farming composed of crop & livestock and iii) 3rd most expected: single cropping of rice as follows;

Expectations for Improvement: Farming System

Expectation for Improvement	Total Score	Rating 1/	
Double cropping of rice	276	1	Most expected
Multiple farming (crop + livestock etc.)	124	2	2nd expected
Single cropping of rice	105	3	3rd expected

1/: See Table C1-18 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for physical works to be done assessed similarly are: i) most expected: adequate irrigation water supply in wet season, ii) 2nd most expected: adequate irrigation water supply in dry season and iii) 3rd most expected: drainage improvement as follows;

Expectations for Improvement: Physical Works

Expectation for Improvement	Total Score	Rating 1/	
Adequate irrigation water supply in wet season	216	1	Most expected
Adequate irrigation water supply in dry season	133	2	2nd expected
Drainage improvement	47	3	3rd expected

1/: See Table C1-18 *Source: Socio-economic Survey by the JICA Study team, 2007*

Agricultural support services required for improvement of agricultural productivity responded by sample farmers and assessed similarly are: i) most required: field extension services (demonstration/field guidance) and ii) 2nd required: provision of quality seed.

Expectations for Agricultural Support Services

Expectation for Improvement	Total Score	Rating 1/	
Field Extension services (demonstration / field guidance)	255	1	Most required
Provision of quality seed	156	2	2nd required
Farmer training (technical & post-harvest operation)	119	3	3rd required

1/: See Table C1-18 *Source: Socio-economic Survey by the JICA Study team, 2007*

The results of the Survey on farming practices, farm input supply and marketing are presented in Attachment C-5.

C1.2 Moung Ruessei River Basin

C1.2.1 Soils

(1) General

For investigating properties of the major soils distributed in the basin, soil profile observations and laboratory analyses of soil samples taken from the 6 representative profiles were conducted under the present Study as explained in the section C1.1.1. The results and findings of the survey were made use of as the principal information for the land suitability classification. The profile descriptions of the representative soils in the basin are presented in Attachment C-2.

(2) Soil Distribution and Characteristics

The soils distributed in the basin are classified at soil sub-unit level following the FAO/UNESCO classification system into 9 soil types (sub-units) as shown in Figure C1-4 and in the following table.

Soil Distribution in the Moung Ruessei River Basin

Soil Sub-unit	Distribution (ha)	Distribution (%)	Soil Sub-unit	Distribution (ha)	Distribution (%)
Gleyic Acrisol (ACg)	17,070	5	Dystric Fluvisol (FLd)	960	-
Plinthic Acrisol (ACp)	28,990	8	Dystric Gleysol (GLd)	65,070	18
Areni-gleyic Acrisol (ACga)	45,930	12	Dystric Leptosol (LPd)	27,720	8
ACg/ACp 1/	67,630	18	LPd/CMd 1/	67,380	18
Gleyic Luvisol (LVg)	48,850	13	Total	369,600	100

1/ soil associations of Gleyic Acrisol/Plinthic Acrisol & Dystric Leptsol/Dystric Cambisol

The river basin is characterized by the distribution of finer textured soils in the lower to middle basin and the distribution of medium textured soils in the middle to upper basin. However, textures of the soils distributed in the mountain areas vary from medium to fine. The dominant soil distributed in the paddy fields of the basin is Gleyic Luvisol (LVg) followed by the association of Gleyic Acrisol and Plinthic Acrisol.

Distributions and characteristics of the soils are discussed in the following sections. The results of the soil analysis are presented in Table C1-19.

(a) Gleyic Acrisol (mapping symbol: ACg)

The soil is distributed in the western side of the middle basin. Almost all lands distributed with this soil are used as paddy fields and rice cultivation under direct sowing system is prevailing practices in such fields. Its distribution accounts for 17,070 ha or 5% of the basin.

The soil has medium to fine textured surface layer (SL~LiC) underlain with finer textured sub soils (LiC to HC). In medium textured soil, surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The medium textured soil is very friable when moist and quite easy to crash by fingers. The effective depth of the soil is deep and no plinthite layer is encountered within 100 cm from the surface.

The surface soils of the representative profiles have acid reaction (pH) and low to moderate

soil fertility judged from moderate total nitrogen, moderate to low cation exchange capacity (CEC) and high exchangeable potassium.

(b) Plinthic Acrisol (mapping symbol: ACp)

The soil is distributed in the middle of the basin and almost all lands distributed with this soil are used as paddy fields. Its distribution accounts for 28,990 ha or 8% of the basin.

The soil generally has medium textured surface layer (SL~L) underlain with finer textured sub soils. Surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The soil is very friable when moist and quite easy to crash by fingers. The effective depth of the soil is deeper than 80cm and plinthite layers are encountered in sub-soils at different depth.

The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from moderate total nitrogen, low cation exchange capacity (CEC) and moderate exchangeable potassium.

(c) Areni-gleyic Acrisol (mapping symbol: ACga)

The soil is distributed in the southern piedmont to mountain areas in the basin and almost all lands distributed with this soil are under forest, shrub or grass cover and use of the lands for agricultural purposes is limited. Its distribution accounts for 45,930 ha or 12% of the basin.

The soil generally has coarse to medium textured layers (LS~SL). Surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The soil is very friable when moist and quite easy to crash by fingers. The effective depth of the soil is deeper than 80cm and plinthite layers are not encountered within 100cm from the surface.

The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from moderate total nitrogen, low cation exchange capacity (CEC) and low exchangeable potassium.

(d) Gleyic Acrisol/Plinthic Acrisol (mapping symbol: ACg/ACp)

The soil association of Gleyic Acrisol and Plinthic Acrisol is distributed extensively in the eastern middle reach of the basin. Lands distributed with the soil are mostly used as paddy fields and rice cultivation under transplanting system is practiced prevailingly. Lands distributed with this association might have low to moderate soil fertility. Its distribution accounts for 67,630 ha or 18% of the basin.

(e) Gleyic Luvisol (mapping symbol: LVg)

The soil is distributed in the border areas with the Battambang River Basin in the middle reach of the basin. Its distribution accounts for 48,850 ha or 13 % of the basin. Lands distributed with the soil are almost exclusively used for rice cultivation, mainly under direct sowing system.

The soil has fine textured layers in the entire profile (LiC~HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to

high soil fertility, judged from moderate total nitrogen, moderate to high cation exchange capacity (CEC) and high exchangeable potassium.

(f) Dystric Fluvisol (mapping symbol: FLd)

The soil is extremely limitedly distributed in the border areas with the Pursat River Basin. Its distribution accounts only for 960 ha or 0.3 % of the basin.

The soil has a medium textured surface layer (SL~L) and finer textured sub-surface layers (SCL~LiC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate soil fertility, judged from moderate total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(g) Dystric Gleysol (mapping symbol: GLd)

The soil is extensively distributed in the seasonally flooded low land areas along the Tonle Sap Lake. The lands distributed with the soils are mostly covered with flooded shrub or grassland and agricultural uses of the land are extremely limited. Its distribution accounts for 65,070 ha or 18 % of the basin.

The soil has fine textured layers in the entire profile (SiC~HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to high soil fertility, judged from moderate to high total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(h) Dystric Leptosol (mapping symbol: LPd)

The distribution of the soil is restricted in the mountain areas of the basin and lands distributed with the soil are covered with forest. Its distribution accounts for 27,720 ha or 8% of the basin.

The texture of the soils is medium to fine. The effective soil depth is depending on location; however, the depth is generally shallow underlain with bed rocks. The surface soils of the representative profiles have acid to neutral reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

(i) Dystric Leptsol/Dystric Cambisol (mapping symbol: LPd/CMd)

The soil association of Dystric Leptsol and Dystric Cambisol is found extensively in the mountain areas of the basin and lands distributed with this soil association are almost exclusively under forest cover. Their distributions account for 67,380 ha or 18% of the basin.

The texture of Dystric Cambisol (CMd) is depending on location and varies from coarse to fine textured (LS to HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, moderate to low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

C1.2.2 Land Suitability

(1) General

The land suitability classification of the river basin for rice and upland crops production has been made by applying the method proposed in the Framework for Land Evaluation (FAO, 1976). For the classification, 3 land characteristics for classification in case of rice and 4 land characteristics in case of upland crops are applied as explained in the section C1.1.2. The criteria applied for the present preliminary land suitability classification and the structure of the suitability classification employed are also discussed in the section.

(2) Suitability Classification

Aiming at examining suitability of the lands in the basin for rice and upland crops cultivation, the land suitability classification has been made based on the criteria set for soil related land characteristics. The results of the classification are presented in Table C1-20 and C1-21 in detail and C1-22 in a summarized manner and as shown below.

Suitability Classification of Soils for Rice Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)	Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)
Gleyic Acrisol	S3c	17,070	5	Dystric Fluvisol	S2c/S2tc	960	-
Plinthic Acrisol	S3c	28,990	8	Dystric Gleysol	S2tc	65,070	18
Areni-gleyic Acrisol	S3c	45,930	12	Dystric Leptosol	S2tc/S3t/N	27,720	8
ACg/ACp 1/	S3c	67,630	18	LPd/CMd 1/	S2 - N	67,380	18
Gleyic Luvisol	S2tc	48,850	13	Total		369,600	100

1/ soil associations of Gleyic Acrisol/Plinthic Acrisol & Dystric Leptsol/Dystric Cambisol

As shown in the table, 31% of the lands in the basin distributed with Gleyic Luvisol (dominant soil in paddy fields), Dystric Gleysol and Dystrci Fluvisol are classified as moderately suitable (S2) for rice production and 43% of the lands distributed with Acrisol are marginally suitable (S3). However, 26% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth, therefore, depending on locations.

Suitability Classification of Soils for Upland Crops

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)	Soil Sub-unit	Suitability Sub-class	Distribution (ha)	(%)
Gleyic Acrisol	S3c/S3tc	17,070	5	Dystric Fluvisol	S2tcp/S3t	960	-
Plinthic Acrisol	S3c/S3tc	28,990	8	Dystric Gleysol	S3t	65,070	18
Areni-gleyic Acrisol	S3c	45,930	12	Dystric Leptosol	S2cp/S3t/N	27,720	8
ACg/ACp 1/	S3c/S3tc	67,630	18	LPd/CMd 1/	S2 ~ N	67,380	18
Gleyic Luvisol	S3t	48,850	13	Total		369,600	100

1/ soil associations of Gleyic Acrisol/Plinthic Acrisol & Dystric Leptsol/Dystric Cambisol

As shown in the table, 74% of the lands in the basin are classified as marginally suitable (S3) for upland crops production with major limitations of surface soil texture and/or top soil CEC. However, the remaining 26% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth of lands, therefore, depending on locations.

C1.2.3 Present Land Use

(1) Methodology

The present land use of the river basin was studied by using the land use maps with 26 land use categories prepared under the Study on the Establishment of GIS Base Data for the Kingdom of Cambodia, 2001 ~ 2003, carried out by JICA. In the present Study, the number of land use categories was simplified into 11 categories by combining similar land use categories in the original maps as is the case in the Battambang River Basin. The simplified land use maps were prepared at a scale of 1/100,000 and reduced to A4 size for reporting purpose as shown in Figure C1-5.

(2) Present Land Use

The land uses of the basin are characterized by forest (30% of the basin) in the southern mountain areas, paddy field (32%) in the intermediate to lowland areas, grassland (13%) in the mountain piedmonts and flooded shrub/forest (12%) extended in the low lying flooded plain extending along the Tonle Sap Lake. The total agricultural land is some 130,960 ha or 35% of the basin. Other major land uses include shrubland and flooded grassland/marsh & swamp. The present land use of the basin is summarized in the following table.

Present Land Use of the River Basin

Land Use Category	Area (ha)	Area (%)	Land Use Category	Area (ha)	Area (%)
Paddy Field	119,250	32	Forest	109,570	30
Field Crop Land	970	-	Flooded Grass Land 1/	11,210	3
Garden Crop Land	8,990	2	Flooded Shrub/Forest	43,110	12
Grassland	46,560	13	Others 2/	3,630	1
Shrubland	26,310	7	**Total**	**369,600**	**100**

1/ : flooded grass land/marsh/swamp ; 2/:including watersurfac/ built-up area etc . Source: JICA Study Team

The descriptions of major land use categories are briefed as follows;

(a) Paddy Field

Paddy field represents 119,250ha or 32% of the basin extending in the intermediate to low land areas in the middle basin and the largest land use category. Most of paddy fields in the basin are rainfed field and the same located in the irrigated schemes are rather limited; some 12,000 ha or 10% of the total paddy field according to the Inventory Survey conducted by JICA in 2006. Further their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins. This category of land includes paddy field in village zones of some 1,100ha or 1% of the total paddy field. Prevailing rice cultivation method in paddy fields located in Battambang Province is direct sowing, while the same located in Pursat Province is transplanting. A prevailing cropping pattern is a single cropping of rice in the wet season. Area under receding or floating rice cultivation is limited to 1,600 ha in the basin.

(b) Field Crop Land

Field crop land is extremely limited to 970 ha and is found in the south-western piedmont in the basin. Major crops cultivated in the land include corn, beans and cassava in wet season.

(c) Garden Crop Land

The extent of this category of land accounts for 8,990 ha or 2% of the basin. The land category includes two sub-categories of garden crop field and village garden crop field. The distributions of these are mostly found along the Moung Ruessei River, Svay Doun Kaev River and other rivers having access to water resources. Nearly 80% of this category of land is the village garden crop field. Major crops cultivated in these lands are vegetables and upland crops mainly in dry season.

(d) Forest

This category of land covers the 2nd largest land surface occupying 109,570 ha or 30% of the basin and extends in the southern mountain areas in the basin. The category of land includes 7 sub-categories of forest. Major one is deciduous forest followed by evergreen broad leafed forest and mixed forest of evergreen and deciduous forest.

(e) Grassland

This category of land accounts for 46,560 ha or 13% of the basin and extends in the mountain piedmont and in the low lying areas along the flooded shrub land. The category of land includes 2 sub-categories of grassland. However, the sub-category of abandoned field covered by grasses is exclusive representing 99% of total.

(f) Flooded Shrub/Forest

This category of land extended widely in the lowland areas up to the Tonle Sap Lake. The land category is composed of flooded shrub land and flooded forest. However, the former accounts for 99% of this category and the later is limited in extent in the basin.

C1.2.4 Agro-demography and Land Holding

Some agro-demographic and land holding features in the basin identified based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented in Table C1-23 and summarized in the following table.

Agro-demographic Features in the Basin in 2003

Items	Features
No. of Households (total)	54,768
No. of Farm Households (No. of crop producing households)	52,436
% of Farm Households to Total Households	92 %
%. of None Farm Households (No. of none crop producing households)	8 %
% of Farm Households Producing Rice	93 %
Total Population (in 2005, SEILA Data Vase)	230,291
Average Family Size (in 2005, SEILA Data Vase)	5.2

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

When assuming that number of farm households is accounted by number of crop producing households, farm households in the basin is calculated at 92% of the total households and none-farm households are estimated at 8%, under more rural conditions compared with the Battambang River Basin Almost all farm households (93% to crop producing households) are producing rice.

The access to data/information on land tenure was rather limited in the present Study.

However, the Commune Survey, MAFF provides some information on the land tenure and holding statuses in the basin is roughly estimated as shown in Table C1-23 and summarized in the following table.

Land Holding Features of the Communes in the Basin in 2003

Indicator	Features
No. of None Farm Households (No. of none crop producing households)	4,332
No. of Landless Households	4,763
No. of Landless Households - No. of None Farm Households	431
Wet Season Rice Cropped Area in 2003	107.897
No. of Households Producing Wet Season Rice in 2003	48,664
Rice Cropped Area per Farm Household in Wet Season (2003)	2.1 ha
%. of Farm Households with Holding Size Less Than 10a	11 %
% of Farm Households with Holding Size More Than 3ha	54 %
% of Landless Households	9%

Source: Commune Survey on Crops & Livestock, 2003, MAFF

As shown in the table, almost all the farm households in the basin appear to have some farmland and, from the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at 2.1 ha. This figure is larger at 3.2 ha in the basin located in Battambang Province. Proportion of land holding households having less than 0.1ha is calculated at 11% and the same of more than 3ha is at 54%.

The number of landless households calculated at 9% of the total households is nearly equal to the number of none crop producing households. Therefore, the landless figure might represent non-farm households domiciling in the basin, especially in urban areas and number of landless farm households might be limited.

C1.2.5 Rice Production

(1) General

Rice production is the most important agricultural activities in the basin and about 93% of farm households had engaged in wet season rice cultivation in 2003. The rice production in the basin is characterized by low and unstable productivity under rainfed conditions. Further, the same as a whole is characterized by a single cropping of rice in wet season mostly under extensive direct sowing method. However, in paddy fields of the basin located in Pursat Province, transplanting is predominant planting method. Rice cultivation in dry season is extremely limited at less than 1% of annual cropped area and the same in early wet season is limited further. Such off-season cultivation is practiced in some irrigated fields and recession paddy fields. Floating/deep water rice cultivation area was some 8,400 ha in 2003 and is practiced in low lying seasonally inundated areas.

As is the case in the Battambang Rive Basin, rice cultivation is mostly carried out under nearly rainfed conditions even in irrigated fields, because of unstable and limited water supply. Further, prolonged rice cultivation season continuing form April to January with the cultivation of rice varieties of different growth durations of early to late and traditional farming practices adapted to the agro-climatic conditions are other characteristic of the rice production in the basin.

(2) Cropping Season and Variety

Rice cropping seasons in the basin are basically similar to those of the Battambang River Basin and consists of: i) wet season rice grown from April/June to December/January both in rainfed and irrigated area and ii) dry season rice cultivated from October/November to February/March in irrigated area and recession fields.

In the basin, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Traditional local varieties other than those selected by CARDI are called by local names and same varieties might be named differently depending on locations. Currently cultivated traditional local varieties appear to have been selected by farmers in the past and have some characteristics suited to local agro-climatic conditions such as drought tolerance and tolerance to inundation. Major varieties grown in the basin are as follows;

Major Varieties Grown in the Basin

Season	Growth Duration	Variety
Wet Season	Medium	Phka. Rumdoul, Phka Rumchang, Somali, Phka Khnei,
	Late	CAR 5, CAR 9, CAR 4, CAR 6, Niang Meng
Dry Season	Early	IR 66, Sen Pidao (promising variety), IR 72

(3) Cropping Calendar and Pattern

The prevailing cropping calendar in the basin is depending on planting method and varieties grown as follows;

Prevailing Cropping Calendar

Season	Planting Method	Duration	Cropping Calendar
Wet Season	Direct Sowing	Early	Sowing – Harvest: May/June – Aug.
		Medium	Sowing – Harvest: May/June – Nov./Dec.
		Late	Sowing – Harvest: May/June – Dec./Jan.
	Transplanting	Early	Transplanting – Harvest: June – Aug.
		Medium	Transplanting – Harvest: July/Aug. – Nov./Dec.
		Late	Transplanting – Harvest: July/Aug. – Dec./Jan.
Dry Season	Direct Sowing	Early	Oct./Nov.. – Feb./Mar.
	Transplanting	Early	Oct./Nov.. – Feb./Mar.

A single cropping of wet season rice is an exclusive cropping pattern both in rainfed and irrigated fields, while a double cropping of wet season rice and dry season rice is also carried out in irrigated fields. In recession fields, a single cropping of dry season rice is exclusive. However, areas under double cropping of rice are extremely limited as a whole and no other crops than rice are cultivated. Accordingly, copping patterns in the basin are summarized in the following table.

Prevailing Cropping Patterns

Field	Cropping Pattern	Note
Irrigated Field	Single cropping of wet season rice	Predominant pattern
	Double cropping of wet season rice + dry season rice	Limited in extent
Rainfed Field	Single cropping of wet season rice	Exclusive pattern
Recession Field	Single cropping of dry season rice	Only in recession field

(4) Cropped Area and Production

(a) Cropped Area and Cropping Intensity

Cropped area and cropping intensity of rice in the basin communes are roughly estimated based on the crop statistics of MAFF and PDAs and by assuming that wet season cropped areas is equal to total areas of paddy fields as shown in Table C1-24 and summarized below.

Cropped Area & Cropping Intensity of Rice 1/

Cropping Season	Cropped Area	Intensity
Wet Season	123,430 ha	100 %
Dry Season	948 ha	0.8 %
Annual	124,378 ha	101 %

1/: Roughly estimated figures *Source: PDAs/MAFF*

As shown in the table, the overall cropping intensity of rice in the paddy fields in the basin communes is estimated at 100% in wet season, only at 1% in dry season and 101 % annually.

(b) Paddy Yield and Production

Yield and production of paddy in the basin communes are estimated on the basis of the crop statistic data of MAFF and PDAs and SEILA Data Base as shown in Table C1-24 and C1-25 and as summarized in the following table.

Rice Yield & Production in the Basin 1/

Source	Season	Average Paddy Yield to:		Production
		Cropped Area	Harvested Area	
PDA/MAFF Statistics	Wet Season	1.5	1.5	184,000 ton
	Dry Season	2.6	2.6	2,500 ton
	Annual			186,500 ton
SEILA data base	Wet Season	1.2	-	
	Dry Season	1.9	-	

1/: Figures of the basin communes *Source: MAFF/PDA & SEILA*

Some differences in paddy yield levels between the data sources are noticed as shown in the tables. On the basis of such information, current yield levels under rainfed condition in the basin are estimated at around 1.0 ton/ha in direct sowing and 1.5 ton/ha in transplanting in wet season. In fully irrigated fields, yield levels are higher than those figures, however, the area extent of fully irrigated fields is extremely limited in the basin. Annual production of paddy in the basin is estimated at around 187,000 tons.

(5) Prevailing Farming Practices

Some farming practices are different between the basin areas located in Battambang and those located in Pursat. Specific features of rice farming practices in the basin are:

- Prevailing of direct sowing method under dry land condition (69%) to transplanting method (31%) for planting as a whole in the basin; while in the basin located in Pursat, transplanting is 69 % and the basin in Battambang, direct sowing is 97% due to large land holding size of paddy field per farm family as shown in Table C1-26,
- Prevailing of mechanical land preparation (71%) in Battambang and prevailing of land preparation by draft animal (80%) in Pursat as shown in Table C1-26,

- High seeding rate in direct sowing (120 to 150 kg/ha), partly aiming at suppressing weed growth by sowing densely, and
- 3rd plowing carried out about 90 days after germination in direct sowing fields.

(6) Food Balance

The food balance of rice in the basin was examined by applying the method adopted in the food balance sheet of MAFF. The result indicates surplus of some 71,000 tons of milled rice in the basin as shown in the following table.

Food Balance of Rice in the Basin 1/

Population in 2005	Milled Rice for Consumption 2/	Rice Requirement	Balance
230,291	103,976	32,932	71,045

1/: Population in 2005 (SILA) & production statistics of PDA & MAFF

2/: (Production – 13% of post-harvest losses & seed requirements) x milling recovery rate (64%)

(7) Weaknesses of Rice Production in the River Bain

The weaknesses of rice production in the basin are similar to those in the Battambang River Basin as enumerated in the followings.

- Unstable and low productivity of rice primarily attributed to limited and unstable availability of water and unstable rainfall distribution,
- Rainfed rice cultivation with poor and unstable productivity remaining as a mainstay in farming activities,
- Prevailing of extensive direct sowing which are characterized by high seeding rate to suppress weed growth and 3rd plowing in August to reduce plant population,
- Prevailing farming practices characterized by use of traditional varieties, continuous use of self produced seeds, high seeding rate, aged seedlings, random planting, limited application of fertilizer, inadequate post-harvest practices, etc.,
- Single cropping of rice and annual low land use intensity at nearly 100%, and
- Farmers preference for medium or late traditional varieties resulted in prolonged cropping season.

(8) Rice Cultivation in Irrigation Systems

The results of the Inventory Survey, 2006, JICA indicate existence of 45 irrigation systems in the basin. Prevailing cropping calendar & pattern and cropping intensity are presented in Table C1-27 and C1-28 and summarized below.

Agricultural Features of Irrigation Systems in the Basin

Item	Agricultural Features of Irrigation Systems
No. of Irrigation Systems	Moung Ruessei Dist :31; Bakan Dist:14; Total: 45 systems
Area of Irrigated Paddy Fields	12,058 ha (including recession fields of 1,571 ha)
Rice Cropped Area & Intensity	Wet season: 9,057 ha & intensity 75%
	Dry season: 3,106 ha & intensity 26% (including recession rice)
	Recession field (dry season): 1,571 ha & intensity 13%
	Annual: 12,163 ha & intensity 101%

Source: The Inventory Survey report

Paddy fields in the command areas of the irrigation systems in the basin account for about 10% of the total paddy field. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins.

Other major agronomic features in the systems identified from the Inventory Survey report are enumerated as follows;

Cropping Calendar & Variety

- Prevailing cropping calendar (from sowing in field or nursery to harvest) is May/June to Nov./Dec. (medium variety) and May/June to December/January (late variety), and
- Variety grown is medium/late varieties in wet season and early variety in dry & early wet season.

Cropping Pattern & Intensity

- Single cropping of wet season rice is exclusive pattern and number of systems where double cropping of rice is carried out is only 6 systems among 45 systems,
- No other crops than rice is cultivated in paddy fields in the systems, and
- Cropping intensities of individual systems are in the range of 100 to 107%, which obtained in a system of irrigation area of 661 ha; and overall intensity as a whole is only 101%.

Planting Methods

- Direct sowing is prevailing method as is the case in the whole basin.

Yield Levels

- Yield levels reported in the supplementary survey on the Inventory Survey conducted by the Study Team are 2.2 ton/ha in wet season in supplemental irrigation fields, 3.0 ton/ha in dry season in fully irrigated field and 0.8 to 0.9 ton/ha in rainfed fields.

C1.2.6 Production of Other Crops

There are some 1,000ha of field crops land and 9,000ha (both in gross) of garden crops land in the basin. Productions of other crops such as upland crops, vegetables and fruits are carried out in such lands.

Compared with rice production, productions of upland crops are extremely limited in the basin as shown in Table C1-29 and summarized in the following table.

Cropped Area of Major Upland Crops In the Basin

Crops	Area (ha)	(%)	Crops	Area (ha)	(%)
Corn	712	30	Cassava	121	5
Soybeans	385	17	Sweet Potato	84	4
Mungbeans	321	14	Sesame	51	2
Groundnut	645	28	Total	2,318	100

Source: PDA Battambang & Pursat

As shown in the table, cropped areas of upland crops are some 2,300 ha or less than 2 % of annual rice cropped area of 124,000ha. Major upland crop is corn followed by groundnut, soybeans and mungbeans although area extent is extremely limited. Major producing district of such crops in the basin is Moung Ruessei and Samlout District of Battambang Province. Major cropping season of upland crops is wet season and cultivation in dry season is rather limited. Further, cultivation of upland crops in paddy fields is seldom practiced in the basin.

Annual cropped area of vegetables is estimated at around 1,000ha, some 300 ha in wet and 700 ha in dry season, in the basin as shown in Table C1-30. Common vegetables include cucumber, tomato, morning glory, Chinese cabbage and string beans. Major cropped areas of vegetables are farm lands (home garden) in villages and river levees having access to water sources for watering categorized as garden crops lands in the present land use.

Major fruit trees found in the basin are banana, coconut and mango, although the planted area as a whole is extremely limited at some 750 ha as shown in Table C1-31.

C1.2.7 Farm Machinery and Equipment

The inventory on farm machinery and equipment in the districts located in the basin is presented in the following table.

Inventory of Farm Machinery in the Basin Districts in 2006

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Heavy
178	1,226	2,593	286	815	45

Source: Department of Agricultural Machinery, MAFF

Mechanical land preparation works for rice cultivation are predominant practices (71% of total) in the basin. The number of rice mills appears to be more than sufficient for milling demand in the basin because marketing of paddy is commonly carried out in the form of unhusked rice.

C1.2.8 Livestock

Livestock sub-sector is an important agricultural activity for farm economy and provides an essential source of draft power and manure for farming in the basin. Accordingly, a substantial number of animals and poultry are raised in the basin and majority of farm families hold some kind of animals as shown in Table C1-32 and as summarized below.

Livestock Population & Holding Status in the Basin in 2003

Item	Cattle	Cow	Draft Cattle	Buffalo	Pig
Population	73,216	22,770	37,815	22,451	47,387
Holding Size/Family	1.4	0.4	0.7	0.4	0.9

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the table, an average holding size of cattle, cow, draft cattle and pig in 2003 is calculated at 1.4, 0.4, 0.7, 0.4 and 0.9 heads per farm household, respectively, equivalent to animal units of 1.9 in total. The holding size of poultry is calculated at 8.3 per farm. However, as the statistic figures include livestock & poultry hold by commercial farms, an actual holding size per farm is lower the said estimates. Distribution of animal population is high in Bakan and Moung Ruessei District compared with other districts in the basin.

Land preparation for paddy cultivation is mostly done by draft animals in the basin (about 60%). However, the increased tendency of tractor uses is noticed from 2004 to 2006 in the statistical data provided by PDAs.

C1.2.9 Marketing

From food balance calculation, annual marketing of some 70,000 tons of paddy by producers (farmers) are estimated in the river basin. The prevailing marketing channels of paddy in the basin are similar to the same in the Battambang River Basin. At the first level, farmers sell rice to the local collectors who himself are quite often farmers who do that kind of business as side activities. The local collectors market rice to the wholesalers or to the rice millers. The wholesalers sell rice further to the traders/large scale wholesalers in/from Phnom Penh or other provinces, who export or market some products to Viet Nam or Thai buyers.

Because of limited market volume by individual farmers, farmers have little bargaining power in price setting. Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy as is the case in other river basins. In the same Survey, no serious constraint for market destination is reported.

C1.2.10 Agricultural Support Services

(1) Institutions

The government institutions involved in agricultural support services at the river basin level are PDA Battambang and Pursat. The organization structure of the PDAs are shown in Figure C1-3 and C1-6.

PDA is a provincial level agricultural agency under the provincial government and is an agency responsible for agricultural development and provision of agricultural supporting services at province, district, commune and village levels. As shown in the figure, both PDAs are composed of 7 technical offices and two planning/administrative offices. Total number of staffs including district level staffs is 364 in Battambang and the same in Pursat is 191.

Major functions of Agronomy Office include technology development, seed production and plant protection and the same of Extension Office are provision of extension services and human resources development. Animal Health Office has functions of provision of veterinary services, technology development and extension services.

PDA has its branch offices at district level called District Agricultural Office (DAO) and in total of 6 DAOs are deployed in the basin.

A number of international and bilateral cooperation organizations and NGOs are involved in agricultural sector support activities in and around the basin. Major activities of the international organizations include JICA, EU, DANIDA and CIDA. NGOs having activities include World Vision, Help-Age and Care International.

(2) Current Support Activities

Current major agricultural support activities are SLPP (livestock sub-sector activities) and ECOSORN (wide range activities including crop & livestock sub-sector) by EU. In addition,

agricultural support activities under NCCD are also implemented by PDA in the basin.

C1.2.11 Rural Credit

Major formal rural credit operators in the river basin are ACLEDA Bank. The numbers of branch (province level) and sub-branch offices (district level) of it operated in the basin are as follows;

Deployment of Branch & Sub-branch Offices of ACLEDA & AMRET

Institute	Branch Offices	Sub-branch Offices
ACLEDA	-	5

Source: ACLED Bank Plc

Further, several NGOs are providing micro credit services in the river basin. However, non-institutional credit providers such as money lenders, rice miller, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

The results of the Socio-economic Survey on farm credit are presented below.

Results of Socio-economic Survey on Farm Credit

Enquiry	Proportion by Reponses	Respondents No.
Access to farm credit	Easy: 38%; difficult: 6%, not received: 56%	120
Amount of credit	Sufficient: 48%; insufficient: 21%; not received: 31%	77
Timing of provision	In time: 32%; delayed: 10%; not received: 58%	120
Procedures for credit application	Easy: 13%; difficult: 26%, not received: 61%	120

Source: Socio-economic Survey in the Project Area by the JICA Study team, 2007

C1.2.12 Capacity to Pay

For the estimation of the capacity-to-pay, farm economic analysis of preliminary nature on a typical farm was made based on the results of the Socio-economic Survey and the crop budget analysis on the current paddy production (Table C1-33).

(1) Typical Farm

Majority of paddy fields in the river basin are categorized into rainfed paddy fields or fields nearly under rainfed conditions. Accordingly, farm family having rainfed paddy fields or fields nearly under rainfed conditions in irrigation systems was selected as a typical farm for the present farm economic analysis.

On the basis of the average holding size of paddy fields per farm family estimated in the section C1.2.4, the typical farm for the present farm economic analysis is defined as follows;

Typical Farm

Irrigation Status	Holding Size 1/
Rainfed paddy field or fields nearly under rainfed conditions in irrigation systems	2.0 ha/family

1/: holding size of paddy field assumed

(2) Present Capacity to Pay

The present farm economy of the typical farms are estimated based on the results of the Socio-economic Survey and the crop budget as shown in Table C1-34 and as below.

Present Farm Economy **(unit: 000Riel)**

Item		Amount
Gross Incomes	Rice Production 1/	1,120
	Other Farm Income	1,209
	Non-farm Income	1,750
	Total Income	4,079
Expenditures	Production Costs of Farm Products	1,329
	Other Expenditures	2,802
	Total Expenditures	4,131
Net Surplus		-52

1/: Direct sowing assumed *Source: JICA Study Team*

As shown in the table, the current farm economy of the typical farm indicates net deficit of Riel 52,000 or 1% of the total gross income.

C1.2.13 Results of Socio-economic Survey

Under the present Study, the agro-economic survey aiming at identifying problems and constraints for irrigated farming, activities implemented for improvement of rice productivity by farmers and expectations for improvement of farming activities have been carried out under the Socio-economic Survey conducted in the Study. The target irrigation systems of the Survey were Prek Chik, Por Canal and Ream Kon in Moung Ruessei District.

The results indicate that the primary constraints in rice farming identified are low paddy yield and irrigation water shortage even in wet season. Farmers expectations for farming and physical works (irrigation) are **productivity improvement of wet season rice** and **adequate irrigation water supply in wet season**, respectively.

The major findings obtained through the survey are presented in Table C-35. Major issues are discussed in the followings.

(1) Farming Constraints and Improvement Measures

Major agronomic and farm management constraints responded by sample farmers and assessed by weighted scoring method are low yield followed by weed problem and crop losses due to pest & disease as follows;

Farming Constraints (agronomy/farm management) in Order of Seriousness

Agronomic & Farm Management Constraints	Total Score	Rating 1/	
Low yield	213	1	Most serious
Weed problem	101	2	2nd serious
Crop losses due to pest & disease	89	3	3rd serious

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Major physical constraints responded by respondents assessed similarly are irrigation water shortage even in wet season followed by irrigation water shortage in dry season as follows;

Farming Constraints (physical) in Order of Seriousness

Physical Constraints	Total Score	Rating 1/	
Irrigation water shortage in wet season	284	1	Most serious
Irrigation water shortage in dry season	111	2	2nd serious
Others	141	3	3rd serious

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Major marketing constraints responded by sample farmers are assessed similarly are unstable market prices of paddy/rice followed by low market prices of paddy/rice as follows;

Marketing Constraints in Order of Seriousness

Marketing Constraints	Total Score	Rating 1/	
Unstable market prices of paddy/rice	274	1	Most serious
Low market prices of paddy/rice	102	2	2nd serious
Unstable market prices of livestock	57	3	3rd serious

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Activities or practices to improve rice productivity implemented in the past 3 years by sample farmers include increasing fertilizer doses and use of quality seeds as follows;

Activities/Practices to Improve Rice Productivity Implemented

Activities/Practices Implemented	No. of Respondents	Proportion (%)
Increased fertilizer doses	83	17
Used of quality seed (high yielding variety)	61	13
Used of quality seed (local variety)	58	12

Source: Socio-economic Survey by the JICA Study team, 2007

Activities necessary to improve rice productivity raised by sample farmers and assessed by weighted scoring method are: i) improvement of farming practices, ii) use of quality seed (local variety) and iii) use of adequate doses of fertilizer as follows;

Necessary Activities to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Improvement of farming practices	279	1	Most required
Use of quality seed (local variety)	185	2	2nd required
Used of adequate doses of fertilizer	168	3	3rd required

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Physical works necessary to improve rice productivity raised by sample farmers and assessed similarly are: i) most required: irrigation water supply for wet season, ii) 2nd most required: irrigation water supply for dry season and iii) 3rd most required: drainage improvement.

Necessary Physical Works to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Irrigation water supply for dry season	317	1	Most required
Irrigation water supply for wet season	147	2	2nd required
Drainage improvement	103	3	3rd required

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

(2) Expectations for Improvement of Farming

Farmers expectations for improvement of farming conditions (agronomic/farm management) raised by the respondents and assessed similarly are: i) most expected: productivity improvement of wet season rice, ii) 2nd most expected: productivity increase of dry season rice and iii) 3rd most expected: productivity improvement of field crops as follows;

Expectations for Improvement: Farming (agronomic & farm management)

Expectation for Improvement	Total Score	Rating 1/	
Productivity improvement of wet season rice	340	1	Most expected
Productivity improvement of dry season rice	125	2	2nd expected
Productivity improvement of field crops	75	3	3rd expected

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for farming system to be adopted assessed similarly are: i) most expected: double cropping of rice and ii) 2nd most expected: multiple farming composed of crop & livestock as follows;

Expectations for Improvement: Farming System

Expectation for Improvement	Total Score	Rating 1/	
Double cropping of rice	287	1	Most expected
Multiple farming (crop + livestock etc.)	140	2	2nd expected

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for physical works to be implemented assessed similarly are: i) most expected: adequate irrigation water supply in wet season, ii) 2nd most expected: adequate irrigation water supply in dry season and iii) 3rd most expected: drainage improvement as shown in the following table.

Expectations for Improvement: Physical Works

Expectation for Improvement	Total Score	Rating 1/	
Adequate irrigation water supply in wet season	327	1	Most expected
Adequate irrigation water supply in dry season	139	2	2nd expected
Drainage improvement	72	3	3rd expected

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

Agricultural support services required for improvement of agricultural productivity responded by sample farmers and assessed similarly are: i) most required: field extension services (demonstration/field guidance), ii) 2nd required: provision of quality seed and iii) 3rd required: farmer training as follows;

Expectations for Agricultural Support Services

Expectation for Improvement	Total Score	Rating 1/	
Field Extension services (demonstration / field guidance)	283	1	Most required
Provision of quality seed	173	2	2nd required
Farmer training (technical & post-harvest operation)	111	3	3rd required

1/: See Table C1-35 *Source: Socio-economic Survey by the JICA Study team, 2007*

The results of the Survey on farming practices, farm input supply and marketing are presented in Attachment C-6.

C1.3 Pursat River Basin

C1.3.1 Soils

(1) General

For investigating properties of the major soils distributed in the basin, soil profile observations and laboratory analyses of soil samples taken from the 6 representative profiles were conducted under the present Study as explained in the section C1.1.1. The results and findings of the survey were made use of as the principal information for the land suitability classification. The profile descriptions of the representative soils in the basin are presented in Attachment C-3.

(2) Soil Distribution and Characteristics

The soils distributed in the basin are classified at soil sub-unit level into 5 soil types (sub-units) as shown in Figure C1-7 and in the following table.

Soil Distribution in the Pursat River Basin

Soil Sub-unit	Distribution	
	(ha)	(%)
Gleyic Acrisol/Plinthic Acrisol	168,620	28
Dystric Fluvisol (FLd)	14,940	3
Dystric Gleysol (GLd)	41,940	7
Dystric Leptosol (LPd)	67,920	11
Dystric Leptsol/Dystric Cambisol	303,530	51
Total	596,500	100

The river basin is characterized by the distribution of medium textured soils in the lowland to intermediate areas and the distribution of fine textured soils in the seasonally inundated lowland areas close to the Tonle Sap Lake. The dominant soil distributed in the paddy fields of the basin is the association of Gleyic Acrisol and Plinthic Acrisol.

Distributions and characteristics of the soils are discussed in the following sections. The results of the soil analysis are presented in Table C1-36 and the descriptions of the typical soil profiles are presented in Attachment C-3.

(a) Gleyic Acrisol/Plinthic Acrisol (mapping symbol: ACg/ACp)

The soil association is distributed in the piedmonts to lowland areas of the basin. Majority of lands distributed with this soil are used as paddy fields and rice cultivation under transplanting system is prevailing practices in such fields. However, parts of the lands distributed with the same are left unused under forest or shrub cover. Its distribution accounts for 168,620 ha or 28% of the basin.

Gleyic Acrisol (ACg) has medium to fine textured surface layer (SL~LiC) underlain with finer textured sub soils (LiC to HC). In medium textured soil, surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The medium textured soil is very friable when moist and quite easy to crash by fingers. The effective depth of the soils is deep and no plinthite layer is encountered within 100 cm from the surface. The surface soils of the representative profiles have acid reaction (pH) and low to moderate soil fertility judged from moderate total nitrogen, moderate to low cation exchange capacity (CEC) and high exchangeable potassium.

Plinthic Acrisol (ACp) generally has medium textured surface layer (SL~L) underlain with finer textured sub soils. Surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The soils are very friable when moist and quite easy to crash by fingers. The effective depth of the soils is deeper than 80cm and plinthite layers are encountered in sub-soils at different depth. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from moderate total nitrogen, low cation exchange capacity (CEC) and moderate exchangeable potassium.

(b) Dystric Fluvisol (mapping symbol: FLd)

The soil is limitedly distributed in the low lying seasonally flooded areas extending along the lake shoreline. Its distribution accounts only for 14,940 ha or 3 % of the basin.

The soil has a medium textured surface layer (SL~L) and finer textured sub-surface layers

(SCL~LiC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate soil fertility, judged from moderate total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(c) Dystric Grey sol (mapping symbol: GLd)

The soil is distributed along the entire lake shoreline. The lands distributed with the soils are mostly covered with flooded shrub or grassland and any agricultural use of the lands could not be conceived under current conditions. Its distribution accounts for 41,490 ha or 7% of the basin.

The soil has fine textured layers in the entire profile (SiC~HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to high soil fertility, judged from moderate to high total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(d) Dystric Leptosol (mapping symbol: LPd)

The distribution of the soil is restricted in the eastern mountain areas of the basin and lands distributed with the soil are covered with forest. Its distribution accounts for 67,920 ha or 11% of the basin.

The texture of the soil is medium to fine. The effective soil depth is depending on location; however, the depth is generally shallow underlain with bed rocks. The surface soils of the representative profiles have acid to neutral reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

(e) Dystric Leptsol/Dystric Cambisol (mapping symbol: LPd/CMd)

The soil association of Dystric Leptsol and Dystric Cambisol covers almost all the mountain areas and lands distributed with this soil association are almost exclusively under forest cover. Its distribution accounts for 303,530 ha or 51% of the basin.

The texture of Dystric Cambisol (CMd) is depending on location and varies from coarse to fine textured (LS to HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, moderate to low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

C1.3.2 Land Suitability

(1) General

The land suitability classification of the river basin for rice and upland crops production has been made by applying the method proposed in the Framework for Land Evaluation (FAO, 1976). For the classification, 3 land characteristics for classification in case of rice and 4 land characteristics in case of upland crops are applied as explained in the section C1.1.2. The criteria applied for the present preliminary land suitability classification and the structure of the suitability classification employed are also discussed in the section.

(2) Suitability Classification of Soils

Aiming at examining suitability of the soils in the basin for rice and upland crops cultivation, the classification of the soils has been made based on the criteria set for soil related land characteristics. The results of the classification are presented in Table C1-37 and C-38 in detail and C1-39 in a summarized manner and as shown below.

Suitability Classification of Soils for Rice Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	Distribution (%)
Gleyic Acrisol/Plinthic Acrisol	S3c	168,620	28
Dystric Fluvisol (FLd)	S2c/S2tc	14,940	3
Dystric Gleysol (GLd)	S2tc	41,940	7
Dystric Leptosol (LPd)	S2tc/S3t/N	67,920	11
Dystric Leptsol/Dystric Cambisol	S2 ~ N	303,530	51
Total		596,500	100

As shown in the table, 10% of the lands in the basin distributed with Dystric Gleysol (GLd) and Dystric Fluvisol (FLd) are classified as moderately suitable (S2) for rice production and 28% of the lands distributed with Acrisol (dominant soils in paddy fields) are as marginally suitable (S3). However, 62% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth of lands, therefore, depending on locations.

Suitability Classification of Soils for Upland Crops Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	Distribution (%)
Gleyic Acrisol/Plinthic Acrisol	S3c/S3tc	168,620	28
Dystric Fluvisol (FLd)	S2tcp/S3t	14,940	3
Dystric Gleysol (GLd)	S3t	41,940	7
Dystric Leptosol (LPd)	S2cp/S3t/N	67,920	11
Dystric Leptsol/Dystric Cambisol	S2 ~ N	303,530	51
Total		596,500	100

As shown in the table, 35% of the lands in the basin are classified as marginally suitable (S3) for upland crops production with major limitations of surface soil texture and/or top soil CEC. However, 62% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth of lands, therefore, depending on locations. The remaining land (3%) is classified as moderately or marginally suitable depending on location.

C1.3.3 Present Land Use

(1) Methodology

The present land use of the river basin was studied by using the land use maps with 30 land use categories prepared under the JICA Study (2001 ~ 2003). In the present Study, the land use categories were simplified into 12 categories by combining similar land use categories as is the case in the Battambang River Basin. The simplified land use maps were prepared at a scale of 1/100,000 and reduced to A4 size for reporting purpose as shown in Figure C-8.

(2) Present Land Use

The land uses of the basin are characterized by the extensive forest cover in the southern and eastern mountain areas occupying about 74% of the basin. Paddy field (11%) is distributed in

the lowland areas and along the Pursat River. The total agricultural land is limited compared with the other river basins and amounts to some 76,200 ha or 13% of the basin. The extents of other land uses are rather limited including grassland, shrubland and flooded shrub/forest.

The present land use of the basin is illustrated in Figure C1-8 and presented as follows.

Present Land Use of the River Basin

Land Use Category	Area (ha)	Area (%)	Land Use Category	Area (ha)	Area (%)
Paddy Field	64,640	11	Forest	446,400	74
Field Crop Land	1,700	-	Flooded Grass Land 1/	9,840	2
Garden Crop Land	8,910	1	Flooded Shrub/Forest	23,310	4
Grassland	15,410	3	Others 2/	4,280	1
Shrubland	22,010	4	**Total**	**596,500**	**100**

1/ : flooded grass land/marsh/swamp ; 2/:including watersurfac/ built-up area etc . Source: JICA Study Team

The descriptions of individual land use categories are briefed as follows;

(a) Paddy Field

Paddy field represents 64,640ha or 11% of the basin extending in the low land areas and along the Pursat River and the 2nd largest land use category. Most of paddy fields in the basin are located within irrigation command areas occupying some 40,000 ha or 62 % of the total paddy field according to the Inventory Survey by JICA in 2006. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins. This category of land includes paddy field in village zones of some 1,130ha or 1% of the total paddy field in the basin. Prevailing rice cultivation method is transplanting and prevailing cropping pattern is a single cropping of rice in the wet season. Area under receding or floating rice cultivation is limited to 590 ha in the basin.

(b) Field Crop Land

Field crop land is extremely limited to 1,700 ha and is found in piedmont areas of Sampov Meas District. Major crops cultivated include corn, beans and cassava in wet season.

(c) Garden Crop Land

The extent of this category of land accounts for 8,910 ha or 1% of the basin. The land category includes two sub-categories of garden crop field and village garden crop field. The distributions of these are mostly found along the Pursat River and other rivers having access to water resources. Nearly 40% of this category of land is the village garden crop field. Major crops cultivated in these lands are vegetables and some upland crops mainly in dry season.

(d) Forest

This category of land occupies 446,400 ha or 74% of the basin and extends in the south and eastern mountain areas. The category of land includes 6 sub-categories of forest. Major one is evergreen broad leafed forest followed by deciduous forest and mixed forest of evergreen.

(e) Shrubland

This category of land accounts for 22,010 ha or 4% of the basin and extends in the mountain

piedmont in the eastern part of the basin. The category of land includes 3 sub-categories of shrubland, woodland & scattered trees and abandoned field covered by shrub. However, the sub-category of shrubland is representing and occupies 54% of total.

(f) Flooded Shrub/Forest

This category of land extended widely in the lowland areas up to the Tonle Sap Lake. The land category is composed of flooded shrub land and flooded forest. However, the former accounts for 86% of this category and the later is limited in extent.

C1.3.4 Agro-demography and Land Holding

Some agro-demographic and land holding features in the basin identified based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented in Table C1-40 and summarized in the following table.

Agro-demographic Features in the Basin in 2003

Items	Features
No. of Households (total)	56,678
No. of Farm Households (No. of crop producing households)	49,487
% of Farm Households to Total Households	87 %
%. of None Farm Households (No. of none crop producing households)	13 %
% of Farm Households Producing Rice	95 %
Total Population (in 2005, SEILA Data Vase)	240,948
Average Family Size (in 2005, SEILA Data Vase)	5.1

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

When assuming that number of farm households is accounted by number of crop producing households, farm households in the basin is calculated at 87% of the total households and none-farm households are estimated at 13%. Almost all farm households (95% to crop producing households) are producing rice. Average family size is estimated at 5.4 members.

The access to data/information on land tenure was rather limited in the present Study. However, the Commune Survey provides some information on the land tenure and holding statuses as shown in Table C1-40 and summarized in the following table.

Land Holding Features of the Communes in the Basin in 2003

Indicator	Features
No. of None Farm Households (No. of none crop producing households)	7,181
No. of Landless Households	4,991
No. of Landless Households - No. of None Farm Households	- 2,190
Wet Season Rice Cropped Area in 2003	55,566 ha
No. of Households Producing Wet Season Rice in 2003	47,044
Rice Cropped Area per Farm Household in Wet Season (200)	1.1 ha
%. of Farm Households with Holding Size Less Than 10a	11 %
% of Farm Households with Holding Size More Than 3ha	26 %
% of Landless Households	8%

Source: Commune Survey on Crops & Livestock, 2003, MAFF

As shown in the table, almost all the farm households in the basin appear to have some farmland and, from the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at 1.1 ha. Proportion of land holding households having less than 0.1ha is calculated at 11% and the same of more than 3ha is at 26%.

The number of landless households calculated at 8% of the total households is smaller than the number of none crop producing households. Therefore, the landless figure might represent non-farm households domiciling in the basin, especially in urban areas and number of landless farm households might be limited.

C1.3.5 Rice Production

(1) General

Rice production is the most important agricultural activities in the basin and wet season rice cultivation was practiced by about 95% of farm households in 2003. Rice production in the basin is characterized by low and unstable productivity in rainfed fields and in irrigation areas being under nearly rainfed conditions. Further, the same as a whole is characterized by a single cropping of rice in wet season mostly under transplanting method. Rice cultivation in dry season is extremely limited at less than 1% of annual cropped area and the same in early wet season is limited further. Such off-season cultivation is practiced in some irrigated fields and recession paddy fields. Floating/deep water rice cultivation area was some 8,200 ha in 2003 and is practiced in low lying seasonally inundated areas.

Even in irrigated fields, rice cultivation is mostly carried out under nearly rainfed conditions because of unstable and limited water supply. Further, prolonged rice cultivation season continuing form April to February with the cultivation of rice varieties of different growth durations of early to late and traditional farming practices are other characteristic of the rice production in the basin.

(2) Cropping Season and Variety

Rice cropping seasons in the basin consists of: i) wet season rice grown from April/July to November/February both in rainfed and irrigated area, diversified cropping seasons compared with the other basins and ii) dry season rice cultivated from October/November to January/February both in irrigated area and recession fields and January/February to April/May in irrigated fields.

In the basin, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Traditional local varieties other than those selected by CARDI are called by local names and same varieties might be named differently depending on locations. Currently cultivated traditional local varieties appear to have been selected by farmers in the past and have some characteristics suited to local agro-climatic conditions such as drought tolerance and tolerance to inundation. Major varieties grown are as follows;

Major Varieties Grown in the Basin

Season	Growth Duration	Variety
Wet Season	Medium	Phka. Rumdoul, Phka Rumchang, Somali, Phka Khnei,
	Late	CAR 5, CAR 9, Niang Meng
Dry Season	Early	IR 66, Sen Pidao (promising variety), IR 72

(3) Cropping Calendar and Pattern

The prevailing cropping calendar in the basin is depending on planting method and varieties grown as shown in the following table.

Prevailing Cropping Calendar

Season	Planting Method	Duration	Cropping Calendar
Wet Season	Direct Sowing	Early	Sowing – Harvest: Apr. – July/Aug.
		Medium	Sowing – Harvest: May/June – Nov./Dec.
		Late	Sowing – Harvest: May/June – Dec./Jan.
	Transplanting	Early	Transplanting – Harvest: Apr. – July/Aug.
		Medium	Transplanting – Harvest: July/Aug. – Nov./Dec.
		Late	Transplanting – Harvest: July/Aug. – Dec./Jan.
Dry Season	Direct Sowing	Early	Oct./Nov.. – Jan./Feb.
	Transplanting	Early	Oct./Nov.. – Jan./Feb. & Jan./Feb. – Apr./May

A single cropping of wet season rice is an exclusive cropping pattern both in rainfed and irrigated fields, while a double cropping of wet season rice and dry season rice is also carried out in irrigated fields in limited extent. In recession fields, a single cropping of dry season rice is exclusive. Accordingly, copping patterns in the basin are summarized as follows;

Prevailing Cropping Patterns

Field	Cropping Pattern	Note
Irrigated Field	Single cropping of wet season rice	Predominant pattern
	Double cropping of wet season rice + dry season rice	Limited in extent
Rainfed Field	Single cropping of wet season rice	Exclusive pattern
Recession Field	Single cropping of dry season rice	Only in recession field

(4) Cropped Area and Production

(a) Cropped Area and Cropping Intensity

Cropped area and cropping intensity of rice in the basin communes are roughly estimated based on the crop statistic of PDA/MAFF and by assuming that wet season cropped areas is equal to total areas of paddy fields as shown in Table C1-41, C1-42 and in the following table.

Cropped Area & Cropping Intensity of Rice 1/

Cropping Season	Cropped Area	Intensity
Wet Season	56,731 ha	100 %
Dry Season	400 ha	0.87%
Annual	57,131 ha	101 %

1/: Roughly estimated figures *Source: PDA/MAFF*

As shown in the table, the overall cropping intensity of rice in the rice fields in the basin communes is estimated at 100% in wet season, only at 1% in dry season and 101 % annually.

(b) Paddy Yield and Production

Yield and production of paddy in the basin communes are estimated based on the statistic data of MAFF/PDAs and SEILA Data Base as shown in Table C1-41 and C1-43 and as follows;

Rice Yield & Production in the Basin 1/

Source	Season	Average Paddy Yield to:		Production
		Cropped Area	Harvested Area	
PDA/MAFF Statistics	Wet Season	1.5	1.5	84,200 ton
	Dry Season	2.0	2.0	800 ton
	Annual			85,000 ton
SEILA data base	Wet Season	1.4	-	
	Dry Season	1.3	-	

1/: Figures of the basin communes *Source: PDA/MAFF & SEILA Data Base*

Some differences in paddy yield levels between the data sources are noticed as shown in the tables. On the basis of such information, current yield levels under rainfed conditions in the basin are estimated at around 1.0 ton/ha in direct sowing and 1.5 in transplanting in wet season. In fully irrigated fields, yield levels are higher than those figures, however, the area extent of fully irrigated fields is extremely limited in the basin. Annual production of rice in the basin is estimated at around 85,000 tons.

(5) Prevailing Farming Practices

Some specific features of rice farming practices in the basin are:

- Prevailing of transplanting method (77%) to direct sowing method (23%) as shown in Table C1-43, and
- Prevailing of land preparation by use of draft animal (83%) to land preparation by tractor (17%) as shown in Table C1-43.

(6) Food Balance

The food balance of rice in the basin was examined by applying the method adopted in the food balance sheet of MAFF. The result indicates surplus of some 13,000 tons of milled rice in the basin as shown in the following table.

Food Balance of Rice in the Basin 1/

Population in 2005	Milled Rice for Consumption 2/	Rice Requirement	Balance
240,948	47,304	34,456	12,848

1/: Population in 2005 (SILA) & crop statistics of PDA & MAFF

2/:(production – post-harvest losses & seed requirements) x milling recovery rate (64%)

(7) Weaknesses of Rice Production in the Target Area

The weaknesses of rice production in the basin are almost similar to those in the other river basins as enumerated in the followings.

- Unstable and low productivity of rice primarily attributed to limited and unstable availability of water, unstable rainfall distribution and poor soil conditions,
- Rainfed rice cultivation with poor and unstable productivity remaining as a mainstay in farming activities,
- Prevailing farming practices characterized by use of traditional varieties, continuous use of self produced seeds, high seeding rate, aged seedlings, random planting, limited application of fertilizer, inadequate post-harvest practices, etc.,
- Single cropping of rice and annual low land use intensity at nearly 100%, and
- Farmers preference for medium or late traditional varieties resulted in prolonged cropping season.

(8) Rice Cultivation in Irrigation Systems

The results of the Inventory Survey indicate existence of 28 irrigation systems in the basin. Prevailing cropping calendar & pattern and cropping intensity are presented in Table C1-44 and C1-45 and summarized in the following table.

Agricultural Features of Irrigation Systems in the Basin

Item	Agricultural Features of Irrigation Systems
No. of Irrigation Systems	Phnom Kravanth Dist: 16; Kandieng Dist.: 9; Krakor Dist.: 1; Bakan Dist: 2; Total: 28 systems
Area of Irrigated Paddy Fields	40,180 ha (including recession fields of 455 ha)
Rice Cropped Area & Intensity	Wet season: 39,673 ha & intensity 99%
	Dry season: 2,425 ha & intensity 6% (including recession rice)
	Recession field (dry season): 455 ha & intensity 1%
	Annual: 42,330 ha & intensity 105%
Yield information reported	2.2 ton/ha in wet season in supplemental irrigation fields, 3.1 ton/ha in dry season & 0.8-0.9 ton/ha in rainfed fields.

Source: The Inventory report

Paddy fields in the command areas of the irrigation systems in the basin account for about 62% of the total paddy field. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins.

Other major agronomic features in the systems identified from the Inventory Survey report are enumerated as follows;

Cropping Calendar & Variety

- Prevailing cropping calendar (from sowing in field or nursery to harvest) is Apr./June to Nov./Dec. (medium variety) and May/June to December/January (late variety),
- Variety grown is medium/late varieties in wet season and early variety in dry & early wet season.

Cropping Pattern & Intensity

- Single cropping of wet season rice is exclusive pattern and number of systems where double cropping of rice is carried out is 12 systems among 28 systems; however, extents of dry season rice cropped fields is limited to 2,425 ha,
- No other crops than rice is cultivated in paddy fields in the systems, and
- Cropping intensities of individual systems are in the range of 100 to 125%, which obtained in a system of irrigation area of 1,600 ha; and overall intensity as a whole is only 105%.

Planting Methods

- Transplanting is prevailing method in the systems.

Yield Levels

- Yield levels reported in the supplementary survey conducted by the Study Team are 2.2 ton/ha in wet season in supplemental irrigated fields, 3.1 ton/ha in dry season in fully irrigated field and 0.8 to 0.9 ton/ha in rainfed fields.

C1.3.6 Production of Other Crops

No reliable statistic information on other crops than rice was accessible in the present Study. However, aiming at obtaining rough features of other crops production, statistic data of MAFF

and PDAs were analyzed.

Compared with rice production, productions of upland crops are extremely limited in the basin as shown in Table C1-46 and summarized in the following table.

Cropped Area of Major Upland Crops In the Basin

Crops	Area (ha)	(%)	Crops	Area (ha)	(%)
Corn	201	25	Cassava	92	11
Soybeans	13	2	Sweet Potato	76	9
Mungbeans	193	24	Sesame	116	14
Groundnut	122	15	Total	813	100

Source: PDA Pursat

As shown in the table, cropped areas of upland crops are about 1% of annual rice cropped area of 57,000ha. Major upland crop is corn followed by mungbeans and groundnut although area extent is extremely limited. Major producing district of such crops in the basin is Phnum Kravan. Major cropping season of upland crops is wet season and cultivation in dry season is rather limited. Further, cultivation of upland crops in paddy fields is seldom practiced. Yield levels of upland crops are low compared with those of the Battambang and Moung Ruessei River Basins.

Annual cropped area of vegetables is estimated at only around 400ha in the basin as shown in Table C1-47. Major vegetables include cucumber, tomato, morning glory, Chinese cabbage and string beans. Major cropped areas of vegetables are farm lands (home garden) in villages and river levees having access to water sources for watering categorized as garden crops lands in the present land use.

Major fruit trees found in the basin are banana, jack fruit and mango, although the planted area as a whole is extremely limited at some 3,100 ha as shown in Table C1-48.

C1.3.7 Farm machinery and Equipment

The inventory on farm machinery and equipment in the districts located in the basin is presented in the following table.

Inventory of Farm Machinery in the Basin Districts in 2006 1/

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Heavy
113	758	2,499	254	1,569	40

1/: Not including Kandieng & Krakor Districts
Source: PDA Pursat

The number of tractor is still limited and land preparation works by draft animals is predominant practices (83% of total) in the basin, however, the works by hand tractor will expand in the future. The number of rice mills appears to be more than sufficient for milling demand in the basin because marketing of paddy is commonly carried out in the form of unhusked rice.

C1.3.8 Livestock

Livestock sub-sector is an important agricultural activity for farm economy and provides an essential source of draft power and manure for farming in the basin. Accordingly, a

substantial number of animals and poultry are raised in the basin and majority of farm families hold some kind of animals as shown in Table C1-49 and as summarized below.

Livestock Population & Holding Status in the Basin in 2003

Item	Cattle	Cow	Draft Cattle	Buffalo	Pig
Population	54,929	16,764	20,746	50,838	56,140
Holding Size/Family	1.2	0.4	0.4	1.1	1.2

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the table, an average holding size of cattle, cow, draft cattle and pig in 2003 is calculated at 1.2, 0.4, 0.4, 1.1 and 1.2 heads per farm household, respectively, equivalent to animal units of 2.3 in total. The holding size of poultry is calculated at 31.1 per farm. However, as the statistic figures include livestock & poultry hold by commercial farms, an actual holding size per farm is lower the said estimates. Distribution of animal population is high in Bakan and Krakor District compared with other districts in the basin.

As indicated in the population of draft buffalo, land preparation for paddy cultivation is mostly done by draft animals in the basin (about 80%). Draft animals will take primary role in land preparation for time being in the basin.

C1.3.9 Marketing

From food balance calculation, annual marketing of some 10,000 tons of paddy by producers (farmers) are estimated in the river basin, rather limited compared with the other basins. The prevailing marketing channels of paddy in the basin are similar to the same in the Battambang River Basin. In the prevailing channel, farmers sell rice to the local collectors who do that kind of business as side activities in many cases. The local collectors market rice to the wholesalers or to the rice millers. The wholesalers sell rice further to the traders/large scale wholesalers in/from Phnom Penh or other provinces.

Because of limited market volume by individual farmers, farmers have little bargaining power in price setting. Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy as is the case in other river basins. In the same Survey, no serious constraint for market destination is reported.

C1.3.10 Agricultural Support Services

(1) Institutions

The government institutions involved in agricultural support services at the river basin level are PDA Pursat. The organization structure of the PDAs are shown in Figure C1-6. As shown in the figures, the PDA is composed of 7 technical offices and two planning/administrative offices. Total number of staffs including district level staffs is 191. PDA has its branch offices at district level called District Agricultural Office (DAO) and in total of 6 DAOs are deployed in the basin.

A number of international and bilateral cooperation organizations and NGOs are involved in agricultural sector support activities in and around the basin. Major activities of the international organizations include ADB, EU and DANIDA.

(2) Current Support Activities

Current major agricultural support activities are SLPP by EU and agricultural sector activities of DANIDA. In addition, agricultural support activities under NCCD are also implemented by PDA in the basin.

C1.3.11 Rural Credit

Major formal rural credit operators in the river basin are ACLEDA Bank and PRASAC. The numbers of branch (province level) and sub-branch offices (district level) of them operated in the basin are as follows;

Deployment of Branch & Sub-branch Offices of ACLEDA & MFIs

Institute	Branch Offices	Sub-branch Offices
ACLEDA	1	8
PRASAC	1	2

Source: ACLED Bank Plc. & PRASAC Micro Finance Institution

Further, several NGOs are providing micro credit services in the river basin. However, non-institutional credit providers such as money lenders, rice miller, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

The results of the Socio-economic Survey on farm credit are presented below.

Results of Socio-economic Survey on Farm Credit

Enquiry	Proportion by Reponses	Respondents No.
Access to farm credit	Easy: 33%; difficult:1 6%, not received: 51%	130
Amount of credit	Sufficient: 24%; insufficient: 23%; not received: 53%	130
Timing of provision	In time: 29%; delayed: 20%; not received: 51%	130
Procedures for credit application	Easy: 13%; difficult: 34%, not received: 53%	130

Source: Socio-economic Survey in the Project Area by the JICA Study team, 2007

C1.3.12 Capacity to Pay

For the estimation of the current capacity-to-pay, farm economic analysis of preliminary nature on a typical farm was made based on the results of the Socio-economic Survey and the crop budget analysis on the current paddy production (Table C1-50).

(1) Typical Farm

Majority of paddy fields in the river basin are categorized into rainfed paddy fields or fields nearly under rainfed conditions. Accordingly, farm family having rainfed paddy fields or fields nearly under rainfed conditions in irrigation systems was selected as a typical farm for the present farm economic analysis.

On the basis of the average holding size of paddy fields per farm family estimated in the section C1.3.4, the typical farm for the present farm economic analysis is defined as follows;

Typical Farm

Irrigation Status	Holding Size 1/
Rainfed paddy field or fields nearly under rainfed conditions in irrigation systems	1.1 ha/family

1/: holding size of paddy field assumed

(2) Present Capacity to Pay

The present farm economy of the typical farms are estimated based on the results of the Socio-economic Survey and the crop budget as shown in Table C1-51 and as below.

Present Farm Economy (unit: 1000 Riel)

Item		Amount
Gross Incomes	Rice Production 1/	924
	Other Farm Income	503
	Non-farm Income	1,855
	Total Income	3,282
Expenditures	Production Costs of Farm Products	682
	Other Expenditures	2,644
	Total Expenditures	3,326
Net Surplus		-44

1/: Transplanting assumed *Source: JICA Study Team*

As shown in the table, the current farm economy of the typical farm indicates net deficit of Riel 44,000 or 1% of the total gross income.

C1.3.13 Results of Socio-economic Survey

Under the present Study, the agro-economic survey aiming at identifying problems and constraints for irrigated farming, activities implemented for improvement of rice productivity by farmers and expectations for improvement of farming activities have been carried out under the Socio-economic Survey conducted in the Study. The target irrigation systems of the Survey were Wat Chre, Wat Loung and Beoung Preah Ponley, respectively in Bakan Karavang and Sampov Meas District.

The results indicate that the primary constraints in rice farming are low paddy yield and irrigation water shortage even in wet season. Farmers expectations for farming and physical works (irrigation) are **productivity improvement of wet season rice** and **adequate irrigation water supply in wet season**, respectively.

The major findings obtained through the survey are presented in Table C-52. Major issues are discussed in the followings.

(1) Farming Constraints and Improvement Measures

Major agronomic and farm management constraints responded by sample farmers and assessed by weighted scoring method are low yield followed by poor soil conditions and crop losses due to pest & disease as follows;

Farming Constraints (agronomy/farm management) in Order of Seriousness

Agronomic & Farm Management Constraints	Total Score	Rating 1/	
Low yield	217	1	Most serious
Poor soil conditions	135	2	2nd serious
Crop losses due to pest & disease	98	3	3rd serious

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Major physical constraints responded by respondents assessed similarly are irrigation water shortage even in wet season followed by irrigation water shortage in dry season as follows;

Farming Constraints (physical) in Order of Seriousness

Physical Constraints	Total Score	Rating 1/	
Irrigation water shortage in wet season	369	1	Most serious
Irrigation water shortage in dry season	137	2	2nd serious
Lack of transportation means	28	3	3rd serious

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Major marketing constraints responded by sample farmers are assessed similarly are unstable market prices of paddy/rice followed by low market prices of paddy/rice as follows;

Marketing Constraints in Order of Seriousness

Marketing Constraints	Total Score	Rating 1/	
Unstable market prices of paddy/rice	251	1	Most serious
Low market prices of paddy/rice	162	2	2nd serious
Unstable market prices of livestock	72	3	3rd serious

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Activities or practices to improve rice productivity implemented in the past 3 years by sample farmers include increased fertilizer doses, applied compost/manure and use of quality seeds (local variety) as follows;

Activities/Practices to Improve Rice Productivity Implemented

Activities/Practices Implemented	No. of Respondents	Proportion (%)
Increased fertilization doses	101	19
Application of compost/manure	77	15
Used quality seed (local variety)	68	13

Source: Socio-economic Survey by the JICA Study team, 2007

Activities necessary to improve rice productivity raised by sample farmers and assessed by weighted scoring method are: i) improvement of farming practices, ii) use of quality seed (high yielding variety) and iii) use of adequate doses of fertilizer as follows;

Necessary Activities to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Improvement of farming practices	270	1	Most required
Use of quality seed (high yielding variety)	214	2	2nd required
Used of adequate doses of fertilizer	201	3	3rd required

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Physical works necessary to improve rice productivity raised by sample farmers and assessed similarly are: i) most required: irrigation water supply for wet season, ii) 2nd most required: irrigation water supply for dry season and iii) 3rd most required: drainage improvement.

Necessary Physical Works to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Irrigation water supply for wet season	270	1	Most required
Irrigation water supply for dry season	214	2	2nd required
Drainage improvement	94	3	3rd required

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

(2) Expectations for Improvement of Farming

Farmers expectations for improvement of farming conditions (agronomic & farm management) raised by the respondents and assessed similarly are: i) most expected: productivity improvement of wet season rice, ii) 2nd most expected: productivity increase of

dry season rice and iii) 3rd most expected: productivity improvement of field crops as follows;

Expectations for Improvement: Farming (agronomic & farm management)

Expectation for Improvement	Total Score	Rating 1/	
Productivity improvement of wet season rice	347	1	Most expected
Productivity improvement of dry season rice	115	2	2nd expected
Productivity improvement of field crops	90	3	3rd expected

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for farming system to be adopted assessed similarly are: i) most expected: double cropping of rice and ii) 2nd most expected: multiple farming composed of crop & livestock as follows;

Expectations for Improvement: Farming System

Expectation for Improvement	Total Score	Rating 1/	
Double cropping of rice	308	1	Most expected
Multiple farming (crop + livestock etc.)	160	2	2nd expected

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for physical works to be implemented assessed similarly are: i) most expected: adequate irrigation water supply in wet season, ii) 2nd most expected: adequate irrigation water supply in dry season and iii) 3rd most expected: drainage improvement as follows;

Expectations for Improvement: Physical Works

Expectation for Improvement	Total Score	Rating 1/	
Adequate irrigation water supply in wet season	362	1	Most expected
Adequate irrigation water supply in dry season	170	2	2nd expected
Drainage improvement	69	3	3rd expected

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

Agricultural support services required for improvement of agricultural productivity responded by sample farmers and assessed similarly are: i) most required: field extension services (demonstration/field guidance), ii) 2nd required: provision of quality seed and iii) 3rd required: farmer training as follows;

Expectations for Agricultural Support Services

Expectation for Improvement	Total Score	Rating 1/	
Field Extension services (demonstration / field guidance)	287	1	Most required
Provision of quality seed	212	2	2nd required
Farmer training (technical & post-harvest operation)	124	3	3rd required

1/: See Table C1-52 *Source: Socio-economic Survey by the JICA Study team, 2007*

The results of the Survey on farming practices, farm input supply and marketing are presented in Attachment C-7.

C1.4 Boribo River Basin

C1.4.1 Soils

(1) General

For investigating properties of the major soils distributed in the basin, soil profile observations and laboratory analyses of soil samples taken from the 6 representative profiles were

conducted under the present Study as explained in the section C1.1.1. The profile descriptions of the representative soils in the basin are presented in Attachment C-4.

(2) Soil Distribution and Characteristics

The soils distributed in the basin are classified at soil sub-unit level following the FAO/UNESCO classification system into 11 soil types (sub-units) as shown in Figure C1-9 and in the following table.

Soil Distribution in the Boribo River Basin

Soil Sub-unit	Distribution		Soil Sub-unit	Distribution	
	(ha)	(%)		(ha)	(%)
Gleyic Acrisol (ACg)	92,340	13	Luvic Arenosol (ARl)	680	-
Plinthic Acrisol (ACp)	23,270	3	ARl/ARh 2/	221,630	31
Areni-gleyic Acrisol (ACga)	1,560	-	Dystric Fluvisol (FLd)	40,650	6
Gleyic-plinthic Acrisol (ACpg)	10,630	1	Dystric Gleysol (GLd)	26,550	4
ACg/ACp 1/	119,750	17	LPd/CMd 3/	153,860	21
Haplic Acrisol-skeletic (Ach-C)	12,220	2	Water/Residential Area	12,260	2
			Total	715,400	100

1/: soil association of Gleyic Acrisol/ Plinthic Acrisol; 2/: association of Luvic Arenosol/Haplic Arenosol

3/: association of Dystric Leptosol/Dystric Cambisol

The soil distribution in the basin is characterized by the extensive distribution of coarse textured soils in the central part of the same and 31% of the basin is covered with sandy soils. Among the sub-units, the association of Luvic Arenosol and Haplic Arenosol (ARl/ARh), sandy soil, is dominant soil followed by the association of Plinthic Acrisol/Gleyic Acrisol.

Distributions and characteristics of the soils are discussed in the following sections. The results of the soil analysis are presented in Table C1-53 and the descriptions of the typical soil profiles are presented in Attachment C-4.

(a) Gleyic Acrisol (mapping symbol: ACg)

The soil is mostly distributed in the southern end of the basin. Majority of lands distributed with this soil are used as paddy fields and rice cultivation under transplanting system is prevailing practices in such fields. However, substantial parts the lands distributed with the same are left unused under shrub or grass cover. Its distribution accounts for 92,340 ha or 13% of the basin.

The soil has medium to fine textured surface layer (SL~LiC) underlain with finer textured sub soils (LiC to HC). In medium textured soil, surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The medium textured soil is very friable when moist and quite easy to crash by fingers. The effective depth of the soil is deep and no plinthite layer is encountered within 100 cm from the surface. The surface soils of the representative profiles have acid reaction (pH) and low to moderate soil fertility judged from moderate total nitrogen, moderate to low cation exchange capacity (CEC) and high exchangeable potassium.

(b) Plinthic Acrisol (mapping symbol: ACp)

The soil is distributed limitedly in a scattered manner in the southern end of the basin.

Majority of lands distributed with this soil are used as paddy fields and rice cultivation under transplanting system is prevailing practices in such fields. However, parts the lands distributed with the same are left unused under shrub or grass cover. Its distribution accounts for 23,270 ha or 3% of the basin.

The soil generally has medium textured surface layer (SL~L) underlain with finer textured sub soils. The soil is very friable when moist and quite easy to crash by fingers. The effective depth of the soil is deeper than 80cm and plinthite layers are encountered in sub-soils at different depth. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from moderate total nitrogen, low cation exchange capacity (CEC) and moderate exchangeable potassium.

(c) Areni-gleyic Acrisol (mapping symbol: ACga)

The soil is distributed limitedly in the basin and the distribution of the same is only 1,560 ha or 0.2% of the basin.

The soils generally have coarse to medium textured layers (LS~SL). Surface soils are highly weathered and have weak cohesion capacity because of leaching out of cementing materials as base, organic matter and silica. The effective depth of the soils is deeper than 80cm and plinthite layers are not encountered within 100cm from the surface.

The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from moderate total nitrogen, low cation exchange capacity (CEC) and low exchangeable potassium.

(d) Gleyic-plinthic Acrisol (mapping symbol: ACpg)

The soil is distributed to a limited extent along the Tonle Sap River in the southern end of the basin and its distribution is only 10,630 ha or 1% of the basin.

The soil appears to have similar properties to the properties of Gleyic Acrisol and Plinthic Acrisol and generally have coarse to medium textured layers. The effective depth of the soil is deep and depth to plinthite layers is variable depending on locations. Fertility of the surface soils is estimated to be low from the properties of the said soils (ACp & ACg).

(e) Gleyic Acrisol/Plinthic Acrisol (mapping symbol: ACg/ACp)

The soil association is distributed in the western and central part of the basin. Majority of lands distributed with this soil are mostly used as paddy fields and rice cultivation under transplanting system is prevailing practices in such fields. However, parts of the lands distributed with the same are left unused under shrub cover. Its distribution accounts for 119,750 ha or 17% of the basin.

(f) Luvic Arenosol/Haplic Arenosol (mapping symbol: ARl/ARh)

The soil association is distributed extensively in the piedmonts to lowland areas in the central part of the basin. Majority of lands distributed with this soil are covered by shrub or grass. While, part of the lands were developed as paddy fields and rice cultivation under transplanting system is prevailing practices in such fields. The distribution of the soil accounts for 221,630 ha or 31% of the basin.

Luvic Arenosol (ARl) has coarse textured surface soils (S) and coarse to medium textured sub-soils (S~LS). The effective depth of the soils is deep. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from low total nitrogen, low cation exchange capacity (CEC) and low exchangeable potassium.

Haplic Arenosol (ARh) has coarse textured surface and sub-surface soils (S). The effective depth of the soils is deep. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility judged from low total nitrogen, low cation exchange capacity (CEC) and low exchangeable potassium.

(g) Dystric Fluvisol (mapping symbol: FLd)

The soil is distributed in seasonally inundated areas along the Tonle Sap River. Most of the lands having the soil cover are left unused under shrub cover. Its distribution accounts for 40,650 ha or 6 % of the basin.

The soil has a medium textured surface layer (SL~L) and finer textured sub-surface layers (SCL~LiC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate soil fertility, judged from moderate total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(h) Dystric Gleysol (mapping symbol: GLd)

The soil is distributed in seasonally inundated areas along the bank of Tonle Sap River. The lands distributed with the soils are covered with flooded shrub or grassland and any agricultural use of the lands could not be conceived under current conditions. Its distribution accounts for 26,550 ha or 4% of the basin.

The soil has fine textured layers in the entire profile (SiC~HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and moderate to high soil fertility, judged from moderate to high total nitrogen, moderate cation exchange capacity (CEC) and high exchangeable potassium.

(i) Dystric Leptsol/Dystric Cambisol (mapping symbol: LPd/CMd)

The soil association of Dystric Leptsol and Dystric Cambisol cover almost all the mountain areas and lands distributed with this soil association are almost exclusively under forest cover. Their distribution accounts for 153,860 ha or 21% of the basin.

The texture of Dystric Leptsol (LPd) is medium to fine and its effective soil depth is depending on location, however, the depth is generally shallow underlain with bed rocks. The surface soils of the representative profiles have acid to neutral reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

The texture of Dystric Cambisol (CMd) is depending on location and varies from coarse to fine textured (LS to HC) and the effective soil depth is deep. The surface soils of the representative profiles have acid reaction (pH) and low soil fertility, judged from moderate to high total nitrogen, moderate to low cation exchange capacity (CEC) and moderate to low exchangeable potassium.

C1.4.2 Land Suitability

(1) General

The land suitability classification of the river basin for rice and upland crops production has been made by applying the method proposed in the Framework for Land Evaluation (FAO, 1976). For the classification, 3 land characteristics for classification in case of rice and 4 land characteristics in case of upland crops are selected as explained in the section C1.1.2. The criteria applied for the present preliminary land suitability classification and the structure of the suitability classification employed are also discussed in the section.

(2) Suitability Classification

Aiming at examining suitability of the soils in the basin for rice and upland crops cultivation, the classification of the soils has been made independently based on the criteria set for soil related land characteristics. The results of the classification are presented in Table C1-54 and C1-55 in detail and C1-56 in a summarized manner and as shown in the following tables.

Suitability Classification of Soils for Rice Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	Distribution (%)	Soil Sub-unit	Suitability Sub-class	Distribution (ha)	Distribution (%)
Gleyic Acrisol	S3c	92,340	13	Luvic Arenosol	S4/N	680	-
Plinthic Acrisol	S3c	23,270	3	ARl/ARh 2/	S4/N	221,630	31
Areni-gleyic Acrisol	S3c	1,560	-	Dystric Fluvisol	S2c/S2tc	40,650	6
Gleyic-plinthic Acrisol	S3	10,630	1	Dystric Gleysol	S2tc	26,550	4
ACg/ACp 1/	S3c	119,750	17	LPd/CMd 3/	S2 - N	153,860	21
Haplic Acrisol-skeletic	S3	12,220	2	Others 4/		12,260	2
				Total		715,400	100

1/: soil association of Gleyic Acrisol/ Plinthic Acrisol; 2/: association of Luvic Arenosol/Haplic Arenosol
3/: association of Dystric Leptosol/Dystric Cambisol 4/: water surface/residential area

As shown in the table, 36% of the lands in the basin distributed with Acrisol are classified as marginally suitable (S3) for rice production and 10% of the lands are moderately suitable (S2). The paddy fields distributed with the soil association of Luvic Arenosol and Haplic Arenosol are classified as conditionally suitable (S4) as land use conversion to other more productive agricultural use is not conceivable. However, the lands of other land use categories than paddy field and distributed with the association are classified as not suitable. The remaining 21% of lands are classified into moderately suitable to not suitable (S2 to N) depending on effective soil depth of lands, therefore, depending on locations.

Suitability Classification of Soils for Upland Crops Production

Soil Sub-unit	Suitability Sub-class	Distribution (ha)	Distribution (%)	Soil Sub-unit	Suitability Sub-class	Distribution (ha)	Distribution (%)
Gleyic Acrisol	S3c/S3tc	92,340	13	Luvic Arenosol	S4/N	680	-
Plinthic Acrisol	S3c/S3tc	23,270	3	ARl/ARh 2/	S4/N	221,630	31
Areni-gleyic Acrisol	S3c	1,560	-	Dystric Fluvisol	S2tcp/S3t	40,650	6
Gleyic-plinthic Acrisol	S3	10,630	1	Dystric Gleysol	S3t	26,550	4
ACg/ACp 1/	S3c/S3tc	119,750	17	LPd/CMd 3/	S2 ~ N	153,860	21
Haplic Acrisol-skeletic	S3	12,220	2	Others 4/		12,260	2
				Total		715,400	100

1/: soil association of Gleyic Acrisol/ Plinthic Acrisol; 2/: association of Luvic Arenosol/Haplic Arenosol
3/: association of Dystric Leptosol/Dystric Cambisol 4/: water surface/residential area

As shown in the table, 46% of the lands in the basin are classified as moderately suitable (S2) or marginally suitable (S3) for upland crops production. However, the lands distributed with Arenosol (31%, sandy soil) are classified as not suitable (N) or into conditionally suitable (S4) when subject lands are used as paddy fields or upland fields. Further, 21% of the lands are classified as moderately suitable (S2) to not suitable (N) depending on effective soil depth of lands, therefore, depending on locations.

C1.4.3 Present Land Use

(1) Methodology

The present land use of the river basin was studied by using the land use maps with 32 land use categories prepared by the JICA Study Team (2001 ~ 2003). In the present Study, the number of land use categories was simplified into 12 categories by combining similar land use categories in the original maps as is the case in the other river basins. The simplified land use maps were prepared at a scale of 1/100,000 and reduced to A4 size for reporting purpose.

(2) Present Land Use

The land uses of the basin are characterized by the extensive shrub cover occupying about 28 % of the whole area and stretching from the mountain piedmonts to low land areas. Paddy field (28%) is distributed in intermediate to low land areas in the whole basin except in mountain areas. The total agricultural land is some 245,400 ha or 34% of the basin. The substantial extent of receding & floating rice fields (17,000 ha) is found along the Tonle Sap River. Forest area occupies about 27% of the basin extending in the western part of the basin. The extents of other land uses are rather limited including grassland, flooded shrub/forest and water surface. The present land use of the basin is illustrated in Figure C1-10 and summarized in the following table.

Present Land Use of the River Basin

Land Use Category	Area (ha)	Area (%)	Land Use Category	Area (ha)	Area (%)
Paddy Field	198,270	28	Shrubland	203,590	28
Receding/Floating Rice Fields	16,980	2	Forest	191,570	27
Field Crop Land	5,340	1	Flooded Shrub/Forest	15,050	2
Garden Crop Land	24,490	3	Others 2/	20,280	3
Grassland	39,830	6	**Total**	**715,400**	**100**

1/: including watersurfac/ built-up area etc . *Source: JICA Study Team*

The descriptions of individual land use categories are briefed as follows;

(a) Paddy Field

This category of land represents 198,270 ha or 28% of the basin extending in the middle to lower basin. Most of paddy fields in the basin are rainfed fields and the same located in the irrigated schemes are rather limited; some 49,000 ha or 25% of the total paddy field according to the Inventory Survey conducted by JICA in 2006. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins. This category of land includes limited extent of paddy field in village zones, some 6,000ha or 3% of total. Prevailing rice cultivation method is transplanting and prevailing cropping pattern is a single cropping of rice

in the wet season. Area under receding or floating rice cultivation is limited to 590 ha.

(b) Receding & Floating Rice Fields

This category of land use is found in a scattered manner along the Tonle Sap River and the extent of the same in the basin is by far the largest among the target four basins. From crop statistics of MAFF, almost all lands of this category are classified as receding rice fields.

(c) Field Crop Land

The field crop land is 5,340 ha or 1% of the basin and found in a scattered manner in the central to southern part of the basin. Major crops cultivated in the land include corn, beans and cassava in wet season.

(d) Garden Crop Land

Garden crop land in the basin accounts for 24,490 ha or 3% of the basin and is the largest among the four target basins. The land category includes two sub-categories of garden crop field and village garden crop field. The distributions of these are mostly found in Boribo and Kampung Chhnang District. Nearly 90% of this category of land is the village garden crop field and net areas of garden crop fields might be far lower than the present land use figure. Major crops cultivated in the lands are vegetables and upland crops mainly in dry season.

(e) Forest

This category of land occupies 191,570 ha or 27% of the basin and extends mostly in mountain areas in the western part of the basin. The category of land includes 6 sub-categories of forest. Major one is deciduous forest followed by evergreen broad leafed forest.

(f) Shrubland

This category of land accounts for 203,590 ha or 28% of the basin and extends in the entire basin except in mountain areas. The category of land includes 3 sub-categories of shrubland, woodland & scattered trees and abandoned field covered by shrub. However, the sub-category of shrubland is representing and occupies 64% of total.

C1.4.4 Agro-demography and Land Holding

Some agro-demographic and land holding features in the basin identified based on the Commune Survey on Crops & Livestock, 2003, MAFF are presented in Table C1-57 and summarized in the following table.

Agro-demographic Features in the Basin in 2003

Items	Features
No. of Households (total)	168,378
No. of Farm Households (No. of crop producing households)	155,336
% of Farm Households to Total Households	92 %
%. of None Farm Households (No. of none crop producing households)	8 %
% of Farm Households Producing Wet Season Rice	70 %
% of Farm Households Producing Dry Season Rice	10 %
Total Population (in 2005, SEILA Data Vase)	230,291
Average Family Size (in 2005, SEILA Data Vase)	5.2

Source: Commune Survey on Crops & Livestock, 2003, MAFF & SEILA Commune Data Base, 2005

When assuming that number of farm households is accounted by number of crop producing households, farm households in the basin is calculated at 92% of the total households and none-farm households are estimated at 8%. Only 70% of the farm households (crop producing households) are producing wet season rice. However, farm households producing dry season rice account for 10% of the same. According, it is estimated that about 80% of farm households are growing rice since double cropping of rice is seldom in the basin. Average family size is estimated at 5.2 members.

The access to data/information on land tenure was rather limited in the present Study. However, the Commune Survey, MAFF provides some information on the land tenure and holding statuses as shown in Table C1-57 and summarized in the following table.

Land Holding Features of the Communes in the Basin in 2003

Indicator	Features
No. of None Farm Households (No. of none crop producing households)	13,042
No. of Landless Households	11,525
No. of Landless Households - No. of None Farm Households	-1,517
Wet Season Rice Cropped Area in 2003	135,785 ha
No. of Households Producing Wet Season Rice in 2003	118,007
Rice Cropped Area per Farm Household in Wet Season (200)	1.2 ha
%. of Farm Households with Holding Size Less Than 10a	7 %
% of Farm Households with Holding Size More Than 3ha	0.1 %
% of Landless Households	0.1 %

Source: Commune Survey on Crops & Livestock, 2003, MAFF

As shown in the table, all the farm households in the basin appear to have some farmland and, from the rice cropped area in wet season, average holding size of paddy field per farm household is roughly estimated at 1.2ha. Proportion of land holding households having less than 0.1ha is calculated at 0.1% and the same of more than 3ha is also at 0.1%.

The number of landless households calculated at 0.1% of the total households is nearly equal to the number of none crop producing households. Therefore, the landless figure might represent non-farm households domiciling in the basin, especially in urban areas and number of landless farm households might be limited.

C1.4.5 Rice Production

(1) General

Rice production is the most important agricultural activities in the basin and rice cultivation in 2003 was practiced by about 80% of farm households. Rice production in the basin is characterized by low and unstable productivity under rainfed conditions. Further, the same as a whole is characterized by a single cropping of rice mostly under transplanting method. Rice cultivation in dry season is about 11% of annual cropped area and the same in early wet season is extremely limited. Such off-season cultivation is practiced in some irrigated fields and recession paddy fields. Floating/deep water rice cultivation area was some 2,000 ha in 2003 and is practiced in low lying seasonally inundated areas.

Even in irrigated fields, the cultivation is mostly carried out under nearly rainfed conditions

because of unstable and limited water supply. Further, prolonged rice cultivation season continuing form May/June to October/December with the cultivation of rice varieties of different growth durations of early to late and traditional farming practices are other characteristics of the rice production in the basin.

(2) Cropping Season and Variety

Rice cropping seasons in the basin consists of: i) wet season rice grown from May/June to October/December both in rainfed and irrigated area and ii) dry season rice cultivated from November/December to February/March both in irrigated and recession fields and February/March to June/July in recession fields.

In the basin, a number of rice varieties are cultivated and cropping seasons vary substantially depending on varieties grown. Traditional local varieties other than those selected by CARDI are called by local names and same varieties might be named differently depending on locations. Currently cropped traditional local varieties appear to have been selected by farmers in the past and have some characteristics suited to local agro-climatic conditions such as tolerance to drought and inundation. Major varieties grown in the basin are as follows;

Major Varieties Grown in the Basin

Season	Growth Duration	Variety
Wet Season	Medium	Phka Rumduol, Chma Prom,
	Late	CAR 5, Kupo Dom, Keng Khnol
Dry Season	Early	IR 66, Sen Pidao (promising variety), IR 42

(3) Cropping Calendar and Pattern

The prevailing cropping calendar in the basin is depending on planting method and varieties grown as follows;

Prevailing Cropping Calendar

Season	Planting Method	Duration	Cropping Calendar
Wet Season	Transplanting	Early	Transplanting – Harvest: May. – July
		Medium	Transplanting – Harvest: June/July – Nov./Dec.
		Late	Transplanting – Harvest: June/July – Dec./Jan.
	Direct Sowing (limited extent)	Early	Sowing – Harvest: Apr. – July
		Medium	Sowing – Harvest: May/June – Nov./Dec.
		Late	Sowing – Harvest: May/June – Dec./Jan.
Dry Season	Direct Sowing	Early	Nov./Dec. – Mar./April & Feb./Mar. – June/July
	Transplanting	Early	Dec./Jan. – Mar./April. & Mar./April – June/July

A single cropping of wet season rice is an exclusive cropping pattern both in rainfed and irrigated fields, while a double cropping of wet and dry season rice is also carried out in irrigated fields in limited extent. In recession fields, a single cropping of dry season rice is exclusive. No other crops than rice are cultivated in paddy fields. Copping patterns in the basin are summarized as follows;

Prevailing Cropping Patterns

Field	Cropping Pattern	Note
Irrigated Field	Single cropping of wet season rice	Predominant pattern
	Double cropping of wet season rice + dry season rice	Limited in extent
Rainfed Field	Single cropping of wet season rice	Exclusive pattern
Recession Field	Single cropping of dry season rice	Only in recession field

(4) Cropped Area and Production

(a) Cropped Area and Cropping Intensity

Cropped area and cropping intensity of rice in the basin communes are roughly estimated based on the crop statistic of PDA/MAFF and by assuming that a total of wet season cropped areas and dry season cropped is equal to total areas of paddy fields as shown in Table C1-58 and as summarized in the following table.

Cropped Area & Cropping Intensity of Rice 1/

Cropping Season	Cropped Area	Intensity
Wet Season	141,691 ha	90 %
Dry Season	15,703 ha	10 %
Annual	157,394 ha	100 %

1/: Roughly estimated figures *Source: PDAs/MAFF*

As shown in the table, the overall cropping intensity of rice in the paddy fields in the basin communes is estimated at 90% in wet season, 10% in dry season and 100 % annually.

(b) Paddy Yield and Production

Yield and production of paddy in the basin communes are estimated on the basis of the statistic data of MAFF and PDAs and SEILA Data Base as shown in Table C1-58 and C1-59 as summarized in the following table.

Rice Yield & Production in the Basin 1/

Source	Season	Average Paddy Yield to:		Production
		Cropped Area	Harvested Area	
PDA/MAFF Statistics	Wet Season	1.6	1.6	232,600 ton
	Dry Season	3.2	3.2	56,300 ton
	Annual			288,900 ton
SEILA data base	Wet Season	1.3	-	
	Dry Season	1.8	-	

1/: Figures of the basin communes; not including Kandal *Source: PDAs/MAAF & SEILA Data Base*

Some differences in paddy yield levels between the data sources are noticed as shown in the tables. On the basis of such information, current yield levels under rainfed conditions in the basin are estimated at around 1.0 ton/ha in direct sowing and 1.5 in transplanting in wet season. In fully irrigated fields, yield levels are higher than those figures, however, the area extent of fully irrigated fields is extremely limited in the basin. Annual production of rice in the basin communes is estimated at around 289,000 tons.

(5) Prevailing Farming Practices

Farming practices in the basin are characterized by: i) prevailing of transplanting method to direct sowing method and prevailing of mechanical land preparation to land preparation by draft animal.

(6) Food Balance

The food balance of rice in the basin was examined by applying the method adopted in the food balance sheet of MAFF. The result indicates surplus of some 55,000 tons of milled rice in the basin as shown in the following table.

Food Balance of Rice in the Basin 1/

Population in 2005	Milled Rice Production	Rice Requirement	Balance
724,403	160,863	106,164	54,699

1/: Population in 2005 (SILA) & crop statistics of PDA & MAFF

2/: (production –13% of post-harvest losses & seed requirements) x milling recovery rate (64%)

(7) Weaknesses of Rice Production in the Target Area

The weaknesses of rice production in the basin are partly attributed to the distribution of paddy fields in areas covered with sandy soils. However, most of the weaknesses are almost similar to those in the other river basins as enumerated in the followings.

- Unstable and low productivity of rice primarily attributed to limited and unstable availability of water, unstable rainfall distribution and poor soil conditions,
- Rainfed rice cultivation with poor and unstable productivity remaining as a mainstay in farming activities,
- Prevailing farming practices characterized by use of traditional varieties, continuous use of self produced seeds, high seeding rate, aged seedlings, random planting, limited application of fertilizer, inadequate post-harvest practices, etc.,
- Single cropping of rice and annual low land use intensity at nearly 100%, and
- Farmers preference for medium or late traditional varieties resulted in prolonged cropping season.

(8) Rice Cultivation in Irrigation Systems

The results of the Inventory Survey, 2006, JICA indicate existence of 159 irrigation systems in the basin. Prevailing cropping calendar & pattern and cropping intensity are presented in Table C1-60 and C1-61 and summarized below.

Agricultural Features of Irrigation Systems in the Basin

Item	Agricultural Features of Irrigation Systems
No. of Irrigation Systems	Pursat Prov.: 15; Kg. Chhnamg Prov.: 114; Kg. Speu Prov.: 11; Kandal Prov.: 19; Total: 159
Area of Irrigated Paddy Fields	49,352 ha (including recession fields of 2,935 ha)
Rice Cropped Area & Intensity	Wet season: 46,872 ha & intensity 90%
	Dry season: 7,310 ha & intensity 14% (including recession rice)
	Recession field (dry season): 3,005 ha & intensity 100%
	Annual: 54,332 ha & intensity 104%
Yield information reported	2.2 ton/ha in wet season in supplemental irrigation fields, 1.0 ton/ha in rainfed fields.(Lum Hack System)

Source: The Inventory Survey report

Paddy fields in the command areas of the irrigation systems in the basin account for about 25% of the total paddy field. However, their irrigation statuses vary from limited extent of fully irrigated to majority of supplemental irrigation fields or fields under rainfed conditions as is the case in the other basins.

Other major agronomic features in the systems identified from the Inventory Survey report are enumerated as follows;

Cropping Calendar & Variety

- Prevailing cropping calendar (from sowing in field or nursery to harvest) is May./June to Nov./Dec. (medium & late variety) ,
- Variety grown is medium/late varieties in wet season and early variety in dry & early wet season.

Cropping Pattern & Intensity

- Single cropping of wet season rice is prevailing pattern and number of systems where double cropping of rice is carried out is only 5 systems among 159 systems, however, the extent of dry season rice cropped fields is 7,310 ha partly because of the existence recession fields where only dry season cropping is practiced,
- No other crops than rice is cultivated in paddy fields in the systems, and
- Cropping intensities of individual systems are in the range of 100 to 133%, which obtained in a system of irrigation area of 900 ha; and overall intensity as a whole is only 104%.

Planting Methods

- Transplanting is prevailing method in the systems.

Yield Levels

- Yield levels reported in the supplementary survey conducted by the Study Team are 2.2 ton/ha in wet season in supplemental irrigated fields and 1.0 ton/ha in rainfed fields (yield level at Lum Hack System).

C1.4.6 Production of Other Crops

Compared with rice production, productions of upland crops are extremely limited in the basin as shown in Table C1-62 and summarized in the following table.

Cropped Area of Major Upland Crops in the Basin

Crops	Area (ha)	(%)	Crops	Area (ha)	(%)
Corn	813	24	Cassava	458	13
Soybeans	0	-	Sweet Potato	794	23
Mungbeans	842	25	Sesame	38	1
Groundnut	478	14	Total	3,422	100

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

As shown in the table, cropped areas of upland crops are about 2% of annual rice cropped area of 157,000ha. Major upland crop is mungbeans followed by corn, sweet potato and groundnut although area extent is extremely limited. Major producing district of such crops in the basin is Baribor of Kampung Chhnang Province and Odongk and Thpong of Kampung Speu Province. Predominant cropping season of upland crops is wet season and cultivation in dry season is rather limited. Further, cultivation of upland crops in paddy fields is seldom practiced. Yield levels of upland crops are low compared with those of the Battambang and Moung Ruessei River Basins.

Annual cropped area of vegetables is estimated at only around 1,800ha in the basin as shown in Table C1-63. Major vegetables include cucumber, tomato, morning glory, Chinese cabbage and string beans. Major cropping season of vegetables in the basin is dry season and major cropped areas of vegetables are levees along the Tonle Sap River and farm lands (home garden) in villages.

Major fruit trees found grown are cashew, banana, coconut and mango, although the planted area as a whole is extremely limited at some 2,100 ha as shown in Table C1-64.

C1.4.7 Farm machinery and Equipment

The inventory on farm machinery and equipment in the districts located in the basin is presented in the following table.

Inventory of Farm Machinery in the Basin Districts in 2006 1/

Tractor	Hand Tractor	Water Pump	Engine Thresher	Rice Mill	
				Small	Heavy
11	1,604	8,490	93	2,380	25

1/: not including figures of 2 districts in Kandal Province
Source: Department of Agricultural Machinery, MAFF

Mechanical land preparation works for rice cultivation are predominant practices in the basin, The number of rice mills appears to be more than sufficient for milling demand in the basin because marketing of paddy is commonly carried out in the form of unhusked rice.

C1.4.8 Livestock

Livestock sub-sector is an important agricultural activity for farm economy and provides an essential source of draft power and manure for farming in the basin. Accordingly, a substantial number of animals and poultry are raised in the basin and majority of farm families hold some kind of animals as shown in Table C1-65 and as summarized below.

Livestock Population & Holding Status in the Basin in 2003

Item	Cattle	Cow	Draft Cattle	Buffalo	Pig
Population	304,932	85,132	128,180	55,739	147,799
Holding Size/Family	2.0	0.5	0.8	0.4	1.0

Source: Commune Survey on Crops & Livestock, 2003, MAFF

From the table, an average holding size of cattle, cow, draft cattle, buffalo and pig in 2003 is calculated at 2.0, 0.5, 0.8, 0.4 and 1.0 heads per farm household, respectively, equivalent to animal units of 2.3 in total. The holding size of poultry is calculated at 1.0 per farm family. However, as the statistic figures include livestock & poultry hold by commercial farms, an actual holding size per farm is lower than the said estimates. Distribution of animal population is high in Kampong Tralach, Rolea B'er, Sameaki Mean Chey of Kampung Chhnang Province and Odong of Kampung Speu Province.

Expansion of areas under mechanical land preparation for rice production is reported in the basin, however, no information on its share was not accessible.

C1.4.9 Marketing

From food balance calculation, annual marketing of some 50,000 tons of paddy by producers (farmers) are estimated in the river basin. The prevailing marketing channels of paddy in the

basin are similar to the same in the other basins. In the prevailing channel, at the first level, farmers sell rice to the local collectors. The local collectors market rice to the wholesalers or to the rice millers. The wholesalers sell rice further to the traders/large scale wholesalers in/from Phnom Penh or other provinces.

Because of limited market volume by individual farmers, farmers have little bargaining power in price setting as is the case in the other basins. Major constraints for paddy marketing identified through the Socio-economic Survey are unstable market prices of paddy followed by low market prices of paddy. In the same Survey, no serious constraint for market destination is reported.

C1.4.10 Agricultural Support Services

(1) Institutions

The government institutions involved in agricultural support services at the river basin level are PDA Kampung Chhnang, Pursat, Kampung Speu and Kandal. The organization structure of the PDA Kampung Chhnang is shown in Figure C1-11.

PDA is a provincial level agricultural agency under the provincial government and is an agency responsible for agricultural development and provision of agricultural supporting services at province, district, commune and village levels. As shown in the figure, the PDA Kanpong Chhnang is composed of 7 technical offices and two planning/administrative offices. Total number of staffs including district level staffs is 197 (skilled 99 & non-skilled 98).

PDA has its branch offices at district level called District Agricultural Office (DAO) and in total of 5 DAOs in Kampung Chhnang, 2 DAOs in Kampung Speu and 2 DAOs in Kandal are deployed in the basin.

A number of international and bilateral cooperation organizations and NGOs are involved in agricultural sector support activities in and around the basin. Major activities of the international organizations include the same of ADB and EU.

(2) Current Support Activities

Current major agricultural support activities in the river basin are ASDP by ADB and SLPP by EU. In addition, agricultural support activities under NCCD are also implemented by PDAs.

C1.4.11 Rural Credit

Major formal operators of rural credit in the river basin are ACLEDA Bank, AMRET and PRASAC. The numbers of branch (province level) and sub-branch offices (district level) of them operated in the basin are as follows;

Deployment of Branch & Sub-branch Offices of ACLEDA & MFIs

Institute	Branch Offices	Sub-branch Offices
ACLEDA	3	9
AMRET	1	4
PRASAC	1	4

Source: ACLED Bank Plc, AMRET Co. Ltd. & PRASAC Micro Finance Institution

Some terms and conditions of ACLEDA Bank and AMRET for farm credit or micro credit for individual are as follows;

Terms & Conditions for Farm Credit for Individual of ACLEDA Bank and AMRET

Institute	Credit period & interest rate		Conditions
ACLEDA	6 months < R.400,000; 3.25%/month	12 months R.400,000 – 6million; 3.5%/month	Provision of collateral & guarantee
AMRET	3 – 12 months; 3.5%/month R. 600,000 – 1,000,000	3 – 18 months; 3.5%/month R. 1,000,000 – 2.,500,000	

Source: ACLED Bank Plc & AMRET Co. Ltd.

Further, several NGOs are providing micro credit services in the river basin. However, non-institutional credit providers such as money lenders, rice miller, farm input suppliers and relatives or friends might continue to be an important source of rural credit.

The results of the Socio-economic Survey on farm credit are presented below.

Results of Socio-economic Survey on Farm Credit

Enquiry	Proportion by Reponses	Respondents No.
Access to farm credit	Easy: 22%; difficult: 16%, not received: 62%	120
Amount of credit	Sufficient: 19%; insufficient: 19%; not received: 62%	107
Timing of provision	In time: 23%; delayed: 13%; not received: 64%	120
Procedures for credit application	Easy: 13%; difficult: 19%, not received: 68%	120

Source: Socio-economic Survey in the Project Area by the JICA Study team, 2007

C1.4.12 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition, farm economic analysis of preliminary nature on a typical farm was made based on the results of the Socio-economic Survey and the crop budget analysis on the current paddy production Table C1-66).

(1) Typical Farm

Majority of paddy fields in the river basin are categorized into rainfed paddy fields or fields nearly under rainfed conditions. Accordingly, farm family having rainfed paddy fields or fields nearly under rainfed conditions in irrigation systems was selected as a typical farm for the present farm economic analysis.

On the basis of the average holding size of paddy fields per farm family estimated in the section C1.4.4, the typical farm for the present farm economic analysis is defined as follows;

Typical Farm

Irrigation Status	Holding Size 1/
Rainfed paddy field or fields nearly under rainfed conditions in irrigation systems	1.2 ha/family

1/: holding size of paddy field assumed

(2) Present Capacity to Pay

The present farm economy of the typical farms are estimated based on the results of the Socio-economic Survey and the crop budget as shown in Table C1-67 and as shown in the following table.

Present Farm Economy (unit: 1000 Riel)

Item		Amount
Gross Incomes	Rice Production 1/	1,008
	Other Farm Income	422
	Non-farm Income	543
	Total Income	1,973
Expenditures	Production Costs of Farm Products	707
	Other Expenditures	1,144
	Total Expenditures	1,851
Net Surplus		122

1/: Transplanting assumed *Source: JICA Study Team*

As shown in the table, the current net surplus (capacity to pay) is estimated at a marginal level of Riel 122,000 (US$ 30) or 6% of the total gross incomes of the typical farm.

C1.4.13 Results of Socio-economic Survey

Under the present Study, the agro-economic survey aiming at identifying problems and constraints for irrigated farming, activities implemented for improvement of rice productivity by farmers and expectations for improvement of farming activities have been carried out under the Socio-economic Survey conducted in the Study. Note: Target irrigation systems of the Survey were Taram & Khvet in Teuk Phos District and Lum Hach in Boribo District.

The results indicate that farmers expectations for farming and physical works (irrigation) are **productivity improvement of wet season rice** and **adequate irrigation water supply in wet season**, respectively.

The major findings obtained through the survey are presented in a narrative manner in Table C1-68. Major issues are discussed in the followings.

(1) Farming Constraints and Improvement Measures

Major agronomic and farm management constraints responded by sample farmers and assessed by weighted scoring method are low yield followed by poor soil conditions and labor shortage as follows;

Farming Constraints (agronomy/farm management) in Order of Seriousness

Agronomic & Farm Management Constraints	Total Score	Rating 1/	
Low yield	200	1	Most serious
Poor soil conditions	123	2	2nd serious
Labor shortage	117	3	3rd serious

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Major physical constraints responded by respondents assessed similarly are irrigation water shortage even in wet season followed by irrigation water shortage in dry season as follows;

Farming Constraints (physical) in Order of Seriousness

Physical Constraints	Total Score	Rating 1/	
Irrigation water shortage in wet season	309	1	Most serious
Irrigation water shortage in dry season	107	2	2nd serious
Lack of transportation means	36	3	3rd serious

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Major marketing constraints responded by sample farmers are assessed similarly are unstable market prices of paddy/rice followed by low market prices of paddy/rice as follows;

Marketing Constraints in Order of Seriousness

Marketing Constraints	Total Score	Rating 1/	
Unstable market prices of paddy/rice	208	1	Most serious
Low market prices of paddy/rice	83	2	2nd serious
Low market prices of livestock	63	3	3rd serious

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Activities or practices to improve rice productivity implemented in the past 3 years by sample farmers include application compost/manure, increasing fertilizer doses and use of quality seeds (local variety) as follows;

Activities/Practices to Improve Rice Productivity Implemented

Activities/Practices Implemented	No. of Respondents	Proportion (%)
Application of compost/manure	79	16
Increasing fertilizer doses	71	15
Used quality seed (local variety)	62	13

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Activities necessary to improve rice productivity raised by sample farmers and assessed by weighted scoring method are: i) improvement of farming practices, ii) use of quality seed (high yielding variety) and iii) use of quality seed (local variety) as follows;

Necessary Activities to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Improvement of farming practices	256	1	Most required
Use of quality seed (high yielding variety)	201	2	2nd required
Use of quality seed (local variety)	174	3	3rd required

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Physical works necessary to improve rice productivity raised by sample farmers and assessed similarly are: i) most required: irrigation water supply for wet season, ii) 2nd most required: irrigation water supply for dry season and iii) 3rd most required: drainage improvement as follows;

Necessary Physical Works to Improve Rice Productivity

Activities/Practices Required	Total Score	Rating 1/	
Irrigation water supply for dry season	321	1	Most required
Irrigation water supply for wet season	150	2	2nd required
Drainage improvement	118	3	3rd required

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

(2) Expectations for Improvement of Farming

Farmers expectations for improvement of farming conditions (agronomic & farm management) raised by the respondents and assessed similarly are: i) most expected: productivity improvement of wet season rice, ii) 2nd most expected: productivity improvement of field crops and iii) 3rd most expected: productivity improvement of dry season rice as shown in the following table.

Expectations for Improvement: Farming (agronomic & farm management)

Expectation for Improvement	Total Score	Rating 1/	
Productivity improvement of wet season rice	332	1	Most expected
Productivity improvement of field crops	91	2	2nd expected
Productivity improvement of dry season rice	77	3	3rd expected

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for farming system to be adopted assessed similarly are: i) most expected: double cropping of rice and ii) 2nd most expected: multiple farming composed of crop & livestock as follows;

Expectations for Improvement: Farming System

Expectation for Improvement	Total Score	Rating 1/	
Double cropping of rice	290	1	Most expected
Multiple farming (crop + livestock etc.)	135	2	2nd expected

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Farmers expectations for physical works to be implemented assessed similarly are: i) most expected: adequate irrigation water supply in wet season, ii) 2nd most expected: adequate irrigation water supply in dry season and iii) 3rd most expected: drainage improvement as follows;

Expectations for Improvement: Physical Works

Expectation for Improvement	Total Score	Rating 1/	
Adequate irrigation water supply in wet season	315	1	Most expected
Adequate irrigation water supply in dry season	137	2	2nd expected
Drainage improvement	92	3	3rd expected

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

Agricultural support services required for improvement of agricultural productivity responded by sample farmers and assessed similarly are: i) most required: field extension services (demonstration/field guidance), ii) 2nd required: provision of quality seed and iii) 3rd required: farmer training as follows;

Expectations for Agricultural Support Services

Expectation for Improvement	Total Score	Rating 1/	
Field Extension services (demonstration / field guidance)	270	1	Most required
Provision of quality seed	190	2	2nd required
Farmer training (technical & post-harvest operation)	137	3	3rd required

1/: See Table C1-68 *Source: Socio-economic Survey by the JICA Study team, 2007*

The results of the Survey on farming practices, farm input supply and marketing are presented in Attachment C-8.

CHAPTER C2 AGRICULTURAL DEVELOPMENT CONCEPT

C2.1 Constraints for Agricultural Development and Proposed Development Directions

On the basis of the findings discussed in the preceding chapters and the results of the Socio-economic Survey on farming constraints, improvement measures and expectations as discussed earlier basin wisely, major problems and constraints in agricultural development in the Basins, which should duly be addressed in the present Study in an integrated manner, have been studied by categorizing issues into: i) agronomic & agro-economic issues, ii) marketing issues and iii) agricultural support services and conceivable development directions are presented in Table C2-1, of which major agronomic issues are discussed in the followings.

The primary agronomic constraint in the basins is unstable and low productivity of rice adversely affected by various factors. Major problems or constraints and proposed development directions are discussed by categorizing them into issues common in all the four basins and basin specific issues as follows;

(a) Issues Common to All Basins

Major constraints for agricultural development common to all the subject river basins include:

- Primary constraint that is attributed to the unstable and low productivity of rice is limited and unstable availability of water because of limitation of irrigation water supply. Most rice fields in the four basins are under rainfed conditions. Further, wet season supplemental irrigation where only a single cropping of rice is ensured is almost exclusive current irrigation status even in the irrigated fields;

  which should be addressed through the development and efficient utilization of available water resources to an extent possible. The priority target of the present Study will be the stabilization and increase of wet season rice production through the sufficient supply of irrigation water and expansion of irrigation command area by way of water resources development and efficient use.

- Prevailing traditional farming practices are also serious problems attributed to low productivity. However, a number of factors are involved in circumstances where such practices prevail;

  which should be addressed through the strengthening of agricultural support services introduced in a well integrated manner and implemented in a farmer participatory manner (because of financial constraints of government institutions). Further, such situations will be improved through the introduction of contract growing or partnership arrangement between farmers and a commercial sector.

- Single cropping of rice is almost exclusive cropping pattern in the basins and annual land use intensity or cropping intensity in paddy fields as a whole is as low as nearly 100%. Further, production of upland crops in paddy fields is not practiced;

  which should be addressed by introducing rice cultivation in the early wet season from end April to July by shifting a start of wet season rice cultivation toward July/August;

which should better be addressed by introduction of upland crops to a possible extent. Chances for cultivation of upland crops appear to exist in the early wet season by shifting a cropping season of wet season rice. For the introduction of upland crops, however, there exist several issues to be solved such as wet injury, drought and seed supply. Field based technology development and extension activities are essential for the promotion of upland crops production in paddy fields.

(b) Basin Specific Issues

- Extensive traditional direct sowing is prevailing rice cultivation method in the Battambang and Pursat River Basin. Compared with transplanting method, yield levels of paddy in direct sowing are reported to be 0.5 to 1.0 ton/ha lower than those in transplanting;

  which should be addressed by the technology development for productivity improvement of direct sowing and the extension of results/findings of the development to farming communities. Technical development activities for direct sowing has been started by BRAND (Battambang Rural Area Nurture and Development Project), JICA. The results/findings of the same should better be verified at farmers levels and disseminated to the communities.

- Extensive distribution of sandy soils is in the Kampong Chhnang River Basin was identified,

  which dictates the need of field based technology development such as split application of fertilizer and compost application and extension activities for improvement of rice production in the Basin.

C2.2 Basic Agricultural Development Concept

C2.2.1 Development Objectives

The development approach of the present Study is the irrigated agriculture development aiming at: i) improvement of productivity and increased production of rice and ii) improvement of land use intensity in off seasons, early wet and dry season, by introducing rice and upland crops cultivation; through the development and efficient utilization of water resources.

C2.2.2 Development Strategies

For the establishment of the development strategies, it was assumed that current planting methods of rice, transplanting and direct sowing in the subject areas, will be maintained in the future as such planting methods have been employed by farmers dictated by their land holding sizes and availability of labor forces and alternation of planting methods will be impractical. Accordingly, the strategies established for the attainment of the said development objectives are established separately for transplanting areas and direct sowing areas as follows;

(a) Transplanting Areas

- Improvement of productivity and increased production of rice envisaged through the introduction of: i) cropping of medium to late medium rice in the wet season and ii)

improved farming practices formulated on the basis of current farming practices which represent to a certain extent capabilities and intensions of farming communities,

- Strengthening of agricultural support services of farmer participatory concept accommodated as a project component for extension of improved farming practices,
- Introduction of early rice and upland crops in the early wet and dry season to increase land use intensity, and
- Envisaging the introduction of upland crops production under rainfed conditions in the early wet season to increase land use intensity and promote crop diversification.

(b) Direct Sowing Areas

- Current cropping calendars prevailing in the direct sowing areas are observed since such calendars might have been established from long farmers efforts in the past and fit to the climatic, agronomic and social environments in the subject areas. There is a possibility to introduce crops in the early wet season as is the case in the transplanting areas by curtailing growth duration of direct sowing rice through introduction of direct sowing method under submerged conditions. However, field based technology development activities are essential for the adaptability and verification tests of the planting method before the introduction of such practices,
- 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 of farmer participatory concept, and
- Envisaging the introduction of upland crops/vegetable production in the dry season to increase land use intensity and promote crop diversification.

C2.3 Basic Agricultural Development Plan

The basic agricultural development plan indicated by cropping pattern and cropping intensity; which are planned in accordance with the results of water balance and irrigation study and the development strategies discussed earlier; target yields are proposed as follows;

(1) Crop Selection

The crop selection under the present development plan has been made as follows;

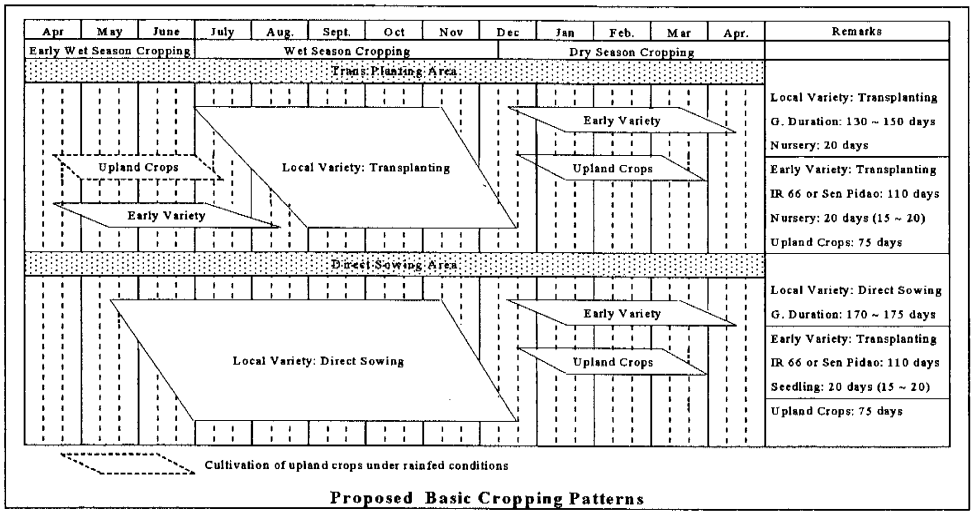
- Rice, current exclusive crop in the main cropping season, wet season, is selected as a crop to be introduced in the season as no other promising crops are conceivable and rice is a by far the most important crop and stable food in the basins. Cultivation of local varieties with good quality and preferred by farming communities in subject areas or improved local varieties are to be selected,
- Introduction of upland crops in the dry season in addition to dry season rice aiming at: i) increasing land use intensity in paddy fields, ii) crop diversification, iii) improvement of nutritional status of farm families by introducing pulses and iv) increasing farm income,
- In transplanting areas, introduction of early rice in the early wet season for utilizing

rainfall and irrigation water resource available in the season by moving the transplanting time from current June/July to July/August,

- There is possibility to introduce upland crops in the early wet season in transplanting areas. However, farming practices or cultivation methods of such crops in the season are yet to be developed, verified and demonstrated in farmers fields. Such situations will not justify allocation of valuable irrigation water for upland crops cultivation. In the current proposed cropping patterns, therefore, the introduction of such crops under rainfed conditions is envisaged for improving land use intensity in paddy fields, and
- As one of candidate upland crops, mungbeans are selected aiming at sufficing domestic consumption, improving nutritional status of farm families and ameliorating soil conditions by cultivation of leguminous crops.

(2) Cropping Pattern and Intensity

Based on the study on the current prevailing cropping patterns and the development strategies discussed above, the proposed basic cropping patterns for normal irrigated areas is formulated as illustrated in Figure C2-1 and as shown below.



The cropping intensity targeted under the plan is as follows;

- Cropping intensity in the wet season of 100% is envisaged in the pattern,
- Intensities of rice in the early wet season and rice and upland crops in the dry season are to be estimated through the water balance study on the individual projects, and
- In transplanting areas, introduction of upland crops in the early wet season under rainfed conditions is envisaged to the extent of 5% of the transplanting areas.

As for the recession areas and areas where only dry season rice is cultivated due probably to inundation in the wet season, the current patterns and intensities are adopted as proposed ones.

(3) Target Crop Yields

The target crop yields under the present plan in which normal irrigation is ensured are studied based on the current yield levels at normal (full) irrigation areas in the basins and the results of the Pilot Project carried out under the Study on Comprehensive Agricultural Development

in Prek Thnot River Basin, JICA and are set as shown in the following table in comparison with the present yield levels.

Target Yields and Present Yield Levels **(Unit: ton/ha)**

Wet Season				Early Wet/Dry Season			
Crop 1/	Target	Present	Increment	Crop 1/	Target	Present	Increment
Improvement of Irrigation Status: Present: Normal Irrigation ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.5	3.0	0.5	Early Rice (T)	3.5	3.0	0.5
Medium Rice (D)	2.8	2.0	0.8	Upland Crops (I)	0.7	-	-
				Upland Crops (R)	0.5	-	-
Improvement of Irrigation Status: Present: Supplemental Irrigation ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.5	2.0	1.5	Early Rice (T)	3.5	2.5	1.0
Medium Rice (D)	2.8	1.5	1.3	Upland Crops (I)	0.7	-	-
				Upland Crops (R)	0.5	-	-
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.5	1.5	2.0	Early Rice (T)	3.5		-
Medium Rice (D)	2.8	1.0	1.8	Upland Crops (I)	0.7	-	-
				Upland Crops (R)	0.5	-	-

1/: T --- transplanting; D --- direct sowing; I --- under irrigation; R --- under rainfed condition
Upland crops represented by mungbeans

The yield increases of 0.5 to 2.0 ton/ha in wet season rice and 0.5 to 1.0 ton/ha in early wet & dry season rice is envisaged under the plan. Current and target yield level of recession rice is set at 2.0 ton/ha and 2.5 ton/ha, respectively.

(4) Proposed Farming Practices

Improvement in farming practices envisaged from the current prevailing practices are: i) proper land leveling & preparation, ii) use of quality seed and adequate seeding rate, iii) raised nursery bed, planting of younger seedling, regular planting and reduced no. of plants per hill (in transplanting), iii) fertilization (increased & timely application including compost or cow dung), iv) introduction of proper on-farm water management & water saving culture, vi) intensified weeding and vi) improvement of post-harvesting practices.

C2.4 Agricultural Support Services

Agricultural support services to be accommodated as a project component for the extension of proposed farming practices and for attaining the project target cropping pattern, cropping intensity and crop yields at an earlier stage as possible include activities on: i) technology development and field extension, ii) farmer training, iii) mass guidance/workshop and iv) PDA staff empowerment. The technology development program aims at technology development for upland crops cultivation in paddy fields and for direct sowing. The list of candidate programs is shown in the following table.

Required Agricultural Support Services

Activity	Program Required
Technology Development	Adaptability test etc.
Field Extension	Plot, farm & area demonstration, seed multiplication
Farmer/Farmer Group Training	Training program, farmer field school, study tour, training & deployment of village extension agent
Mass Guidance/Workshop	Mass guidance/workshop
Staff Empowerment	Staff training, study tour

In addition, for the improvement of land use intensity and crop diversification in paddy fields as targeted in the development strategy, development and dissemination of upland crops farming technologies is essential. For the purpose, the ranching of technical development cum extension project for upland crops production promotion is proposed. In the project, field based technology development and extension of improved practices and technologies are envisaged under the collaboration of MAFF, PDAs, CARDI and foreign experts.

C2.5 Proposed Approaches for Marketing Issues

Conceivable approaches for the development directions proposed for the marketing issues in Table C2-1 are presented in the followings.

C2.5.1 Proposed Approaches for Group Marketing

Major paddy marketing constraints identified in the present Study are low market price of paddy and unstable market prices. Further, farmers practical knowledge on the importance of post-harvest practices and product quality is still limited. Production increase expected under the with-project condition might invite other constraints in marketing such as limited market destination. The proposed approach for such issue is the promotion of group marketing.

The basic demand of markets for agricultural products is supply of a constant (given) volume and quality of products at a given timing. Therefore, the prerequisite condition for market development of agricultural products is to meet such basic market demand.

The proposed approaches to cope with the slated constraints will be time series or stepwise approaches of: i) improvement of productivity and quality of products through improvement of farming practices, ii) formation of farmer groups and introduction of group economic activities such as group purchasing of farm inputs and technology transfer within a group and among groups, iii) introduction of contract growing or partnership arrangement, iv) intensification of group economic activities toward cooperative shipment and cooperative marketing followed and v) formation of cooperatives by uniting groups. The government support activities toward such approaches will be guidance/extension and farmer/farmer group training activities and provision of market information to farmer groups. The proposed approaches is illustrated in Figure C2-2 and explained in the followings;

(a) Improvement of Productivity and Quality of Products

The 1st and essential step to take in the proposed approaches is to improve farming practices and technologies of target groups (farmers) and to improve productivity and quality of subject crops or commodities through the extension activities and by way of efforts of target groups themselves. In the proposed approaches, priority should be placed on productivity improvement through the improvement of farming practices and quality improvement of products should better be envisaged after the attainment of productivity improvement.

(b) Formation of Groups of Interested Farmers

In parallel with the activities for the said improvement of productivity and quality of products, formation of a group with interested farmers will be the 2nd step. As market demand is a given volume, a group formation is an essential approach because of the limitation of land holding sizes by individuals in the basins.

As marketing is a business activity, marketing skills or business mind of individual farmers or groups are to be enhanced through extension activities. Further, within a group or among groups, technology transfer among members is to be institutionalized. Such technology improvement activities should better be promoted by advanced or key farmers in a group or groups. The external guidance are to be directed to those key farmers intensively and technologies, knowledge and experiences received by them are to be disseminated to fellow members through farmer-to-farmer extension. The technology transfer to the key farmers should cover both technical and business/marketing aspects essential for the improvement of marketing.

(c) Initial Group Economic Activity

The initial group economic activity will be group purchasing of farm inputs aiming at improvement of productivity and quality of products and also saving farming costs. The introduction of contract growing or partnership arrangement could also be attempted at this stage as an initial group economic activity.

(d) Improvement of Farmers Access to Market Information

Provision of market information will be a government intervention. However, efforts of groups for market development are also necessary activities toward the introduction of advanced group economic activities.

(e) Advanced Group Economic Activity

The advanced group economic activities include cooperative shipment of products followed by cooperative marketing when product quality of members become uniform. Processing of products or expansion of contract growing or partnership arrangement are also potential activities of those groups.

(f) Formation of Cooperatives

The formation of cooperatives to establish groups as a legal entity will be the final step in the proposed approaches for improvement of marketing by uniting interested groups having economic activities.

C2.5.2 Approaches for Promotion of Rice Export

In global rice markets, the substantial expansion of rice trade is projected[1] in the present master plan target period of 2008 to 2020. The document indicated in the foot note further mentions the expansion of long-grain varieties in the global trade by saying that "In recent years, long-grain varieties have accounted for around three-fourth of global rice trade and are expected to account for the bulk of trade growth over the next decade". The projections indicate the existence of chances for Cambodia to expand rice export in the global trade.

---

[1] Quoated "USDA estimates that global rice trade is projected to grow 2.4% per year from 2007 50 2016 and that by 2016, the same reaches nearly 35 million tons, nearly 25 percent above the record set in 2002.", from Outlook: USDA's 10 year projection for global rice imports

As a member of the World Trade Organization, Cambodia can export its products to 148 other member countries under MFN (Most Favored Nation) tariff rates. Further, the country can export to other ASEAN member countries under the Common Effective Preferential Tariff Rates. However, the country has not been able to capture such opportunities.

For the promotion of rice export in the global market, there appears to be various constraints to be removed which are related with production and trade facilitation. Accordingly, to expand rice export in the market, nation wide integrated and overall steps must be taken to remove such constraints faced in the country.

The formation of a national framework for the development of export market and for the promotion of rice export should better be envisaged to solve such constraints participated by all the stakeholders involved in rice production and marketing. The primary role in those economic activities are to be taken by the private sector under the guidance and supervision of the government institutions.

The conceivable stakeholders and their functions/roles in the framework are as shown in the following table.

Conceivable National Framework for Promotion of Rice Export

Stakeholders	Roles/Functions
Producer (farmer groups/farmer groups)	- Improvement of farming & post-harvest practices - Production increase & improvement of quality
	- Cultivation of a variety demanded by traders
	- Standardization of products
	- Planned production & shipment of quality paddy
	- Cooperative shipment
Producers/Rice Millers/Traders	- Contract growing, partnership arrangement for production of variety selected by millers/traders
Rice Millers	- Renovation of rice milling & storage facilities - Innovation in rice milling technology
Traders	- Market research & development
	- Release of market information to other stake holders
	- Providing information on promising varieties to producers/MAFF/PDAS
	- Planned collection of paddy/rice
MAFF/MOC	- Market information release
	- Supervising transactions by stake holders
MAFF/PDAs	- Extension services, formation of farmer groups
MAFF/MOC/Rice Millers/Traders	- Standardization of quality & packaging
CARDI/MAFF	- Development of improved farming practices
	- Breeding & multiplication of promising varieties
AQUIP Seed Company/MAFF/PDA	- Production & supply of promising seeds
Government Institutions concerned	- Legislation of laws & regulations concerned - Issuing certificates concerned