Table III-17 Proposed Farming Practices

Inputs:	Unit	Lowland rice	Coffee*	Tea	Cardamom**	Cabbage	Potato	Groundnut	Soybeans	Maize	Pineapple
Yield	t/ha	4	*3	1	0.4	20	20	2	2	3	25
1 Nursery/seedling											
Seed	Kg	50				0.8	1500	45	60	15	
Seedling	No./ha	0	625	12000	20000						10000
Fertilizer	Kg	0	0								0
Chemicals	Kg		0								0
2 Labour force:	man/day										
Field preparation		37				20	20	20	20	20	40
Fencing		0				10	10	10	10	10	
Nursery		10				10					
Transplanting/seeding		28			10	10	10	10	10	5	
Weeding		17	90	10	20	20	20	20	20	20	10
Irrigation/watering		5	5	5		5	5	5	5	5	
Harvesting/threshing		56	50	130	20	20	15	20	15	15	15
Drying			20	40	5						
Pruning			40	30							
sub-total		153	205	215	55	95	80	85	80	75	65
3 Animal power											
Plowing/harrowing		15	0	0	0	10	10	20	20	20	0
Transportation		3	3		0	10	7	5	5	5	10
4 Material:											
Fertilizers	Kg	***270	****300	****300	0	***400	300	350	350	****300	****400
Chemicals	Lit.	4	0	0	0	4	4	4	4	4	0
5 Others											

Spacing: Robusta 2mx4m; Arabica 1mx2m; Cabbage 0.7mx0.7m; Cardamom 2mx2m; Groudnut 0.3mx0.3m; Soybeans 0.5mx0.2m; Pineapple 1mx1m

* Robusta shares 90% of the coffee in the area, unhulled dry cherry.
** Uplnad crop without mixing upland rice
*** (16:16:16)x200kg, Urea x 70kg
**** (16:16:16)

Table III-18 Anticipated Crop Production With Project

Crops	Present						With project						Increment	
	Wet season			Dry season			Wet season			Dry season				
	Area (ha)	Yield (t/ha)	Prod. (ton)	Area (ha)	Yield (t/ha)	Prod. (ton)	Area (ha)	Yield (t/ha)	Prod. (ton)	Area (ha)	Yield (t/ha)	Prod.	Area (ha)	Prod. (ton)
Coffee	2,980	0.3	894	2,980	0	0	3,730	1.5	5,595	3,730	0.0	0	750	4,701
Tea	90	0.17	15	90	0.1	8	90	0.5	45	90	0.5	45	0	67
Field crops	240	1	240	0	0	0	220	2.0	440	4,470	2.0	8,940	4,450	9,140
Upland rice	1,380	1.5	2,070	0	0	0	0		0	0		0	-1,380	-2,070
Cardamom	290	0.3	87	290	0	0	10	0.3	3	10	0.3	0	-280	-84
Lowland rice	1,730	2.6	4,498	0	0	0	17,070	4.0	68,280	5,560	4.0	22,240	20,900	86,022
Vegetables	0	8	0	0	8	0	290	20.0	5,800	850	20.0	17,000	1,140	22,800
Total	6,710	-	7,804	3,360	-	8	21,410	-	80,163	14,710	-	48,225	25,580	120,576

Table III-19 Main Crops/Livestock in and around Scheme Areas

Scheme area /village	Coffee (ha)	Tea (ha)	Upland rice (ha)	Lowland rice (ha)	Cabbage (ha)	Ground nuts (ha)	Chilly (ha)	Cotton (ha)	Carda-mom (ha)	Durian (tree)	Buffalo (head)	Cattle (head)	Horse (head)	Pig (head)	Poultry (head)	Faish pond (ha)
Upper Champi																
Lak 33	64	23	8						8	205		110		70	200	
Lak 35	179	73	3								2	130		150	550	0.1
Lak 36	158	40										250		120	1200	
Lak 38	295	11										270	10	80	250	0.1
Lak 40	325	19										250		300	1100	1.0
Lak 42	86	16										5		10	120	
Lak 43	340	39										340	10	60	1100	1.0
Lak 45	180	33										360	60	50	150	2.0
Total	1627	254	11						8	205	2	1715	80	840	4670	4.2
Upper Tapung																
Phoulangkeo	73		17		4							140	30	60	100	1.0
Houaisan	233				90							380	110	50	330	4.0
Xetapung	124				40							170	30	50	1120	1.0
Total	430		17		134							690	170	160	1550	6.0
Upper Kapheu																
Phouak-noi	111		45									80		130	2000	
Sixiangmai	59		36	2							1	70		160	200	0.1
On-noi	84		49									50		180	450	
Phouak-gnai	103		82									150		170	880	
On-gnai	118		47									70		220	890	0.3
Total	475		259	2							1	420	0	860	4420	0.4
Lower Xeset																
Natteu			4	9		20					40	40		30	200	
Sengvang-gnai			31	29		58	42	31			70	250		300	1500	2.0
Houakhoua			21			26					10	70		80	200	
Sengvang-noi			26	19		19					60	80		70	460	
Khonleng			18			8	8				10	30		50	210	
Natou			8	23		11	10				80	70		70	200	
Total			108	80		142	60	31			270	540		600	2770	2.0
Upper Tayun																
Chakamlit	22		19	7					5		70	30		20	250	0.6
Khamkok	46		10	57							150	30		70	200	
Chakam-mai	30		18	9							160	40		50	260	0.3
Total	98		47	73					5		380	100		140	710	0.9

Data source: Data were collected through village offices concerned.

Table III-20(1/5) Crop Area and Production in and around Upper Champi Area

Scheme: Upper champi Village: All District: Pakxong

Family		Coffee		Tea		Upland rice		Cardamom		Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(ton)	(ha)	(ton)
Count	673	646	590	342	332	16	14	14	4	1	187	42	228
Max	19	21.0		4.0		2.0		1.0		1	117	5	25
Min	1	0.10		0.08		0.20		0.20		1	1	1	1
Total	4084	1626	414.2	252.6	82.47	11.1	4.98	8.2	0.14	1	1656	84	496
Averag	6.1	2.52	0.70	0.74	0.25	0.69	0.36	0.59	0.04	1.0	8.9	2.0	2.2

Coffee + Tea farmers

Family		Coffee		Tea		Upland rice		Cardamom		Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(ton)	(ha)	(ton)
Count	342	327	301	342	332	12	10	8	2	1	112	26	131
Max	19	11	9	4	3	2	0.8	1	0.05	1	39	5	25
Min	1	0.2	0.01	0.08	0.01	0.25	0.15	0.3	0.02	1	1	1	1
Total	2226	753.1	195.8	252.6	82.47	9.3	4.31	5.1	0.07	1	874	53	295
Averag	6.5	2.3	0.65	0.74	0.25	0.78	0.43	0.64	0.04	1.0	7.8	2.0	2.3

Coffee +others farmers

Family		Coffee		Tea		Upland rice		Cardamom		Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(ton)	(ha)	(ton)
Count	331	319	289	0	0	4	4	6	2	0	75	16	97
Max	15	21.0	8.0	0	0	1	0.35	1	0.05	0	117	4	14
Min	1	0.1	0.0	0	0	0.2	0.02	0.2	0.02	0	1	1	1
Total	1858	873.3	218.3	0	0	1.8	0.67	3.1	0.07	0	782	31	201
Averag	5.6	2.7	0.8	######	######	0.5	0.2	0.5	0.0	#####	10.4	1.9	2.1

Yield of crops

Family		Coffee		Tea		Upland rice		Cardamom		Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(ton)	(ha)	(ton)
Count		589	590	332	332	14	14	4	4				
Max		21.0	9.0	4.0	3.0	2.0	0.8	1.0	0.1				
Min		0.20	0.01	0.08	0.01	0.2	0.0	0.30	0.02				
Total		1546.8	414.2	240.1	82.5	10.3	5.0	2.8	0.14				
Average		2.63	0.70	0.72	0.25	0.74	0.36	0.70	0.04				
Yield/ha			0.27		0.34		0.48		0.050				

Data sources are the village offices concerned. Figures indicated as "Count" show the number of collected data.

Table III-20(2/5) Crop Area and Production in and around Upper Tapung Area

Scheme:Upper Tapoung Village: All District: Pakxong

Family		Coffee		Cabbage		Upland rice				Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod						
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)			(head)	(head)	(head)	(head)
Count	240	231	213	149	148	23	22				154	90	59
Max	14.0	25.5	19.2	4.0	120.0	1.6	2.9				37	7	8
Min	2.0	0.1	0.0	0.1	0.1	0.3	0.2				1.0	1.0	1.0
Total	1418	428.7	167.7	134.4	1147	16.6	12.77				676	168	111
Averag	5.9	1.86	0.79	0.90	7.75	0.72	0.58				4.4	1.9	1.9

Coffee + Cabbage farmers

Family		Coffee		Cabbage		Upland rice				Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod						
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)			(head)	(head)	(head)	(head)
Count	149	142	129	149	148						98	61	28
Max	14	25.5		4							22	7	7
Min	2	0.1		0.1							1	1	1
Total	862	285.1	119.8	134.4	1147						393	116	47
Averag	5.8	2.01	0.93	0.90	7.75						4.0	1.9	1.7

Coffee + Upland rice farmers

Family		Coffee		Cabbage		Upland rice				Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod						
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)			(head)	(head)	(head)	(head)
Count	23	23	20			23	22				11	9	13
Max	12	5.0				1.6					37	4	8
Min	2	0.5				0.3					1	1	1
Total	158	42.0	12.94			16.6	12.77				76	13	32
Averag	6.9	1.8	0.6			0.7	0.6				6.9	1.4	2.5

Coffee only farmers

Family		Coffee		Cabbage		Upland rice				Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod						
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)			(head)	(head)	(head)	(head)
Count	68	66	64								45	20	18
Max	13	6.0									30	5	4
Min	2	0.5									2	1	1
Total	398	101.6	34.97								207	39	32
Averag	5.9	1.5	0.5								4.6	2.0	1.8

Yield of crops

Family		Coffee		Cabbage		Upland rice				Buffalo	Cattle	Horse	Pig
S. No.	Member	Area	Prod	Area	Prod	Area	Prod						
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)			(head)	(head)	(head)	(head)
Count		213	213	126	126	22	22						
Max		25.5	19.2	4.0	120.0	1.5	2.0						
Min		0.1	0.0	0.2	2.0	0.3	0.2						
Total		409.4	167.7	119.1	1125.5	12.5	7.3						
Average		1.9	0.8	0.92	8.67	0.7	0.4						
Yield/ha			0.41		9.5		0.58						

Data sources are the village offices concerned. The figures indicated as "Count" show the number of collected data.

Table III-20(3/5) Crop Area and Production in and around Upper Kapheu Area

Scheme: Upper Kapheu Village: All District: Laongam

Family		Coffee		Tea		Upland rice		Lowland Rice		Buffalo	Cattle	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count		414	167			420	44	3	3		82	148	186
Max		7.0	3.0			3.2	5.0	1.0	3.0		8.0	19	80
Min		0.1	0.0			0.1	0.1	0.4	1.5		1.0	1	1
Total		475.4	67.1			264.4	53.1	1.9	7.2		200	351	2063
Average		1.1	0.40			0.6	1.2	0.6	2.4		2.4	2.4	11.1

Coffee + Upland rice farmers

Family		Coffee		Tea		Upland rice		Lowland Rice		Buffalo	Cattle	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count		380	158	0	0	420	44	2	2	0	82	143	181
Max		6.6	3.0			3.2	5.0	0.5	2.7		8.0	19	80
Min		0.1	0.0			0.1	0.1	0.4	1.5		1.0	1	1
Total		422.5	62.6			264.4	53.1	0.9	4.2		200	335	2015
Average		1.1	0.4			0.6	1.2	0.5	2.1		2.4	2.3	11.1

Coffee only farmers

Family		Coffee		Tea		Upland rice		Lowland Rice		Buffalo	Cattle	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count		34	9	0	0	0	0	1	1	0	0	5	5
Max		7.0	2.0					1.0	3.0			6	20
Min		0.4	0.0					1.0	3.0			1	2
Total		52.9	4.5					1.0	3.0			16	48
Average		1.6	0.5					1.0	3.0			3.2	9.6

Yield of crops

Family		Coffee		Tea		Upland rice		Lowland Rice		Buffalo	Cattle	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count		167	167			44	44						
Max		6.6	3.0			3.0	5.0						
Min		0.1	0.0			0.1	0.1						
Total		212.1	67.1			36.2	53.1						
Average		1.3	0.40			0.8	1.2						
Al. av.			0.32				1.5						

Data sources are the village offices concerned. The figures indicated as "Count" show the number of data collected.

Table III-20(4/5) Crop Area and Production in and around Lower Xeset Area

Scheme: Lower Xeset Village: All District: Salavan

Family		Groundnut		Chilly		Upland rice		Lowland Rice		Cotton		Buffalo	Cattle
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod		
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)
Count		300	77	197	82	211	45	106	38	102	0	12	14
Max		3.5	0.9	1.0	0.0	4.0		2.6		0.7		6	5
Min		0.1	0.2	0.1	0.0	0.1		0.2		0.1		1	1
Total		141.7	27.8	60.2	1.5	107.9	54.7	78.7	59.5	30.6		32	36
Average		0.5	0.4	0.3	0.0	0.5	1.2	0.7	1.6	0.3		2.7	2.6
Vill. av													

Lowland rice + upland rice + other crops farmers

Family		Groundnut		Chilly		Upland rice		Lowland Rice		Cotton		Buffalo	Cattle
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod		
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)
Count		74	33	63	36	0	0	78	37	26	0	7	6
Max		1.6	0.2	1.0	0.0	0	0	2.5	2.2	0.7	0	5	5
Min		0.1	0.2	0.1	0.0	0	0	0.3	1.0	0.2	0	1	1
Total		33.6	5.7	19.2	0.6	0	0	58.6	58.0	9.2	0	16	13
Average		0.5	0.2	0.30	0.02	#####	#####	0.7	1.6	0.4	#####	2	2
Vill. av													

Upland rice + other crops farmers

Family		Groundnut		Chilly		Upland rice		Lowland Rice		Cotton		Buffalo	Cattle
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod		
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)
Count		155	41	109	43	185	44	0	0	60	0	3	7
Max		1.8	0.9	0.6	0.0	4.0	3.0	0	0	0.5	0	4	5
Min		0.1	0.2	0.1	0.0	0.1	0.5	0	0	0.1	0	1	1
Total		57.5	21.5	33.1	0.8	97.3	54.1	0	0	16.8	0	9	19
Average		0.4	0.5	0.3	0.0	0.5	1.2	#####	#####	0.3	#####	3	3
Vill. av													

Yield of crops

Family		Groundnut		Chilly		Upland rice		Lowland Rice		Cotton		Buffalo	Cattle
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod	Area	Prod		
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)
Count		77	77	82	82	45	45	38	38	0	0		
Max		0.4	0.9	0.4	0.0	1.5	3.0	1.0	2.2				
Min		0.1	0.2	0.1	0.0	0.3	0.5	0.5	1.0				
Total		18.9	27.8	18.7	1.5	26.7	54.7	22.5	59.5				
Average		0.24	0.35	0.23	0.02	0.59	1.21	0.59	1.57				
Yield/ha			1.47		0.08		2.05		2.64				

Data sources are the concerned village offices. The figures indicated as "Count" show the number of data collected.

Table III-20(5/5) Crop Area and Production in and around Upper Tay-Un Area

Scheme: Upper Tay-Un Village: All District: Thateng

Family		Coffee		Lowland Rice		Upland rice		Cardamom		Cattle	Buffalo	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count	27	94.0	53.0	62.0	50.0	53.0	25.0	6.0	0	27	43	18	46
Max	9	3.0	1.2	3.0	3.0	2.3	3.6	1.0	0	7	14	13	50
Min	2	0.1	0.02	0.05	0.1	0.1	0.2	0.5	0	1	1	1	1
Total	129	97.8	14.7	72.7	84.1	46.8	33.5	4.7	0.0	62	170	66	385
Averag	4.8	1.0	0.3	1.2	1.7	0.9	1.3	0.8	#####	2.3	4.0	3.7	8.4

Lowland rice + coffee + upland crops farmers

Family		Coffee		Lowland Rice		Upland rice		Cardamom		Cattle	Buffalo	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count	8	52	33	62	50	6	1	2	0	13	16	7	18
Max	8	3.0	1.2	3.0	3.0	1.0	1.0	1.0	0	7	14	10	50
Min	2	0.2	0.0	0.1	0.1	0.1	1.0	0.5	0	2	1	1	1
Total	39	65.3	11.9	72.7	84.1	3.0	1.0	1.5	0	35	85	20	202
Averag	4.9	1.3	0.4	1.2	1.7	0.5	1.0	0.8	#####	2.7	5.3	2.9	11.2

Upland rice + coffee + other crops farmers

Family		Coffee		Lowland Rice		Upland rice		Cardamom		Cattle	Buffalo	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count	19	39	19	0	0	47	24	4	0	13	25	10	25
Max	9	2.0	0.4	0	0	2.3	3.6	1.0	0	4	6	13	20
Min	2	0.1	0.0	0	0	0.3	0.2	0.6	0	1	1	1	1
Total	90	30.6	2.3	0	0	43.8	32.5	3.2	0	25	81	36	167
Averag	4.7	0.8	0.12	#####	#####	0.9	1.4	0.8	#####	1.9	3.2	3.6	6.7

Yield of crops

Family		Coffee		Lowland Rice		Upland rice		Cardamom		Cattle	Buffalo	Pig	Poultry
S. No.	Member	Area	Prod	Area	Prod	Area	Prod	Area	Prod				
		(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(ha)	(ton)	(head)	(head)	(head)	(head)
Count		53	53	16	16	25	25						
Max		3.0	1.2	1.8	3.0	2	3.6						
Min		0.1	0.0	0.1	0.1	0.3	0.2						
Total		62.7	14.7	12.5	20.9	24.2	33.5						
Average		1.2	0.3	0.8	1.3	1.0	1.3						
Yield/ha			0.2		1.7		1.4						

Data sources are the villge offices concerned. Figures indicated as "Count" show the collected number of data.

Table III-21 Anticipated Crop Production in Priority Area With Project

Upper Champi Scheme

Crops	Wet season	Yield	Prod.	Dry season	Yield	Prod.	Prod.total
Coffee*	500		0	500	1.5	750	750
Tea	120	0.5	60	120	0.5	60	120
Upland crops**	110	3	330	0		0	330
Vegetables***	0		0	110	20	2200	2200
Total	730		390	730		810	3400

* The yield of coffee is of hulled dried beans.

** Upland crops is represented by maize.

*** Vegetables is represented by cabbages.

Upper Tapoung Scheme

Crops	Wet season	Yield	Prod.	Dry season	Yield	Prod.	Prod.total
Upland crops	40	3	120	40	3	120	240
Vegetables	40	20	800	40	20	800	1600
Total	80		920	80		920	1840

Upper Kapheu Scheme

Crops	Wet season	Yield	Prod.	Dry season	Yield	Prod.	Prod.total
Coffee	900		0	900	1.5	1350	1350
Lowland rice	100	4	400	0		0	400
Upland crops**	0		0	100	2	200	200
Total	1000		400	1000		1550	1950

* Upland crops are represented by groundnut.

Lower Xe set Scheme

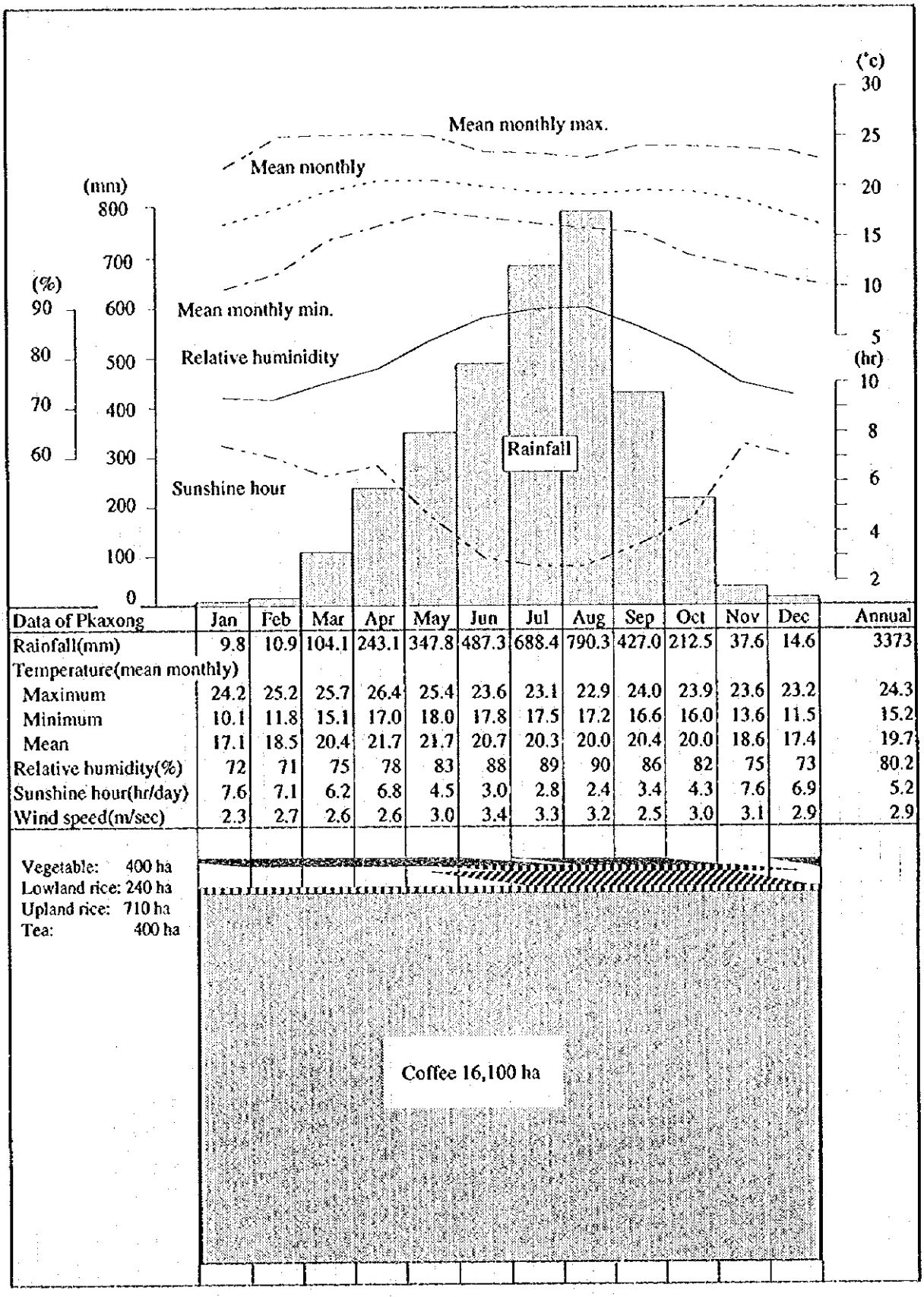
Crops	Wet season	Yield	Prod.	Dry season	Yield	Prod.	Prod.total
Lowland rice	200	4	800	200	4	800	1600
Lowland rice	800	4	3200	0		0	3200
Upland crops	0		0	800	2	1600	1600
Total	1000		4000	1000		2400	6400

Upper Tay-un Scheme

Crops	Wet season	Yield	Prod.	Dry season	Yield	Prod.	Prod.total
Lowland rice	70	4	280	70	4	280	560
Lowland rice	80	4	320	0		0	320
Lowland rice	180	4	720	0		0	720
Upland crops**	0		0	80	2	160	160
Total	330		1320	150		440	1760

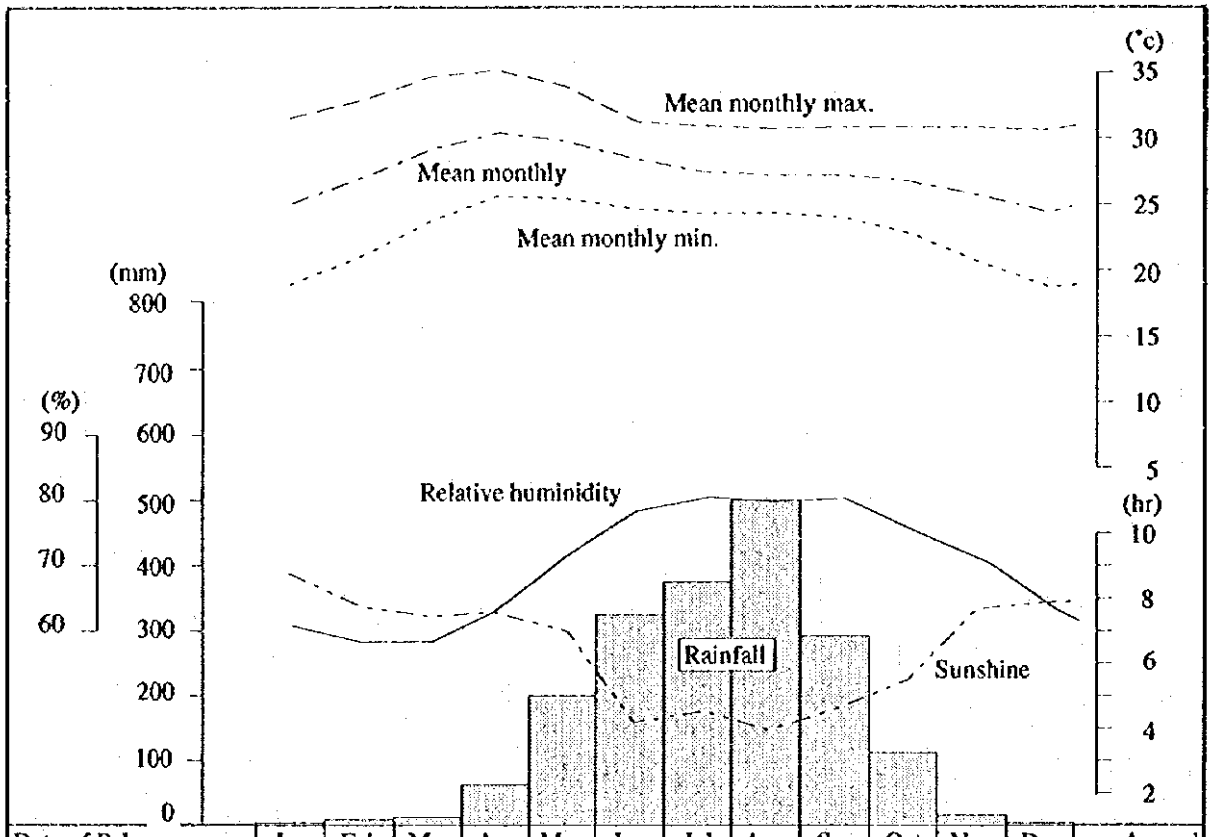
** Upland crops are represented by groundnut.

Figures



Data of Pkaxong	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	9.8	10.9	104.1	243.1	347.8	487.3	688.4	790.3	427.0	212.5	37.6	14.6	3373
Temperature(mean monthly)													
Maximum	24.2	25.2	25.7	26.4	25.4	23.6	23.1	22.9	24.0	23.9	23.6	23.2	24.3
Minimum	10.1	11.8	15.1	17.0	18.0	17.8	17.5	17.2	16.6	16.0	13.6	11.5	15.2
Mean	17.1	18.5	20.4	21.7	21.7	20.7	20.3	20.0	20.4	20.0	18.6	17.4	19.7
Relative humidity(%)	72	71	75	78	83	88	89	90	86	82	75	73	80.2
Sunshine hour(hr/day)	7.6	7.1	6.2	6.8	4.5	3.0	2.8	2.4	3.4	4.3	7.6	6.9	5.2
Wind speed(m/sec)	2.3	2.7	2.6	2.6	3.0	3.4	3.3	3.2	2.5	3.0	3.1	2.9	2.9

Figure III-1 Present Cropping Pattern in Pakxong District



Data of Pakxe	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	2.4	8.5	14.1	59.4	201.3	324.6	376.3	500.5	296.9	116.7	17.5	2.2	1920
Temperature(mean monthly):													
Maximum	32.0	33.5	35.0	35.8	33.8	31.4	30.9	30.6	31.1	31.1	31.1	30.7	32.3
Minimum	18.6	21.5	23.7	25.5	25.1	24.6	24.1	24.1	23.8	22.6	20.6	18.3	22.7
Mean	25.3	27.4	29.4	30.7	29.5	28.0	27.5	27.4	27.4	27.0	25.8	24.5	27.5
Relative humidity(%)	61	58	58	63	72	79	81	80	80	75	70	63	70.0
Sunshine hour(hr/day)	8.8	7.8	7.5	7.6	7.1	4.2	4.7	4.1	4.7	5.6	7.7	7.9	6.5
Wind speed(m/sec)	2.5	2.6	2.9	2.8	2.8	2.4	2.2	2.2	2.0	2.3	2.6	2.7	2.5

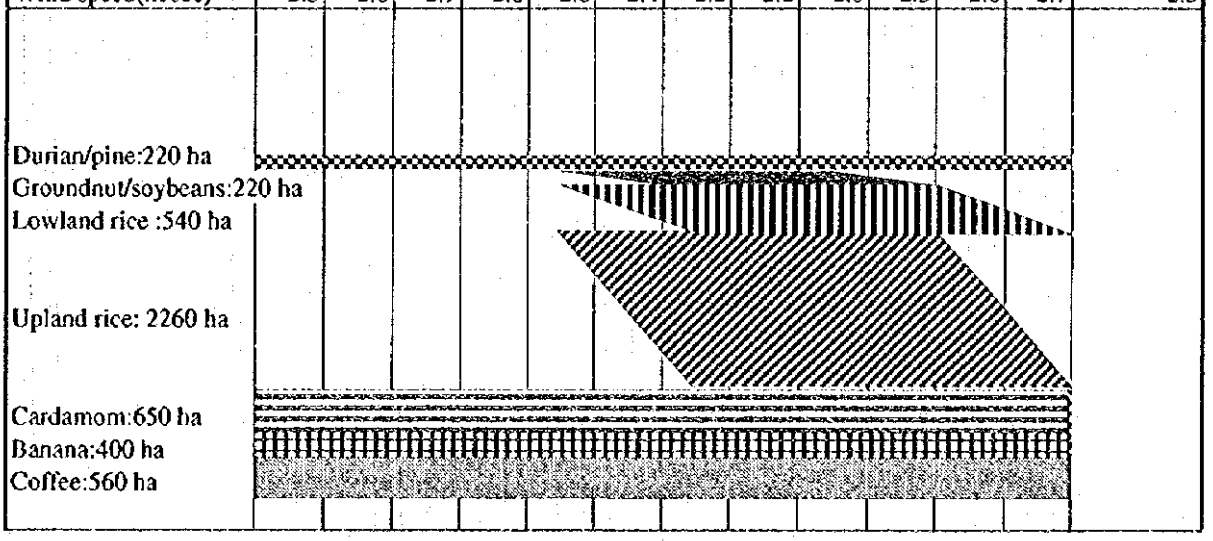
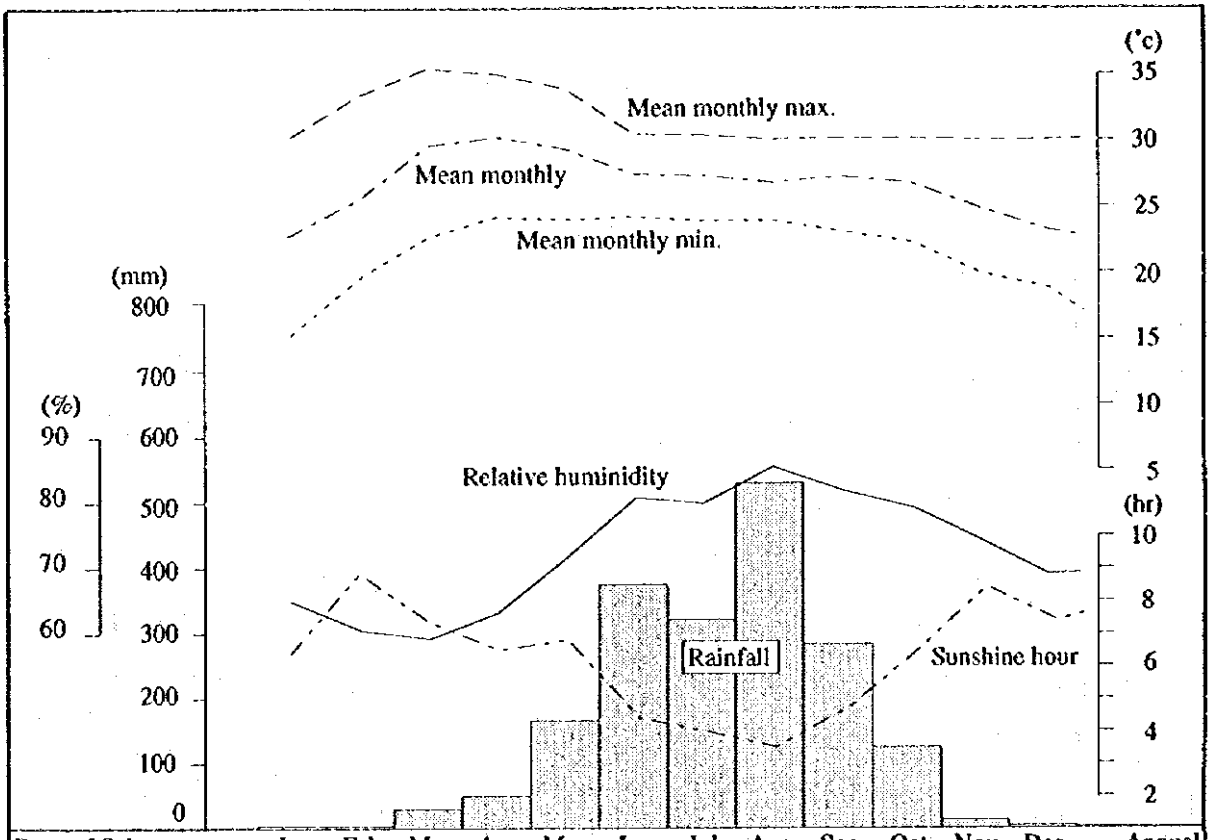


Figure III-2 Present Cropping Pattern in Bachinag Disrict



Data of Salavan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	3.6	2.0	32.3	51.3	161.6	384.6	325.8	538.2	285.3	123.1	17.7	0.6	1926
Temperature:													
Maximum	30.7	33.5	35.6	35.1	33.7	30.8	30.6	29.7	30.8	30.8	30.4	29.7	31.8
Minimum	15.4	19.1	22.7	24.4	24.2	24.4	23.9	23.8	23.5	22.4	19.7	18.0	21.8
Mean	23.1	26.3	29.3	30.2	29.0	27.5	27.3	26.7	27.2	27.0	25.0	23.0	26.8
Relative humidity	65	61	59	63	72	81	80	86	82	79	74	68	72.5
Sunshine hour	6.4	8.9	7.4	6.6	6.9	4.4	4.1	3.6	4.9	6.5	8.4	7.4	6.3
Wind speed	1.9	1.9	1.9	1.9	1.9	1.7	2.0	1.7	1.6	1.8	2.2	2.2	1.9

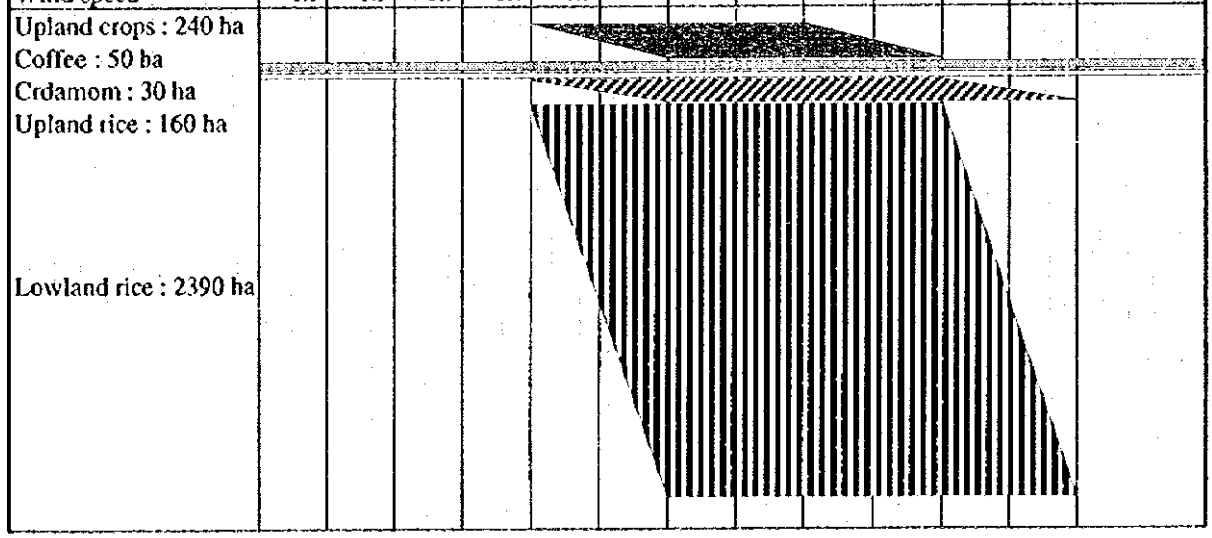
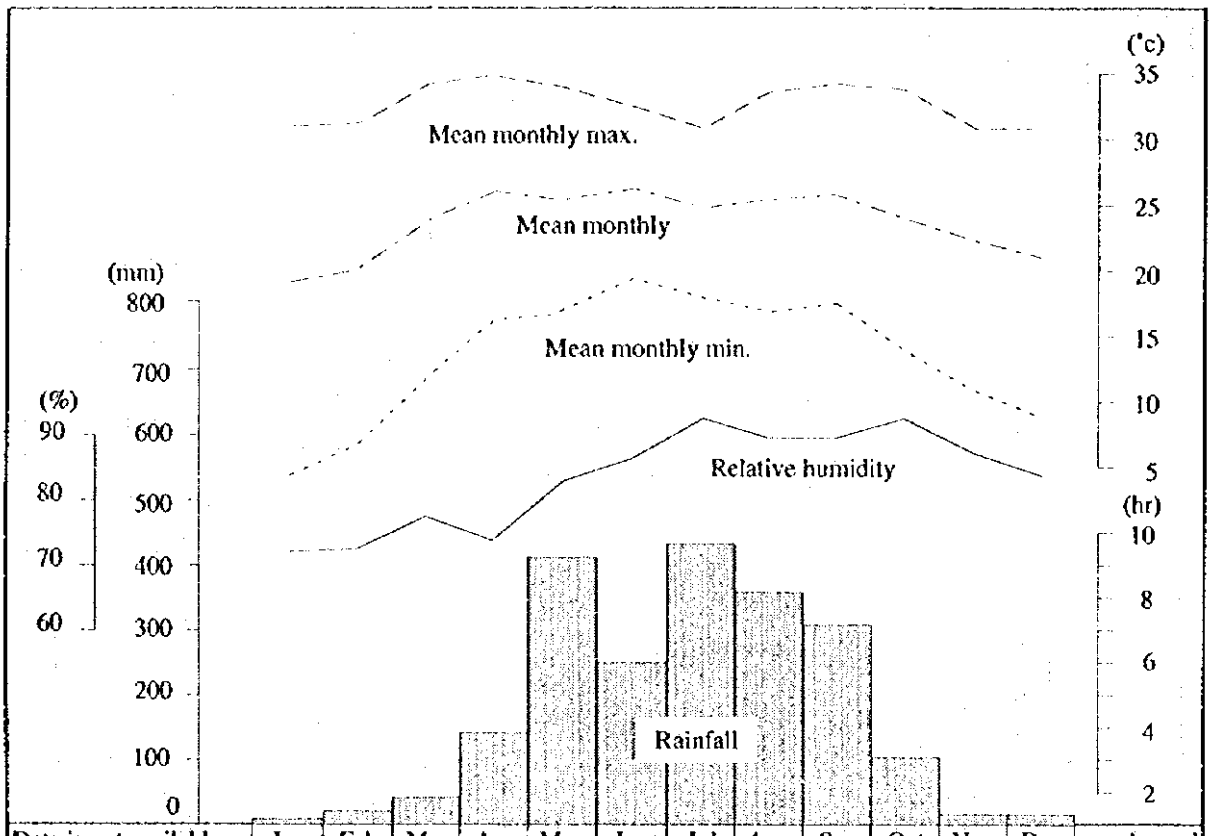


Figure III-3 Present Cropping Pattern in Salavan Disrict



Data is not available	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	0.5	21.5	45.8	145.4	416.0	252.7	439.4	368.3	303.8	103.5	13.2	13.2	2123.3
Temperature(mean monthly):													
Maximum	31.0	31.3	34.5	34.8	33.8	32.5	31.5	33.6	34.2	33.0	31.2	31.3	32.7
Minimum	4.8	6.5	12.2	16.5	16.8	19.5	17.7	17.1	17.5	13.8	11.2	8.8	13.5
Mean	18.8	20.2	23.8	25.8	25.4	25.8	24.9	25.3	25.5	23.8	22.5	21.4	23.6
Relative humidity(%)	72	73	77	74	83	86	93	89	89	92	87	84	83.3
Sunshine hour(hr/day)													
Wind speed(m/sec)													

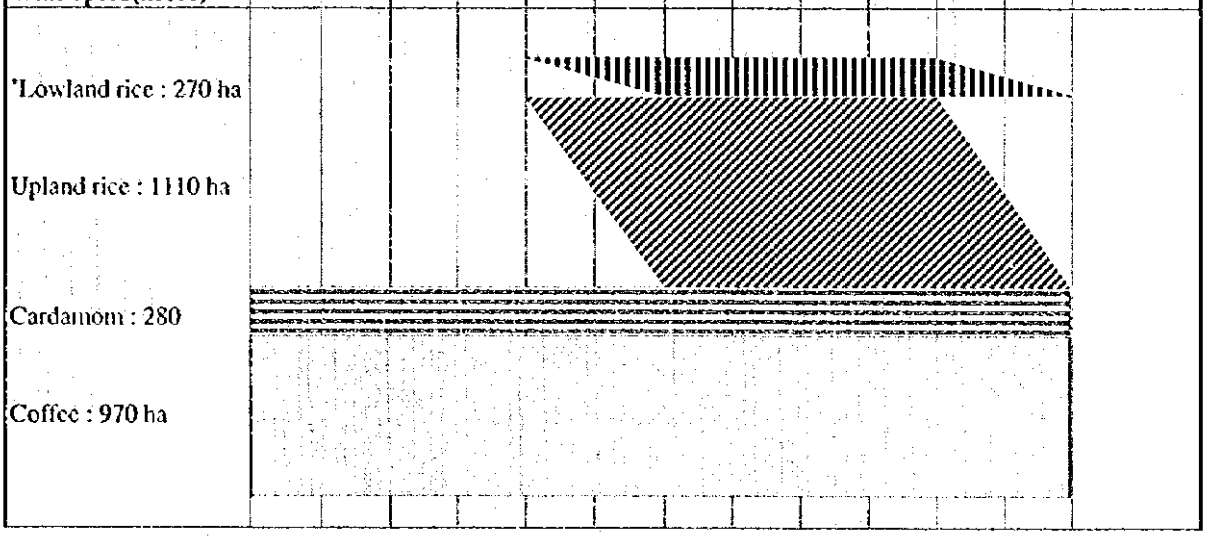
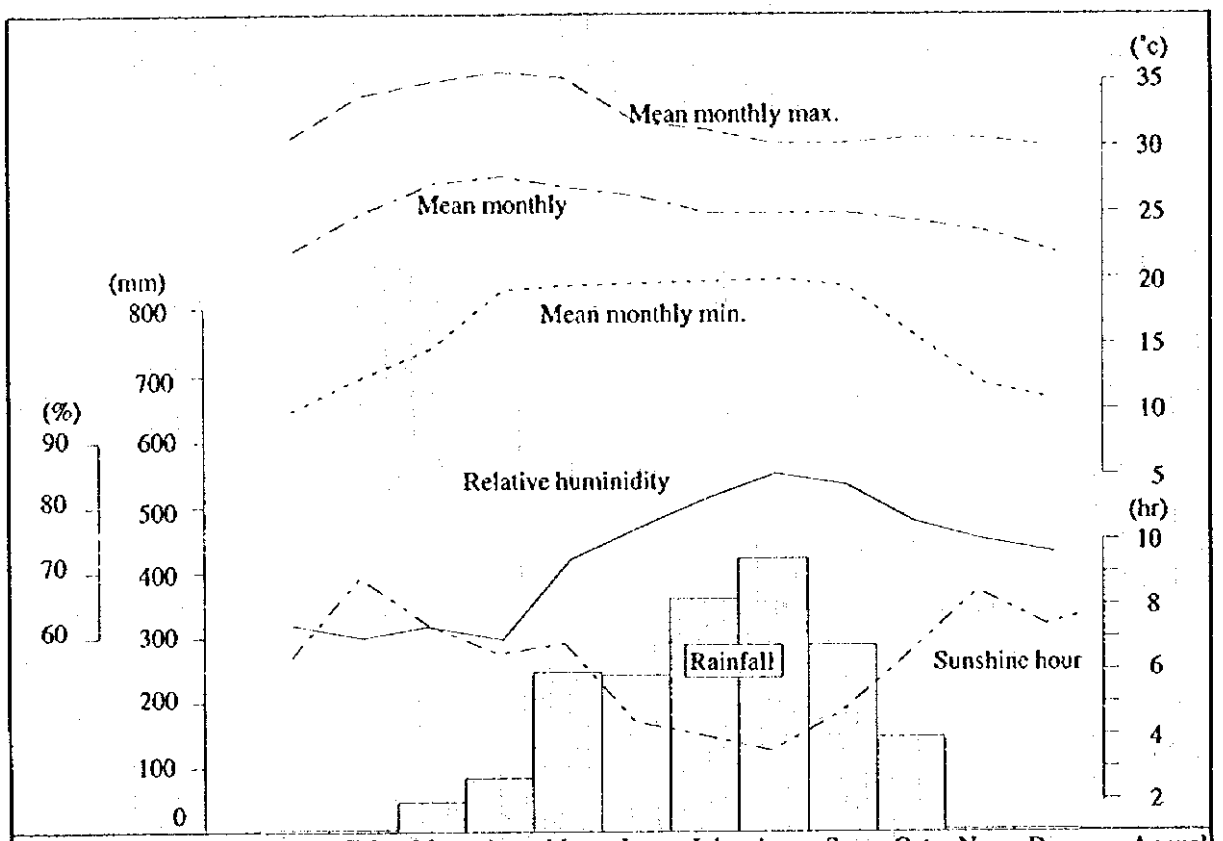
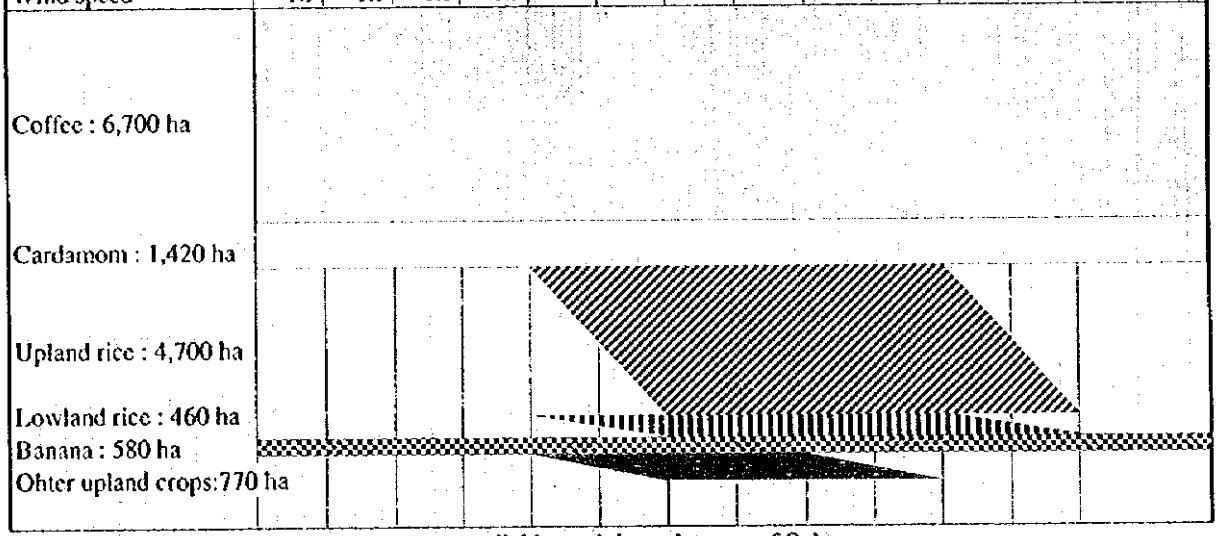


Figure III-4 Present Cropping Pattern in Thateng District



Data of Salavan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	10.7	3.3	49.5	77.9	245.8	247.5	358.7	366.7	281.8	145.8	6.6	1.9	1796
Temperature:													
Maximum	30.8	33.8	34.9	35.9	35.2	31.7	31.3	30.2	30.5	30.7	30.7	29.7	32.1
Minimum	9.7	12.5	14.8	18.3	19.0	19.3	19.7	19.6	22.0	15.3	11.7	11.1	16.1
Mean	22.1	25.1	27.1	27.6	27.0	25.9	24.9	24.8	25.0	23.9	22.9	21.5	24.8
Relative humidity	62	58	60	59	72	77	81	84	83	77	70	68	70.9
Sunshine hour*	6.4	8.9	7.4	6.6	6.9	4.4	4.1	3.6	4.9	6.5	8.4	7.4	6.3
Wind speed*	1.9	1.9	1.9	1.9	1.9	1.7	2.0	1.7	1.6	1.8	2.2	2.2	1.9



* These data for Laongam are not available, and these data are of Salavan.

Figure III-5 Present Cropping Pattern in Laongam District

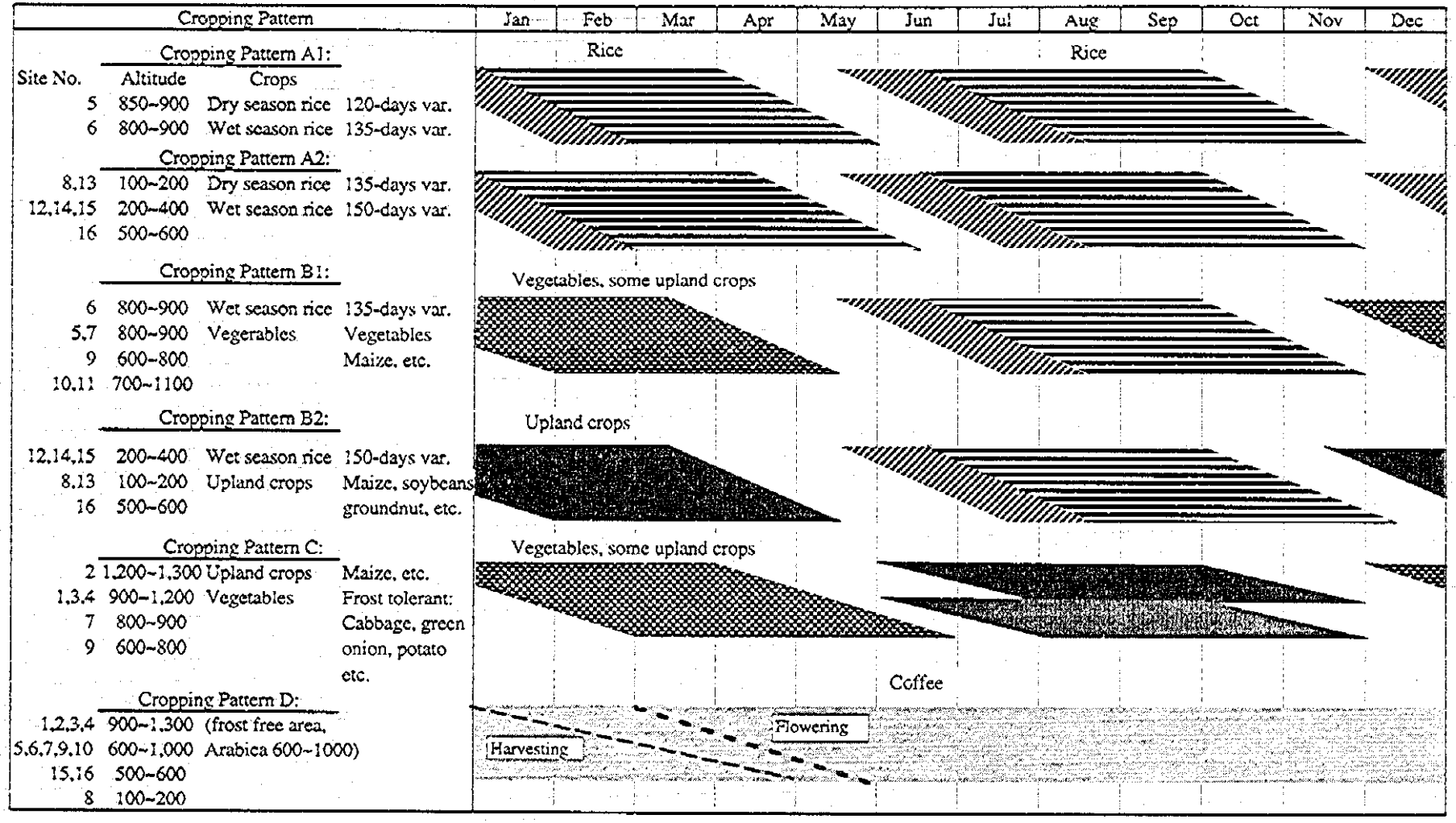
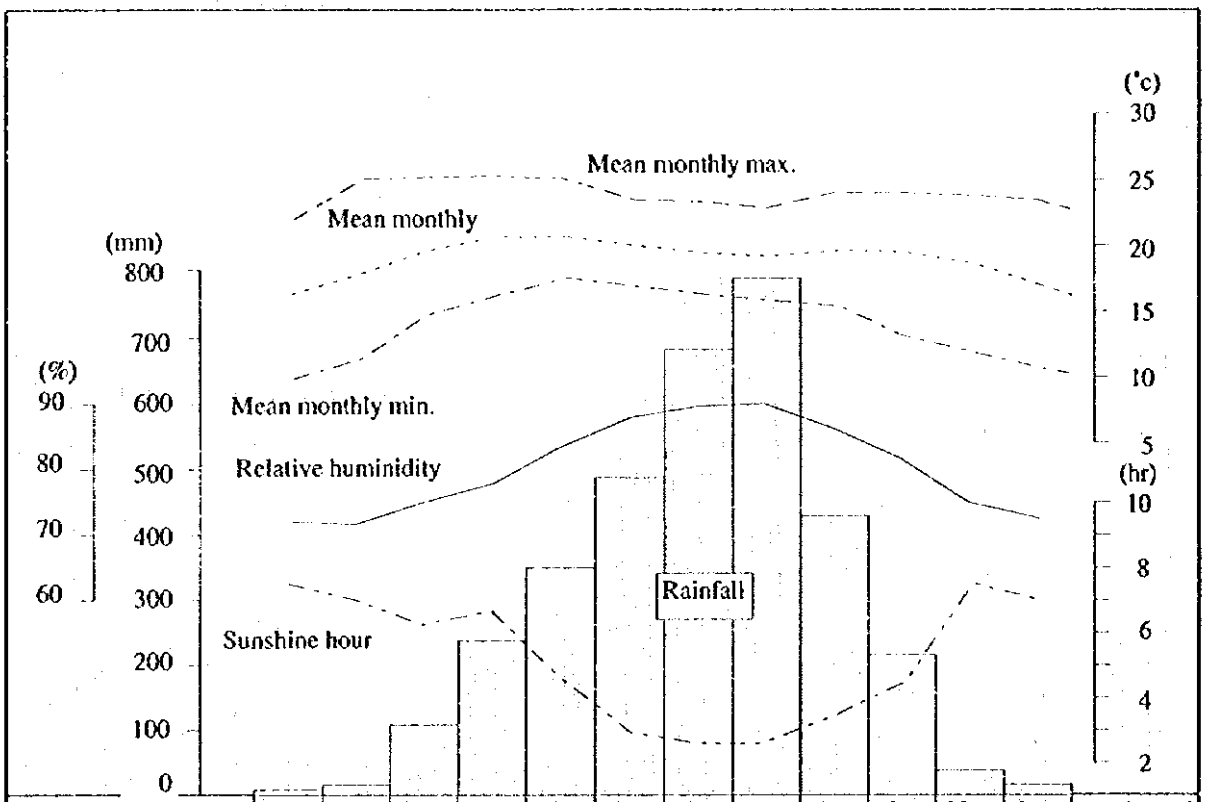


Figure III-6 Proposed ÇsTypical Cropping Pattern (16 projects)



Data of Pkaxong	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	9.8	10.9	104.1	243.1	347.8	487.3	688.4	790.3	427.0	212.5	37.6	14.6	3373
Temperature(mean monthly)													
Maximum	24.2	25.2	25.7	26.4	25.4	23.6	23.1	22.9	24.0	23.9	23.6	23.2	24.3
Minimum	10.1	11.8	15.1	17.0	18.0	17.8	17.5	17.2	16.6	16.0	13.6	11.5	15.2
Mean	17.1	18.5	20.4	21.7	21.7	20.7	20.3	20.0	20.4	20.0	18.6	17.4	19.7
Relative humidity(%)	72	71	75	78	83	88	89	90	86	82	75	73	80.2
Sunshine hour(hr/day)	7.6	7.1	6.2	6.8	4.5	3.0	2.8	2.4	3.4	4.3	7.6	6.9	5.2
Wind speed(m/sec)	2.3	2.7	2.6	2.6	3.0	3.4	3.3	3.2	2.5	3.0	3.1	2.9	2.9

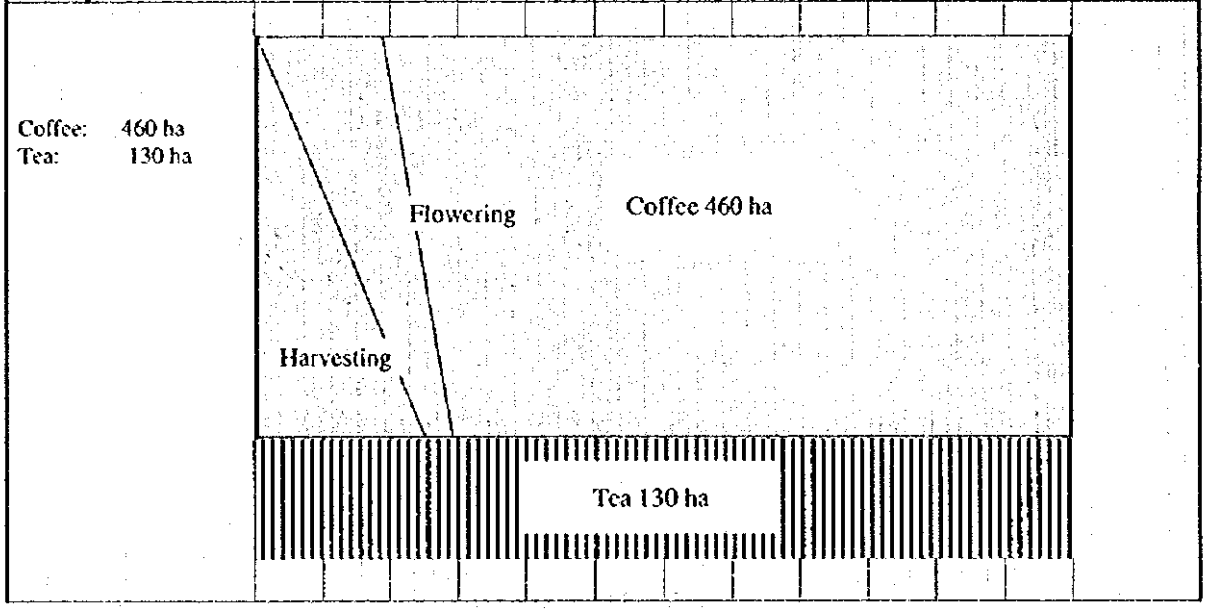
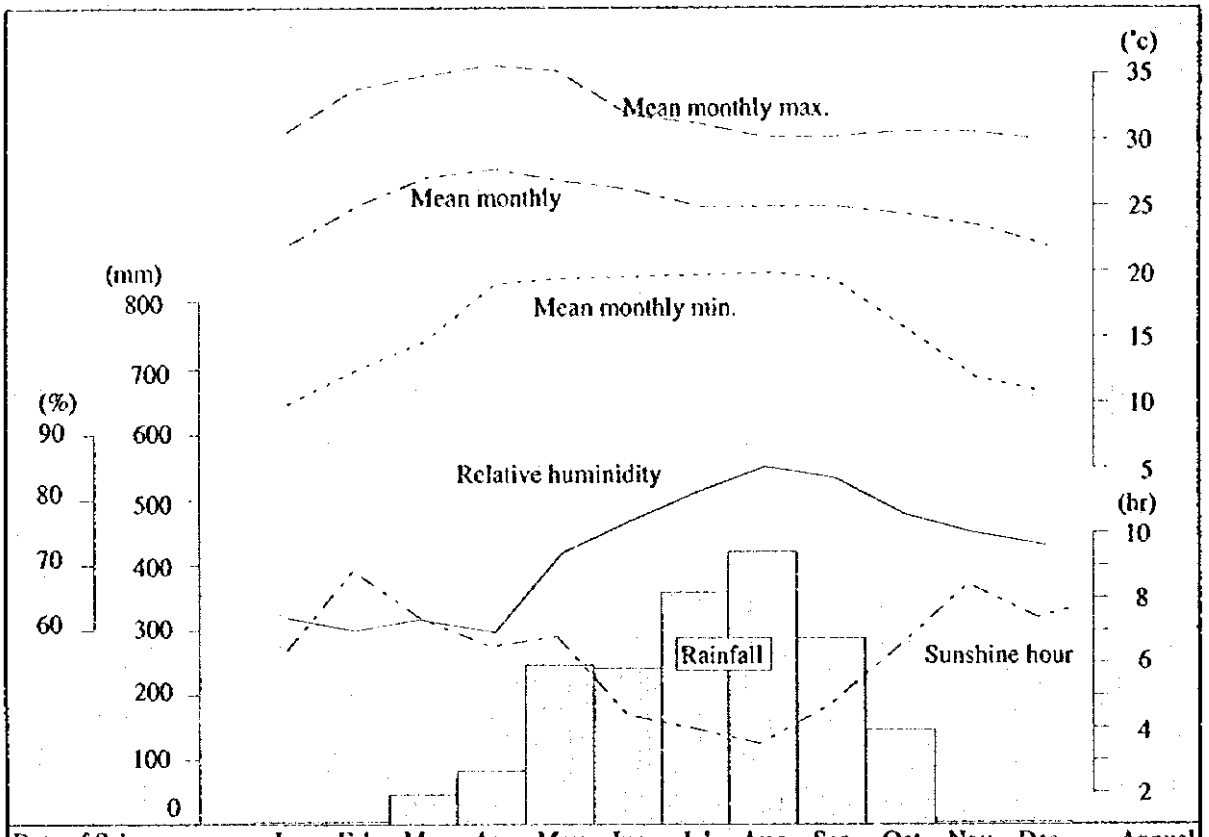
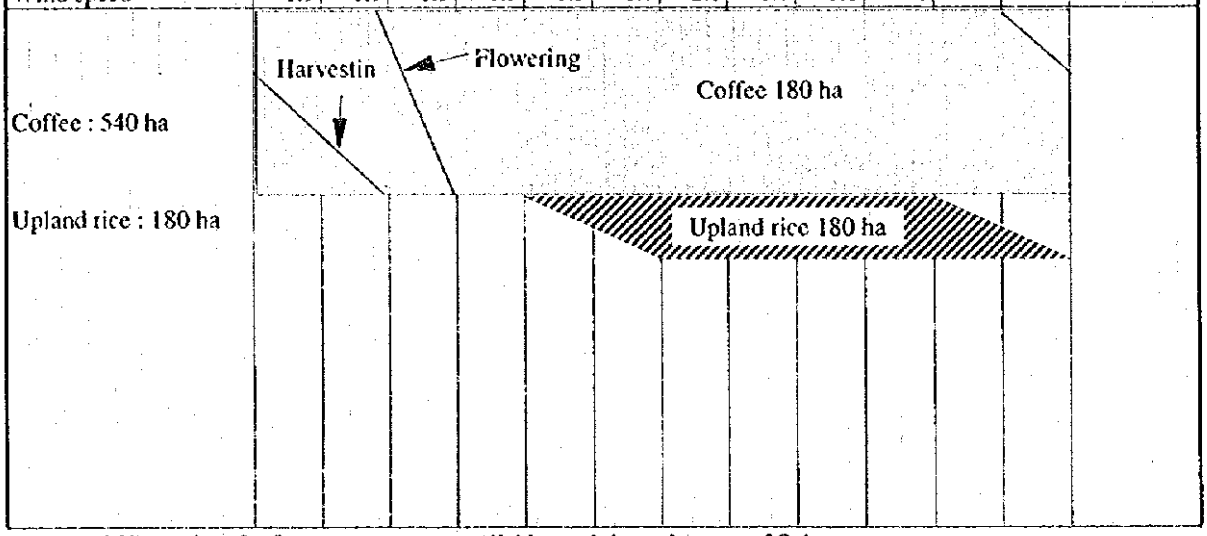


Figure III-7(1/4) Present Cropping Pattern in Upper Champi Area

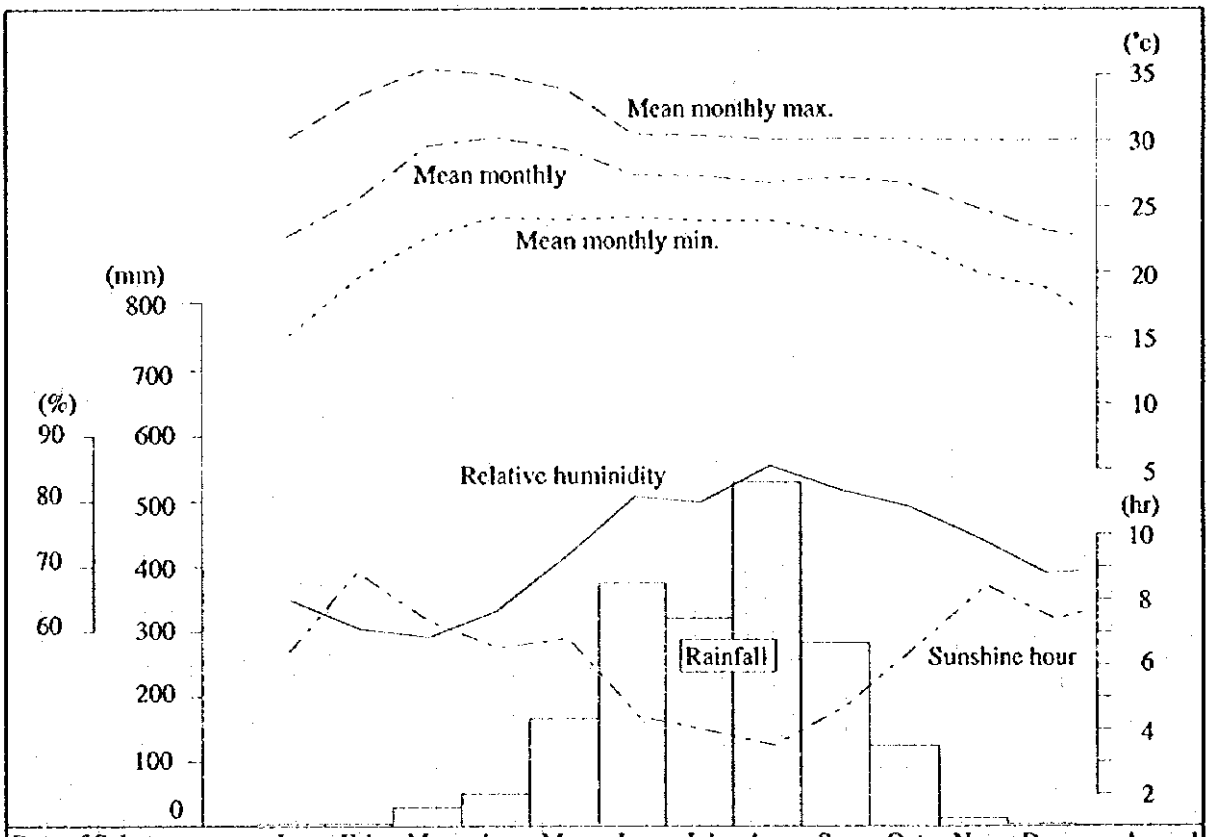


Data of Salavan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	10.7	3.3	49.5	77.9	245.8	247.5	358.7	366.7	281.8	145.8	6.6	1.9	1796
Temperature:													
Maximum	30.8	33.8	34.9	35.9	35.2	31.7	31.3	30.2	30.5	30.7	30.7	29.7	32.1
Minimum	9.7	12.5	14.8	18.3	19.0	19.3	19.7	19.6	22.0	15.3	11.7	11.1	16.1
Mean	22.1	25.1	27.1	27.6	27.0	25.9	24.9	24.8	25.0	23.9	22.9	21.5	24.8
Relative humidity	62	58	60	59	72	77	81	84	83	77	70	68	70.9
Sunshine hour*	6.4	8.9	7.4	6.6	6.9	4.4	4.1	3.6	4.9	6.5	8.4	7.4	6.3
Wind speed*	1.9	1.9	1.9	1.9	1.9	1.7	2.0	1.7	1.6	1.8	2.2	2.2	1.9



* These data for Laongam are not available, and these data are of Salavan.

FigureIII-7(2/4) Present Cropping Pattern in Upper Kapheu Area



Data of Salavan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	3.6	2.0	32.3	51.3	161.6	384.6	325.8	538.2	285.3	123.1	17.7	0.6	1926
Temperature:													
Maximum	30.7	33.5	35.6	35.1	33.7	30.8	30.6	29.7	30.8	30.8	30.4	29.7	31.8
Minimum	15.4	19.1	22.7	24.4	24.2	24.4	23.9	23.8	23.5	22.4	19.7	18.0	21.8
Mean	23.1	26.3	29.3	30.2	29.0	27.5	27.3	26.7	27.2	27.0	25.0	23.0	26.8
Relative humidity	65	61	59	63	72	81	80	86	82	79	74	68	72.5
Sunshine hour	6.4	8.9	7.4	6.6	6.9	4.4	4.1	3.6	4.9	6.5	8.4	7.4	6.3
Wind speed	1.9	1.9	1.9	1.9	1.9	1.7	2.0	1.7	1.6	1.8	2.2	2.2	1.9

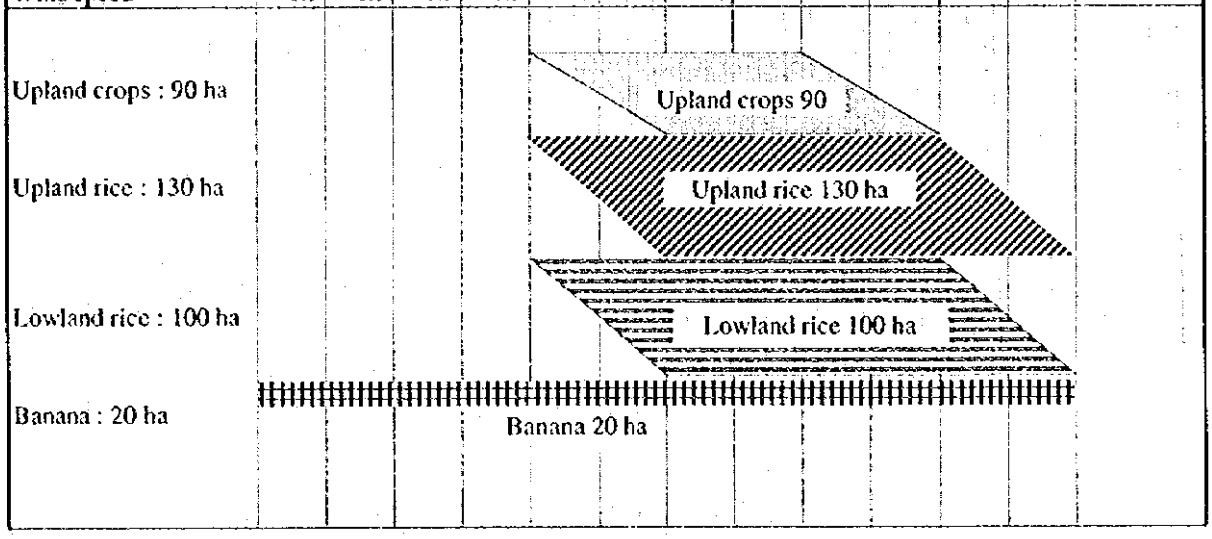
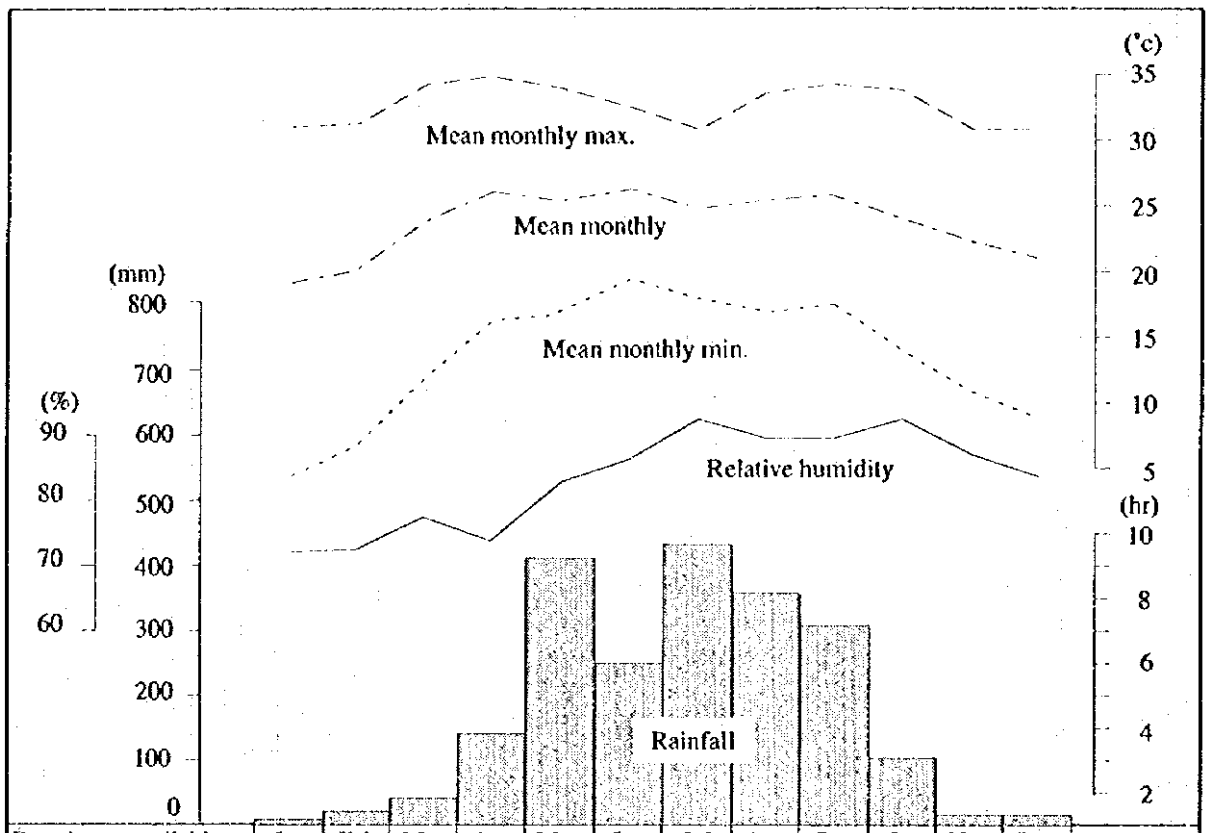


Figure III-7(3/4) Present Cropping Pattern in Lower Xe Set Area



Data is not available	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	0.5	21.5	45.8	145.4	416.0	252.7	439.4	368.3	303.8	103.5	13.2	13.2	2123.3
Temperature(mean monthly):													
Maximum	31.0	31.3	34.5	34.8	33.8	32.5	31.5	33.6	34.2	33.0	31.2	31.3	32.7
Minimum	4.8	6.5	12.2	16.5	16.8	19.5	17.7	17.1	17.5	13.8	11.2	8.8	13.5
Mean	18.8	20.2	23.8	25.8	25.4	25.8	24.9	25.3	25.5	23.8	22.5	21.4	23.6
Relative humidity(%)	72	73	77	74	83	86	93	89	89	92	87	84	83.3
Sunshine hour(hr/day)													
Wind speed(m/sec)													

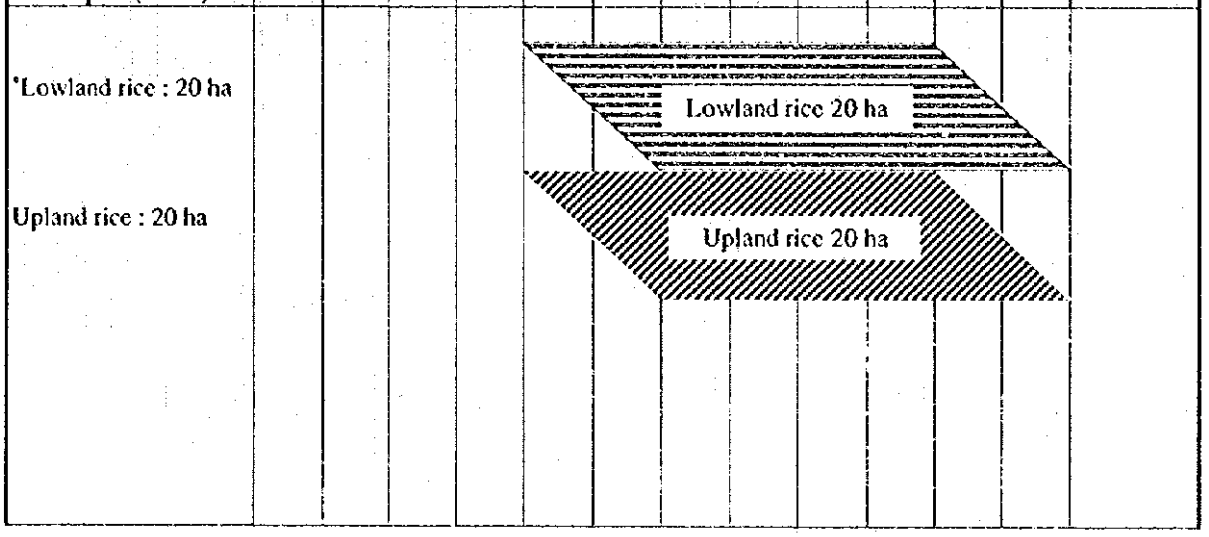
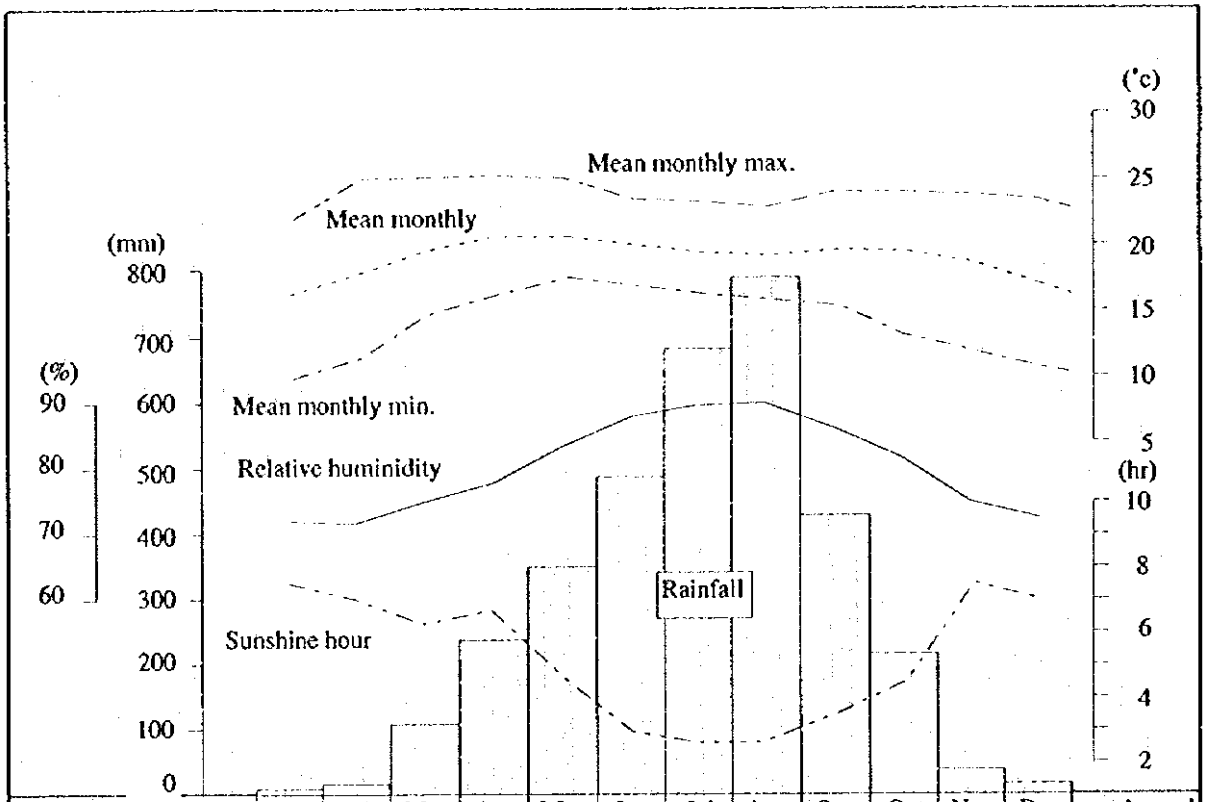


Figure III-7(4/4) Present Cropping Pattern in Upper Tay-Un Area



Data of Pkaxong	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	9.8	10.9	104.1	243.1	347.8	487.3	688.4	790.3	427.0	212.5	37.6	14.6	3373
Temperature(mean monthly)													
Maximum	24.2	25.2	25.7	26.4	25.4	23.6	23.1	22.9	24.0	23.9	23.6	23.2	24.3
Minimum	10.1	11.8	15.1	17.0	18.0	17.8	17.5	17.2	16.6	16.0	13.6	11.5	15.2
Mean	17.1	18.5	20.4	21.7	21.7	20.7	20.3	20.0	20.4	20.0	18.6	17.4	19.7
Relative humidity(%)	72	71	75	78	83	88	89	90	86	82	75	73	80.2
Sunshine hour(hr/day)	7.6	7.1	6.2	6.8	4.5	3.0	2.8	2.4	3.4	4.3	7.6	6.9	5.2
Wind speed(m/sec)	2.3	2.7	2.6	2.6	3.0	3.4	3.3	3.2	2.5	3.0	3.1	2.9	2.9

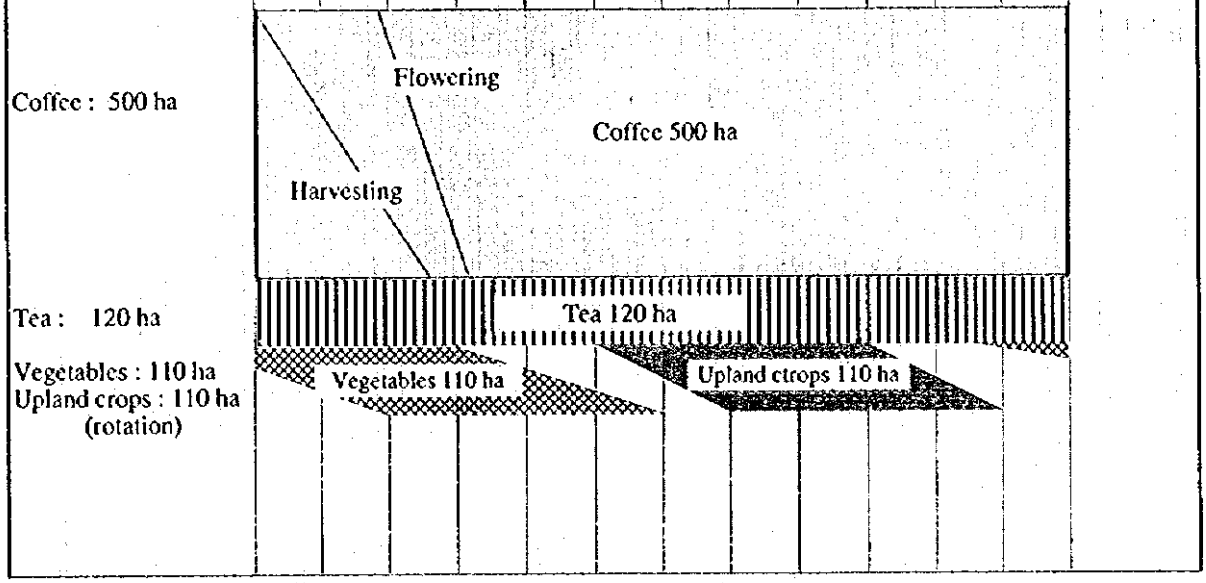
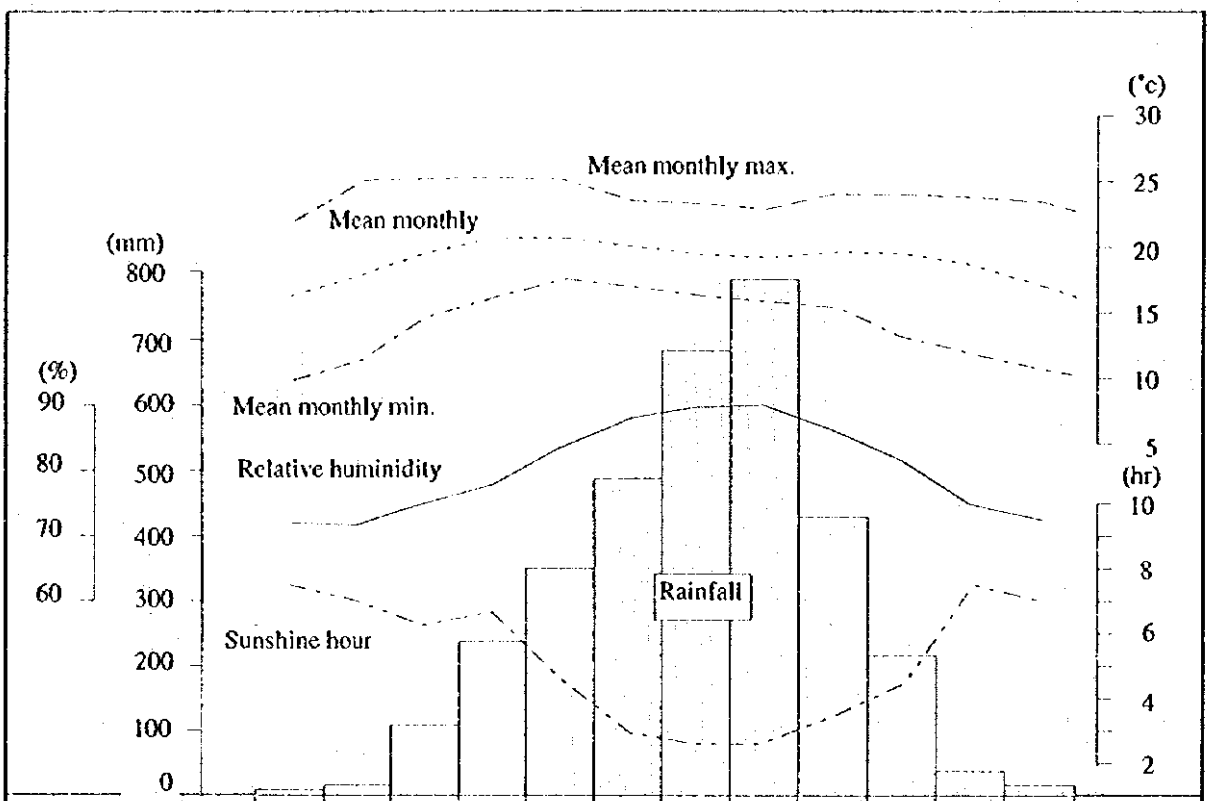


Figure III-8(1/5) Proposed Cropping Pattern in Upper Champi Area



Data of Pkaxong	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	9.8	10.9	104.1	243.1	347.8	487.3	688.4	790.3	427.0	212.5	37.6	14.6	3373
Temperature(mean monthly)													
Maximum	24.2	25.2	25.7	26.4	25.4	23.6	23.1	22.9	24.0	23.9	23.6	23.2	24.3
Minimum	10.1	11.8	15.1	17.0	18.0	17.8	17.5	17.2	16.6	16.0	13.6	11.5	15.2
Mean	17.1	18.5	20.4	21.7	21.7	20.7	20.3	20.0	20.4	20.0	18.6	17.4	19.7
Relative humidity(%)	72	71	75	78	83	88	89	90	86	82	75	73	80.2
Sunshine hour(hr/day)	7.6	7.1	6.2	6.8	4.5	3.0	2.8	2.4	3.4	4.3	7.6	6.9	5.2
Wind speed(m/sec)	2.3	2.7	2.6	2.6	3.0	3.4	3.3	3.2	2.5	3.0	3.1	2.9	2.9

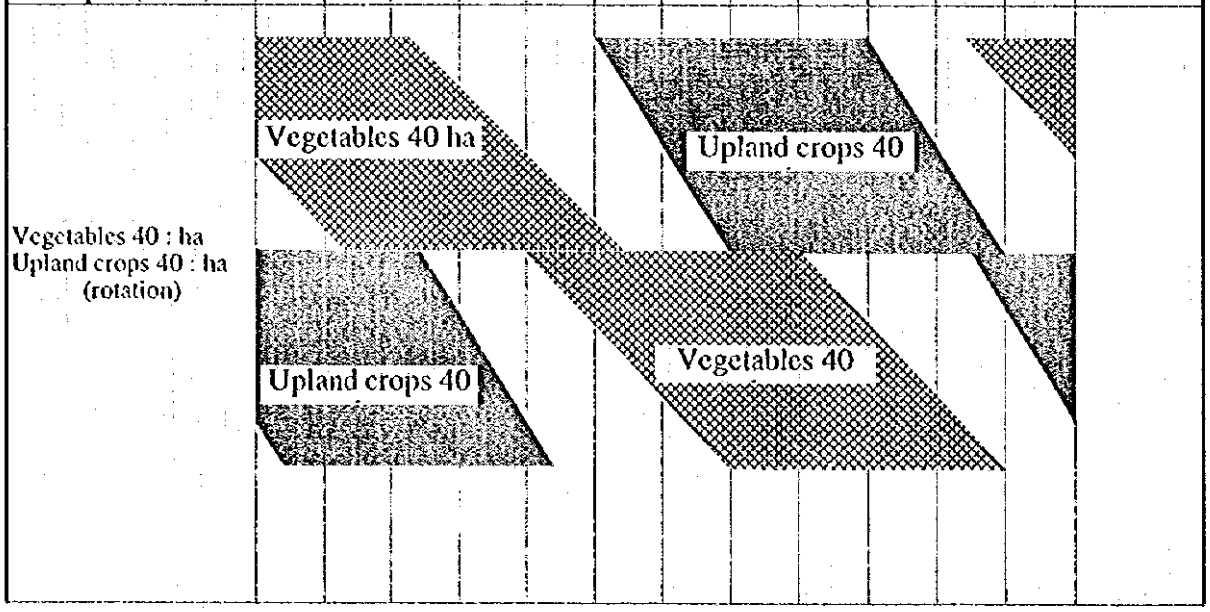
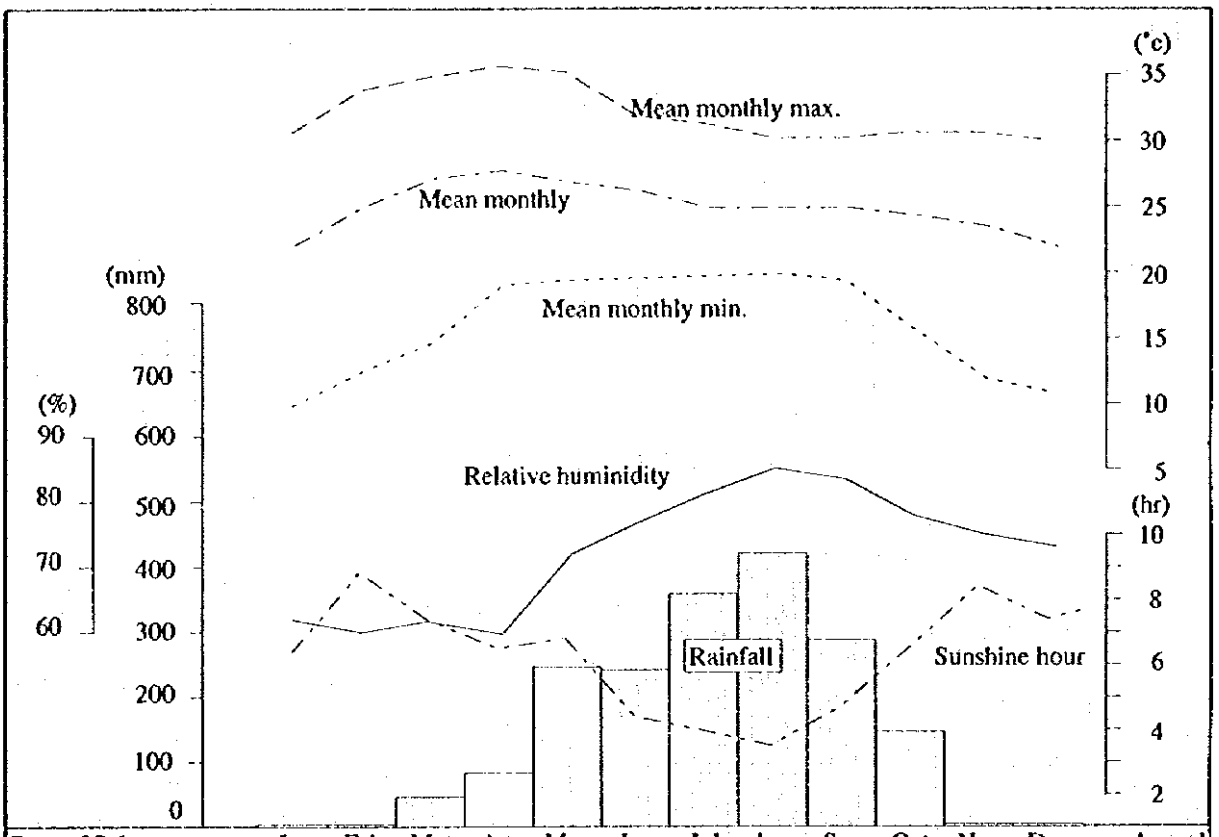
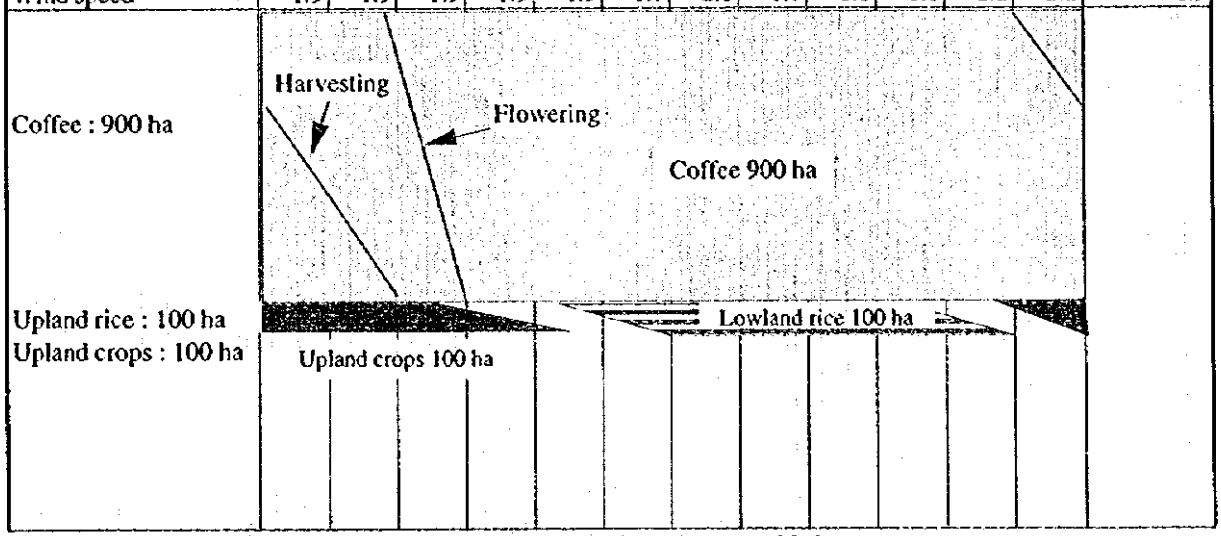


Figure III-8(2/5) Proposed Cropping Pattern in Upper Tapoung Area

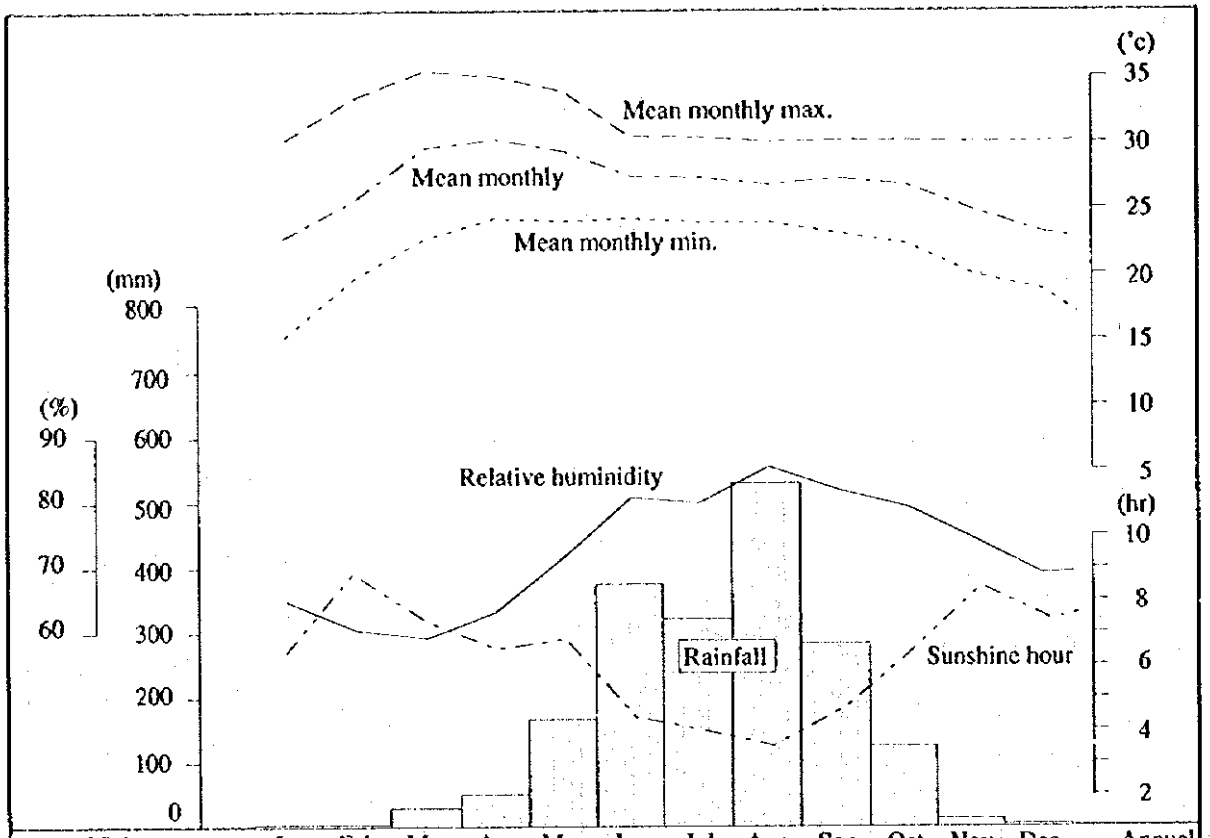


Data of Salavan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	10.7	3.3	49.5	77.9	245.8	247.5	358.7	366.7	281.8	145.8	6.6	1.9	1796
Temperature:													
Maximum	30.8	33.8	34.9	35.9	35.2	31.7	31.3	30.2	30.5	30.7	30.7	29.7	32.1
Minimum	9.7	12.5	14.8	18.3	19.0	19.3	19.7	19.6	22.0	15.3	11.7	11.1	16.1
Mean	22.1	25.1	27.1	27.6	27.0	25.9	24.9	24.8	25.0	23.9	22.9	21.5	24.8
Relative humidity	62	58	60	59	72	77	81	84	83	77	70	68	70.9
Sunshine hour*	6.4	8.9	7.4	6.6	6.9	4.4	4.1	3.6	4.9	6.5	8.4	7.4	6.3
Wind speed*	1.9	1.9	1.9	1.9	1.9	1.7	2.0	1.7	1.6	1.8	2.2	2.2	1.9



* These data for Laongam are not available, and these data are of Salavan.

Figure III-8(3/5) Proposed Cropping Pattern in Upper Kapheu Area



Data of Salavan	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall	3.6	2.0	32.3	51.3	161.6	384.6	325.8	538.2	285.3	123.1	17.7	0.6	1926
Temperature:													
Maximum	30.7	33.5	35.6	35.1	33.7	30.8	30.6	29.7	30.8	30.8	30.4	29.7	31.8
Minimum	15.4	19.1	22.7	24.4	24.2	24.4	23.9	23.8	23.5	22.4	19.7	18.0	21.8
Mean	23.1	26.3	29.3	30.2	29.0	27.5	27.3	26.7	27.2	27.0	25.0	23.0	26.8
Relative humidity	65	61	59	63	72	81	80	86	82	79	74	68	72.5
Sunshine hour	6.4	8.9	7.4	6.6	6.9	4.4	4.1	3.6	4.9	6.5	8.4	7.4	6.3
Wind speed	1.9	1.9	1.9	1.9	1.9	1.7	2.0	1.7	1.6	1.8	2.2	2.2	1.9

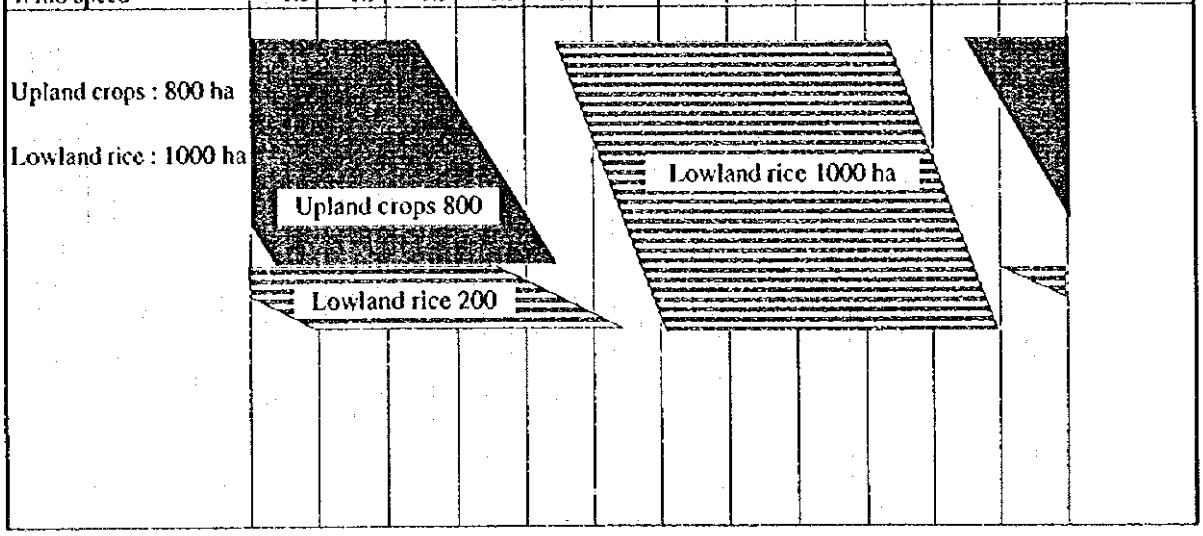
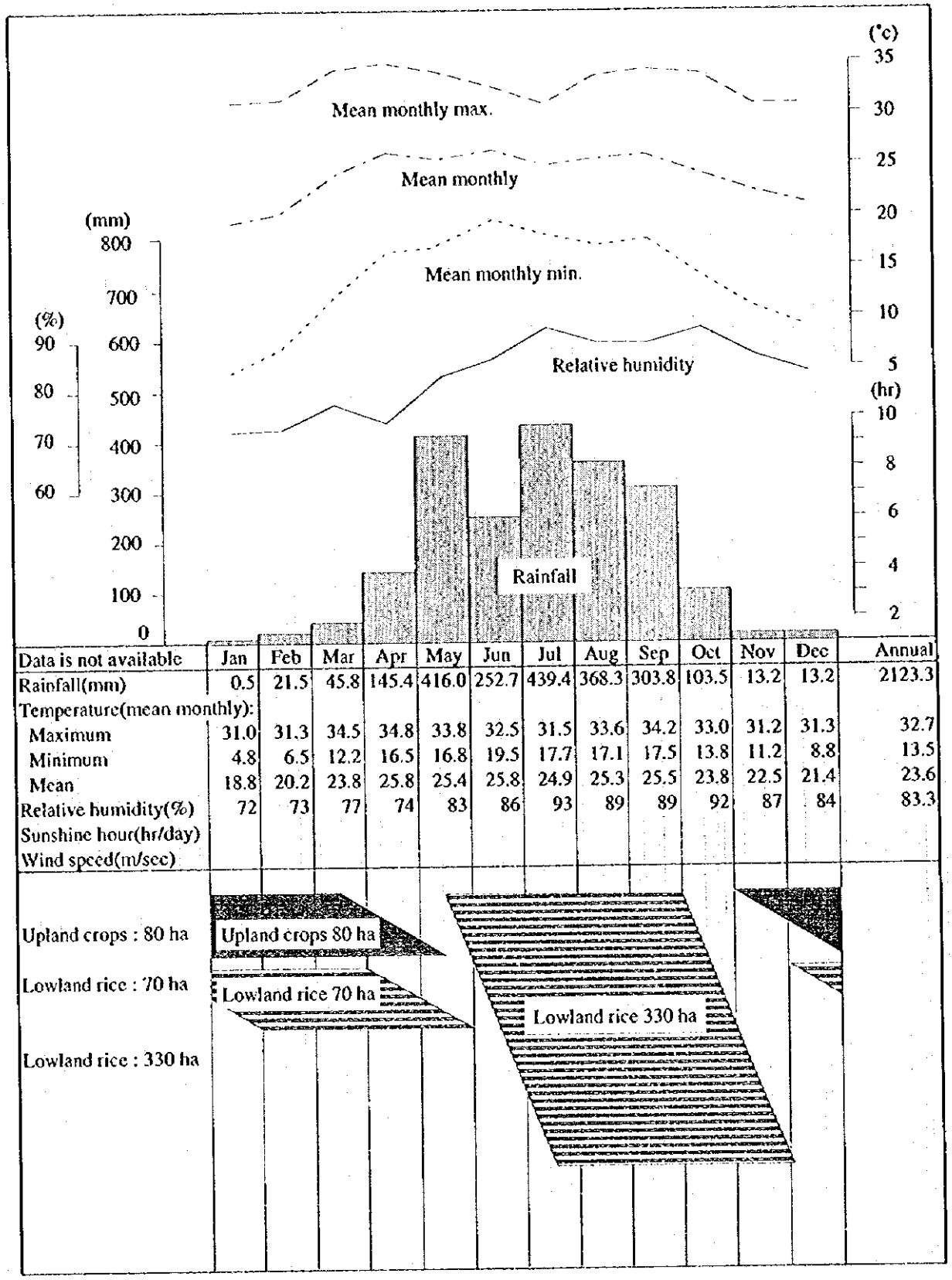


Figure III-8(4/5) Proposed Cropping Pattern in Lower Xe Set Area



Data is not available	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall(mm)	0.5	21.5	45.8	145.4	416.0	252.7	439.4	368.3	303.8	103.5	13.2	13.2	2123.3
Temperature(mean monthly):													
Maximum	31.0	31.3	34.5	34.8	33.8	32.5	31.5	33.6	34.2	33.0	31.2	31.3	32.7
Minimum	4.8	6.5	12.2	16.5	16.8	19.5	17.7	17.1	17.5	13.8	11.2	8.8	13.5
Mean	18.8	20.2	23.8	25.8	25.4	25.8	24.9	25.3	25.5	23.8	22.5	21.4	23.6
Relative humidity(%)	72	73	77	74	83	86	93	89	89	92	87	84	83.3
Sunshine hour(hr/day)													
Wind speed(m/sec)													

Figure III-8(5/5) Proposed Cropping Pattern in Upper Tay-Un Area

ANNEX IV

IRRIGATION AND DRAINAGE

MASTER PLAN

ANNEX-IV
IRRIGATION AND DRAINAGE

Table of Contents

List of Tables

List of Figures

MASTER PLAN

ANNEX-IV
IRRIGATION AND DRAINAGE

1 PRESENT CONDITIONS

1.1 National and Regional Development Progress and Current Program

In the third 5-year economic development plan, MAF, Lao PDR emphasizes the following 5 components of agriculture development aspect.

i) Increase of paddy production
ii) Increase of commodity production
iii) Reduction of slash and burning cultivation
iv) Rural development
v) Human resource development

MAF makes a reinforcement of irrigation development program to increase paddy production and to reduce areas of slash and burn cultivation.

According to the review report on the progress of the development plan 1993 - 1994, the harvested paddy field in rainy and dry seasons are achieved about 600, 000 ha and total production of dry paddy including upland paddy is approximately 1.57 million ton equivalent to about 95 % of the target production FY 1993/94. The achieved production of paddy are supported by the improvement of technical farming method as well as the increase of irrigation facilities.

In the implementation of irrigation development projects for this one (1) year FY 1993/94, plan and study of 24 projects, construction of 78 projects, continuous implementation of construction of the 21 projects and maintenance works of 22 projects are carried out. As a results of these implementation of the projects, irrigation areas are achieved 145,000 ha in rainy season and 22,000 ha in dry season. In line with the these activities and progress of the implementation, further irrigation development is scheduled to carry out through the 3 type projects, (i) small scale irrigation development projects which aim to develop small area of less than 100 ha, (ii) medium scale irrigation development projects which aim rather large areas of more than 200 ha and (iii) flood alleviation projects which aim to prevent existing irrigation areas and facilities from floods in the Implementation Program of irrigation development for the 5 years from 1996 to 2000.

In the Implementation Program, the irrigation areas of about 321,000 ha in rainy season and about 52,800 ha in dry season are scheduled to develop in the whole country for the 5 years. The scheduled development areas of the 3 provinces of Champasak, Salavan and Sekong are about 61,500 ha in rainy season 15,900 ha in dry season, and those in the study area are about 6,000 ha in rainy season and 400 ha in dry season. Irrigation development of the Study area will cover about 2 % of the national target area in rainy season and about 1 % of the national target area in dry season. Summary of the Implementation Program is shown in Table IV-1.

1.2 Existing Irrigation and Drainage Projects

1.2.1 Existing Irrigation and Drainage Development Projects

The existing irrigation projects of 16 nos. are found out in the Study areas, of which are financed by Central and Local Governments, NGO and Foreign Aid such as SIDA and USAID. Total irrigation area of the 16 projects is estimated at about 1,600 ha, and main irrigated crop is paddy. Main purpose of the project is to provide supplementary irrigation water for paddy field in rainy season, the irrigated paddy areas in dry season are drastically decreased because of the limitation of available water.

Off take facilities of irrigation water for the projects are mainly small scale concrete weirs with intake gates. Irrigation water is conveyed through small earth canals by gravity method. Canal networks are generally established by secondary and/or sub secondary canals. Tertiary canal systems are not found out at the on-farm. Irrigation water is supplied to paddy fields by paddy fields without canals at the on-farm. Main drainage canals are only found out in the project areas, and drainage canals have double functions of water conveyance such as drainage functions to evacuate excess water from paddy fields and to convey water for irrigation to lower paddy fields.

Maintenance works of irrigation facilities are mainly entrusted to village people after construction. Minor maintenance works of irrigation facilities such as maintenance works of earth canals and rehabilitation works of small related structures are only carried out by village people. Extension works on maintenance works and water management are not much carried out to farmers by the district offices concerned. Access roads to main irrigation facilities of projects are generally maintained well by village people, but in some cases, maintenance works of access roads are abandoned, and access roads are not jeepable.

Table IV-2 gives a summary of existing irrigation and drainage projects in the Study area. The existing irrigation and drainage projects of the Study area are summarized in each the province area as mentioned below.

(1) Champasak Province

The Study area are administratively covered by two (2) district areas, Pakxong District and Bachiang District. The existing irrigation projects of 6 sites which are constructed by the Central and Local Governments and NGO are scattered in the Study area of both districts. Total irrigation areas of these projects are estimated at about 660 ha. Main crop of irrigation areas is paddy, and furthermore, irrigation of coffee trees, vegetable, fruit trees and nursery trees for reforestation are also executed in the small farms. Provincial Agriculture and Forestry Service executes the construction of two irrigation projects, Palay irrigation project in the Bachiang District and Thongvay irrigation project in the Pakxong District.

Palay irrigation projects is financed by Central Government and Provincial Agriculture and Forestry Service, and main purpose of the project is to develop paddy field of about 400 ha in rainy season and about 150 ha in dry season including existing paddy fields. The water resource is Palay river. Irrigation area is expanded in the hilly area with EL. 300 m to 340 m. The off-taking method is simple concrete weir. Concrete lined head race with rectangular section are constructed. Design discharge is 0.5 m^3/sec in the plan. Weir and head race of canal system are under construction by a local contractor. Canal system from secondary canals to tertiary canals and layout of on-farm system are not clear at present.

Thongvay irrigation project is located in the high land plain with the elevation of about 950 m. Water resource of irrigation is Xe Katam river. The project is financed by SIDA and Provincial Agriculture and Forestry Service, and main purpose of the project is to supply irrigation water for existing paddy field through rehabilitation works of existing irrigation facilities. Irrigation area is estimated at about 400 ha in rainy season and about 100 ha in dry season. The off-taking method is simple concrete weir. Existing earth canal system are rehabilitated connecting with a new weir.

(2) Salavan Province

The Study area is covered by Laongam and Salavan Districts of Salavan Province. The existing irrigation projects of 4 nos. are found out in both district areas. In Laongam District, one (1) project is constructed by using the fund of SIDA. The project area is located at B. Len village. The project is just completed in 1994, and operation of irrigation starts in the beginning of 1995. Water resources of the project is mainly springs located near the village. Main purpose of the project is to supply water for inland fishery cultivation, paddy field and upland crops in order to decrease of slash and burn farming in the area. Irrigation area is about 150 ha in rainy season and about 20 ha in dry season.

In accordance with the information of Loangam District Agriculture and Forestry Service, primitive irrigation facilities are temporary constructed at about 26 village areas by farmers themselves in rainy season for cultivation of upland paddy. However, exact irrigation area are not obtained by the District Agriculture and Forestry Service. In Salavan District, 3 existing irrigation and drainage projects are found out in the Study area, and the project facilities have been constructed by USAID. The projects aim mainly to provide supplementary irrigation for paddy field in rainy season.

(3) Sekong Province

The Study area is administratively covered by Thateng District, and 6 irrigation projects existed in the Study area. Total irrigation area of these existing projects is about 800 ha. Main crop of irrigation area is paddy, and a few areas of coffee trees are irrigated. In rainy season, farmers prepare temporary weirs by using timber, bamboo and gabion, and carried out irrigation to paddy field in some village areas. In the hill side area of Thateng District, artesian wells are found out in the 4 villages, namely, Thateng, Houase, Sen Tai and Kapu villages. Ground water of artesian wells is used for domestic use of village people and irrigation to coffee trees and other upland crops in the village areas.

The Nam Sai irrigation project is latest constructed project in the area and financed by NGO. Water resources of the project is Nam Sai river, and irrigation area of 150 ha is scattered in the 4 village areas, namely, Nonglao, Kapu, Khamkok and Nong Nok villages. Each irrigation area are connected by main and secondary canals which were constructed by each village farmer.

1.2.2 Current Plans of Irrigation and Drainage Development Projects

In accordance with the information of provincial and district agriculture and forestry services, 14 irrigation and drainage development projects are newly proposed in the Study area of Champasak, Salavan and Sekong Provinces. The development plans are mainly prepared by provincial and district agriculture and forestry services. Main purposes of new irrigation development projects are to give suitable water supply to coffee trees after flowering stage of coffee trees in the Pakxong District of Champasak Province and to increase paddy production and to improve a living standard of coffee grower in Thateng District of Sekong Province.

As the results of field survey on existing irrigation and drainage projects in the Study area, the necessity of rehabilitation works of some existing irrigation and drainage facilities could be pointed out, but the rehabilitation works are not involved in the future development implementation program of the 14 irrigation and drainage development projects. Table IV-3 gives a summary of the irrigation and drainage development projects mentioned above.

1.2.3 Existing Upland Crop Development Projects

(1) Lao Upland Agriculture Development Project

With regard to the existing development projects of upland crops, the upland crop development project financed by World Bank and the Governments of Australia and France is found out in the Study area. The purposes of the project are to increase farmers' s income and to up grade farmers' living standard through research work of upland crops, extension works and technical training of plantation. Main crop of the research and extension works through the project is coffee trees, and crops of agriculture extension works are coffee, soybeans, groundnut, maize, fruit trees and vegetables.

Main components of the project implementation are

i) Establishment of upland crop research station for coffee trees, fruit trees, vegetables and upland paddy, and
ii) Extension and training of upland crops plantation through some branch offices of the project.

The research station of the project which is located at KM 35 of the road No.23 from Pakxe to Pakxong and has the experimental farm of 210 ha. The project areas are extended in the Provinces of Champasak, Salavan and Sekong Province areas, and the project areas of about 5,500 km^2 ranges from EL 400 m to EL 1,200 m of Boloven Plateau, except for the south-eastern area of the Plateau as shown in Figure IV-1.

The extension works of coffee trees and other upland crops are carried out to make the pilot villages of extension works of coffee trees and other upland crops along the road No.20 from Pakxe to near crossing point with Xe set river, one section of the road No. 23 from near Pakxe to Pakxong, the other section of road No. 23 from B. Thateng to B. Beng and the road No.16 from B. Thateng to B. Kafe. Irrigation and drainage development activities of the project are scheduled to implement as the future phase of the project. The project will be implemented by the middle of 1995. Future implementation program of the project is not fixed yet at present.

(2) Swedish International Development Agency (SIDA) projects

Activities of SIDA are also found out at the 2 existing irrigation project sites of the Study area, Thongvay irrigation project of Pakxong District and B. Len irrigation project of Laongam District. Main purpose of SIDA projects is to provide agriculture infrastructures in order to decrease slash and burn cultivation and to prevent deforestation.

In case of the Thongvay project, rehabilitation work of existing irrigation facilities are being carried out to provide stable water supply to paddy field of about 100 ha. Water resources of the project is Xe Katam. B. Len project has small weir, main canal and farm ponds cum inland fishery ponds. Irrigation area is about 150 ha in rainy season and about 20 ha in dry season. Water resources of the project are some springs which are located near the B. Len. Upland crops such as vegetables, soybeans, ground nut, etc. and paddy are planted in the irrigation area at present..

(3) Lao - IRRI research and training project

The project has been implemented since 1990 in order to make research development and support of paddy and carry out training in Lao. The project is monitored by IRRI, and financed by SDC. The implementation of project is extended by 1996. Main activities of the project is not found out in the Study area. However, Phone Ngnam Centre is established for research works of lowland rice in Champasak Province.

1.3 Design and Implementation of Existing Irrigation and Drainage Projects

1.3.1 Design Standards

The design standards of plan and design for irrigation and drainage development are not authorized by the Lao PDR at present, and the specified design standards are adopted at project by project. Therefore, estimation method of irrigation water requirements for crops is not authorized by the Lao PDR. FAO's estimate method of irrigation water requirement is generally adopted at the majority of irrigation development projects in Lao. PDR.

In accordance with information of the Department of Irrigation, Provincial Agriculture and Forestry Service, irrigation water requirement of paddy in dry season is generally estimated at 2.0 lit./sec/ha and applied to the plan and design of irrigation development in the Champasak Province area. Water requirements of other upland crops in the 3 provincial areas are not studied by the Department of Irrigation at the present.

1.3.2 Construction Materials and Equipment

(1) Construction Materials

Except for local construction materials, a majority of construction materials are imported from Thailand and Vietnam. In the 3 province areas, main market of construction materials is Pakxe, and the materials are delivered to main towns of the provinces and construction sites from Pakxe. Quantity balance of construction materials is unstable at Pakxe market because of small stock capacities of market and much activities of construction projects in the 3 province areas.

Quality of construction materials are generally questionable to sustain some certain grade and / or the specified quality of the standards because of insufficient stock conditions at markets and sites and transportation methods.

(2) Construction Equipment

A majority numbers of heavy construction equipment are pooled by the state contractors. Release system of construction equipment to individual private contractors are also established and functioned.

1.3.3 Tenders and Contractors

Tender system for construction work of local irrigation development projects has been adopted since 1994 in the Champasak Province area. In accordance with the Vientiane CPC information note, No. 1103 / CPC dated Dec. 14, 1994, in case of the contract prices for construction works of more than 50 million Kip, the review and evaluation of project owner's

estimate before tender and the tender evaluation to be conducted by the committee after tender shall be made in the procedure of tender system.

Contractors in the 3 province areas are broadly divided into 2 groups such as the state contractors and private contractors. All private contractors are local contractors who don't have strongly financial and technical background. Two state contractors have field activities, and their financial and technical qualification are comparatively better than the private contractors.

1.4 Water Right and Water Charge

1.4.1 Water Low and Water Right

According to the information of Department of Irrigation, MAF, draft water law of the Lao PDR was prepared by the Department in October 1994, and being discussed in the Government at present. Therefore, the water rights for irrigation, hydro power station, domestic water supply, etc. are not found out clearly in the Boloven plateau. Only the traditional and/or chronological water uses are found out.

1.4.2 Water Users Association and Water Charge

Water users association and water charge system for existing irrigation projects are being established since 1994 as the initial stages, and the Local Governments' activities on the works are starting in line with the establishment of the water laws. In the Study area, primitive water users groups and their activities are found out in 2 existing irrigation projects, Nam Sai irrigation project of Thateng District, Sekong Province, and Ngang Kham irrigation projects of Bachiang District, Champasak Province.

Nam Sai project has irrigation area of about 150 ha which scattered in 3 villages, namely, B. Kapu, B. Houay Say and B. Nhong Nok. Water users groups of the 3 villages has taken their activities for irrigation since October 1994. Main activities of water users groups is maintenance work of canals. However, water charge collection is not carried out.

Gnang Kham irrigation project has water users group which was established in November 1994 under the guidance of District Agriculture and Forestry Service. The water users group is consisting of 30 family farmers, and their main activities is also maintenance work of canals. Collection of water charge is still discussed in the water users group. Technical guidance and some extension work of agriculture to water users groups are not carried out by the District Service as well as the Provincial Service.

2 PHYSICAL CONSTRAINTS FOR DEVELOPMENT

2.1 Irrigation and Drainage

2.1.1 Soils and Erosion

The areas of a shallow soils are widely expanded in Pakxong and Laongam zones, and the areas have many rock out-crops. The parent materials of the soils are sand stone, clay stone and basalt. The area are estimated at approximately 45 % of the Study area. Characteristics of the soils are much erosive against heavy rainfall in the slope areas, and high permeability and drainability.

2.1.2 Topographical Constraint for Off-taking of Irrigation Water

The majority of rivers and streams in the Study area have steep slopes and soil erosion of river banks are accelerated by floods. Moreover, a huge numbers of big stones and rocks and weathered rock layers are found out in the river bottoms and banks, and water falls and rapids of river flow are also found out at many places of rivers. Therefore, the deep valleys of the rivers give hard conditions of the off-taking water by gravity method.

2.1.3 Poor Co-ordination between Main Canals and On-Farm Development

In case of the majority of existing irrigation projects, the off-taking facilities and main canals are generally constructed by the Government, and construction works of on-farm facilities are entrusted to farmers groups without technically suitable guidance. Therefore, much water loss of irrigation are found out during water supply due to the poor co-ordination of canal system. Technical extension works of O & M are not found out in the field.

In planning of irrigation development, the Government offices concerned are not considered the detailed on-farm development plan, at present. More effective water supply system shall be considered in the planning stage, and more co-ordinated canal system shall be constructed under sufficiently technical supervision of the Government concerned.

2.2 Water Management and O & M Works

Water users groups are being established in the existing irrigation projects of the Study area since 1994, and their activities are concentrated into only maintenance works of canals without any technical guidance from provincial and district agriculture and forestry services. The water management for the projects seem not to establish yet and so far to function in the project areas at present. Main reason of these constraints is the shortage of human resources and insufficient extension activities of the Government offices concerned.

2.3 Land Use and Land Concessions

In the south-eastern part of the Study area, hydropower development projects at 2 rivers are being executed and will be executed within a few months under the supervision of MIH. In connection with these activities of the projects, the Local Government has already proposed the watershed conservation plans around both project areas to make a reinforcement of reforestation. The forest conservation area is estimated at approximately 80,000 ha.

Furthermore, in the Champasak Province area, land concessions to state company and private sector are accelerated for forest development, livestock and cash crop cultivation such as fruit trees, sugarcane and upland crops. However, land concessions are not found out in the 2 province areas of Sekong and Salavan Provinces. In accordance with the information of Champasak Provincial Agriculture and Forestry Service and CPC, the land concessions are approved in the 2 district areas of about 29,750 ha by the Central Government as of the year of 1995. Table IV-4 shows a summary of the land concessions in the Study area. The majority of the lands are located at central area of the Boloven Plateau near Pakxong village and the areas along the road No. 20 from Pakxe to Bachiang village. Social infrastructures such as main roads and electric power supply are generally established around the lands. Figure IV-2 shows the location of the land concessions in the Study area. At present, the further land concessions of about 6,200 ha are being claimed to the Central Government, but the Government's approval on these applications are not issued. Table IV-5. and Figure IV-3. show a summary of the land concessions and the location of the lands.

As shown in Figures IV-2 and V-3, much ambiguity of locations of the lands are found out. The Local Government recognised the ambiguity of locations but no activities for the solution of the ambiguity seem to be taken by the Government. The locations of land concessions near Pakxong village have much possibility of the water pollution by livestock business and the disturbance of water resources of the Boloven Plateau in future.

Furthermore, the land concessions in the southern part of Bachiang District area has much ambiguity of locations of the lands, and have hard conditions to establish future land use plan and water resources development plan at present.

2.4 Quality Control of Works

The quality control of construction works are not executed in the majority of irrigation development projects in the Study area, especially earth works and concrete works because of the shortage of human resources such as the qualified and sufficient numbers of project managers, engineers and technicians. The laboratories for soil and concrete tests and construction materials are not available in and around the Study area. Therefore, the majority of irrigation and drainage facilities seem not to have the sufficient durability as specified ordinarily. More higher quality control works of projects shall be need to avoid much loss of investment as soon as possible.

2.5 Construction Materials, Equipment and Labor

(1) Shortage of Labor

One of main constraints for implementation of the projects in Lao PDR is shortage of labor, technician, engineers and project managers. In the Study area, the same constraints are found out in the field and the offices concerned. Shortage of labor in the construction sites of the Study area are very severe to execute the works because of far distance to the site from villages and a few numbers of village people.

Furthermore, quality and quantity shortage of technician and engineers are also found out at the offices concerned of the Study area. At present, mechanical construction method is adopted at a majority of construction sites of the Study area to cope with the labor shortage problems.

(2) Shortage of Construction Materials

Pakxe market has unstable balance conditions of construction materials at present, because a majority of construction materials are mainly imported from Thailand, and activities of big hydropower development project affect the stock conditions of materials at the market.

(3) Transportation Cost

At present, transportation costs of construction materials are being monitored by the local Government through the issuance of information note on new prices of construction for irrigation project in the Champasak Province. The information note is issued in November 1994. The recommended transportation costs are estimated by using some steps - percentages of the shop prices for materials based on the district areas. However, the actual transportation cost is still accounted from market area to project sites based on the ton-km system.

3 BASIC CONCEPT OF IRRIGATION AND DRAINAGE DEVELOPMENT

3.1 Co-ordination of National and Regional Irrigation Development Program

The agriculture development policies of third 5-year economic development plan (1996-2000) are (i) the decrease of the slash and burn cultivation and (ii) the increase of rice production through the increase of yield of paddy and the enlargement paddy fields through irrigation and drainage development. The Loa PDR will intend to implement many irrigation and drainage development programs which are fit the national economic development programs. In the plan, the irrigation areas to be developed in the 3 provincial areas of Salavan, Sekong and Champasak are only 6,000 ha in rainy season and 400 ha in dry season.

Through the implementation of the projects, it shall be clear to develop the irrigation and drainage areas of more than the national target areas, and it shall contribute the national and regional irrigation development programs. Furthermore, in the line with the excellent co-ordination of the other irrigation and drainage development programs in the Study area, the crop diversification program in upland crops fields shall be established for the up-grading of living standards of village peoples and for the decrease of the slash and burn cultivation

3.2 Rehabilitation Plan of Existing Irrigation and Drainage Projects

In the Study area, 15 existing irrigation projects are found out, and the present status of projects and conditions of irrigation and drainage facilities are confirmed. The majority numbers of the existing projects are newly accomplished projects before a few years from 1992 to 1994. Project facilities are maintained well. Old projects which were accomplished in the beginning of 1980's are 4 projects, namely, B. Ving Kham, B. Phao Gnai and B. Soung in Salavan Province and Houay Set in Champasak Province. Maintenance conditions of project facilities are not appreciated well, and rehabilitation works of project facilities are necessary.

The existing projects of 3 sites in Salavan Province have small irrigation areas ranging from 50 ha to 150 ha and the water resources of respective irrigation projects are small tributaries of Houay Laka river and the return flow water of upper irrigation areas. And, the 3 projects can be involved into the future development plan of Lower Nam Sai IARDP. Therefore, the rehabilitation plan of the 3 project facilities will be involved in the future development plan.

The other old project, Houay Set p project in Champasak Province is not involved in any proposed IARDP area, but has a trouble on water use and absorption of Xe Set river with Xe Set hydropower station at present. The water allocation problem of Xe Set river are still being discussed in the CPC of Champasak. Therefore, in this study, rehabilitation plans of the Houay Set projects is not considered.

3.3 New Development Projects

3.3.1 Co-ordination of Land Use and Agriculture Development Plans

The future land use consisting of water shed conservation areas, bio-diversify conservation areas, soil erosion conservation areas, forest development areas, livestock development areas and arable land of agriculture are examined in the Study area, and the necessity of the irrigation and drainage development are pointed out in certain areas in view of agriculture development. In order to clarify the potential of irrigation development, water balance study are made based on the estimated water resources.

3.3.2 Executing Organization of Projects and O & M Works

Executing body of the projects will be Development Committee which consists of Ministry of Agriculture and Forestry, Governors, cabinets and agriculture and forestry services of the 3 provinces. The Development Committee will implement construction of facilities, operation and maintenance works and agriculture extension works after construction works.

3.3.3 Proposed Irrigation Methods and Future Extension Works

Furrow irrigation methods will be applied for upland crops, and flood irrigation method, for paddy, taking into consideration the cheaper initial investment and the easy maintenance works. As for irrigation method for coffee, fruits and multi-purpose spices trees, pond and basin irrigation method will be adopted at the on-farm level by conveying irrigation water through small farm ditches. Irrigation water for coffee and fruits trees and upland crops will be supplied with an interval of a few days, and in case of paddy, irrigation will be carried out for 24 hours.

For implementing successful extension works in near future, research and demonstration stations of vegetable, upland crops, fruits trees including coffee trees and multi-purposes spices trees, inland fishery and livestock will be established in the Study area. More technical irrigation systems such as sprinkler and drip irrigation systems are not planned in the fields of the Study area at present, but the trials and research works of technical irrigation methods will be involved into the implementation programs of the research and demonstration stations to evaluate the effectiveness of the irrigation methods and to monitor the practices of O & M works in the each station areas.

3.3.4 Supplementary Irrigation for Wet Season Paddy and Upland Crops

In accordance with the hydrological data in the Study area, annual rainfall will range from 2,400 mm in the lower land area and 3,600 mm in the higher mountain area. Rainfall of more than 90 % will be in the wet season, and rainfall in December to February will not be expected, therefore the effectiveness of rainfall for dry season crops is will not be expected well, and the similar amount of irrigation water requirement will need at any probability of drought years. In the transition period from dry season to rainy season, the existing agriculture land of coffee, fruit tree, upland crops, upland rice, etc. have been severely dried up due to the unstable rainfall conditions.

Therefore, supplemental irrigation development is made to sustain the stable growth of wet season paddy and upland crops, and as for irrigation to perennial crops such as coffee, fruit and multi-purpose spices trees, irrigation development in the most critical growth seasons which are the flowering stage for the coffee trees and nursery stages for multi-purpose spices trees, will be made.

3.3.5 Soil Conservation Plan of Irrigation and Drainage Development

Since the proposed development areas for cultivation of upland crops, vegetable and coffee trees have a rather steep gradient ranging from 1/20 to 1/10 and are covered by erosive top soils such as basaltic weathered soils, sandy, silt soils, etc.. Much soil erosion will be considered during rainy season. In order to cope with soil erosion in the field, soil conservation plan at the on-farm including irrigation and drainage canals system will need. The conservation

plan will be made to expect the natural change in the grading of farm plots through natural mechanization of soil erosion.

As the farming technology of coffee, fruit and multi-purpose spices trees, the small semi-circle bunds will be established at lower slop sides of the planted trees, and farm bunds will be provided with a certain intervals in the each farm plot. Farm ditches to supply irrigation water will be laid out to connect the small semi-circle bunds mentioned above in parallel direction with topographical contour lines. Moreover, protection bund combined with the function of farm roads will be laid out with an interval of approximately 100 m in parallel direction with topographical contour lines. The farm bunds and protection bunds have the filter sections which control and convey the exceeded rain water in the farm plots through the gravel and stone filters to the next farm plots. The tertiary drains have the filter sections which are laid across a protection bunds, and the excess rain water and the eroded soils will be controlled at the filter sections.

4 DEVELOPMENT PLAN

4.1 Irrigation Water Requirement

(1) Potential evapo-transpiration

Potential evapo-transpiration (ETo) in the Study area are estimated by the modified Penman method using monthly meteorological data of 3 stations namely, Pakxong, Pakxe and Salavan. The ETo are estimated as follows.

(Unit : mm/day)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Pakxong Station											
4.1	5.3	5.5	5.8	4.9	4.2	4.0	3.8	3.9	4.4	5.1	4.7
Pakxe Station											
6.2	7.4	8.2	8.3	7.1	4.8	4.6	4.3	4.5	4.8	5.8	5.9
Salavan Station											
4.7	6.5	7.1	6.9	6.4	4.7	4.7	4.1	4.7	5.1	5.4	4.9

(2) Crop coefficient

The proposed cropping patterns are proposed to fit the meteorological conditions based on the elevation of the Study area, such as low land areas, middle elevated areas and high land areas. Main crops in the proposed cropping patterns are rainy season and dry season paddy, upland crops such as soybeans, maize, etc., vegetables, fruit trees and coffee trees. Since the crop coefficient varies with kind of crops, planting season and period of crop growth, the crop coefficient of the proposed crops are made referring to " Crop Water Requirements, FAO Irrigation and Drainage Paper No.24 ". The estimated crop coefficient are shown in Table IV-6.

(3) Probable rainfall

For calculating the probable rainfall, the rainfall data of the 3 stations, namely Pakxong, Pakxe and Salavan, are adopted. The probable annual rainfall with a return period of 5 years are theoretically calculated, and the standard design year for the irrigation water requirements is determined as the hydrological year which has the nearest annual rainfall to the theoretical rainfall. The probable rainfall of the 3 stations are estimated as follows.

(Unit : mm/month)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Pakxong Station											
0	23	162	346	414	368	436	567	338	358	13	0
Pakxe Station											
0	0	1	15	61	296	340	559	336	149	9	0
Salavan Station											
0	12	10	65	236	458	244	377	74	287	7	0

(4) Effective rainfall

The effective rainfall is estimated on a monthly basis, based on " the monthly effective rainfall curve " developed by the Committee for Co-ordination of Investigation of the Lower Mekong Basin (the Mekong Committee), as shown in Figure IV-4.

(5) Puddling requirement and Percolation for paddy field

Since the field data of soils, soil moisture before and after puddling, percolation loss, etc. are not available, puddling requirement will be assumed at 180 mm / time referring to the similar irrigation and drainage development projects in Lao PDR.

(6) Nursery requirement

Nursery bed will be assumed at 1/40 of paddy field, and the nursery requirement covers preparation of nursery bed, evapo-transpiration and percolation. Water for preparation of nursery bed is assumed the same water amount of puddling requirement, and evapo-transpiration and percolation will be assumed at 5 mm /day and 3 mm / day respectively.

Therefore, the nursery requirement is estimated below.

(i)	Preparation of nursery bed	180 mm
(ii)	Evapo-transpiration	300 mm
(iii)	Percolation	180 mm
	Total	660 mm

Nursery Requirement 660 mm / 40 = 17 mm / time

(7) Overall irrigation efficiency

Overall irrigation efficiency consists of conveyance and application efficiencies. Conveyance efficiency will be assumed at 85 % because of canal lining of main and secondary canal, and application efficiency are assumed at 70 % for paddy field and 60 % for upland crops field. Overall irrigation efficiencies are assumed at 60 % for paddy field and 51 % for upland crops field.

(8) Seasonal irrigation water requirements

Tables IV-7 to V-10 show the seasonal irrigation water requirements in each the areas, based on the proposed cropping patterns. Seasonal irrigation requirements for each the proposed cropping pattern are summarized below.

(Unit : mm/month)

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Total

Pakxong Area												
Cropping Pattern A												
289	339	210	0	0	0	0	0	0	0	5	11	919
Cropping Pattern B												
173	228	74	0	0	0	0	0	0	0	11	102	588
Cropping Pattern C												
107	194	62	0	0	0	0	0	0	0	60	38	460
Coffee												
172	175	39	0	0	0	0	0	0	0	192	194	771
Laongam Area												
Cropping Pattern A												
268	429	568	386	43	0	0	0	0	174	183	112	2,162
Cropping Pattern B1												
200	313	362	177	15	0	0	0	0	38	23	86	1,215
Cropping Pattern B2												
200	313	362	177	15	0	0	0	0	174	194	106	1,543
Cropping Pattern C												
121	278	364	296	138	0	0	0	0	62	65	40	1,363
Coffee												
195	243	294	234	169	0	0	0	0	16	208	202	1,561
Salavan Area												
Cropping Pattern A												
268	412	554	316	0	0	0	0	264	50	186	113	2,163
Cropping Pattern B												
218	321	350	37	0	0	17	0	264	50	197	92	1,546
Cropping Pattern C												
121	263	351	230	4	0	0	0	129	0	65	40	1,203
Coffee												
195	229	283	176	0	0	0	0	83	0	210	203	1,378

4.2 Water Balance of H. Lamphan and H. Nam Sai Dam Plans

(1) H. Lamphan Dam Plan

The Lamphan dm is proposed to supply irrigation water for the Middle Lamphan IARDP area, and the proposed cropping pattern is double rice crops. For the estimation of the required storage capacity of reservoir, the reservoir operation are made based on the assumption mentioned below.

(a) Runoff

Mean monthly runoff of H. Lamphan river are estimated on the specific discharge as shown in Table IV-11, based on monthly rainfall for the 6 years from 1989 to 1994.

(b) Seasonal irrigation requirement

The seasonal irrigation water requirements are estimated by using the following assumptions of evapo-transpiration and effective rainfall.

i) Potential evapo-transpiration which are estimated by using mean monthly meteorological data at the Salavan station is adopted for the estimation of irrigation

water requirements because the radical change and ranges of meteorological conditions such as temperature, sun shin, humidity and wind velocity the will not be expected, and

ii) the effective rainfall for the same 6 years are estimated based on the mean monthly rainfall at the same station.

The seasonal irrigation water requirements are estimated as shown in Table IV-11.

(c) Water balance of Lamphan reservoir

The reservoir operation are calculated by the formula below.

$$(R - (L1 + L2 + M + D)) = C + SP$$

Where,

R	: Seasonal runoff	L1	: Evaporation loss
L2	: Seepage loss	M	: Maintenance flow
D	: Irrigation demand	C	: Reservoir capacity
SP	: Spill out discharge		

Evaporation and seepage losses from reservoir are assumed at 7 mm /day. The maintenance flow released from the dam are estimated as the nil, taking into consideration the current social condition and water use in the down stream from dam site. Based on these assumptions, the required reservoir capacity which can supply water to irrigation area with a dependability of 80 % is estimated at 42 MCM as shown in Table IV-11.

(2) H. Nam Sai Dam Plan

Nam Sai dam is planed at about 6 km upper stream from B. Thouay to supply irrigation water for the Lower Nam Sai IARDP, and the active capacity of reservoir is designed about 20 MCM, applying maximum water use for irrigation area of about 3,800 ha. Irrigation water requirement and water balance is made by the means of similar method.

4.3 Drainage Water Requirement

(1) Drainage water requirement of paddy field

The drainage requirement of paddy field is estimated to evacuate the surplus rain water for the drainage period of the 3 days by using the probable daily rainfall which has a dependability of 80 %. The probable daily rainfall are estimated at 4.7 lit. / sec / ha to 8.7 lit. / sec / ha, based on the each river basins.

(2) Drainage water requirement of upland field

The drainage requirement of upland crops field is estimated by using the rational method because the projects areas mainly range from 10 km2 to 50 km2. The runoff coefficient is assumed at 0.5, taking into consideration the proposed crops, crop farming system and soil conservation plan at on-farm. The drainage requirements are estimated at 7.1 lit / sec / ha. to 12.0 lit./ sec /ha at each the river basin.

4.4 Irrigation Development Potentials

4.4.1 Water Balance Study

Since the land capability evaluation and land use plan are made in view points from soils, topographical conditions including elevation, crop growth conditions / characteristics of crops and present land use aspects, the potential of irrigation development will be estimated to make the water balance study based on the land resources.

As for the water resources development in the Study area, the reservoirs of the 2 existing dams and the 4 proposed dams are found out. At present, the 2 dam reservoirs, namely Xe set reservoir and Lamphan reservoir, are can be involved for irrigation development program through the Study. The other 4 dam reservoirs have been scheduled to implement or being implemented for hydro-power development program, and can not be expected to involve for irrigation development. Therefore, the water resources development programs for irrigation are considered the 2 dam reservoirs, and the water of rivers and streams in the Study area.

In the water balance calculation, since water demand are mainly seasonal irrigation requirements, the domestic water demand are accounted to involve into the irrigation requirements because of small amount. The water balance are made in the critical period of seasonal irrigation requirements at each the river.

The Study area will be divided into the 3 block areas, taking into account the rainfall and runoff conditions. In Laongam and Salavan areas, critical conditions of irrigation water requirement are found out the 2 seasons such as the transition period between the dry and wet seasons and the wet season. The concept of supplementary irrigation for the wet season crops cultivation is adopted in the both areas. As the Pakxong area has comparatively much and sufficient rainfall for wet season crops cultivation, and the critical periods of seasonal irrigation requirements are found out during the transition period from dry season to wet season only. Therefore, water balance in the Pakxong area is made in the transition period of the seasons.

Laongam area	low land located with the elevation of less than 400 m and expanded from H. Champi river basin to H. Tapoung river basin
Salavan area	areas expanded from H. Tapoung river basin to H. Lamphan river basin
Pakxong area	higher land located with the elevation of more than 400 m and expanded from Champi river basin to H. Xe Pian river basin via Xe set river.

The conditions of water balance calculation are summarized below.

i) Water use of existing irrigation projects are estimated based on the proposed cropping pattern. Total irrigation areas of the 15 existing projects are estimated at about 1,600 ha, and assumed to have a double rice cultivation.

ii) The irrigation requirements in the potential areas are estimated under the following conditions of the altitude of topography and land use.

- Areas with the altitude of more than 1,000 m

  Present planted areas of coffee is sustained and considered not to extend. Farm lands of cropping pattern Type-C are extended. The other 2 cropping pattern Type-A and Type-B are not considered.

- Areas with the altitude of 600 m to 1,000 m

  Present planted areas of paddy and coffee are sustained, and extension of cropping pattern Type-B and Type-C are carried out. Extension of the planted areas for both the cropping patterns are even, 1.0 : 1.0.
- Areas with the altitude of 400 m to 600 m

  Present planted areas of coffee are sustained, and extension of cropping pattern Type-C areas are not considered. Extension of cropping pattern Type-A and Type-B are carried out. Extension of the planted areas for both the cropping patterns are assumed at even, 1.0 : 1.0.
- Areas with the altitude of less than 400 m

  Present planted areas of coffee are sustained, and extension of cropping pattern Type-C areas are not considered. Extension of cropping pattern Type-A and Type-B are carried out. Extension of the planted areas for both the cropping patterns are assumed to be 2.0 : 1.0.

iii) Return flows are estimated at 10 % of the irrigation water from the existing and proposed irrigation areas.

iv) Minimum maintenance flows of rivers and streams are estimated at 5 % of the runoff at the off-take sites.

Figure IV-5 shows the concept mentioned above.

4.4.2 Potential Areas of Irrigation Development

As a result of water balance calculation, the maximum irrigation areas which can be irrigated in view from the maximum water use during critical season of agriculture farming are estimated at 90,710 ha. The areas are also screened again based on the land capability and future land use plans, and the potential irrigation development areas are finally estimated.

The estimated potential areas for irrigation development are approximately 54,670 ha in the Study area excluding irrigation areas of 36,040 ha which irrigation water can be off-taken within the Study area, but the irrigation area are located outside of the Study area, and the potential irrigation area of 54,670 ha can be classified as summarized below by the types of cropping pattern and the topographical altitudes. Table IV-12 shows the estimated potential irrigation areas, and Figure IV-6 shows the locations of the potential areas.

The potential areas of 54,670 ha are summarized below.

Areas with the altitude of more than 1,000 m
- 1,970 ha for coffee
- 480 ha for Cropping pattern Type-C

Areas with the altitude of 600 m to 1,000 m
- 6,255 ha for coffee
- 2,090 ha for Cropping pattern Type-A
- 5,245 ha for Cropping pattern Type-B
- 2,530 ha for Cropping pattern Type-C

Areas with the altitude of 400 m to 600 m
- 3,160 ha for coffee
- 515 ha for Cropping pattern Type-A
- 800 ha for rainy season paddy
- 3,555 ha for Cropping pattern Type-B

Areas with the altitude of less than 400 m

7,635 ha for Cropping pattern Type-A
11,630 ha for rainy season paddy
8,805 ha for Cropping pattern Type-B

4.4.3 Potentials by Gravity Irrigation Method

The potential irrigation areas which water can be supplied by gravity irrigation method are estimated at 36,005 ha of 30 projects including the 15 existing projects. The detailed information are shown in Table IV-12. Irrigation water can be off taken by weir and intake gates at the rivers and streams and conveyed into the potential irrigation areas. The potential areas are summarized below.

Areas with the altitude of more than 1,000 m
1,700 ha for coffee
350 ha for Cropping pattern Type-C
Areas with the altitude of 600 m to 1,000 m
2,815 ha for coffee
140 ha for Cropping pattern Type-A
2,010 ha for Cropping pattern Type-B
1,160 ha for Cropping pattern Type-C
Areas with the altitude of 400 m to 600 m
2,700 ha for coffee
45 ha for Cropping pattern -A
800 ha for rainy season paddy
3,085 ha for Cropping pattern Type-B
Areas with the altitude of less than 400 m
3,025 ha for Cropping pattern Type-A
11,630 ha for rainy season paddy
6,545 ha for Cropping pattern Type-B

4.4.4 Potentials by Pump Irrigation Method

The potential irrigation areas except for the areas to be irrigated by gravity method are estimated at 18,665 ha as shown in Table IV-12. Recommendable irrigation method for the potential areas are pump irrigation because the erosion of river banks are deeply accelerated and it has the hard conditions to off-take irrigation water by gravity method. The potential areas to be irrigated by pumps are summarized below.

Areas with the altitude of more than 1,000 m
270 ha for coffee
130 ha for Cropping pattern Type-C
Areas with the altitude of 600 m to 1,000 m
3,440 ha for coffee
1,950 ha for Cropping pattern Type-A
3,235 ha for Cropping pattern Type-B
1,370 ha for Cropping pattern Type-C
Areas with the altitude of 400 m to 600 m
460 ha for coffee
470 ha for Cropping pattern Type-A
470 ha for Cropping pattern Type-B

Areas with the altitude of less than 400 m
4,610 ha for Cropping pattern Type-A
2,260 ha for Cropping pattern Type-B

4.4.5 Strategy of Development

The strategies of irrigation development are made to give the advantageous points at the cheaper investment, the easy maintenance works, the easy establishment of water users association and the easy water operation.

The potential areas consist of existing irrigation areas and the other areas to be newly developed. All the existing irrigation facilities which have been constructed by the Central and Local Governments are weirs and intake gates. Water is off taken at the rivers by gravity irrigation method. The irrigation systems have been already functioned, even, they have some constrains and subjects to operation, water management, maintenance of facilities, extension work and water users' association. The existing irrigation areas shall be considered to sustain the current implementation and to up-grade the agriculture extension works and support system, and only agriculture and extension development program will be discussed in the Study. Because the majority of the irrigation facilities are newly constructed and sustained the fine conditions.

In the new development areas, the 3 types of irrigation methods such as (i) gravity method, (ii) pump method and (iii) the combined method of gravity and pump can be considered. The higher advantageous method is the gravity irrigation method because of the cheaper investment and the easy maintenance works. The pump irrigation method is not recommendable at present, taking into account the present conditions of farmers' familiarity with irrigation, farmers' financial fundamental, O & M works of irrigation facilities, support system of irrigation development and technical extension works in the Study area, and it will take so much times to develop and extend the pump irrigation method.

Therefore, the strategies of irrigation development at the first stage is to sustain the current implementation of the existing projects and to up-grade the agriculture extension works and support system in the existing irrigation areas, and to make irrigation development in the new areas by the gravity irrigation method. After the first stage, the pump irrigation method and the combined method of gravity and pump will be extended in the new area.

4.4.6 Proposed Development Areas

The potential areas for irrigation are estimated through the water balance study, and total irrigation potential area are estimated at 54,670 ha consisting of the gravity irrigation areas of 36,005 ha and the pump irrigation areas of 18,665 ha. The gravity irrigation areas are expanded 30 sites in the Study area including the existing irrigation areas.

In the long term irrigation development program by the year of 2010, the implementation program of gravity irrigation development will be examined and discussed, taking into account the project scales such as total development areas, the technical grades of irrigation extension, farmers' familiarity with technical operation and the development stages of water users' association. Furthermore, the following 6 conditions are considered to select more advantageous projects of the gravity irrigation method :

(i) the easy access for water operation,

what the land owners (farmers) and water users association will be in and around the projects areas and they can have higher possibility to provide the access roads to project areas with the cheaper investment,

(ii) the positive activities of water users associations including the excellent maintenance activities,

what the higher and excellent co-ordination and corporation among the members of water users associations will be expected, and social co-ordination and corporation among the ethnic groups in the same project area will be highly desirable and

(iii) the easy approach of establishment for agriculture support system including the strengthening of farmers' financial fundamental

what the social co-ordination and corporation among the ethnic groups in the same project area will be highly desirable, and the activities of agriculture support system can be found out at present and expect further extension in future.

(iv) the advantageous locations as the pilot and demonstration projects

what the project areas are located near the center of regional areas and / or can be expected to become the representative situation of regional economy.

(v) the optimized scale of irrigation and drainage development projects as the small scale projects

what the area scales of the projects are appreciated to have the ranges from 500 ha to 2,000 ha , taking into consideration the areas of existing irrigation projects ranging 30 ha to 400 ha, scales of provincial budgets of O & M works and human resources such as engineers, technicians and extension workers.

(vi) sustaining implementation programs of the existing irrigation and drainage development projects

what the majority of the existing projects in the Study areas are newly constructed projects and the O & M works of the projects are also scheduled to carry out by the Local Government. It will be clear that the rehabilitation works of the projects are not necessary.

Table IV-13 shows the selection of more advantageous projects by using the 6 conditions mentioned above. Total potential areas of approximately 21,285 ha consisting of 16 sites can be proposed as more advantageous projects shown in Table IV-14. The proposed projects of 16 sites are illustrated in Figure IV-7.

4.4.7 Proposed Implementation Program

Implementation of irrigation and drainage development in the Study area will be scheduled based on the conditions below.

(i) It will take more than 15 years that implementation of overall irrigation and drainage development in the Study area are carried out.

(ii) Gravity irrigation projects will be given higher priority orders for the implementation because of easy O & M works and cheaper O & M costs.

(iii) It can be appreciated to carry out the implementation of all the gravity irrigation projects proposed in the Study for the 15 years by the year of 2010, but it will be so hard to implement all the gravity irrigation projects, taking into account the present budget conditions and the present availability and capabilities of human resources including agriculture extension workers. it could be recommended to

make a programs on the implementation of the selected 16 projects for the 15 years

(iv) The targets of project implementation for the 15 years are to implement a few demonstration projects of typical agriculture development in the Boloven Plateau in the initial stage of the implementation, to extend the effectiveness of the projects to the adjacent areas, and to extend the projects in the Study area in the line with the extension of the demonstration effectiveness.

(v) Moreover, the implementation of the research and demonstration stations will be carried out for the strengthening of the extension works, in the line with the implementation of a few demonstration projects of typical agriculture development.

Therefore, the implementation program will be proposed;

The gravity irrigation projects of 16 sites will be programmed to carry out for 15 years by the year of 2010, and the implementation of other gravity irrigation projects will be carried out after the 15 years, and those of pump irrigation projects are expected to implement in future. The implementation of the 16 projects will be stage wised into the 3 phases of each the 5 years by the year of 2010, and the priorities of implementation will be given to the most advantageous projects which can be expected much effectiveness of the agriculture extension and demonstration effects around the project areas.

As for the water resources development, the O & M for the existing water resources facilities such as dam, small reservoirs, farm ponds, tubewells and pumps shall be made a reinforcement and extended during the Phase I & II, and the new water resources development for irrigation such as the Middle Lamphan projects will start in the Phase III.

Implementation strategies of irrigation and drainage facilities and farm roads during the Phase I are to give the extension of O &M for the existing facilities and to start the development of new facilities, and the strengthening of O & M and development of new facilities will be carried out in the Phase II & III.

As for the water management, the targets of water management during the Phase I are the extension of water management technology in the existing project areas and the establishment of water users association. Those of Phase II & III are the strengthening of the extension on water management technology in the new project areas and strengthening of the activities of water users associations.

The proposed implementation programs are summarized below, and are illustrated in Figure IV-8.

Phase I (1996-2000)	5 projects such as Upper Champi, Upper Tapoung, Upper Kapheu, Lower Xe Set and Upper Tayun
Phase II (2001-2005)	5 projects such as Lower Xe Pian, Middle Tapoung, Lower Tapoung, Upper Thon and Upper Makchan
Phase III (2005-2010)	6 projects such as Lower Champi, Lower Namsai, Middle Lamphan, Middle Xe Katam, Middle Namtang and Lower Makchan-Gnai

5 DESIGN

5.1 Design Standards and Irrigation Methods

The concept of design for the proposed 16 irrigation development projects are made as follows:

(1) Design Standards

Since the authorized standards for plan and design in the Lao PDR are not confirmed yet, and it will be judged that the general conditions of topography, the area-scale of river basins and the gradients of rivers in the Study area are so similar to those in Japan, the standards of plan and design published by Ministry of Agriculture, Forestry and Fishery, Japan and the other equivalent standards will be adopted in this Study.

(2) Irrigation Method

The proposed irrigation method is gravity irrigation to off take irrigation water by weir and intake gates. Water supply is continued for 24 hours in paddy fields by flooding method and made with a rotation interval of 6 days in upland fields by furrow irrigation method. As for the water supply for coffee trees, small pond and basin irrigation method is adopted.

In case that the seasonal irrigation requirements of the wet season crops are not appeared, design irrigation discharges of the project areas are ordinarily estimated at the peak discharge of the seasonal irrigation requirement, based on the combination of the proposed cropping patterns for each the project area. In case that the seasonal irrigation requirements of wet season crops are found out, supplementary irrigation method for the wet season crops, especially, wet season paddy, the design irrigation discharge of the projects are estimated at the peak requirement in the wet season.

5.2 Canal Layout

The development of farm lands can be divided into the 3 types such as (i) paddy fields, (ii) upland crops fields including vegetables fields and (iii) lands of coffee, fruit trees and multi-purpose spices trees. The paddy fields shall be developed in the flat lands which have a topographical slope of less than 0.1 % , and the maximum slope for the upland crops fields and lands of coffee, fruit trees and multi-purpose spices trees can be 15 %. In the extension program of the land use, the severe examination on the topographical slopes shall be carried out, and the leveling work for paddy fields and the grading work for upland crops fields shall be decreased.

Main and secondary canals are designed as concrete lining canals to prevent much water loss, soil erosion and easy maintenance works. The majority sections of the canals are laid out along the existing roads, and made the straight out. In case of upland crops fields, farm ponds are provided at the head of tertiary canals to make the easy water operation for irrigation rotation at the on-farm. Tertiary block is designed to range 30 ha to 60 ha, and the average length of tertiary canals are designed to range 500 m to 700m.

5.3 Headwork and Intake Facilities

Headwork is designed as concrete weir of gravity type, and design floods of weirs are probable flood with a return period of 100 years. Over flow depth of design water is designed

to range 0.6 m to 2.8 m. Weirs are designed to be broad crest type, and the one (1) side or both sides of the off-take methods are designed for irrigation water. Intake gates are designed to have the steel screens to off take the surface water and to prevent the inflow of river bed loads, and the settling basins are designed at head race canals.

Aprons are designed at up stream and down stream from weirs, and gabion protections are designed to sustain the smooth hydraulic condition at the transition sections from weir to river courses.

5.4 Dam and Reservoir

In the water resources development of the 16 project sites, only 2 new dams and reservoirs, namely, Lamphan dam and Nam Sai dam. Furthermore, the released water from existing dam, namely Xe Set dam and reservoir is concerned.

Detailed technical and engineering information on topography and geology are not available for both dams. The Lanphan dam is designed as rock fill zone type, and dam height of 32 m and dam length of 250 m are assumed. Reservoir capacity is estimated at total capacity of 50 MCM consisting of the active capacity of 42 MCM and dead capacity of 18 MCM.

The Nam Sai dam is planed to provide in the upstream of about 6 km from B. Thouay, and active capacity of dam is assumed about 20 MCM with a dam height of about 8 m. Detailed topographical and geological surveys are need in future in order to make and confirm more technical soundness of plan and design for dam and reservoir.

On the other hand, the Xe Set dam and reservoir are existing facilities, and functioned as hydropower project at present. Taking into consideration the current operation of hydropower station, the reservoir capacity is not so large and the runoff at the reservoir are estimated at about 2 m^3/ sec in dry season. Therefore, the irrigation development plan is to use the tail water released from the Xe Set hydropower station for irrigation in the lower reaches of the dam by construction of regulation ponds. The operation hours of releasing water from power station is estimated at about 3 hours / day in dry season, and the minimum released discharge from hydropower station is estimated at 147,000 m3 / day in drought year with a reliability of 80 %. The regulation pond is designed to have the storage capacity of 130,000 m3.

5.5 On-Farm System

In paddy field, one (1) tertiary irrigation block is designed to range from 30 ha to 60 ha, tertiary irrigation canal and drainage canals are provided. Inspection roads cum farm roads are deigned along tertiary canals and drains. Quaternary canal and drains are laid out to cover one (1) quaternary irrigation block ranging from 5 ha to 10 ha, and a farm road is provided between quaternary canal and drain. Turnout boxes are designed at the head of tertiary irrigation canals, and division boxes are provided at quaternary irrigation canals with an interval of about 100 m to supply water to a farm plot.

In upland crops field, one (1) tertiary block is designed to be 30 ha to 60 ha, and a farm pond is provided at head of tertiary canal for the easy regulation of rotation of irrigation water. Farm ditches are designed to branch at any sections of quaternary canals and to have a parallel direction with to the topographical contour lines.

The soil conservation plan are involved on farm development system. Semi circle bunds are designed at lower side from the planted trees for pond irrigation, and the on-farm bunds for

alley cultivation of upland crops are designed. Furthermore, the protection bund against the soil erosion are laid out with an interval of about 100 m. The protection bunds have some gravel filter sections to flow out the excess rain water from farm plots to farm plots. The same gravel filter sections are also provided at crossing point with quaternary drains for the prevention of soil erosion along the drains.

5.6 Drainage Canal System

Drainage canals are designed to use the natural depression areas, rivers and streams, and tertiary drains are designed to catch the excess rain water in the tertiary blocks, and to joint with secondary and / or main drains.

5.7 Inspection and Farm Roads

Inspection road are designed to provide along main and secondary canals, and the inspection roads are also designed to have a function of farm roads. Inspection roads of tertiary canals are also designed to have a double functions for inspection and farm roads. Transportation loads are assumed 4 ton trucks, taking into account the present road conditions. The other type of farm roads are designed to provide along quaternary canals and drain for transportation of farming input and output.

6 PROPOSED DEVELOPMENT AREAS

6.1 Salient Features of Proposed Development Areas

The salient features of the 16 projects are summarized below.

i) Upper Champi Project

Location	Pakxong District, Champasak Province
Altitude	900.m to 1,200.m
Water resources	H. Champi
Proposed cropping pattern and	Coffee 725 ha
Irrigation area (net)	Type-C 5 ha
Type and dimension of weir	Broad crest type H 1. m x W 20.m
Number of intake gates	1. no.
Design discharge	0.53 m^3 / sec
Irrigation canals	26.6 km
Drainage canals	13.4 km
Farm ponds	31. nos.
Farm roads	30.1 km

ii) Upper Tapoung Project

Location	Pakxong District, Champasak Province
Altitude	900.m to 1,300.m
Water resources	H. Tapoung
Proposed cropping pattern and	Type-C 50 ha
Irrigation area (net)	
Type and dimension of weir	Broad crest type H 1.m x W 20.m
Number of intake gates	2. nos.
Design discharge	0.04 m^3 / sec
Irrigation canals	4.3 km

	Drainage canals	2.4 km
	Farm ponds	4. nos.
	Farm roads	5.3 km

iii) Lower Xe Pian Project

Location	Pakxong District, Champasak Province
Altitude	900.m to 1,100.m
Water resources	Xe Pian
Proposed cropping pattern and	Coffee 650 ha
Irrigation area (net)	Type-C 100 ha
Type and dimension of weir	Broad crest type H 1.m x W 50.m
Number of intake gates	1. no.
Design discharge	0.54. m^3 / sec
Irrigation canals	18.5 km
Drainage canals	12.1 km
Farm ponds	10. nos.
Farm roads	19.4 km

iv) Upper Makchan Project

Location	Pakxong District, Champasak Province
Altitude	900.m to 1,200.m
Water resources	H. Makchan
Proposed cropping pattern and	Coffee 370 ha
Irrigation area (net)	Type-C 100. ha
Type and dimension of weir	Broad crest type H 1.m x W 30.m
Number of intake gates	2. nos.
Design discharge	0.35 m^3 / sec
Irrigation canals	19.7 km
Drainage canals	11.7 km
Farm ponds	28. nos.
Farm roads	19.9 km

v) Middle Xe Katam Project

Location	Pakxong District, Champasak Province
Altitude	850.m to 900.m
Water resources	Xe Katam
Proposed cropping pattern and	Type-A 140. ha
Irrigation area (net)	Type-B 480. ha
Type and dimension of weir	Broad crest type H 1.5.m x W 40.m
Number of intake gates	1. no.
Design discharge	0.87 m^3 / sec
Irrigation canals	13.7 km
Drainage canals	6.7 km
Farm roads	13.7 km

vi) Middle Namtang Project

Location	Pakxong District, Champasak Province
Altitude	800.m to 900.m
Water resources	H. Namtang
Proposed cropping pattern and	Coffee 145. ha
Irrigation area (net)	Type-B 120. ha
Type and dimension of weir	Broad crest type H 1.5 m x W 40.m
Number of intake gates	2. nos.
Design discharge	0.25 m^3 / sec

Irrigation canals	9.8. km
Drainage canals	1.1 km
Farm ponds	6. nos.
Farm roads	9.8 km

vii) Lower Makchan Gnai Project

Location	Pakxong District, Champasak Province
Altitude	800.m to 900.m
Water resources	H. Makchang Gnai
Proposed cropping pattern and	Coffee 260 ha
Irrigation area (net)	Type-B 80 ha
Type and dimension of weir	Broad crest type H 1.m x W 30.m
Number of intake gates	2. nos.
Design discharge	0.32 m^3 / sec
Irrigation canals	9.6 km
Drainage canals	2.7 km
Farm ponds	6. nos.
Farm roads	9.6 km

viii) Lower Champi Project

Location	Bachiang District, Champasak Province
Altitude	100.m to 200.m
Water resources	H. Champi
Proposed cropping pattern and	Type-B.2 2,600 ha
Irrigation area (net)	
Type and dimension of weir	Broad crest type H 2.m x W 40.m
Number of intake gates	1. no.
Design discharge	3.52 m^3 / sec of supplementary irr.
Irrigation canals	62.9 km
Drainage canals	25.5 km
Farm ponds	59. nos.
Farm roads	65.1 km

ix) Upper Kapheu Project

Location	Laongam District, Salavan Province
Altitude	600.m to 800.m
Water resources	H. Kapheu
Proposed cropping pattern and	Coffee 860. ha
Irrigation area (net)	Type-B.1 140. ha
Type and dimension of weir	Broad crest type H 1.m x W 15.m
Number of intake gates	1. no.
Design discharge	1.32 m^3 / sec of supplementary irr.
Irrigation canals	27.0 km
Drainage canals	22.4 km
Farm ponds	24. nos.
Farm roads	27.1 km

x) Middle Tapoung Project

Location	Laongam District, Salavan Province
Altitude	700.m to 1,000.m
Water resources	H. Tapoung
Proposed cropping pattern and	Coffee 370. ha
Irrigation area (net)	Type-B 80. ha
Type and dimension of weir	Broad crest type H 1.m x W 40.m

	Number of intake gates	2. nos.
	Design discharge	0.49 m^3 / sec
	Irrigation canals	13.1 km
	Drainage canals	6.8 km
	Farm ponds	13. nos.
	Farm roads	13.1 km
xi)	Lower Tapoung Project	
	Location	Laongam District, Salavan Province
	Altitude	300.m to 600.m
	Water resources	H. Tapoung
	Proposed cropping pattern and	Type-B.1 2,800 ha
	Irrigation area (net)	Type-B.2 1,700. ha
	Type and dimension of weir	Broad crest type H 2.m x W 40.m
	Number of intake gates	2. nos.
	Design discharge	5.4. m^3 / sec of supplementary irr.
	Irrigation canals	114.2 km
	Drainage canals	80.7 km
	Farm ponds	95. nos.
	Farm roads	118.8 km
xii)	Lower Xe Set Project	
	Location	Salavan District, Salavan Province
	Altitude	300.m to 400.m
	Water resources	Xe Set
	Proposed cropping pattern and	Type-B 1,800 ha
	Irrigation area (net)	
	Type and dimension of weir	Broad crest type H 1.5.m x W 50.m
	Number of intake gates	1. no.
	Design discharge	2.39 m^3 / sec of supplementary irr.
	Regulation Pond	130,000. m^3
	Irrigation canals	47.6 km
	Drainage canals	42.5 km
	Farm ponds	45. nos.
	Farm roads	57.1 km
xiii)	Lower Namsai Project	
	Location	Salvan District, Salavan Province
	Altitude	100.m to 200.m
	Water resources	H.Namsai
	Proposed cropping pattern and	Type-A 1,500 ha
	Irrigation area (net)	Rainy Season Paddy 1,700 ha
		Type-B 640 ha
	Type and dimension of weir	Broad crest type H 2.5.m x W 50.m
	Number of intake gates	1. no.
	Design discharge	3.9 m^3 / sec of supplementary irr.
	Irrigation canals	100.0 km
	Drainage canals	60.0 km
	Farm ponds	45. nos.
	Farm roads	100.0 km
xiv)	Upper Thon Project	
	Location	Salavan District, Salavan Province

	Altitude	200.m to 300.m
	Water resources	H. Thon
	Proposed cropping pattern and	Rainy season paddy 400. ha
	Irrigation area (net)	Type-B 240. ha
	Type and dimension of weir	Broad crest type H 1.m x W 30.m
	Number of intake gates	1. no.
	Design discharge	0.40 m^3 / sec of supplementary irr.
	Irrigation canals	15.6 km
	Drainage canals	13.9 km
	Farm roads	18.1 km
xv)	Middle Lamphan Project	
	Location	Thateng District, Sekong Province
	Altitude	200.m to 400.m
	Water resources	H.Lamphan
	Proposed cropping pattern and	Type-A 2,000 ha
	Irrigation area (net)	Type-B 900.ha
	Type of dam and dimension	Rock fill dam H 32.m x W 250.m
	Reservoir Capacity	Active capacity 42 MCM
		Dead capacity 18 MCM
	Type of Emergency Spillway	Concrete shut type
	Dimension of spillway	W 46.m x L 330.m
	Type and dimension of weir	Broad crest type H 2.5.m x W 50.m
	Number of intake gates	1. no.
	Design discharge	6.0 m^3 / sec
	Irrigation canals	43.2 km
	Farm roads	41.1 km
xvi)	Upper Tayun Project	
	Location	Thateng District, Sekong Province
	Altitude	500.m to 600.m
	Water resources	H. Tayun
	Proposed cropping pattern and	Type-A 45.ha
	Irrigation area (net)	Type-B 240.ha
		Type-B 45 ha
	Type and dimension of weir	Broad crest type H 1.m x W 30.m
	Number of intake gates	1. no.
	Design discharge	0.4 m^3 / sec of supplementary irr.
	Irrigation canals	5.8 km
	Drainage canals	4.5 km
	Farm ponds	5. nos.
	Farm roads	5.8 km

6.2 Construction Costs of Proposed Development Areas

Construction costs are estimated at the price level of May 1995 taking into consideration the survey results on the costs of labor, construction materials and construction equipment, the current price estimation method, tender method, local contractors' work capacities. The construction costs are estimated with the conditions of the international competition bidding (ICB), and the following conditions and assumptions are given.

i) Local portions of costs are consisted of labor costs, material costs of timber, gravel, sand and stone, and foreign portions covers others.

ii) Construction materials are assumed to transport from Pakxe to the respective project sites, and the transportation costs are estimated broadly to divide into the 4 price steps in the areas by the areas.

iii) Working ratio and work capabilities are estimated, taking into the present conditions of cost estimation in the Study area and site conditions.

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 15 % of the direct construction costs.

vi) Overhead and profit of contractors are assumed 15 % of the construction costs including the physical contingency.

vii) Administration costs are assumed 5 % of the sum of construction costs and land acquisition costs.

viii) Engineering costs are assumed 10 % of the sum of construction cost and physical contingency.

ix) Exchange ratio is assumed as follows;

US $ 1.0 = Kip 730

The construction costs for 16 projects are estimated at US $ 242 millions. The costs for irrigation and drainage development is about US $ 191 million. The project costs are summarized below. The detailed information and estimated methods are described in Annex-IX.

	Projects	Construction Cost (US$ Million) Irrigation & Drainage	Rural Infrastructure	Total
i)	Upper Champi Project	7.94	4.84	12.78
ii)	Upper Tapoung Project	1.35	1.60	2.95
iii)	Lower Xe Pian Project	6.76	6.03	12.79
iv)	Upper Makchan Project	7.33	1.34	8.67
v)	Middle Xe Katam Project	6.64	1.59	8.24
vi)	Middle Namtang Project	2.95	4.68	7.63
vii)	Lower Makchan Gnai Project	4.01	0.93	4.94
viii)	Lower Champi Project	20.80	2.85	23.65
ix)	Upper Kapheu Project	7.95	2.01	12.02
x)	Middle Tapoung Project	4.89	1.83	6.72
xi)	Lower Tapoung Project	31.12	6.35	37.47
xii)	Lower Xe Set Project	15.94	3.09	19.03
xiii)	Lower Namsai Project	30.39	5.92	36.31
xiv)	Upper Thon Project	4.61	2.01	6.62
xv)	Middle Lamphan Project	36.10	2.27	38.36
xvi)	Upper Tayun Project	2.62	1.29	3.87
	TOTAL	191.38	50.66	242.04

Procurement costs of O & M equipment are estimated based on the work quantity of each the Phase as follows;

Phase I	US$ 1.24 million
Phase II	US$ 1.04million
Phase III	US$ 1.99 million

Replacement costs such as gates and accessories are assumed to occur with an interval of 25 years.

Tables

Table IV-1 Implementation Program of Irrigation Development and Flood Alleviation Projects in the 3 Province Areas and the Study Area (1/2)

(1996-2000)

No.	Descriptions	Province	Number of Proposed Projects	Irrigation Area (Ha) Rainy season	Irrigation Area (Ha) Dry season	Number of Proposed Projects in the Study Area	Irrigation Area (Ha) Rainy season	Irrigation Area (Ha) Dry season
I	SMALL SCALE IRRIGATION DEVELOPMENT PROJECTS							
	1 PLAN AND STUDY	Champasak	6	481	-	0	0	0
		Sekong	8	439	-	1	50	-
		Salavan	3	160	-	0	0	0
	SUBTOTAL			1,080			50	
	ALL PROVINCES			9,900			9,900	
	%			11%			1%	
	2 NEW CONSTRUCTION	Champasak	9	653	305	0	0	0
		Sekong	1	668	275	2	200	200
		Salavan	3	160	160	0	0	0
	SUBTOTAL			1,481	740		200	200
	ALL PROVINCES			10,502	2,795		10,502	2,795
	%			14%	26%		2%	7%
	3 REHABILITATION	Sekong	10	70	70	0	0	0
	SUBTOTAL			70	70		0	0
	ALL PROVINCES			653	241		653	241
	%			11%	29%		0%	0%
II	MEDIUM SCALE IRRIGATION PROJECTS							
	1 PLAN AND STUDY	Champasak	16	10,910	-	0	0	-
		Sekong	6	1,725	-	1	200	-
		Salavan	15	21,550	-	1	5,000	-
	SUBTOTAL			34,185			5,200	
	ALL PROVINCES			179,972			179,972	
	%			19%			3%	
	2 NEW CONSTRUCTION	Champasak	15	10,970	9,650	1	300	160
		Sekong	9	2,975	700	1	225	20
		Salavan	8	2,720	1,170	0	0	0
	SUBTOTAL			16,665	11,520		525	180

Table IV-1 Implementation Program of Irrigation Development and Flood Alleviation Projects in the 3 Province Areas and the Study Area (2/2)

ALL PROVINCES			76,419	40,952		76,419	40,952
%			22%	28%		1%	0%

No.	Descriptions	Province	Number of Proposed Projects	Irrigation Area (Ha) Rainy season	Irrigation Area (Ha) Dry season	Number of Proposed Projects in the Study Area	Irrigation Area (Ha) Rainy season	Irrigation Area (Ha) Dry season
3	REHABILITATION	Sekong	3	498	498	0	0	0
	SUBTOTAL			498	498		0	0
	ALL PROVINCES			6,175	3,128		6,175	3,128
	%			8%	16%		0%	0%
4	UNDER CONSTRUCTION	Champasak						
		Sekong	4	220	100	0	0	0
		Salavan	4	3,800	2,700	0	0	0
	SUBTOTAL			4,020	2,800		0	0
	ALL PROVINCES			8,485	5,409		8,485	5,409
	%			47%	52%		0%	0%
III	FLOOD ALLEVIATION PROJECTS							
1	PLAN AND STUDY	Salavan	2	2,000	-	0	0	0
	SUBTOTAL			2,000			0	0
	ALL PROVINCES			21,060			21,060	0
	%			9%			0%	0%
2	NEW CONSTRUCTION	Champasak	1	500	0	0	0	0
		Sekong	4	1,000	245	0	0	0
		Salavan	3	0	0	0	0	0
	SUBTOTAL			1,500	245		0	0
	ALL PROVINCES			7,910	300		0	0
	%			19%	82%		0%	0%
	TOTAL			61,499	15,873		5,975	380
	ALL PROVINCES			321,076	52,825		313,166	52,525
	%			19%	30%		2%	1%

Table IV-2 Existing Irrigation Projects in and around the Study Area (Champasak,Salavan and Sekong Provinces)

No.	No. of Locations	Project	Water Resources	Location: Village	Location: District	Method of off-take	Actual Irrigation Area (ha): Rainy Season	Actual Irrigation Area (ha): Crops	Actual Irrigation Area (ha): Dry Season	Actual Irrigation Area (ha): Crops	Construction Cost: Construction Year	Construction Cost: Kip Million	Construction Cost: US $ Thousand	Fund	Implementation Agency: Construction	Implementation Agency: O & M	Remarks
CHAMPASAK PROVINCE																	
1	1	Houay Set (Kong Toun)	Houay Set	Katoun	Paksong	Weir	50	Coffee trees	-	Coffee trees	1996	8.40	185.60	Province/District	Province	District	
2	2	Thong Houng	Thoang Houng	Nong Mek	Paksong	Weir	20	Paddy	20	Paddy	1993	34.50	49.40	Province	Province	District	
3	3	Thong Vay (Xe Katam)	Xe Katam	Xe Katam	Paksong	Weir	100	Paddy	48	Paddy	under const.	50.00		Province/SIDA	Province/District	-	Rehabilitation works of the old USAID
4	4	Houay Palay	Houay Palay	Thong kim	Bachiang	Weir	400	Paddy	150	Paddy	1992	723.50	1,039.30	Ministry/Province	Province	District	project
5	5	Houay Ngang (KM 12)	Houay Ngang	Chiengsai	Bachiang	Weir	70	Paddy	35	Paddy	1993	30.26	43.27	NGO	Province	Village	
		SUBTOTAL					640		253								
SALAVAN PROVINCE																	
1	6	Nong Deng	Xe Set	Boung Sai	Salavan	Weir	500	Paddy	70	Paddy	1987	274.6		Province	Province	Village	
2	7	Nakhoysoda	H. Khalong	Nakignoa	Salavan	Weir	170	Paddy	0	Paddy	1954						
3	8	Nasay Soung	Vangloth	Nasay	Laongam	Weir	50	Paddy	30	Paddy	1987	0.40					
4	9	Soutavadi	Xe Set	Soutavadi	Salavan	Weir	15	Paddy	10	Paddy	1990	4		Village	Village	Village	
5	10	Houng Soung	H. Soung	B. Soung	Salavan	Weir	119	Paddy	0	Paddy	1993	14.96		CAA/USAID	CAA/USAID	Village	
6	11	B. Vang Kham	H. Laha	B. Viang Kham	Salavan	Weir	30	Paddy	10	Paddy	1990	0.7		Village/USAID	Village/USAID	Village	
7	12	B.Len	H. Tounvan/Spring	B.Len	Laongam	Weir	70	Paddy	0	Paddy, Vegetable	1994	40		SIDA	Province	Village	
8	13	Dongmon	H.Tapoung	B. Dongmon	Laongam	Gates	250	Paddy	20	Paddy	1987	42.10		Gov./ Village	Gov.	Village	
9	14	B. Katene		B.Katene	Laongam	Weir	20	Paddy	5	Paddy	1995	4.67		Gov./ Village	Gov.	Village	
10	15	B. Lalay	H. Meung	B.Lalap	Salavan	Weir	50	Paddy	30	Paddy	1994	6.85		Gov./ Village	Gov.	Village	
11	16	B. La-Hang	Pa Luo	B. La-Hang	Laongam	Weir	30	Paddy	10	Paddy	1994	3.62		Gov./ Village	Gov.	Village	
12	17	B. A Vao	A.Vao	B. A Vao	Salavan	Weir	30	Paddy	10	Paddy	1994	3.62		Gov./ Village	Gov.	Village	
13	18	Nasay Gnay	Houa Poa	B. Nasay Gnay	Salavan	Weir	21	Paddy	21	Paddy		0.5		Village	Village	Village	
14	19	Nataun	Houa Poa	B. Nataun	Salavan	Weir	28	Paddy	0	Paddy		1.00		Village	Village	Village	
15	20	Dongko	H. Soung	B. Dongko	Salavan	Weir	10	Paddy	0	Paddy		0.30		Village	Village	Village	
16	21	Senvang Gnai	H. Lavang	B.Senvang Gnai	Laongam	Weir	5	Paddy	0	Paddy		0.50		Village	Village	Village	
17	22	Goung Khan	H. Lat	B.	Laongam	Weir	25	Paddy	0	Paddy		0.50		Village	Village	Village	
18	23	Keng Kubao	H. Leng	B. Leunbou	Laongam	Weir	15	Paddy	0	Paddy		0.30		Village	Village	Village	
19	24	Leun Leng	H. Leng	B. Leun Leng	Laongam	Weir	10	Paddy	0	Paddy		0.80		Village	Village	Village	
20	25	H. Pao	H. Pao	B. Houa Pao	Laongam	Weir	25	Paddy	0	Paddy		0.30		Village	Village	Village	
21	26	Khanuane	H. Khanuane	B. Khanuane	Laongam	Weir	45	Paddy	5	Paddy		0.50		Village	Village	Village	
22	27	Nkalone	H. Set	B. Nakalone	Laongam	Weir	40	Paddy	20	Paddy		0.50		Village	Village	Village	
23	28	Namy Neua	Tingking	B. Namy Neua	Salavan	Weir	35	Paddy	15	Paddy		0.40		Village	Village	Village	
24	29	Namy Tay	Cha Houa	B. Namy Tay	Laongam	Weir	30	Paddy	10	Paddy		0.40		Village	Village	Village	
		SUBTOTAL					1,623		266								
SEKONG PROVINCE																	
1	30	H. Dakang (I)	H.Dakang	Hoa Xe	Thateng	Weir	150	Paddy	6	Paddy	1993	15.00		Province	Province	Village	
2	31	B. Nong bok	H.Dakang	B. Nong Nok	Thateng	Weir	150	Paddy	30	Paddy	1992	13.10		Province	Province	Village	
3	32	Nam Sai	Nam Say	Nonglos, Kapu, Khamkok, Nong Nok	Thateng	Weir	86	Paddy/Coffee	0	Paddy/Coffee	1992	8.20		CAA (NGO)	District/Village	Village	
4	33	B.Loumra(B. Kub)	H. Thone	B.Loumra	Thateng	Weir	48	Paddy	0	Paddy	1993	28.70		Province	Province	Village	
5	34	B.Nonglao	H. Tanyun	B.Nonglao	Thateng	Weir	12	Paddy	0	Paddy	1994	7.30		Province	Province	Village	
6	35	H. Tapur	H. Tapur	B. Kafe	Thateng	Gate	12	Paddy	0	Paddy	1988			Village	Village	Village	
		SUBTOTAL					458		36								
		TOTAL					2,721		555								

Table IV-3 Irrigation Development Plans in and around the Study Area (Champasak,Salavan and Sekong Provinces)

No.	Project	Water Resources	Location		Method of off-take	Off-take discharge (m3/sec)	Resevior Capacity (1,000 m3)	Irrigation Area (ha)				Remarks
			Village	District				Rainy Season	Crops	Dry Season	Crops	
CHAMPASAK PROVINCE												
1	Xepian or Houayxang	Xepian	Xepian or Houayxang	Pakxong	Weir			???		???	Coffee	Being Planed by Provincial Office
2	KM 40	Houay Champi	KM 40	Pakxong	Weir ??			???		???	Coffee & Cabbage	Being Planed by Provincial Office
3	MaKchan	Houay Makchan	KM 15	Pakxong	Weir			???	Coffee	???	Coffee	Being Planed by Provincial Office
	SUBTOTAL											
SALAVAN PROVINCE												
1	Nam Sai Irrigation	H. Nam Sai	-	Salavan	Weir				Paddy		Paddy, Upland crop	Being Studied by Provincial Office
2	Senvang Noy	H. Thon	Senvang Noy / Beng	Salavan	Weir				Paddy		Paddy, Upland crop	Being Planed by Provincial Office
3	Sixiangmai	H.H.Kapheir	Sixiangmai / Phouak Noy	Laongam	Weir				Upland crop		Coffee / Upland crop	Plan by Viemame Expert
	SUBTOTAL											
SEKONG PROVINCE												
1	B. Caphe	H. Tapout	B. Caphe	Thateng				8	Paddy	-	-	Being Planed by District Office
2	B.Torlork	H. Pavangai	B.Torlork	Thateng				70	Paddy	-	-	Being Planed by District Office
3	B. Thong Yao	H. Lanphanh	B. Thong Yao	Thateng				225	Paddy	-	-	Being Planed by District Office
4	B. Don Xa	H. Par	B. Don Xa	Thateng				30	Paddy	-	-	Being Planed by District Office
5	B. Thong Kong	H. Thong Kong	B. Thong Kong	Thateng				15	Paddy	-	-	Being Planed by District Office
6	B. Thateng	H. Nanong	B. Thateng (Paleng)	Thateng				200	Paddy	-	-	Being Planed by District Office
7	B. Yokthong	H. Tit	B. Yokthong	Thateng				100	Paddy	-	-	Being Planed by District Office
8	B. Kalam	H. Don	B. Kalam	Thateng				50	Paddy	-	-	Being Planed by District Office
	SUBTOTAL											

Table IV-4 Land Concessions in the Study Area

No.	Company	Location District	Area (ha)	Land Use	Commencement
1	Patanahgasicam Company	Bachiang	1,500	Upland crops, Fruit trees	1993
				Forest development	
2	Asia Tech.	Bachiang	300	Sugarcane	1994
3	DAFI	Bachiang	1,500	Upland crops, Fruit trees	1991
			5,500	Forest development	1991
4	Mr. no.1	Bachiang	200	Upland crops, Forest development	1992
5	Mr. no.2	Bachiang	200	Upland crops, Forest development	1992
6	Mr. no.3	Bachiang	200	Upland crops, Forest development	1992
7	Mr. no.4	Bachiang	200	Upland crops	1992
8	Mr. no.5	Bachiang	200	Fruit trees	1992
9	Mr. no.6	Bachiang	700	Live stock, Fishery	1991
10	Mr. no.7	Bachiang	200	Upland crops, Forest development	1991
				Fishery	
11	Mr. no.8	Bachiang	400	Live stock	1991
	SUBTOTAL		11,100		
12	Asia Tech.	Pakxong	16,000	Forest development	1995
13	Mr. no.9	Pakxong	400	Live stock	1991
14	Mr. no.10	Pakxong	350	Live stock	1990
15	Mr. no.11	Pakxong	400	Live stock	1992
16	Mr. no.12	Pakxong	600	Live stock	1992
17	Mr. no.13	Pakxong	400	Live stock	1992
18	Mr. no.14	Pakxong	200	Live stock	1992
19	Mr. no.15	Pakxong	300	Live stock	1992
	SUBTOTAL		18,650		
	TOTAL		29,750		

Table IV-5 Application for Land Concessions in the Study Area

(The Government's approval are not issued as of April 1995)

No.	Company	Location			Area	Land Use	Remarks
		Village	District	Province	(Ha)		
1	Mr. no.1	Nong Poy	Pakxong	Champasak	1,000	Live stock	Application of land concession have
2	Mr. no.3	Kong Toon	Pakxong	Champasak	300	Live stock	Approval are not issued by April 1995
3	Mr. no.4	Makchane	Pakxong	Champasak	350	Live stock	
4	Mr. no.6	Phou Kok	Pakxong	Champasak	120	Live stock	
5	Mr. no.7	Daseua	Pakxong	Champasak	200	Live stock	
6	Mr. no.8	Being	Pakxong	Champasak	200	Live stock	
7	Mr. no.9	Keing Do	Pakxong	Champasak	800	Live stock	
8	Mr. no.10	Meug Phay	Pakxong	Champasak	300	Live stock	
9	Mr. no.12	Being	Pakxong	Champasak	300	Live stock	
10	Mr. no.14	Champi	Pakxong	Champasak	100	Live stock	
11	Mr. no.15	Phoukok	Pakxong	Champasak	600	Live stock	
12	Mr. no.16	Thong ka Long	Pakxong	Champasak	300	Live stock	
13	Mr. no.17	Km 20	Pakxong	Champasak	400	Live stock	
14	Mr. no.18	Hinlab	Pakxong	Champasak	300	Live stock	
15	Mr. no.20	Thong Chat	Pakxong	Champasak	400	Live stock	
16	Mr. no.23	Makchan	Pakxong	Champasak	200	Live stock	
	TOTAL				5,870		

Table IV-6 Crop Coefficient

CROP COEFFICIENT	Initial Stage	Middle Stage	Matured Stage	Harvest Stage
Paddy	0.9	1.1	1.3	1.0

Dry Season Paddy	1st month	2nd month	3rd month	4th month	5th month
120 days variety	1.0	1.2	1.1		
		1.0	1.2	1.1	
			1.0	1.2	1.1
	1.0	1.1	1.1	1.2	1.1

135 days variety	1st month	2nd month	3rd month	4th month	5th month	6th month
	1.0	1.2	1.2	1.0		
		1.0	1.2	1.2	1.0	
			1.0	1.2	1.2	1.0
	1.0	1.1	1.1	1.1	1.1	1.0

Wet Season Paddy	1st month	2nd month	3rd month	4th month	5th month	6th month
135 days variety	0.9	1.0	1.3	1.2		
		0.9	1.0	1.3	1.2	
			0.9	1.0	1.3	1.2
	0.9	1.0	1.1	1.1	1.2	1.2

150 days variety	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month
	0.9	1.0	1.3	1.2	1.0		
		0.9	1.0	1.3	1.2	1.0	
			0.9	1.0	1.3	1.2	1.0
	0.9	1.0	1.1	1.2	1.2	1.1	1.0

CROP COEFFICIENT	Initial Stage	Middle Stage	Matured Stage	Harvest Stage
Upland Crops (Maize & Soybean)	0.7	0.8	1.0	0.7
Vegetable	0.8	0.9	1.0	0.7

Upland crops in dry season	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month
	0.7	0.8	0.9	1.0	0.8		
		0.7	0.8	0.9	1.0	0.8	
			0.7	0.8	0.9	1.0	0.8
	0.7	0.7	0.8	0.9	0.9	0.9	0.8

Upland crops in wet season	1st month	2nd month	3rd month	4th month	5th month	6th month
	0.8	0.9	1.0	0.9		
		0.8	0.9	1.0	0.9	
			0.8	0.9	1.0	0.9
	0.8	0.8	0.9	0.9	0.9	0.9

Vegetable	1st month	2nd month	3rd month	4th month	5th month	6th month	7th month
	0.8	0.9	1.0	0.7			
		0.8	0.9	1.0	0.7		
			0.8	0.9	1.0	0.7	
				0.8	0.9	1.0	0.7
	0.8	0.9	0.9	0.9	0.9	0.9	0.7

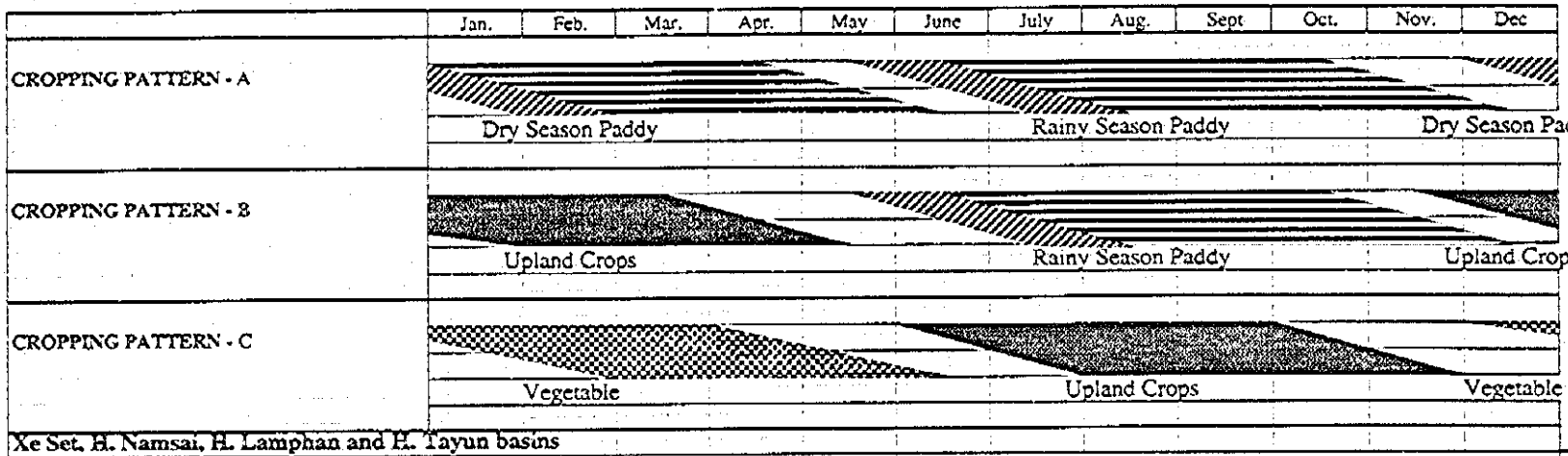
Table IV-7 Irrigation Water Requirement in Pakxong Area (1/2)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
CROPPING PATTERN - A	Dry Season Paddy						Rainy Season Paddy					Dry Season Paddy	
CROPPING PATTERN - B	Upland Crops						Rainy Season Paddy					Upland Crops	
CROPPING PATTERN - C	Vegetable						Upland Crops					Vegetable	
Makchan-gnai, Xe Pian (Upper site),and Tapoung basins													
Monthly Rainfall (1988)	0.0	22.9	161.5	346.3	414.1	368.0	436.4	566.6	338.3	358.2	13.2	0.0	3,026
Potential Evapo-transpiration (Pakxong)	128.0	150.0	170.0	174.0	152.0	126.0	124.0	116.0	117.0	135.0	154.0	144.0	1690.0
CROPPING PATTERN - A													
Dry Season Paddy													
Crop Coefficient (Kc)	1.00	1.10	1.10	1.15	1.10							0.00	
Crop Evapotranspiration (ETcrop)	128.0	165.0	187.0	200.1	167.2							0.0	847
Percolation	93.0	84.0	93.0	90.0	93.0							0.0	453
Effective Rainfall	0.0	19.5	137.3	230.0	289.0							0.0	676
Area Factor	0.25	0.75	0.94	0.50	0.06							0.0	
Puddring Water	108.0	36.0										36.0	180
Nursery Water	10.0											10.0	20
Net Irrigation Requirement	173	203	126	0	0							46	548
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.05	1.13	1.20	1.15		
Crop Evapo-transpiration (ETcrop)						113.4	117.8	121.8	132.6	162	177.1		825
Percolation						60	64	64	60	64	60		372
Effective Rainfall					289.9	257.6	305.5	396.6	236.8	250.7	11.2		1,748
Area Factor						0.06	0.5	0.94	0.94	0.5	0.06		
Puddring Water					11	79	79	11					180
Nursery Water					6	9	6						21
Net Irrigation Requirement					0	0	0	0	0	0	3		3
Irrigation Efficiency	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field													
Gross Irrigation Requirement (mm)	289	339	210	0	0	0	0	0	0	0	5	77	919
(lit/sec/ha)	1.08	1.40	0.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.29	

Table IV-7 Irrigation Water Requirement in Pakxong Area (2/2)

CROPPING PATTERN - B													
Upland Crops													
Crop Coefficient (Kc)		0.78	0.88	0.90	0.90	0.80						0.70	0.73	
Crop Evapo-transpiration (ETcrop)		100.3	132.5	153.0	156.6	121.6						107.8	104.4	876
Effective Rainfall		0.0	16.0	113.1	162.8	165.6						9.2	0.0	467
Area Factor		0.88	1.00	0.94	0.50	0.06						0.1	0.5	
Net Irrigation Requirement		88	116	38	0	0						6	52	300
Rainy Season Paddy														
Crop Coefficient (Kc)							0.90	0.95	1.05	1.13	1.20	1.15		
Crop Evapo-transpiration (ETcrop)							113.4	117.8	121.8	132.6	162	177.1		825
Percolation							60	64	64	60	64	60		372
Effective Rainfall						289.9	257.6	305.5	396.6	236.8	250.7	11.2		1,748
Area Factor							0.06	0.5	0.94	0.94	0.5	0.06		
Puddring Water						11	79	79	11					180
Nursery Water						6	9	6						21
Net Irrigation Requirement						0	0	0	0	0	0	3		3
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.51	
Conveyance Efficiency 85 %														
Application Efficiency 70 % of paddy field, 60 % of upland crops														
Gross Irrigation Requirement	(mm)	173	228	74	0	0	0	0	0	0	0	11	102	588
	(lit/sec/ha)	0.65	0.94	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.38	
CROPPING PATTERN - C														
Vegetable														
Crop Coefficient (Kc)		0.85	0.90	0.85	0.87	0.85	0.70						0.80	
Crop Evapo-transpiration (ETcrop)		108.8	135.0	144.5	150.8	129.2	88.2						115.2	872
Effective Rainfall		0.0	16.0	113.1	162.8	165.6	158.2						0.0	616
Area Factor		0.50	0.83	1.00	0.83	0.50	0.17						0.17	
Net Irrigation Requirement		54	99	31	0	0	0						20	204
Upland Crops														
Crop Coefficient (Kc)							0.75	0.83	0.88	0.92	0.93	0.9		
Crop Evapo-transpiration (ETcrop)							94.5	102.3	102.5	107.3	124.9	130.9		662
Effective Rainfall							173.0	205.1	266.3	159.0	168.4	9.2		981
Area Factor							0.25	0.75	1.00	1.00	0.75	0.25		
Net Irrigation Requirement							0	0	0	0	0	30		30
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	
Conveyance Efficiency 85 %														
Application Efficiency 60 % of upland crops														
Gross Irrigation Requirement	(mm)	107	194	62	0	0	0	0	0	0	0	60	38	460
	(lit/sec/ha)	0.40	0.80	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.14	

Table IV-8 Irrigation Water Requirement in Salavan Area (1/2)

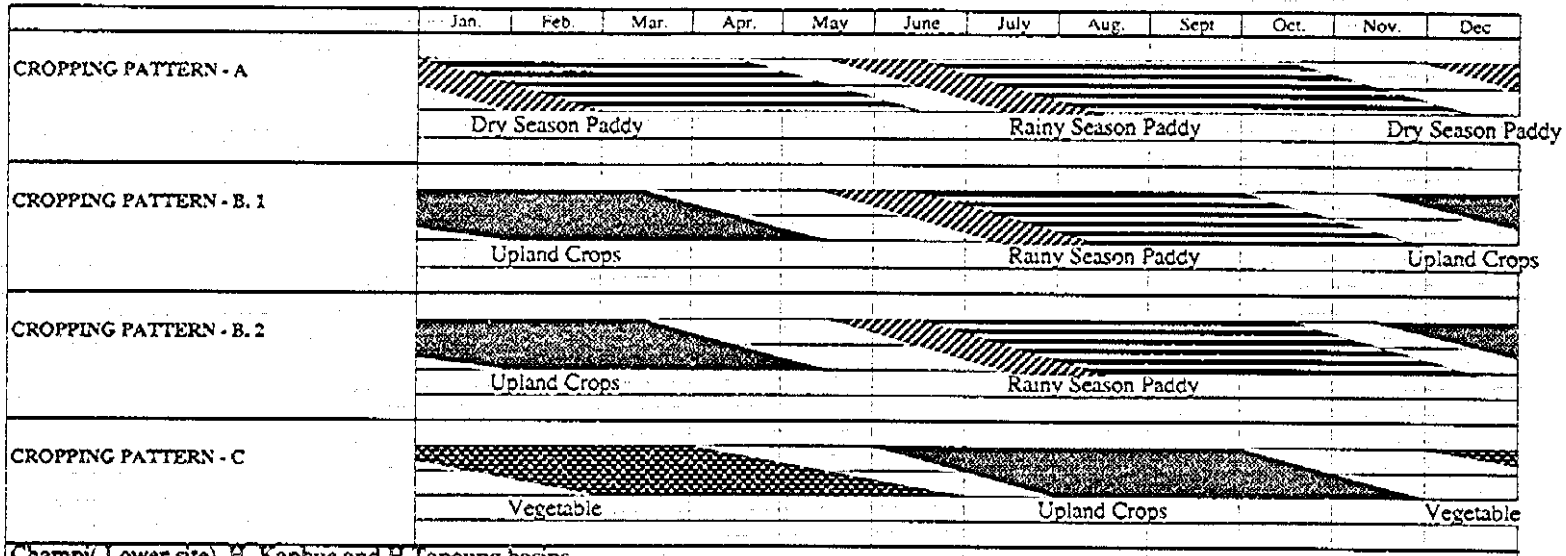


	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
Xe Set, H. Namsai, H. Lamphan and H. Tayun basins													
Monthly Rainfall (Salavan 1988)	0.0	12.1	10.1	64.6	236.3	457.9	244.0	376.8	73.6	286.8	6.6	0.0	1,769
Potential Evapo-transpiration (Salavan)	145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1979.0
CROPPING PATTERN - A													
Dry Season Paddy													
Crop Coefficient (Kc)	1.00	1.10	1.13	1.13	1.10	1.00						0.00	
Crop Evapotranspiration (ETcrop)	145.0	199.1	248.2	235.7	218.9	141.0						0.0	1,188
Percolation	93.0	84.0	93.0	90.0	93.0	90.0						0.0	543
Effective Rainfall	0.0	10.3	8.6	54.9	165.4	320.5						0.0	560
Area Factor	0.25	0.75	1.00	0.75	0.3	0.0						0.0	
Puddring Water	90.0	45.0										45.0	180
Nursery Water	11.0											10.0	21
Net Irrigation Requirement	161	247	333	189	0	0						55	985
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)						126.9	139.7	136.5	161.0	181.7	174.2	151.0	1,071
Percolation						60	64	64	60	64	60	64	436
Effective Rainfall					200.9	265.6	195.2	263.8	62.6	200.8	5.6	0.0	1,194
Area Factor						0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddring Water					11	79	79	11					180
Nursery Water					11	10							21
Net Irrigation Requirement					0	0	0	0	158	30	111	13	313
Irrigation Efficiency	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field													
Gross Irrigation Requirement (mm)	268	412	554	316	0	0	0	0	264	50	186	113	2,163
(lit/sec/ha)	1.00	1.70	2.07	1.22	0.00	0.00	0.00	0.00	1.02	0.19	0.72	0.42	

Table IV-8 Irrigation Water Requirement in Salavan Area (2/2)

CROPPING PATTERN - B														
Upland Crops														
Crop Coefficient (Kc)		0.85	0.95	0.90	0.40							0.70	0.73	
Crop Evapo-transpiration (ETcrop)		123.3	172.0	197.1	83.2							113.4	109.5	798
Effective Rainfall		0.0	8.5	7.1	45.2							2.3	0.0	63
Area Factor		0.90	1.00	0.94	0.50	0.06						0.05	0.40	
Net Irrigation Requirement		111	163	179	19	0						6	44	521
Rainy Season Paddy														
Crop Coefficient (Kc)							0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)							126.9	139.7	136.5	161.0	181.7	174.2		920
Percolation							60	64	64	60	64	60	64	436
Effective Rainfall						200.9	320.5	170.8	263.8	62.6	200.8	5.6	0.0	1,225
Area Factor							0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddring Water						11	79	79	11					180
Nursery Water						11	10	0	0					21
Net Irrigation Requirement						0	0	10	0	158	30	111	4	314
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.6/0.51	
Conveyance Efficiency 85 %														
Application Efficiency 70 % of paddy field, 60 % of upland crops														
Gross Irrigation Requirement	(mm)	218	321	350	37	0	0	17	0	264	50	197	92	1,546
	(lit/sec/ha)	0.81	1.33	1.31	0.14	0.00	0.00	0.06	0.00	1.02	0.19	0.76	0.34	
CROPPING PATTERN - C														
Vegetable														
Crop Coefficient (Kc)		0.85	0.90	0.85	0.87	0.85	0.70						0.80	
Crop Evapo-transpiration (ETcrop)		123.3	162.9	186.2	180.3	169.2	98.7						120.8	1,041
Effective Rainfall		0.0	8.5	7.1	45.2	165.4	183.2						0.0	409
Area Factor		0.50	0.87	1.00	0.87	0.50	0.17						0.17	
Net Irrigation Requirement		62	134	179	117	2	0						21	515
Upland Crops														
Crop Coefficient (Kc)							0.75	0.83	0.88	0.92	0.93	0.85		
Crop Evapo-transpiration (ETcrop)							105.8	121.3	113.1	128.3	146.2	137.7		752
Effective Rainfall							183.2	134.2	150.7	62.6	172.1	5.6		708
Area Factor							0.25	0.75	1.00	1.00	0.75	0.25		
Net Irrigation Requirement							0	0	0	66	0	33		99
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	
Conveyance Efficiency 85 %														
Application Efficiency 60 % of upland crops														
Gross Irrigation Requirement	(mm)	121	263	351	230	4	0	0	0	129	0	65	40	1,203
	(lit/sec/ha)	0.45	1.09	1.31	0.89	0.01	0.00	0.00	0.00	0.50	0.00	0.25	0.15	

Table IV-9 Irrigation Water Requirement in Laongam Area (1/3)



Champi(Lower site), H. Kaphue and H.Tapoung basins													
Monthly Rainfall (Pakxe 1991)	0.0	0.0	0.7	14.9	61.1	295.8	340.2	558.7	335.7	148.6	8.7	0.5	1,765
Potential Evapo-transpiration (Salavan)	145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1979.0
CROPPING PATTERN - A													
Dry Season Paddy													
Crop Coefficient (Kc)	1.00	1.10	1.13	1.13	1.10	1.00						0.00	
Crop Evapotranspiration (ETcrop)	145.0	199.1	248.2	235.7	218.9	141.0						0.0	1,188
Percolation	93.0	84.0	93.0	90.0	93.0	93.0						0.0	546
Effective Rainfall	0.0	0.0	0.6	12.7	51.9	207.1						0.4	273
Area Factor	0.25	0.75	1.00	0.75	0.3	0.0						0.0	
Puddring Water	90.0	45.0										45.0	180
Nursery Water	11.0											10.0	21
Net Irrigation Requirement	161	257	341	232	26	0						55	1,071
Rainy Season Paddy													
Crop Coefficient (Kc)						0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)						126.9	139.7	136.5	161.0	181.7	174.2	151.0	1,071
Percolation						60	64	64	60	64	60	64	436
Effective Rainfall					51.9	207.1	238.1	279.4	235.0	126.3	7.4	0.4	1,146
Area Factor						0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddring Water					11	79	79	11					180
Nursery Water					11	10							21
Net Irrigation Requirement					0	0	0	0	0	105	110	12	227
Irrigation Efficiency	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	
Conveyance Efficiency 85 %													
Application Efficiency 70 % of paddy field													
Gross Irrigation Requirement (mm)	268	429	568	386	43	0	0	0	0	174	183	112	2,162
(lit/sec/ha)	1.00	1.77	2.12	1.49	0.16	0.00	0.00	0.00	0.00	0.65	0.71	0.42	

Table IV-9 Irrigation Water Requirement in Laongam Area (2/3)

CROPPING PATTERN - B.1														
Upland Crops														
Crop Coefficient (Kc)		0.78	0.88	0.90	0.90	0.80						0.70	0.73	
Crop Evapo-transpiration (ETcrop)		113.6	159.9	197.1	187.2	159.2						113.4	109.5	1,040
Effective Rainfall		0.0	0.0	0.5	7.0	28.7						4.1	0.2	41
Area Factor		0.90	1.00	0.94	0.50	0.06						0.05	0.40	
Net Irrigation Requirement		102	160	185	90	8						5	44	594
Rainy Season Paddy														
Crop Coefficient (Kc)							0.90	0.95	1.05	1.13	1.20	1.15		
Crop Evapo-transpiration (ETcrop)							126.9	139.7	134.4	158.7	189.6	186.3		936
Percolation							60	64	64	60	64	60		372
Effective Rainfall						51.9	207.1	238.1	391.1	235.0	104.0	7.4		1,235
Area Factor							0.06	0.5	0.94	0.94	0.5	0.06		
Puddring Water						11	79	79						169
Nursery Water						6	9	6						21
Net Irrigation Requirement						0	0	0	0	0	23	7		30
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.51	
Conveyance Efficiency 85 %														
Application Efficiency 70 % of paddy field, 60 % of upland crops														
Gross Irrigation Requirement	(mm)	200	313	362	177	15	0	0	0	0	38	23	86	1,215
	(lit/sec/ha)	0.75	1.30	1.35	0.68	0.06	0.00	0.00	0.00	0.00	0.14	0.09	0.32	

CROPPING PATTERN - B.2														
Upland Crops														
Crop Coefficient (Kc)		0.78	0.88	0.90	0.90	0.80						0.70	0.73	
Crop Evapo-transpiration (ETcrop)		113.6	159.9	197.1	187.2	159.2						113.4	109.5	1,040
Effective Rainfall		0.0	0.0	0.5	7.0	28.7						4.1	0.2	41
Area Factor		0.90	1.00	0.94	0.50	0.06						0.05	0.40	
Net Irrigation Requirement		102	160	185	90	8						5	44	594
Rainy Season Paddy														
Crop Coefficient (Kc)							0.90	0.95	1.07	1.15	1.15	1.08	1.00	
Crop Evapo-transpiration (ETcrop)							126.9	139.7	136.5	161.0	181.7	174.2	151.0	1,071
Percolation							60	64	64	60	64	60	64	436
Effective Rainfall						251.4	207.1	238.1	279.4	235.0	126.3	7.4	0.4	1,345
Area Factor							0.06	0.5	0.94	1	0.94	0.5	0.06	
Puddring Water						11	79	79	11					180
Nursery Water						11	10							21
Net Irrigation Requirement						0	0	0	0	0	105	110	12	227
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51/0.6	0.6	0.6	0.6	0.6	0.6	0.6/0.51	0.6/0.51	
Conveyance Effieiency 85 %														
Application Efficiency 70 % of paddy field, 60 % of upland crops														
Gross Irrigation Requirement	(mm)	200	313	362	177	15	0	0	0	0	174	194	106	1,543
	(lit/sec/ha)	0.75	1.17	1.35	0.66	0.06	0.00	0.00	0.00	0.00	0.65	0.72	0.40	

Table IV-9 Irrigation Water Requirement in Laongam Area (3/3)

CROPPING PATTERN - C														
Vegetable														
Crop Coefficient (Kc)		0.85	0.90	0.85	0.87	0.85	0.70						0.80	
Crop Evapo-transpiration (ETcrop)		123.3	162.9	186.2	180.3	169.2	98.7						120.8	1,041
Effective Rainfall		0.0	0.0	0.5	7.0	28.7	139.0						0.2	175
Area Facor		0.50	0.87	1.00	0.87	0.50	0.17						0.17	
Net Irrigation Requirement		62	142	186	151	70	0						21	630
Upland Crops														
Crop Coefficient (Kc)							0.75	0.83	0.88	0.92	0.93	0.85		
Crop Evapo-transpiration (ETcrop)							105.8	121.3	113.1	128.3	146.2	137.7		752
Effective Rainfall							139.0	136.1	139.7	134.3	104.0	6.1		659
Area Facor							0.25	0.75	1.00	1.00	0.75	0.25		
Net Irrigation Requirement							0	0	0	0	32	33		65
Irrigation Efficiency		0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	
Conveyance Efficiency 85 %														
Application Efficiency 60 % of upland crops														
Gross Irrigation Requirement	(mm)	121	278	364	296	138	0	0	0	0	62	65	40	1,363
	(lit/sec/ha)	0.45	1.15	1.36	1.14	0.51	0.00	0.00	0.00	0.00	0.23	0.25	0.15	

Table IV-10 Irrigation Water Requirement of Coffee

MA-16		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept	Oct.	Nov.	Dec	
Coffee Makchan-gnai, Xe Pian, Champi (Upper site) and Tapoung basins, Site No. 1, 2, 3 & 4		Flowering												
Coffee Champi(Lower site), H. Kaphue and H.? Xe Set, H. Namsai, H. Lamphan and H. Tayun basins, Site No. 16		Flowering												
Makchan-gnai, Xe Pian, Champi (Upper Site) and Tapoung basins, Site No. 1, 2, 3 & 4														
Monthly Rainfall (Paksong 1988)		0.0	22.9	161.5	346.3	414.1	368.0	436.4	566.6	338.3	358.2	13.2	0.0	3,026
Potential Evapo-transpiration (Paksong)		128.0	150.0	170.0	174.0	152.0	126.0	124.0	116.0	117.0	135.0	154.0	144.0	1,690
Coffee														
Crop Coefficient (Kc)		0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
Crop Evapo-transpiration (ETcrop)		83.2	97.5	110.5	113.1	98.8	81.9	80.6	75.4	76.1	87.8	100.1	93.6	1,099
Effective Rainfall		0.0	16.0	113.1	225.1	194.6	173.0	205.1	266.3	159.0	168.4	9.2	0.0	1,530
Net Irrigation Requirement		83	81	0	0	0	0	0	0	0	0	91	94	349
Irrigation Efficiency		0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Conveyance Efficiency 85 %														
Application Efficiency 70 %														
Gross Irrigation Requirement	(mm)	140	137	0	0	0	0	0	0	0	0	153	157	587
	(lit/sec/ha)	0.52	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.59	
Champi(Lower site), H. Kaphue and H.Tapoung basins, Site No. 9, 10 & 11														
Monthly Rainfall (Paksc 1991)		0.0	0.0	0.2	14.9	61.1	295.8	340.2	558.7	335.7	148.6	8.7	0.5	1,765
Potential Evapo-transpiration (Salavan)		145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1,979
Coffee														
Crop Coefficient (Kc)		0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
Crop Evapo-transpiration (ETcrop)		94.3	117.7	142.4	135.2	129.4	91.7	95.6	83.2	91.0	102.7	105.3	98.2	1,286
Effective Rainfall		0.0	0.0	0.5	10.4	42.8	139.0	159.9	262.6	157.8	104.0	6.1	0.4	883
Net Irrigation Requirement		94	118	142	125	87	0	0	0	0	0	99	98	762
Irrigation Efficiency		0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Conveyance Efficiency 85 %														
Application Efficiency 70 %														
Gross Irrigation Requirement	(mm)	158	198	238	210	146	0	0	0	0	0	167	164	1,281
	(lit/sec/ha)	0.59	0.82	0.89	0.81	0.54	0.00	0.00	0.00	0.00	0.00	0.64	0.61	
Xe Set, H. Namsai, H. Lamphan and H. Tayun basins, Site No. 16														
Monthly Rainfall (Salavan 1988)		0.0	32.3	0.2	64.6	236.3	457.9	244.0	376.8	73.6	286.8	6.6	42.0	1,769
Potential Evapo-transpiration (Salavan)		145.0	181.0	219.0	208.0	199.0	141.0	147.0	128.0	140.0	158.0	162.0	151.0	1,979
Coffee														
Crop Coefficient (Kc)		0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	
Crop Evapo-transpiration (ETcrop)		94.3	117.7	142.4	135.2	129.4	91.7	95.6	83.2	91.0	102.7	105.3	98.2	1,286
Effective Rainfall		0.0	8.5	7.1	45.2	153.6	215.2	158.6	177.1	51.5	186.4	4.6	0.0	1,008
Net Irrigation Requirement		94	109	135	90	0	0	0	0	39	0	101	98	667
Irrigation Efficiency		0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
Conveyance Efficiency 85 %														
Application Efficiency 70 %														
Gross Irrigation Requirement	(mm)	158	183	227	151	0	0	0	0	66	0	169	165	1,121
	(lit/sec/ha)	0.59	0.76	0.85	0.58	0.00	0.00	0.00	0.00	0.26	0.00	0.65	0.62	

Table IV-11 Water Balance Calculation of Lamphan Reservoir

			Jan	Feb.	Mar.	Apr	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Irrigation Demand		1989	7.49	12.88	14.26	3.43	0.00	0.00	0.00	0.00	2.52	8.48	5.62	3.28
	MCM	1990	7.75	12.48	10.37	9.26	0.00	0.00	0.00	0.00	0.00	6.99	4.03	3.28
		1991	7.76	12.88	16.18	10.79	0.00	0.00	0.00	0.00	0.00	4.33	5.43	3.10
		1992	6.58	12.74	16.28	10.90	0.00	0.00	0.00	0.00	3.09	6.77	5.66	3.28
		1993	7.76	12.88	15.13	6.75	0.00	0.90	0.00	0.00	2.67	10.56	5.61	3.06
		1994	7.76	12.84	15.04	8.99	0.00	0.00	0.00	0.00	0.00	9.49	5.49	3.25
Runoff		1989	2.77	1.71	1.48	2.32	8.28	15.45	20.19	28.13	31.42	15.45	5.96	3.85
	MCM	1990	3.34	1.62	2.50	2.50	6.05	6.93	13.92	18.85	25.67	36.04	18.63	12.73
		1991	3.59	2.01	2.30	2.83	4.99	7.32	33.36	46.38	38.17	31.64	11.12	6.67
		1992	2.89	2.12	1.83	1.68	3.48	14.12	25.54	40.98	27.33	16.65	7.65	4.98
		1993	3.75	2.52	2.52	2.56	6.36	5.45	16.66	32.50	36.89	16.02	7.87	4.81
		1994	3.51	2.55	2.60	6.67	13.96	18.23	36.88	38.46	38.97	23.28	10.65	6.37
RESERVOIR OPERATION RESULT														
	MCM	1989	36.19	24.04	10.17	8.01	15.21	29.61	42.00	42.00	42.00	42.00	41.29	40.77
		1990	35.27	23.43	14.48	6.67	11.64	17.52	30.35	42.00	42.00	42.00	42.00	42.00
		1991	36.75	24.90	9.93	0.91	4.82	11.09	42.00	42.00	42.00	42.00	42.00	42.00
		1992	37.23	25.63	10.09	0.00	2.40	15.47	39.92	42.00	42.00	42.00	42.00	42.00
		1993	36.91	25.57	11.87	6.63	11.90	15.41	30.98	42.00	42.00	42.00	42.00	42.00
		1994	36.67	25.40	11.88	8.51	21.38	38.56	42.00	42.00	42.00	42.00	42.00	42.00

Table IV-12 Potential of Irrigation Development (1/2)

(Unit : ha)

Location and River Basin	No. of Location	STUDY AREA																				OUTSIDE OF STUDY AREA						TOTAL	Location					
		More than 1000 m				1000 m ~ 600 m				600 m ~ 400 m					Less than 400 m							Less than 400 m							Study Area			Outside of Study Area		
		A	B	C	Coffee	A	B	C	Coffee	A1	A	B	C	Coffee	A1	A	B	C	Coffee	A1	A	B	C	Coffee		Gravity	Pump	Subtotal	Gravity	Pump	Subtotal
Pakxong																																			
Xe Pon																																			
Gravity Lower Xe Pon	1			100	650																							750	750					
Pump New Area	P1,P2			130	270		530	530	540																			2,000		2,000				
Sub-total		0	0	230	920	0	530	530	540	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			2,750	750	2,000	0	0	0	0
H.Malixhan																																			
Gravity Upper Malixhan	2			100	370																							470	470					
Lower Malixhan	3						80		260																			340	340					
Pump New Area	P3							50	120																			170		170				
Sub-total		0	0	100	370	0	80	50	380	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			980	810	170	0	0	0	0
H.Nathong																																			
Gravity Middle Nathong	4						120		145																			265	265					
Pump New Area	P4						15	40	50																			105		105				
Sub-total		0	0	0	0	0	135	40	195	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			370	265	105	0	0	0	0
Xe Kaman																																			
Gravity Thaeray	5						30	30	40																			100	100					
Thong Hong	6						10	10																				20	20					
Middle Xe Kaman	7					140	600																					620	620					
Pump New Area	P5						90	50	60																			160		160				
Sub-total		0	0	0	0	140	570	90	100		0	0	0	0		0	0	0	0		0	0	0	0	0			900	740	160	0	0	0	0
H.Champa																																			
Gravity Thaeray	8															50	30											80	80					
Sub-total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	30	0	0	0	0	0	0	0	0			80	80	0	0	0	0	0
Lamam																																			
H.Tamnang																																			
Gravity Upper Tamnang	9			20	30																							50	50					
Middle Tamnang	10						80		370																			450	450					
Lower Tamnang	11											1,800		2,700														4,500	4,500					
New Area	12														4,700		2,300			5,300		2,700						15,000	7,000		8,000			
Sub-total		0	0	20	30	0	80	0	370	0	0	1,800	0	2,700	4,700	0	2,300	0	0	5,300	0	2,700	0	0				20,000	12,000	0	8,000	0	0	
H.Kaphao																																			
Gravity Upper Kaphao	13						100		900																			1,000	1,000					
Pump New Area	P6					1,950	1,950		1,950							3,700	1,600											11,250		11,250				
Sub-total		0	0	0	0	1,950	2,050	0	2,850	0	0	0	0	0	0	3,700	1,600	0	0	0	0	0	0	0	0			12,250	1,000	11,250	0	0	0	0
H.Pako																																			
Gravity Houay Pako	14															160	80											240	240					
Sub-total		0	0	0	0	0	0	0	0	0	0	0	0	0	0	160	80	0	0	0	0	0	0	0	0			240	240	0	0	0	0	0
H.Champa																																			
Gravity Upper Champa	15			110	620																							730	730					
Lower Champa	16														930		570			680		420						2,600	1,500		1,100			
New Area	17																			4,130	110	60						1,300			1,300			
Pump New Area	P7															910	460											1,370		1,370				
Sub-total		0	0	110	620	0	0	0	0	0	0	0	0	0	930	910	1,030	0	0	1,810	110	480	0	0			6,000	2,230	1,370	0	2,400	0	0
Salavan																																			
Xe Set																																			
Gravity Houay Set	18			20	30																							50	50					
Lower Xe Set	19									560		1,240																1,800	1,800					
New Area	21														3,000		2,500			13,600		6,900						26,000	7,900	0	20,500			
Sub-total		0	0	20	30	0	0	0	0	560	0	1,240	0	0	3,000	0	2,500	0	0	13,600	0	6,900	0	0			29,850	9,350	0	0	20,500	0	0

Table IV-12 Potential of Irrigation Development (2/2)

(Unit : ha)

Location and River Basin	No. of Location	Altitude Range of Irrigation Area: More than 1,000 m A	B	C	Coffee	1,000 m ~ 600 m A	B	C	Coffee	600 m ~ 400 m A1	A	B	C	Coffee	Less than 400 m A1	A	B	C	Coffee	OUTSIDE OF STUDY AREA: Less than 400 m A1	A	B	C	Coffee	TOTAL	Location: Study Area Gravity	Study Area Pump	Study Area Subtotal	Outside of Study Area Gravity	Outside of Study Area Pump	Outside of Study Area Subtotal
H.Thon																															
Gravity Upper Thon	20														400	240									640	640					
New Area	21															1,700	800								2,500	2,500					
Subtotal		0	0	0	0	0	0	0	0	0	0	0	0	0	400	1,940	800	0	0	0	0	0	0	0	3,140	3,140	0	0	0	0	0
H.Tay - Un																															
Gravity H.Nongkan	22						50	50	50																150	150					
Upper Tay - Un	23									240	45	45													330	330					
Middle Lamphan	24															250					1,750	900			2,900	250		2,650			
Pump New Area	P9,P10						530	530	540		470	470		460											3,000		3,000				
Subtotal		0	0	0	0	0	580	580	590	240	515	515	0	460	0	250	0	0	0	0	1,750	900	0	0	6,380	730	3,000	0	2,650	0	0
H.Lam																															
Gravity B.Vieng Khan	25															25	15								40	40					
B.Phae - Chai	26															30	20								50	50					
B.Saeng	27															40	10								50	50					
Subtotal		0	0	0	0	0	0	0	0	0	0	0	0	0	0	95	45	0	0	0	0	0	0	0	140	140	0	0	0	0	0
H.Nonkate																															
Gravity Nanoon	28						870	870	850																2,590	2,590					
Heuay Xin	29						190	200	200																590	590					
Lower Nanoon	30														600	530	220				1,100	970	420		3,840	1,350		2,490			
Pump New Area	P11						160	130	180																510		510				
Subtotal		0	0	0	0	0	1,220	1,200	1,230	0	0	0	0	0	600	530	220	0	0	0	1,100	970	420	0	0	7,530	4,530	510	0	2,490	0	0
TOTAL		0	0	480	1,970	2,090	5,245	2,530	6,255	800	515	3,555	0	3,160	11,630	7,835	8,805	0	0	21,810	2,830	11,400	0	0	90,710	36,005	18,665	54,670	36,040	0	36,040
Gravity		0	0	350	1,700	140	2,010	1,160	2,815	800	45	3,085	0	2,700	11,630	3,025	6,545	0	0	21,810	2,830	11,400	0	0	72,045	36,005	0	36,005	36,040	0	36,040
Pump		0	0	130	270	1,950	3,235	1,370	3,440	0	470	470	0	460	0	4,810	2,260	0	0	0	0	0	0	0	18,665	0	18,665	18,665	0	0	0
					2,450				16,120					8,030					28,070				36,040							
																			54,670				90,710							

Type-A	10,240
Type-B	17,605
Type-C	3,010
Type-A1	12,430
Coffee	11,385
	54,670