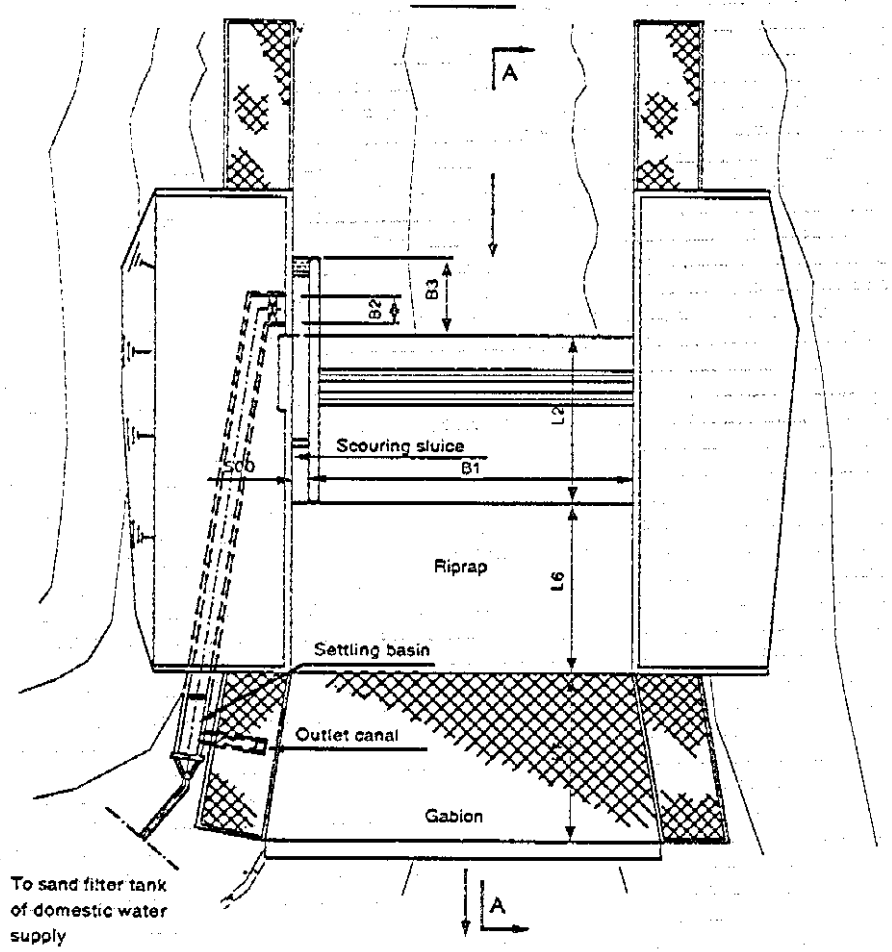
IX-F-6

PLAN



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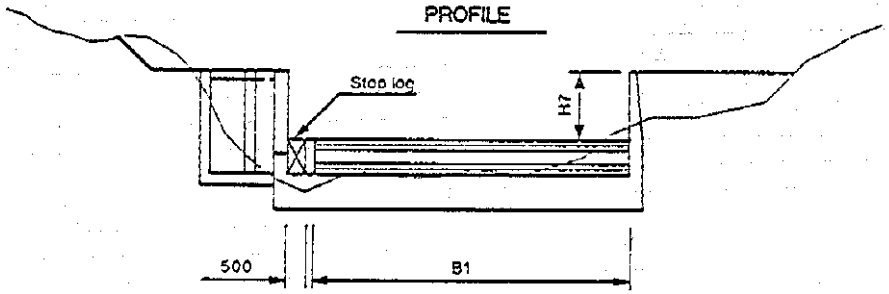

SECTION A - A

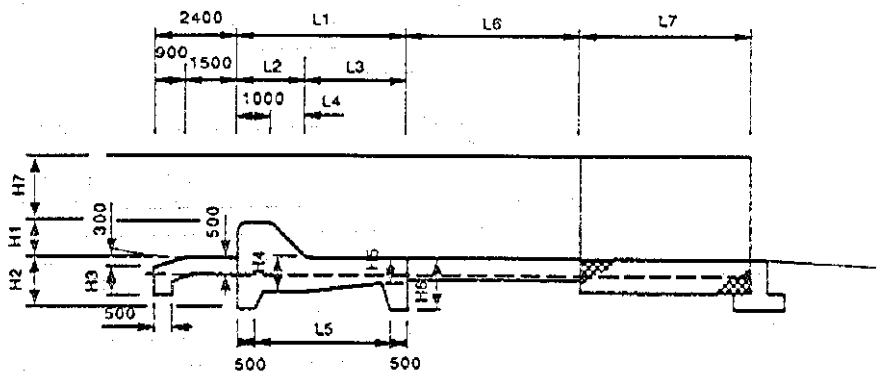

Table on size of facilities

Unit: mm

No.	Site name	B1	B2	B3	H1	H2	H3	H4	H5	H6	H7
1	Upper Chempi	19,500	1,000	2,500	1,000	2,000	800	1,000	700	1,500	2,500
3	Lower Xepian	9,500	1,000	2,500	1,000	2,000	800	1,000	700	1,500	1,300
10	Middle Tapoung	39,500	1,000	2,500	1,000	2,000	800	1,000	700	1,500	2,200
12	Lower Xeset	9,500	1,000	2,500	1,000	2,000	800	1,000	700	1,500	1,300
16	Upper Tayun	19,500	1,000	2,500	1,000	2,000	800	1,000	700	1,500	1,400

No.	Site name	L1	L2	L3	L4	L5	L6	L7
1	Upper Chempi	5,000	2,000	3,000	1,000	4,000	10,200	20,400
3	Lower Xepian	5,000	2,000	3,000	1,000	4,000	1,900	1,900
10	Middle Tapoung	5,000	2,000	3,000	1,000	4,000	8,200	16,400
12	Lower Xeset	5,000	2,000	3,000	1,000	4,000	1,900	1,900
16	Upper Tayun	5,000	2,000	3,000	1,000	4,000	2,300	2,300

THE LAO PEOPLE'S DEMOCRATIC REPUBLIC
MINISTRY OF AGRICULTURE AND FORESTRY

THE INTEGRATED AGRICULTURAL AND RURAL DEVELOPMENT PROJECT IN BOLOVEN PLATEAU

TITLE OF DRAWING

INTAKE FACILITIES FOR DOMESTIC WATER SUPPLY

NIPPON KOEI CO., LTD
NAIGAI ENGINEERING CO., LTD

Figure IX-6

FEASIBILITY STUDY

ANNEX-IX
COST ESTIMATION

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FEASIBILITY STUDY

ANNEX IX
(COST ESTIMATION)

1 ESTIMATION OF CONSTRUCTION COST

1.1 Basic Conditions of Cost Estimation

Construction costs are estimated at the price level of December 1995 taking into consideration the updated costs of labor, construction materials and equipment, the current price estimation method, tender method, local contractors' work capacities, etc.

In the Study, the construction costs are estimated with the conditions of the international competitive bidding (ICB), and the following conditions and assumptions.

i) Proportion between local and foreign currencies are assumed as local portion : foreign portion = 3 : 7 . Local portions of costs are consisted of labor costs, material costs of timber, gravel, sand and stone, and the remaining covered by foreign costs.
ii) Construction materials are assumed to be transported from Pakxe to the respective scheme sites, and the transportation costs are estimated broadly to be divided into the 5 price steps in the areas by the areas.
iii) Working ratio and work capabilities of equipment are estimated based on the present prevailing conditions in the Study area.
iv) Land acquisition costs are estimated at US $ 5.0 / ha, based on the present land concession fee in the Study area.
v) Physical contingency is assumed at 10 % of the direct construction costs.
vi) Overhead and profit of contractors are assumed at 15 % of the direct construction costs.
vii) Engineering costs are assumed at 10 % of the sum of direct construction cost and physical contingency.
viii) Exchange rate is applied as follows; US $ 1.0 = Kip 920

Costs of labor and construction materials for the estimation are summarized in Tables IX.1 to IX. 2.

1.2 Quantities of Civil Works

Construction of civil works in the each scheme is broadly divided into four (4) categories, agricultural and rural infrastructures, highland vegetable trial and demonstration station of agricultural extension facility and marketing facilities. civil works of agricultural infrastructure is further divided into main irrigation and drainage facilities and on-farm development facilities shown below.

(i) Main irrigation and drainage facilities ;

- Diversion weir / dam and reservoir and intake structures
- Main and secondary canals with related structures
- Regulation / farm ponds
- Main and secondary drains and related structures
- Inspection / farm roads

(ii) On -farm development facilities

- Tertiary and field canals with related structures
- Tertiary and field drains with related structures
- Farm road to be provided along tertiary canal

- Farm bund to be provided along topographic contour lines
- Land clearing and leveling for paddy field

Construction volume of the each scheme is shown below.

(1) Upper Champi Scheme

Item	Quantity	Unit	Excavation (m^3)	Embankment (m^3)	Concrete (m^3)	Pavement (m^3)
Intake Weir	1	nos.	26,247	4,964	11,290	
Dam No.1	1	nos.	11,240	33,428	495	
Main Secondary Canals	20.7	km	19,240	33,056	4,904	
Farm road	21.2	km	5,638	75,172		9,556

(2) Upper Tapoung Scheme

Item	Quantity	Unit	Excavation (m^3)	Embankment (m^3)	Concrete (m^3)	Pavement (m^3)
Intake Weir	1	nos.	13,126	3,281	6,427	
Main Secondary Canals	2.6	km	2,979	5,764	919	
Farm road	5.3	km	1,408	18,780		2,387

(3) Upper Kapheu Scheme

Item	Quantity	Unit	Excavation (m^3)	Embankment (m^3)	Concrete (m^3)	Pavement (m^3)
Intake Weir	1	nos.	21,905	1,963	2,208	
Dam No.1	1	nos.	10,923	19,810	156	
Dam No.2	1	nos.	11,146	15,376	145	
Dam No.3	1	nos.	11,345	17,808	187	
Dam No.4	1	nos.	10,398	17,722	205	
Main Secondary Canals	15.1	km	11,125	28,345	4,130	
Farm road	15.3	km	3,753	50,038		6,361

(4) Lower Xe Set Scheme

Item	Quantity	Unit	Excavation (m^3)	Embankment (m^3)	Concrete (m^3)	Pavement (m^3)
Intake Weir	1	nos.	646,641	24,057	29,015	
Regulation Pond	1	nos.	178,003	3,908	10,936	
Main Secondary Canals	22.2	km	40,527	52,739	11,097	
Farm road	26.0	km	6,908	92,111		11,709

(5) Upper Tay-Un Scheme

Item	Quantity	Unit	Excavation (m^3)	Embankment (m^3)	Concrete (m^3)	Pavement (m^3)
Dam No.1	1	nos.	13,763	20,999	1,188	
Dam No.2	1	nos.	37,845	48,477	3,555	
Dam No.3	1	nos.	16,625	9,856	2,099	
Main Secondary Canals	4.9	km	3,727	1,560	959	
Farm road	5.0	km	1,318	17,576		2,234

1.3 Construction Cost

Direct construction cost of each scheme is summarized below. Total construction cost, including physical contingency, administration cost and engineering cost is estimated at about

US $ 39.7 million for the 5 schemes as shown in Table IX.3.

Construction Cost of the 5 Schemes

(US $ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost			
Preparatory Works	240	103	343
Agricultural Infrastructure	13,915	5,965	19,880
Rural Infrastructure	4,904	2,105	7,009
2 On - farm Development	1,957	841	2,798
Subtotal	21,021	9,009	30,030
3 Land Acquisition		14	14
4 Engineering Services	2,102	900	3,002
5 Purchasing Cost of O & M Equipment)	960		960
6 Highland Vegetable Trial & Demonstration Station	1,320	304	1,624
7 Marketing Facilities	777	205	982
8 Physical Contingency	2,102	900	3,002
Grand Total	28,282	11,332	39,614

The cost of the each scheme is shown below.

Construction Cost of the Upper Champi Schemes

(US $ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost			
Preparatory Works	60	26	86
Agricultural Infrastructure	2,830	1,213	4,043
Rural Infrastructure	1,186	509	1,695
2 On - farm Development	380	163	543
Subtotal	4,456	1,911	6,367
3 Land Acquisition	0	4	4
4 Engineering Services	446	191	637
5 Purchasing Cost of O & M Equipment)	168	72	240
6 Physical Contingency	446	191	637
Grand Total	5,516	2,369	7,885

Construction Cost of the Upper Tapoung Schemes

(US $ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost			
Preparatory Works	12	5	17
Agricultural Infrastructure	798	342	1,140
Rural Infrastructure	1,249	536	1,785
2 On - farm Development	49	21	70
Subtotal	2,108	904	3,012
3 Land Acquisition	12	5	17
4 Engineering Services	211	90	301
5 Purchasing Cost of O & M Equipment)	48	0	48
6 Physical Contingency	211	90	301
Grand Total	2,590	1,089	3,679

Construction Cost of the Upper Kapheu Schemes

(US $ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost			
Preparatory Works	72	31	103
Agricultural Infrastructure	2,604	1,116	3,720
Rural Infrastructure	1,085	465	1,550
2 On - farm Development	571	246	817
Subtotal	4,332	1,858	6,190
3 Land Acquisition	0	4	4
4 Engineering Services	433	186	619
5 Purchasing Cost of O & M Equipment)	288	0	288
6 Physical Contingency	433	186	619
Grand Total	5,486	2,234	7,720

Construction Cost of the Lower Xe Set Schemes

(US $ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost			
Preparatory Works	72	31	103
Agricultural Infrastructure	6,157	2,639	8,796
Rural Infrastructure	1,005	432	1,437
2 On - farm Development	728	312	1,040
Subtotal	7,962	3,414	11,376
3 Land Acquisition	0	4	4
4 Engineering Services	796	341	1,138
5 Purchasing Cost of O & M Equipment)	288	0	288
6 Physical Contingency	796	341	1,138
Grand Total	9,842	4,101	13,943

Construction Cost of the Upper Tay - Un Schemes

(US $ 1,000)

Description	F.C	L.C	Total
1 Direct Construction Cost			
Preparatory Works	24	10	34
Agricultural Infrastructure	1,526	655	2,181
Rural Infrastructure	379	163	542
2 On - farm Development	229	99	328
Subtotal	2,158	927	3,085
3 Land Acquisition	0	1	1
4 Engineering Services	216	93	309
5 Purchasing Cost of O & M Equipment)	96	0	96
6 Physical Contingency	216	93	309
Grand Total	2,686	1,114	3,800

1.3.1 Direct Construction Cost

The detailed direct construction costs of the 5 scheme are shown in Table IX.4 to Table IX. 8.

1.3.2 Land Acquisition Cost

Land acquisition cost for intake structures, canals, drains, highland vegetable trial and demonstration station and marketing facilities are estimated at about US $ 14,000 as shown in Table IX.9.

1.3.3 Procurement Cost of O & M Equipment

Procurement cost of O & M equipment is estimated at US $ 960,000. Necessary number of O & M equipment is estimated based on assumption of O & M work quantities and workable days. Main O & M works are assumed to be grading and compacting works of roads, rehabilitation of canals, etc., and the equipment such as bulldozer, backhoe, motor grader and dump trucks are provided. Furthermore, vehicles are provided to carry out operation of domestic water supply and village community hall. Cost of spare parts is estimated at 10 % of procurement cost. The detailed is shown in Table IX.10.

1.4 Cost of Highland Vegetable Trial and Demonstration Station

Construction cost of highland vegetable trial and demonstration station is estimated at US $ 1,624,000 as shown in Table IX. 11. Costs of these facilities and equipment are broadly divided into two (2) groups, (i) buildings and irrigation and drainage facilities, and (ii) procurement of farm machinery, vehicle, extension materials and office equipment. Construction cost of buildings and irrigation and drainage facilities are estimated at US $ about 1,050,000, and procurement cost of machinery, equipment, etc. is estimated at US $ about 574,000.

1.5 Cost of Marketing Facilities

Marketing facilities are planned to provide wholesale market and rice banks, and the costs also consist of construction cost of buildings, parking lot and loading spaces, and procurement cost of rice mill equipment. Total construction cost including purchasing cost of rice mill, etc. is estimated at US $ 982,000 as shown in Table IX. 12. The construction costs are estimated at US $ 327,000 for wholesale marketing facilities and US $ 655,000 for rice

banks. The purchasing cost of each rice mill is estimated at about US $ 39,817 for the 6 proposed villages.

1.6 O & M Cost

O & M cost consists of administration expenses and maintenance cost for irrigation and domestic water supply facilities. The administration expenses estimated at US $34,000 a year, based on the structural conditions of O & M offices. The cost mainly consists of salaries of O & M staff, operation costs such as fuel cost of vehicles and equipment and office expenses. On the other hand, maintenance cost of the facilities is estimated to assume 1 % of direct construction cost. Total O & M cost is estimated at about US $ 257,000 / a year as shown in Table IX.13.

1.7 Replacement Cost

Replacement cost of agricultural and rural infrastructure is estimated US $ 2.8 million as shown in Table IX. 14. The other facilities are O & M equipment, vehicle, motor cycle and radio system, etc. for operation of O & M office.

Tables

Table IX.1 Table on Labor cost

Unit: Kips

Description	Unit	Price	Remarks
Common Labor	man/day	2,500	8hr/day
Skillful Labor	man/day	4,000	
Foreman	man/day	6,000	
Carpenter	man/day	3,000	
Chief of Carpenter	man/day	5,000	
Reinforeced Worker	man/day	2,700	
Chief of Reinforced Worker	man/day	5,700	
Mason	man/day	3,300	
Chief of Mason	man/day	5,700	
Assistant Driver	man/day	1,500	
Driver	man/day	3,500	
Assistant Operator	man/day	3,000	
Equipment Operator	man/day	5,000	
Mechanic	man/day	3,500	
Skillful Mechanic	man/day	8,000	
Senior Field Superintendent	man/day	20,000	

Table IX.2 Table on Material Cost

Description	Unit	Selected price	Remarks
Sand	m³	3,000	Excepted transport
Gravel (30-20mm)	m³	3,400	
Gravel (13- 5mm)	m³	3,400	
Gravel (5- 2mm)	m³	3,400	
Crushed stone for pavement	m³	9,500	
Cement	ton	87,000	
Reinforeced iron bar (D10)	ton	575,000	
Reinforeced iron bar (D12)	ton	500,000	
Reinforeced iron bar (D16)	ton	500,000	
Reinforeced iron bar (D21)	ton	490,000	
Steel board (3mmx1.2mx2.4m)	peace	64,800	
Poly vinyl chloride pipe Dia.13 (strong) (L=4.0m	peace	1,800	
Poly vinyl chloride pipe Dia.19 (strong) (L=4.0m	peace	2,000	
Poly vinyl chloride pipe Dia.25 (strong) (L=4.0m	peace	2,800	
Poly vinyl chloride pipe Dia.32 (strong) (L=4.0m	peace	3,200	
Poly vinyl chloride pipe Dia.38 (strong) (L=4.0m	peace	4,000	
Poly vinyl chloride pipe Dia.100 (strong) (L=4.0	peace	18,800	
Wood	m³	400,000	
Plywood (3mmx1.2mx2.4m)	peace	5,400	
Plywood (4mmx1.2mx2.4m)	peace	6,400	
Nail	kg	800	
Wire	kg	850	
Galvanized iron mesh (1.8mÂ-10m)	peace	55,000	
Galvanized iron mesh (1.5mÂ-10m)	peace	45,000	
Slate (0.5mx1.2m) white	peace	1,700	
Slate (0.5mx1.2m) color	peace	2,100	
Sod	m²	1,600	
Gasoline	lit.	275	
Diesel	lit.	252	
Engine oil	lit.	1,600	
Grease	kg	2,500	

Table IX.3 The Project Cost

Unit: US$

	Description	Foreign Currency	Local Currency	Total
1	Construction Cost			
	(1) Preparatory Work	240,000	103,000	343,000
	(2) Upper Champi Scheme			
	a) Agricultural Development Works	2,830,000	1,213,000	4,043,000
	b) Rural Infrastructure Works	1,186,000	509,000	1,695,000
	(Sub-Total)	4,016,000	1,722,000	5,738,000
	(3) Upper Tapoung Scheme			
	a) Agricultural Development Works	798,000	342,000	1,140,000
	b) Rural Infrastructure Works	1,249,000	536,000	1,785,000
	(Sub-Total)	2,047,000	878,000	2,925,000
	(4) Upper Kapheu Scheme			
	a) Agricultural Development Works	2,604,000	1,116,000	3,720,000
	b) Rural Infrastructure Works	1,085,000	465,000	1,550,000
	(Sub-Total)	3,689,000	1,581,000	5,270,000
	(5) Lower Xe Set Scheme			
	a) Agricultural Development Works	6,157,000	2,639,000	8,796,000
	b) Rural Infrastructure Works	1,005,000	432,000	1,437,000
	(Sub-Total)	7,163,000	3,070,000	10,233,000
	(6) Upper Tay-Un Scheme			
	a) Agricultural Development Works	1,526,000	655,000	2,181,000
	b) Rural Infrastructure Works	379,000	163,000	542,000
	(Sub-Total)	1,906,000	817,000	2,723,000
	Total ((1) to (6))	19,062,000	8,170,000	27,232,000
2	On-farm Development Cost			
	(1) Upper Champi Scheme	380,000	163,000	543,000
	(2) Upper Tapoung Scheme	49,000	21,000	70,000
	(3) Upper Kapheu Scheme	571,000	246,000	817,000
	(4) Lower Xe Set Scheme	728,000	312,000	1,040,000
	(5) Upper Tay-Un Scheme	229,000	99,000	328,000
	Total	1,957,000	841,000	2,798,000
3	Sub-Total (1 - 2)	21,021,000	9,009,000	30,030,000
4	Land Acquisition cost		14,000	14,000
5	Engineering and Administration cost (3x10%)	2,102,000	900,000	3,002,000
6	Purchasing cost	960,000		960,000
7	Highland Vegetable Trial ans Demonstration Station	1,320,000	304,000	1,624,000
8	Marketing facilities	777,000	205,000	982,000
9	Physical Contingencies (3x10%)	2,102,000	900,000	3,002,000
10	Grand Total	28,282,000	11,332,000	39,614,000

Table IX. 4 Direct Construction Cost (Upper Champi Scheme)

Unit: US$

	Description of Item	Unit	Quantity	Amount F/C	Amount L/C	Amount Total	Remarks
I	Agricultural Devevelopment Works						
(1)	Temporary works			85,000	37,000	122,000	
	(sub-total)			85,000	37,000	122,000	1
(2)	Head works & Dam						
	Weir body	L.S.		669,000	288,000	957,000	
	Silding Basin	L.S.		56,000	24,000	80,000	
	Dam body	L.S.		398,000	171,000	569,000	
	Dam intake (Headrace)	L.S.		37,000	17,000	54,000	
	Dam intake (Tower)	L.S.		14,000	7,000	21,000	
	(sub-total)			1,176,000	505,000	1,681,000	2
(3)	Main irrigation canal						
	Canal	km	4.7	39,000	17,000	56,000	
	Turnout	nos	9.0	7,000	3,000	10,000	
	Impact box	nos	4.0	1,000	1,000	2,000	
	Road crossing	nos	8.0	98,000	43,000	141,000	
	Farm pond	nos	7.0	121,000	52,000	173,000	
	(sub-total)			267,000	115,000	382,000	3
(4)	Secondary irrigation canal						
	Canal	km	13.0	107,000	47,000	154,000	
	Turnout	nos	35.0	29,000	13,000	42,000	
	Impact box	nos	28.0	11,000	5,000	16,000	
	Road crossing	nos	36.0	13,000	6,000	19,000	
	Farm pond	nos	36.0	547,000	235,000	782,000	
	(sub-total)			709,000	304,000	1,013,000	4
(5)	Secondary drainage canal						
	Canal	km	3.0	6,000	3,000	9,000	
	Road crossing	nos	4.0	4,000	3,000	7,000	
	Drainage shute	km	1.1	58,000	26,000	84,000	
	Junction facility	nos	8.0	6,000	3,000	9,000	
	(sub-total)			76,000	33,000	109,000	5
(6)	Farm road						
	Farm road (Type A)	km	21.2	515,000	221,000	736,000	
	(sub-total)			515,000	221,000	736,000	6
	Total 1			2,830,000	1,213,000	4,043,000	7=(1 to 6)
2	Rural Infrastructure Works						
(1)	Water supply works						
	Related structures	L.S.		24,000	11,000	35,000	
	Distribution pipe	km	40.1	604,000	260,000	864,000	
	(sub-total)			629,000	270,000	899,000	8
(2)	Primary school improvement						
	School building	nos	7.0	243,000	105,000	348,000	
	(sub-total)			243,000	105,000	348,000	9
(3)	Village community hall						
	Building & radio system	nos	8.0	313,000	135,000	448,000	
	(sub-total)			313,000	135,000	448,000	10
	Total 2			1,186,000	509,000	1,695,000	11=(8 to 10)
	Total 3 (Total 1+ Total 2)			4,016,000	1,722,000	5,738,000	
3	On-farm facilities						
	Upland field (less than 5%)	ha	400.0	199,000	86,000	285,000	
	Upland field (more than 5%)	ha	280.0	180,000	78,000	258,000	
	Total			380,000	163,000	543,000	
	Grand Total			4,396,000	1,885,000	6,281,000	

Table IX.5 Direct Construction Cost (Upper Tapoung Scheme)

Unit: US$

	Description of Item	Unit	Quantity	Amount F/C	Amount L/C	Amount Total	Remarks
1	Agricultural Deveyelopment Works						
(1)	Temporary works	L.S.		32,000	15,000	47,000	
	(sub-total)			32,000	15,000	47,000	1
(2)	Head works						
	Weir	L.S.		437,000	188,000	625,000	
	(sub-total)			437,000	188,000	625,000	2
(3)	Main irrigation canal						
	Canal	km	1.6	12,000	6,000	18,000	
	Turnout	nos	2.0	1,000	1,000	2,000	
	Road crossing	nos	2.0	1,000	1,000	2,000	
	Farm pond	nos	2.0	53,000	24,000	77,000	
	(sub-total)			69,000	30,000	99,000	3
(4)	Secondary irrigation canal						
	Canal	km	0.8	5,000	3,000	8,000	
	Turnout	nos	3.0	2,000	1,000	3,000	
	Drop	nos	6.0	2,000	1,000	3,000	
	Road crossing	nos	1.0	1,000	0	1,000	
	Farm pond	nos	3.0	77,000	34,000	111,000	
	(sub-total)			88,000	38,000	126,000	4
(5)	Secondary drainage canal						
	Canal	km	0.2	1,000	0	1,000	
	Road crossing	nos	1.0	2,000	1,000	3,000	
	Drainage shute	km	0.2	15,000	7,000	22,000	
	Junction facility	nos	1.0	5,000	3,000	8,000	
	(sub-total)			23,000	11,000	34,000	5
(6)	Farm road						
	Farm road (Type A)	km	5.3	146,000	63,000	209,000	
	(sub-total)			146,000	63,000	209,000	6
	Total 1			798,000	342,000	1,140,000	7=(1 to 6)
2	Rural Infrastructure Works						
(1)	Water supply works						
	Related structures	L.S.		101,000	44,000	145,000	
	Distribution pipe	km	1.0	141,000	61,000	202,000	
	(sub-total)			242,000	105,000	347,000	8
(2)	Primary school improvement						
	School building	nos	3.0	88,000	39,000	127,000	
	(sub-total)			88,000	39,000	127,000	9
(3)	Village community hall						
	Building & radio system	nos	3.0	131,000	57,000	188,000	
	(sub-total)			131,000	57,000	188,000	10
(4)	Road improvement						
	Village road	km	12.9	786,000	337,000	1,123,000	
	(sub-total)			786,000	337,000	1,123,000	11
	Total 2			1,249,000	536,000	1,785,000	12=(8 to 11)
	Total 3 (Total 1+ Total 2)			2,047,000	878,000	2,925,000	
3	On-farm facilities						
	Upland field (less than 5%)	ha	80.0	49,000	21,000	70,000	
	Total			49,000	21,000	70,000	
	Grand Total			2,096,000	899,000	2,995,000	

Table IX.6 Direct Construction Cost (Upper Kapheu Scheme)

Unit: US$

	Description of Item	Unit	Quantity	Amount F/C	Amount L/C	Amount Total	Remarks
1	Agricultural Devevelopment Works						
(1)	Temporary works			79,000	34,000	113,000	
	(sub-total)			79,000	34,000	113,000	1
(2)	Head works & Dam						
	Weir body	L.S.		158,000	69,000	227,000	
	Silting Basin	L.S.		60,000	26,000	86,000	
	Dam No.1	L.S.		277,000	120,000	397,000	
	Dam No.2	L.S.		225,000	97,000	322,000	
	Dam No.3	L.S.		259,000	111,000	370,000	
	Dam No.4	L.S.		257,000	111,000	368,000	
	(sub-total)			1,239,000	531,000	1,770,000	2
(3)	Main irrigation canal						
	Canal	km	2.2	23,000	10,000	33,000	
	Turnout	nos	10.0	8,000	4,000	12,000	
	Impact box	nos	6.0	2,000	2,000	4,000	
	Road crossing	nos	9.0	5,000	3,000	8,000	
	Farm pond	nos	9.0	156,000	67,000	223,000	
	(sub-total)			196,000	84,000	280,000	3
(4)	Secondary irrigation canal						
	Canal	km	11.8	92,000	40,000	132,000	
	Turnout	nos	25.0	21,000	10,000	31,000	
	Impact box	nos	17.0	7,000	3,000	10,000	
	Road crossing	nos	26.0	9,000	4,000	13,000	
	Farm pond	nos	26.0	491,000	211,000	702,000	
	(sub-total)			621,000	267,000	888,000	4
(5)	Secondary drainage canal						
	Canal	km	1.1	2,000	1,000	3,000	
	Road crossing	nos	4.0	0	1,000	1,000	
	Drainage shute	km	0.7	41,000	18,000	59,000	
	Junction facility	nos	6.0	4,000	3,000	7,000	
	(sub-total)			49,000	21,000	70,000	5
(6)	Farm road						
	Farm road (Type A)	km	15.3	419,000	180,000	599,000	
	(sub-total)			419,000	180,000	599,000	6
	Total 1			2,604,000	1,116,000	3,720,000	7=(1 to 6)
2	Rural Infrastructure Works						
(1)	Water supply works						
	Related structures	L.S.		18,000	8,000	26,000	
	Distribution pipe	km	17.9	259,000	111,000	370,000	
	(sub-total)			277,000	119,000	396,000	8
(2)	Primary school improvement						
	School building	nos	4.0	111,000	48,000	159,000	
	(sub-total)			111,000	48,000	159,000	9
(3)	Village community hall						
	Building & radio system	nos	5.0	194,000	84,000	278,000	
	(sub-total)			194,000	84,000	278,000	10
(4)	Road improvement						
	Village road	km	13.0	501,000	216,000	717,000	
	(sub-total)			501,000	216,000	717,000	11
	Total 2			1,085,000	465,000	1,550,000	12=(8 to 11)
	Total 3 (Total 1+ Total 2)			3,689,000	1,581,000	5,270,000	
3	On-farm facilities						
	Upland field (less than 5%)	ha	710.0	394,000	169,000	563,000	
	Upland field (more than 5%)	ha	190.0	137,000	59,000	196,000	
	Paddy field	ha	100.0	40,000	18,000	58,000	
	Total			571,000	246,000	817,000	
	Grand Total			4,260,000	1,827,000	6,087,000	

Table IX.7 Direct Construction Cost(Lower Xe Set Scheme)

Unit: US$

	Description of Item	Unit	Quantity	Amount F/C	Amount L/C	Amount Total	Remarks
1	Agricultural Devevelopment Works						
(1)	Temporary works			210,000	90,000	300,000	
	(sub-total)			210,000	90,000	300,000	1
(2)	Head works & Regulation Pond						
	Weir body	L.S.		2,268,000	972,000	3,240,000	
	Regulation pond body	L.S.		1,191,000	511,000	1,702,000	
	Pond (Tower)	L.S.		10,000	5,000	15,000	
	Pond (Headrace)	L.S.		2,000	1,000	3,000	
	Pond (Energy dissipator)	L.S.		3,000	2,000	5,000	
	(sub-total)			3,475,000	1,490,000	4,965,000	2
(3)	Main irrigation canal						
	Canal	km	3.6	110,000	48,000	158,000	
	Turnout	nos	14.0	12,000	6,000	18,000	
	Impact box	nos	3.0	4,000	3,000	7,000	
	Road crossing	nos	15.0	27,000	12,000	39,000	
	Farm pond	nos	10.0	322,000	139,000	461,000	
	(sub-total)			478,000	205,000	683,000	3
(4)	Secondary irrigation canal						
	Canal	km	11.0	186,000	80,000	266,000	
	Turnout	nos	24.0	21,000	10,000	31,000	
	Impact box	nos	6.0	2,000	2,000	4,000	
	Road crossing	nos	31.0	23,000	10,000	33,000	
	Farm pond	nos	25.0	744,000	319,000	1,063,000	
	(sub-total)			977,000	420,000	1,397,000	4
(5)	Secondary drainage canal						
	Canal	km	7.6	31,000	14,000	45,000	
	Road crossing	nos	25.0	18,000	9,000	27,000	
	Drainage shute	km	0.0	3,000	2,000	5,000	
	Junction facility	nos	13.0	15,000	7,000	22,000	
	(sub-total)			69,000	30,000	99,000	5
(6)	Farm road						
	Farm road (Type A)	km	26.0	946,000	406,000	1,352,000	
	(sub-total)			946,000	406,000	1,352,000	6
	Total 1			6,157,000	2,639,000	8,796,000	7=(1 to 6)
2	Rural Infrastructure Works						
(1)	Water supply works						
	Related structures	L.S.		19,000	9,000	28,000	
	Distribution pipe	km	16.6	250,000	108,000	358,000	
	(sub-total)			270,000	116,000	386,000	8
(2)	Primary school improvement						
	School building	nos	5.0	112,000	48,000	160,000	
	(sub-total)			112,000	48,000	160,000	9
(3)	Village community hall						
	Building & radio system	nos	6.0	213,000	92,000	305,000	
	(sub-total)			213,000	92,000	305,000	10
(4)	Road improvement						
	Village road	km	7.0	410,000	176,000	586,000	
	(sub-total)			410,000	176,000	586,000	11
	Total 2			1,005,000	432,000	1,437,000	12=(7 to 11)
	Total 3 (Total 1+ Total 2)			7,162,000	3,071,000	10,233,000	
3	On-farm facilities						
	Paddy field	ha	1,000.0	728,000	312,000	1,040,000	
	Total			728,000	312,000	1,040,000	
	Grand Total			7,890,000	3,383,000	11,273,000	

Table IX.8 Direct Construction Cost (Upper Tay-Un Scheme)

Unit: US$

	Description of Item	Unit	Quantity	Amount F/C	Amount L/C	Amount Total	Remarks
1	Agricultural Devevelopment Works						
(1)	Temporary works			63,000	27,000	90,000	
	(sub-total)			63,000	27,000	90,000	1
(2)	Dam works						
	Dam No.1	L.S.		301,000	129,000	430,000	
	Dam No.2	L.S.		687,000	295,000	982,000	
	Dam No.3	L.S.		177,000	76,000	253,000	
	(sub-total)			1,165,000	500,000	1,665,000	2
(3)	Main irrigation canal						
	Canal	km	2.5	46,000	20,000	66,000	
	Turnout	nos	6.0	5,000	3,000	8,000	
	Drop	nos	4.0	2,000	1,000	3,000	
	Road crossing	nos	3.0	1,000	1,000	2,000	
	(sub-total)			55,000	24,000	79,000	3
(4)	Secondary irrigation canal						
	Canal	km	2.3	29,000	13,000	42,000	
	Turnout	nos	6.0	5,000	3,000	8,000	
	Drop	nos	2.0	1,000	0	1,000	
	Road crossing	nos	4.0	2,000	1,000	3,000	
	(sub-total)			37,000	17,000	54,000	4
(5)	Secondary drainage canal						
	Canal	km	0.1	1,000	0	1,000	
	Drainage shute	km	0.1	9,000	4,000	13,000	
	Junction facility	nos	1.0	0	1,000	1,000	
	(sub-total)			10,000	5,000	15,000	5
(6)	Farm road						
	Farm road (Type A)	km	5.0	194,000	84,000	278,000	
	(sub-total)			194,000	84,000	278,000	6
	Total 1			1,526,000	655,000	2,181,000	7=(1 to 6)
2	Rural Infrastructure Works						
(1)	Water supply works						
	Related structures	L.S.		112,000	48,000	160,000	
	Distribution pipe	km	0.8	14,000	7,000	21,000	
	(sub-total)			126,000	55,000	181,000	8
(2)	Primary school improvement						
	School building	nos	2.0	44,000	20,000	64,000	
	(sub-total)			44,000	20,000	64,000	9
(3)	Village community hall						
	Building & radio system	nos	3.0	106,000	46,000	152,000	
	(sub-total)			106,000	46,000	152,000	10
(4)	Road improvement						
	Village road	km	1.7	101,000	44,000	145,000	
	(sub-total)			101,000	44,000	145,000	11
	Total 2			379,000	163,000	542,000	12=(8 to 11)
	Total 3 (Total 1+ Total 2)			1,905,000	818,000	2,723,000	
3	On-farm facilities						
	Paddy field	ha	330.0	229,000	99,000	328,000	
	Total			229,000	99,000	328,000	
	Grand Total			2,134,000	917,000	3,051,000	

Table IX.9 Land Acquisition Cost

Description of Item	Unit	Quantity	Amount (US$)			Remarks
			F/C	L/C	Total	
1 Intake Facilities						
(1) Upper Champi	ha	2.0	-	120	120	
(2) Upper Tapoung	- ditto-	1.0	-	60	60	
(3) Upper Kapheu	- ditto-	2.0	-	100	100	
(4) Lower Xe Set	- ditto-	10.0	-	500	500	
(5) Upper Tay-Un	- ditto-	5.0	-	225	225	
Sub-total				1,005	1,005	
2 Canal						
(1) Upper Champi	ha	64	-	3,185	3,185	
(2) Upper Tapoung	- ditto-	16	-	795	795	
(3) Upper Kapheu	- ditto-	46	-	2,290	2,290	
(4) Lower Xe Set	- ditto-	16	-	780	780	
(5) Upper Tay-Un	- ditto-	15	-	745	745	
Sub-total				7,795	7,795	
3 Highland Vegetable Trial and Demonstration Station						
Hilly area	ha	50.0	-	3,200	3,200	
Sub-total				3,200	3,200	
4 Marketing Facilities						
Market and Rice bank	ha	1.6	-	2,000	2,000	
Sub-total				2,000	2,000	
5 Grand Total			-	14,000	14,000	

Table IX.10 O & M Equipment

Description of Item	Unit	Quantity	Unit Rate (US$)			Amount (US$)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
1 Bulldozer, 15ton	Nos	1	181,000	-	181,000	181,000	-	181,000	
2 Backhoe, 0.5 m3	Nos	1	127,000	-	127,000	127,000	-	127,000	
3 Tire roller, 8 to 20 ton	Nos	1	102,000	-	102,000	102,000	-	102,000	
4 Moter grader, 3.1m	Nos	1	134,000	-	134,000	134,000	-	134,000	
5 Water tanker, 6,000 l	Nos	1	70,000	-	70,000	70,000	-	70,000	
6 Dump track, 8ton	Nos	2	80,000	-	80,000	160,000	-	160,000	
7 Pickup track	Nos	3	20,800	-	20,800	62,400	-	62,400	
8 Moter cycle, 250cc	Nos	6	6,200	-	6,200	37,200	-	37,200	
9 Spare parts	%	10		-		86,400	-	86,400	
Total						960,000		960,000	

Table IX.11 Highland Vegetable Training and Demonstration Station

Description of Item	Unit	Quantity	Unit Rate (US$)			Amount (US$)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
1 Building									
Main building	m2	500	227	98	325	113,750	48,750	162,500	
Laboratory of tea	m2	170	227	98	325	38,675	16,575	55,250	
Domitory and dining room	m2	500	227	98	325	113,750	48,750	162,500	
Garage for farm machinery	m2	240	66	29	95	15,886	6,810	22,696	
Garage for vechicle	m2	100	66	29	95	6,619	2,838	9,457	
Farm administrative buolding	m2	340	100	43	143	34,018	14,580	48,598	
Green house	m2	500	44	19	63	22,065	9,457	31,522	
Net house	m2	500	13	6	19	6,657	2,854	9,511	
Manure house	m2	60	66	29	95	3,971	1,703	5,674	
Cow shed	m2	250	66	29	95	16,548	7,093	23,641	
Pump house	Nos	1	8,533	3,657	12,190	8,533	3,657	12,190	
Water tannks	Nos	1	2,929	1,256	4,185	2,929	1,256	4,185	
Elevated water tank	Nos	1	15,180	6,506	21,686	15,180	6,506	21,686	
Quaters for staff	m2	1000	227	98	325	227,500	97,500	325,000	
Sub-total						626,081	268,328	894,409	
2 Equipments									
Equipments	LS	1				574,000	-	574,000	
Sub-total						574,000	-	574,000	
3 Farm facilities									
Electric pump	Nos	1	3,142	-	3,142	3,142	-	3,142	
Preparation of T & D field	ha	50	1,481	635	2,116	74,070	31,745	105,815	
Pipe line	m	700	13	7	20	9,576	4,105	13,681	
Splinkler	Nos	4	8,238	-	8,238	32,952	-	32,952	
Sub-total						119,741	35,850	155,591	
3 Grand Total						1,320,000	304,000	1,624,000	

Table IX.12 Marketing Facilities

Description of Item	Unit	Quantity	Unit Rate (US$)			Amount (US$)			Remarks
			F/C	L/C	Total	F/C	L/C	Total	
1 Wholesale Market									
Facilities									
Embankment	m3	720	1	1	2	1,008	432	1,440	
Gravel pavement	m3	240	25	11	36	6,048	2,592	8,640	
Asphalt pavement	m3	360	30	13	43	10,836	4,644	15,480	
Concrete	m3	240	40	18	58	9,744	4,176	13,920	
Working space	m2	1200	66	29	95	79,877	34,234	114,111	
Warehouse	m2	100	99	43	142	9,940	4,260	14,200	
Office	m2	300	228	98	326	68,460	29,340	97,800	
Equipments									
Generator, 5kw	Nos	1	6,260	-	6,260	6,260	-	6,260	
Track, 5ton	Nos	1	41,347	-	41,347	41,347	-	41,347	
Wireless radio system	Nos	1	7,608	-	7,608	7,608	-	7,608	
Personal Computer	Nos	1	3,804	-	3,804	3,804	-	3,804	
Printer	Nos	1	1,434	-	1,434	1,434	-	1,434	
Scales	Nos	1	956	-	956	956	-	956	
Sub-total						247,322	79,678	327,000	
2 Rice Bank									
Building									
Storage Space	m2	1050	99	43	142	104,370	44,730	149,100	
Drying yard	m2	1200	65	29	94	78,960	33,840	112,800	
Office	m2	300	228	98	326	68,460	29,340	97,800	
Housing for rice mill	m2	600	65	29	94	39,480	16,920	56,400	
Equipment									
Ricemill	Nos	6	39,817	-	39,817	238,900	-	238,900	
Sub-total						530,170	124,830	655,000	
3 Grand Total						777,000	205,000	982,000	

Table IX.13 Annual O & M Cost for the 5 Schemes

Items		Quantity	Unit	Unit Price	Cost (US $)
Salaries					
	Staff				
	-Authority	360	M-M	45	16,200
	-Water Users' Association	120	M-M	35	4,200
	-Farmers'Asoociation	60	M-M	35	2,100
	-Water Committee	60	M-M	40	2,400
	Labor	300	M-M	30	9,000
	Subtotal-1				33,900
Operation Cost					
	Electric charge	14,400	KWh	0.02	288
	Fuel, etc. for vehicle	22,886	lit.	0.35	8,010
	Subtotal-2				8,298
Office Expences					
		12	US$/month	200	2,400
Maintenance Cost					
	Civil works	1.00	%/year		198,530
	Equipment & Communication	1.00	%/year		2,207
	Facilities				
	Subtotal-3				200,737
	Subtotal				245,335
Miscellaneous		5	%		12,267
	TOTAL				257,602

Table IX.14 Replacement Cost

Item	Duration Period	Cost (US$ 1,000)
For the 5 Scheme		
Gates	25	1,637
Pump	25	36
O & M Equipment	20	961
Radio System	20	220
Total		2,854
For the Upper Champi Scheme		
Gates	25	437
O & M Equipment	20	192
Radio System	20	70
Total		699
For the Upper Tapoung Scheme		
Gates	25	92
Pump	25	17
O & M Equipment	20	192
Radio System	20	26
Total		327
For the Upper Kapheu Scheme		
Gates	25	456
O & M Equipment	20	192
Radio System	20	44
Total		692
For the Lower Xe Set Scheme		
Gates	25	502
O & M Equipment	20	192
Radio System	20	52
Total		746
For the Upper Tay-Un Scheme		
Gates	25	148
Pump	25	19
O & M Equipment	20	192
Radio System	20	26
Total		385

ANNEX X

ENVIRONMENT

ANNEX-10 ENVIRONMENT

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THE FEASIBILITY STUDY

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ANNEX-X ENVIRONMENT

1 INTRODUCTION

The feasibility study stems from the masterplan study prepared during Phase I of the study. The focus and proposals in the latter study are of a general nature aiming to improve the processes of resource use and resource management. In the feasibility study the underlying principles of resource conservation remain the same but application varies depending on requirements in each priority area.

This section on the environment in the feasibility study report focuses on the state of the environment in the selected priority schemes, examines the current ground situation in natural resource status, analyses shortcomings from what might be the ideal environmental state, reviews likely impacts of the project on the environment and discusses mitigation measures for project implementation. An over-riding goal in project formulation is to bring about a favourable development scenario that would ensure sustainable resource use.

This discussion is therefore, more specific to the five priority schemes that have been selected as the immediate beneficiaries of the aid programme. A related discussion has been presented in more general terms in the preceding section - the masterplan study - which addressed a phased out integrated development program for the entire Boloven Plateau.

Two of the priority schemes, Upper Tapoung and Upper Champi, lie at elevations above 1,000 m; two others, Upper Kapheu and Upper Tayun between 500 and 800 m; and one, Lower Xe Set, at elevations between 300 and 400 m. The general slopes vary from about 1.5 per cent in Lower Xe Set to about 3.5 per cent in Upper Kapheu.

Available climatic data, which is limited in place and time, indicate an annual rainfall varying from 3,375 mm at Pakxong, at an elevation of xxxx m to 1,925 mm at Salavan, at an elevation of xxxx m. The land around Pakxong is a large plain extending over 400 km^2 at the highest point of the plateau and serves as the starting point for all the rivers that drain the plateau. These flow in all directions. Detailed climatic and water resources data are presented in Annex-1, Meteorology and Hydrology, of the main report.

Therefore, the physical features of the priority schemes highlight an hydraulic importance in the economic development of the areas; hydroelectricity generation (energy) and agricultural development being the two important sectors. The latter is the main focus of the current government development effort, although much of it is at a low technological level. The national energy sector has vast development potential with over 10,000 MW of technical capacity available for exploitation, out of which only a small fraction has been utilized.

Since the principal objective of the project is integrated agricultural and rural development, it attempts to use existing water resources as the central focus. Along with irrigation and drainage, complementary provision is being made for improved agriculture and support services, better roads, additional and better equipped schools, improved sanitation and water supply, and strengthened marketing linkages. There is however, no provision for the development of hydroelectricity. Each development sector is detailed in the respective subject annexes.

Development necessarily implies the use of natural resources, some of which are renewable while others are not. Examples of the former are water and soil, while minerals fall into the latter group. The economy of the Lao PDR is heavily dependent on the natural resource base; forests and water in the main. This is so for rural households for day to day survival and also for the government, looking to improve foreign exchange earnings. Because resources can be quickly over-utilized, exhausted and degraded, only careful use will ensure

availability for the continued use of future generations. This is the essence of sustainable resource use. Unless conservation is practised without delay, production processes in the Lao PDR will become increasingly difficult and costly.

The objective of the environmenal assessment is to examine the impacts of the proposed development on the resource base and predict those that might have adverse effects. Attempts will be made to mitigate identified adverse impacts so as to minimise the damaging effects on the environment. On the other hand, certain aspects of this development programme will seek to enhance the potential of resources that are presently of marginal benefit.

2 PRESENT CONDITIONS OF THE PRIORITY SCHEMES

Besides discussing the biological resources, this section also examines the institutional aspects and capacity building in the public sector and, the skills within the farmer community, as these are considered an integral part of the effort to raise productivity of the land.

2.1 Land Use

2.1.1 General

Land use classes are based on FAO recommendations with minor revisions having being made at the commencement of the National Forest Inventory. Accordingly, the National Office of Forest Inventory and Planning identifies six land use classes. These are:

current forest
- having a crown density of at least 20 per cent; includes forest plantations even with lesser densities;

potential forest
- degraded forest land suitable for forestry;

other wooded areas
- degraded land unsuitable for forestry;

permanent agriculture
- crop production and grazing land;

other land uses
- non-productive land and that used for purposes other than agriculture and forestry; and,

water
- natural or artificial water bodies.

The villages in the five priority schemes are described elsewhere in the report. Land allocation in each village follows somewhat of a set pattern. The village of Houakhoua in the Lower Xe Set scheme is taken as an example to show its distribution of land. A map dated January 18, 1996, prepared by the Salavan Province Forestry Technical Group, available with the village chief, shows the following uses of land in the village. This map is also publicly exhibited, painted on a board at the junction on road no. 20. However, certain areas of conservation value have not been included. The distribution as shown on the map is as follows:

	Land use	Extent (ha)
(i)	Protected forest	17.28
(ii)	Conservation forest	2.94
(iii)	Young fallow	148.07
(iv)	Paddy	3.0
(v)	Village	4.08
(vi)	Teak	3.05
(vii)	Reforestation	13.74
(viii)	Old fallow	25.34
(ix)	Lake	0.5
(x)	Field crops area	56.96
(xi)	Untitled area along part of Houay Xe Set	-

2.1.2 Priority schemes

The current land use in the five priority schemes is detailed in Annex-2, Soils and Land Use. It appears that natural systems are found only in limited extents as much of the land is opened up. For example, forest land in Upper Kapheu is only 3 per cent and the bush land is 36 per cent. Bush land is what had earlier been in forest. Cultivated land amounts to 61 per cent. Lower Xe Set has 30 per cent forest cover, 33 per cent bush and 28 per cent agricultural land. Upper Tapoung has 90 per cent of its land area in bush. Hence forest land has been gradually taken up by shifting cultivation and subsequently left to fallow. This is the bush. Table 1 provides a summary of land uses in the five projects. All crop land is grouped together as cultivated land.

The pattern of crop production is detailed in Annex-III, Agriculture. Paddy, coffee, tea, banana and cabbage are the main crops. Except paddy, the others enter the export trade in varying quantities. Coffee has the highest export value.

Paddy is grown as lowland and upland types. Being the staple food, each family desires to have food security in rice. This is the main reason for the continuation of shifting cultivation. Coffee is grown in all schemes except Xe Set, while tea is grown in Upper Champi only. Banana thrives in the lowland Xe Set area and cabbage is confined to Upper Tapoung. A variety of other rainfed upland crops are also grown.

2.2 Forests

Large extents of virgin natural forests are not found in the priority scheme areas. Only forest remnants remain. The land use survey reveals the following forest areas in the priority schemes.

Scheme	Extent(ha)	Per cent
Upper Champi	115	13.33
Upper Tapoung	9	9.47
Upper Kapheu	34	2.88
Lower Xe Set	379	30.08
Upper Tay-Un	69	16.43

Total extents are as low as 3 per cent in Upper Kapheu to 30 per cent in Lower Xe Set. Hence, all schemes have suffered extensive deforestation. The predominant forest type in the locality is the Upper Mixed Deciduous forest. There are also small extents of

Upper Dry Evergreen, Lower Mixed Evergreen, Lower Mixed Deciduous and Gallery forest types. Much of the available forest land is of poor quality. There has been deforestation over the years for shifting cultivation and logging. Shifting cultivation still continues. Forest fires have also contributed to this loss.

At the present time forest harvesting is a state-controlled operation with annual logging quotas being determined on the basis of the annual allowable cut. There is restricted logging taking place presently, unlike in the period after 1991, when a ban on logging was in force. For 1995/96 ending September, 637,000 m^3 has been decided upon by the government. Not all quotas are logged however. Most of the time previous cuttings have not yet been collected due to various logistic problems. The current provincial allocations are as follows: Champasak - 20,000 m^3, collection from previous cuttings; Salavan - 10,000 m^3, part collection and part cutting; and Sekong - 8,000 m^3, collection from previous cuttings.

The land use class of potential forest is actually deforested land that is not properly utilised. It is also called bush and carries varying stages of secondary growth or is presently undergoing degradation due to a poor vegetation cover. Sometimes land from this class is allocated for shifting cultivation. Extents of this land area vary from 5 per cent in Upper Champi to 91 per cent in Upper Tapoung. The area in Upper Tay-Un is also particularly high, being about 66 per cent. In the country almost 40 per cent of the total land area falls into this category. Because it is not utilised properly, this is a big loss to the national economy.

Forest land is assigned to village administrative authorities for management, including reforestation. Table 2 shows the distribution of village forest land in the five priority schemes. Such land is supposedly delineated and may include degraded land, planted forests, forest fallows, degraded forests and even natural forests. The provisions are laid out in a decree issued by the Minister for Agriculture and Forestry. In reality there is some confusion when trying to identify such in the field. There are also discrepancies between these figures and that of the provincial land use classification.

For example, in B. Houakhoua, Lower Xe Set, the map discussed in section 2.1 did not corresspond to the field situation. The protected forest area did not appear to be one such. It indicated signs of human use -- for shifting cultivation and vegetable growing. A part of it had been allocated for a pagoda. An important land area such as along the right bank of the Houay Xe Set is not considered for protection. The gallery (river bank) forest has disappeared except for small stretches along the river. Some sections of the river bank are completely degraded as has happened by the temple at B. Senvang Gnai. At this point, the bank is being washed away so rapidly that the village may have to be relocated soon. During the dry season, river banks and even parts of the river bed are used to cultivate vegetables.

According to the decree on Provisions on the Rights and Duties in Forestry Resources Management at Village Level issued by the Minister for Agriculture and Forestry, an impressive list of functions is listed as the responsibility of village administration committee. They have authority to effectively manage and preserve forests, develop plans, educate people, monitor changes, organise forest protection and management, draw up rules to suit village needs and work towards eliminating shifting cultivation.

The decree also requests citizens to protect reserved areas, catchments, river banks, animal habitats and hydropower catchments. It is also forbidden to clear catchments, mountain slopes and dense forests. In reality very little happens to implement any of the above.

People may however, collect non-timber forest produce from protected areas and, with appropriate permission, extract limited quantities of timber from village forests for personal needs. Some of the non-timber forest products are sticklac, benzoin, cardomom, bamboo, rattan, leaves, nuts, mushrooms and a wide variety of wildlifewhich bring in a small income to families but most are put to household use.

In the recent reorganisation of the Forest Department, it has been reported that a village forester is being appointed for managing forestry work in the village under the direction of the village administrative committee. The more important responsibilities of this position include execution of policies, plans, regulations, directives and laws which will be introduced from time to time. Monitoring shifting cultivation and prohibiting burning of forests are other functions. Such a position clearly needs a very good understsnding of natural systems, ecological linkages and techniques of forest planting and management.

Coming down long periods of time are customary rights over forest land and produce which are said to have legal obligation. These are generally unwritten, very old and repeated time and again, having root in custom. Customary rights are seen by the community as creating rights and obligations. The rights regarding the use of forest land and forest produce are to be exercised freely by their holders within bounds set by custom. These rights however, can vary between ethnic groups and locations.

Some of the more common customary rights are,

- harvest forest produce for community needs without a permit from the Ministry;
- commercially harvest produce found in abundance in sustainable volumes;
- obtain a plot for shifting cultivation from the village committee;
- hunt non-protected species of wildlife;
- form a user group for harvesting and sale of non-timber forest produce; and,
- prevent outsiders harvesting in village forests.

2.3 Wildlife

The larger species of wildlife are extremely rare in and around the village areas in spite of the rich species diversity reported to be present in the Lao PDR. They are confined to the well forested areas due to hunting pressure. The Minister for Agriculture and Forestry, has by decree prohibited the killing or capturing of 21 species of mammals, 14 species of birds and six species of reptiles. There are also 64 additional species protected during the close season from July to November.

2.4 Wetlands

Wetlands of the Boloven Plateau are confined to the area around Pakxong and are ecologically important. These are grassy plains, marshy in most places and there are also scattered hills. All the hills have been deforested. There are numerous ponds of varying size associated with springs and these play the very important role of feeding the streams that lead to the rivers. The Phase I study identified 18 ponds and these ranged from 1.5 - 12 ha. Most of the major rivers in Southern Laos originate in these wetlands. Some of the rivers are H. Xe Pian-Xe Namnoy, H. Makchang, H. Bangliang, H. Champi and H. Xe Set.

Part of the Upper Tapoung scheme falls within the Pakxong wetland area. The wetland makes up its small catchment of 4 km^2. Similarly, it also forms the catchment of the Xe Set scheme but in this instance, the extent is much larger, being 325 km^2. It extends southward to the Pakxong-Houaykong road. This lies at elevations between 1,000 m and 1,350 m and cover several hundred square kilometres. It is an area of high rainfall and the average annual rainfall at Pakxong is 3,412 mm.

In the Upper Tay-Un scheme, wetland systems (swamps) are scattered around a large area and together make up about 4 per cent of the land area. These provide small fish and other forms of animal protein for domestic consumption. In the dry season,

maintenance of the water table is a positive benefit.

Larger economic benefits are varieties of fish, amphibians, reptiles and molluscs harvested on a regular basis in the Pakxong wetlands. Wild birds are also trapped or hunted. These are sources of income generation. In some of the larger waterbodies, aquaculture using tilapia and common carp, is practised. Village people have shown interest in fish farming, seeing its economic advantages. A variety of plants with possibilities of economic exploitation are also found in these wetlands.

2.5 Protected Areas

There are no protected or conservation areas within the priority schemes, so set up either by the provincial or central administrations . However, there are those land areas having varying densities of forest canopy, in the care of village administrations and somewhat loosely referred to as protection and consevation forests. Sometimes these descriptions are misnomers when assessed against the vegetation status.

2.6 Agricultural Systems

This section will consider shifting cultivation, soil and water conservation and, agrochemical use and the possiblity of offering subsidies for conserving natural resources.

2.6.1 Shifting cultivation

Shifting cultivation is considered undesirable in the present time but nevertheless provides the basis for the maintenance of cultural values of a large number of ethnic groups. Under low population densities as found earlier in the humid tropics, the system had much to offer for ecological and social stability. As practised then with a long fallow, it had some good features such as nutrient cycling and crop diversity. The long fallow also helped in the suppression of weeds and pests. Generally the land is left to fallow soon after weeds become a problem. The closing of the canopy of the secondary growth quickly eliminates weed growth. When this same piece of land is reopened some 15 years later, it has regained its fertility and provides a weed and pest-free field.

Government's desire to eliminate shifting cultivation is in keeping with its policy of a shift to a market-oriented agriculture and forestry sector, with the introduction of the New Economic Mechanism in 1988. The new policies aim at,

- diversifying agricultural production;
- protecting farmers' property rights;
- increasing farm productivity;
- providing agricultural tax incentives;
- protecting forest, soil and water resources; and,
- introducing modern conservation and management techniques.

Over the years government has made a number of efforts to find viable alternatives to this farming system. For example, in the late 1970s and early 80s, some 16,000 families were settled in permanent agriculture. Agroforestry systems have also been introduced. While this desire continues, government is also mindful of ensuring that basic food security of rural people is met. Towards this end, government permits the Land and Forest Distribution Committee / Village Administrative Committee / Village Chief to allocate non-forest land to individuals or families for the sole purpose of meeting family food requirements. Wherever possible local authorities are also requested to assist farmer families to transform from shifting to settled forms of agriculture.

Table 3 shows the land area subject to shifting cultivation in each of the five schemes. It is most extensive in Upper Kapheu - 412 ha, but the average holding size, is highest in Upper Tayun, with each family having an 1-ha holding. The fallow cycles are as short as one year in certain Upper Kapheu villages, and rise to a little over five years in some other villages in the same scheme. Often paddy is the main crop alternated with a variety of upland crops.

Of the eight villages in the Upper Champi scheme, only the people of one village practise shifting cultivation. On an average each family has a 0.4-ha holding which is the lowest extent in all the schemes. Perhaps the reason for this low incidence of shifting cultivation in this scheme is the financial success of the farmers who mostly grow coffee. Coffee is extensively grown in the area which is bordered by the Pakse-Pakxong national road, providing easy accessibility which is an advantage to obtaining better market prices. Coffee is also a relatively easy crop to grow and the current prices are very good. The only attention given to the crop is at the time of harvesting. Here too labour is often hired. On the other hand, paddy is a more difficult crop to manage and the risks are greater. Given the easy life the villager is used to, and the prosperity from coffee, he may perhaps consider buying the rice an easier option than attempting to grow it under difficult conditions.

2.6.2 Soil erosion

Management of agricultural systems is generally poor. Soil erosion is the most widespread. A number of factors determine rates of erosion. Among these are the potential ability of rain to cause erosion, referred to as erosivity; soil properties or erodability; land forms; and catchment management. The availability of organic matter in the soil improves soil structure, infiltration and waterholding capacity and has a positive impact in reducing erosion.

Direct measurement is the preferred method to estimate sediment loss although empirical formulae are also used.The loss of soil from agricultural land has not been quantified in the Lao PDR. It is only recently that sediment runoff plots have been set up at the Hin Heup Upland Research Station to measure the rate of soil loss under different farming conditions. Although not quantified, it is not difficult to conclude that erosion is a negative factor in crop production and hardly any attention seems to be paid to it in all priority schemes.

Coffee is a major export-oriented crop in the Boloven Plateau. Often it is grown on steep land without erosion control of any kind. It has been reported that the coffee yield is on the decline. One contributory factor could well be the loss of top soil along with its plant nutrients and the lack of fertiliser application. Even when prices are good, farm inputs are not used. One enterprising farmer in B. Nongchoua however,who has a large herd of cattle, bring the animals at night into pens created in the coffee fields. The land is slightly undulating.The dung and urine gets incorporated into the soil. There is leaf-fall but no living cover on the ground. In this way some organic matter and plant nutrients are added. This to some extent is a realisation of the need for nutrient inputs. If this effort had been commbined with some mechnical soil conservation measures such as contour drains and bunds, the end-result (productivity) could be better.

Tea is another crop that is cause for concern. It is randomly planted, so widely spaced and so poorly managed, that open spaces between bushes which are also clean weeded, will continue to be sources of sediment generation.

2.6.3 Agrochemical use

The use of pesticides is at extremely low levels in all priority areas. However, an exception is pesticide use in cabbage cultivation in Upper Tapoung. Here highly toxic chemicals are used. Two of those used, folidol or methyl parathion is classified by WHO as "extremely hazardous" and DDT as "moderately hazardous". The latter is supposedly banned

worldwide. Both are also banned in the country but there is a big gap between regulations in the book and enforcement in the field. There are many entry points into the country and not all official land border points are well manned. Illegal entry is possible from neighbouring countries.

Facilities are available for pesticide analysis in aquatic systems at the Institute of Hygiene and Epidemiology of the Ministry of Public Health in Vientiane but is confined to routine studies of the Mekong Commission. DDT has been identified in Mekong waters. At the Phon Ngam Research Station in Pakse, some work on pest control is being carried out under the Lao-IRRI Rice project and integrated pest management has been just introduced. The pace of work is slow.

Fertiliser use is extremely limited except a little in vegetable cultivation. Some coffee farmers are now beginning to use a little fertiliser. All fertilisers are imported.

2.6.4 Economic incentives

Farmers generally are reluctant investors of time, effort and money for long-term gain. Short-term profit maximisation appears to be more attractive. Therefore, investment in soil and water conservation are rarely taken up. This is seen in the Lao PDR as well. There are a number of reasons for this state and some of these are tenurial issues, low profitability, high risk, unattractive markets, poor infrastructure, policy disincentives, slow resource degradation, poor technology or lack of it, and low levels of farmer education. In some countries the state has offered subsidies as incentives to achieve certain objectives such as higher productivity and improved soil and water conservation which are obviously in the national interest.

The state had been responsible for all of the above-named, during its long period of central control. Even then, services had been of a poor standard; for example, many shortages in agricultural inputs, low technological level and low productivity. With the current liberalisation, conditions have not moved far from what they had been, and farmers also do not have the capability to organise themselves into groups to seek solutions to their shortcomings. Hence, it appears that not all communities have the capacity to adjust to reforms that are introduced although a long-term benefit is offered. They need a certain time period to adjust themselves and the full impact of reforms need to be softened to some extent by state intervention. The offer of subsidy payments is one way of achieving desired objectives and is used by governents in many countries.

2.7 Aquatic Systems

In the priority schemes, aquatic systems are made up of rivers, streams, small ponds and the wetland ecosystems of the Upper Tapoung and Upper Tay-Un schemes. All are natural systems except for a few scattered man-made ponds where aquaculture is practised. The rivers, streams and the wetlands exhibit different hydrological patterns during wet and dry seasons. The latter is very dry and water scarcities are not uncommon.

In Upper Kapheu and Upper Champi, rivers flow in deep valleys. The river beds are rocky over long stretches which does not make fishing attractive as the fish habitat is confined to the small pools found at intervals along the river. Species are limited to the smaller indigenous types which are not of much commercial value. However, some of the family protein needs are met by this means. The daily catch averages 0.5 - 1.0 kg, which may be somewhat more during the rainy season. Table 4 provides some information on the species diversity in the priority schemes.

The H.Tay-Un flows through a relatively flat area and the banks are marshy in many places. Presently aquaculture is being introduced here and the construction of ponds is taking place along the river. The people appear to like this idea as it should bring in extra family income and is also well suited to be an occupation for family women.

2.8 Domestic Energy

The energy sector is dealt with in Annex-7, Rural Infrastructure. However, the energy requirement, which in the priority areas is primarily for domestic use, is almost entirely obtained from firewood or plant parts. About 95 per cent of the people are dependent on wood energy. Firewood is collected from the common forest. The impacts on the environment lie in so far as the demand for firewood compels the use of natural forests. This points to the need to make provision for firewood planting if certain villages are likely to experience firewood shortages. It was reported in Thateng that certain parts of the district experience firewood difficulties. However, where coffee is grown, the prunings are said to provide adequate quantities of firewood. Thateng being at a higher elevation could experience a colder dry season and people need more energy to keep warm. Hence what is available in the district may not be sufficient. The *kabong* resin torch is commonly used to illuminate the home in Thateng and in Upper Tay-Un.

A run-of-river minihydro plant operates on the Houay Champi at Pakxong. It however, ceases to operate during the 5-month dry season from December to April. A prosperous and enterprising coffee farmer in B.Nongchoua operates a microhydro plant. A few people use kerosene to light up their homes.

2.9 Watershed Management

The siltation on H. Xe Don and the difficulties experienced in power generation during the dry season particularly, at the Selabam hydropower facility, which is a run-of-river operation on the H. Xe Don, is a good example of watershed problems. Due to insufficient water, power generation at the present time is only 50 per cent of what was anticipated in the feasibility study. Shifting cultivation and irrigation projects in the basin of the river are attributed as the causes for low water availability.

The following are the basin areas for each priority scheme:

Scheme	Area (km^2)
H. Champi, Lak 47	16.0
H. Champi, Lak 43	36.0
H. Tapoung	4.0
H. Kapheu	24.0
H. Xe Set	325.0
H. Tay-Un	21.0
H. Thon	8.0

It has not been possible to study the ecological and socioeconomic characteristics of these areas. The basin areas will be referred to as catchments in the sections that follow, being small components of larger river basins. The entire river together with its tributaries will be referred to as the watershed. Some aspects of catchment management common to all schemes are outlined below. At the time of field studies no special initiatives in watershed management could be seen in any of the five priority schemes.

Land use often does not appear to be within accepted capability and suitability criteria. It is common to see steep slopes and river banks being opened up for cultivation. Agricultural practices do not in any way contribute to soil and water conservation. Some of the fundamental principles of crop husbandry appear to be ignored; contour planting on sloping land, for example. Tea, grown only in the hilly Upper Champi scheme, is randomly planted, widely spaced, and so poorly managed, that the open spaces which are also clean weeded, continue to be sources of sediment generation. The sediment finally ends up in streams and rivers.

During the dry season, when rivers and streams run low and are reduced to narrow channels, people begin to cultivate vegetables on the banks, and even on the river bed itself. This practice, which clears bank vegetation and loosens the soil, promotes bank and bed erosion when the rivers run full again in the rainy season.

2.10 Water Quality

Fertiliser and pesticides, and the absence of industrial growth. Low population densities and a predominantly rural lifestyle are also contributory. Even the larger town centres are quite rural in outlook.

A suspect non-point source however, is in the H.Tapoung below B. Xetapung, where agrochemical residues are likely to show up after draining from the cabbage cultivation further upstream. Section 2.6.3 on agrochemical use further elaborates on pesticide analysis in aquatic systems.

Water quality analysis has been carried out at seven river intake sites during Phase III of the project and detailed results are presented in Annex-I, Meteorology and Hydrology. On the Champi there are two sites, at Lak 43 and 47, and one each on the Houay Tay-Un and Houay Thon, both in the Upper Tay-Un scheme.The other three schemes provided one site each.

It has been concluded that it is possible to use the water from these rivers for agricultural and domestic purposes. However, in Tapoung and Tay-Un, the values for iron exceeded the standard of 0.3 mg/l. For drinking purposes this water may have to undergo some treatment. All samples have also shown a weak alkalinity; slightly more than what might be preferred for most crops, including paddy. The conductivity values are well below permissible levels for crop growth. The coliform values are also within accepted levels.

2.11 Environmental Health

Irrigation development projects are frequently associated with disease problems when large concentrations of workers and settlers come together, perhaps from a number of other regions. Often they bring with them certain types of communicable diseases. With poor living and sanitation and uncertain water quality, there can easily be disease outbreaks.

Even without irrigation projects a number health problems are evident in the priority areas. Malaria is considered the most important public health problem in these areas and is hyper-endemic. It also causes high morbidity among children under one year. Other health problems are reported to be diarrhoea and acute respiratory infections. Some basic malaria control measures have been carried out by the provincial health authorities. These include spraying of mosquito breeding sites and houses, drainage of ponded water and promoting the use of mosquito nets.

Several species of the *Anopheles* mosquito are responsible for transmission

of the parasitic protozoan *Plasmodium*. These species typically breed in stagnant water. As water is a requirement for certain life stages of the mosquito vector, irrigation projects are usually favourable sites. The requirements of the larval stages are met by standing shallow bodies of water, such as slow moving irrigation ditches and drains and small pools of stagnant water. These are present in all priority areas. Health is discussed in greater detail in Annex-6, Socio-Economy.

At work sites there is the risk of disease spreading if workers come from other regions where certain diseases may be endemic. Malaria is one such disease but it is already present in the scheme areas. Providing pure water and sanitation are issues that can have health-related effects. Accidents at work sites can be expected and precautions will be good management strategy.

2.12 URBANISATION

Urbanisation has not affected any of the priority areas. There are only poorly developed villages, often with difficult access. The amenities are quite primitive in most instances. There is very little ongoing trade in the villages. Towns outside the priority schemes cater to the needs of the people. For example, Laongam serves Upper Kapheu and Lower Xe Set. Pakxong serves Upper Tapoung and Upper Champi. Thateng serves Upper Tay-Un. However, it is quite common for people to even go far to the larger towns such as Pakse, Sekong and Salavan to look for their needs. Such visits are also considered as social outings, breaking the monotony of what others might consider a dull life. Therefore, problems commonly associated with urbanisation are not found.

2.13 Cultural and Aesthetic Aspects

There are no reported sites of archaeological interest. However, a large number of ethnic groups is part of the country's national cultural diversity. Annex-6, Socio-Economy, discusses socio-economic and cultural aspects of the different ethnic groups that live in the priority schemes. There is some effort to improve the educational standards of ethnic groups. Unfortunately there is no attempt to preserve the cultural identity of each group by promoting the folk arts such as music and dancing, and handicrafts. With the country being opened up for tourism, such promotion could serve to generate new income.

Of aesthetic interest are the Pakxong wetlands, a part of which falls within the Upper Tapoung priority scheme. There are also a number of waterfalls; some inaccessible, but others such as on the Houay Xe Set, providing the basis for limited tourist development.

2.14 Physical Infrastructure

It was apparent that the poor condition of roads pevent economic progress of many villages, particularly when far away from a town where farmers can find markets for their produce or buy what they want. Roads with steep slopes such as those leading to the river crossings are often badly erodedon either bank. Hence subsistence farming continues in these villages. A good example of remotness and difficult road condition is B. Natou in Lower Xe Set. Given roads in at least fair condition, many farmers, particularly those owning coffee land, are owners of motor cycles and two-wheel tractors, and this makes life and farm work so much easier.

2.15 CONSTRAINTS TO CONSERVATION

2.15.1 Institutional weakness

All institutions from the central government to the village level have important roles to play in resource management and the production processes. They should therefore, effect a smooth flow of information to the grassroot level, identify problems at this level and bring about an efficient co-ordination between planners, decision-makers, implementing agencies and farmers.

The number of technicians working at grassroot level is insufficient. Most of the staff tend to remain in towns where living conditions are better. Policy decisions are necessary in this regard. The contact between technicians and farmers is few and at too long intervals. The Forest Department has gone through a reorganisation programme quite recently and reportedly have transferred many officers out of Vientiane into the provinces and districts. This movement is yet to be streamlined. The recent appointment of village foresters, while being a good decision, requires further attention by way of improving of their educational level.

Institutions should also review individual subject matter schedules so that identified key areas are given due attention and importance. Some important areas seem to be left out presently. For example, soil and water conservation does not find a place in the agricultural extension programme. The entire basis of successful agriculture lies in the availability of good quality soil and water resources. Without these two basic resources a nation will collapse.

2.15.2 Staff training

A poor educational system which presently includes only secondary and technician schools, is responsible for poor quality staff. The absence of university education further aggravates the problem. The earlier facility of graduate education offered by the socialist block of countries has now ceased. Even otherwise, expert review of the qualified staff position in the country does not give much credit to the quality of education imparted by that system. This indeed is an unfortunate situation which will take some time to correct. It would involve the establishment of tertiary education and the overhaul of technician and secondary education to present day modern standards. Making available teachers who are competent and also dedicated is yet another difficult undertaking.

2.15.3 Farmer training

As farmers still practise farming techniques that are subsistence-oriented, productivity is low and resources are poorly conserved. Farmer training is not well organised and the quality of training is poor. Staff shortages at grassroot level are another serious drawback.This aspect is addressed in Annex-6, Socio-Economy.

2.15.4 Public awareness

Public awareness on environmental issues is very poor judging from how farmers handle their farming practices. This is evident even in their approach to the home environment.

3 PROPOSED CONSERVATION MEASURES

Environmental management concerns the attainment of sustainable growth

using appropriate policies and incentives. After the introduction of the New Economic Mechanism, the Lao PDR is slowly coming up with a variety of policy reforms in natural resources management. However, translation of policy to success in the field often falls far short of expectations due to a number of reasons. While some are of a technical nature, many are institutional. These include institutional weaknesses, farmer doubts about new technology, market imbalances, population pressure, and resource tenure arrangements.

When land is incorrectly farmed it leads to degradation and reaches the point when further agricultural production becomes uneconomic or is simply not possible. Some of the reasons for degradation are nutrient depletion, structural decline, biological decline, chemical deterioration and soil erosion. But the most fundamental resource management challenge is commercialisation and the growing competition with incompatible patterns of resource exploitation. These however, need resolution at national level.

3.1 Environmental Planning

Land use planning, with its requirement of a series of field investigations, takes time and is not a recommendation that can be immediately implemented. Nevertheless it is important to make a beginning. It can be gradually developed depending on available resources. In a country such as the Lao PDR there are inherent constraints. There is a serious drawback to technology transfer as the level of allround education, and therefore absorption, remain low standard. However, some basic principles of land use planning should be taken into account without delay when considerng land allocation.

Environmental impact assessment is another very useful tool in resource management. An attempt to predict environmental impacts at an early stage of a proposed development can be a beginning that will set in motion a thought process into what adverse impacts may arise. These can include social impacts (people who might be affected), economic impacts (monetary losses that might occur directly or indirectly) and ecological impacts(environmental effects). There are of course the beneficial aspects; that is why projects are planned and implemented. Hence it is necessary and important to assess the adverse and beneficial impacts. With present levels of manpower in the country, and with some training on the subject matter, it should be possible to expose staff to preliminary environmental assessment procedures. To be effective, impact assessment should be a component of village level planning. Hence all village foresters should undergo training in basic ecology and impact assessment. Its application should be at all levels of resource management.

The study revealed an example of non-application of either the principles of land use planning or of environment impact assessment. In the last couple of years large scale land concessions had been made in the Boloven Plateau. It is known that neither land use planning nor environmental impact assessment had been utilised in deciding on the allocations. Some of the proposed development activities are very likely to cause adverse impacts on the water resources, particularly those in zones 3, 5 and 7 in Pakxong district. The primary concern of land use planning and environmental impact assessment in this instance, if applied, should have been to ensure that the water resources that feed almost all the rivers in the south of Laos, is not put in danger .

As a beginning to the use of land for purposes other than preserving in the natural state, certain fundamental criteria have to be adopted to ensure that resource quality is not in anyway degraded. It is very necessary to maintain the production processes in order to keep up with increasing demand from the land as population increases. Good agricultural land may also decrease as the non-food needs of people, such as roads, towns, buildings and amenities keep increasing.

Land use planning will enable the rational allocation of resources according to the suitability criteria of each unit of land. This will ensure that each class of land will be

utilised according to its capability. For example, good agricultural land should be reserved and allocated only for agriculture and housing needs of the community will be met by land that is unsuitable for agriculture. With the adoption of such basic concepts, it will be possible to obtain the optimum benefits from the land for present and future generations.

3.2 Agricultural Land Management

Agriculture is the most important occupation of all rural households. Of the country's population, 95 per cent are rural. This situation will continue well into the future. Therefore, it is important to manage agricultural land within limits of good agricultural practice in order to keep these economically productive in the present as well as in future years.

Exposure of decision-makers to land use planning will help them make rational decisions such as providing the better land for crop production on the basis of land capability and suitability. "Capability" refers to the range of possible uses which the land can be put to without damaging its production ability. "Suitability" is a measure of the best use for a particular unit of land.

This section will discuss soil and water conservation, sustainable agricultural management, shifting cultivation and soil and water pollution. These are applicable to all priority schemes. However, the methodologies may change from scheme to scheme. For example Lower Xe Set, Upper Tapoung and Upper Tay-Un have mild gradients when compared to Upper Champi and Upper Kapheu. In the latter schemes much coffee is grown on steep land, the land is clean weeded and soil organic matter status appears to be low. In the former schemes paddy and upland crops are mainly grown.

3.2.1 Soil and water conservation

Soil and water conservation should in reality be implemented for an entire drainage basin whether there is agriculture or not. That on agricultural land is for specific reasons of maintaining productivity as it has a direct benefit to the farming community. In this section only that on agricultural land will be discussed. It necessarily follows that most recomendations for soil and water conservation also leads to fertility generation and this section is therefore, closely linked to the section on sustainable agricultural managemnt that follows. There are factors other than technical that play a part in preventing agricultural land degradation to which soil erosion is partly contributory. These are availability of resources, inappropriate policies and lack of knowledge.

The resource of land itself is not limiting in the Lao PDR. However, upland farmers are basically subsistence farmers and even if desirous, do not have the financial resources to effect changes. Coffee farmers on the other hand often enjoy good prices and have the financial resources to invest in conservation. But they do not do so. Many countries of the world that had ignored soil conservation have had disastrous results. Policies sometimes may not be in the best interests of resource conservation as purely economic interests could be the driving force. The land concessions in Pakxong district in some way point to this. Tenurial issues also determine farmers' interest in long-term mangement. Knowledge should be transferred to both farmers and government staff at provincial and district level. The lack of it is about the biggest obstacle to achieving desired objectives in resource management.

Soil and water conservation methodologies may be grouped into two; agronomic methods and mechanical or engineering methods. Which method to apply depends upon a site decision. Usually a combination of methods is the likely choice as different stages of crop growth require different approaches. Seasonal and permanent agriculture will have obvious differences. There will be differences between lowlands, usually below 2 per cent slope, and uplands upto about 30 per cent slope.

Lowlands being alluvial plains and usually cultivated in paddy, are not so

much erosion-prone. The bunds that are an essential part of lowland paddy, are an insurance against soil movement. Lowland paddy is the proposed crop for Upper Tay-Un and the topography is one of mild gradients. Upland soils have an undulating to steep topography and when opened up are exposed to erosion.

(1) Mechanical measures

Deforested land in Upper Tapoung has been classified as bush and secondary forest. This land is disused presently. Seasonal agriculture like that which is proposed for the Upper Tapoung scheme, will use this land for cabbage cultivation.

Although the gradient is mild, as a precautionary measure, certain soil conservation measures are proposed for the Upper Tapoung scheme. A priority is that all land preparation should be done on the contour, as this will encourage the formation of terraces after some years of cultivation. To achieve this objective, the creation of low contour bunds is proposed at intervals of about 20-30 m, while at the same time, provision should be made for the diversion of excess water through interception and diversion ditches as cabbage and most other vegetables require good drainage. Contours can be marked using the simple A-frame.

For upland crops that are grown on gradients upto 30 per cent or more, soil conservation measures will take a different perspective. Such lands are found in the Upper Champi, Upper Kapheu and Lower Xe Set schemes. In Lower Xe Set where gradients are mild, contour bunds are recommended at 15-25 m intervals depending on crops grown. These can be on the same basis as above; with hedgerows. Alley cropping is also suitable as a soil conservation measure.

In Upper Champi and Upper Kapheu where gradients are steeper, 10-15 m intervals are suggested for thecontour drains. If rainfall is heavy and runoff greater than infiltration, contour drains can be graded to suit drainage requirements; to drain away surplus into natural drainage ways. When a drain and a bund are used together, the space between two drains can assume a terrace form after time.

Project proposals seek to increase the land under economic crops and this is part of government policy. Crop diversification is also considered. In Upper Champi 160 ha of disused land are being converted into agricultural use. A part of this is to be grown with coffee and a part with vegetables and upland crops. In Upper Kapheu, 490 ha of similar land are being turned over largely to coffee and a small part to lowland paddy. It is proposed that all new planting of coffee and shade trees be carried out on the contour.

(2) Cultural measures

Coffee, in the mature growth stage when grown under shade, is similar in some ways to a natural tropical rain forest, although the plant density is not quite so. There may also be a ground cover of miscellaneous weeds made up of broad-leaved plants and grasses. Then there is the ground layer of fallen leaves, twigs, other plant parts and the humus layer just above the soil. The ground layer in a coffee field is not as rich in its organic content as that in a forest. The forest vegetation, by intercepting and dispersing rain drops at different vertical levels, protects the soil from the damaging effects of heavy tropical rain. Its energy is broken and allowed to infiltrate into the soil by gently dripping from the topmost canopy, through a large volume of leaves, twigs and branches to the ground layer. The thick organic ground layer acts as a sponge to absorb rain water and leave soil pores always open. Soil micro-organic activity proceeds at favourable rates and organic matter is incorporated with surface soil.

The similarities are that there are at least two canopy levels -- that of the shade trees as the main canopy, and the coffee as the sub-canopy. This forest appearence can easily be simulated in a coffee field by appropriate planting distances of the coffee and shade trees. Minimum of mechanical conservation measures as described above will be necessary,

depending on the gradients. Subsequent plant care should ensure as closed a canopy structure as possible. Weeds at the ground layer will depend on the light intensity filtering through but will not be as diverse as in a forest. Organic matter levels will also be much lower than on the forest floor on account of a poorer leaf fall and the removal of berries and, branches after pruning.

In an immature coffee plantation, at the time of establishment, a minimal soil cover will be present. The exposed soil will therefore be susceptible to erosion. A way of minimising soil loss will be by establishing a leguminous cover crop even before planting the coffee. This acts as a live mulch. The concept of cover cropping has been successful in plantations of rubber, coconut and oil palm. Some tropical varieties of cover crops are *Pueraria, Desmodium, Centrosema* and *Psophocarpus.* Most leguminous cover crops grow profusely and produce a large volume of leaf and herbaceous stem which contributes very valuable organic matter under tropical farming systems. There are many other benefits of cover crops that contribute to improving the physical, biological and chemical properties of soils. Some of these are adding nitrogen, lowering soil temperature, buffering pH and preventing weed growth. Growth of the cover is faster in the early stages if a little phosphatic fertiliser is applied. The benefits of live and dead mulches in preventing erosion and increasing yield have been field-proven in many tropical countries.

Some management of the cover is required early on as the small coffee plants may otherwise be smothered by creeping varieties of cover crops, eg. *Pueraria.* It is also possible to use cut materials as mulch or even intercrop the coffee field with seasonal crops such as vegetables, grain legumes, maize, groundnut and other useful plants for a couple of years.

It has often been said that the coffee yield in the Bolovens has suffered from moisture stress. While this is correct, it is also quite clear that coffee lands are not being properly maintained in an agronomic sense. This means that there is also a nutrient loss along with a soil loss if erosion is the main issue. The question is : can the yield decline be arrested by improving management. This means: improving infiltration and reducing runoff; improving soil organic matter; improving shade level; improving tree management; improving soil nutrient status; using varieties of coffee appropriate to each agro-climatic zone and restricting planting to frost-fre areas.

Often plants are used in combination with mechanical measures. Hedgerows can be planted on the bund, serving also to strengthen it. Leguminous shrubs such as *Sesbania* spp., *Crotalaria* spp., *Albizzia* sp. and *Flemingia congesta.* will provide other benefits as well. The loppings of these shrubs can be used as green manure and as thatch for mulching. Another plant currently gaining wide acceptance in the tropics is vetiver grass, *Vativeria zizanoides,* a densely tufted plant which is easily adapted to a wide range of soil and climatic conditions. It persists for a long time without maintenance and is planted an contour bunds or simply across the slope or along drains. Soil moving downslope gets trapped among the tufts of grass. Yet another possible practice is strip cropping, where strips of grass on the contour alternate with vegetable beds. These practices of using plants to strengthen mechanical measures are well suited to the cabbage culture in Upper Tapoung and upland farming on the mild gradients of Lower Xe Set.

(3) Mulching

Mulching is a practice that has a large range of benefits in crop production. It has certain disadvantages too, such as difficulty in obtaining large qantities of materials and the attraction to termites. These however, can be overcome and the advantages of mulching outweigh the disadvantages.

Live mulching is possible in a crop such as maize. Preliminary work carried out at the International Institute of Tropical Agriculture in Ibadan, Nigeria, in the late seventies

had come up with some very interesting results. It had been shown that the yield of maize was higher in live mulch plots than in bare tilled or untilled plots. Weed growth was eight times more in tilled unweeded plots than in the live mulch plots of *Desmodium* and *Psophocarpus* . Another very significant observation had been the high incidence of earthworms in the live mulch plots than in the unmulched plots. The presence of earthworms in an agricultural soil is an indication of very favourable soil conditions for root growth.

(4) Alley cropping

Alley cropping or avenue cropping is another method of soil conservation that can be successfully adopted on land of all gradients. The soil is held in place by avenues of deep-rooted tree species planted on the contour at convenient intervals. Some useful tree species are *Leucaena, Gliricidia, Albizzia,* and *Calliandra* . Leguminous species will have the added benefit of nitrogen supply. At the beginning of the season, trees are lopped and the loppings are used to mulch the inter-row space. Woody portions can be used for firewood.

Crops are grown in the space between the two tree avenues. While the addition of nitrogen to the cropped plots will take place through the mulched loppings and that added by nodule bacteria, other elements will also be brought up from the deeper soil layers and released when the mulched loppings decay. The avenues of trees also act as windbreaks and bring about favourable microclimatic effects on certain crops. The slope may finally assume a terraced shape after some years of cultivation. The system can also sometimes be an agroforestry system depending on what species are planted. A similarity with the sloping agricultural land technology adopted in the Philippines is also seen.

(5) Cover crops

Cultivated plots, where particularly widely spaced crops, such as maize, tobacco, groundnut, coffee, tea and fruit trees are grown, are very susceptible to erosion soon after crop establishment as the soil is exposed to rain. This drawback can to a great extent be minimised by growing cover crops or by adopting mixed cropping in coffee and fruit culture. Cover crops can play an useful role in improving soil physical, chemical and microbiological properties.

(6) Tillage

A number of systems of tillage have been tried out in tropical agriculture including the no-till option with direct seeding through a stubble mulch. Tillage can have a degrading effect on soils when carried out at extreme moisture levels and hence on productivity. Ploughing and cultivating during extremes of soil moisture bring about destruction of soil structure. It is not being addressed here for want of locally available information but is a factor to be mindful of.

(7) Incentive subsidy

As an incentive to have the soil resource conserved, it is proposed that the government considers granting of a soil and water conservation subsidy to coffee farmers who cultivate land above a specified gradient. Coffee is selected because it is presently an export crop and shows promise of being so in the future also. Therefore, the land on which coffee grows should be carefully conserved, so that benefits of the world trade will continue to reach the Lao farmers.

A well designed soil and water conservation programme can be implemented in the project areas involving the coffee farmers. Initially it should be carried out on a trial basis and if found to work satisfactorily, may be extended to cover all coffee holdings. The method of conservation to be adopted will be a combination of methods that will suit particular

situations. For example, coffee on mild gradients just planted, will do well with cover crops but mature coffee under shade will not have luxuriant covers and will require some mechanical measures also. These will be carried out on the instructions of qualified technical staff.

The subsidy, to be paid in cash, will meet part of the cost of carrying out prescribed soil conservation practices. The financial implications of the subsidy can be met by a cess, ie. a tax to be determined and levied on each kg of coffee at the point of export. The cess or tax will go into a fund which will be placed in deposit and will collect interest. Good quality coffee will naturally attract a greater world demand and the more coffee exported will collect a higher total cess. Payment of the subsidy will be on each hectare, phased out in instalments, for work executed in the field. For example, the first instalment will be for field preparation and planting with the establishment of cover crops.

Thus, a total conservation programme, from planting can be spread over about 3-4 years and will include vegetational cover crops and mechanical bunds and or drains. The idea is only presented in a conceptual form and not in an elaborated manner for implementation. If the concept is accepted, details will have to be worked out

3.2.2 Sustainable agriculture

Traditional agroecosystems are genetically diverse and often contain strains of wild crop plants. This genetic diversity allows the farmers to exploit different microclimates while benefitting from a high degree of pest and disease resistence. In Thailand and Indonesia, farmers maintain a diversity of paddy varieties that suit a range of environmental conditions. Sometimes high yielding varieties are grown in the dry season with irrigation, thus taking advantage of good growing conditions. During the wet season, traditional varieties are grown as these can tolerate pest and disease outbreaks and can withstand changing conditions due to unreliable rainfall.

This section introduces a farming philosophy that can be adopted by farmers in all priority schemes. Lowland farmers who are used to a paddy monoculture season after season, can also bring about elements of diversity by adopting simple techniques. It is nothing new, and components of it have been traditionally practised by tropical farmers, including those of the Asian region, over long periods of time. It is a strategy of multiple use. The basis is the tropical plant diversity and the adoption of polycultures as against monocultures, particularly in upland agriculture, whereby simulation of a tropical forest ecosystem is accomplished. A tropical forest is a self-contained ecosystem where inputs, outputs, and all other systems are in equilibrium. Even pests and diseases are kept in check where no single pest is capable of reaching endemic proportions. In agriculture, when output is greater than input, ie. when the biomass that is taken out of the land (harvest, prunings), is not supplemented by nutrient application, agronomic problems arise. It must not be forgotten that the green revolution has also brought about its own share of problems.

(1) Plant nutrient supply

The maintenance of soil fertility in cropped land, often by the addition of supplemental plant nutients in the form of fertlisers and manures, are basic requirements of present day agriculture, expected to produce in sufficient quantities to keep pace with growing populations. In the project areas, very little fertiliser is used and the little used is imported. It is also always not available to the farmer. Manures are however, available in rural areas from livestock and plants, often in large quantities and not put to good use. Productivity is reported to be on the decline in the Boloven Plateau and ways and means are urgently needed to remedy the situation.

The concept of integrated nutrient supply appears to hold promise under local conditions. It is a broad concept, examining status of, and relationships between the soil,

plants and livestock, and alternative possibilities of nutrient supply. Traditional systems of nutient supply have utilised a number of ways of making available plant requirements.

In nutrient recycling, organic matter collected within the farm is used to provide plant nutrients. These include livestock wastes and other nutrient sources. In nutrient pumping, nutrients picked up by deep rooted trees are made available from leaf-fall, to surface feeding crops, as is put to practise in the alley cropping system discussed earlier. In biological nitrogen fixation, symbiotic or non-symbiotic micro-organisms are used in crop husbandry to help increase soil nitrogen. Additional nutrients can even be supplied by reintroducing eroded sediments from within or outside the farm. When nutrient losses in agriculture, cannot be corrected by natural recycling, such as what is taken away in the harvest, these have to be provided for by inputs such as mineral fertilisers and organic manures.

Nutrients from organic sources are particularly necessary to keep soils in good condition. Where soils are infertile, acid or highly erodible, management is better effected by the use of manures or a combination of manures and fertilisers, rather than by fertiisers alone. Manures have the added value of improving soil physical properties, supplying plant growth hormones and substances that provide resistance from pests and diseases and reduce the toxic concentrations of metals in soil solution.

With large numbers of livestock being maintained for commercial purposes by almost all households, it should be possible to introduce management systems that allow for collection of waste which is presently unutilised, so that it can be used in the field. This possibility should be examined in the demonstration farms to be set up.

The use of green manure is a method of organically supplying plant nutrients in both lowland and upland agriculture. Large amounts can be obtained from outside the farms. Farm boundaries can also be utilised to grow green manure trees. Gliricidia sepium is a very good example of a green manure tree which produces large amounts of leaf and twig, stand pruning and provides nitrogen, being leguminous.

Rice straw is another organic source of nutrients, being particularly a good source of carbon, nitrogen, potassium and silicon. It can be used in the rice cropping systems. In a long-term experiment on a Sri Lankan farmer's field, straw applied treatments receiving about 30 kg N/ha less than the normal recommended dosage, and no potassium fertiliser, have given equivalent or higher grain yields than treatments receiving the full dose of inorganic fertiliser. Straw under Sri Lankan conditions has around 0.6 per cent nitrogen and 1.6 per cent potassium.

(2) Integrated farming systems

The integration of crop and livestock farming is an ideal situation to be maintained in tropical agriculture. Animal waste provides large amounts of plant nutrients. Urine contains as much as 50 per cent of the value of the waste containing as much as two-thirds of the nitrogen and four-fifths of the potassium. If livesock management can be made systematic with proper housing, almost all the waste can be collected in a suitable form and used in the fields. A cemented or well rammed earthen floor will prevent too much losses of nutrients. Bedding of paddy straw or grass will absorb much of the urine and mixed with the dung can be used in composting. In the alternative the waste can be directly led into a composting pit some distance away from the housing every 3-4 days.

Similarly, if poultry can be reared on the deep litter system, the litter can be used in the fields about once every 12-18 months. Fresh poultry litter may contain over 3 per cent nitrogen and 2 per cent potassium and many trace elements.

(3) Multipurpose trees and shrubs

There are many opportunities of growing trees and shrubs of utility value in farming and in the household. Tree crop culture also fits in well with land rehabilitation programmes. Many ecological benefits can also be expected. When grown on paddy field bunds and on boundary fences, trees and shrubs will provide regular loppings for green manuring and mulching. A steady supply of round poles, sticks, fodder, firewood and timber are other benefits that are possible.

Among species that are suitable are *Gliricidia* spp., *Sesbania* spp., *Acacia auriculifomis*, *Leucaena leucocephala* and *Eucalyptus canaddulensis*. Under Indian conditions it has been reported that *Gliricidia sepium* produced 18 kg of leaves/plant/year, having a nitrogen content of 0.5 kg. On this basis 100 plants will produce 50 kg of nitrogen.

Under Philippine conditions, Napier grass, *Pennisetum purpureum*, produced 3 kg of dry matter/10 linear metres every 30 days. It has been reported that 750 linear metres are adequate to meet all the fodder requirements of a draught animal.

(4) Agrochemical use

As the problem of agrochemical use is limited to one of toxic pesticides in cabbage cultivation in Upper Tapoung, two recommendations are made: firstly, extension staff should educate themselves and train farmers in correct pesticide use; of the dangers to themselves and to the community, including those who consume the harvested produce. Since most rural people depend on the natural waterbodies for domestic water supply, the community in a larger area can be affected if water sources get polluted. Secondly, government should enforce pesticide regulations if legislation has been enacted. It should also ensure strict controls at entry points into the country so that toxic chemicals do not enter the country. Illegal entry can also be checked at the point of sale, usually the retail store.

Water anaylsis of suspected aquatic bodies is suggested although ther are practical difficulties. In H. Tapoung, a point below the drainage basin where cabbage is grown should be the sampling site. This is not locally possible but some mechanism may have to be worked out with the Mekong Commission as only the programmes of this institution can undertake the testing.

If conclusively proved, strict controls are recommended. An implementaiom programme will be as follows : (a) conduct a short training for extension staff, including village level workers, (b) survey farmers using the toxic chemicals and confiscate stocks, (c) conduct an education programme for farmers of the affected drainage basin, (d) identify dealers having the chemicals and confiscate stocks, (e) safely dispose confiscated stocks, and (f) survey entry points into the country and educate customs staff on correct identification procedure and follow up action.

In the Cambodia-IRRI rice research programme, it has been revealed that the ratio of natural enemies of paddy pests is 2:1, ie. for every paddy pest, there are two natural enemies. This study also revealed that of 22 samples of chemicals analysed, only five had the strength claimed on the packing. Ten had extremely low concentrations or none at all. This shows that farmers are paying hard-earned money in buying either water or some coloured liquid, and that by spraying highly toxic chemicals, they are destroying the natural balances that control pests without additional cost to himself. The Cambodian national integrated pest management (IPM) programme in its perliminary work, showed that pesticide use can be drastically reduced, if not totally eliminated.

At this point of time, it does not seem good sense to recommend an IPM programme as the institutional capacity cannot cope with the demands of the subject. However, the immense possiblities of IPM are recorded here for likely adoption at a future date. IPM can

be defined as "a system that relies on a variety of approaches for controlling pests, including physical, biological, genetic and cultural methods as well as pesticides. It relies on the concept of an economic threshold of pest population density or crop damage, below which the cost to control a pest is greater than the benefit of doing so. In agriculture IPM components include efforts to breed crops resistent to pests and diseases, use of cover crops for weed control, timing of planting, crop rotation, and introduction of predators and parasites."

An IPM programme can reduce pesticide use, cost of production, health hazards to humans and animals and promote multiplication of natural predators and parasites. Pest resistence can occur from repeated use of chemicals in high doses, when pests initially acquire tolerance levels. Pests then become resistent and can withstand very high doses. Control using a single or group of pesticides become impossible and still more toxic chemicals are then used. The vicious cycle continues.

(5) Shifting cultivation

One of the objectives of providing irrigation water is to encourage settled farming systems and discourage shifting cultivation. Hence all the potential land for shifting cultivation in all schemes is being converted into arable land with the provision of irrigation. Existing vegetation types on this land are bush, grass and secondary forest. In the five schemes these lands total 2,090 ha. Apart from shifting cultivation, these land categories are used by for grazing village cattle and also provide firewood and minor forest produce. Most of these are already degraded and the herbage is of poor nutritive value. There are no planned afforestration programmes for these lands.

With the provision of the basic need of the farmer - water, it is upto the farmer to maintain the productivity of the land and it is upto the government to facilitate production by supplying the farming infrastructure. Components are a good extension service, credit, inputs and above all reliable marketing linkages. In effect it is a package of items that have to be provided to make rural living attractive and move the farmer from the subsistence level to the commercial level.

3.3 Catchments of Regulation Ponds

In southern Laos, watershed management, should have emphasis, as water resources have considerable hydropower and irrigation potential. The subject has only recently been recognised by the government with the formation of the National Office for Nature Conservation and Watershed Management and efforts are being made to bring about a more systematic approach to resource management through recognition of the watershed as a unit of planning.

Generally in an irrigation project, the focus is on the command area and the reservoir, which together are regarded as a unit for planning purposes. However, the river basin upstream of the reservoir is equally important and should be an integral part of the planning process. The life and performance of the reservoir are intimately linked to what activities occur upstream.

It is proposed that each catchment be studied during the implementation phase to determine the intensity of human use and degradation. Hence the study will be socioeconomic as well as ecological. Some components for a socioeconomic and resources survey are as follows:

socioeconomic survey

- demographic data;
- occupational data;
- degree of dependence on the land and its resources;

resources survey

- types, extent and quality of natural vegetation;
- nature and extent of gallery forest;
- types, extent and quality of planted forests;
- species of wildlife and diversity;
- subsistence/commercial dependence on non-timber forest produce;
- agricultural activities, including shifting cultivation;
- other resources, eg. minerals, cultural and aesthetic;
- hydrometeorological data; and,
- boundary identification and marking.

The ideal will be to have each catchment declared a totally protected area purely because it serves vital interests of the community. However, this may not be possible as there could be human habitation and activity. Nevertheless, it is proposed that all catchments be maintained in as good a preserved state as possible depending on the level of human use. Catchment management plans should be prepared on the basis of the survey results.

(1) River bank protected areas

As an interim urgent measure it is proposed that both banks of all rivers and streams be declared protected areas to an agreed distance from each bank. This can vary according to the width of the river or stream. Sometimes the project may be undertaken only on one bank but it is good practice to declare both banks as a long-term measure. Where the natural vegetation on a bank is destroyed, and would have been forest earlier (gallery forest), the original status should be recreated by reforestation. Various decrees indicate the need to preserve gallery forest but does not specify the extent to be so declared. This will have to be agreed upon. The banks of the H.Tapoung and H.Tay-Un and H.Thon do not naturally support forest vegetation. These have a vegetation more of grasses. A large part of the headwaters of the H. Xe Set lie in the flat Pakxong wetlands. These should be preserved in the same state as the original natural vegetation.

When tree vegetation has to be reintroduced on river banks, it may even be undertaken on a community participatory basis with village people, on condition that only non-timber forest produce can be harvested from areas so planted. Such a programme can be planned by the village administrative committee and co-ordinated by the village forestry officer. It may not be difficult to have this proposal linked to donors working in the area. The stretch of river/stream bank so utilised can be called a river/stream reservation. People will plant and maintain the reservation upto maturity and even beyond as they are the designated beneficiaries to some of the produce. In this way the state can reduce costs on establishment and maintenance, and also expect a high success rate in tree planting. Extraction of timber should not be permitted. Hence, the greater percentage of species planted will be of value to the community such as fruit trees, and fodder trees where systematic harvesting of branches may be allowed.

The following steps are proposed in a simple model:

i. decide on the river /stream and area of bank, and the size including width of reservation to be allocated to each family;
ii. involve a suitable number of families on a pilot basis;
iii determine the range of species to be grown;
iv. prepare contractual agreement;

v. provide free plants and advice;
vi. permit some intercropping with food plants during the first few years, depending on gradient, and with proper advice on cultivation practices;
vii. utilise the concept of mulching as much as possible;
viii. use contour drains where gradients require such;
ix. enlist support of district forestry services to raise required plants; and,
x. provide food aid and free fertiliser to participants as incentives if the project can be linked to a donor, may be even a private voluntary organisation (PVO).

(2) Pakxong wetlands

The importance of the Pakxong wetland to the project lies in it forming the larger part of the Xe Set catchment; actually the headwaters. Besides, the wetland is the nursery for all the rivers that have beginnings in the Boloven Plateau. This is a natural system -- an intricate system of grasslands, hills, springs, ponds and lakes -- all feeding the hydrological network.

In the masterplan study the recommendation has been made for the conservation of this entire area above the 1,200 m contour - an area of over 400 km^2. This same recommendation is made for the Xe Set and Tapoung catchments as well. In the latter case the area is only 4 km^2 and all of it lies in the Pakxong wetlands. However, there are many human activities taking place including large scale land concessions. Hence it may not be possible to have total protection without human activity. A number of low hills are present in the plain. It is recommended that all these hills be reforested as they are an integral part of the wetland landscape.

3.4 Forests

There is only limited opportunity for forest conservation. For example in Upper Tapoung, there is very little forest, being less than 10 per cent and the largest extent of 30 per cent is in Lower Xe Set. Actually these areas are made up of small fragmented patches of varying quality. The distribution of forests in each scheme is shown in the maps presented in Annex-2, Soils and Land Use. As the bush land is to be converted into agriculture, there is no land available for reforestation. However, in Lower Xe Set there is a substantial area made up of soils and land forms not quite suitable for agriculture and this land area although found in scattered extents, can be converted into forms of forestry.

Therefore, at least for ecological reasons, these remaining forest patches should be protected and preserved. Some of this forest land may be administered by village administrations. Although each village chief claims forest land to be under that particular village, boundaries are unclear and according to reliable sources, delineation into village custody is incomplete. Some of the forest land is subject to the customary rights provisions and hence available for the use of the people. When delineation is finally completed, village administrations should, with the assistance of district and provincial forestry services, draw up plans for the management of the existing forests. Management will include enrichment planting as most of these are of poor quality, reforestation, determination of customary rights, harvesting of non-timber forest produce, and inventorising the forest wealth of food, medicinal, fibre, fodder and timber species. Village administrations should also make it a point to make a meaningful contribution to the national tree planting day by undertaking projects to increase the amount of tree cover in each village. It is not possible at this stage to specify exact land areas or identify specific locations for this work. There are many abandoned areas in a village that can be used for this purpose. Planting for firewood need is another useful long-term planning exercise.

The appointment of a village forest officer should hopefully make it possible to undertake the above and effect co-ordination between the village administration and district and provincial forestry services. The forestry officer should of course have been trained initially in natural resource mangement. Otherwise he/she is not going to be very useful. The duties should also include the following:

- accurate boundary marking of village forests and demarcating into different uses;
- surveying and mapping different forest types;
- identifying land for enrichment planting and reforestation;
- identifying areas for customary rights;
- inventorising multiple uses of forests so that the village is aware of what assets it has;
- reforesting the degraded gallery (river bank) forest ;
- initiating proposals to have gallery forests declared strictly protected areas; and,
- educating people about the ecological importance of forests.

The most important single activity however, is reforestation of the gallery forest whenever rivers and streams flow through scheme areas. This could be co-ordinated by the village forestry officer and implemented by the District Forestry Services. If a participatory form of reforestation is preferred, then species to be planted will depend upon the choice of the people. Where watercourses flow through grasslands, no reforestation is possible. Instead, grass, the natural vegetation will be aintained. The subject is also discussed in section 3.3 on catchments.

While all larger watercourses bordering and flowing through the schemes require protection of river banks and legal status as protected areas, the following require reforestation of the gallery forest :

- H. Champi partly on the left bank;
- H. Kapheu on th right bank and H. Houn on the left bank; and,
- H. Xe Set on the right bank and H. Lanan on the left bank;

H. Tapoung, H.Tay-Un and H.Thon do not flow through natural forest vegetation.

Lower Xe Set has a large area of discontinous land, in land capability class III, amounting to 633 ha. These soils which are basaltic and dystric nitosols, have severe limitations in crop growth, thereby restricting the possible range of crops and also requiring special conservation practices if agriculture is to be practised. Similar land classes are found in other scheme areas also, but in lesser extents. There is also the land class IV, in other scheme areas, which has even more limitations than land class III, and therefore further limits crop production. It is recommended that these lands be put into forestry. Some of it can be in commercial timber production on a participatory basis, and also set aside for firewood production. Management can be under the direction of one of the village forestry schemes.

The proposals for reforestation and new planting of trees will create a demand for a variety of tree species and not all of this new demand can be met by the present capability of the District Forestry Services. Hence, strengthening of the district capability is also recommended as part of the project activities. The institution has adequate staff but lacks in resources including finances to pay for new equipment. Each district should be provided with a motor cycle to facilitate transportation undertaken on behalf of project activities. District staff will supervise field operations and take part in farmer training. They will also participate in the proposed catchment surveys. Additional equipment required to service extra planting needs in the five schemes are as follows:

- shade material, 5,000 m;
- polyfilm, 200 kg;
- water pump and pipeline, 5 units;
- tools, 5 sets ; and,

- knapsack sprayer, 5 nos.

Forest conservation is also is connected with a number of institutional issues. One of the priorities in village forest management is "clarification of rights and responsibilities including demarcation and protection of forests". Traditional tenure and management systems have vested local people with a role in the management of land, water and forests. Forest management is undergoing changes from decentralisation to centralisation and back to decentralisation. Village communities are at the present time, called upon to play incresingly vital roles in the management of their own resources.

3.5 Wildlife

In the absence of extensive forest habitats, wildlife does not have much chance to get established. Hence, diversity of wildlife is low, being only the smaller types. Besides, with so much land opened up for cultivation, the presence of wildlife will be a problem for successful cultivation. Even at present with scattered forest patches, wild boar cause a fair amount of crop damage. Only the smaller animal species can have a chance to survive. Some bird species, including migrants, will use the wetland habitats, particularly around Pakxong. The small weirs across the rivers will not cause serious impacts to fish movement as river morphology does not anyway permit such movement. Fishing in the rivers is not a substantial economic activity.

3.6 Water Quality

On the basis of available water quality data from the Phase III study, surface river flow in the rivers tested, are without major drawbacks. Proposals have been made in the discussion on Sustainable Agriculture in section 3.1.2 (4), in relation to agrochemical use and possible residues in aquatic systems. It is not expected that fertiliser will in the near future be used to such extents leading to eutrophication. However, a monitoring programme can give indications of changing water quality.

Parameters to be concerned about in a future monitoring programme are plant nutrients levels, pesticide levels and surveys of fish in rivers and regulation ponds to determine beneficial species in respect to feeding on mosquito larvae.

3.7 Environmental Health

Provision of basic facilities at work sites will help prevent disease outbreaks. These include water and sanitation primarily, and care to avoid accidents. Availability of some basic medicine will be useful. Preventive action for malaria control include spraying, good sanitation that prevents collection of water in discarded containers such as tins and cans, draining stagnant pools of water, introducing larvicidal fish species into the new waterbodies and chemoprophylaxis. These should be the responsibility of individuals and institutions identified at the beginning of project planning.

Components of a malaria management plan will involve local communities and may include the following:

- preliminary survey of vector distribution;
- vector control by chemical and biological means;
- preliminary clinical survey of suspected people;
- treatment of carriers;
- survey for vector introduction;
- proper design of irrigation network;
- correct water transfer;
- involvement of water users' associations;
- routine spraying; and,

- community education.

Communicable diseases such as gastrointestinal diseases are caused by contaminated food and water, and unsanitary conditions. Such diseases are grouped as follows: Water-borne (cholera and typhoid), water-washed (diarrhoea and eye problems), water-based (worm infestations), water-related (malaria) and water-dispersed (some amoebic diseases). These can be controlled by the provision of potable water and sanitary disposal of sewage and waste. Tuberculosis control lies in good housing and sanitation and effective treatment of carriers.

3.8 Mitigation of Construction Impacts

Construction work during project implementation in each scheme will consist of regulation pond(s), dam(s), intake weir(s), access roads, canals, buildings, roads, water tanks and pipelines. The problems created by construction work will however, be only of a temporary nature. The larger earthwork will be in the construction of regulation ponds, intake weirs, roads and canals. These activities will generate localised environmental problems through the necessity for borrow areas, earth transport, vehicle movement and concentration of construction workers. The associated problems will be dust, noise, oil pollution from machinery, sedimentation, and creation of depressions in which water collects providing opportunities for the malaria mosquito to breed.

As the major construction sites are to be in locations isolated from villages, noise, dust and the nuisance factor will be minimal. The work itself will be of short duration. Therefore, noise, dust, and likely issues to the community from labour gangs, will only be temporary problems. However, if borrow pits are further away from dam sites, and earth has to be moved through villages, the problem of dust will be a nuisance to villagers during the dry season. During wet weather when heavy vehicles repeatedly pass up and down, the roads will become muddy.

Dust on the roads passing through villages can be minimised by a fine spray of water using a bowser attachment. Work may generally be confined to the dry season. Working during rains is also difficult. Damage caused to roads during construction should be repaired without delay by the contractors. Keeping machinery in good working order will keep noise levels down.

Borrow areas tend to get forgotten when construction activity stops. Then a series of degrading sequences take place over time. Two of these are, the eroding processes; and mosquito breeding in pits and the spread of malaria. As far as possible, areas should be restored at least to the point where degradation can be minimised. A series of actions can be taken towards restoration, one of which could be fish culture if soil conditions permit.

On completion of excavation, the exposed surface should be levelled off to eliminate pits that might otherwise collect water and allow mosquito breeding. Erosion of this area should not cause sedimentation of nearby fields if there are any. If there is such a possibility, steps should be taken to avoid this by constructing interception drains. A quick growing creeper such as *Pueraria* can be grown although it may be somewhat difficult to have it established. The creeper is leguminous and spreads rapidly. The application of a little phosphatic fertiliser will speed up growth.

3.9 Institutional Aspects

Given the situation that other issues have been resolved, institutional strengthening is a major requirement to achieve desired levels of resource management. It applies at all levels of government administration, research and extension, from provincial to village level. While quality of basic knowledge has to be improved among all staff, quantity is also required in some instances, eg. agricultural extension services. There is no institution for

environmental affairs. As almost all development activity concerns the soil, water and natural vegetation, forestry, agriculture and irrigation institutions have to focus attention on environmental protection and management.

A review of subject matter handled by all resource managing institutions is recommended, adding new areas where necessary. Hence, soil and water conservation should be included as a priority in agricultural extension work, incorporating catchment management as well. Limited awareness of land use planning and environmental impact assessment are two subject areas which should be included in all training modules.

Staff training at all levels is another priority. In view of the poor basic knowledge and absorptive capacity, training modules have to be prepared with great care. Foreign training is often made available by the donor community. To make the best out of such training, a knowledge of english is a must. The english knowledge of staff is very poor and immediate steps should be taken to upgrade this. If not foreign fellowships will be wasted by a poor absorption capacity.

3.10 Monitoring

As environmental changes relating to natural resources are good indicators of resource quality, regular monitoring will be a useful management tool. At the present time, the pace of economic development has increased so much, often due to population pressure and political push, that sometimes, there is insufficient assessment of the impacts of resource allocation. Therefore, inappropriate decisions can lead to resource degradation. A simple example would be the allocation of stream headwater zones for agriculture, by replacing the existing natural vegetation.

Monitoring concerns gathering of information and observing changes of selected parameters over time and space . It can be done during both construction and operation phases of the project. It provides a means of assessing the effectiveness of mitigating measures if any have been adopted and is a mechanism that allows mangement to be advised about changing trends in environmental quality. Data gathered during the operation phase of a project will be useful only if evaluated against baseline data obtained before project start-up. This would indicate changes taking place and would allow management decisions and corrective action on adverse changes.

Generally all natural resources should be monitored to obtain a status picture at any particular time. More importantly, these include forests, soils, wildlife and waterbodies. This is a big undertaking for a country such as the Lao PDR, particularly at sub-national levels. There are no analytical facilities in the south of the country. None are proposed either. Part of the process should be the responsibility of the national government where manpower and financial resources are at a higher level than in the districts. Thus the forest cover is monitored by the Forest Department's National Office of Forest Inventory and Planning. The important requirement is for information to filter downwards; in fact to establish two-way communication channels.

For the present time, it is recommended that only limited water quality analysis be carried out in view of the logistic difficulties encountered in carrying out testing. Conductivity, suspended solids, nitrate and nitrite nitrogen, phosphate, and iron analysis can be carried out on an annual basis. Data for these are available from field studies and can be used as baseline information against which results of subsequent monitoring can be assessed. As more land is being brought under cultivation and better practices like increased fertilisation is recommended, it will be useful to keep track of the movement of plant nutrients, mainly nitrogen and posphorous. To the range of parameters, pesticide analysis in the H.Tapoung basin should be added and has to be done with the assistance of the Mekong Commission. The other analyses are possible in the Irrigation Department at Vientiane.

Tables

Table 1 Summary of Present Land Use

Project Area	Land Use	Extent (ha)	Percent (%)
Upper Champi	Cultivated	630	73.00
	Bush	42	4.87
	Grass	76	8.81
	Forest	115	13.33
	Sub-total	(863)	
Upper Tapoung	Bush	86	90.53
	Forest	9	9.47
	Sub-total	(95)	
Upper Kaphen	Cultivated	720	61.02
	Bush	426	36.10
	Forest	34	2.88
	Sub-total	(1,180)	
Lowee XeSet	Cultivated	357	28.33
	Bush	421	33.41
	Grass	103	8.17
	Forest	379	30.08
	Sub-total	(1,260)	
Upper Tay-Un	Cultivated	49	11.67
	Bush	276	65.71
	Grass	13	3.10
	Forest	69	16.43
	Swap	13	3.10
	Sub-total	(420)	
	Total	3,818	

Source: Annex-2, Soils and Land Use

Table 2 Distribution of Village Forests

unit: ha

Area / Village	Reserved Forest (Total)	Common Forest (Total)
Upper Champi		
Lak 33	0	16
Lak 35	10	0
Lak 36	0	0
Lak 38	9	0
Lak 40	1,379	0
Lak 42	0	0
Lak 43	0	2
Lak 45	20	2,980
Sub-total	1,418	2,998
Upper Tapoung		
Phoulangkeo	3	6,400
Hovaisan	15	336
Xetapung	0	800
Sub-total	18	7,536
Upper Kaphen		
Phonak-noi	7	380
Sixiangmai	8	140
On-noi	200	98
Nongchoua	220	2,000
Phonak-guai	8	566
On-gnai	3	105
Sub-total	446	3,289
Lower XeSet		
Natteu	100	150
Senvang-gnai	51	334
Houakhoua	3	102
Senvang-noi	12	289
Khonleng	2	300
Natou	400	200
Sub-total	568	1,375
Upper Tay-Un		
Chakamlit	20	180
Khamkok	0	2,000
Chakam-nai*	0	0
Sub-total	20	2,180

* Shares resource with Chakamlit

Source: Village chief interview

Table 3 Land under Shifting Cultivation

unit: ha

Area / Village	Extent	Reserved Forest (Total)	Common Forest (Total)
Upper Champi			
Lak 33	25	0	16
Sub-total		0	16
Upper Tapoung			
Phoulangkeo		3	6,400
Hovaisan		15	336
Xetapung		0	800
Sub-total		18	7,536
Upper Kaphen			
Phonak-noi		7	380
Sixiangmai		8	140
On-noi		200	98
Nongchoua		220	2,000
Phonak-guai		8	566
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Sub-total		446	3,289
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Chakamlit		20	180
Khamkok		0	2,000
Chakam-nai*		0	0
Sub-total		20	2,180

* Shares resource with Chakamlit

Source: Village chief interview

Table 4 Some Fish Species Reported Present in Rivers

Lao Name	Upper Champi	Upper Tapoung	Upper Kaoheu	Lower Xe Set	Upper Tay-Un
Pa Chat	x	x	x	x	x
Pa Kaot	x		x	x	x
Pa Pok		x			
Pa Sieu		x	x	x	x
Pa Kom	x				
Pa Padouk	x		x	x	x
Pa Katou			x	x	
Pa Pakouk	x	x	x	x	x
Pa Kiang		x	x	x	
Pa Keng	x		x	x	x
Pa Chout			x	x	
Pa Keung		x	x	x	
Pa Nai	x	x	x	x	x
Pa Koat	x				x
Pa Nin	x	x	x	x	x
Pa Hounmouang		x			
Pa Shout			x		

x : Reported present by villagers.

ANNEX XI

PROJECT EVALUATION

ANNEX XI
PROJECT EVALUATION

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II. Feasibility Study

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ANNEX - XI PROJECT EVALUATION

GENERAL

Project evaluation was made through an assessment of the project feasibility in view of economic, financial, socio-economic and environmental aspect. This annex consists of two (2) sections such as i) Master plan study and ii) Feasibility study. In the former section, the evaluation was carried out for 16 model development projects. On the other hand, in the later section the selected five (5) priority development schemes was evaluated. The evaluations for 16 model projects were carried out at the price of March, 1995, and the ones of the 5 priority schemes were at December, 1995.(It means the exchange rate is also difference with the points.) The basic procedure is same for both evaluations, but the accuracy is difference. The former is a preliminary survey and the later is a feasibility survey level.

Part I Master Plan Study

I-1 PRELIMINARY ECONOMIC EVALUATION

I-1.1 Basic Assumption

The economic justification was carried out on the basis of Economic Internal Rate of Return (EIRR), calculated based on the estimated project costs and incremental project benefits. The justification was carried out for the whole and each proposed Projects. Major assumptions for the estimation of EIRR are summarized below :

i) The economic useful life of the each Project is 50 years,
ii) All prices are expresses at April 1995 price in kip,
iii) The exchange rate of US$ 1.00 = Kip 730 as of average during April to May, 1995 is applied,
iv) A standard conversion factor (SCF) of 0.97 is applied to domestic cost elements such as transport, handling and processing for estimation of economic value, and
v) The transfer payment such as tax, duty, subsidy and interest are excluded for the estimation of economic costs and prices.

I-1.2 Agricultural Benefit

(1) Economic Prices of Agricultural Commodities

Economic prices of farm inputs and tradable farm products (rice, coffee, tea, maize and soybean) are estimated on the basis of World Bank projection of world market prices for 2005 in constant price 1994. Economic prices of other non-tradable farm outputs (vegetables, fruits, etc) and farm inputs (seed/seedling, machinery) are set at same financial price. Economic price of unskilled labor wage was valuated by the shadow wage rate of 0.47, estimated based on the rate of the JICA Savannakhet project (1992) and the data of field survey. Economic prices of tradable farm outputs and inputs are shown in Table XI-I-1. Comparison table of financial and economic price of agricultural commodities is shown in Table XI-I-2

(2) Agricultural Benefits

Agricultural benefits accrued from the irrigation development are estimated by an increase in crop yields and cropping intensity. The anticipated crop yield under the irrigated condition is set out the average unit yields under irrigated condition in tropical area, due to the lack of data and information in Lao. Preset farming practice is mainly done by single cropping of upland crops, lowland rice and vegetables. However, under future development condition it will be changes to double cropping condition of these crops.

The economic crop budgets under future condition are shown in Table XI-I-3 and XI-I-4, respectively. Based on the result of economic crop budget, net production values under future condition without and with Projects are estimated as 1,091 million kips and 14,057 million kips, respectively. The economic incremental irrigation benefit will be 12,966 million kips or 18 million US$ in total for an irrigation area of 21,400 ha, and will be 657 kip/ha. The economic incremental benefits are presented in Table XI-I-5 and summarized as below :

Project No.	Without Project Net Income ('000kip)	With Project Net Income ('000kip)	Incremental Benefit ('000kip)	Incremental Benefit ('000 US$)
1	107,650	758,500	650,850	892
2	0	94,720	94,720	130
3	71,630	1,074,830	1,003,200	1,374
4	21,770	746,900	725,130	993
5	43,200	961,500	918,300	1,258
6	37,320	352,880	315,560	432
7	4,050	467,780	463,730	635
8	38,880	1,489,870	1,450,990	1,988
9	159,060	1,073,740	914,680	1,253
10	66,290	633,810	567,520	777
11	196,950	1,640,960	1,444,010	1,978
12	25,260	761,530	736,270	1,009
13	269,140	1,789,340	1,520,200	2,082
14	26,390	278,560	252,170	345
15	21,520	1,734,220	1,712,700	2,346
16	1,960	197,430	195,470	268
Total	**1,091,070**	**14,056,570**	**12,965,500**	**14,761**

I-1.3 Other Development Benefits

Excepting agricultural benefits as mentioned as above, the following benefit is expected to be born from the proposed projects. However, these direct benefits were not estimated in this report, and the evaluation was done based on the agricultural benefit and cost.

i) Road improvement

- Saving of vehicle operation costs (VOC)
- Saving of costs for routine road maintenance and periodic repairs
- Reduction in post-harvest losses during the transportation of farm products

ii) Establishment of rural water supply system

- Increase of the beneficiaries in rural water supply
- Saving of times and mitigation of works for women and child

iii) Establishment of micro hydro power system

- Saving of alternative costs for electric power supply
- Increase of the beneficiaries in electric power supply

I-1.4 Economic Cost

In this preliminary evaluation, the cost for rural road, water supply and micro hydro power developments and for establishment of some facilities were excluded from the project costs, since the benefits from them were not included as a direct project benefits. Consequently, the financial project costs excluding the transfer payment and price contingencies consist of following items, relating to irrigation and drainage development.

i) Construction cost for project works,
ii) O&M equipment,
iii) Administration costs,

iv) Engineering services,
v) Land acquisition, and
vi) Physical contingency

The financial costs were converted to the economic costs by applying a standard conversion factor (SCF) for local currency portion. The economic cost is estimated at US$ 190 million in total as summarized below :

(unit : '000 US$)

Project No.	Economic Cost	Project No.	Economic Cost
1	7,864	9	7,874
2	1,340	10	4,842
3	6,701	11	30,839
4	7,265	12	15,792
5	6,582	13	30,115
6	2,919	14	4,569
7	3,968	15	35,771
8	20,611	16	2,599
Whole Project	189,653	-	-

I-1.5 Annual O&M Costs

The annual operation and maintenance costs consist of salaries of project staff, project office expenses, operation and maintenance costs of facilities and equipment. The financial O&M costs were converted to the economic costs by using SCF and shadow wage rate for local currency portion. The annual economic O&M costs of the whole Project is estimated at US$ 1.4 million as summarized below :

(unit : '000 US$)

Project No.	Economic Cost	Project No.	Economic Cost
1	66	9	66
2	11	10	41
3	56	11	258
4	61	12	66
5	55	13	252
6	24	14	38
7	33	15	150
8	173	16	22
Whole Project	1,373	-	-

I-1.6 Economic Evaluation

I-1.6.1 Economic Internal Rate of Return (EIRR)

Based on the economic costs and benefits, EIRR was calculated for the economic evaluation of the each and whole Project. The results are shown in Table XI-I-6 and XI-I-7, and summarized as below :

Project No.	Location	EIRR (%)	Project No.	Location	EIRR (%)
1	Upper Champi	9.3	9	Upper Kapuheu	13.1
2	Upper Tapoung	8.1	10	Middle Tapoung	13.9
3	Lower Xe Pian	16.0	11	Lower Tapoung	4.6
4	Upper Makchan	11.9	12	Lower Xe Set	5.1
5	Middle Xe Katam	16.5	13	Lower Namsai	5.0
6	Middle Namtang	12.8	14	Upper Thon	6.1
7	Lower Makchan-Gnai	13.9	15	Middle Lamphan	5.0
8	Lower Champi	7.9	16	Upper Tay-Un	8.8
Whole 16 Project		7.9			

I-1.6.2 Sensitive Analysis

In order to evaluate soundness of the whole Project to the possible changes in the economic condition in future, the sensitivity analysis were made for the following case.

Case I 10 % Project cost increase due to unforeseen geological and topographical conditions, unexpected increase of material costs, increase in costs for environmental restoration attributed to unproper construction methods

Case II 10 % project benefit decrease due to unexpected low price of farm products and low crop yield

Case III Combination of Case I and II

The effects of these changes on EIRR are summarized as shown below :

Case		EIRR (%)
Case I	: Project cost overrun by 10 %	6.9
Case II	: Benefit decrease by 10 %	7.0
Case III	: Combination of Case I and II	6.1

I-2 FINANCIAL EVALUATION

In order to assess the farm household economy in the Project area from the financial aspect, farm budget analysis on different farming types is made under with and without the Project, as shown in Table XI-I-8 and summarized below:.

(unit of income : '000kip)

	Without Project Condition				With Project Condition		
Main cropping type	Coffee	S & B	Low. R	Ave.	Coffee	Low. R	Ave.
Ave. farm size (ha)	2.1	1.2	1.0	1.9	2.4	2.5	2.5
No. of benefit. (HH)	1,634	1,012	2,025	4,671	1,740	8,244	9,984
1. Gross income	(564)	(417)	(432)	(475)	(3,573)	(2,454)	(2,694)
- Farm income	564	342	382	437	3,572	2,454	2,694
- Non-farm income	0	75	50	38	0	0	0
2. Production Cost	125	26	35	65	643	814	777
3. Net Income	439	391	397	410	2,930	1,640	1,917
4. Living expenses	(429)	(391)	(397)	(407)	(1,535)	(1,535)	(1,535)
- food item	333	303	309	316	874	874	874
- non-food item	96	87	89	91	661	661	661
5. Net reserve	10	0	0	3	1,392	104	382

Remark : S&B is slash & Burn farming, Low.R is Lowland Rice farming.
Note : Average family size is 5.7 persons per household

After implementing of the Project, the slash and burn farmers will shift the farming type to lowland rice farming and/or coffee farming from the view points of sustainability and productivity. The farmers will get about seven (7) to ten (10) fold farm income after implementation of the Project. Living expense also drastically increase, consequently, the living condition of beneficial farmers will be substantially improved and farmer will be able to try to operate intensive farming.

I-3 JUSTIFICATION

Based on the result of economic and financial evaluation for the proposed Projects, the Project is justified as summarized below :

i) Economic Internal Rate of Return (EIRR) is 4.6 to 16.5 % of the 16 model projects and 7.9 % of the whole project. It is not easy to say that the all Projects are fully economically feasible in view of the national economy, as it is apparent from the result of sensitivity analysis.

ii) The farm economy will be drastically increased to about 7 to 10 times compared with the without Project condition. From the financial point of view, the large benefit will be born to the beneficial farmers after implementing of the Project. It is possible to say that the immediate implementation of the Project should be accelerated.

iii) It is easily expectable that the dissemination and expansion effect to the surrounding area will be born from the implemented project, which will be functioned as core project. The following effects are able to be considered. Therefore, it is recommendable to implement the Project in an early stage.

- reduction of slash and burn
- improvement of the farming practice
- improvement of living condition and rural life
- improvement of marketing system

I-4 NON-MONETARY EVALUATION

I-4.1 Social Impact

(1) Increase of farm income

Farmers have to live upon limited as well as unstable agriculture output due to the operating of inefficient farming practices such as slash and burn farming and rainfed rice farming. However, the farmers' income will be increased considerably after implementing of the Projects, because of the increase in crop production and improvement of marketing system. The increase of the net farm income will function to provide motive power in the improvement of living standards of the farmers as well as rural economic development.

(2) Improvement of rural life and correction of living differentials

The direct effects on improvement of living and health conditions in the Project areas will be expected directly by the programs of rural water supply system for supplying clean and safe water for villagers. In addition, it is expected that the community development will stimulate improvement of illiteracy, public healthy, nutrition and homekeeping. This in turn will progress and stabilize rural living conditions. The improvement of living conditions translates into a rise in the social status of women, which can be expected to contribute rural socio-economy. These circumstances will promote better rural living conditions, functioning to expand the improvement of rural society and living differentials with the area and surrounding urban areas will be anticipated.

(3) Expansion of women's activity

In addition, the women's activities will be improved and expanded through the community development, establishment of water supply system and clinics, improvement of road and schools. An increase in the farmer's income will also improve women's activities in the farm families of the Project area and also other families throughout the economic chain, since housewives in many cases are said to manage family budget.

(4) Improvement of local transportation

The local transportation within the Study area will be improved considerably by the improvement of the existing roads. This will not only enhance the marketing activities of farm products but also contribute to the improvement of accessibility and communication between villages and town.

(5) Increase in employment opportunity

The project implementation will increase employment opportunity in the Study area in terms of farm labors and construction workers. In addition, enhancement of marketing activities will also generate the employment in related sectors.

(6) Room for future transmigration

After implementation of the selected Projects, newly agricultural land will be born at about 15,000 ha. This has functions as not only area expansion of farm household but also the room for the future transmigration. Taking into consideration proposed average holding size of 2.5 ha for the existing and new farmers, about 4,100 households will be able to transmigrate to the area in future.

I-4.2 Environmental Impacts

(1) Reducing of the Slash and Burn cultivation practice

The Project can not only prevent further deterioration of land resources in the Study area but also improve agricultural land productivity by changing farming practice to permanent agriculture. By the Project, about 15,000 ha of slash and burn cultivation area will be shifted to the permanent farming area.

(2) Water quality

Promotion of soil conservation and environmentally friendly farming practices by the Project will result in improving water quality and water quantity in the downstream area.

(3) Improvement of living environment

The living environment problems in the Study area are low farm income due to inefficient farming practice, poor marketing condition, poor road condition, poor rural water supply, and insufficient social facilities both in quality and in quantity, and these issues cause inconvenience and disadvantages to the rural people in the Study area. The implementation of the Projects will contribute to migrate the living environmental issues by the improvement of social infrastructures and several extension services for improvement in rural living standards, as well as to increase farmers' income.

I-4.3 Other Impacts

Since the Project has a function as model project to demonstrate the other area, the effects of the Projects will be expanded in and around the Study area after implementing of the Projects and improvement of support service systems, as mentioned above. In addition, since the Project will be implemented in the area of diverse ethnic minorities, it will become an example to incorporate diverse ethnic minority into a project.

Tables

Table XI-1-1 Economic Price Structure for Tradable Commodities (1995 constant price)

(1) Rice (Import parity)

Item	Unit	2005	
Projected FOB price at Bangkok <1	US$/ton	291	
Quality adjustment (for glutinous rice : 85%)	US$/ton	247	=
Freight and insurance	US$/ton	60	+
CIF Sommeck	US$/ton	307	=
Transportation and handling to Pakse <2	US$/ton	6	+
Market price at Pakse (Dry rice equivalent)	US$/ton	313	=
Conversion from rice to dried paddy (60 %)	US$/ton	188	
Transportation from Study area to Pakse <2	US$/ton	9	-
Farm gate price <3	US$/ton	179	=
(1US$ = 730 kip)	kip/kg	131	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index.
<2 Processing costs are assumed equal to the value of by-products.
<3 Based on result of interview survey
<3 Taxes and duties excluded, SCF is 0.97

(2) Tea (Export parity)

Item	Unit	2005	
Projected CIF price at London <1	US$/ton	1,951	
Quality adjustment	US$/ton	1,366	=
(for quality discount : 70%)			
Freight and insurance	US$/ton	65	-
FOB Someck	US$/ton	1,301	=
Transport and handling costs to factory <2	US$/ton	74	-
Processing cost	US$/ton	429	-
Transport and handling costs to farmgate <2	US$/ton	15	-
Farm gate price <3	US$/ton	782	=
(1US$ = 730 kip)	kip/kg	571	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index.
<2 Based on result of interview survey
<3 Taxes and duties excluded, SCF is 0.97

(3) Soybean (Import parity)

Item	Unit	2005	
Projected CIF price at Rotterdam <1	US$/ton	270	
Freight and insurance	US$/ton	75	+
CIF Thanaleng	US$/ton	345	=
Transportation and handling to Vientiane (Tha Ngone)	US$/ton	5	+
Market price at Vientiane (Tha Ngone)	US$/ton	350	=
Transportation cost from Study area to Vientiane <2	US$/ton	57	-
Farm gate price <3	US$/ton	293	=
(1US$ = 730 kip)	kip/kg	214	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index.
<2 Data source from IBRD, Agricultural Sector Memorandom (1994)
<3 Taxes and duties excluded, SCF is 0.97

(4) Groundnut (Export parity)

Item	Unit	2005	
Projected CIF price at US Gulf <1	US$/ton	311	
Freight and insurance	US$/ton	60	-
CIF Sommeck	US$/ton	251	=
Transportation and handling to Pakse	US$/ton	7	-
Market price at Pakse	US$/ton	257	=
Transport and handling cost from farmgate to Pakse <2	US$/ton	20	-
Farm gate price <3	US$/ton	237	=
(1US$ = 730 kip)	kip/kg	173	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index. Since the price of groundnut is not given in World Bank forecast, a price more than 15% of soybean was assumed as same way as the estimation o IFAD.
<2 Including storage costs
<3 Taxes and duties excluded, SCF is 0.97

(5) Maize (Import Parity)

Item	Unit	2005	
Projected FOB price at Rotterdam <1	US$/ton	99	
Freight and insurance	US$/ton	50	+
CIF Thanaleng	US$/ton	149	=
Transportation and handling to Vientiane (Tha Ngone)	US$/ton	5	+
Market price at Vientiane (Tha Ngone)		154	=
Transportation cost from Study area to Vientiane <2	US$/ton	57	-
Farm gate price <3	US$/ton	92	=
(1US$ = 730 kip)	kip/kg	67	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index.
<2 Data source from IBRD, Agricultural Sector Memorandom (1994)
<3 Taxes and duties excluded, SCF is 0.97

(6) Coffee (Export parity)

Item	Unit	2005	
Projected CIF price at New York and Humburg <1	US$/ton	2,136	
Quality adjustment	US$/ton	1,495	=
(for Robusta & quality discount : 80%)			
Freight and insurance	US$/ton	150	-
FOB Someck	US$/ton	1,345	=
Transport and handling costs to Pakse <2	US$/ton	97	-
Green coffee equivalent	US$/ton	1,249	=
Milling charge	US$/ton	26	-
Transportation from farmgate	US$/ton	9	-
Economic farm gate price <3	US$/ton	1,214	=
(1US$ = 730 kip)	kip/kg	886	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index.
<2 Net figure for all internal transport, storage and handling costs, multiplied by 1 as SCF
<3 Taxes and duties excluded, SCF IS 0.97

(7) Farm Input - Urea - (Import parity)

	Unit	2005	
Projected FOB price at N.W.Europe <1	US$/ton	160	
Freight and insurance	US$/ton	61	+
CIF Someck	US$/ton	221	=
Transport and handling cost (Someck - Pakse)	US$/ton	7	+
Marketing and dealer's cost <2	US$/ton	40	+
Transport and handling cost to farmgate	US$/ton	8	+
Farm gate price	US$/ton	277	=
(1US$ = 730 kip)	kip/kg	202	

Remarks : <1 Based on World Bank Commodity Price Forcast 1990 - 2005 (Feb. 1995) in constant 1990 prices, adjusting to 1995 constant price by applying MUV index.
<2 Including storage costs
<3 Taxes and duties excluded, SCF is 0.97

Table XI-I-2 Finanacial and Economic Farm Gate Prices of Agricultural Inputs and Outputs

(Economic price is in1995 cpnstant price)

Items	Unit	Financial Price	Economic Price
Output <1			
Rice	Kip/kg	150	131
Coffee*1	Kip/kg	1,150	886
Tea	Kip/kg	500	571
Soybean	Kip/kg	156	214
Grounfnut	Kip/kg	250	173
Maize	Kip/kg	103	67
Cabbage	Kip/kg	100	97
Potato	Kip/kg	113	109
Cardamom	Kip/kg	1,500	1,500
Agro-Input <2			
Seed			
- Cabbage	Kip/kg	145,000	145,000
- Maize	Kip/kg	2,000	2,000
- Potato	Kip/kg	180	174
- Soybean	Kip/kg	156	214
- Groundnut	Kip/kg	250	173
Urea	Kip/kg	230	202
16-20-0	Kip/kg	230	202
16-16-16	Kip/kg	270	237
Incecticide	Kip/lit	9,500	8,343
Pesticide	Kip/lit	9,500	8,343
Labour charge	Kip/day	1,200	562
Animal Power	Kip/day	2,400	1,124

Remark : <1 : Economical price of tradable crops is based on the World Bank Price Forcast 1990-2005 (Feb. 1995), and non-tradable crop's prices are adjusted by SCF

<2 : Economical price of Urea is based on the World Bank Price Forcast 1990-2005 (Feb. 1995) and the others are adjusted by SCF

Table XI-I-3 Economic Crop Budget without Project Condition

	Unit	Upland Rice			Lowland Rice			Coffee			Tea		
		Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)
A. Gross Income													
(1) Yield	(kg)	1,500	131	196,500	2,600	131	340,600	300	886	265,800	260	571	148,460
B. Production Costs													
B-1 Farm Input													
(1) Seed/Seedling*1	(kg)	80	131	10,480	50	131	6,550	625	1	781	12,000	1	12,000
(2) Fertilizer													
Urea	(kg)	0	202	0	0	202	0	0	202	0	0	202	0
16-20-0	(kg)	0	202	0	100	202	20,200	0	202	0	0	202	0
16-16-16	(kg)	0	237	0	0	237	0	0	237	0	0	237	0
(3) Agro-chemicals													
Incecticide	(kg)	0	8,343	0	0	8,343	0	0	8,343	0	0	8,343	0
Pesticide	(kg)	0	8,343	0	0	8,343	0	0	8,343	0	0	8,343	0
Sub total				10,480			26,750			781			12,000
B-2 Labour Requirement													
(1) Hired Labour	man-day	0	562	0	0	562	0	80	562	44,960	0	562	0
(2) Family Labour	man-day	198	562	111,276	148	562	83,176	90	562	50,580	190	562	106,780
B-3 Animal Power													
Animal	head-day	0	1,124	0	18	1,124	20,232	1	1,124	1,124	0	1,124	0
B-4 Others				520			1,340			2,290			600
Total				122,796			132,838			102,025			119,980
C. Net Return (A-B)				73,704			207,762			163,775			28,480

Remarks : *1 : Seedling costs of pernial crops (coffee, tea, cardamom) are discounted based on the hearvest life

	Unit	Cardamon			Cabbage			Groundnuts		
		Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)
A. Gross Income										
(1) Yield	(kg)	300	1,500	450,000	8,000	97	776,000	1,000	173	173,000
B. Production Costs										
B-1 Farm Input										
(1) Seed	(kg)	20,000	1	20,000	1	145,000	116,000	45	173	7,785
(2) Fertilizer										
Urea	(kg)	0	202	0	200	202	40,400	0	202	0
16-20-0	(kg)	0	202	0		202	0	0	202	0
16-16-8	(kg)	0	237	0	200	237	47,400	0	237	0
(3) Agro-chemicals										
Incecticide	(lit)	0	8,343	0	2	8,343	16,686	0	8,343	0
Pesticide	(lit)	0	8,343	0	0	8,343	0	0	8,343	0
Sub total				20,000			220,486			7,785
B-2 Labour Requirement										
(1) Hired Labour	man-day	0	562	0	0	562	0	0	562	0
(2) Family Labour	man-day	60	562	33,720	95	562	53,390	90	562	50,580
B-3 Animal Power										
Animal	head-day	0	1,124	0	13	1,124	14,612	2	1,124	2,248
B-4 Others				1,000			11,020			390
Total				55,720			310,528			61,393
C. Net Return (A-B)				394,280			465,472			111,607

Table XI-I-4 Economic Crop Budget with Project Condition

	Unit	Lowland Rice			Coffee			Tea			Cardamon		
		Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)
A. Gross Income													
(1) Yield	(kg)	4,000	131	524,000	1,500	886	1,329,000	1,000	571	571,000	400	1,500	600,000
B. Production Costs													
B-1 Farm Input													
(1) Seed/Seedling	(kg)	50	131	6,550	625	1	625	12,000	1	12,000	20,000	1	20,000
(2) Fertilizer													
Urea	(kg)	70	202	14,140	0	202	0	0	202	0	0	202	0
16-20-0	(kg)	200	202	40,400	0	202	0	0	202	0	0	202	0
16-16-16	(kg)	0	237	0	300	237	71,100	300	237	71,100	0	237	0
(3) Agro-chemicals													
Inceeticide	(kg)	4	8,343	33,372	0	8,343	0	0	8,343	0	0	8,343	0
Pesticide	(kg)	0	8,343	0	0	8,343	0	0	8,343	0	0	8,343	0
Sub total				94,462			71,725			83,100			20,000
B-2 Labour Requirement													
(1) Hired Labour	man-day	73	562	41,026	110	562	61,820	100	562	56,200	0	562	0
(2) Family Labour	man-day	80	562	44,960	95	562	53,390	115	562	64,630	55	562	30,910
B-3 Animal Power	head-day	18	1,124	20,232	3	1,124	3,372	0	1,124	0	0	1,124	0
B-4 Others				6,770			6,680			6,970			1,000
Total				207,450			196,987			210,900			51,910
C. Net Return (A-B)				316,550			1,132,013			360,100			548,090

Remarks : *1 ; Seedling costs of pernial crops (coffee, tea, cardamom) are discounted based on the harvest life

	Unit	Cabbage			Potato			Soybeans			Groundnuts		
		Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)	Quantity	unit price (kip)	Amount (kip)
A. Gross Income													
(1) Yield	(kg)	20,000	97	1,940,000	20,000	109	2,180,000	2,000	214	428,000	2,000	174	348,000
B. Production Costs													
B-1 Farm Input													
(1) Seed	(kg)	1	145,000	116,000	1,500	173	259,500	60	214	12,840	45	174	7,830
(2) Fertilizer													
Urea	(kg)	250	202	50,500	0	202	0	0	202	0	0	202	0
16-20-0	(kg)	0	202	0	300	202	60,600	350	202	70,700	350	202	70,700
16-16-16	(kg)	300	237	71,100	0	237	0	0	237	0	0	237	0
(3) Agro-chemicals													
Inceeticide	(lit)	2	8,343	16,686	2	8,343	16,686	2	8,343	16,686	2	8,343	16,686
Pesticide	(lit)	2	8,343	16,686	2	8,343	16,686	2	8,343	16,686	2	8,343	16,686
Sub total				270,972			353,472			116,912			111,902
B-2 Labour Requirement													
(1) Hired Labour	man-day	0	562	0	0	562	0	0	562	0	0	562	0
(2) Family Labour	man-day	95	562	53,390	80	562	44,960	80	562	44,960	85	562	47,770
B-3 Animal Power	head-day	20	1,124	22,480	17	1,124	19,108	25	1,124	28,100	25	1,124	28,100
B-4 Others				13,550			17,670			5,850			5,600
Total				360,392			435,210			195,822			193,372
C. Net Return (A-B)				1,579,608			1,744,790			232,178			154,628

Table XI-1-5 Economic Incremental Benefit of the Projects

Project No.	Crops *1	Net Irrigated Area (ha)	Without Project Condition: Cropped Area (ha)	Value ('000 kip)	Cost ('000 kip)	Net Income ('000 kip)	Crops *2	With Project Condition: Cropped Area (ha)	Value ('000 kip)	Cost ('000 kip)	Net Income ('000 kip)	Incremental Benefit ('000 kip)	Incremental Benefit ('000 US$)
1.	Coffee		640	170,047	65,271	104,776	Coffee	640	850,560	126,072	724,488		
	Tea		88	13,064	10,558	2,506	Tea	88	50,248	18,559	31,689		
	Upland rice		5	983	614	369	Field crops	10	4,280	1,958	2,322		
	Total	733	733	184,094	76,443	107,650	Total	738	905,088	146,589	758,499	650,848	892
2.	Fallow land		0	0	0	0	Field crops	50	21,500	9,791	11,709		
			0	0	0	0	Vegetables	50	103,000	19,890	83,110		
	Total	50	0	0	0	0	Total	100	124,400	29,681	94,719	94,719	130
3.	Coffee		391	103,928	39,892	64,036	Coffee	647	859,863	127,451	732,412		
	Upland rice		103	20,240	12,648	7,592	Vegetables	206	424,360	81,947	342,413		
	Total	750	494	124,167	52,540	71,628	Total	853	1,284,223	209,398	1,074,825	1,003,198	1,374
4.	Coffee		132	35,056	13,467	21,618	Coffee	372	494,388	73,279	421,109		
	Upland rice		2	393	246	147	Vegetables	196	403,760	77,969	325,791		
	Total	470	134	35,479	13,713	21,766	Total	568	898,148	151,248	746,900	725,134	993
5.	Coffee		98	26,048	9,998	16,050	Coffee	98	130,242	19,305	110,937		
	Lowland rice		125	42,535	16,605	25,930	Lowland rice	457	239,468	94,805	144,663		
	Upland rice		16	3,144	1,965	1,179	Field crops	191	81,748	37,402	44,346		
							Vegetables	398	819,880	158,325	661,555		
	Total	621	239	71,767	28,568	43,199	Total	1,144	1,271,338	309,836	961,502	918,302	1,258
6.	Coffee		170	45,186	17,344	27,842	Coffee	170	225,930	33,488	192,442		
	Upland rice		75	14,738	9,210	5,528	Vegetables	75	154,500	29,835	124,665		
	Lowland rice		19	6,471	2,524	3,947	Lowland rice	113	59,212	23,442	35,770		
	Total	264	264	66,395	29,078	37,317	Total	358	439,642	86,765	352,877	315,560	432
7.	Coffee		18	4,784	1,836	2,948	Coffee	280	372,120	55,156	316,964		
	Upland rice		15	2,948	1,842	1,106	Lowland rice	38	19,912	7,883	12,029		
							Vegetables	84	172,010	33,216	138,794		
	Total	341	33	7,732	3,678	4,054	Total	402	564,042	96,256	467,786	463,733	635
8.	Coffee		10	2,658	1,020	1,638	Coffee	10	13,290	1,970	11,320		
	Cardamom		7	3,150	390	2,760	Cardamom	7	4,200	363	3,837		
	Upland rice		76	14,934	9,332	5,602	Lowland rice	4,180	2,190,320	867,141	1,323,179		
	Lowland rice		139	47,343	18,464	28,879	Field crops	980	341,040	189,505	151,535		
	Total	2,593	232	68,085	29,207	38,878	Total	5,177	2,548,850	1,058,979	1,489,871	1,450,993	1,988
9.	Coffee		865	229,917	88,252	141,665	Coffee	865	1,149,585	170,394	979,191		
	Upland rice		236	46,374	28,980	17,394	Lowland rice	240	125,760	49,788	75,972		
							Field crops	80	34,240	15,666	18,574		
	Total	1,105	1,101	276,291	117,231	159,060	Total	1,185	1,309,585	235,848	1,073,737	914,678	1,253
10	Coffee		368	97,761	37,525	60,236	Coffee	368	488,811	72,457	416,384		
	Upland rice		82	16,147	10,091	6,057	Lowland rice	41	21,484	8,505	12,979		
							Vegetables	123	253,380	48,930	204,450		
	Total	450	450	113,908	47,615	66,293	Total	532	763,705	129,892	633,813	567,520	777
11.	Coffee		187	49,705	19,079	30,626	Coffee	187	248,523	36,837	211,686		
	Lowland rice		12	4,087	1,594	2,493	Lowland rice	4,310	2,258,440	894,110	1,364,331		
	Cardamom		282	126,900	15,713	111,187	Field crops	420	146,160	81,216	64,944		
	Field crops		90	15,570	5,525	10,045							
	Upland rice		578	113,572	70,976	42,601							
	Total	4,497	1,149	309,839	112,887	196,952	Total	4,917	2,653,123	1,012,162	1,640,961	1,444,009	1,978
12.	Lowland rice		65	22,139	8,634	13,505	Lowland rice	1,800	943,200	373,410	569,790		
	Upland rice		2	393	246	147	Field crops	1,240	431,520	239,781	191,739		
	Filed crops		104	17,992	6,385	11,607							
	Total	1,800	171	40,524	15,265	25,259	Total	3,040	1,374,720	613,191	761,529	736,270	1,009
13.	Lowland rice		1,255	427,453	166,712	260,741	Lowland rice	5,340	2,798,160	1,107,783	1,690,377		
	Upland rice		114	22,401	13,999	8,402	Field crops	640	222,720	123,758	98,962		
	Total	3,840	1,369	449,854	180,710	269,144	Total	5,980	3,020,880	1,231,541	1,789,339	1,520,195	2,082
14	Lowland rice		105	35,763	13,948	21,815	Lowland rice	880	461,120	182,556	278,564		
	Field crops		41	7,093	2,517	4,576							
	Total	640	146	42,856	16,465	26,391	Total	850	461,120	182,556	278,564	252,173	345
15.	Coffee		92	24,454	9,386	15,067	Coffee	92	122,268	18,123	104,145		
	Lowland rice		8	2,725	1,063	1,662	Lowland rice	4,704	2,464,896	975,845	1,489,051		
	Upland rice		65	12,773	7,982	4,791	Field crops	912	317,376	176,355	141,021		
	Total	2,900	165	39,951	18,431	21,520	Total	5,708	2,904,540	1,170,323	1,734,217	1,712,697	2,346
16.	Coffee		5	1,329	510	819	Coffee	5	6,645	985	5,660		
	Lowland rice		3	1,022	399	623	Lowland rice	524	274,576	108,704	165,872		
	Upland rice		7	1,376	860	516	Field crops	168	58,290	32,390	25,900		
	Total	351	15	3,726	1,768	1,958	Total	697	339,511	142,079	197,432	195,474	268
Whole 16 Project		21,408	6,695	1,831,668	743,601	1,091,068		32,278	20,862,915	6,806,343	14,056,572	12,965,504	17,761

Table XI-I-6 Economic Cost and Benefit Stream of the each Project (1/2)

(1) Upper Champi (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	3,146	0		3,146	0	-3,146
2	4,719	13		4,732	0	-4,732
3		26		26	446	419
4		40		40	669	629
5		53		53	892	839
6		66		66	892	826
7		66		66	892	826
8		66		66	892	826
9		66		66	892	826
10		66		66	892	826
25		66		66	892	826
26		66		66	892	826
27		66	597	663	892	229
28		66		66	892	826
29		66		66	892	826
50		66		66	892	826
51		66		66	892	826
52		66		66	892	826
53		66		66	892	826
54		66		66	892	826
	7,864	3,361	597	11,822	45,693	33,871
	9.3%					

(2) Upper Tpoung (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	1,340	0		1,340	0	-1,340
2		2		2	65	63
3		4		4	97	93
4		7		7	130	123
5		9		9	130	121
6		11		11	130	119
7		11		11	130	119
8		11		11	130	119
9		11		11	130	119
10		11		11	130	119
25		11		11	130	119
26		11	249	260	130	-130
27		11		11	130	119
28		11		11	130	119
29		11		11	130	119
50		11		11	130	119
51		11		11	130	119
52		11		11	130	119
53		11		11	130	119
54		11		11	130	119
	1,340	573	249	2,161	6,760	4,618
	8.1%					

(3) Lower Xe Pian (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	4,691	0		4,691	0	-4,691
2	2,010	8		2,018	0	-2,018
3		18		18	687	669
4		25		25	1,031	1,005
5		37		37	1,374	1,338
6		42		42	1,374	1,332
7		51		51	1,374	1,324
8		56		56	1,374	1,318
9		56		56	1,374	1,318
10		56		56	1,374	1,318
25		56		56	1,374	1,318
26		56		56	1,374	1,318
27		56		56	1,374	1,318
28		56		56	1,374	1,318
29		56		56	1,374	1,318
50		56		56	1,374	1,318
51		56		56	1,374	1,318
52		56		56	1,374	1,318
53		56		56	1,374	1,318
54		56		56	1,374	1,318
	6,701	2,819	314	9,835	70,430	60,595
	16.0%					

(4) Upper Makchan (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	7,265	0		7,265	0	-7,265
2		12		12	497	484
3		24		24	745	721
4		37		37	993	957
5		49		49	993	945
6		61		61	993	932
7		61		61	993	932
8		61		61	993	932
9		61		61	993	932
10		61		61	993	932
25		61		61	993	932
26		61		61	993	932
27		61		61	993	932
28		61		61	993	932
29		61		61	993	932
50		61		61	993	932
51		61		61	993	932
52		61		61	993	932
53		61		61	993	932
54		61		61	993	932
	7,265	3,105	572	10,942	51,902	40,960
	11.9%					

(5) Middle Xe Kaiam (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	6,582	0		6,582	0	-6,582
2		11		11	629	618
3		22		22	943	921
4		33		33	1,258	1,225
5		44		44	1,258	1,214
6		55		55	1,258	1,203
7		55		55	1,258	1,203
8		55		55	1,258	1,203
9		55		55	1,258	1,203
10		55		55	1,258	1,203
25		55		55	1,258	1,203
26		55	244	299	1,258	959
27		55		55	1,258	1,203
28		55		55	1,258	1,203
29		55		55	1,258	1,203
50		55		55	1,258	1,203
51		55		55	1,258	1,203
52		55		55	1,258	1,203
53		55		55	1,258	1,203
54		55		55	1,258	1,203
	6,582	2,813	244	9,638	65,729	56,089
	16.5%					

(6) Middle Namtang (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	2,919	0		2,919	0	-2,919
2		5		5	216	211
3		10		10	324	314
4		15		15	432	418
5		20		20	432	413
6		24		24	432	408
7		24		24	432	408
8		24		24	432	408
9		24		24	432	408
10		24		24	432	408
25		24		24	432	408
26		24	276	300	432	132
27		24		24	432	408
28		24		24	432	408
29		24		24	432	408
50		24		24	432	408
51		24		24	432	408
52		24		24	432	408
53		24		24	432	408
54		24		24	432	408
	2,919	1,247	276	4,442	22,586	18,144
	12.8%					

(7) Lower Makchan-Gnai (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	3,968	0		3,968	0	-3,968
2		7		7	318	311
3		13		13	476	463
4		20		20	635	615
5		27		27	635	609
6		33		33	635	602
7		33		33	635	602
8		33		33	635	602
9		33		33	635	602
10		33		33	635	602
25		33		33	635	602
26		33	295	328	635	307
27		33		33	635	602
28		33		33	635	602
29		33		33	635	602
50		33		33	635	602
51		33		33	635	602
52		33		33	635	602
53		33		33	635	602
54		33		33	635	602
	3,968	1,696	295	5,960	33,192	27,235
	13.9%					

(8) Lower Champi (Unit : '000 US$.)

Year	Cost Construct.	Cost O & M	Cost Replace.	Cost Total	Irrigation Benefit	Balance
1	10,306	0		10,306	0	-10,306
2	10,306	26		10,332	0	-10,332
3		36		36	994	958
4		52		52	1,491	1,439
5		86		86	1,988	1,901
6		121		121	1,988	1,867
7		173		173	1,988	1,815
8		173		173	1,988	1,815
9		173		173	1,988	1,815
10		173		173	1,988	1,815
25		173		173	1,988	1,815
26		173	1,091	1,264	1,988	724
27		173		173	1,988	1,815
28		173		173	1,988	1,815
29		173		173	1,988	1,815
50		173		173	1,988	1,815
51		173		173	1,988	1,815
52		173		173	1,988	1,815
53		173		173	1,988	1,815
54		173		173	1,988	1,815
	20,611	8,612	1,091	30,314	101,868	71,554
	7.9%					

Table XI-I-6 Economic Cost and Benefit Stream of the each Project (2/2)

(9) Upper Kapheu (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	3,149	0		3,149	0	-3,149
2	4,724	13		4,737	0	-4,737
3		26		26	626	600
4		40		40	940	900
5		53		53	1,253	1,200
6		59		59	1,253	1,194
7		66		66	1,253	1,187
8		66		66	1,253	1,187
9		66		66	1,253	1,187
10		66		66	1,253	1,187
25		66		66	1,253	1,187
26		66	555	621	1,253	632
27		66		66	1,253	1,187
28		66		66	1,253	1,187
29		66		66	1,253	1,187
50		66		66	1,253	1,187
51		66		66	1,253	1,187
52		66		66	1,253	1,187
53		66		66	1,253	1,187
54		66		66	1,253	1,187
	7,874	3,358	555	11,787	64,215	52,428
	13.1%					

(10) Middle Tapoung (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	4,842	0		4,842	0	-4,842
2		8		8	389	381
3		16		16	583	567
4		24		24	777	753
5		32		32	777	745
6		41		41	777	737
7		41		41	777	737
8		41		41	777	737
9		41		41	777	737
10		41		41	777	737
25		41		41	777	737
26		41	402	443	777	335
27		41		41	777	737
28		41		41	777	737
29		41		41	777	737
50		41		41	777	737
51		41		41	777	737
52		41		41	777	737
53		41		41	777	737
54		41		41	777	737
	4,842	2,099	402	7,313	40,620	33,307
	13.9%					

(11) Lower Tapoung (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	9,252	0		9,252	0	-9,252
2	12,236	16		12,351	0	-12,351
3	9,252	31		9,283	0	-9,283
4		52		52	989	937
5		90		90	1,484	1,393
6		129		129	1,978	1,849
7		181		181	1,978	1,797
8		220		220	1,978	1,758
9		258		258	1,978	1,720
10		258		258	1,978	1,720
25		258		258	1,978	1,720
26		258	1,755	2,013	1,978	-35
27		258		258	1,978	1,720
28		258		258	1,978	1,720
29		258		258	1,978	1,720
50		258		258	1,978	1,720
51		258		258	1,978	1,720
52		258		258	1,978	1,720
53		258		258	1,978	1,720
54		258		258	1,978	1,720
	30,839	12,606	1,755	45,200	99,399	54,199
	4.6%			27,290	13,764	-13,526

(12) Lower Xe Set (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	7,896	0		7,896	0	-7,896
2	7,896	17		7,913	0	-7,913
3		33		33	504	471
4		40		40	756	717
5		46		46	1,009	962
6		60		60	1,009	949
7		66		66	1,009	942
8		66		66	1,009	942
9		66		66	1,009	942
10		66		66	1,009	942
25		66		66	1,009	942
26		66	717	783	1,009	225
27		66		66	1,009	942
28		66		66	1,009	942
29		66		66	1,009	942
50		66		66	1,009	942
51		66		66	1,009	942
52		66		66	1,009	942
53		66		66	1,009	942
54		66		66	1,009	942
	15,792	3,371	717	19,881	51,690	31,809
	5.1%					

(13) Lower Namsai (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	12,046	0		12,046	0	-12,046
2	9,034	20		9,055	0	-9,055
3	9,034	53		9,087	0	-9,087
4		88		88	1,041	953
5		114		114	1,562	1,448
6		139		139	2,082	1,944
7		189		189	2,082	1,893
8		227		227	2,082	1,855
9		252		252	2,082	1,830
10		252		252	2,082	1,830
25		252		252	2,082	1,830
26		252	1,306	1,558	2,082	524
27		252		252	2,082	1,830
28		252		252	2,082	1,830
29		252		252	2,082	1,830
50		252		252	2,082	1,830
51		252		252	2,082	1,830
52		252		252	2,082	1,830
53		252		252	2,082	1,830
54		252		252	2,082	1,830
	30,115	12,439	1,306	43,860	104,644	60,784
	5.0%			26,946	14,490	-12,456

(14) Upper Thon (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	4,569	0		4,569	0	-4,569
2		8		8	173	165
3		15		15	259	244
4		23		23	345	322
5		31		31	345	315
6		38		38	345	307
7		38		38	345	307
8		38		38	345	307
9		38		38	345	307
10		38		38	345	307
25		38		38	345	307
26		38	232	270	345	75
27		38		38	345	307
28		38		38	345	307
29		38		38	345	307
50		38		38	345	307
51		38		38	345	307
52		38		38	345	307
53		38		38	345	307
54		38		38	345	307
	4,569	1,953	232	6,754	18,049	11,295
	6.1%					

(15) Middle Lamphan (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	7,154	0		7,154	0	-7,154
2	10,731	15		10,746	0	-10,746
3	10,731	30		10,761	0	-10,761
4	7,154	45		7,199	0	-7,199
5		75		75	1,173	1,098
6		90		90	1,760	1,670
7		105		105	2,346	2,241
8		120		120	2,346	2,226
9		135		135	2,346	2,211
10		150		150	2,346	2,196
25		150		150	2,346	2,196
26		150	472	622	2,346	1,724
27		150		150	2,346	2,196
28		150		150	2,346	2,196
29		150		150	2,346	2,196
50		150		150	2,346	2,196
51		150		150	2,346	2,196
52		150		150	2,346	2,196
53		150		150	2,346	2,196
54		150		150	2,346	2,196
	35,771	7,359	472	43,602	115,548	71,946
	5.0%					

(16) Upper Tay-Un (Unit : '000 US$.)

Year	Cost: Construct.	Cost: O & M	Cost: Replace.	Cost: Total	Irrigation Benefit	Balance
1	2,599	0		2,599	0	-2,599
2		4		4	134	130
3		9		9	201	192
4		13		13	268	255
5		17		17	268	250
6		20		20	268	248
7		22		22	268	246
8		22		22	268	246
9		22		22	268	246
10		22		22	268	246
25		22		22	268	246
26		22	223	245	268	23
27		22		22	268	246
28		22		22	268	246
29		22		22	268	246
50		22		22	268	246
51		22		22	268	246
52		22		22	268	246
53		22		22	268	246
54		22		22	268	246
	2,599	1,109	223	3,930	13,991	10,061
	8.8%					

Table XI-I-7 Economic Cost and Benefit Stram of the Whole Project

(Unit:US$.)

Year	Cost				Irrigation Benefit	Balance
	Construction	O & M	Replacement	Total		
1	7,635			7,635		-7,635
2	9,443	29		9,471	65	-9,407
3	7,896	57		7,953	1,170	-6,784
4	7,896	102		7,999	1,738	-6,260
5	2,599	148		2,747	2,779	32
6	9,411	181		9,592	3,165	-6,427
7	11,956	214		12,170	4,045	-8,124
8	11,262	267		11,529	4,889	-6,640
9	12,336	332		12,668	6,106	-6,562
10	9,252	385		9,637	6,698	-2,939
11	25,782	447		26,229	8,030	-18,199
12	22,685	550		23,234	9,154	-14,081
13	23,734	660		24,395	10,179	-14,216
14	17,460	791		18,251	11,960	-6,290
15	10,306	933		11,239	13,921	2,682
16		1,045		1,045	16,181	15,136
17		1,138		1,138	17,264	16,126
18		1,232		1,232	17,761	16,529
19		1,306		1,306	17,761	16,455
20		1,373		1,373	17,761	16,388
21		1,373		1,373	17,761	16,388
22		1,373		1,373	17,761	16,388
23		1,373		1,373	17,761	16,388
24		1,373		1,373	17,761	16,388
25		1,373		1,373	17,761	16,388
26		1,373	249	1,622	17,761	16,139
27		1,373	1,152	2,525	17,761	15,236
28		1,373		1,373	17,761	16,388
29		1,373	717	2,090	17,761	15,671
30		1,373	223	1,596	17,761	16,165
31		1,373	1,755	3,128	17,761	14,633
32		1,373	804	2,177	17,761	15,584
33		1,373	314	1,687	17,761	16,074
34		1,373		1,373	17,761	16,388
35		1,373	402	1,775	17,761	15,986
36		1,373	244	1,617	17,761	16,144
37		1,373	276	1,649	17,761	16,112
38		1,373	1,601	2,974	17,761	14,787
39		1,373	472	1,845	17,761	15,916
40		1,373	1,091	2,464	17,761	15,297
41		1,373		1,373	17,761	16,388
42		1,373		1,373	17,761	16,388
43		1,373		1,373	17,761	16,388
44		1,373		1,373	17,761	16,388
45		1,373		1,373	17,761	16,388
46		1,373		1,373	17,761	16,388
47		1,373		1,373	17,761	16,388
48		1,373		1,373	17,761	16,388
49		1,373		1,373	17,761	16,388
50		1,373		1,373	17,761	16,388
51		1,373		1,373	17,761	16,388
52		1,373		1,373	17,761	16,388
53		1,373		1,373	17,761	16,388
54		1,373		1,373	17,761	16,388
55		1,373		1,373	17,761	16,388
	189,653	59,251	9,300	258,204	792,259	534,055
EIRR =	7.9%					