

## CHAPTER B 3 AGRICULTURAL DEVELOPMENT PLAN

### B3.1 Ream Kon Rehabilitation Sub-project Area

#### B3.1.1 Land Use Plan

The land use plan under the with-project condition is presented in comparison with the present/without-project land use as follows;

**Present/Without-project & With-project Land Use of the Project Area**

Land Use Sub-category	Present		With-project		Increment
	(ha)	(%)	(ha)	(%)	(ha)
Paddy Field					
- Normal Irrigation Paddy Field			1,890	100	1,890
- Supplemental Irrigation Paddy Field	50	2			- 50
- Rainfed Paddy Field	1,970	98			- 1,970
Sub-total	2,020	100	1,890	100	- 130
Right-of-ways	150	7	280	13	130
Total	2,170	100	2,170	100	0

As shown in the table, the development of 1,890 ha of normal irrigation paddy field is aimed at under the project by the conversion of 50 ha of supplemental irrigation fields and 1,970 ha of rainfed fields. The decrease of paddy fields due to land use conversion to right-of-ways is estimated at 130 ha.

#### B.3.1.2 Proposed Cropping Pattern and Cropped Area

##### (1) Crop Selection

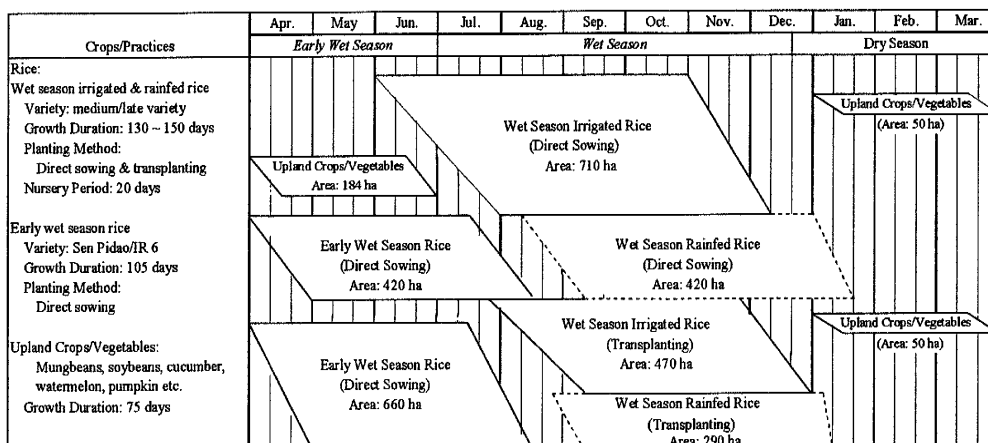
The crop selection under the present plan has been made based on the development concept discussed earlier as follows;

- Rice, current exclusive crop in the wet season, is selected as a crop to be introduced in the season as no other promising crops are conceivable and rice is the most important crop and staple food in the area. Cultivation of local varieties with good quality and preferred by farming communities or improved local varieties is to be selected,
- Introduction of irrigated upland crops/vegetables production in early wet and dry season 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,
- Introduction of early rice in the early wet season under direct sowing as is currently practiced in the area, and
- Candidate upland crops could include mungbeans, soybeans and corn and the same of vegetables include cucumber, water melon, pumpkin and gourd currently cultivated in and around the sub-project area. Production of beans are selected partly aiming at sufficing domestic consumption, improving nutritional status and ameliorating soil conditions by cultivation of legumes in addition to the crop diversification envisaged earlier. The current price increase of grains may justify the introduction of such crops under irrigation. However, farming practices for irrigated upland crops/vegetables

production in paddy fields are yet to be developed, verified and demonstrated in farmers fields. For the successful introduction of the crops, intensified extension supports should be accommodated as a key component of the sub-project.

## (2) Cropping Pattern and Cropped Area

Based on the study on current cropping patterns, the development concept discussed earlier and the irrigation water balance study, the proposed cropping pattern is formulated as follows;



**Proposed Cropping Pattern: Ream Kon Sub-project**

The cropping intensity targeted under the plan is as follows;

- Rice cropping intensity of 100% in wet season is planned in the pattern by assuming that rice cultivation under rainfed conditions (because of limitation in irrigation water supply) will be carried out as is currently practiced in non-irrigated fields in the season (intensity of irrigated rice 62% & the same of rainfed rice 38%),
- Intensity of rice in the early wet season is targeted at 57%. In addition, the intensity of 10% of upland crops/vegetables under irrigation is envisaged to promote crop diversification in the sub-project area, and
- In dry season, upland crops/vegetables cultivation under irrigation to the extent of 100 ha is planned.

The planned cropped areas and cropping intensity envisaged in the pattern are shown in Table B3.1-1 and summarized in the following table.

**Planned Cropped Area & Cropping Intensity under the Project**

Crop	Cropping Season							
	Early Wet Season		Wet Season		Dry Season		Annual	
	Area	Intensity	Area	Intensity	Area	Intensity	Area	Intensity
Irrigated Rice	1,080	57	1,180	62			2,260	119
Irrigated Rice (direct sowing)	1,080	57	710	37.5			1,790	94.7
Irrigated Rice (transplanting)			470	24.9			470	24.9
Rainfed Rice			710	38			710	38
Rainfed Rice (transplanting)			420	22.2			420	22.2
Rainfed Rice (direct sowing)			290	15.3			290	15.3
Rice Total	1,080	57	1,890	100	0	0	2,970	157
Upland Crops/Vegetables	184	10			100	5	284	15
Total	1,264	67	1,890	100	100	5	3,254	172

### B3.1.3 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 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 of Paddy (Unit: ton/ha)**

Wet Season				Early Wet/Dry Season			
Crop 1/	Target	Present	Increment	Crop 1/	Target	Present	Increment
Improvement of Irrigation Status: Present: Supplemental Irrigation ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.5	2.2	1.3	Early Rice (D)	3.0	2.5	0.5
Medium Rice (D)	2.8	1.5	1.3	Upland Crops 3/	1.0	-	-
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.5	1.7	1.8	Early Rice (D)	3.0	2.5	0.5
Medium Rice (D)	2.8	1.0	1.8	Upland Crops 3/	1.0	-	-

1/: T --- transplanting; D --- direct sowing 2/: Including pump irrigation fields

3/: Upland crops: average of mungbeans & soybeans

Yield increases of 1.3 to 1.8 ton/ha in wet season rice and 0.5 ton/ha in early wet season rice are envisaged under the plan. The target yields of irrigated upland crops and vegetables are set at: mungbeans 0.9ton/ha, soybeans 1.1 ton/ha, watermelon 9.0 ton/ha and cucumber 10.0 ton/ha (Current yield level of mungbeans in the area is 0.5 ton/ha under rainfed).

### B3.1.4 Crop Production Plan

The crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.1-1 and summarized as follows;

**Present & With-project Crop Production of the Project Area**

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		100	5	2.1	214
Rainfed Paddy Field: Wet Season Rice		2,120	105	1.4	2,897
Annual	Rice	2,220	110	1.4	3,111
	Upland Crops (mungbeans)	10	0.5	0.5	5
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		2,260	120	3.0	6,873
Rainfed Rice 1/		710	38	1.3	913
Annual	Rice	2,970	157	2.6	7,786
	Upland Crops/Vegetables 2/	284	15	-	1,015
Increment (II - I)					
Annual	Rice	750	47	1.2	4,675
	Upland Crops/Vegetables	274	15	-	1,010

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply

2/: Total of upland crops & vegetables, represented by mungbeans, soybeans, watermelon & cucumber

Note: Rice figures are total of wet & early wet season rice and direct sowing & transplanting rice

As shown in the table, the increase of overall average yield of 1.2 ton/ha from 1.4 to 2.6 ton/ha and annual paddy production increase of some 4,700 tons are expected. The paddy production under the sub-project is about 250% of the current production level in the area.

Under the sub-project, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be about 1,020 tons, increase of about 1,000 tons from the present level. Successful introduction of the crops through the proposed extension activities will further expand the cultivation of the crops in the area in the future.

### B3.1.5 Proposed Farming Practices

Proposed improved farming practices of paddy to be adopted 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), iv) fertilization (increased & timely application including compost or cow dung), v) introduction of proper on-farm water management & water saving culture, vi) intensified weeding and vii) improvement of post-harvesting practices.

### B3.1.6 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition compared with the present/without-project condition, farm economic analyses on the typical farms defined for the estimation of the current capacity to pay in the section B1.1.13 were made based on the crop budget analyses on the proposed cropping pattern under the project (Table B1.1- 12, B1.1-13 & B3.1-2).

#### (1) Typical Farms

The typical farms defined for the farm economic analyses are as shown in the following table.

**Typical Farms for Analysis**

Type	Irrigation Status		Planting Method in Wet Season	Holding Size
	Present/Without-project	With-project		
Type A-1	Rainfed paddy field	Normal Irrigation	Transplanting	2.4 ha/family
Type A-2	Rainfed paddy field	Pump Irrigation	Transplanting	2.4 ha/family
Type B-1	Rainfed paddy field	Normal Irrigation	Direct Sowing	2.4 ha/family
Type B-2	Rainfed paddy field	Pump Irrigation	Direct Sowing	2.4 ha/family

The results of farm economic analyses of typical farms under the with-project condition are presented in comparison with the same under the present/without project condition in Table B3.1-3 and summarized in the following table.

**Farm Economy under With-project Condition 1/**

Item		Amount (Riel 1,000.-)			
		Type A-1	Type A-2	Type B-1	Type B-2
Gross Incomes	Rice Production	10,786	10,786	9,092	9,092
	Upland Crops/Vegetables Production	985	-	985	-
	Other Farm Incomes	630	630	630	630
	Non-farm Income	2,060	2,060	2,060	2,060
Total Income		14,461	13,476	12,767	11,782
Expenditures	Production Costs of Farm Products	5,701	6,135	5,377	5,114
	Other Expenditures	4,820	4,820	4,319	4,319
	Total Expenditures	10,521	10,955	9,696	9,433
Net Surplus		3,940	2,521	3,071	2,349

1/: Assuming other farm income & non-farm income are same in both cases

As shown in the tables, the farm economic statuses of all the typical farms under the

with-project condition will be greatly improved mainly because of the sharp increase of annual cropping intensity (from 110% at present to 172% in case of the Type A-1 and B-1 and 110% to 157% in case of the Type A-2 and B-2) and increase of paddy yields. The net surplus or capacity to pay is estimated at Riel 3,940,000 (US\$ 961.-) or 27% of total income and Riel 2,521,000 (US\$ 615.-) or 19% of the same for the Type A-1 and A-2, respectively. Similarly, the same is estimated at Riel 3,071,000 (US\$ 749.-) or 24% of total income and Riel 2,349,000 (US\$ 573.-) or 20% of the same for the Type B-1 and B-2, respectively.

The incremental net surpluses account for Riel 3,371,000 (US\$ 822.-) and Riel 1,952,000 (US\$ 476.-) from the present level, respectively for Type A-1 and Type A-2. The same for Type B-1 and B-2 are respectively Riel 3,314,000 (US\$ 808.-) and Riel 2,952,000 (US\$ 720.-) as shown below.

### Incremental Income & Net Surplus under With-project Condition

Unit: Riel 1,000

Factor	Type A-1 (normal)			Type A-2 (pump)			Type B-1 (normal)			Type B-2 (pump)		
	Present	With Project	Increment	Present	With Project	Increment	Present	With Project	Increment	Present	With Project	Increment
Total Incomes	7,304	14,461	7,157	7,304	13,476	6,172	5,610	12,767	7,157	5,610	11,782	6,172
Net Income	4,569	8,760	4,191	4,569	7,341	2,772	3,357	7,390	4,033	3,357	6,668	3,311
Net Surplus	569	3,940	3,371	569	2,521	1,952	-243	3,071	3,314	-243	2349	2,592
(increment in %)	100	692	592	100	443	343	100	-	-	100	-	-

Source: JICA Study Team

### B3.1.7 Agricultural Extension Activities

Under the sub-project, the substantial increases of yields and annual cropping intensity of paddy and the introduction of irrigated upland crops/vegetables production are envisaged, which dictates the introduction of intensified extension activities in the area. The proposed activities are development interventions aiming at strengthening of agricultural extension services for attaining the sub-project targets of crop yields and cropping pattern at an earlier stage as possible. The activities accommodated as sub-project component and the implementation and cost schedules of the same are presented in Table B3.1-4 and summarized in the following table.

#### Estimated Costs for Agricultural Extension Activities 1/

Activity	Estimated Cost (US\$)
Field Extension Programs	69,200
Farmer/Farmer Group Training Programs	19,600
Mass Guidance/Workshop	1,600
Support Fund for Extension Staff 2/	21,760
Staff Empowerment	4,000
Provision of Transportation Means	4,200
Total	120,360

1/: Program direct costs

2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

Major extension activities include field programs (adaptability test, demonstration plot, farm & area, upland crops/rice seed multiplication), farmer & farmer group training programs (training course, FFS/IPM, study tour), mass guidance/workshop, staff empowerment, support fund for extension staffs and provision of transportation means.

The implementation of the activities is scheduled for the period of 4 years in the sub-project and the overall cost is estimated at US\$ 120,000.-.

### B3.2 Por Canal Rehabilitation Sub-project Area

#### B3.2.1 Land Use Plan

The land use plan under the with-project condition is presented in comparison with the present/without-project land use as follows;

**Present/Without-project & With-project Land Use of the Project Area**

Land Use Sub-category	Present		With-project		Increment (ha)
	(ha)	(%)	(ha)	(%)	
Paddy Field					
- Normal Irrigation Paddy Field			1,940	100	1,940
- Supplemental Irrigation Paddy Field	100	5			- 100
- Rainfed Paddy Field	1,970	95			- 1,970
Sub-total	2,070	100	1,940	100	- 130
Right-of-ways	160	7	290	13	130
Total	2,230	100	2,230	100	0

As shown in the table, the development of 1,940 ha of normal irrigation paddy field is aimed at under the project by the conversion of 100 ha of supplemental irrigation fields and 1,970 ha of rainfed fields. The decrease of paddy fields due to land use conversion to right-of-ways is estimated at 130 ha.

#### B3.2.2 Proposed Cropping Pattern and Cropped Area

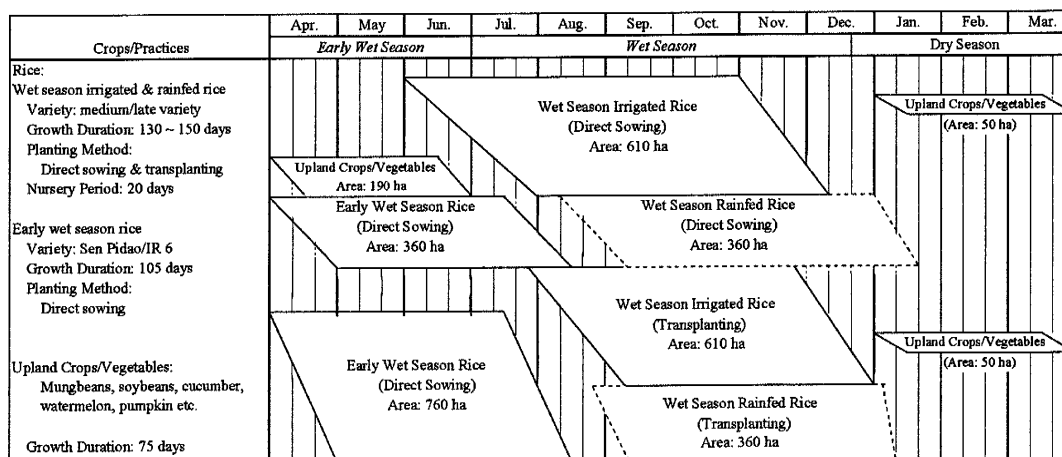
##### (1) Crop Selection

The crop selection under the present plan has been made on the basis of the approaches applied for the Ream Kon sub-project discussed in the section B3.1.2 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 staple food in the area,
- Introduction of irrigated upland crops/vegetables production in early wet and dry season 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,
- Introduction of early rice in the early wet season under direct sowing as is currently practiced in the area for utilizing rainfall and irrigation water resource available in the season, and
- Candidate upland crops could include mungbeans, soybeans and corn and the same of vegetables include cucumber, water melon, pumpkin and gourd currently cultivated in and around the sub-project area. However, for the successful introduction of the crops, intensified extension supports should be accommodated as an essential component of the sub-project.

## (2) Cropping Pattern and Cropped Area

Based on the study on the current prevailing cropping patterns, the development strategies discussed above and the results of irrigation water balance study, the proposed cropping pattern is formulated as follows;



### Proposed Cropping Pattern: Por Canal Sub-project

The cropping intensity targeted under the plan is similar to the same for the Ream Kon sub-project area as follows;

- Rice cropping intensity of 100% in wet season is planned in the pattern by assuming that rice cultivation under rainfed conditions (because of limitation in irrigation water supply) will be carried out as is currently practiced in non-irrigated fields in the season (intensity of irrigated rice 63% & the same of rainfed rice 37%),
- Intensity of rice in the early wet season is targeted at 58%. In addition, the intensity of 10% of upland crops/vegetables under irrigation is envisaged to promote crop diversification in the sub-project area, and
- In dry season, upland crops/vegetables cultivation under irrigation to the extent of 100 ha is planned.

The planned cropped areas and cropping intensity envisaged in the pattern are shown in Table B3.2-1 and summarized in the following table.

### Planned Cropped Area & Cropping Intensity under the Project

Unit: ha & %

Crop	Cropping Season							
	Early Wet Season		Wet Season		Dry Season		Annual	
	Area	Intensity	Area	Intensity	Area	Intensity	Area	Intensity
Irrigated Rice	1,120	58	1,220	63			2,340	121
Irrigated Rice (direct sowing)	360	19	610	31.4			970	50.4
Irrigated Rice (transplanting)	760	39	610	31.4			1,370	70.4
Rainfed Rice			720	37			720	37
Rainfed Rice (transplanting)			360	18.6			360	18.6
Rainfed Rice (direct sowing)			360	18.6			360	18.6
<b>Rice Total</b>	<b>1,120</b>	<b>58</b>	<b>1,940</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>3,060</b>	<b>158</b>
Upland Crops/Vegetables	190	10			100	5	290	15
<b>Total</b>	<b>1,310</b>	<b>68</b>	<b>1,940</b>	<b>100</b>	<b>100</b>	<b>5</b>	<b>3,350</b>	<b>173</b>

### B3.2.3 Target Crop Yields

The target crop yields under the present plan in which normal irrigation is ensured are set at the same levels with the Ream Kon sub-project area as shown in comparison with the present yield levels in the following table

Wet Season				Early Wet/Dry Season			
Crop 1/	Target	Present	Increment	Crop 1/	Target	Present	Increment
Improvement of Irrigation Status: Present: Supplemental Irrigation ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.5	2.2	1.3	Early Rice (D)	3.0	2.5	0.5
Medium Rice (D)	2.8	1.5	1.3	Upland Crops 2/	-	-	-
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.5	1.7	1.8	Early Rice (D)	3.0	2.5	0.5
Medium Rice (D)	2.8	1.0	1.8	Upland Crops 2/	-	-	-

1/: T --- transplanting; D --- direct sowing      2/ Upland crops: average of mungbeans & soybeans

Yield increases of 1.3 to 1.8 ton/ha in wet season rice and 0.5 ton/ha in early wet season rice are envisaged under the plan. The target yields of irrigated upland crops and vegetables are set rather conservatively as follows;

Crops	Target Yield	Crops	Target Yield
Mungbeans	0.9 ton/ha	Watermelon	9.0 ton/ha
Soybeans	1.1 ton/ha	Cucumber	10.0 ton/ha

### B3.2.4 Crop Production Plan

The crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.2-1 and summarized as follows;

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		200	10	2.2	435
Rainfed Paddy Field: Wet/Early Wet Season Rice		2,280	110	1.5	3,435
Annual	Rice	2,480	120	1.6	3,870
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		2,340	121	3.1	7,203
Rainfed Rice 1/		720	37	1.4	972
Annual	Rice	3,060	158	2.7	8,175
	Upland Crops	290	15	-	1,055
Increment (II - I)					
Annual	Rice	580	38	1.1	4,306
	Upland Crops	290	15	-	1,055

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply.

2/: Total of upland crops & vegetables, represented by mungbeans, soybeans, watermelon & cucumber.

Note: Rice figures are total of wet & early wet season rice and direct sowing & transplanting rice

As shown in the table, the increase of overall average yield of 1.1 ton/ha from 1.6 to 2.7 ton/ha and annual paddy production increase of some 4,300 tons are expected. The paddy production under the sub-project is about 210% of the current production level in the area.



Under the sub-project, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be about 1,100 tons. Successful introduction of the crops through the proposed extension activities will further expand the cultivation of the crops in the area in the future.

### B3.2.5 Proposed Farming Practices

Proposed improved farming practices of paddy to be adopted are same as those for the Ream Kon sub-project and include proper land preparation, use of quality seed and proper seeding rate, improved nursery & planting method, proper fertilization & water management etc.

### B3.2.6 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition compared with the present/without-project condition, farm economic analyses on the typical farms defined for the estimation of the current capacity to pay in the section B1.2.13 were made based on the crop budget analyses on the proposed cropping pattern under the project (Table B1.1-12, B1.1-13 & B3.1-2).

#### (1) Typical Farms

The typical farms defined for the farm economic analyses are as shown in the following table.

**Typical Farms for Analysis**

Type	Irrigation Status		Planting Method in Wet Season	Holding Size
	Present/Without-project	With-project		
Type A	Rainfed paddy field	Normal Irrigation	Transplanting	2.4 ha/family
Type B	Rainfed paddy field	Normal Irrigation	Direct Sowing	2.4 ha/family

The results of farm economic analyses of typical farms under the with-project condition are presented in comparison with the same under the present/without project condition in Table B3.2-2 and summarized in the following table.

**Farm Economy under With-project Condition 1/**

Item		Amount (Riel 1,000.-)	
		Type A	Type B
Gross Incomes	Rice Production	11,658	9,810
	Upland Crops/Vegetables Production	1,075	1,075
	Other Farm Incomes	1,120	1,120
	Non-farm Income	1,980	1,980
Total Income		15,833	13,985
Expenditures	Production Costs of Farm Products	6,307	5,951
	Other Expenditures	4,400	4,400
	Total Expenditures	10,707	10,351
Net Surplus		5,126	3,634

1/: Assuming other farm income, non-farm income & other expenditures are same in both cases

As shown in the tables, the farm economic statuses of both the typical farms under the with-project condition will be improved to a great extent mainly because of the sharp increase of annual cropping intensity of about 50% from 120% at present to 172% under the project and increase of paddy yields. The net surplus or capacity to pay are estimated at Riel 5,126,000 (US\$ 1,250.-) or 32% of total income for the Type A and Riel 3,634,000 (US\$ 886.-) or 26% of total income for Type B. The incremental net surpluses account for

Riel 3,533,000 (US\$ 862.-) and Riel 3,363,000 (US\$ 820.-) from the present level, respectively for Type A and Type B as shown below.

**Incremental Income & Net Surplus under With-project Condition (unit: Riel 000)**

Factor	Type A			Type B		
	Present	With-project	Increment	Present	With-project	Increment
Total Incomes	8,838	15,833	6,995	6,990	13,985	6,995
Net Income	3,283	7,546	4,263	1,961	6,054	4,093
Net Surplus	1,593	5,126	3,533	271	3,634	3,363
(increment in %)	(100)	(322)	(222)	(100)	(1,341)	(1,241)

Source: JICA Study Team

### B3.2.7 Agricultural Extension Activities

Under the sub-project, the substantial increases of yields and annual cropping intensity of paddy and the introduction of irrigated upland crops/vegetables production are envisaged as is the case in the Ream Kon sub-project. The proposed activities are development interventions aiming at strengthening of agricultural extension services for attaining the sub-project targets of crop yields and cropping pattern at an earlier stage as possible. The activities accommodated as sub-project component and the implementation and cost schedules of the same are presented in Table B3.2-3 and summarized in the following table.

**Estimated Costs for Agricultural Extension Activities 1/**

Activity	Estimated Cost (US\$)
Field Extension Programs	69,200
Farmer/Farmer Group Training Programs	19,600
Mass Guidance/Workshop	1,600
Support Fund for Extension Staff 2/	21,760
Staff Empowerment	4,000
Provision of Transportation Means	4,200
<b>Total</b>	<b>120,360</b>

1/: Program direct costs

2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

Major extension activities are as discussed in the section B3.1.4 and include field programs (including seed multiplication program), farmer & farmer group training programs mass guidance/workshop, staff empowerment, support fund for extension staffs and provision of transportation means.

The implementation of the activities is scheduled for the period of 4 years in the sub-project and the overall cost is estimated at US\$ 120,000.-.

### B3.3 Damnak Ampil Rehabilitation Sub-project

#### B3.3.1 Land Use Plan

The land use plan under the with-project condition is presented in comparison with the present/without-project land use as shown in the following table.

### Present/Without-project & With-project Land Use of the Project Area

Land Use Sub-category	Present		With-project		Increment
	(ha)	(%)	(ha)	(%)	(ha)
Paddy Field					
- Normal Irrigation Paddy Field			2,270	100	2,270
- Supplemental Irrigation Paddy Field	500	21			- 500
- Rainfed Paddy Field	1,930	79			- 1,930
Sub-total	2,430	100	2,270	100	- 160
Right-of-ways	180	7	340	13	160
Total	2,610	100	2,610	100	0

As shown, the development of 2,270 ha of normal irrigation paddy field is aimed at under the project by the conversion of 500 ha of supplemental irrigation fields and 1,930 ha of rainfed fields. The decrease of paddy fields due to land use conversion to right-of-ways is 160 ha.

### B3.3.2 Proposed Cropping Pattern and Cropped Area

#### (1) Crop Selection

The crop selection under the present plan has been made basically on the basis of the development concept discussed earlier 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 area,
- Introduction of irrigated upland crops/vegetables production in early wet season 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, and
- Candidate upland crops could include mungbeans, groundnut, soybeans and corn and vegetables include cucumber, water melon, pumpkin and gourd cultivated in and around the sub-project area. However, for the successful introduction of the crops, intensified extension supports should be planned as a component of the sub-project.

#### (2) Cropping Pattern and Cropped Area

Based on the study on the current prevailing cropping patterns, the development strategies discussed above and the results of irrigation water balance study, the proposed cropping pattern is formulated as follows;

Crops/Practices	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	Early Wet Season			Wet Season					Dry Season			
<b>Rice:</b> Wet season irrigated rice Growth Duration: 130 ~ 150 days Planting Method: Transplanting Nursery Period: 20 days												
<b>Upland Crops/Vegetables:</b> Mungbeans, groundnut, cucumber, watermelon, pumpkin etc. Growth Duration: 75 days												

### Proposed Cropping Pattern: Damnak Ampil Sub-project

The cropping intensity targeted under the plan is as follows;

- Rice cropping intensity of 100% in wet season under irrigation is planned in the pattern within the availability of irrigation water, and
- Introduction of upland crops/vegetables under irrigation in early wet season to the extent of cropping intensity 15% is envisaged by availing irrigation water supply in the season to promote crop diversification in the sub-project area.

The planned cropped areas and cropping intensity envisaged in the pattern are shown in Table B3.3-1 and as summarized in the following table.

**Planned Cropped Area & Cropping Intensity under the Project**

Unit: ha & %

Crop	Cropping Season							
	Early Wet Season		Wet Season		Dry Season		Annual	
	Area	Intensity	Area	Intensity	Area	Intensity	Area	Intensity
Irrigated Rice			2,270	100			2,270	100
Upland Crops/Vegetables	340	15					340	15
Total	340	15	2,270	100	0	0	2,610	115

### B3.3.3 Target Crop Yields

The target crop yields under the present plan in which normal irrigation is ensured are studied, as is the case for the other sub-project areas, based on the current yield levels at normal (full) irrigation areas 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	Target	Present	Increment
Improvement of Irrigation Status: Present: Supplemental Irrigation ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.3	2.0	1.3	Upland Crops 3/	1.1	-	-
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation							
Medium Rice (T)	3.3	1.5	1.8	Upland Crops 3/	1.1	-	-

1/: T --- transplanting 2/: Including pump irrigation fields 3/ Upland crops: average of mungbeans & groundnut

Yield increases of 1.3 to 1.8 ton/ha in wet season rice are envisaged under the plan. The target yields of irrigated upland crops and vegetables are set rather conservatively as follows;

**Target Yields of Upland Crops/Vegetables**

Crops	Target Yield	Crops	Target Yield
Mungbeans	0.9 ton/ha	Watermelon	9.0 ton/ha
Groundnut	1.3 ton/ha	Cucumber	10.0 ton/ha

### B3.3.4 Crop Production Plan

The crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.3-2 and summarized in the followings.

### Present & With-project Crop Production of the Project Area

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		500	23	2.3	1,150
Rainfed Paddy Field: Wet Season Rice		1,930	79	1.5	2,895
Annual	Rice	2,490	102	1.6	4,045
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		2,270	100	3.3	7,491
Annual	Rice	2,270	100	3.3	7,491
	Upland Crops	340	15	-	1,214
Increment (II - I)					
Annual	Rice	- 220	- 2	1.7	3,446
	Upland Crops	340	15	-	1,214

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply.

2/: Total of upland crops & vegetables, represented by mungbeans, groundnut, watermelon & cucumber.

Note: Rice figures are total of wet & early wet season rice and direct sowing & transplanting rice

As shown, the increase of overall average yield of 1.7 ton/ha from 1.6 to 3.3 ton/ha and annual paddy production increase of some 3,400 tons are expected. The paddy production under the sub-project is about 185% of the current production level in the area. Under the sub-project, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be some 1,200 tons, increase of all from the present level.

#### B3.3.5 Proposed Farming Practices

Proposed improved farming practices of paddy to be adopted 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), iv) fertilization (increased & timely application including compost or cow dung), v) introduction of proper on-farm water management & water saving culture, vi) intensified weeding and vii) improvement of post-harvesting practices as proposed for the other sub-project areas.

#### B3.3.6 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition compared with the present/without-project condition, farm economic analyses on the typical farms defined for the estimation of the current capacity to pay in the section B1.3.13 was made based on the crop budget analysis on the proposed cropping pattern under the project (Table B1.1-12, B1.1-13 & B3.1-2).

##### (1) Typical Farms

The typical farms for the farm economic analysis are as shown in the following table.

**Typical Farms for Analysis**

Type	Irrigation Status		Holding Size
	Present/Without-project	With-project	
Type A-1	Rainfed paddy field	Normal Irrigation	1.2 ha/family
Type A-2	Rainfed paddy field	Pump Irrigation	1.2 ha/family
Type B	Supplemental irrigation	Normal Irrigation	1.2 ha/family

The results of farm economic analyses of typical farms under the with-project condition are

presented in Table B3.3-2 and summarized in the following table.

**Farm Economy under With-project Condition 1/**

Item		Amount (Riel 1,000)	
		Type A-1/TypeB	Type A-2
Gross Incomes	Rice Production	4,356	4,356
	Upland Crops/Vegetables Production 2/	541	-
	Other Farm Incomes	1,119	1,119
	Non-farm Income	1,916	1,916
	Total Income	7,932	7,391
Expenditures	Production Costs of Farm Products	2,361	2,394
	Other Expenditures	4,080	4,080
	Total Expenditures	6,441	6,474
Net Surplus		1,491	917

1/: Assuming other farm income, non-farm income & other expenditures are same in both cases

2/: No cropping of upland crops/vegetables assumed under pump irrigation

As shown in the tables, the farm economic statuses of both the typical farms under the with-project condition will be improved mainly because of the increase of paddy yields under irrigation and introduction of upland crops/vegetables under the project (Type A-1 & B). The net surplus or capacity to pay are estimated at Riel 1,491,000 (US\$ 364.-) or 19% of total income for Type A-1 and B and Riel 917,000 (US\$ 224.-) or 12% of total income for Type A-2. The incremental net surpluses account for Riel 1,299,000 (US\$ 317.-), Riel 725,000 (US\$ 177.-) and Riel 806,000 (US\$ 197.-) from the present level, respectively for Type A-1, A-2 and B as shown below.

**Incremental Income & Net Surplus under With-project Condition**

Unit: Riel. 1,000

Factor	Type A-1 (normal)			Type A-2 (pump)			Type B (normal)		
	Present	With-project	Increment	Present	With-project	Increment	Present	With-project	Increment
Total Incomes	5,015	7,932	2,917	5,015	7,391	2,376	5,675	7,932	2,257
Net Income	3,592	5,571	1,979	3,592	4,997	1,405	4,085	5,571	1,486
Net Surplus	192	1,491	1,299	192	917	725	685	1,491	806
(increment in %)	100	777	677	100	478	378	100	218	118

Source: JICA Study Team

**B3.3.7 Agricultural Extension Activities**

Under the sub-project, the substantial increases of paddy yields and the introduction of irrigated upland crops/vegetables production are envisaged, which dictates the introduction of intensified necessity extension activities in the area. The proposed activities are development interventions aiming at strengthening of agricultural extension services for attaining the sub-project target crop yields at an earlier stage as possible. The activities accommodated as the sub-project component and the implementation and cost schedules of the same are presented in Table B3.3-3 and summarized in the following table.

**Estimated Costs for Agricultural Extension Activities (unit US\$) 1/**

Activity	Cost	Activity	Cost
Field Extension Programs	75,850	Mass Guidance/Workshop	1,800
Farmer/Farmer Group Training Programs	21,200	Staff Empowerment	4,000
Support Fund for Extension Staff 2/	23,680	Provision of Transportation Means	4,350
		Total	130,880

1/: Program direct costs 2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

Major extension activities include field programs (adaptability test, demonstration plot, farm & area, upland crops/rice seed multiplication), farmer & farmer group training programs (training course, FFS/IPM, study tour), mass guidance/workshop, staff empowerment, support fund for extension staffs and provision of transportation means.

The implementation of the activities is scheduled for the period of 4 years in the sub-project and the overall cost is estimated at US\$ 131,000.-.

### B3.4 Wat Loung Rehabilitation Sub-project

#### B3.4.1 Land Use Plan

The land use plan under the with-project condition is presented in comparison with the present/without-project land use as follows;

**Present/Without-project & With-project Land Use of the Project Area**

Land Use Sub-category	Present		With-project		Increment
	(ha)	(%)	(ha)	(%)	(ha)
Paddy Field					
- Normal Irrigation Paddy Field			2,540	100	2,540
- Supplemental Irrigation Paddy Field	130	5			- 130
- Rainfed Paddy Field	2,590	95			- 2,590
Sub-total	2,720	100	2,540	100	- 180
Right-of-ways	200	7	380	13	180
Total	2,920	100	2,920	100	0

As shown in the table, the development of 2,540 ha of normal irrigation paddy field is aimed at under the project by the conversion of 130 ha of supplemental irrigation fields and 2,590 ha of rainfed fields. The decrease of paddy fields due to land use conversion to right-of-ways is estimated at 180 ha.

#### B3.4.2 Proposed Cropping Pattern and Cropped Area

##### (1) Crop Selection

The crop selection under the present plan has been made on the basis of the approaches applied for the Damnak Ampil sub-project discussed in the section B3.3.2 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 area,
- Introduction of irrigated upland crops/vegetables production in early wet season 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, and
- Candidate upland crops could include mungbeans, groundnut, soybeans and corn and the same of vegetables include cucumber, water melon, pumpkin and gourd currently cultivated in and around the sub-project area. However, for the successful introduction of the crops, intensified extension supports should be accommodated as an essential component of the sub-project.

## (2) Cropping Pattern and Cropped Area

Based on the study on the current prevailing cropping patterns, the development strategies discussed above and the results of irrigation water balance study, the proposed cropping pattern is formulated as follows;

Crops/Practices	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
	Early Wet Season			Wet Season						Dry Season		
<b>Rice:</b> Wet season irrigated rice Growth Duration: 130 ~ 150 days Planting Method: Transplanting Nursery Period: 20 days				Wet Season Irrigated Rice Medium/Late Medium Variety Area: 2,540 ha								
<b>Upland Crops/Vegetables:</b> Mungbeans, groundnut, cucumber, watermelon, pumpkin etc. Growth Duration: 75 days	Upland Crops/Vegetables Area: 380 ha											

### Proposed Cropping Pattern: Wat Loung Sub-project

The cropping intensity targeted under the plan is similar to the same for the Damnak Ampil sub-project area as follows;

- Rice cropping intensity of 100% in wet season under irrigation is planned in the pattern within the availability of irrigation water, and
- Introduction of upland crops/vegetables under irrigation in early wet season to the extent of cropping intensity 15% is envisaged by availing irrigation water supply in the season to promote crop diversification in the sub-project area.

The planned cropped areas and cropping intensity envisaged in the pattern are shown in Table B3.4-1 and summarized in the following table.

### Planned Cropped Area & Cropping Intensity under the Project

Unit: ha & %

Crop	Cropping Season							
	Early Wet Season		Wet Season		Dry Season		Annual	
	Area	Intensity	Area	Intensity	Area	Intensity	Area	Intensity
Irrigated Rice			2,540	100			2,540	100
Upland Crops/Vegetables	380	15					380	15
<b>Total</b>	<b>380</b>	<b>15</b>	<b>2,540</b>	<b>100</b>	<b>0</b>	<b>0</b>	<b>2,920</b>	<b>115</b>

### B3.4.3 Target Crop Yields

The target crop yields under the present plan in which normal irrigation is ensured are set at the same levels with the Damnak Ampil sub-project 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 Season			
Crop 1/	Target	Present	Increment	Crop	Target	Present	Increment
Improvement of Irrigation Status: Present: Supplemental Irrigation ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.3	2.0	1.3	Upland Crops 3/	1.1	0.5	0.3
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.3	1.5	1.8	Upland Crops 3/	1.1	0.5	0.3

1/: T – transplanting 2/: Including pump irrigation fields 3/: Upland crops average of mungbeans & groundnut



Yield increases of 1.3 to 1.8 ton/ha in wet season rice are envisaged under the plan. The target yields of irrigated upland crops and vegetables are set rather conservatively as follows;

#### Target Yields of Upland Crops/Vegetables

Crops	Target Yield	Crops	Target Yield
Mungbeans	0.9 ton/ha	Watermelon	9.0 ton/ha
Groundnut	1.3 ton/ha	Cucumber	10.0 ton/ha

1/: Current yield level: watermelon 5.5 ton/ha & cucumber 6.0 ton/ha under rainfed

#### B3.4.4 Crop Production Plan

The crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.4-1 and summarized as follows;

#### Present & With-project Crop Production of the Project Area

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		175	6	2.1	373
Rainfed Paddy Field: Wet Season Rice		2,590	95	1.5	3,885
Annual	Rice	2,765	102	1.5	4,258
	Upland Crops	30	1		174
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		2,540	100	3.3	8,382
Annual	Rice	2,540	100	3.3	8,382
	Upland Crops 2/	380	15	-	1,342
Increment (II - I)					
Annual	Rice	- 225	- 2	1.8	4,125
	Upland Crops	350	14	-	1,168

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply.

2/: Total of upland crops & vegetables, represented by mungbeans, groundnut, watermelon & cucumber.

Note: Rice figures are total of wet & early wet season rice and direct sowing & transplanting rice

As shown in the table, the increase of overall average yield of 1.8 ton/ha from 1.5 to 3.3 ton/ha and annual paddy production increase of some 4,100 tons are expected. The paddy production under the sub-project is about 200% of the current production level in the area. Under the sub-project, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be some 1,300 tons, increase of about 1,200 tons from the present level. Successful introduction of the crops through the proposed extension activities will further expand the cultivation of the crops in the area in the future.

#### B3.4.5 Proposed Farming Practices

Proposed improved farming practices of paddy to be adopted are same with the practices proposed for the Damnak Ampil sub-project and include proper land preparation, quality seed & proper seeding rate, improved nursery & planting method, proper fertilization & water management etc. as discussed in the section B3.3.5.

#### B3.4.6 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition compared with the present/without-project condition, farm economic analyses on the typical farm Type A (farm with rainfed paddy field; rainfed fields accounting for 95% of total paddy

field in the sub-project area) defined for the estimation of the current capacity to pay in the section B1.4.13 were made based on the crop budget analysis on the proposed cropping pattern under the project (Table B1.1-12, B1.1-13 & B3.1-2).

### (1) Typical Farms

The typical farms for the farm economic analysis are as shown in the following table.

**Typical Farms for Analysis**

Type	Irrigation Status		Holding Size
	Present/Without-project	With-project	
Type A-1	Rainfed paddy field	Normal Irrigation	1.4 ha/family
Type A-2	Rainfed paddy field	Pump Irrigation	1.4 ha/family

The results of farm economic analyses of typical farms under the with-project condition are presented in Table B3.4-2 and summarized in the following table.

**Farm Economy under With-project Condition**

Item		Amount (Riel 1,000.-)	
		Type A-1	Type A-2
Gross Incomes	Rice Production	5,082	5,082
	Upland Crops/Vegetables Production 2/	632	-
	Other Farm Incomes	1,100	1,100
	Non-farm Income	1,690	1,690
Total Income		8,504	7,872
Expenditures	Production Costs of Farm Products	2,692	2,731
	Other Expenditures	3,440	3,440
	Total Expenditures	6,132	6,171
Net Surplus		2,372	1,701

1/: Assuming other farm income, non-farm income & other expenditures are same in both cases

2/: No cropping of upland crops/vegetables assumed under pump irrigation

As shown in the tables, the farm economic statuses of both the typical farms under the with-project condition will be substantially improved mainly because of the increase of paddy yields under irrigation and introduction of upland crops/vegetables (in case of Type A-1). The net surplus or capacity to pay are estimated at Riel 2,372,000 (US\$ 579.-) or 28% of total income for Type A and Riel 1,701,000 (US\$ 415.-) or 22% of total income for Type A-2. The incremental net surpluses account for Riel 1,740,000 (US\$ 424.-) and Riel 1,069,000 (US\$ 261.-) from the present level, respectively for Type A-1 and Type A-2 as shown below.

**Incremental Income & Net Surplus under With-project Condition (unit: Riel 000)**

Factor	Type A-1			Type A-2		
	Present	With-project	Increment	Present	With-project	Increment
Total Incomes	5,100	8,504	3,404	5,100	7,872	2,772
Net Income	3,502	5,812	2,310	3,502	5,141	1,639
Net Surplus	632	2,372	1,740	632	1,701	1,069
(increment in %)	(100)	(375)	(275)	(100)	(269)	(169)

Source: JICA Study Team

### B3.4.7 Agricultural Extension Activities

The proposed activities are development interventions aiming at strengthening of agricultural extension services for attaining the sub-project target crop yields and cropping pattern at an earlier stage as possible. The activities accommodated as the sub-project component and the

implementation and cost schedules of the same are presented in Table B3.4-3 and summarized in the following table.

**Estimated Costs for Agricultural Extension Activities 1/**

Activity	Estimated Cost (US\$)
Field Extension Programs	87,550
Farmer/Farmer Group Training Programs	21,700
Mass Guidance/Workshop	2,000
Support Fund for Extension Staff 2/	28,800
Staff Empowerment	4,000
Provision of Transportation Means	6,000
Total	150,050

1/: Program direct costs

2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

Major extension activities are as discussed in the section B3.3.7 and include field programs including seed multiplication program, farmer & farmer group training programs mass guidance/workshop, staff empowerment, support fund for extension staffs and provision of transportation means.

The implementation of the activities is scheduled for the period of 4 years in the sub-project and the overall cost is estimated at US\$ 150,000.-.

### B3.5 Wat Chre Rehabilitation Sub-project Area

#### B3.5.1 Land Use Plan

The land use plan under the with-project condition is presented in comparison with the present/without-project land use as follows;

**Present/Without-project & With-project Land Use of the Project Area**

Land Use Sub-category	Present		With-project		Increment (ha)
	(ha)	(%)	(ha)	(%)	
Paddy Field					
- Normal Irrigation Paddy Field			1,020	100	1,020
- Supplemental Irrigation Paddy Field	60	6			- 60
- Rainfed Paddy Field	1,030	94			- 1,030
Sub-total	1,090	100	1,020	100	- 70
Right-of-ways	80	7	150	13	70
Total	1,170	100	1,170	100	0

As shown in the table, the development of 1,020 ha of normal irrigation paddy field is aimed at under the project by the conversion of 60 ha of supplemental irrigation fields and 1,030 ha of rainfed fields. The decrease of paddy fields due to land use conversion to right-of-ways is estimated at 70 ha.

#### B3.5.2 Proposed Cropping Pattern and Cropped Area

##### (1) Crop Selection

The crop selection under the present plan has been made on the basis of the approaches applied for the Damnak Ampil sub-project discussed in the section B3.3.2 as follows;

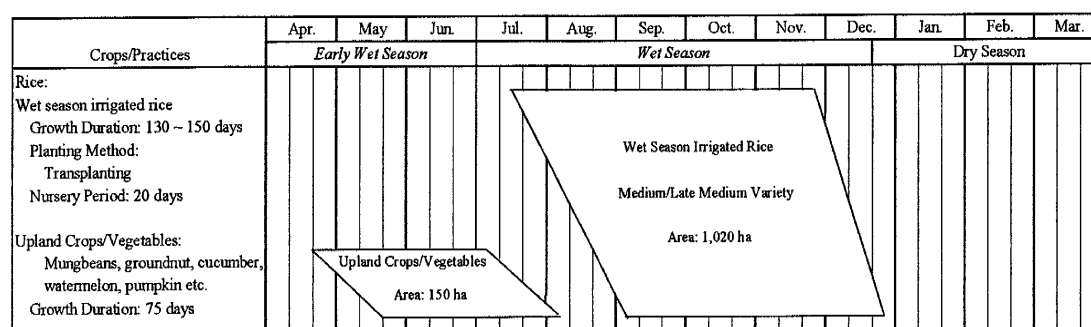
- Rice, current exclusive crop in the main cropping season, wet season, is selected as a crop to be introduced in the season as no other promising crops are conceivable and

rice is a by far the most important crop and stable food in the area,

- Introduction of irrigated upland crops/vegetables production in early wet season 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, and
- Candidate upland crops could include mungbeans, groundnut, soybeans and corn and the same of vegetables include cucumber, water melon, pumpkin and gourd currently cultivated in and around the sub-project area. However, for the successful introduction of the crops, intensified extension supports should be accommodated as an essential component of the sub-project.

## (2) Cropping Pattern and Cropped Area

Based on the study on the current prevailing cropping patterns, the development strategies discussed above and the results of irrigation water balance study, the proposed cropping pattern is formulated as follows;



### Proposed Cropping Pattern: Wat Chre Sub-project

The cropping intensity targeted under the plan is similar to the same for the Damnak Ampil and Wat Loung sub-project areas as follows;

- Rice cropping intensity of 100% in wet season under irrigation is planned in the pattern within the availability of irrigation water, and
- Introduction of upland crops/vegetables under irrigation in early wet season to the extent of cropping intensity 15% is envisaged by availing irrigation water supply in the season to promote crop diversification in the sub-project area.

The planned cropped areas and cropping intensity envisaged in the pattern are shown in Table B3.5-1 and summarized in the following table.

### Planned Cropped Area & Cropping Intensity under the Project

Unit: ha & %

Crop	Cropping Season							
	Early Wet Season		Wet Season		Dry Season		Annual	
	Area	Intensity	Area	Intensity	Area	Intensity	Area	Intensity
Irrigated Rice			1,020	100			1,020	100
Upland Crops/Vegetables	150	15					150	15
Total	150	15	1,020	100	0	0	1,170	115

### B3.5.3 Target Crop Yields

The target crop yields under the present plan in which normal irrigation is ensured are set at the same levels with the Damnak Ampil and Wat Loung sub-projects as shown in the following table in comparison with the present yield levels.

Wet Season				Early Wet Season			
Crop 1/	Target	Present	Increment	Crop	Target	Present	Increment
Improvement of Irrigation Status: Present: Supplemental Irrigation ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.3	2.0	1.3	Upland Crops 3/	1.1	-	-
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.3	1.5	1.8	Upland Crops 3/	1.1	-	-

1/: T – transplanting 2/: Including pump irrigation fields 3/: Upland crops: average of mungbeans & groundnut

Yield increases of 1.3 to 1.8 ton/ha in wet season rice are envisaged under the plan. The target yields of irrigated upland crops and vegetables are set rather conservatively as follows;

Crops	Target Yield	Crops	Target Yield
Mungbeans	0.9 ton/ha	Watermelon	9.0 ton/ha
Groundnut	1.3 ton/ha	Cucumber	10.0 ton/ha

1/: Current yield level: watermelon 5.5 ton/ha & cucumber 6.0 ton/ha under rainfed

### B3.5.4 Crop Production Plan

The crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.5-1 and summarized as follows;

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		60	6	2.0	120
Rainfed Paddy Field: Wet Season Rice		1,030	94	1.5	1,545
Annual	Rice	1,090	100	1.5	1,665
	Upland Crops	30	3	-	174
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		1,020	100	3.3	3,366
Annual	Rice	1,020	100	3.3	3,366
	Upland Crops 2/	150	15	-	585
Increment (II – I)					
Annual	Rice	- 70	0	1.8	1,701
	Upland Crops	120	12	-	411

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply.

2/: Total of upland crops & vegetables, represented by mungbeans, groundnut, watermelon & cucumber.

Note: Rice figures are total of wet & early wet season rice and direct sowing & transplanting rice

As shown in the table, the increase of overall average yield of 1.8 ton/ha from 1.5 to 3.3 ton/ha and annual paddy production increase of some 1,700 tons are expected. The paddy production under the sub-project is about 200% of the current production level in the project area. Under the sub-project, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be about 600 tons, increase of about 400 tons from the present level. Successful introduction of the crops through the proposed

extension activities will further expand the cultivation of the crops in the area in the future.

### B3.5.5 Proposed Farming Practices

Proposed improved farming practices of paddy to be adopted are same with the practices proposed for the Damnak Ampil sub-project and include proper land preparation, quality seed & proper seeding rate, improved nursery & planting method, proper fertilization & water management etc. as discussed in the section B3.3.5.

### B3.5.6 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition compared with the present/without-project condition, farm economic analyses on the typical farm Type A (farm with rainfed paddy field; rainfed fields accounting for 94% of total paddy field in the sub-project area) defined for the estimation of the current capacity to pay in the section B1.5.13 were made based on the crop budget analyses on the proposed cropping pattern under the project (Table B1.1-12, B1.1-13 & B3.1-2).

#### (1) Typical Farms

The typical farms for the farm economic analysis are as shown in the following table.

**Typical Farms for Analysis**

Type	Irrigation Status		Holding Size
	Present/Without-project	With-project	
Type A-1	Rainfed paddy field	Normal Irrigation	1.6 ha/family
Type A-2	Rainfed paddy field	Pump Irrigation	1.6 ha/family

The results of farm economic analyses of typical farms under the with-project condition are presented in Table B3.5-2 and summarized in the following table.

**Farm Economy under With-project Condition**

Item		Amount (Riel 1,000.-)	
		Type A-1	Type A-2
Gross Incomes	Rice Production	5,808	5,808
	Upland Crops/Vegetables Production 2/	723	-
	Other Farm Incomes	290	290
	Non-farm Income	1,740	1,740
Total Income		8,561	7,838
Expenditures	Production Costs of Farm Products	2,790	2,834
	Other Expenditures	2,940	2,940
	Total Expenditures	5,730	5,774
Net Surplus		2,831	2,064

1/: Assuming other farm income, non-farm income & other expenditures are same in both cases

2/: No cropping of upland crops/vegetables assumed under pump irrigation

As shown in the tables, the farm economic statuses of both the typical farms under the with-project condition will be substantially improved mainly because of the increase of paddy yields under irrigation and introduction of upland crops/vegetables (in case of Type A-1). The net surplus or capacity to pay are estimated at Riel 2,831,000 (US\$ 690.-) or 33% of total income for Type A-1 and Riel 2,064,000 (US\$ 503.-) or 26% of total income for Type A-2. The incremental net surpluses account for Riel 2,161,000 (US\$ 527.-) and Riel 1,394,000 (US\$ 340.-) from the present level, respectively for Type A-1 and Type A-2 as shown below.

**Incremental Income & Net Surplus under With-project Condition (unit: Riel 000)**

Factor	Type A-1			Type A-2		
	Present	With-project	Increment	Present	With-project	Increment
Total Incomes	4,670	8,561	3,891	4,670	7,838	3,168
Net Income	3,130	5,771	2,641	3,130	5,004	1,874
Net Surplus	670	2,831	2,161	670	2,064	1,394
(increment in %)	(100)	(423)	(323)	(100)	(308)	(208)

Source: JICA Study Team

### B3.5.7 Agricultural Extension Activities

The proposed activities are development interventions aiming at strengthening of agricultural extension services for attaining the sub-project target crop yields and cropping pattern at an earlier stage as possible. The activities accommodated as the sub-project component and the implementation and cost schedules of the same are presented in Table B3.5-3 and summarized in the following table.

**Estimated Costs for Agricultural Extension Activities 1/**

Activity	Estimated Cost (US\$)
Field Extension Programs	36,000
Farmer/Farmer Group Training Programs	12,800
Mass Guidance/Workshop	800
Support Fund for Extension Staff 2/	10,880
Staff Empowerment	3,200
Provision of Transportation Means	2,100
Total	65,780

1/: Program direct costs

2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

Major extension activities are as discussed in the section B3.3.7 and include field programs including seed multiplication program, farmer & farmer group training programs mass guidance/workshop, staff empowerment, support fund for extension staffs and provision of transportation means.

The implementation of the activities is scheduled for the period of 4 years in the sub-project and the overall cost is estimated at US\$ 66,000.-.

### B3.6 Lum Hach Rehabilitation Sub-project

#### B3.6.1 Land Use Plan

The land use plan under the with-project condition is presented in comparison with the present/without-project land use as follows;

**Present/Without-project & With-project Land Use of the Project Area**

Land Use Sub-category	Present		With-project		Increment (ha)
	(ha)	(%)	(ha)	(%)	
Paddy Field					
- Normal Irrigation Paddy Field			3,100	100	3,100
- Supplemental Irrigation Paddy Field	200	6			- 200
- Rainfed Paddy Field	3,120	94			- 3,120
Sub-total	3,320	100	3,100	100	- 220
Right-of-ways	250	7	470	13	220
Total	3,570	100	3,570	100	0

As shown in the table, the development of 3,100 ha of normal irrigation paddy field is aimed at under the project by the conversion of 200 ha of supplemental irrigation fields and 3,120 ha of rainfed fields. The decrease of paddy fields due to land use conversion to right-of-ways is estimated at 220 ha.

### B3.6.2 Proposed Cropping Pattern and Cropped Area

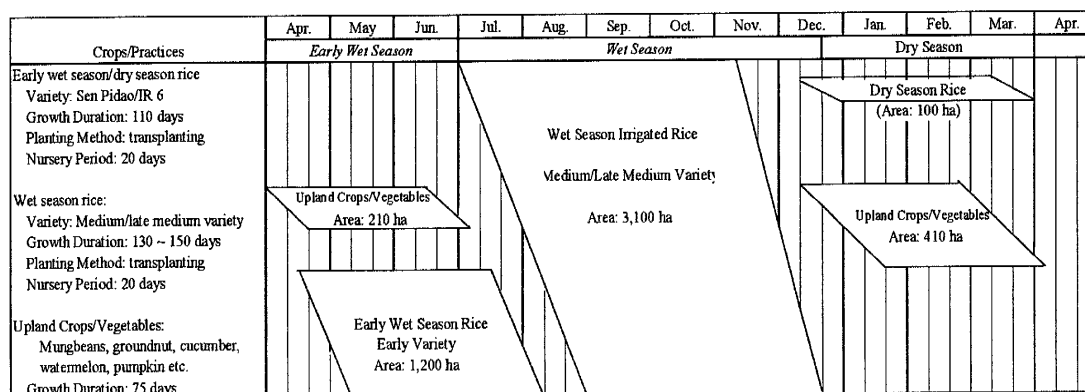
#### (1) Crop Selection

The crop selection under the present plan has been made basically on the basis of the development concept discussed earlier 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 staple food in the area,
- In early wet and dry season, cultivation of early rice is planned by sharing available irrigation water in the seasons with upland crops/vegetables,
- Introduction of irrigated upland crops/vegetables production in early wet and dry season 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, and
- Candidate upland crops could include mungbeans, groundnut, soybeans and corn and the same of vegetables include cucumber, water melon, pumpkin and gourd currently cultivated in and around the sub-project area. However, for the successful introduction of the crops, intensified extension supports should be accommodated as an essential component of the sub-project.

#### (2) Cropping Pattern and Cropped Area

Based on the study on the current prevailing cropping patterns, the development strategies discussed above and the results of irrigation water balance study, the proposed cropping pattern is formulated as follows;



**Proposed Cropping Pattern: Lum Hach Sub-project**

The cropping intensity targeted under the plan is as follows;

- Rice cropping intensity of 100% in wet season is planned in the pattern as is currently



practiced,

- Intensity of rice in the early wet season is targeted at 39% within the availability of irrigation water supply after sparing some water for upland crops/vegetables production. In dry season, an intensity of rice is limited to 3% by allocating available irrigation water to upland crops/vegetables cultivation, and
- The annual intensity of 20% of upland crops/vegetables under irrigation is envisaged to promote crop diversification in the sub-project area. The targeted cropping intensity of the crops is 7% in early wet season and 13% in dry season.

The planned cropped areas and cropping intensity envisaged in the pattern are shown in Table B3.6-1 and as summarized in the following table.

### Planned Cropped Area & Cropping Intensity under the Project

Unit: ha & %

Crop	Cropping Season							
	Early Wet Season		Wet Season		Dry Season		Annual	
	Area	Intensity	Area	Intensity	Area	Intensity	Area	Intensity
Irrigated Rice	1,200	39	3,100	100	100	3	4,400	142
Upland Crops/Vegetables	210	7			410	13	620	20
Total	1,410	7	3,100	100	510	16	5,020	162

### B3.6.3 Target Crop Yields

The target crop yields under the present plan in which normal irrigation is ensured are studied, as is the case in the other sub-project areas, based on the current yield levels at normal (full) irrigation areas 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: Supplemental Irrigation ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.0	1.7	1.3	Early Rice (T)	3.0	-	-
				Upland Crops 3/	1.1	-	-
Improvement of Irrigation Status: Present: Rainfed ⇒ With-project: Normal Irrigation 2/							
Medium Rice (T)	3.0	1.2	1.8	Upland Crops 3/	1.1	-	-

1/: T -- transplanting 2/: Including pump irrigation fields 3/: Upland crops: average of mungbeans & groundnut

Yield increases of 1.3 to 1.8 ton/ha in wet season rice are envisaged under the plan. Target yield of early wet and dry season rice is set at 3.0 ton/ha and the same of irrigated upland crops and vegetables are set rather conservatively as follows;

### Target Yields of Upland Crops/Vegetables

Crops	Target Yield	Crops	Target Yield
Mungbeans	0.9 ton/ha	Watermelon	9.0 ton/ha
Groundnut	1.3 ton/ha	Cucumber	10.0 ton/ha

1/: Current yield level: watermelon 5.5 ton/ha & cucumber 6.0 ton/ha under rainfed

### B3.6.4 Crop Production Plan

The crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.6-1 and summarized as follows;

**Present & With-project Crop Production of the Project Area**

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		200	6	1.7	340
Rainfed Paddy Field: Wet Season Rice		3,120	94	1.2	3,744
Annual	Rice	3,320	100	1.2	4,084
	Upland Crops	40	1	-	232
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		4,400	142	3.0	13,200
Annual	Rice	4,400	142	3.0	13,200
	Upland Crops 2/	620	20	-	735
Increment (II – I)					
Annual	Rice	1,080	42	1.8	9,116
	Upland Crops	580	19	-	503

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply.

2/: Total of upland crops & vegetables, represented by mungbeans, groundnut, watermelon & cucumber.

Note: Rice figures are total of wet & early wet season rice and direct sowing & transplanting rice

As shown in the table, the increase of overall average yield of 1.8 ton/ha from 1.2 to 3.0 ton/ha and annual paddy production increase of some 9,100 tons are expected. The paddy production under the sub-project is about 320% of the current production level in the project area. Under the sub-project, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be some 730 tons, increase of about 500 tons from the present level. Successful introduction of the crops through the proposed extension activities will further expand the cultivation of the crops in the area in the future.

### B3.6.5 Proposed Farming Practices

Proposed improved farming practices of paddy envisaged 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), iv) fertilization (increased & timely application including compost or cow dung), v) introduction of proper on-farm water management & water saving culture, vi) intensified weeding and vii) improvement of post-harvesting practices as proposed for the other sub-project areas.

### B3.6.6 Capacity to Pay

For the estimation of the incremental capacity-to-pay under the with-project condition compared with the present/without-project condition, farm economic analyses on the typical farm Type A (farm with rainfed paddy field; rainfed fields accounting for 94% of total paddy field in the sub-project area) defined for the estimation of the current capacity to pay in the section B1.6.13 were made based on the crop budget analyses on the proposed cropping pattern under the project (Table B1.1-12, B1.1-13 & B3.1-2).

(1) **Typical Farms**

The typical farms for the farm economic analysis are as shown in the following table.

Type	Irrigation Status		Holding Size
	Present/Without-project	With-project	
Type A-1	Rainfed paddy field	Normal Irrigation	1.4 ha/family
Type A-2	Rainfed paddy field	Pump Irrigation	1.4 ha/family

The results of farm economic analyses of typical farms under the with-project condition are presented in Table B3.6-2 and summarized in the following table.

Item		Amount (Riel 1,000.-)	
		Type A-1	Type A-2
Gross Incomes	Rice Production	6,390	6,270
	Upland Crops/Vegetables Production	842	-
	Other Farm Incomes	550	550
	Non-farm Income	570	570
Total Income		8,352	7,390
Expenditures	Production Costs of Farm Products	3,481	3,605
	Other Expenditures	1,550	1,550
	Total Expenditures	5,031	5,155
Net Surplus		3,321	2,235

1/: Assuming other farm income, non-farm income & other expenditures are same in both cases

2/: No cropping of upland crops/vegetables assumed under pump irrigation

As shown in the tables, the farm economic statuses of both the typical farms under the with-project condition will be greatly improved mainly because of the increase of annual cropping intensity of 62% in the Type A-1 and 39 % in the Type A-2 from the present 100% and the increase of paddy yields under irrigation. The net surplus or capacity to pay are estimated at Riel 3,321,000 (US\$ 810.-) or 40% of total income for Type A-1 and Riel 2,235,000 (US\$ 545.-) or 30% of total income for Type A-2. The incremental net surpluses account for Riel 3,055,000 (US\$ 745.-) and Riel 1,969,000 (US\$ 480.-) from the present level, respectively for Type A-1 and Type A-2 as shown below.

**Incremental Income & Net Surplus under With-project Condition (unit: Riel 000)**

Factor	Type A-1			Type A-2		
	Present	With-project	Increment	Present	With-project	Increment
Total Incomes	2,968	8,352	5,384	2,968	7,390	4,422
Net Income	1,546	4,871	3,325	1,546	3,785	2,239
Net Surplus	266	3,321	3,055	266	2,235	1,969
(increment in %)	(100)	(1,248)	(1,148)	(100)	(840)	(740)

Source: JICA Study Team

**B3.6.7 Agricultural Extension Activities**

Under the sub-project, the substantial increases of yields and annual cropping intensity of paddy and the introduction of irrigated upland crops/vegetables production are envisaged, which dictates the introduction of intensified extension activities in the area. The proposed activities are development intervention aiming at strengthening of agricultural extension services for attaining the sub-project targets of cropping pattern and crop yields at an earlier

stage as possible. The activities accommodated as sub-project component and the implementation and cost schedules of the same are presented in Table B3.6-3 and summarized in the following table.

**Estimated Costs for Agricultural Extension Activities 1/**

Activity	Estimated Cost (US\$)
Field Extension Programs	109,700
Farmer/Farmer Group Training Programs	24,400
Mass Guidance/Workshop	2,400
Support Fund for Extension Staff 2/	32,640
Staff Empowerment	4,000
Provision of Transportation Means	6,300
Total	179,440

1/: Program direct costs

2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

Major extension activities include field programs (adaptability test, demonstration plot, farm & area, upland crops/rice seed multiplication), farmer & farmer group training programs (training course, FFS/IPM, study tour), mass guidance/workshop, staff empowerment, support fund for extension staffs and provision of transportation means.

The implementation of the activities is scheduled for the period of 4 years in the sub-project and the overall cost is estimated at US\$ 179,500.-.

### B3.7 Overall Development Features

The overall development features of the 6 sub-projects are summarized into: i) overall land use plan, ii) overall crop production plan and iii) overall agricultural extension activities planned under the sub-projects.

#### B3.7.1 Overall Land Use Plan

The overall land use plan/irrigation development plan under the with-project condition is presented in comparison with the present/without-project land use as follows;

**Present/Without-project & With-project Land Use of the Project Area**

Land Use Sub-category	Present		With-project		Increment (ha)
	(ha)	(%)	(ha)	(%)	
Paddy Field					
- Normal Irrigation Paddy Field			12,760	100	12,760
- Supplemental Irrigation Paddy Field	1,040	8			- 1,040
- Rainfed Paddy Field	12,610	92			- 12,610
Sub-total	13,650	100	12,760	100	- 890
Right-of-ways	1,020	7	1,910	13	890
Total	14,670	100	14,670	100	0

As shown in the table, the development of 12,760 ha of normal irrigation paddy field is aimed at under the project by the conversion of 1,040 ha of supplemental irrigation fields and 12,610 ha of rainfed fields. The irrigated fields under the project increase 11,720 ha or the same is about 12 times of the present level. The decrease of paddy fields due to land use conversion to right-of-ways is estimated at 890 ha.

### B3.7.2 Overall Crop Production Plan

The overall crop production plan under the with-project condition is presented in comparison with the present/without-project crop production in Table B3.7-1 and summarized as follows;

#### Present & With-project Overall Crop Production of the Project Area

Land Use Sub-category/Crops		Cropped Area (ha)	Intensity (%)	Yield (t/ha)	Production (t)
I. Present/Without-project Crop Production					
Supplemental Irrigation Paddy Field: Rice		1,295	9	2.0	2,632
Rainfed Paddy Field: Wet Season Rice		13,070	96	1.4	18,400
Annual	Rice	14,365	105	1.5	21,032
	Upland Crops/Vegetables	110	1	-	585
	Overall	14,475	106	-	-
II. With-project Crop Production					
Normal Irrigation Paddy Field: Rice		14,830	116	3.1	46,515
Rainfed Rice 1/		1,430	11	1.3	1,885
Annual	Rice	16,260	127.4	3.0	48,400
	Upland Crops/Vegetables	2,064	16.2	-	7,405
	Overall	18,324	144	-	-
Increment (II - I)					
Annual	Rice	1,895	22.2	1.5	27,368
	Upland Crops/Vegetables	1,954	15.4	-	6,820
	Overall	3,849	38	-	-

1/: Cultivation of wet season rice under rainfed conditions due to limitation of irrigation water supply

As shown in the table, the increase of overall average yield of 1.5 ton/ha from 1.5 to 3.0 ton/ha and annual paddy production increase of some 27,400 tons are expected. The paddy production under the sub-project is about 2,300% of the current production level in the project areas. Under the sub-projects, the expansion of upland crops/vegetables production is envisaged and the production volume of the crops is estimated to be some 7,400 tons, increase of about 6,800 tons from the present level.

Increases of annual cropping intensity or land use intensity are 22% for paddy from the present 105% to 127% and 15% for upland crops/vegetables from the present 1% to 16%. Overall increase of cropping intensity is estimated at 38% from the present 106% to 144%.

### B3.7.3 Overall Agricultural Extension Activities

The overall cost estimates for agricultural extension activities accommodated as sub-project components are summarized in the following table.

#### Overall Costs for Agricultural Extension Activities 1/

Activity	Estimated Cost	
	(US\$)	(%)
Field Extension Programs	448,000	58
Farmer/Farmer Group Training Programs	119,000	16
Mass Guidance/Workshop	10,000	1
Support Fund for Extension Staff 2/	140,000	18
Staff Empowerment	23,000	3
Provision of Transportation Means	27,000	4
Total	767,000	100

1/: Program direct costs

2/: Provision of support for VAA (village Agriculture Extension Agent) & field staff

The overall costs for the agricultural extension activities are estimated at US\$ 767,000.- as shown in the table. Among the planned activities, field extension programs, support fund for extension staff and farmer/farmer group training programs account for 58%, 18% and 16%, respectively.

### B3.8 Labor Balance under With-project Condition

The labor balances under with-project condition have been examined for the sub-projects with the substantial increase in annual cropping intensity under the project, the Ream Kon, Por Canal and Lum Hach Sub-projects. For the balance study, the following assumptions are set based on the proposed cropping patterns and agro-demographic features of the sub-projects.

**Assumptions for Labor Balance**

Item	Ream Kon	Por Canal	Lum Hach
Paddy Field Holding Size	2.2 ha/family	2.4 ha/family	1.4 ha/family
<b>Cropping Pattern &amp; Cropped Area</b>			
Early Wet Season Irrigated Rice	1.3 ha	1.4 ha	0.55 ha
Wet Season Irrigated Rice	1.4 ha	1.5 ha	1.4 ha
Wet Season Rainfed Rice	0.8 ha	0.9 ha	-
Upland Crops/Vegetables	0.33 ha	0.36 ha	0.28 ha
Family Labor Force	3.0/family	3.2/family	2.7/family
Working Days/Month	25 days	25 days	25 days

The result of labor balance study is indicated in Table B3.8-1, B3.8-2 and B3.8-3. As shown in the tables, some labor shortages (about 12 to 14% of annual labor requirements) will be encountered under the with-project condition in all the sub-project areas. In the Ream Kon and Por Canal sub-projects areas, shortages will occur at harvesting time of early wet season rice and transplanting & harvesting time of wet season rice. In the Lum Hach sub-project area, the same will occur at transplanting & harvesting time of wet season rice. Such labor shortages will be solved through labor exchange arrangement or hiring labor as currently practiced in the areas.

In the other sub-project areas, increases in labor requirements under the with-project condition will be limited as the increase in cropping intensity is limited to 15% in early wet season, current off-farming season.

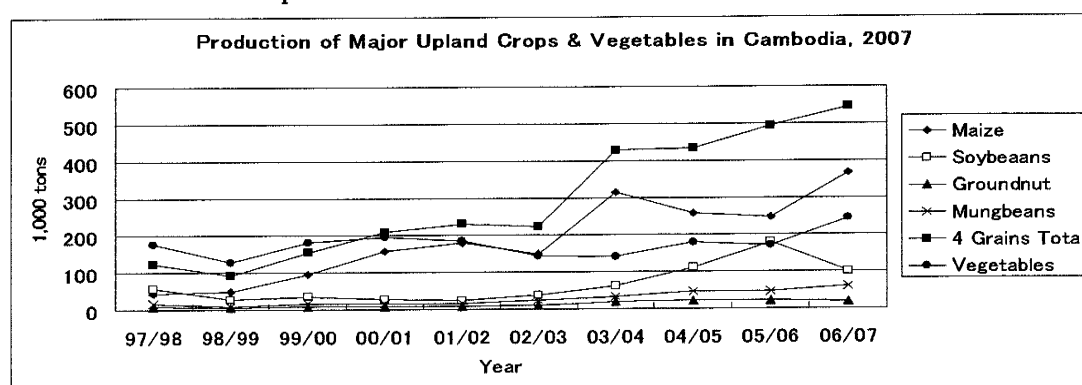
## CHAPTER B 4 MARKET STUDY

In the present project, the introduction of irrigated upland crops/vegetables is envisaged and the expansion of cropped areas and production of such crops (some 6,800 tons from the present level) is expected in the project areas. Aiming at preliminary examining marketability of such crops in the domestic and global market, the present market study has been made. The scope of the study include: i) production and marketing of major upland crops/vegetables and preliminary estimation of future domestic demand in Cambodia, ii) current global demand and supply of project related major grains and projections for future global demand for the same, iii) trade on the same and iv) world market prices of food commodity and factors contributing to recent hikes of the market prices.

### B.4.1 Production and Marketing of Upland Crops/Vegetables in Cambodia

#### B.4.1.1 Production of Upland Crops/Vegetables

The production trends of major upland crops and vegetables in Cambodia for the period of 1998/99 to 2006/07 are presented in Table B4.1-1 and illustrated in the following figure.



Source: Agricultural Statistics, MAFF, 1997/98 & 2006/07

Production volumes of major upland crops and vegetable in 1998/99 and 2006/07 in the country are summarized as follows;

#### Major producing Provinces of Upland Crops & vegetables

Commodity	1997/98	2006/07	Increase (%)
Maize	42,420t	367,170t	866
Soybeans	56,340t	100,100t	178
Groundnut	6,960t	18,370t	264
Mungbeans	15,310t	60,950t	398
Sub-total	121,030	546,590	452
Vegetables	176,790t	243,860t	138

Source: Agricultural Statistics, MAFF, 1997/98 & 2006/07

As shown in the table, the production increases of maize and mungbeans from 1997/98 to 2006/07 are remarkable. The production volume of 4 major upland crops in 2006/07 is 4.5 times of those in 1997/98. The average annual growth rate of the productions of 4 crops from 1997/98 to 2006/07 is estimated at as high as 18%.

The sharp increase in production volumes of maize in recent years in Cambodia is mainly attributed to the production increase in the provinces in the Thai border areas, Battambang and

Pailin. The same of mungbeans is mainly attributed to the production increases in Battambang and Bantheay Mean Chey. While, the production increase of soybeans in Kompong Cham contributes largely to the national production increase of the crop.

Major producing provinces of upland crops and vegetables in 2006/07 in Cambodia are as shown in the following table.

**Major Producing Provinces of Upland Crops & vegetables, 2006/07**

Commodity	Province		
	Largest	2 <sup>nd</sup> Largest	3 <sup>rd</sup> Largest
Maize	Battambang	Pailin	Kompong Cham
Soybeans	Battambang	Kompong Cham	Prey Veng
Groundnut	Kompong Cham	Battambang	Mondulkiri
Mungbeans	Battambang	Banteay Mean Chey	Kandal
Vegetables	Pailin	Kompong Cham	Prey Veng

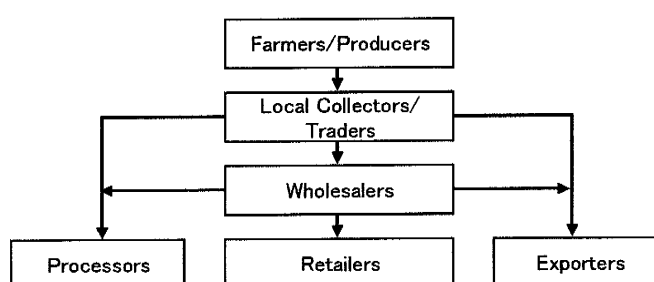
#### B.4.1.2 Marketing of Upland Crops/Vegetables

The major marketing channels of major project related grains (maize, soybeans, groundnut & mungbeans) are reported in “Report on Agricultural Marketing System and Marketing Potential, MAFF, 2006” and “Report on Diversified Production Plan Based on Marketing Development in North-western Region, MAFF, 2007”, both prepared under the support of JICA. According to the reports, marketing channels of the grains in major producing areas are as follows;

##### (1) Maize

The prevailing marketing channel of maize (yellow maize) in the major producing provinces (Battambang, Pailin, Kompong Cham and Kandal) are generalized as shown in the following figure.

The largest user of maize in Cambodia is the feed mill of CPF (Charoen Pokphand Foods) Cambodia in Kandal Province. Other users are small scale feed millers and pig and poultry raising farmers.



Source: MAFF, 2007 (aforementioned)

**Prevailing Marketing Channel of Maize (yellow maize)**

In international marketing, local collectors in producing areas play an important role in product sourcing and distribution to three large wholesale markets in Cambodia, wholesalers in Phnom Penh, cross-border traders in Thailand and the same in Vietnam. The wholesalers in Phnom Penh distribute products to retail networks and exporters. The main international destination markets of maize are Vietnam and Thailand through cross-border trade. Products in Battambang and Pailin are generally marketed to Thailand and the same in Kompong Cham and Kandal are mostly marketed to Vietnam.

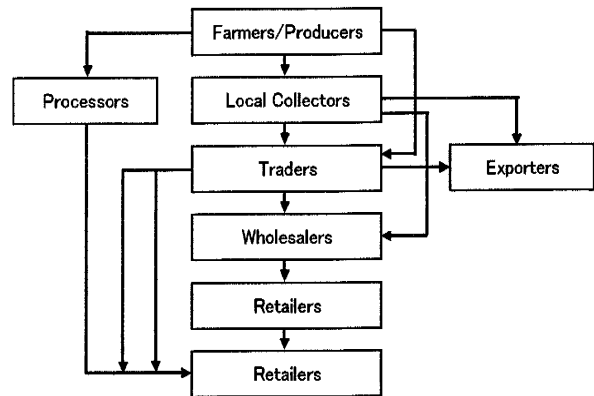


**(2) Soybeans**

The prevailing marketing channel of soybeans in the major producing provinces (Battambang, Kompong Cham and Pailin) are generalized as shown in the following figure.

As is the case in maize, the largest user of soybeans in Cambodia is the mill of CPF (Charoen Pokphand Foods) Cambodia in Kandal Province. Other users include small and medium scale processors of soybean meal, soy sauce, tofu etc. and poultry and pig farmers.

The main international destination markets of soybeans are Vietnam and Thailand through cross-border trade. Products in Battambang and Pailin are generally marketed to Thailand and the same in Kompong Cham are mostly marketed to Vietnam.



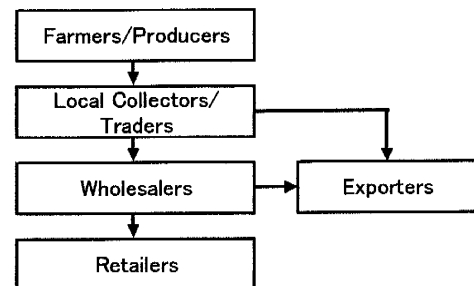
Source: MAFF, 2007 (aforementioned)

Prevailing Marketing Channel of Soybeans

**(3) Groundnut**

The prevailing marketing channel of groundnut in the major producing provinces (Kompong Cham and Battambang) are generalized as shown in the following figure.

Products of Kompong Cham are generally marketed to Phnom Penh Orussey Market and other province level markets. While, products of Battambang are mostly exported to Thailand through cross-border trade. However, exports volume of groundnut is limited at present and products are mostly consumed domestically. No groundnut oil processing factory is operating in Cambodia.



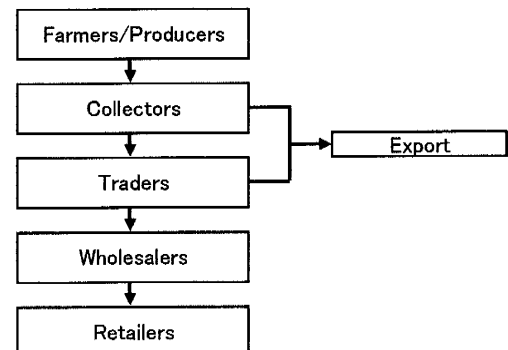
Source: MAFF, 2007 (aforementioned)

Prevailing Marketing Channel of Groundnut

**(4) Mungbeans**

The prevailing marketing channel of mungbeans in the major producing provinces (Battambang, Banteay Mean Chey and Kompong Cham) are generalized as shown in the figure.

Products of Kompong Cham are generally marketed to Phnom Penh Orussey Market and other province level markets. While, products of Battambang and Banteay Mean Chey are mostly exported to Thailand through cross-border trade and partly marketed to Phnom Penh and other provinces.



Source: MAFF, 2007 (aforementioned)

Prevailing Marketing Channel of Mungbeans

**(5) Vegetables**

Generally vegetable production is usually practiced in small scale with variety of crops in Cambodia and production surplus of products is limited. Accordingly, major marketing destinations appear to be nearby markets at village and commune level. However, watermelon and cucumber produced in some sub-project areas are marketed through village collectors to markets at district and province level. In case of watermelon, village collectors procure products by a whole field and harvesting is carried out by the collectors. When a certain volume of crop is produced in a village, collectors at village or commune level will come to procure the products for marketing to wholesalers or to large markets.

**B.4.1.3 Market Potential of Upland Crops/Vegetables Studied by MAFF**

Future marketing potential of upland crops/vegetables preliminary studied by MAFF are reported in “Report on Agricultural Marketing System and Marketing Potential, MAFF, 2006” and “Report on Diversified Production Plan Based on Marketing Development in North-western Region, MAFF, 2007” as follows;

*Many kinds of agricultural products of Cambodia have potential for exports. --- In the near future, agricultural products of Cambodia have high potential in exporting to Thailand, Vietnam, Malaysia, Singapore, China, South Korea and Hong Kong. Maize, cassava, cashew nut, soybeans, mungbeans, groundnut, sesame, tobacco and pepper etc. would be considered as the potential production for exports to the international markets presently as well as in the future (page 123, Report in 2006).*

*In the domestic market, there are a lot of imported vegetables from Vietnam and Thailand. It is necessary to substitute such imported products with domestic products at the first step to develop horticulture in Cambodia. As highland vegetables like cabbage, carrot and potato are difficult to compete with imported crops, 100% of perishable vegetables (leafy vegetable) that are easily damaged by transportation need to be supplied from domestic production (page 87, Report in 2007)*

**B.4.1.4 Preliminary Estimation of Future Domestic Demand for Upland Crops/Vegetables**

For the preliminary estimation of domestic demands for some upland crops, the following estimated per capita consumptions of crops in Cambodia, Thailand and Vietnam are applied.

**Per Capita Consumption of Major Grains (unit: kg/year) 1/**

Commodity	Per Capita Consumption/Year		
	Cambodia	Thailand	Vietnam
Maize	7.1	59.9	62.2
Soybeans	-	3.7	5.8

1/: Estimated consumption in 2007, World Food Statistics & Graphics, Kyushu University, Japan (original source:FAOSTAT)

When per capita consumptions in Cambodia are to be improved to the levels of Thailand and Vietnam, production volumes in the country to be expanded are roughly estimated as follows;

**Estimated Production Volumes Required to Increase Consumption Levels 1/**

Commodity	Current (2006/07) Production	Production Volume Required to Improve Consumption Levels to	
		Thailand	Vietnam
Maize 1/	367,000	880,500	914,000
Soybeans 1/	100,100	54,400	85,300

1/: Estimated by: 14.7 million (Cambodian projected population in 2008) x per capita annual consumption

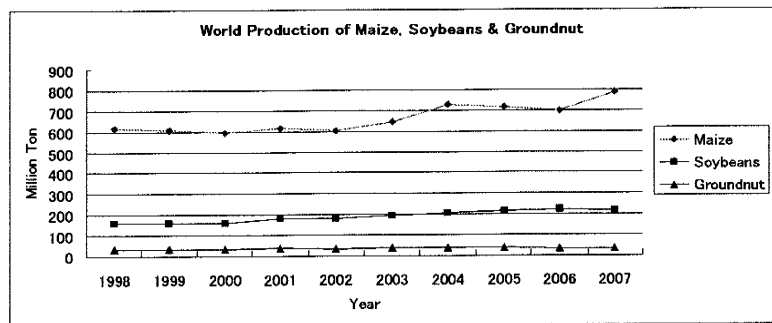
As shown in the table, maize production in Cambodia is to be expanded to 2.4 to 2.5 times of the present production level when consumption level is to be increased by domestic production to those of Thailand and Vietnam. On the other hand, soybeans production in the country appears to be sufficient to increase consumption level equivalent to the same of the two countries. However, the current export volume of soybeans (28,000 tons in 2005) is taken into account, the deficit of soybeans production of some 13,000 tons is estimated to attain the consumption level of Thailand.

## B4.2 Global Demand and Supply of Major Grains

### B4.2.1 Current Global Production of Major Grains

The production trends of maize, soybeans and groundnut in the world from 1998 to 2007 are as shown in the figure.

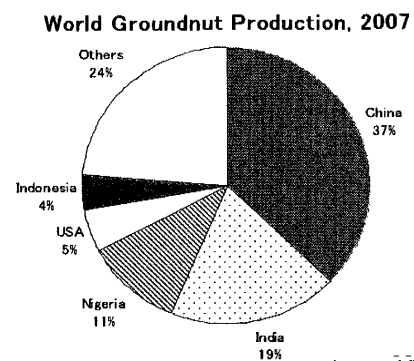
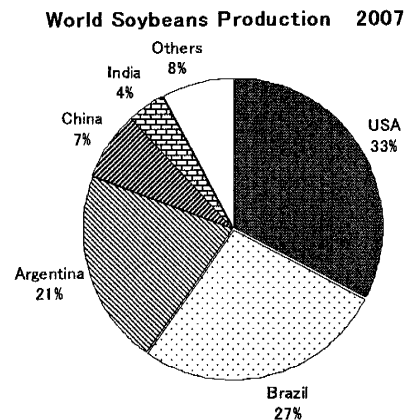
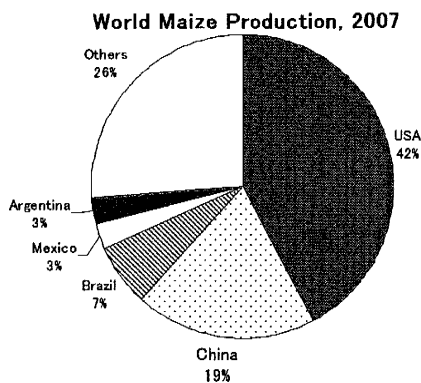
The production increase of maize during 10 years from 1998 to 2007 is 128% and the same of soybeans is 135%. The production volume of groundnut is nearly constant (103%).



Source: World Food Statistics & Graphics, Kyushu University, Japan

The annual production growth rates from 1998 to 2007 are calculated at 2.8% and 3.4%, respectively for maize and soybeans.

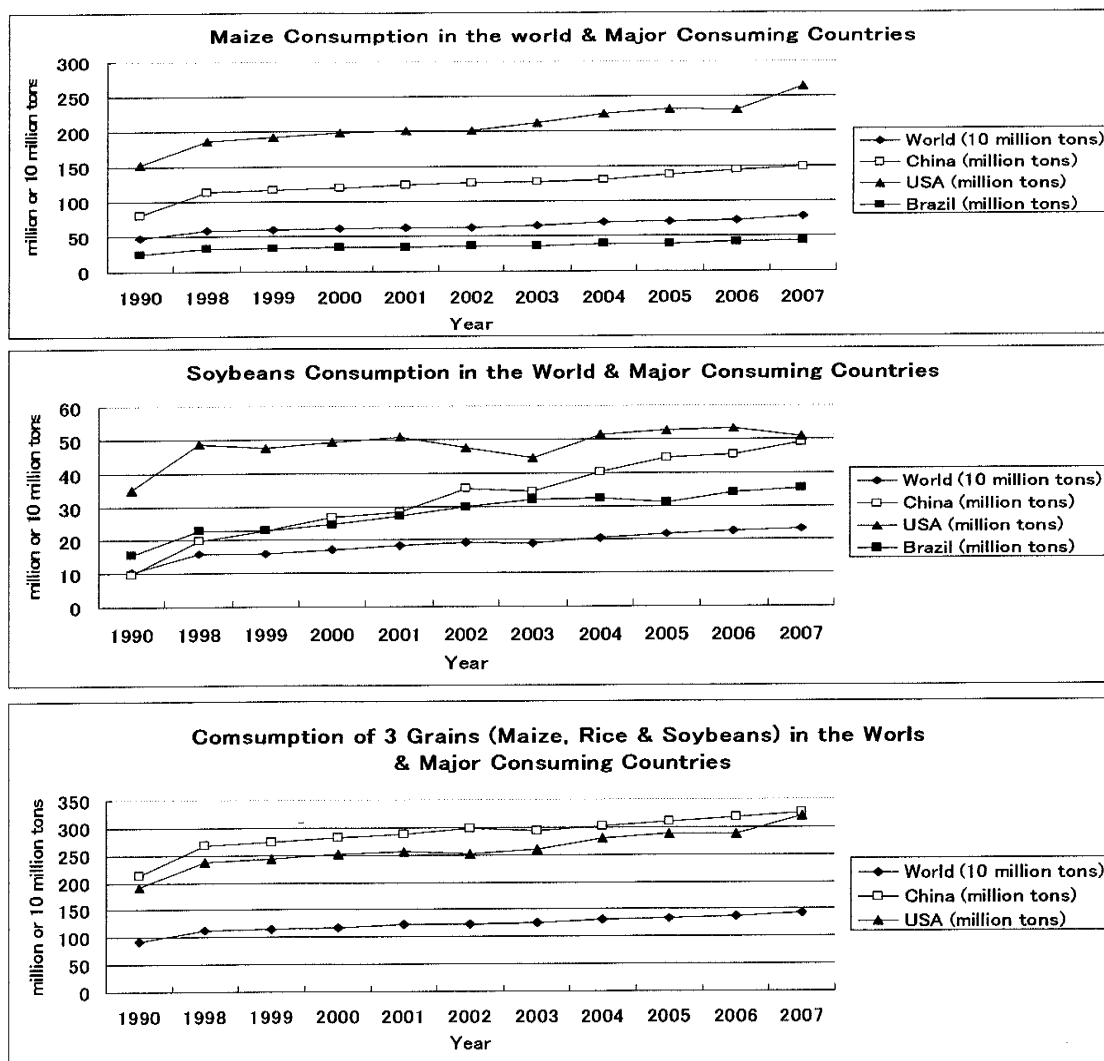
In 2007, the world production volumes of maize, soybeans and groundnut are respectively estimated at 784.6, 216.1 and 34.8 million tons (FAOSTAT). Major producing countries of each commodity estimated by FAO (FAOSTAT) are as follows;



As shown in the graphs, the largest producing country of maize in 2007 is USA followed by China and Brazil. The same of soybeans is USA followed by Brazil and Argentina and the same of groundnut is China followed by India and Nigeria.

### B4.2.2 Current Global Consumptions of Major Grains

The past trends in consumptions of major grains (maize, soybeans, rice) in the world and major consuming countries (China, USA, Brazil) are illustrated in the following figure.



Source: World Food Statistics & Graphics, Kyushu University, Japan (original source: FAOSTAT)

As shown in the figures, the increase of maize consumption in USA and the same of soybeans in China are remarkable and those increases in two countries played important roles in the consumption increases of the 3 major grains in the world. The annual growth rates of the world consumptions of maize, soybeans and the 3 grains including rice from 1998 to 2007 are estimated at 3%, 4% and 3%, respectively.

The major consuming countries of the 3 major grains are as shown in the following table.

**Major Consuming Countries, 2007**

Maize (million tons)		Soybeans (million tons)		Rice (million tons)	
Country	Volume	Country	Volume	Country	Volume
USA	264	USA	51	China	127
China	149	China	49	India	91
Brazil	43	Brazil	35	Indonesia	36
World	774	World	230	World	422

### B4.2.3 Global Demand Projections of Major Grains

The global demands of major grains for 2015 and 2030 are projected in “World Agriculture: Towards 2015/2030, An FAO Perspective, FAO, 2003”. The followings have been prepared on the basis of the report.

#### (1) Demand Projections for Aggregate Agricultural Commodities

The annual growth rates of aggregated demand for all crops and livestock products are estimated as shown in the following table.

**Annual Growth Rates of Demand for Aggregate Commodities (%)**

Area	1979 - 1999	1997/99 -2015	2015 - 2030	1997/99 - 2030
World	2.1	1.6	1.4	1.5
Developing Countries	3.7	2.2	1.7	2.0
Industrial Countries	1.0	0.7	0.6	0.7
Transitional Countries	-1.7	0.5	0.4	0.5
Sub-Saharan Africa	3.1	2.9	2.8	2.9
East Asia	4.7	1.8	1.3	1.6

As shown in the table, the annual growth rate of demand for all crops and livestock products in the world is projected to be at 1.6% for the period of 1997/99 - 2015 and 1.5% for 1997/99 - 2030 , lower than the same of 2.1% for the period 1979 - 1999. The decrease in the growth rate for 1997/99 - 2015 is partly contributed by the slowdown of growth in demand for the commodities in China.

#### (2) Demand Projections for Cereals

The annual growth rates of demand for cereals are estimated as shown in the following table.

**Annual Growth Rates of Demand & World Production of Cereals**

Area	Annual Growth Rate (%)			
	1979 - 1999	1997/99 -2015	2015 - 2030	1997/99 - 2030
World	1.4	1.4	1.2	1.3
Developing Countries	2.6	1.9	1.5	1.7
Industrial Countries	1.0	0.8	0.6	0.7
Transitional Countries	-1.9	0.7	0.7	0.7
Year	1974/76	1997/99	2015	2030
World Production (million tons)	1,233	1,864	2,380	2,830

The annual growth rates of demand for cereals in the world for the period of 1997/99 - 2015 and 1997/99 - 2030 are projected at 1.4% and 1.3%, respectively, slightly lower than the rate of 1.4% in the past two decades of 1979 - 1999. The increase of demand increase in 2015 and 2030 from the level of 1997/99 is projected at 516 and 966 million tons, respectively. The demand levels of 2015 and 2030 are estimated at 128% and 152% of the base year of 1997/99, respectively.

#### (3) Demand Projections for Oil Crops, Vegetable Oils and Products

The annual growth rates of demand for oil crops, vegetable oils and products are estimated as shown in the following table.

## Growth Rates of Demand & World Production of Oil Crops, Vegetable Oils & Products

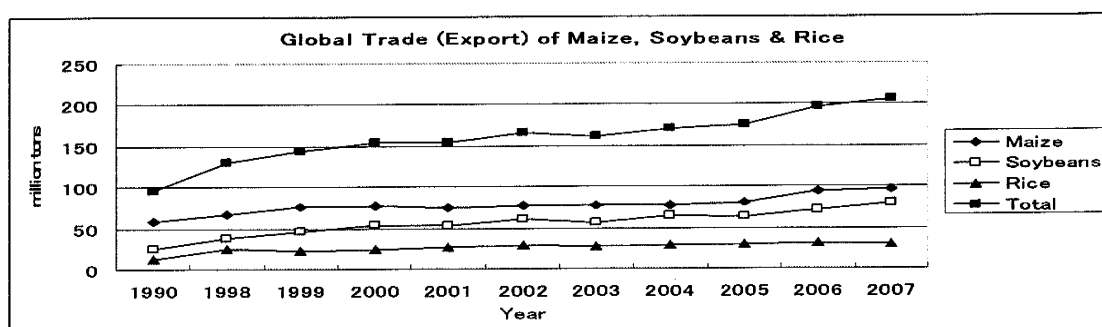
Area	Annual Growth Rate (%)			
	1979 - 1999	1989 - 1999	1997/99 -2015	2015 – 2030
World	3.9	3.7	2.7	2.2
Developing Countries	4.8	4.6	3.2	2.5
Industrial Countries	3.4	3.1	1.7	1.8
Transitional Countries	-0.4	-1.4	1.3	1.4
Year	1974/76	1997/99	2015	2030
World Production (million tons)	-	98.3	150.5	208.6

The annual growth rates of demand for the commodities in the world for the period of 1997/99 - 2015 and 2015 - 2030 are projected at 2.7% and 2.2%, respectively, substantially lower than the rate of 3.9% in the past two decades of 1979 - 1999. The increase of demand in 2015 and 2030 from the level of 1997/99 is projected at 52 and 110 million tons, respectively. The demand levels of 2015 and 2030 are estimated at 153% and 212% of the base year of 1997/99, respectively.

### B4.3 Trade of Major Grains

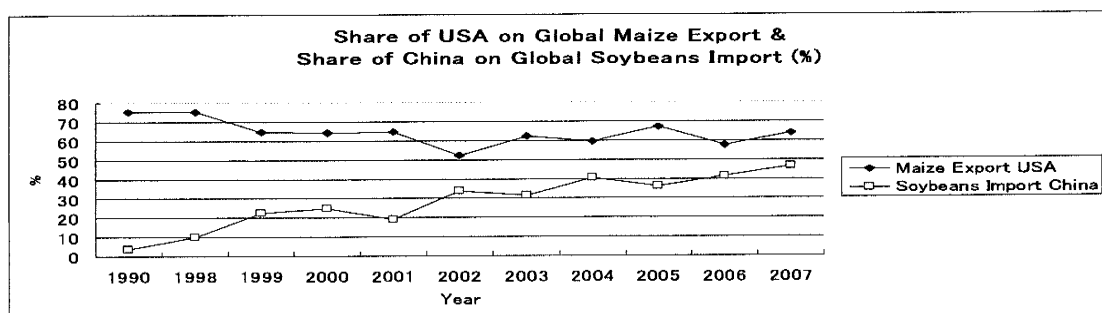
#### B4.3.1 Global Trade of Major Grains

The global trade features of the project related major grains (maize, soybeans & rice) are illustrated in the following figure.



Source: World Food Statistics & Graphics, Kyushu University, Japan (original source: FAOSTAT)

As shown in the figure, the increases in trade volumes of maize and soybeans are substantial in recent years. The annual growth rates of global trade of maize, soybeans and rice from 1998 to 2007 are calculated at 4%, 8% and 2%, respectively. The same of the 3 major grains is estimated at 5%.

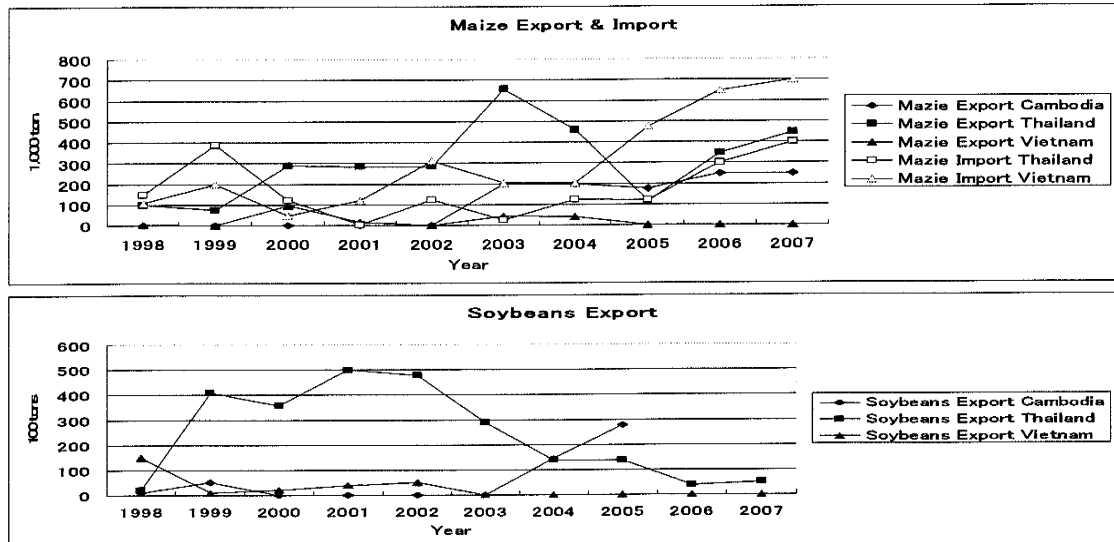


As shown in the figure, USA has continued to be the largest exporter of maize although its share to world total tends to decline from 1998. On the other hand, China's sharp increases in

soybeans import in recent years are clearly indicated in the figure and its share to the world import of the commodity is 47% in 2007.

### B4.3.2 Trade of Major Grains in Cambodia, Thailand and Vietnam

The trade features of the project related major grains of Cambodia, Thailand and Vietnam are shown in the following figures.



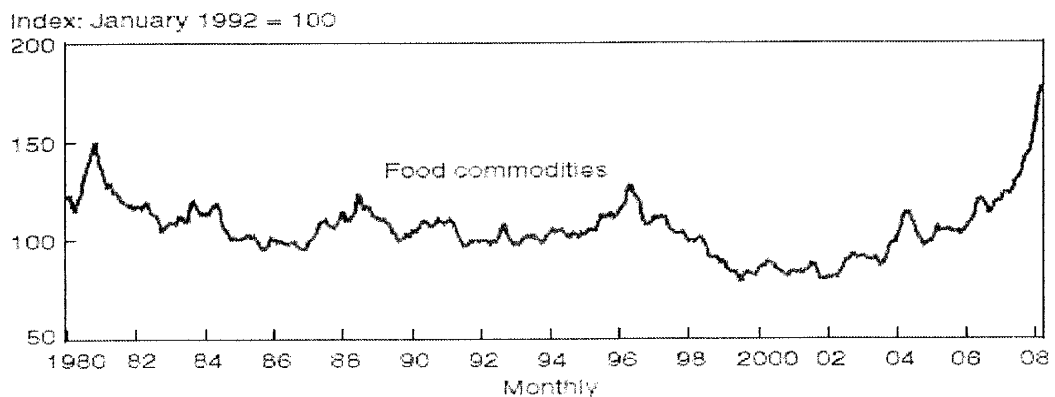
Source: World Food Statistics & Graphics, Kyushu University, Japan (original source: FAOSTAT)

### B4.4 World Market Prices of Food Commodities

Trends of world market prices for major food commodities such as grains and vegetable oils and factors contributing to recent price hikes of the commodities are studied in details in “Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices, Ronald Trostle, USDA, 2008”. The followings are prepared based on the report.

#### B4.4.1 Trends of World Market Prices

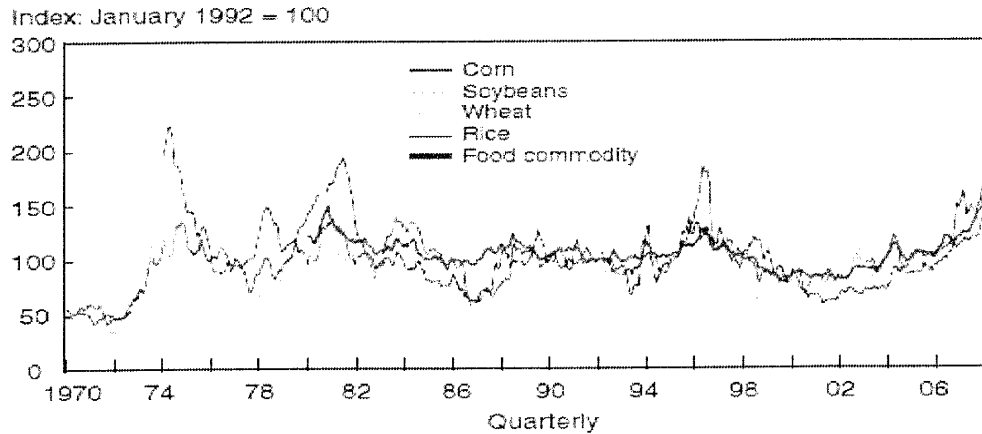
World market prices of major food commodities such as grains and vegetable oils have recently risen sharply from 2006 and reached to historic high levels as shown below.



Source: Global Agricultural Supply and Demand: factors Contributing to the Recent Increase in Food Commodity Prices, Ronald Trostle, USDA, 2008 (original source; IMF International Financial Statistics)

The figure indicates an index of world monthly prices for food commodities (grains, vegetable oils, meats, seafood, sugar, banana and various other commodities).

The world market prices of four major traded crops of corn, soybeans, wheat and rice, which account for a large share of staple foods in the world, also show the similar trend with the same of all the food commodity as shown in the following table.



Source: *Global Agricultural Supply and Demand: factors Contributing to the Recent Increase in Food Commodity Prices*, Ronald Trostle, USDA, 2008 (original source; IMF International Financial Statistics)

#### B.4.4.2 Factors Contributing to Recent Hikes in Food Commodity Prices<sup>1</sup>

Many factors have contributed to the hikes in food commodity prices. Some factors reflect trends of slower growth in production and more rapid growth in demand that have contributed to a tightening of world balances of grains and oilseeds over the last decade. However, no one factor has been the cause of the price hikes in food commodity prices. Major factors contributing to the price hikes are enumerated as follows;

- As per capita incomes rose, consumers in developing countries not only increased per capita consumption of staple food, they also diversified their diets to include more meat, dairy products and vegetable oils, which in turn, amplified the demand for grains and oilseeds,
- Global economic growth has been strong since the late 1990s. For developing countries, growth has been quite strong since the early 1990s. Growth in Asia has been exceptionally strong for more than a decade. Unusually rapid economic growth in China and India has provided a powerful and sustained stimulus to the demand for agricultural products,
- The world population growth rate has been trending down since before the 1970s, however, the number of people on earth is still rising by about 75 million (1.1%) per year. This rising population occurred mostly in developing countries amplifies the global demand for agricultural products and energy,
- Global consumption of meat has been growing much more rapidly than consumption

<sup>1</sup> Prepared based on “Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices, Ronald Trostle, USDA, 2008”



of grains and oilseeds. As the demand for meat rises, the demand for grain and protein feeds used to produce the meat grows proportionally more quickly, as for the production of a unit of meat, several units of grains or protein feeds are consumed,

- The shift toward more liberalized trade reduced trade barriers and facilitated trade, which in turn reduced the need for individual countries to hold stocks,
- The rapidly increasing world prices for food grains, feed grains, oilseeds and vegetable oils caused domestic food prices at the consumer level to rise in many countries. In response to rising food prices, some countries began to take protective policy measures designed to reduce the impact of rising world food commodity prices on their own consumers. However, such measures typically force greater adjustments and higher prices onto global markets, and
- In the fall of 2007, some exporting countries made policy changes designed to discourage exports so as to keep domestic food supplies and restrain increases in food prices.