

APPENDIX H. FARM ECONOMIC SURVEY

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Name of Villages of Socio-economic Survey for The Master Plan Study on
The Integrated Agriculture and Water Resources Development Project
on Huai Mong, Nam Suel and Huai Luang River Basins.

No.	Coding	Village number	Village Name	Tambon	District	Province
Huai Mong River Basin (50 Samples)						
Upper :						
1.	101-105	5	Thung Sa-Wang	Ban Mo	Si Chiang Mai	Nong Khai
2.	106-110	3	Pho Tak	Pho Tak	Si Chiang Mai	Nong Khai
3.	111-115	5	Khok Khon	Khok Khon	Tha Bo	Nong Khai
4.	116-120	7	Kham Charoen	Kham Duang	Ban Phu	Udon Thani
Middle :						
1.	201-205	5	Thon (Phu Din)	Ban Phu	Ban Phu	Udon Thani
2.	206-210	3	Cham Pa Dong	Cham Pa Mong	Ban Phu	Udon Thani
3.	211-215	7	Non Som Bun	Kham Dong	Ban Phu	Udon Thani
4.	216-220	1	Na Si	Na Si	Suwan Khu Ha	Nong Bua Lamphu
Lower :						
1.	301-305	4	Wang Hin Sa	Dong Ma Fai	Suwan Khu ha	Nong Bua Lamphu
2.	306-310	4	Nong Bua Noi	Na Dan	Suwan Khu ha	Nong Bua Lamphu
3.	311-315	3	Kok Kho	Na Klang	Na Klang	Nong Bua Lamphu
4.	316-320	1	Kut Chik	Kut Chik	Nong Bua Lamphu	Nong Bua Lamphu
Nam Suel River Basin (40 Samples)						
Upper :						
1.	401-405	2	Na Kai	Nong Kom Kao	Muang	Nong Khai
2.	406-410	3	Phon Ngam	Wat Thai	Muang	Nong Khai
3.	411-415	1	Lao	Seng Nang Khao	Phon Phi Sai	Nong Khai
4.	416-420	1	Thai	Ban Thai	Phon	Udon Thani
Lower :						
1.	501-505	5	Dong Na Kham	Nong Nang	Tha Bo	Nong Khai
2.	506-510	7	Phon Wal	Sa Khai	Sa Khai	Nong Khai
3.	511-515	9	Nong Pla Siu	Khua Nam	Ban Phu	Udon Thani
4.	516-520	4	Na Di	Chiang Wang	Phon	Udon Thani
Huai Luang River Basin (100 Samples)						
Upper :						
1.	701-705	7	Na Mai Rao	Kut Bong	Phon Phi Sai	Nong Khai
2.	706-710	6	Dong Sa Phang	Na Nang	Phon Phi Sai	Nong Khai
3.	711-715	11	Dong Wal	Ban Chan	Ban Dung	Udon Thani
4.	716-720	3	Thon Kham Huat	Ban Dung	Ban Dung	Udon Thani
5.	721-725	1	Chiang Da	Chiang Da	Seng Khom	Udon Thani
6.	726-730	3	Non Nok Ho	Seng Khom	Seng Khom	Udon Thani
7.	731-735	3	Yang	Ban Lao	Phon	Udon Thani
Middle :						
1.	801-805	7	Na Sai	Na Bua	Phon	Udon Thani
2.	806-810	4	Na Nok Hong	Na Sai	King Amphoe Phi Bun Rai	Udon Thani
3.	811-815	4	Na Ya	Soi Phrao	Nong Han	Udon Thani
4.	816-820	5	Muang	Nong Han	Nong Han	Udon Thani
5.	821-825	3	Nong Bua Noi	Phak Top	Nong Han	Udon Thani
6.	826-830	9	Pa Kao	Huai Sam Phad	Kum Pha Wa Pi	Udon Thani
7.	831-835	1	Sam Phrao	Sam Phrao	Muang	Udon Thani
Lower :						
1.	901-905	3	Non Kham	Chiang Phin	Muang	Udon Thani
2.	906-910	9	Huai Sam Pun	Nong Hai	Muang	Udon Thani
3.	911-915	8	Nong Hin	Nong Phai	Muang	Udon Thani
4.	916-920	4	Tham Kong Phai	Non Than	Nong Bua Lam Phu	Nong Bua Lam Phu
5.	921-925	7	Nong Sarvan	Nong O	Nong Wu So	Udon Thani
6.	926-930	1	Kut Mak Fai	Kut Mak Fai	Nong Wu So	Udon Thani

Sample

20

20

20

20

20

35

35

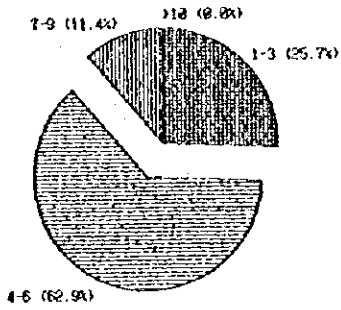
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200

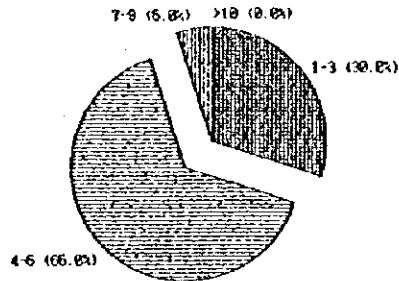
Remark: - 1. 5 Households per sample village.
2. Classified by Upper, Middle and Lower in each basin,
except Nam Suel River Basin have only Upper and Lower.

1. Family Size

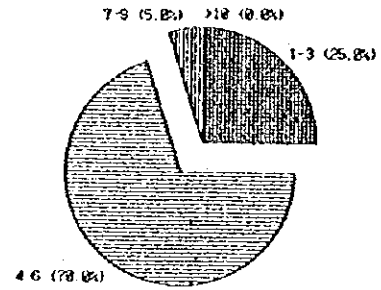
Huai Luang Upstream
Average 4.68 persons



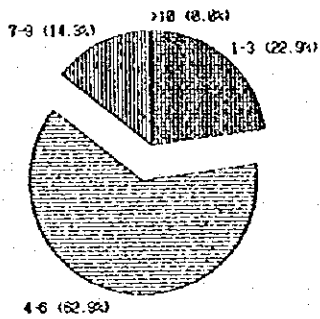
Huai Hong Upstream
Average 4.65 persons



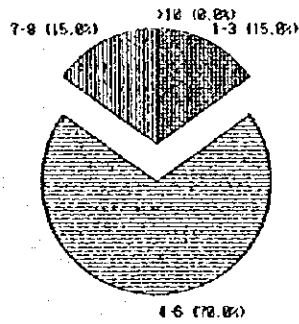
Nan Sui Upstream
Average 4.30 persons



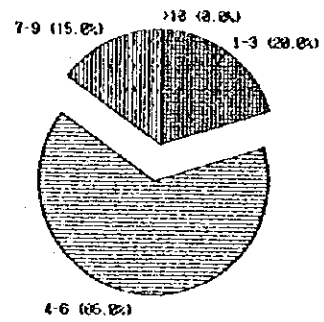
Huai Luang Middlestream
Average 4.60 persons



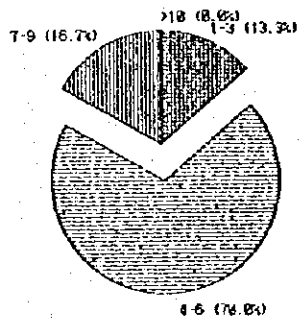
Huai Hong Middlestream
Average 4.90 persons



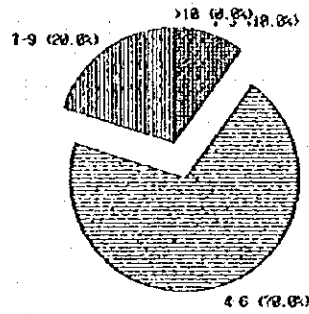
Nan Sui Downstream
Average 4.65 persons



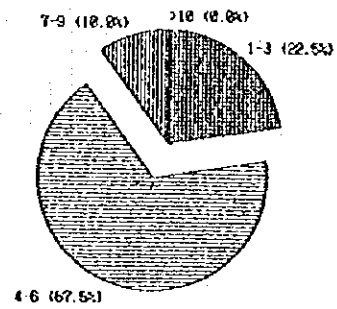
Huai Luang Downstream
Average 5.03 persons



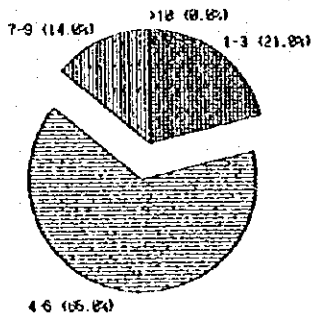
Huai Hong Downstream
Average 5.20 persons



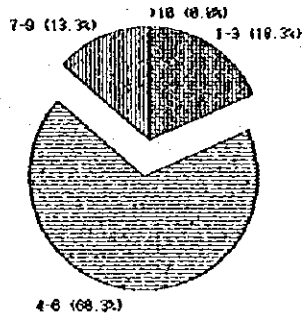
Nan Sui Basin
Average 4.40 persons



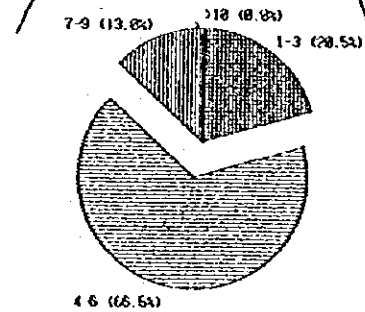
Huai Luang Basin
Average 4.75 persons



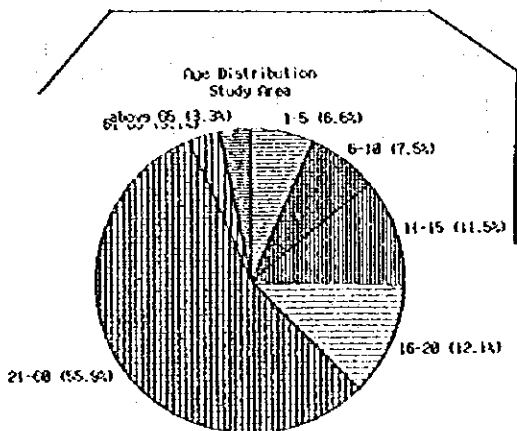
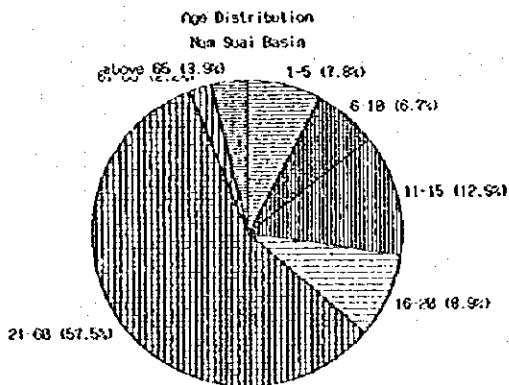
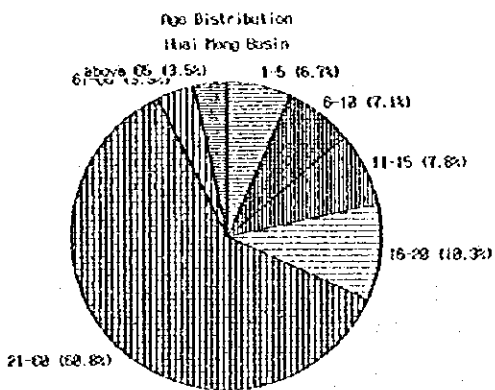
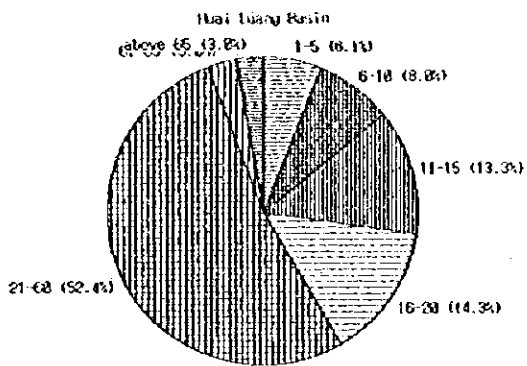
Huai Hong Basin
Average 4.67 persons



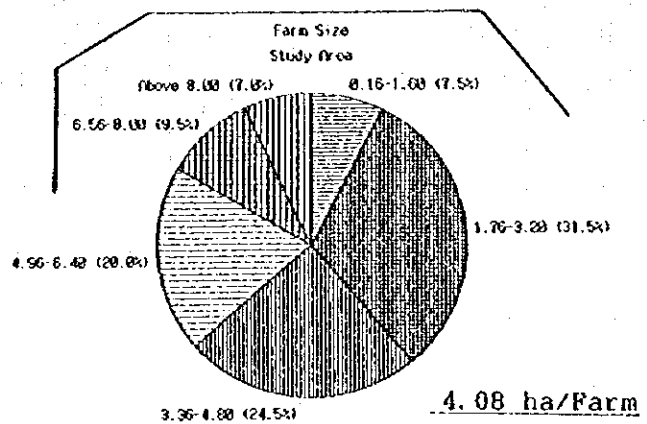
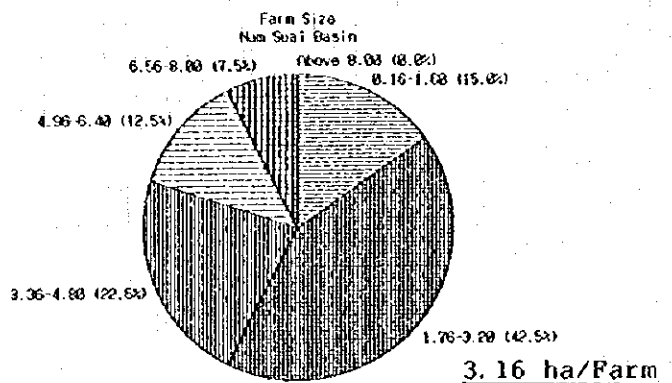
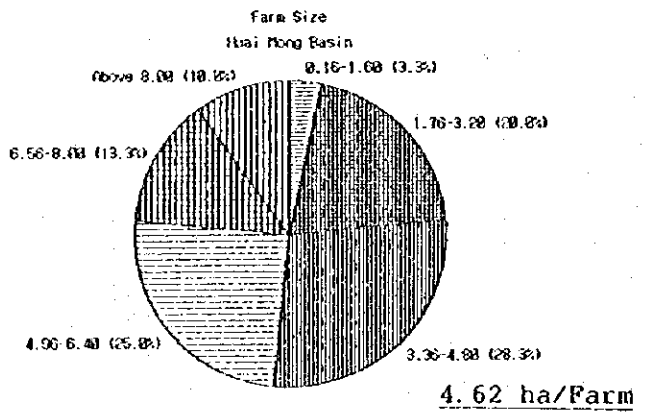
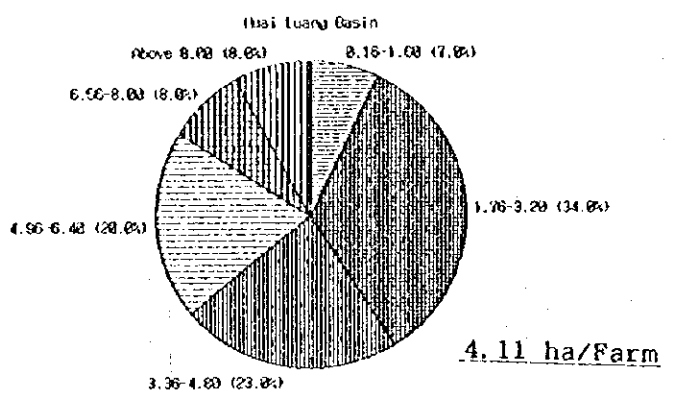
Study Area
Average 4.69 persons



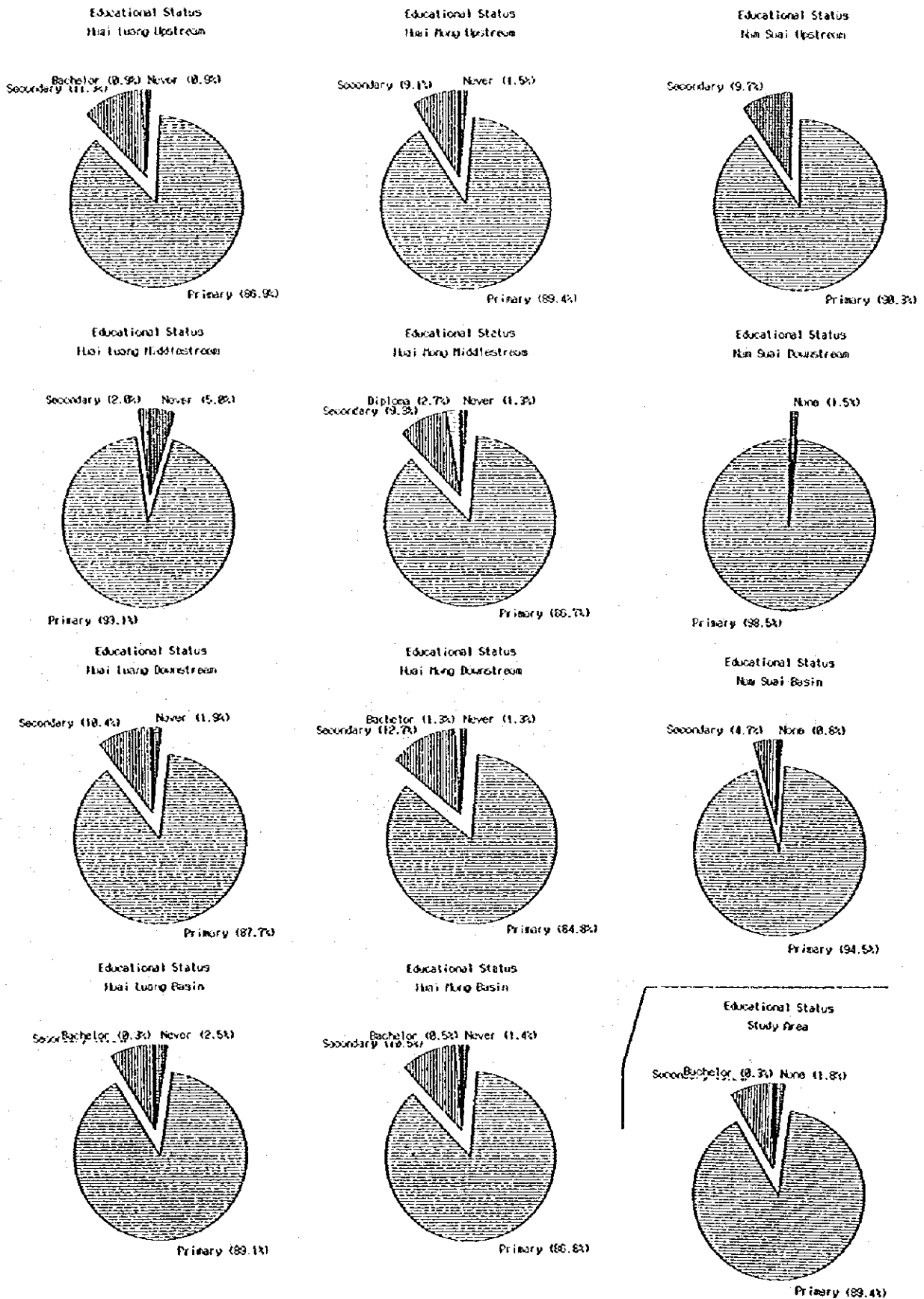
2. Age Distribution



3. No. of Farm Households by Farm Size

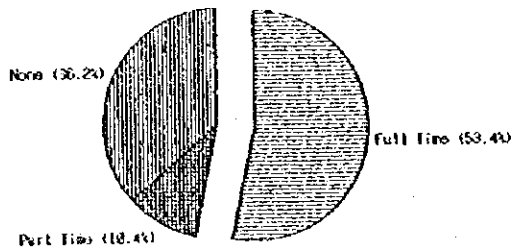


4. Educational Status of Farm Families

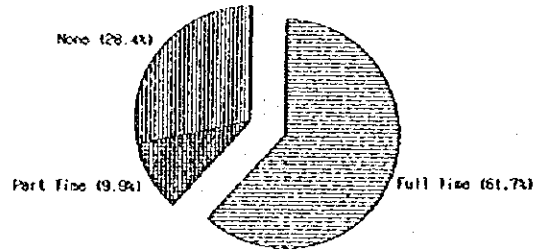


5. Working Conditions
 5.1 Family Farm Labour Available per Family

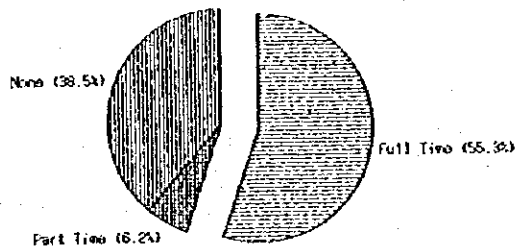
Huai Luang Upstream
 2.97 persons/family



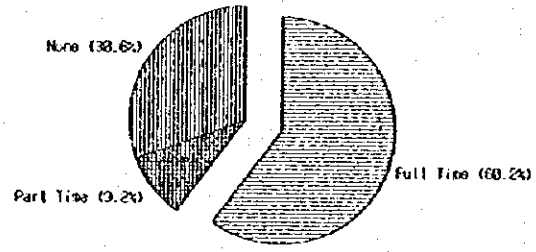
Huai Hong Upstream
 2.97 persons/family



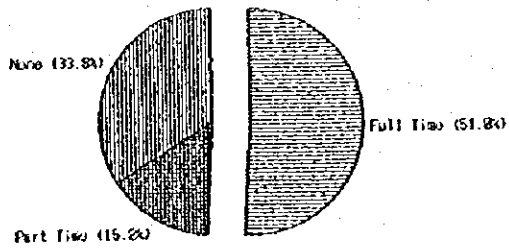
Huai Luang Middlestream
 2.83 persons/family



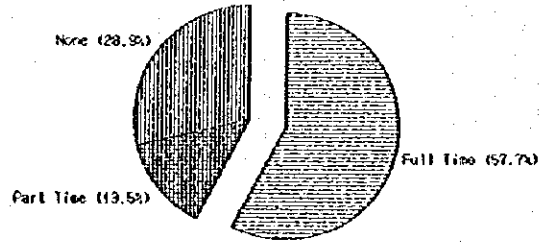
Huai Hong Middlestream
 3.4 persons/family



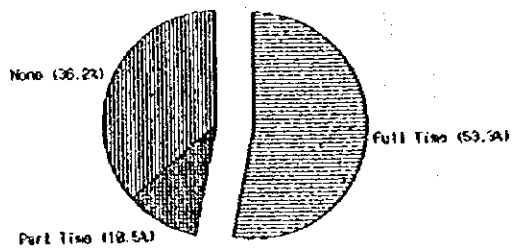
Huai Luang Downstream
 3.33 persons/family



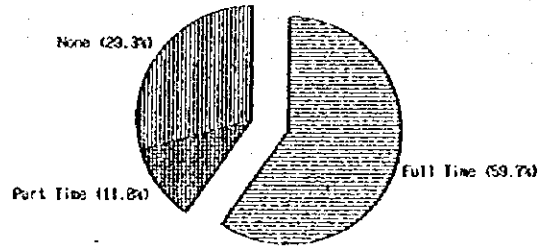
Huai Hong Downstream
 3.7 persons/family



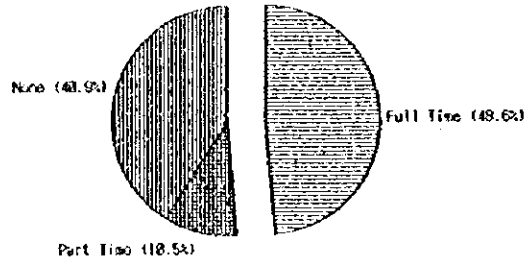
Huai Luang Basin
 3.03 persons/family



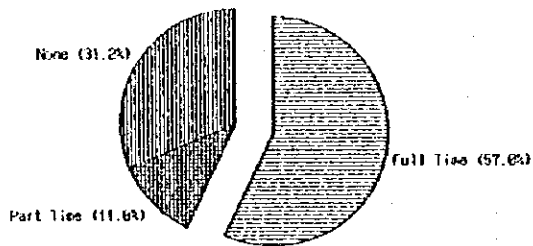
Huai Hong Basin
 3.33 persons/family



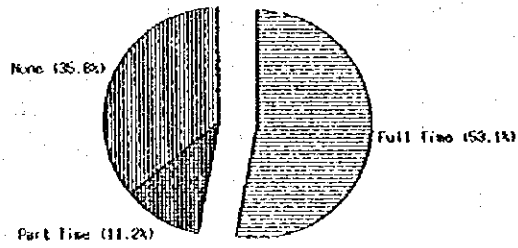
Nan Sui upstream
2.56 persons/family



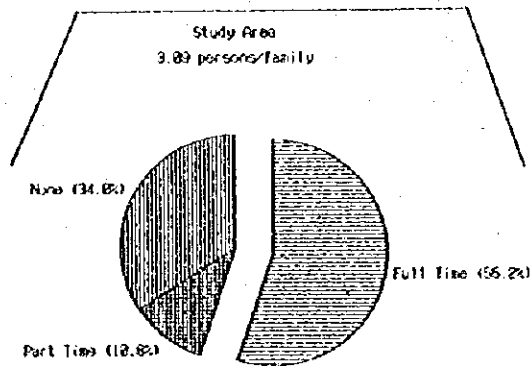
Nan Sui Downstream
3.28 persons/family



Nan Sui Basin
2.89 persons/family



Study Area
3.03 persons/family

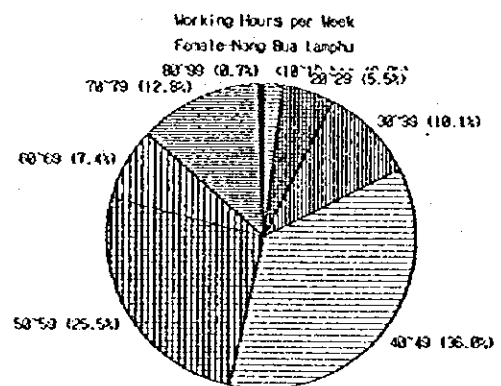
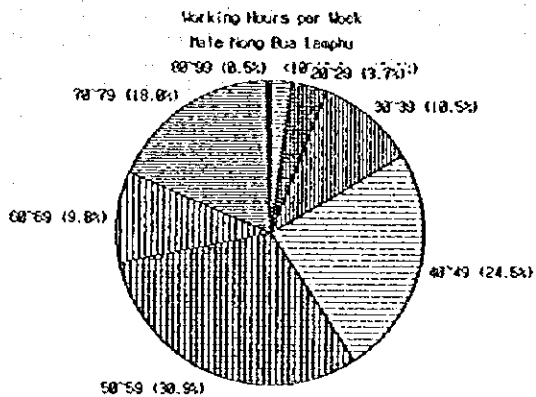
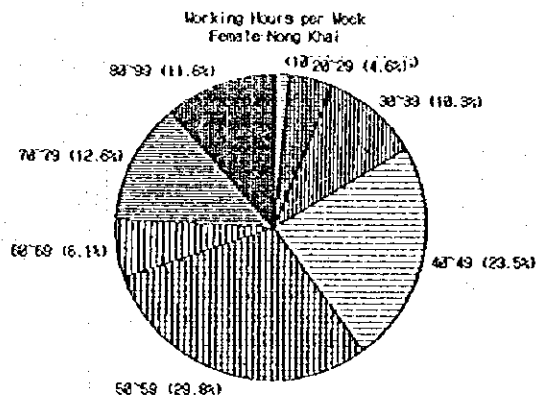
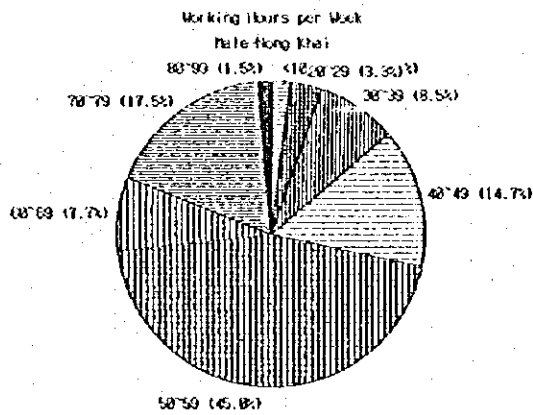
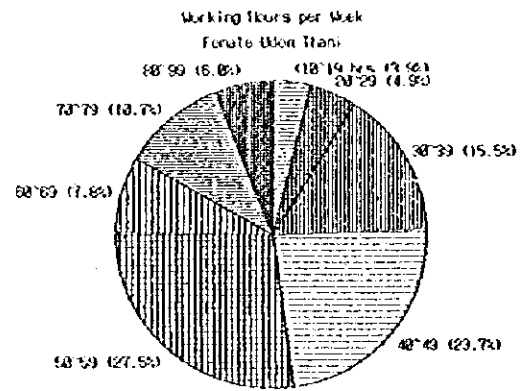
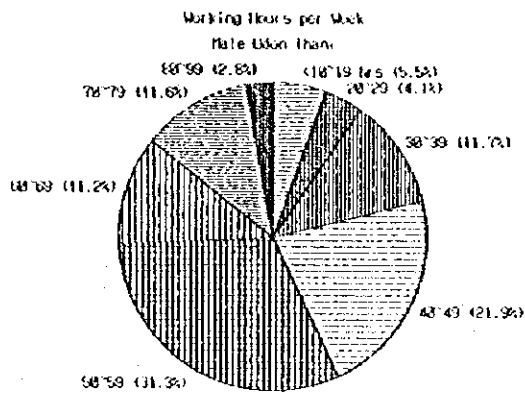


Labour based on Farm Economic Survey
(Unit: Man. day)

	Huai Luang				Huai Mong				Nam Suai				Average		
	per Rai		per ha		per Rai		per ha		per Rai		per ha		per ha		
	Family	Hired	Family	Hired	Family	Hired	Family	Hired	Family	Hired	Family	Hired	Family	Hired	
Rainfed															
Paddy (TP)	7.92	2.17	48.50	13.56	7.31	3.15	45.59	19.69	8.07	2.19	50.44	13.69	48.54	15.65	
Paddy (BC)	5.16	0.66	32.25	4.13	5.19	1.41	32.44	8.81	4.72	2.69	29.50	16.81	31.40	9.92	
Upland Paddy-wet	7.45	0.00	46.56	0.00	-	-	-	-	9.02	0	56.38	0.00	51.47	0.00	
Maize	-	-	-	-	1.75	1.50	10.94	9.38	-	-	-	-	10.94	9.38	
Cassava	7.41	2.82	46.31	17.63	7.64	3.56	47.75	22.25	-	-	-	-	47.03	19.94	
Sweet corn	7.25	0.00	45.31	0.00	-	-	-	-	-	-	-	-	45.31	0.00	
Sugarcane	-	-	-	-	1.82	11.72	11.38	73.25	-	-	-	-	11.38	73.25	
Groundnut-dry	17.50	0.00	109.38	0.00	18.00	5.00	112.50	31.25	-	-	-	-	110.94	15.63	
Mango	6.60	0.00	41.25	0.00	-	-	-	-	-	-	-	-	41.25	0.00	
Irrigated															
Paddy (TP)	9.31	2.98	58.19	18.63	8.07	3.57	50.44	22.31	6.69	3.02	41.81	18.88	50.15	19.94	
Paddy (BC)	9.79	0.86	61.19	5.38	-	-	-	-	-	-	-	-	61.19	5.38	
Soybean	-	-	-	-	10.75	0.00	67.19	0.00	-	-	-	-	67.19	0.00	
Sweet corn	8.67	0.33	54.19	2.06	-	-	-	-	-	-	-	-	54.19	2.06	
Groundnut-dry	20.50	0.00	128.13	0.00	-	-	-	-	-	-	-	-	128.13	0.00	
Yambean	51.00	0.00	318.75	0.00	-	-	-	-	-	-	-	-	318.75	0.00	
Cucumber	35.50	0.00	221.88	0.00	-	-	-	-	-	-	-	-	221.88	0.00	
Stringbean	41.83	0.00	261.44	0.00	-	-	-	-	30.25	0	189.06	0.00	225.25	0.00	
Tomato	52.00	0.00	325.00	0.00	30.30	1.20	189.38	7.50	17.37	0	108.56	0.00	207.65	2.59	
Tomato (second)	-	-	-	-	32.54	4.38	203.38	27.38	-	-	-	-	203.38	27.38	
Pumpkin	-	-	-	-	-	-	-	-	21.76	0	136.00	0.00	136.00	0.00	
Maligold	207.50	0.00	1,296.88	0.00	-	-	-	-	-	-	-	-	1,296.88	0.00	
Chrysanthomum	50.29	0.00	314.31	0.00	-	-	-	-	-	-	-	-	314.31	0.00	

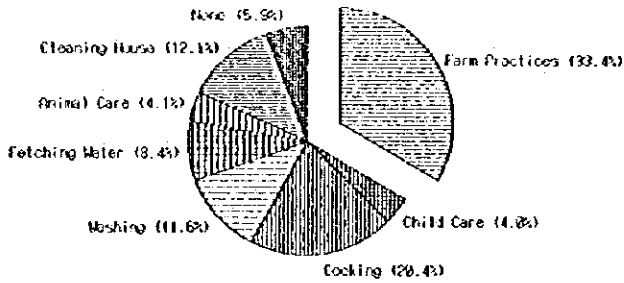
Source: Farm Economic Survey Nov. 1995

5.2 Working Hours per Week

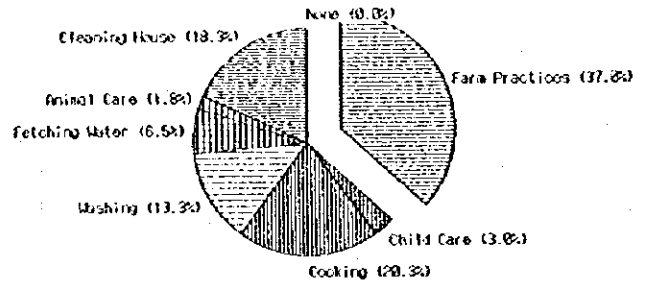


5.3 Farmer's Wife's Activities in a Year

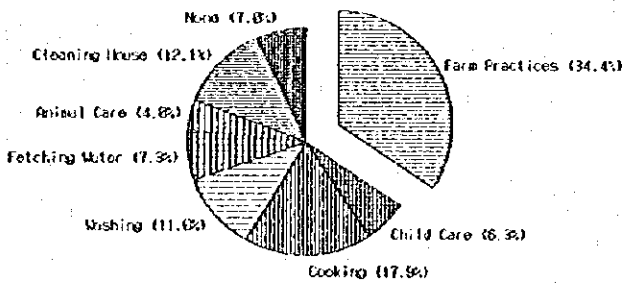
Farmer's Wife's Activities
Huai Luang Upstream



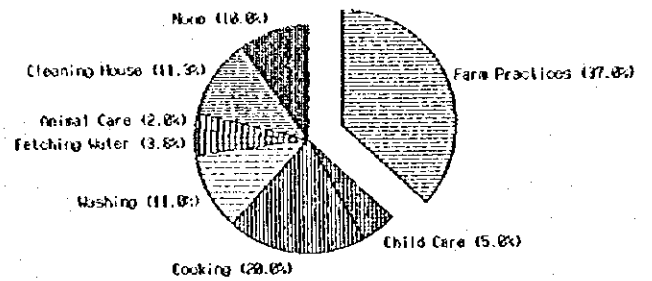
Farmer's Wife's Activities
Huai Hong Upstream



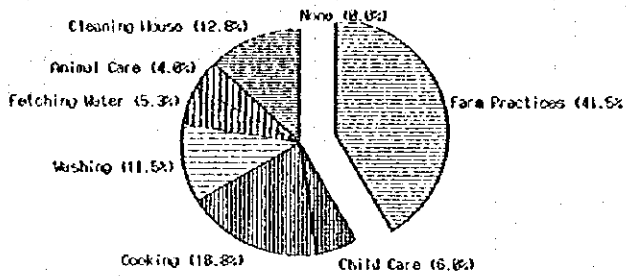
Farmer's Wife's Activities
Huai Luang Middlestream



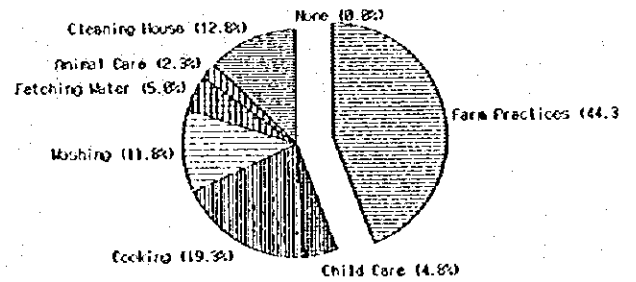
Farmer's Wife's Activities
Huai Hong Middlestream



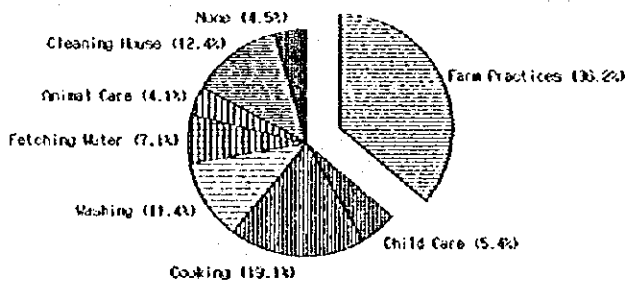
Farmer's Wife's Activities
Huai Luang Downstream



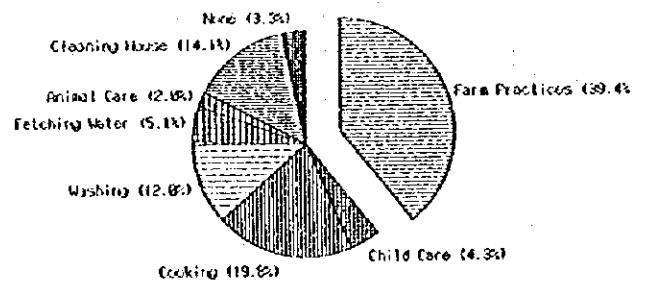
Farmer's Wife's Activities
Huai Hong Downstream



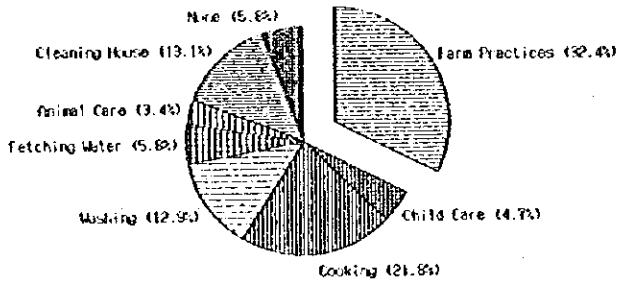
Farmer's Wife's Activities
Huai Luang Basin



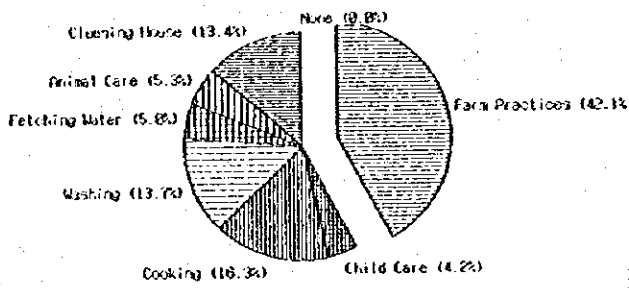
Farmer's Wife's Activities
Huai Hong Basin



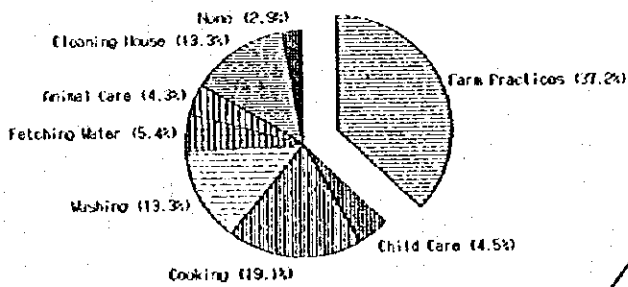
Farmer's Wife's Activities
Nam Suai Upstream



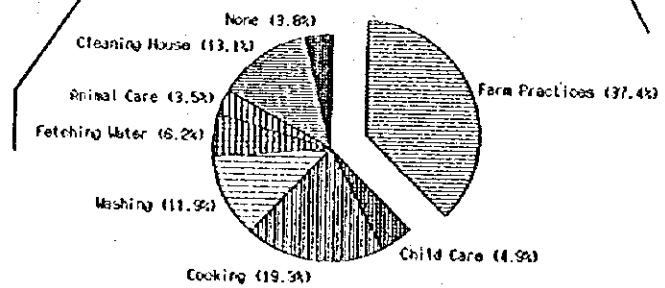
Farmer's Wife's Activities
Nam Suai Downstream



Farmer's Wife's Activities
Nam Suai Basin



Farmer's Wife's Activities
Study Area



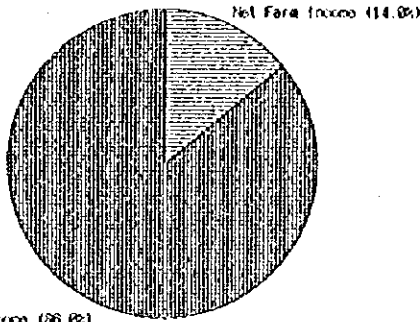
5.4 Participation of Farmer's Wife Activities

	(unit:%)							
	Crop Husbandry				Animal Husbandry			
	Good	Medium	Little	None	Good	Medium	Little	None
Huai Luan Basin								
Upper Stream	54.29	34.29	2.86	8.57	8.57	25.71	17.14	48.57
Middle Stream	62.86	31.43	0.00	5.71	11.43	31.43	17.14	40.00
Down Stream	66.67	32.00	2.00	5.00	10.00	28.00	18.00	44.00
Sub-Total	61.00	32.00	2.00	5.00	10.00	28.00	18.00	44.00
Huai Mong Basin								
Upper Stream	60.00	35.00	0.00	5.00	0.00	30.00	5.00	65.00
Middle Stream	55.00	25.00	5.00	15.00	5.00	10.00	30.00	55.00
Down Stream	50.00	45.00	5.00	0.00	5.00	5.00	30.00	60.00
Sub-Total	55.00	35.00	3.33	6.67	3.33	15.00	21.67	60.00
Nam Suai Basin								
Upper Stream	47.37	26.32	10.53	15.79	10.53	15.79	26.32	47.37
Down Stream	57.89	36.84	5.26	0.00	10.53	47.37	21.05	21.05
Sub-Total	52.63	31.85	7.89	7.89	10.53	31.58	23.68	34.21
Total	57.58	32.83	3.54	6.06	8.06	24.75	20.20	46.97
	Fetching Drinking Water				Home Industry			
	Good	Medium	Little	None	Good	Medium	Little	None
Huai Luan Basin								
Upper Stream	34.29	28.57	11.43	25.71	0.00	11.43	17.14	71.43
Middle Stream	40.00	20.00	22.86	17.14	8.57	8.57	11.43	71.43
Down Stream	40.00	20.00	26.67	13.33	3.33	6.67	16.67	73.33
Sub-Total	38.00	23.00	20.00	19.00	4.00	9.00	15.00	72.00
Huai Mong Basin								
Upper Stream	35.00	5.00	25.00	35.00	0.00	5.00	20.00	75.00
Middle Stream	20.00	25.00	10.00	45.00	5.00	10.00	15.00	70.00
Down Stream	20.00	20.00	15.00	45.00	0.00	5.00	25.00	70.00
Sub-Total	25.00	16.67	16.67	41.67	1.67	6.67	20.00	71.67
Nam Suai Basin								
Upper Stream	26.32	15.79	21.05	36.84	5.26	5.26	21.05	68.42
Down Stream	15.79	31.58	21.05	31.58	0.00	0.00	21.05	78.95
Sub-Total	21.05	23.68	21.05	34.21	2.63	2.63	21.05	73.68
Total	30.81	21.21	19.19	28.79	3.03	7.07	17.68	72.22

Source: Farm Economic Survey, Nov. 1996

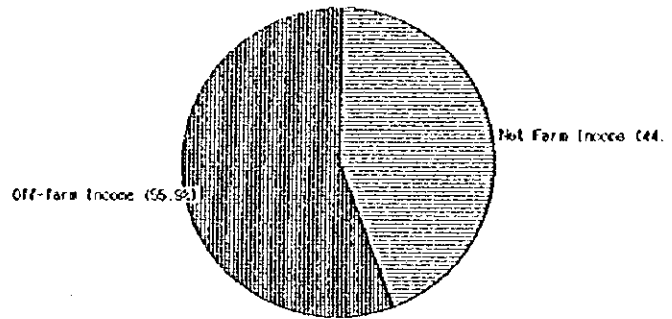
6. Farm Household Income per Year

Farm Household Income
Huaì Luang Upstream



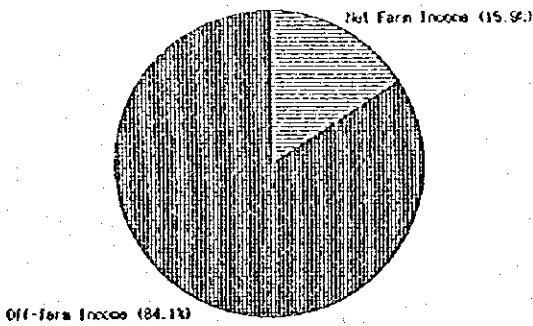
Net Farm Income/Family (B)	11,896
Off-farm income (B)	73,286
Total Income (B)	85,182

Farm Household Income
Huaì Hong Upstream



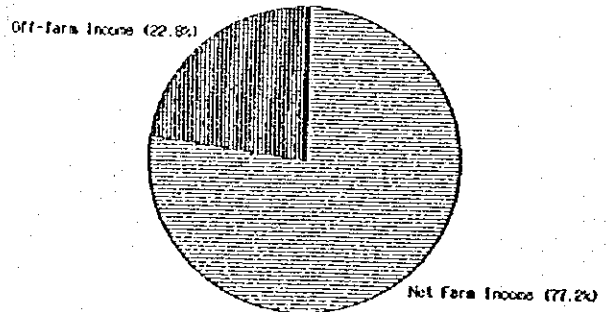
Net Farm Income/Family (B)	26,232
Off-farm income (B)	33,230
Total Income (B)	59,462

Farm Household Income
Huaì Luang Middlestream



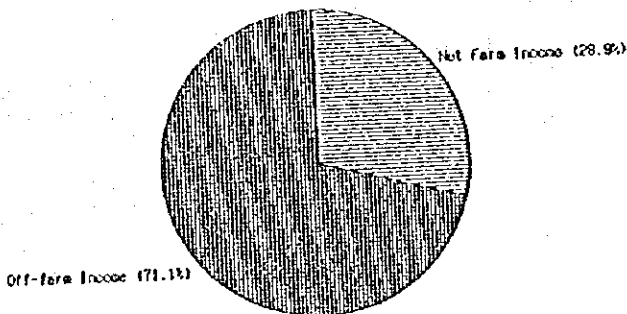
Net Farm Income/Family (B)	6,184
Off-farm income (B)	32,634
Total Income (B)	38,818

Farm Household Income
Huaì Hong Middlestream



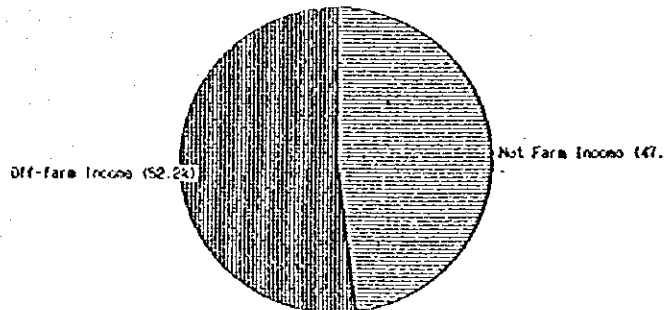
Net Farm Income/Family (B)	85,856
Off-farm income (B)	25,320
Total Income (B)	111,176

Farm Household Income
Huaì Luang Downstream



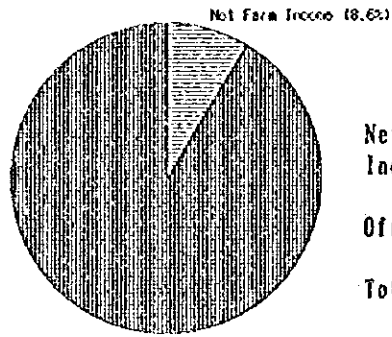
Net Farm Income/Family (B)	24,193
Off-farm income (B)	59,397
Total Income (B)	83,590

Farm Household Income
Huaì Hong Downstream



Net Farm Income/Family (B)	38,158
Off-farm income (B)	41,622
Total Income (B)	79,780

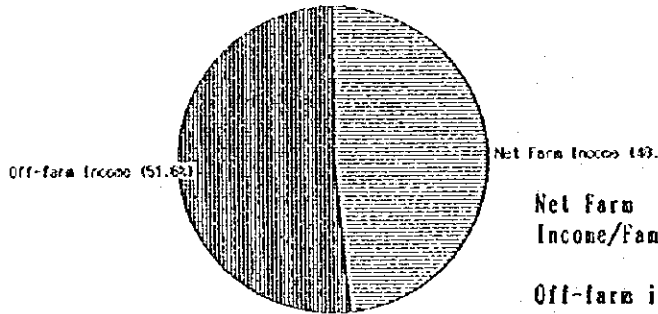
Farm Household Income
Nan Sui Upstream



Net Farm Income/Family (B)	3,833
Off-farm income (B)	40,955
Total Income (B)	44,788

Off-farm Income (91.4%)

Farm Household Income
Nan Sui Downstream



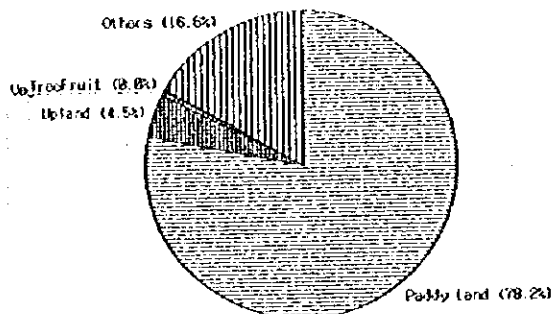
Net Farm Income/Family (B)	22,835
Off-farm income (B)	24,333
Total Income (B)	47,168

Off-farm Income (51.6%)

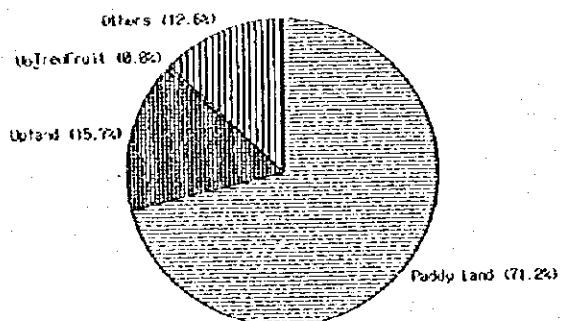
8. Irrigation

7. Land Use

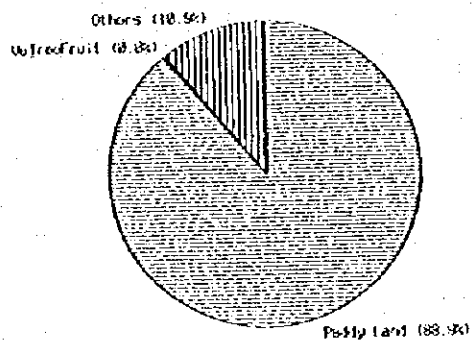
Huai Luang Basin



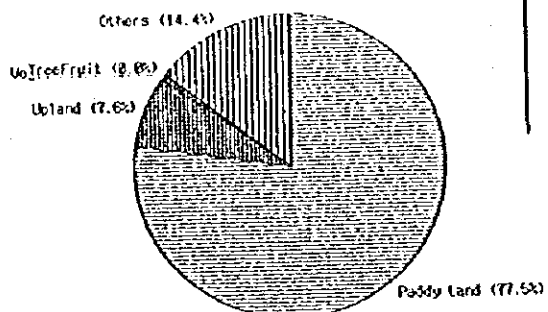
Land Use
Huai Luang Basin



Land Use
Nam Suai Basin

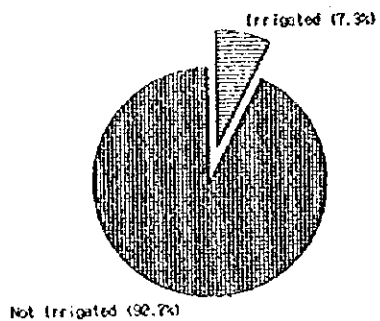


Land Use
Study Area

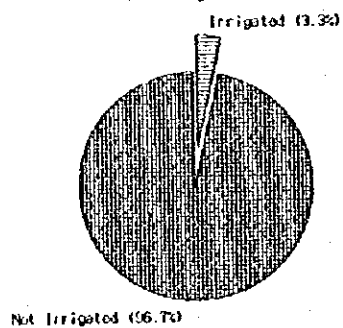


Huai Luang

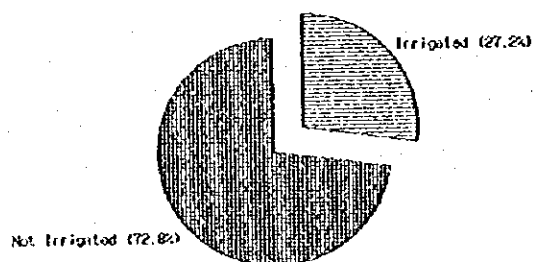
Huai Luang Upper



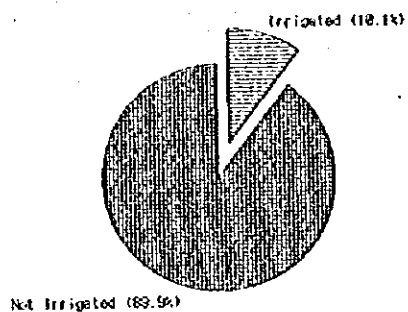
Irrigation
Huai Luang Middle



Irrigation
Huai Luang Lower

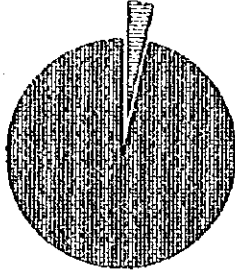


Irrigation
Huai Luang Overall



Huai Mong

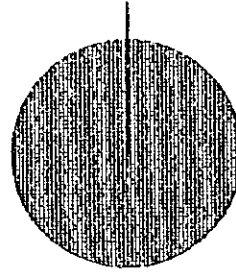
Huai Mong Upper
Irrigated (3.7%)



Not Irrigated (96.3%)

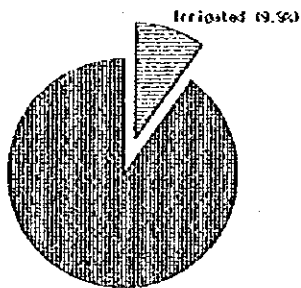
Nam Suai

Nam Suai Upper
Irrigated (0.0%)



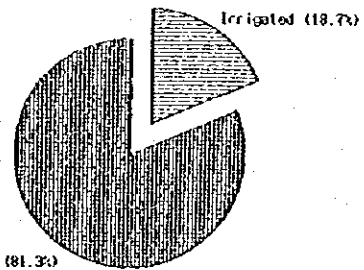
Not Irrigated (100.0%)

Irrigation
Huai Mong Middle



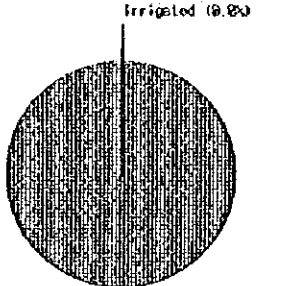
Not Irrigated (90.5%)

Irrigation
Nam Suai Lower



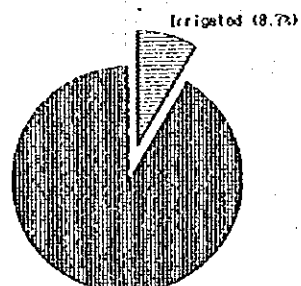
Not Irrigated (81.3%)

Irrigation
Huai Mong Lower



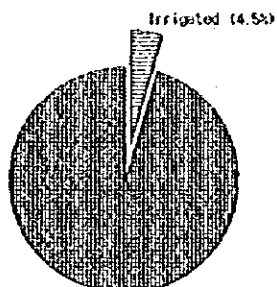
Not Irrigated (100.0%)

Irrigation
Nam Suai Overall



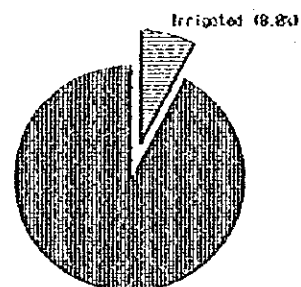
Not Irrigated (91.3%)

Irrigation
Huai Mong Overall



Not Irrigated (95.5%)

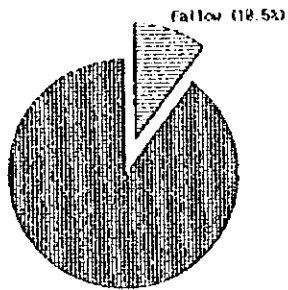
Irrigation
Study Area



Not Irrigated (91.2%)

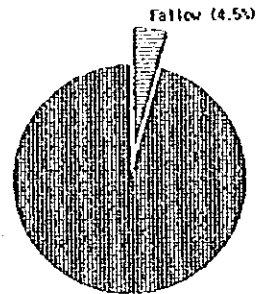
9. Fallow Land

Huai Luang Upper



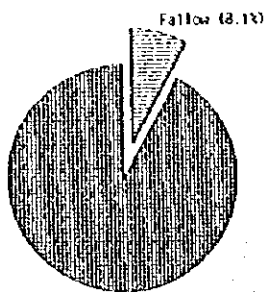
Planted/others (89.5%)

Fallow Land
Huai Hong Upper



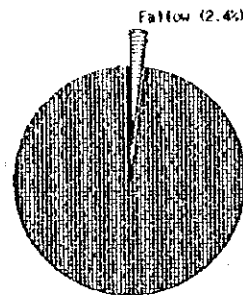
Planted/others (95.5%)

Fallow Land
Huai Luang Middle



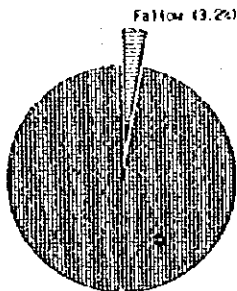
Planted/others (91.9%)

Fallow Land
Huai Hong Middle



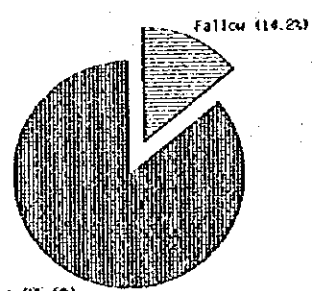
Planted/others (97.6%)

Fallow Land
Huai Luang Lower



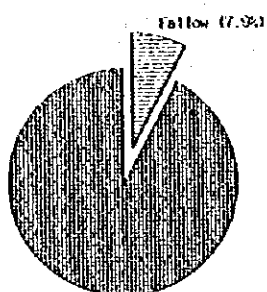
Planted/others (96.8%)

Fallow Land
Huai Hong Lower



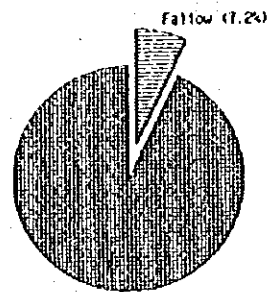
Planted/others (85.8%)

Fallow Land
Huai Luang Overall



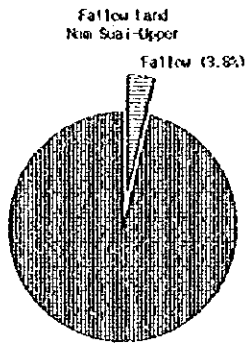
Planted/others (92.1%)

Fallow Land
Huai Hong Overall

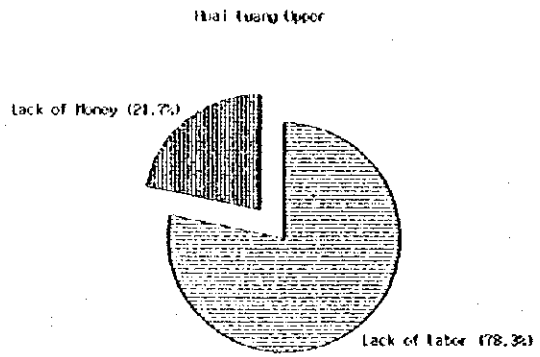


Planted/others (92.8%)

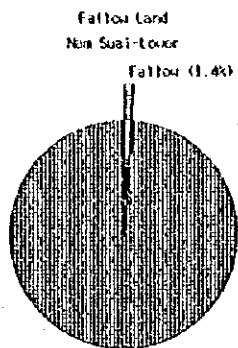
10. Reason for Fallow Land



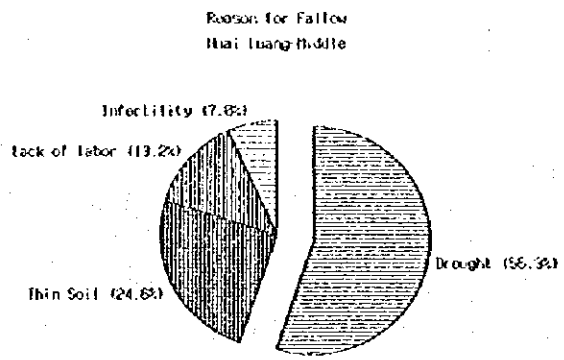
Planted/others (96.2%)



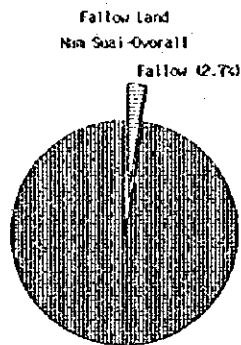
Lack of labor (78.3%)



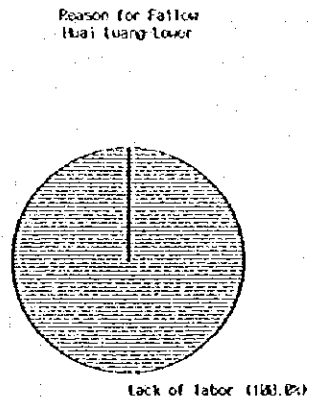
Planted/others (98.6%)



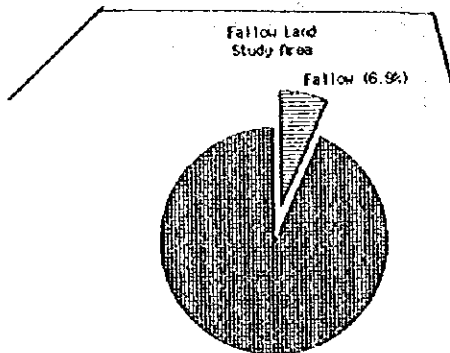
Drought (56.3%)



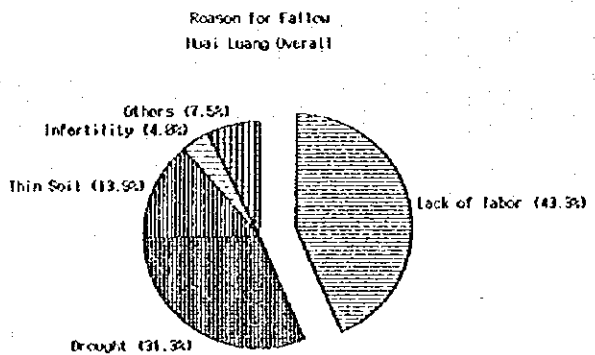
Planted/others (97.3%)



Lack of labor (100.0%)

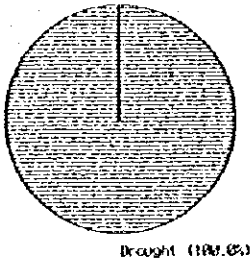


Planted/others (93.2%)

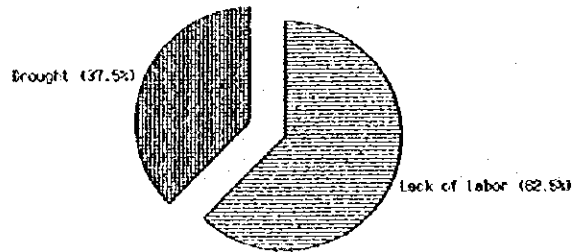


Lack of labor (43.3%)

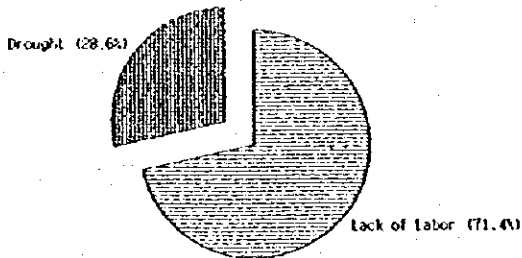
Reason for Fallow
Hwai Hong Upper



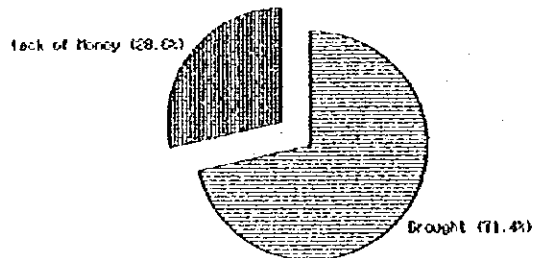
Reason for Fallow
Nua Sui-Upper



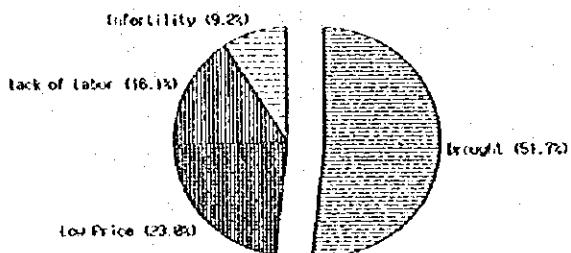
Reason for Fallow
Hwai Hong Middle



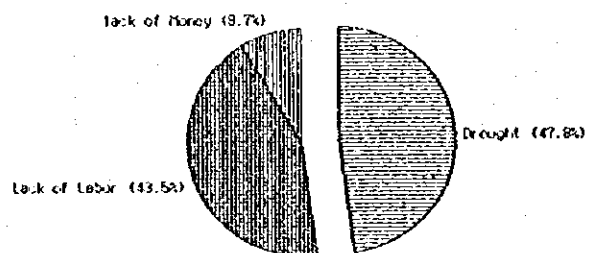
Reason for Fallow
Nua Sui-Lower



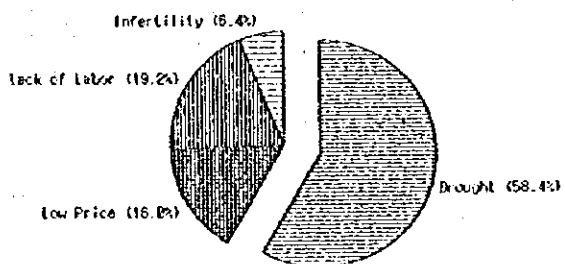
Reason for Fallow
Hwai Hong Lower



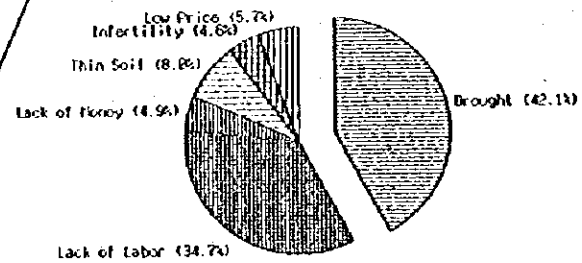
Reason for Fallow
Nua Sui-Overall



Reason for Fallow
Hwai Hong Overall

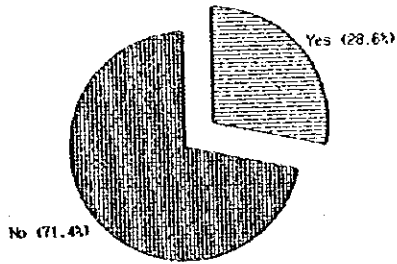


Reason for Fallow
Study Area

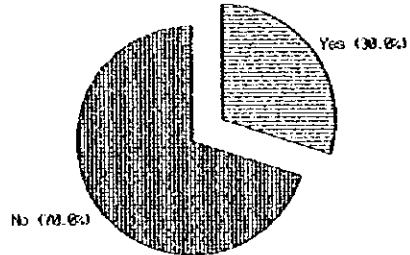


II. Migrant Workers

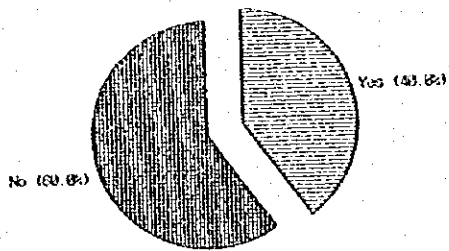
Huai Luang Upper



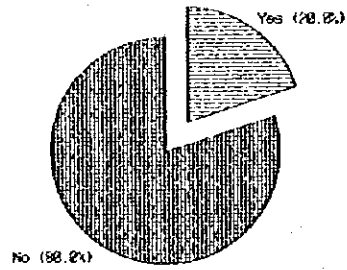
Migrant Workers
Huai Hong Upper



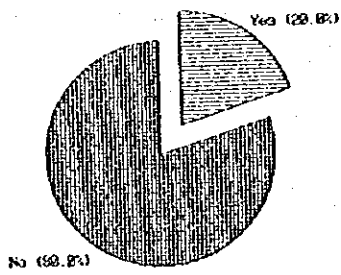
Migrant Workers
Huai Luang Middle



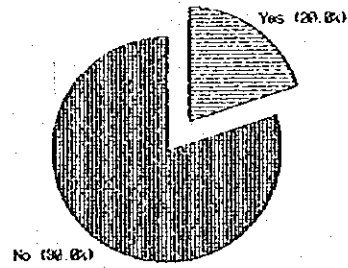
Migrant Workers
Huai Hong Middle



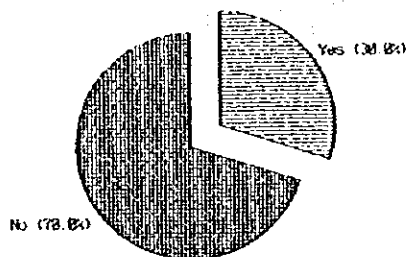
Migrant Workers
Huai Luang Lower



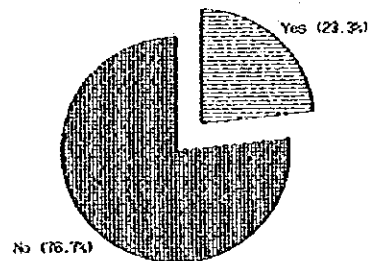
Migrant Workers
Huai Hong Lower



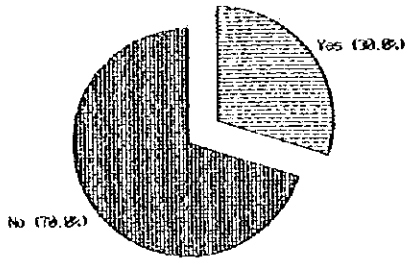
Migrant Workers
Huai Luang Overall



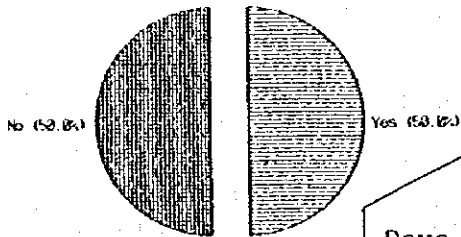
Migrant Workers
Huai Hong Overall



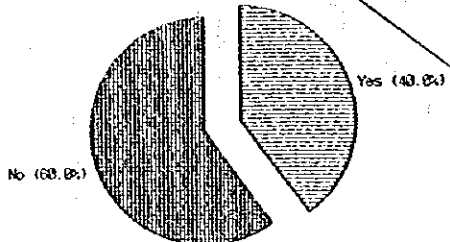
Migrant Workers
Nam Suai-Upper



Migrant Workers
Nam Suai-Lower



Migrant Workers
Nam Suai-Overall



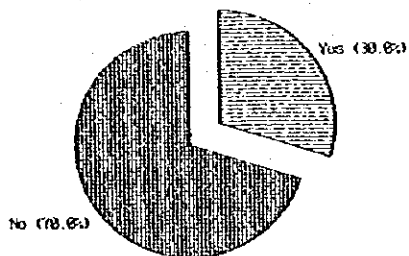
Days worked as migrant workers -- Average 105 days
Places being worked

Bangkok	35%
Inside province	48%
Other regions	11%

Average annual income from migrant works

16,270 Bahts/Farm household

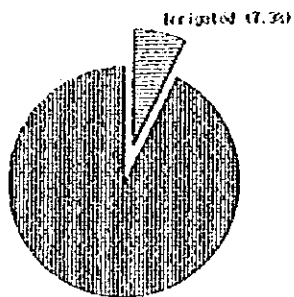
Migrant Workers
Study area



12. Relationship Between Irrigation and Farm Income

Huai Luang

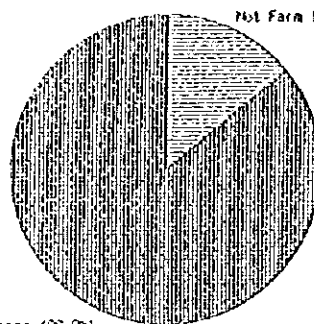
Huai Luang Upper



Not Irrigated (92.7%)

Farm Household Income

Huai Luang Upstream

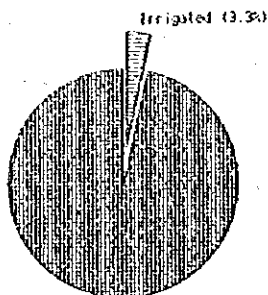


Off-farm Income (85.4%)

Net Farm Income/Family (8)	11,896
Off-farm income (8)	73,286
Total Income (8)	85,182

Irrigation

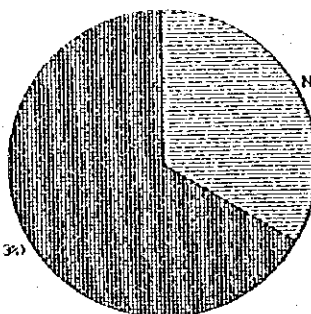
Huai Luang Middle



Not Irrigated (96.7%)

Farm Household Income

Huai Luang Middlestream

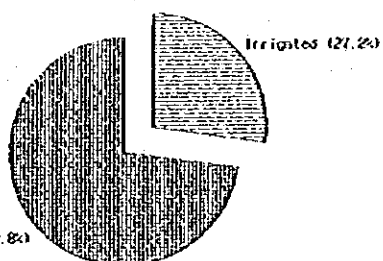


Off-farm Income (66.3%)

Net Farm Income/Family (8)	16,573
Off-farm income (8)	32,634
Total income (8)	49,207

Irrigation

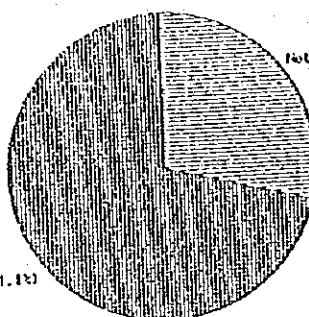
Huai Luang-Lower



Not Irrigated (72.8%)

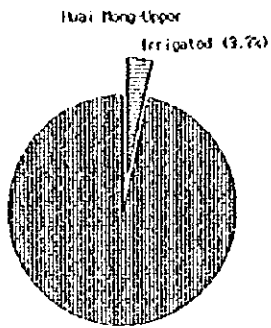
Farm Household Income

Huai Luang Downstream



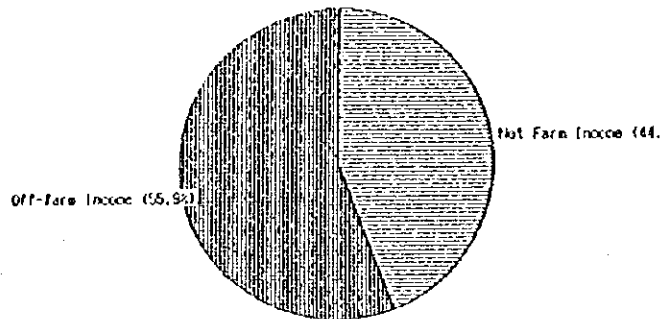
Off-farm Income (71.1%)

Net Farm Income/Family (8)	24,193
Off-farm income (8)	59,397
Total income (8)	83,590



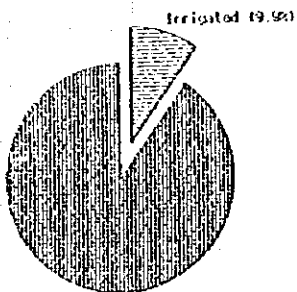
Not Irrigated (96.7%)

Farm Household Income
Ibajong Upstream



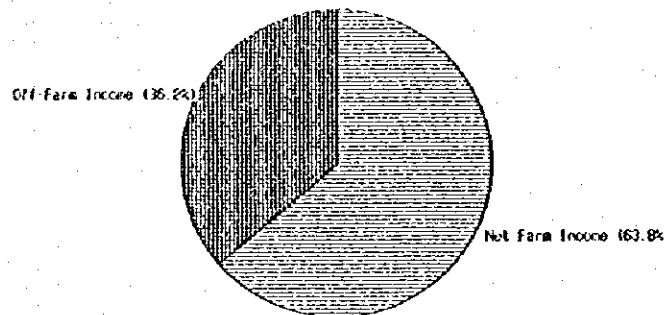
Net Farm Income/Family (B)	26,232
Off-farm income (B)	33,230
Total Income (B)	59,462

Irrigation
Ibajong Middle



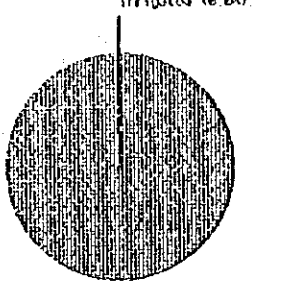
Not Irrigated (90.1%)

Farm Household Income
Ibajong Middlestream



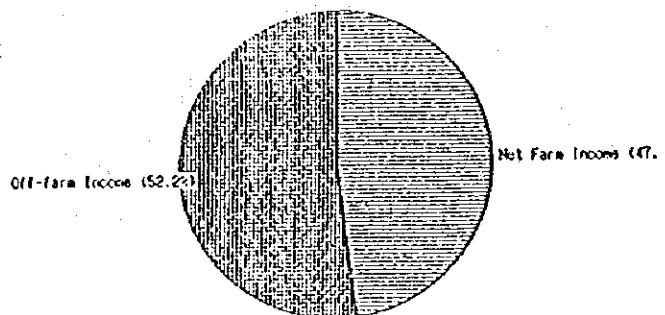
Net Farm Income/Family (B)	44,582
Off-farm income (B)	25,320
Total Income (B)	69,902

Irrigation
Ibajong Lower

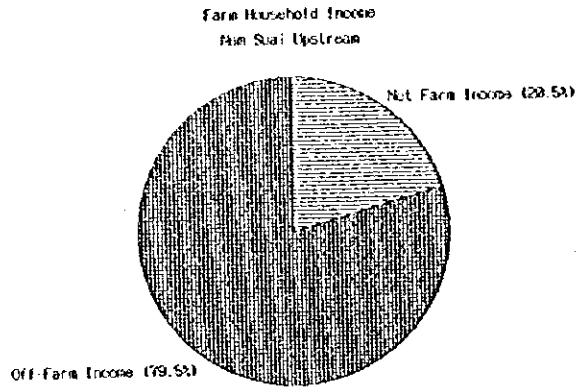
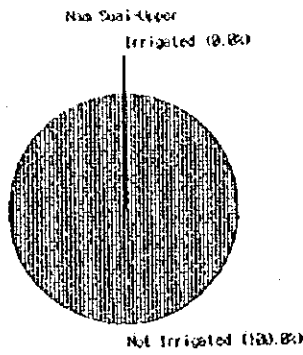


Not Irrigated (99.0%)

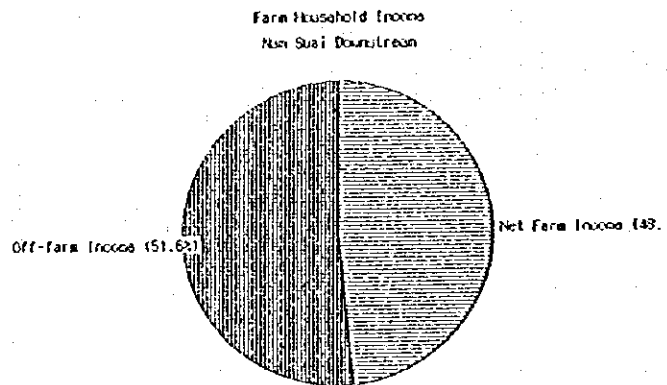
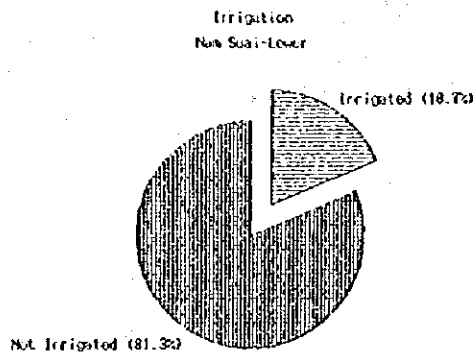
Farm Household Income
Ibajong Downstream



Net Farm Income/Family (B)	38,158
Off-farm income (B)	41,622
Total Income (B)	79,780

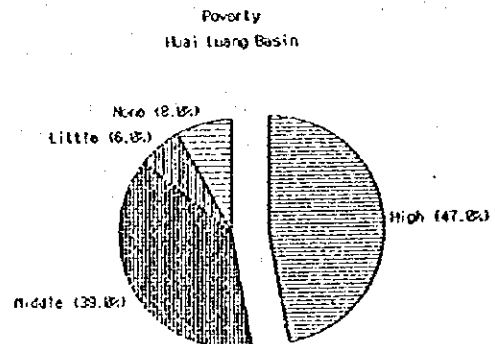
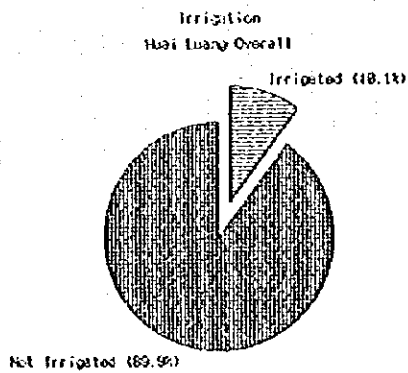
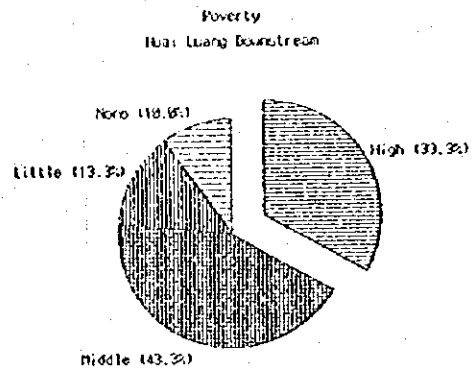
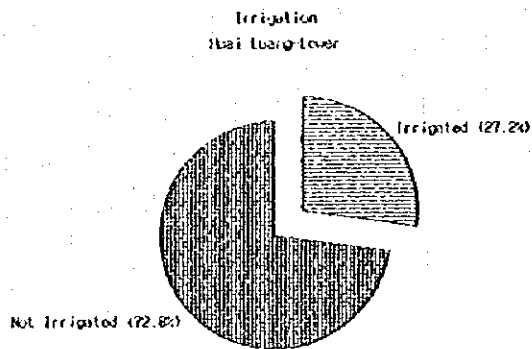
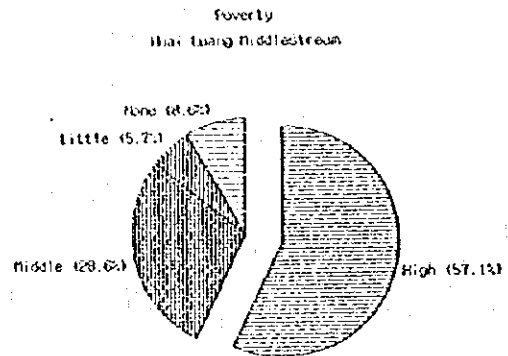
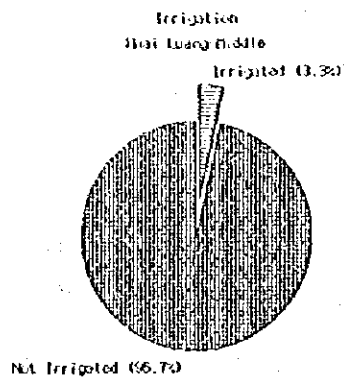
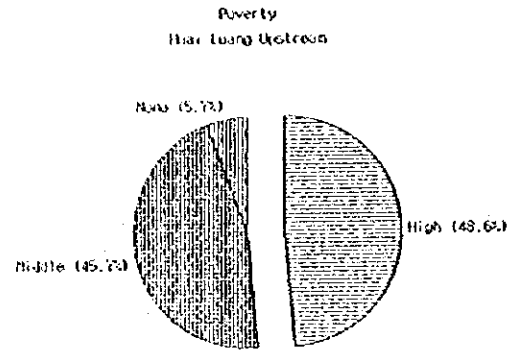
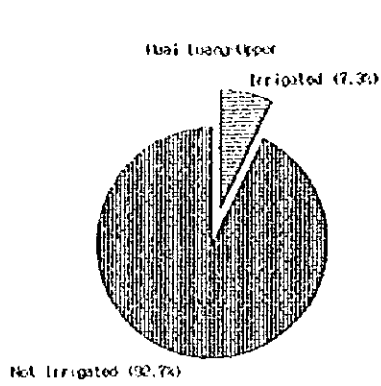


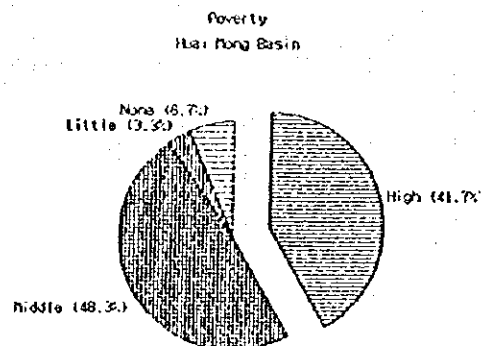
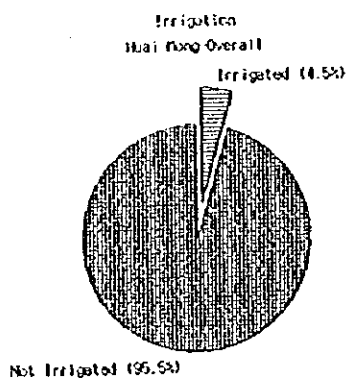
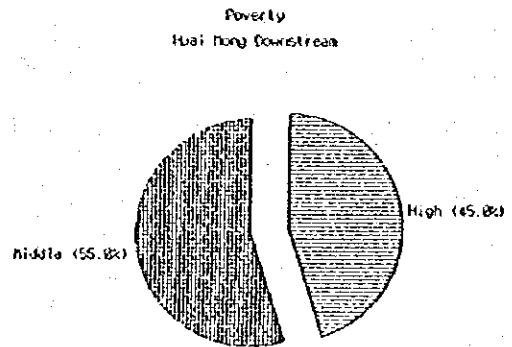
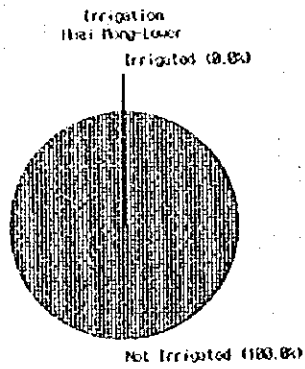
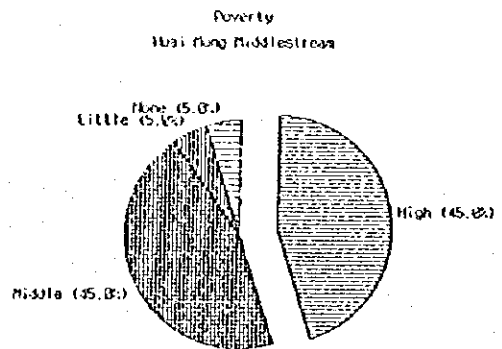
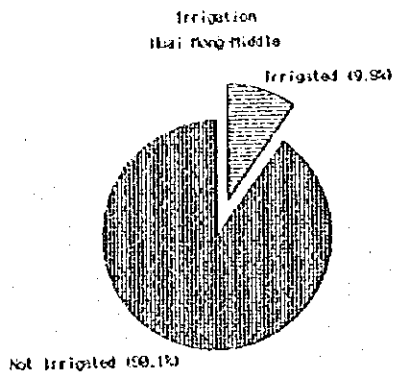
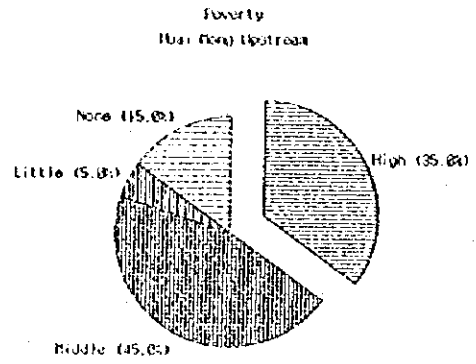
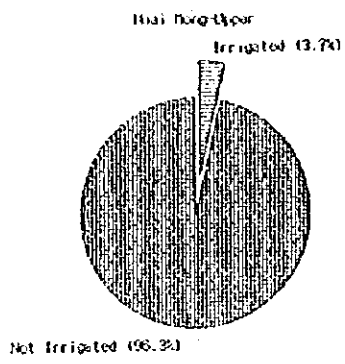
Net Farm Income/Family (B)	10,545
Off-farm income (B)	40,955
Total Income (B)	51,500

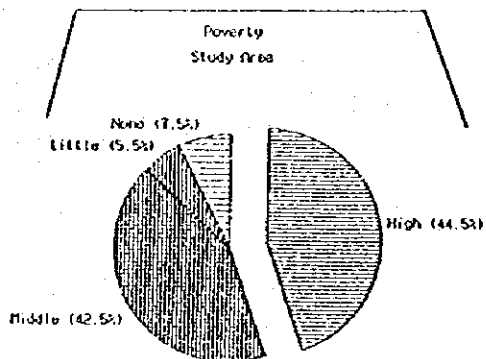
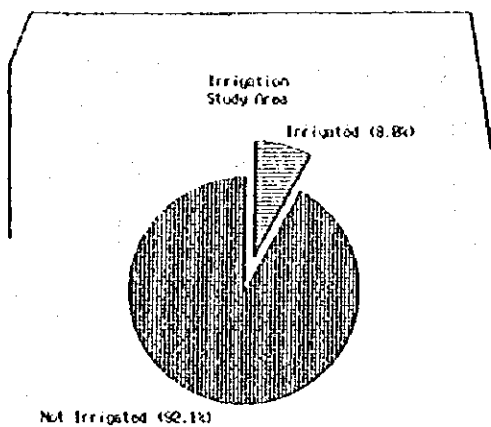
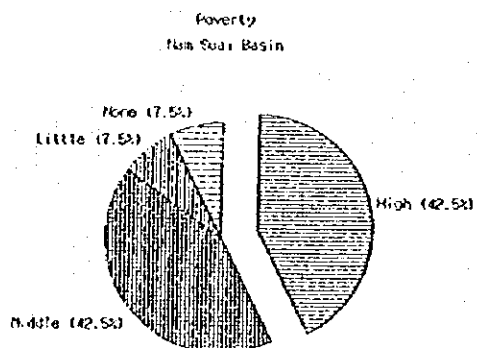
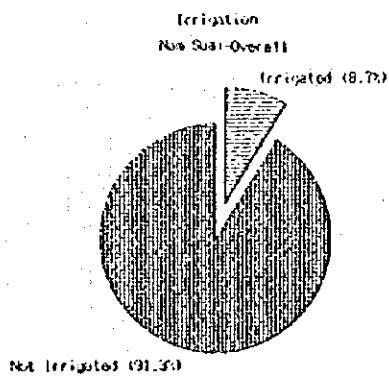
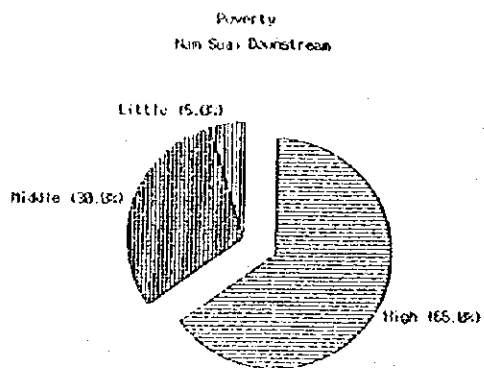
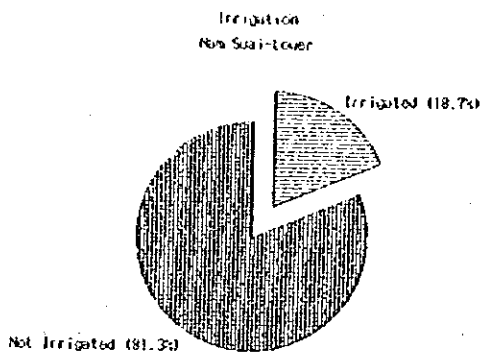
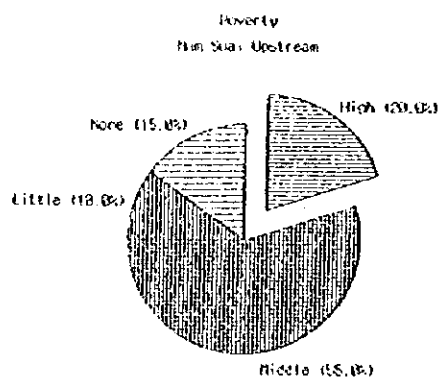
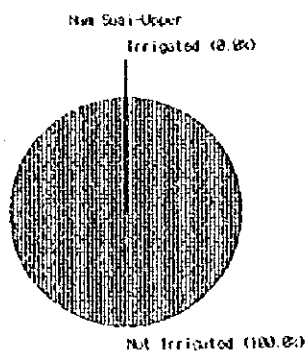


Net Farm Income/Family (B)	22,835
Off-farm income (B)	24,333
Total Income (B)	47,168

13. Relationship Between Irrigation and Poverty

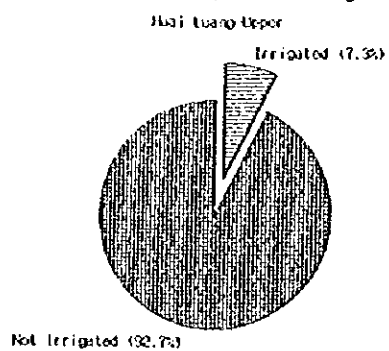




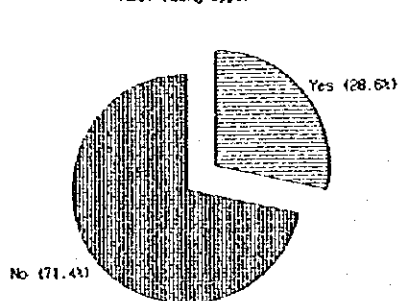


14. Relationship Between Irrigation and Migrant Workers

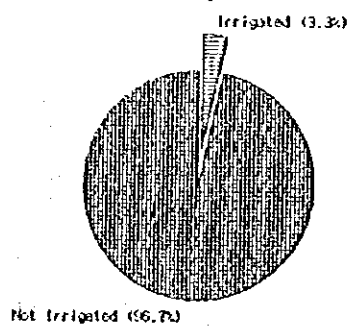
Irrigation
Huai Luang



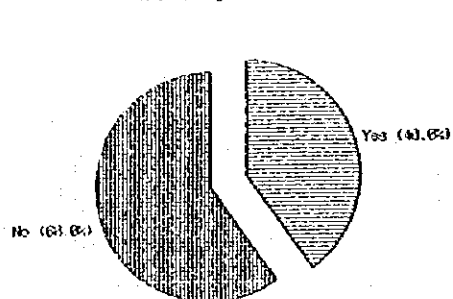
Migrant Workers
Huai Luang-Upper



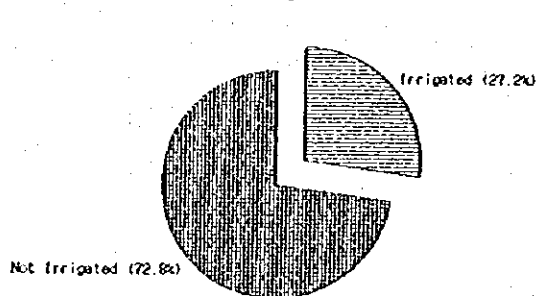
Irrigation
Huai Luang-Middle



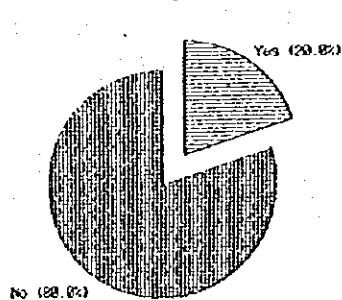
Migrant Workers
Huai Luang-Middle



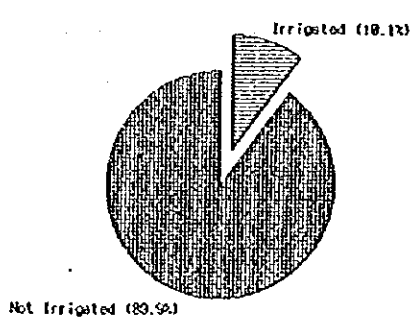
Irrigation
Huai Luang-Lower



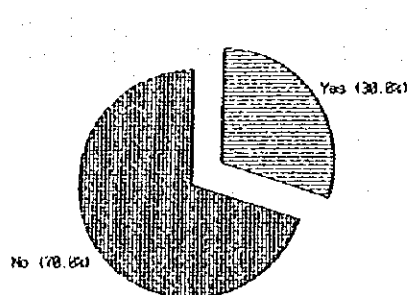
Migrant Workers
Huai Luang-Lower



Irrigation
Huai Luang-Overall



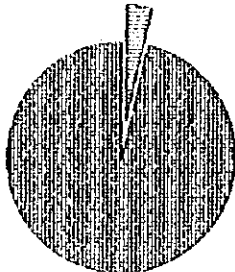
Migrant Workers
Huai Luang-Overall



Huai Mong

Huai Mong-Upper

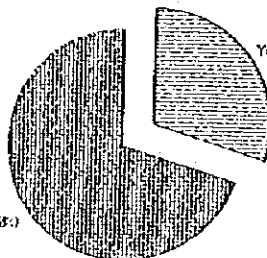
Irrigated (3.7%)



Not Irrigated (96.3%)

Migrant Workers
Huai Mong-Upper

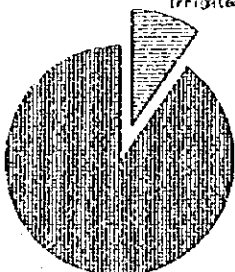
Yes (30.8%)



No (69.2%)

Irrigation
Huai Mong-Middle

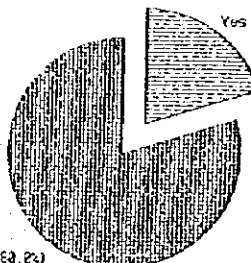
Irrigated (9.9%)



Not Irrigated (90.1%)

Migrant Workers
Huai Mong-Middle

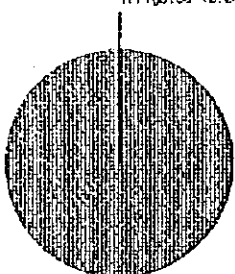
Yes (20.8%)



No (79.2%)

Irrigation
Huai Mong-Lower

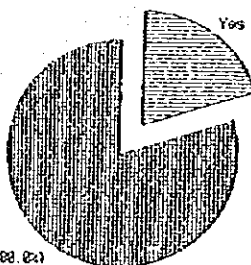
Irrigated (0.8%)



Not Irrigated (99.2%)

Migrant Workers
Huai Mong-Lower

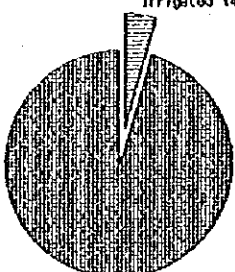
Yes (20.8%)



No (79.2%)

Irrigation
Huai Mong-Overall

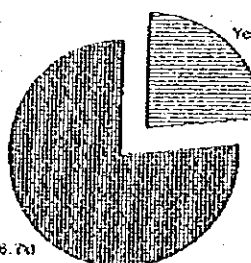
Irrigated (4.5%)



Not Irrigated (95.5%)

Migrant Workers
Huai Mong-Overall

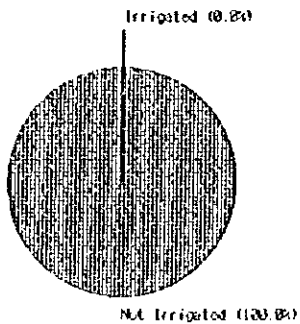
Yes (23.3%)



No (76.7%)

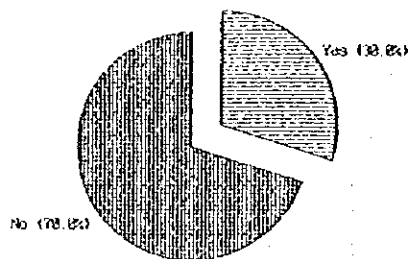
Nam Suai

Nam Suai-Upper



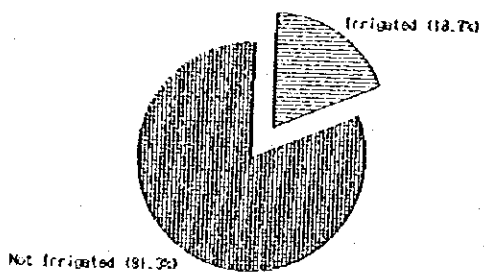
Migrant Workers

Nam Suai-Upper



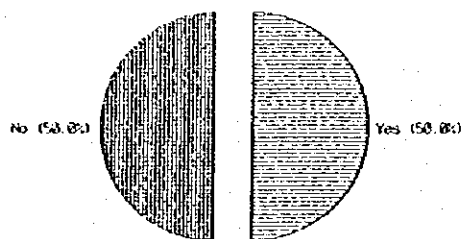
Irrigation

Nam Suai-Lower



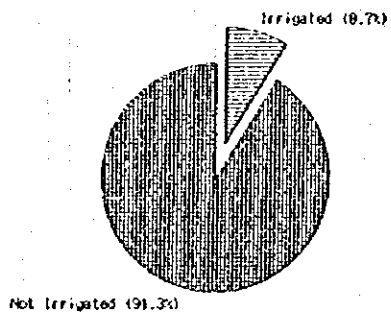
Migrant Workers

Nam Suai-Lower



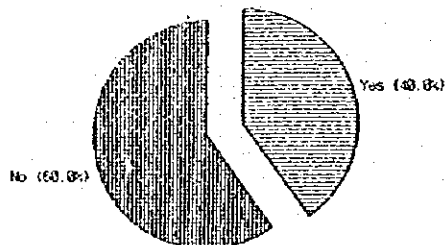
Irrigation

Nam Suai-Overall



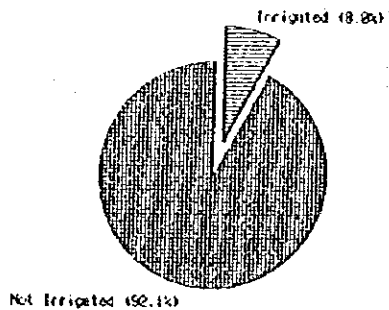
Migrant Workers

Nam Suai-Overall



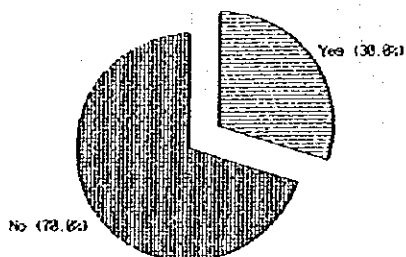
Irrigation

Study Area



Migrant Workers

Study Area



15. Crops Planted by River Basin

Huai Luang

Crops	Upper		Middle		Lower	
	Area (rai)	Farms Reported	Area (rai)	Farms Reported	Area (rai)	Farms Reported
Huai Luang						
Non-glutinous rice (TP)						
wet season	141.50	16	213.00	16	22.00	3
dry season	10.00	1	0.00	0	0.00	0
Glutinous rice (TP)						
wet season	556.50	33	583.00	35	302.50	27
dry season	19.00	2	0.00	0	0.00	0
Non-glutinous rice (BC)						
wet season	22.00	1	24.00	2	24.00	2
dry season	0.00	0	0.00	0	0.00	0
Glutinous rice (BC)						
wet season	10.00	1	15.00	1	49.00	2
dry season	0.00	0	0.00	0	0.00	0
Upland/Glutinous						
wet season	14.00	1	6.00	1	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Maize						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Sweet Corn						
wet season	3.00	1	6.00	1	0.00	0
dry season	0.00	0	0.00	0	3.00	1
Cassava						
wet season	0.00	0	0.00	0	107.00	9
dry season	0.00	0	0.00	0	0.00	0
Groundnut						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	1.50	2
Soybeans						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Sugarcane						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Tomatoes						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	2.00	1
Cucumber						
wet season	0.00	0	0.00	0	0.00	0
dry season	2.00	1	0.00	0	0.00	0
Stringbeans						
wet season	0.00	0	0.00	0	1.50	1
dry season	0.00	0	0.00	0	0.00	0
Yambeans						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	2.00	1
Pumpkin						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Crysanthemum						
wet season (3 times)	0.00	0	0.00	0	14.00	7
dry season (3 times)	0.00	0	0.00	0	8.00	5
Jasmine						
wet season	0.00	0	0.00	0	2.00	1
dry season	0.00	0	0.00	0	0.00	0
Mango						
	2.00	1	0.00	0	3.00	1

Crops Planted by River Basin Huai Mong

Crops	Upper		Middle		Lower	
	Area (rai)	Farms Reported	Area (rai)	Farms Reported	Area (rai)	Farms Reported
huai Mong						
Non-glutinous rice (TP)						
wet season	71.00	10	68.00	4	36.50	2
dry season	0.00	0	396.00	20	0.00	0
Glutinous rice (TP)						
wet season	243.00	15	0.00	0	313.75	16
dry season	0.00	0	0.00	0	0.00	0
Non-glutinous rice (BC)						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Glutinous rice (BC)						
wet season	21.00	2	0.00	0	72.50	5
dry season	0.00	0	0.00	0	0.00	0
Upland/Glutinous						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Maize						
wet season	0.00	0	0.00	0	20.00	1
dry season	0.00	0	0.00	0	0.00	0
Sweet Corn						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Cassava						
wet season	129.00	6	0.00	0	49.00	3
dry season	0.00	0	0.00	0	0.00	0
Groundnut						
wet season	0	0	0.00	0	0.00	0
dry season	2.00	1	0.00	0	0.00	0
Soybeans						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	6.00	1	0.00	0
Sugarcane						
wet season	0.00	0	71.00	4	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Tomatoes						
wet season	2.50	1	0.00	0	0.00	0
dry season	10.00	4	4.00	1	0.00	0
Cucumber						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Stringbeans						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Yambeans						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Pumpkin						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Crysanthemum						
wet season (3 t)	0.00	0	0.00	0	0.00	0
dry season (3 t)	0.00	0	0.00	0	0.00	0
Jasmine						
wet season	0.00	0	0.00	0	0.00	0
dry season	0.00	0	0.00	0	0.00	0
Mango						
	0.00	0	0.00	0	0.00	0

Crops Planted by River Basin Nam Suai

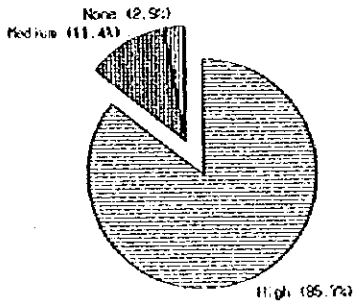
Crops	Upper		Lower	
	Area (rai)	Farms Reported	Area (rai)	Farms Reported
Nam Suai				
Non-glutinous rice (TP)				
wet season	84.50	9	24.00	4
dry season	0.00	0	0.00	0
Glutinous rice (TP)				
wet season	250.50	18	300.00	20
dry season	0.00	0	0.00	0
Non-glutinous rice (BC)				
wet season	8.00	1	0.00	0
dry season	0.00	0	0.00	0
Glutinous rice (BC)				
wet season	28.00	2	0.00	0
dry season	0.00	0	0.00	0
Upland/Glutinous				
wet season	0.00	0	8.00	1
dry season	0.00	0	0.00	0
Maize				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Sweet Corn				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Cassava				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Groundnut				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Soybeans				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Sugarcane				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Tomatoes				
wet season	0.00	0	0.00	0
dry season	0.00	0	12.00	3
Cucumber				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Stringbeans				
dry season 1	0.00	0	1.00	1
dry season 2	0.00	0	1.00	1
Yanbeans				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Pumpkin				
wet season	0.00	0	0.00	0
dry season	0.00	0	2.00	1
Crysanthemum				
wet season (3 times)	0.00	0	0.00	0
dry season (3 times)	0.00	0	0.00	0
Jasmine				
wet season	0.00	0	0.00	0
dry season	0.00	0	0.00	0
Mango				
	0.00	0	0.00	0

16. Estimated Cropping Intensity

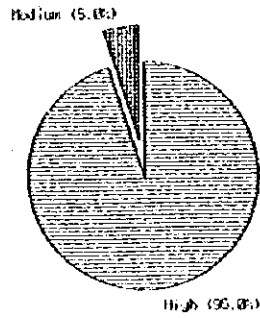
		rai	÷	rai	=	%
Huai Luang	Upper	780	÷	926.15	=	84.2
	Middle	847.0	÷	1032.2	=	82.06
	Lower	541.5	÷	540.6	=	100.17
	Total	2168.5	÷	2498.95	=	86.78
<hr/>						
Huai Mong	Upper	490.5	÷	519.4	=	94.44
	Middle	545.5	÷	568.4	=	95.95
	Lower	491.75	÷	596.6	=	82.43
	Total	1527.75	÷	1684.4	=	90.70
<hr/>						
Nam Suai	Upper	371.0	÷	407.0	=	91.15
	Lower	348.0	÷	350.0	=	99.43
	Total	719.0	÷	757.0	=	94.98
<hr/>						
Grand Total		4415.25	÷	4940.35	=	89.37%

17. Problems by River Basin
17.1 Lack of Water

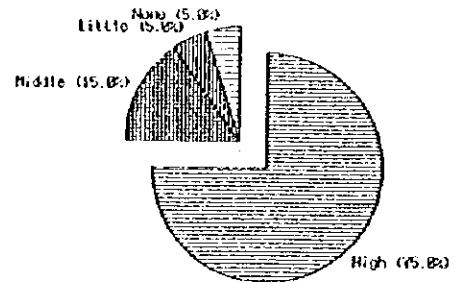
Lack of water
Huai Luang Upstream



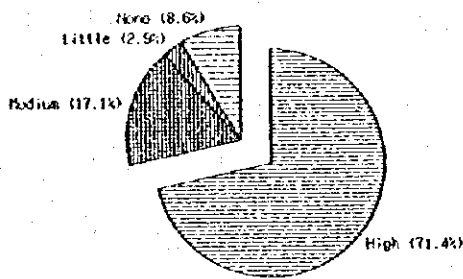
Lack of Water
Huai Mong Upstream



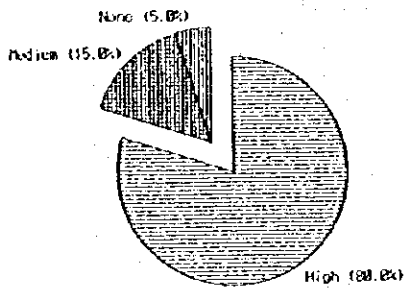
Lack of Water
Nam Suai Upstream



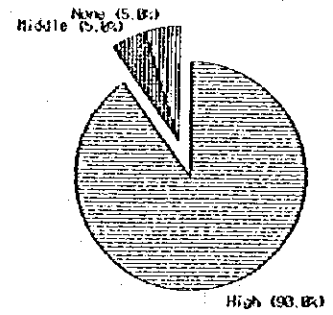
Lack of Water
Huai Luang Middlestream



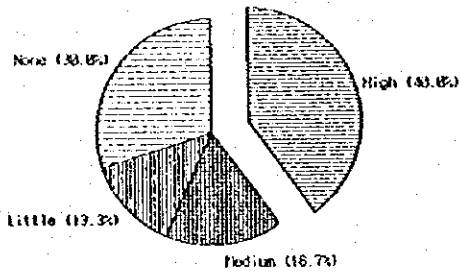
Lack of Water
Huai Mong Middlestream



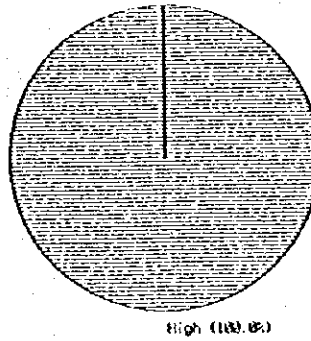
Lack of Water
Nam Suai Downstream



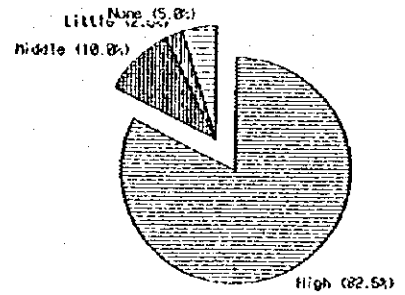
Lack of Water
Huai Luang Downstream



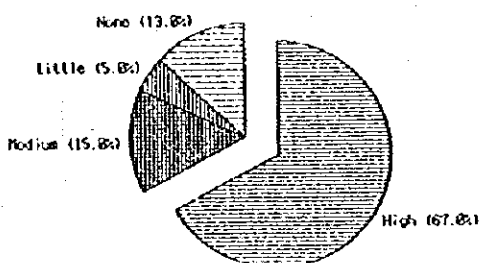
Lack of Water
Huai Mong Downstream



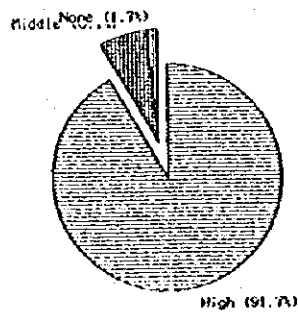
Lack of Water
Nam Suai Basin



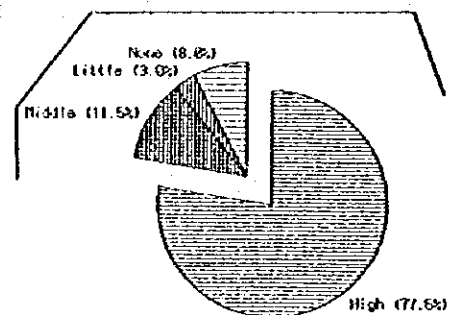
Lack of Water
Huai Luang Basin



Lack of Water
Huai Mong Basin

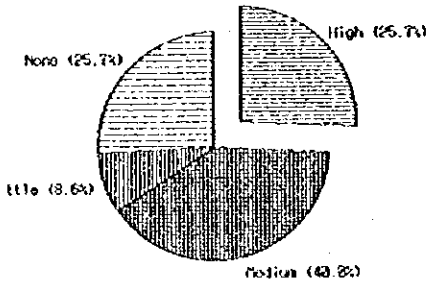


Lack of Water
Study Area

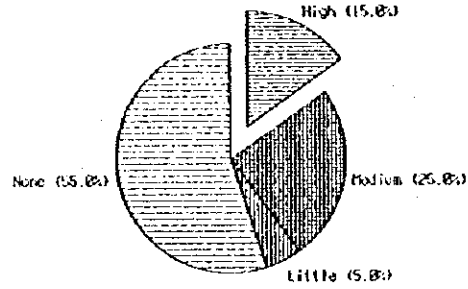


17.2 Low Fertility of Soil

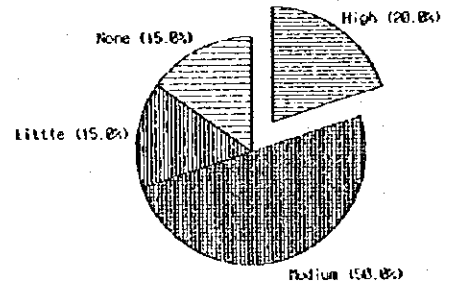
Low Fertility of Soil
Huai Luang Upstream



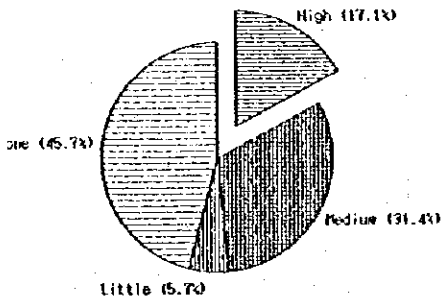
Low Fertility of Soil
Huai Hong Upstream



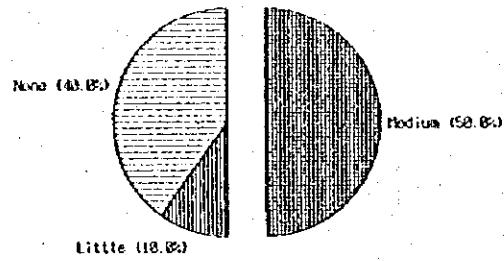
Low Fertility of Soil
Nam Suai Upstream



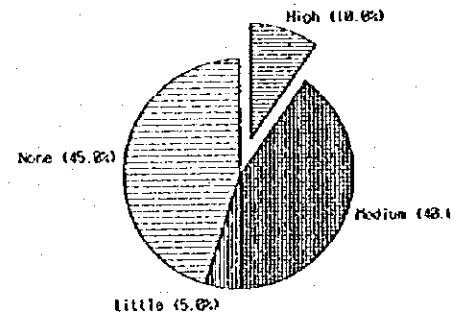
Low Fertility of Soil
Huai Luang Middlestream



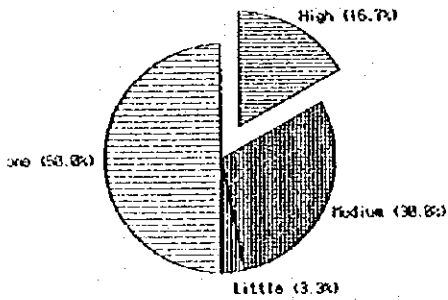
Low Fertility of Soil
Huai Hong Middlestream



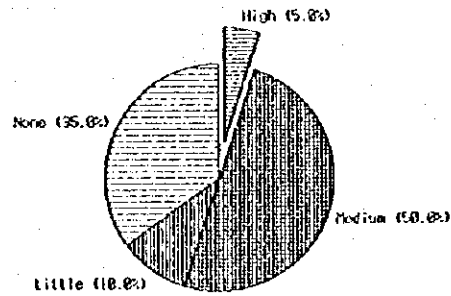
Low Fertility of Soil
Nam Suai Downstream



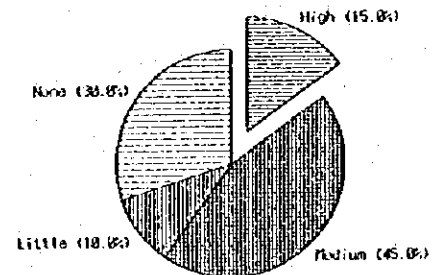
Low Fertility of Soil
Huai Luang Downstream



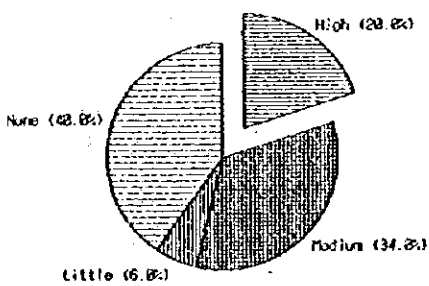
Low Fertility of Soil
Huai Hong Downstream



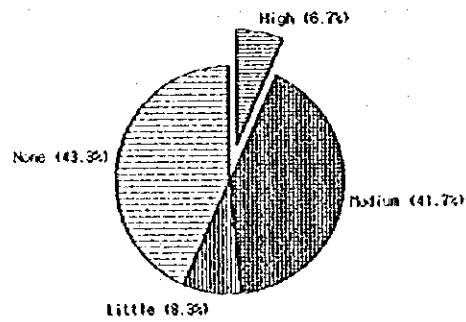
Low Fertility of Soil
Nam Suai Basin



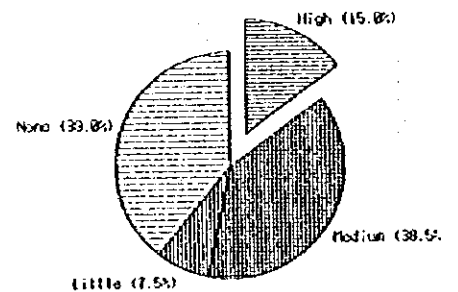
Low Fertility of Soil
Huai Luang Basin



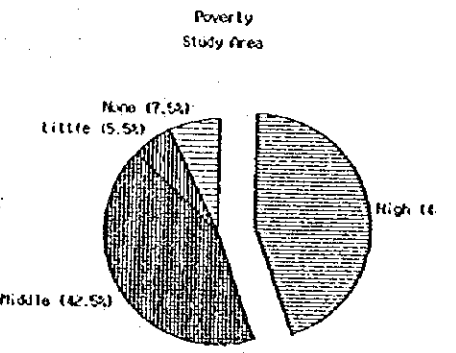
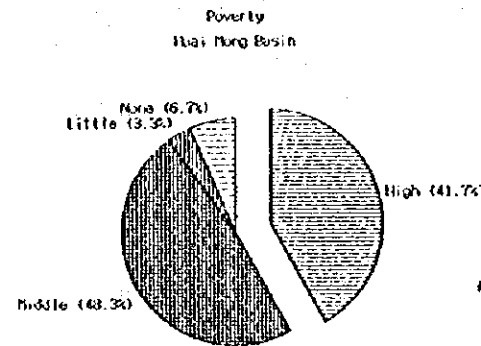
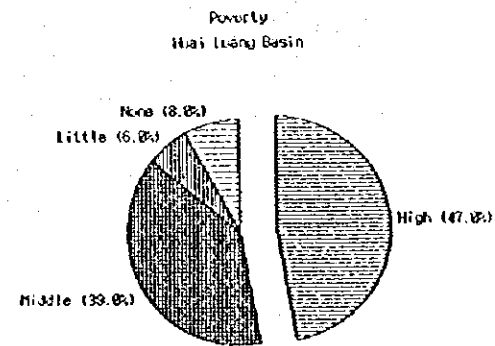
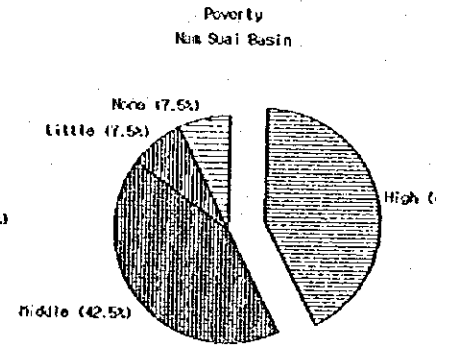
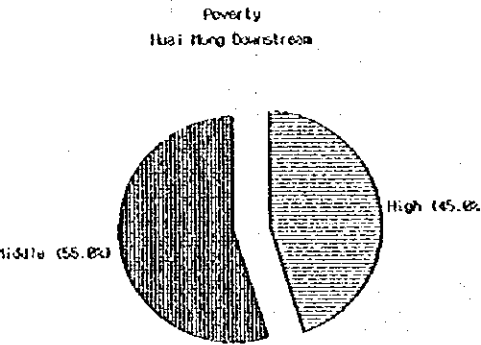
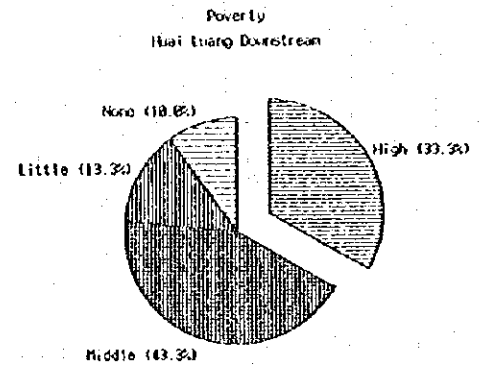
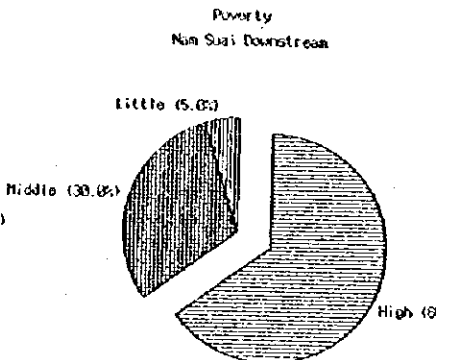
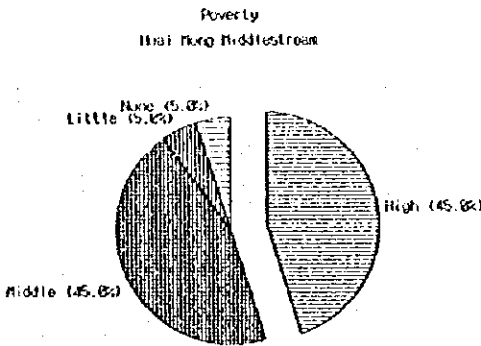
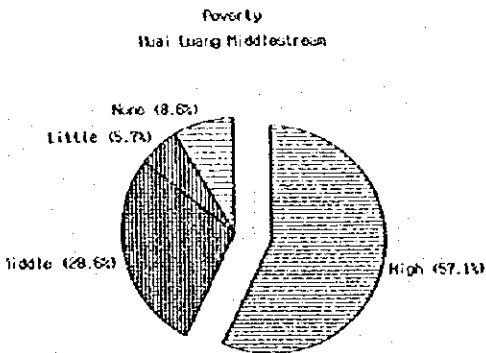
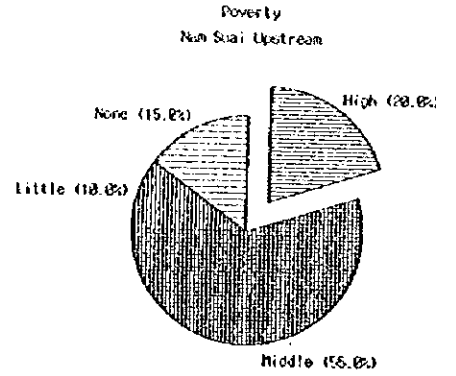
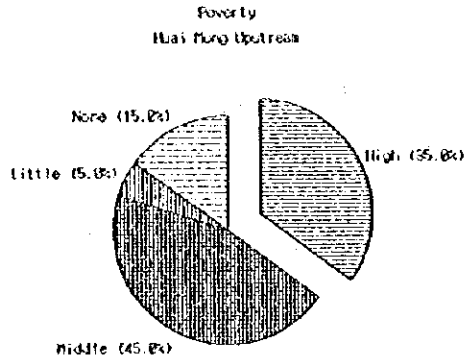
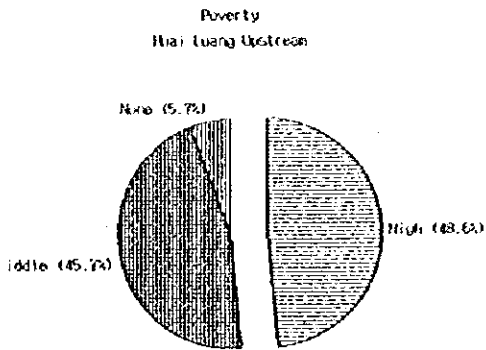
Low Fertility of Soil
Huai Hong Basin



Low Fertility of Soil
Study Area

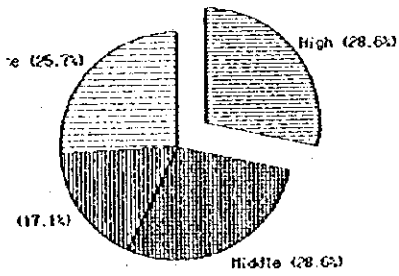


17.3 Poverty

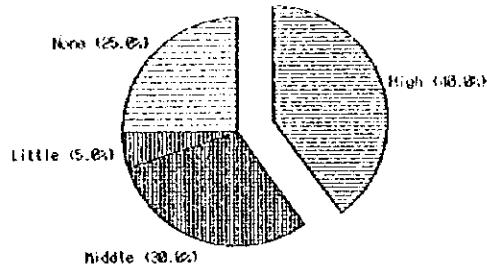


17.4 Few Employment Opportunity

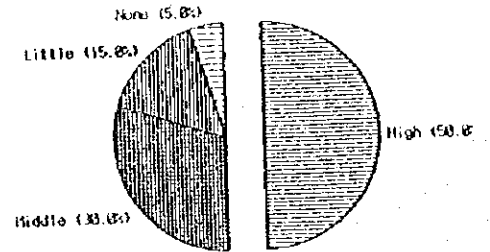
Few Employment Opportunity
Huai Luang Upstream



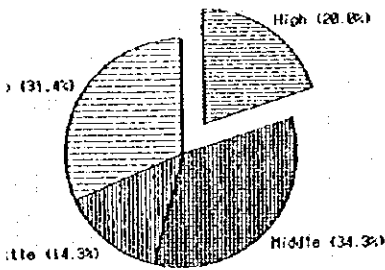
Few Employment Opportunity
Huai Hong Upstream



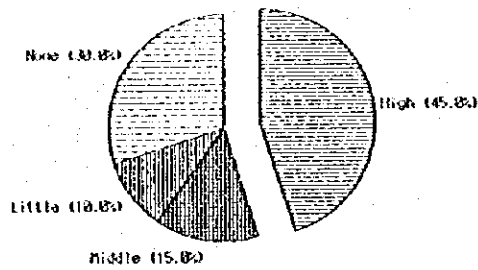
Few Employment Opportunity
Nam Suai Upstream



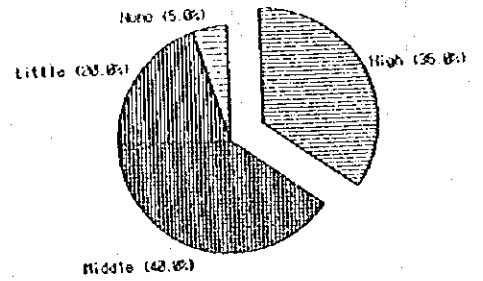
Few Employment Opportunity
Huai Luang Middlestream



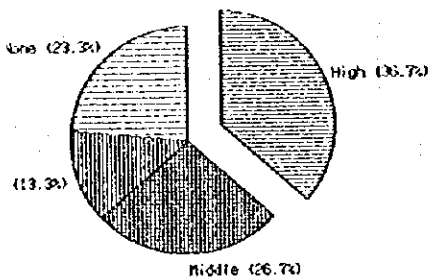
Few Employment Opportunity
Huai Hong Middlestream



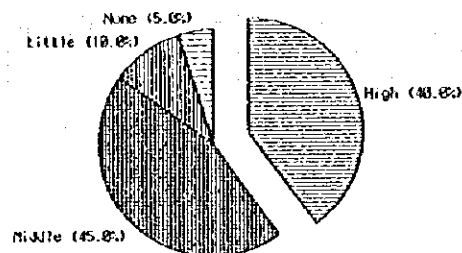
Few Employment Opportunity
Nam Suai Downstream



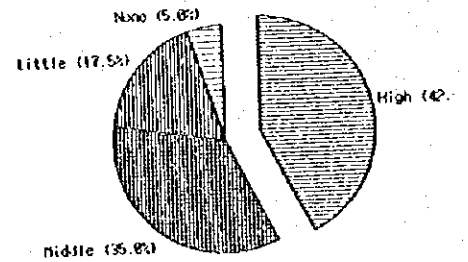
Few Employment Opportunity
Huai Luang Downstream



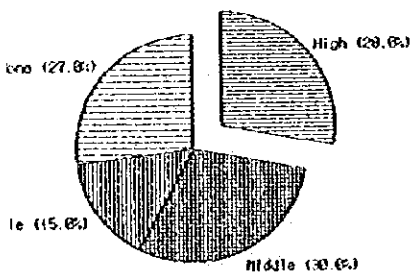
Few Employment Opportunity
Huai Hong Downstream



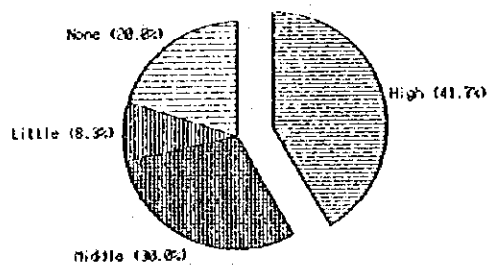
Few Employment Opportunity
Nam Suai Basin



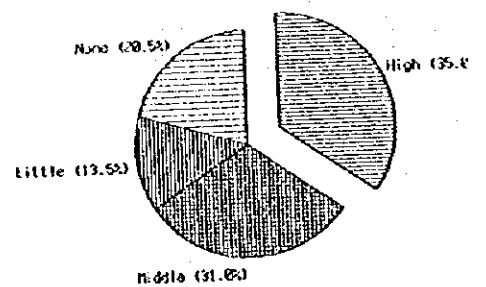
Few Employment Opportunity
Huai Luang Basin



Few Employment Opportunity
Huai Hong Basin

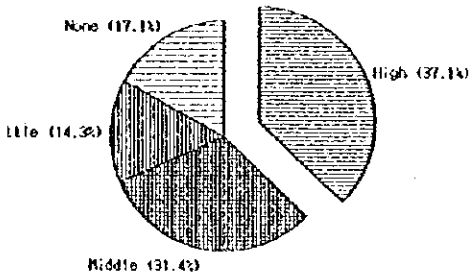


Few Employment Opportunity
Study Area

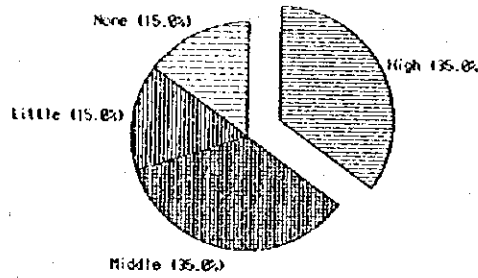


17.5 Lack of Fund

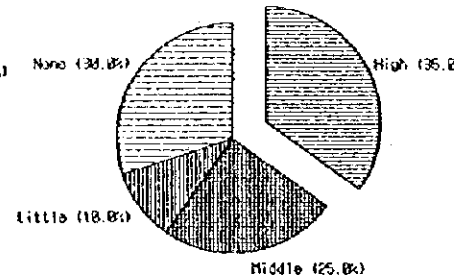
Lack of Fund
Huai Luang Upstream



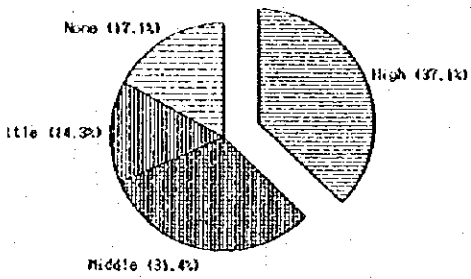
Lack of Fund
Huai Nung Upstream



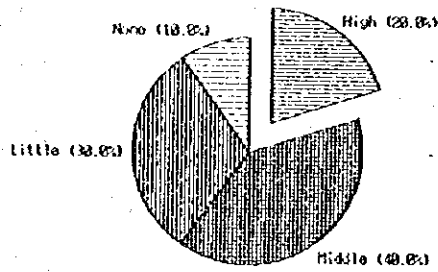
Lack of Fund
Nam Suai Upstream



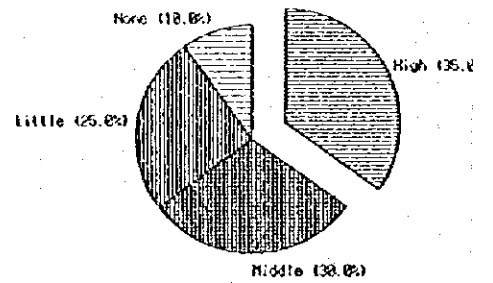
Lack of Fund
Huai Luang Middlestream



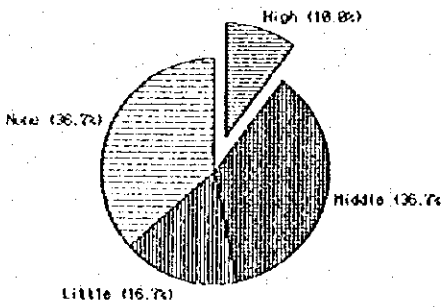
Lack of Fund
Huai Nung Middlestream



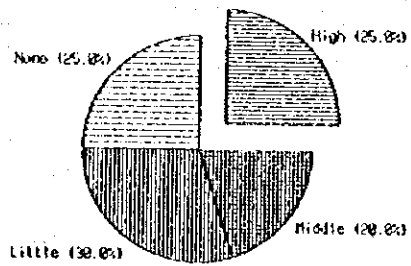
Lack of Fund
Nam Suai Downstream



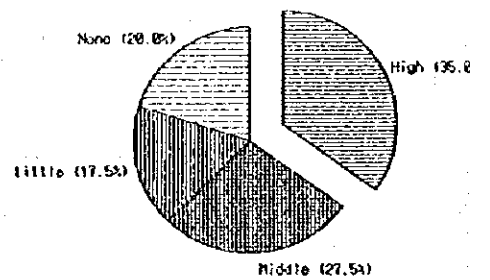
Lack of Fund
Huai Luang Downstream



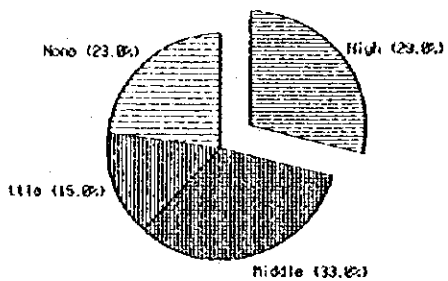
Lack of Fund
Huai Nung Downstream



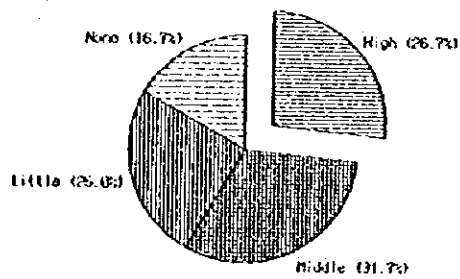
Lack of Fund
Nam Suai Basin



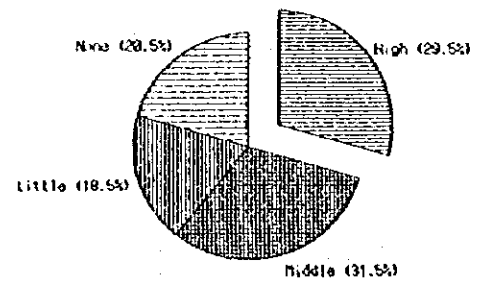
Lack of Fund
Huai Luang Basin



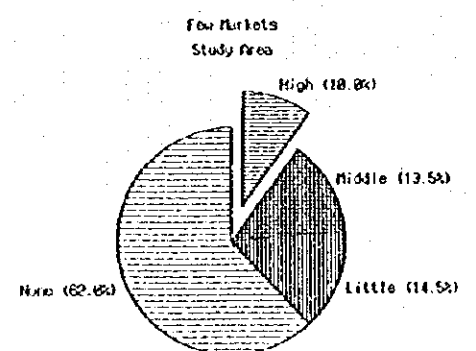
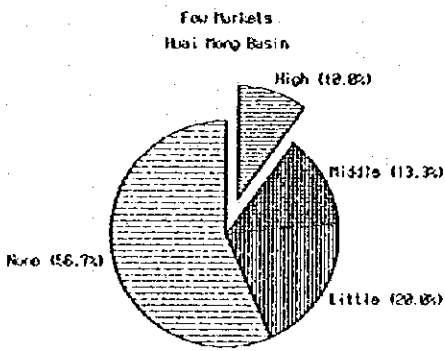
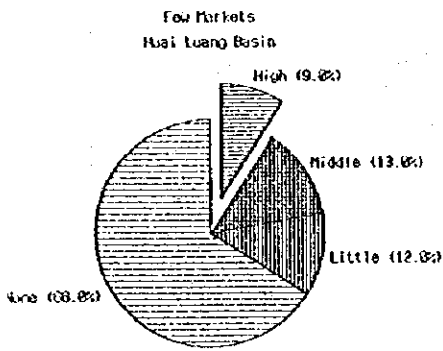
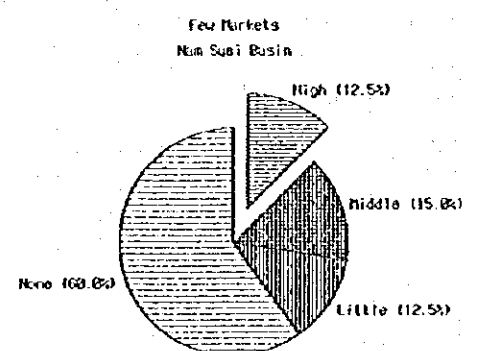
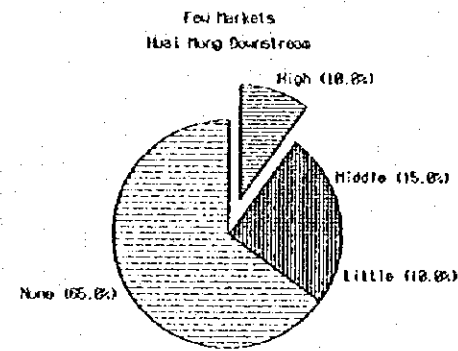
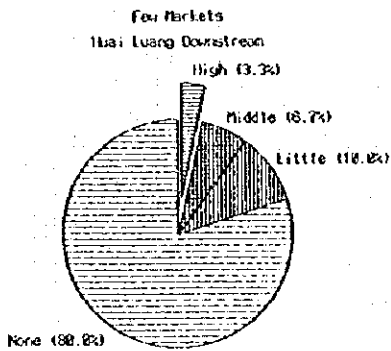
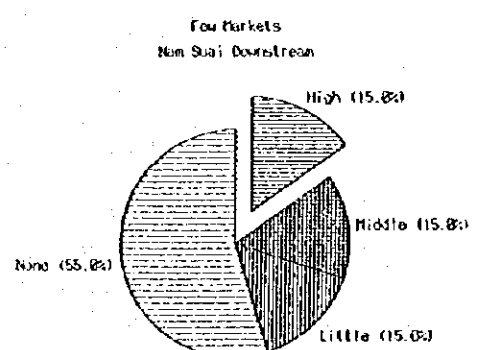
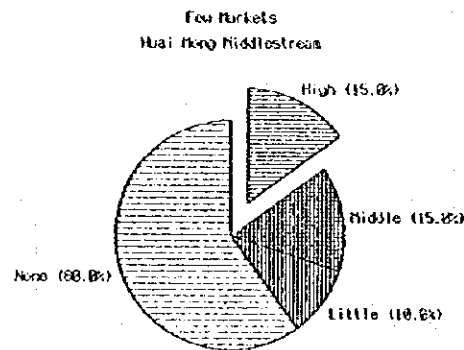
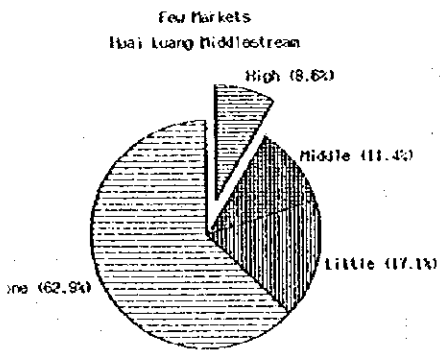
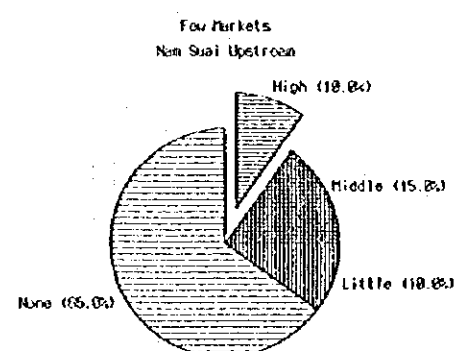
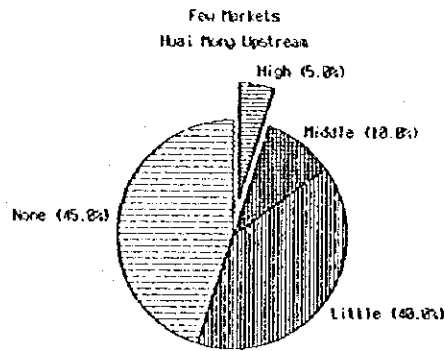
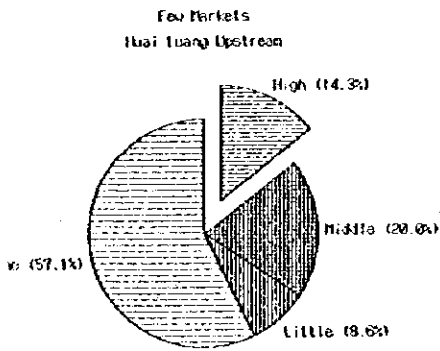
Lack of Fund
Huai Nung Basin



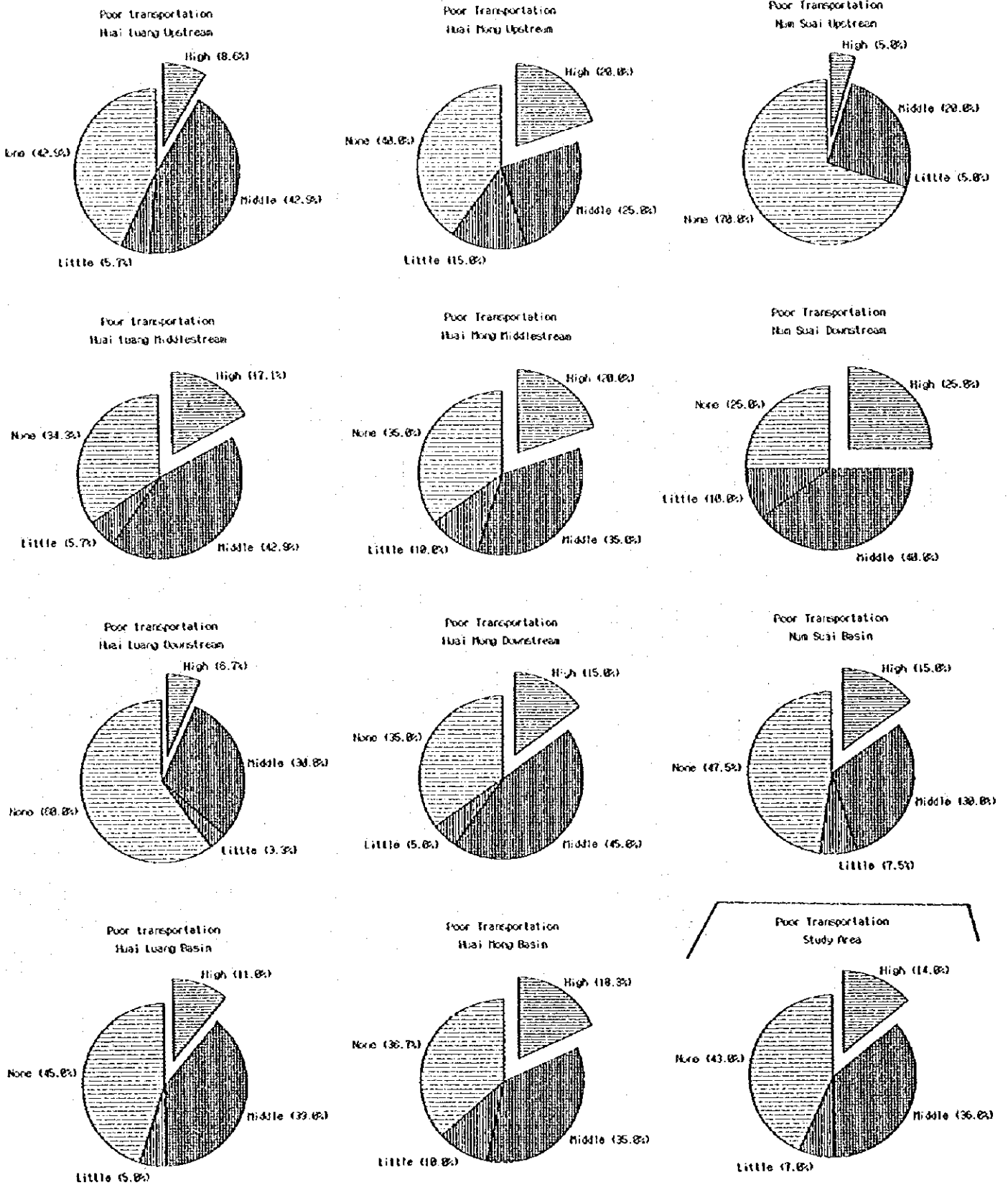
Lack of Fund
Study Area



17.6 Few Markets

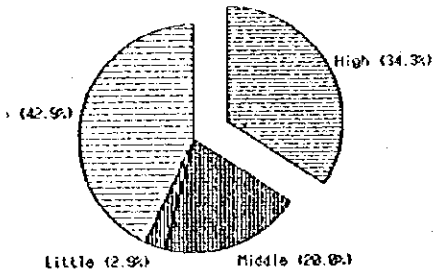


17.1 Poor Transportation Systems

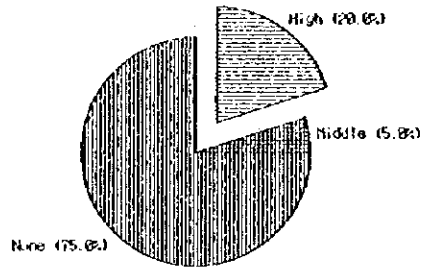


17.8 Lack of Clinic Center

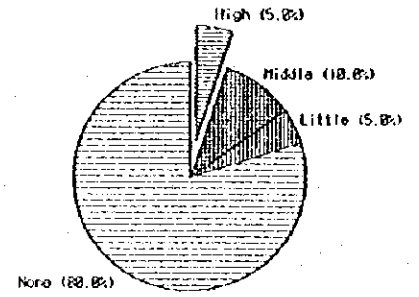
Lack of Clinic Center
Huai Luang Upstream



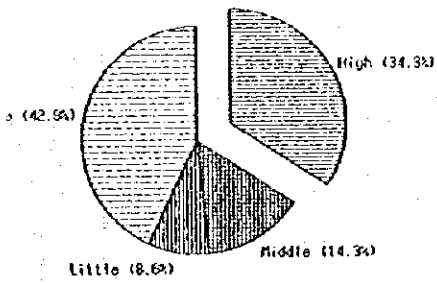
Lack of Clinic Center
Huai Nong Upstream



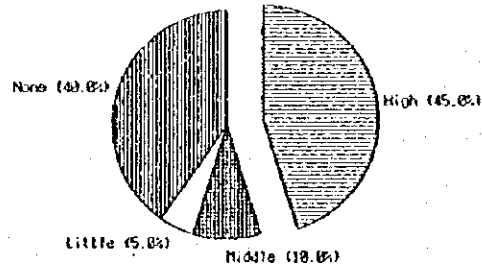
Lack of Clinic Center
Nam Suai Upstream



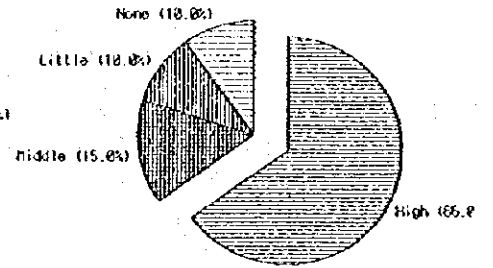
Lack of Clinic Center
Huai Luang Middlestream



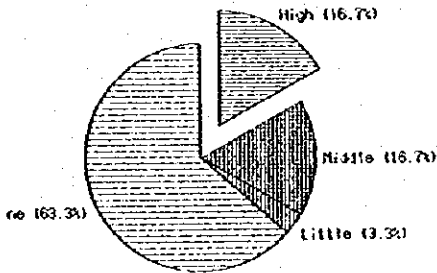
Lack of Clinic Center
Huai Nong Middlestream



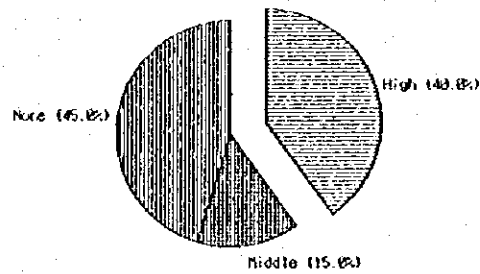
Lack of Clinic Center
Nam Suai Downstream



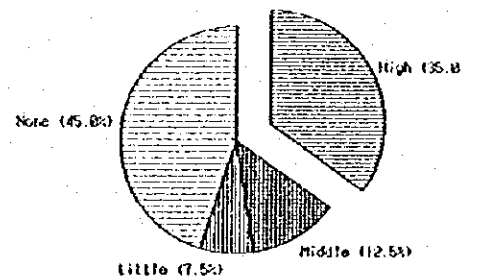
Lack of Clinic Center
Huai Luang Downstream



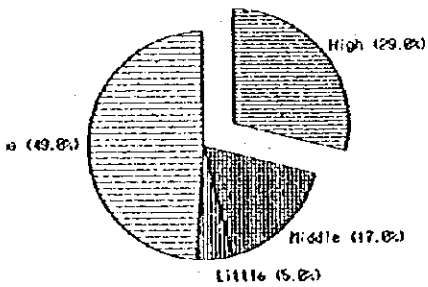
Lack of Clinic Center
Huai Nong Downstream



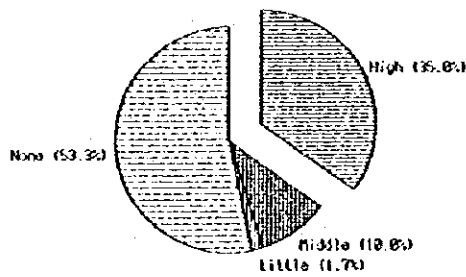
Lack of Clinic Center
Nam Suai Basin



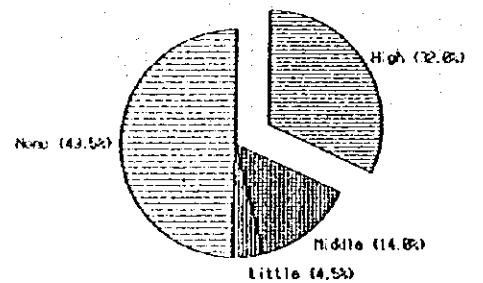
Lack of Clinic Center
Huai Luang Basin



Lack of Clinic Center
Huai Nong Basin

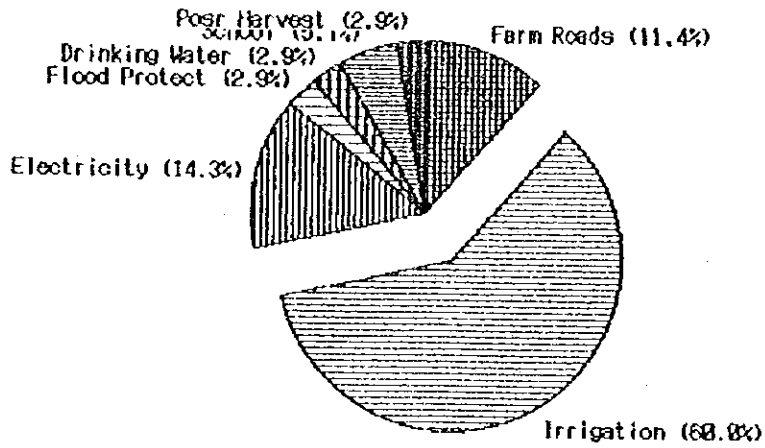


Lack of Clinic Center
Study Area



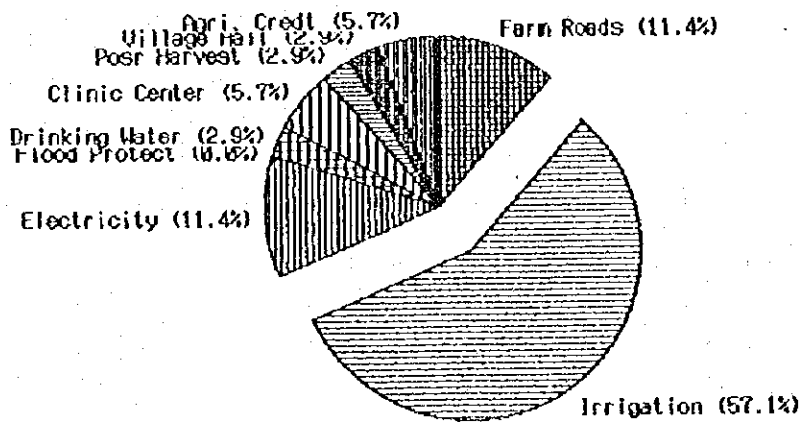
18. Projects to be Implemented with Priority

Huai Luang Upstream



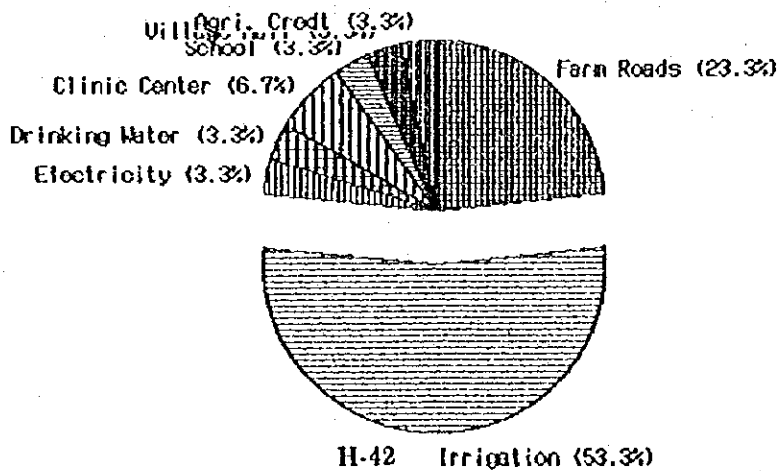
Projects to be Implemented

Huai Luang Middlestream

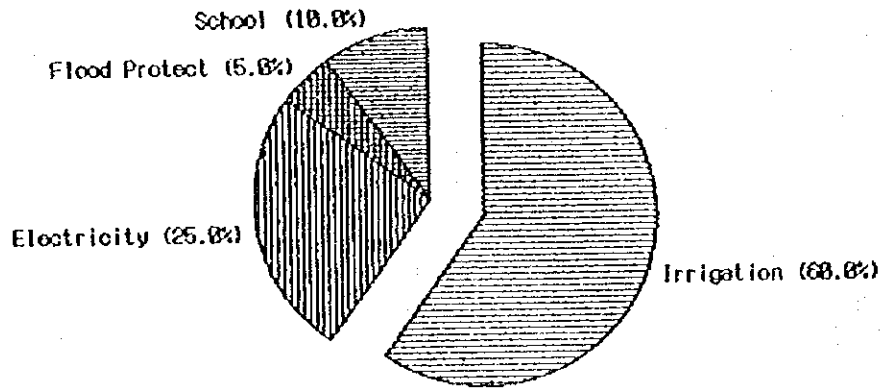


Projects to be Implemented

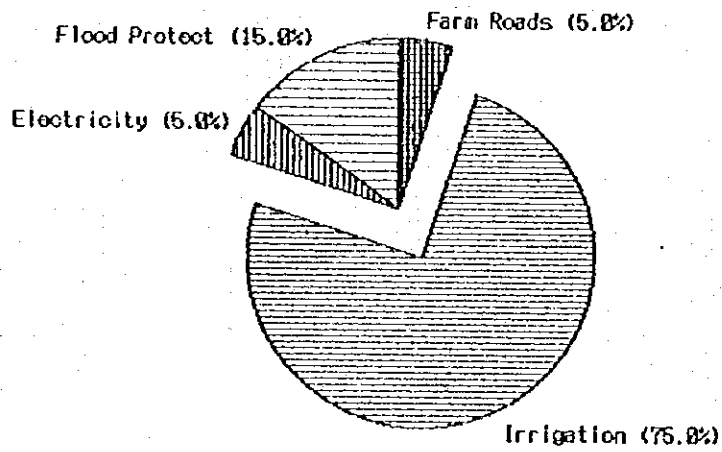
Huai Luang Downstream



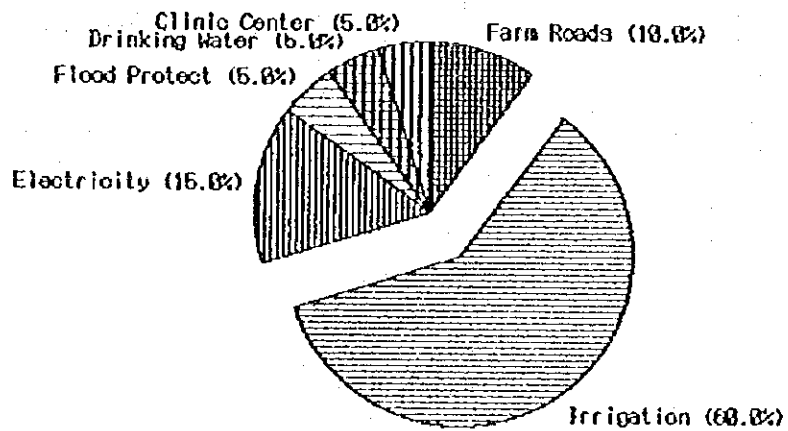
Projects to be Implemented
Huai Hong Upstream



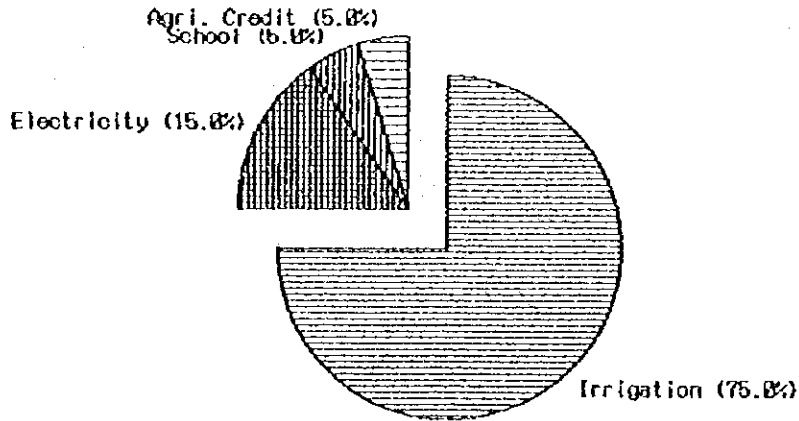
Projects to be Implemented
Huai Hong Middlestream



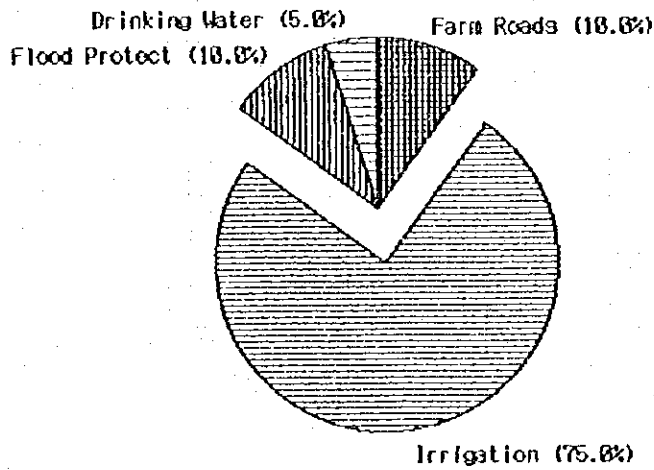
Projects to be Implemented
Huai Hong Downstream



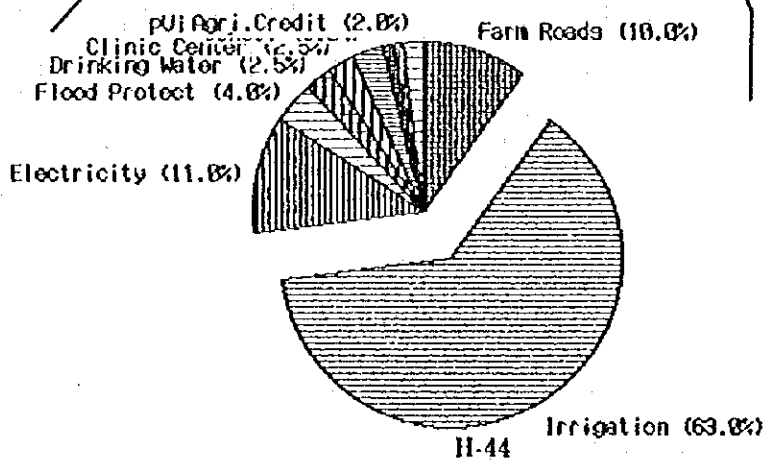
Projects to be Implemented
Nam Suai Upstream



Projects to be Implemented
Nam Suai Downstream

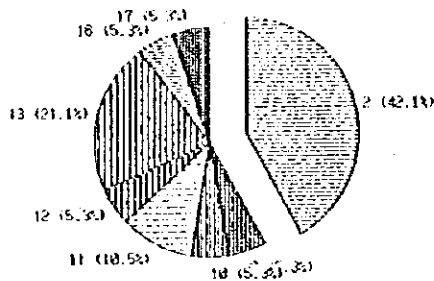


Projects to be Implemented
Overall Study Area

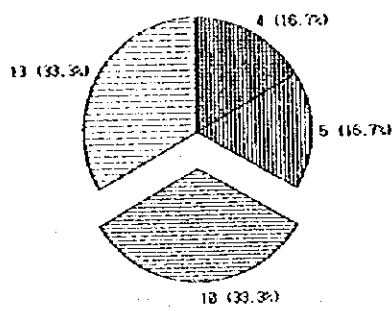


19. Intention to Farming Type

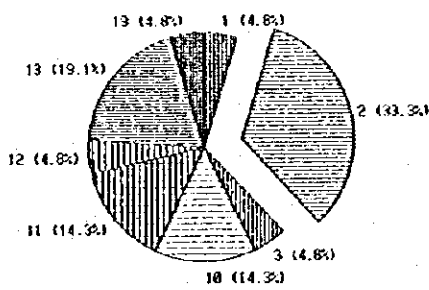
Intention to Farming Type
Hlai Luang Upstream



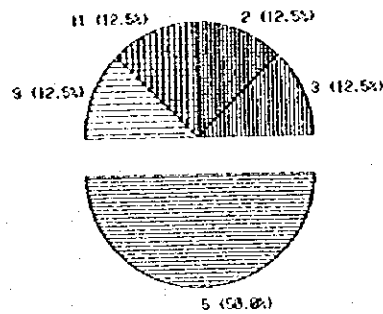
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Hlai Luang Upstream



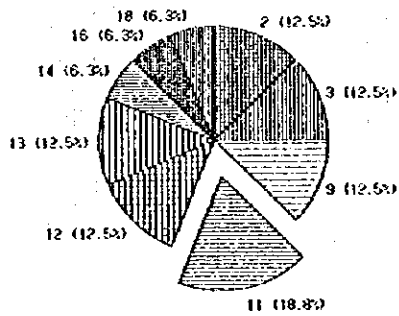
Intention to Farming Type
Hlai Luang Middlestream



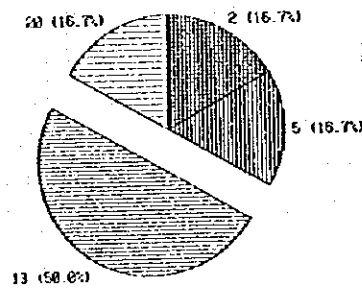
Intention to Farming Type
Hlai Luang Middlestream



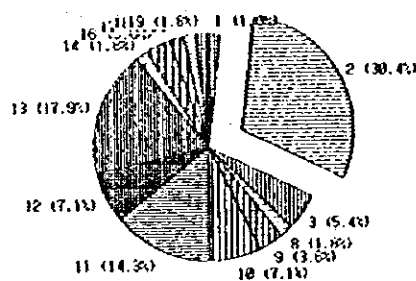
Intention to Farming Type
Hlai Luang Downstream



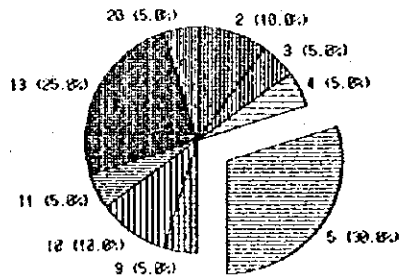
Intention to Farming Type
Hlai Luang Downstream



Intention to Farming Type
Hlai Luang Basin

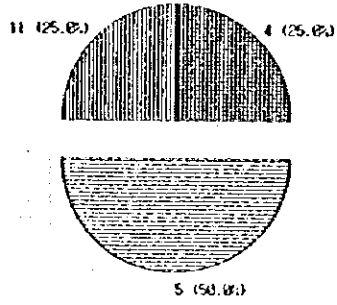


Intention to Farming Type
Hlai Luang Basin

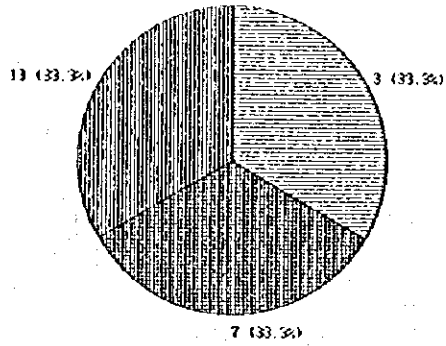


- 1 - First paddy + Second paddy
- 2 - First paddy + Fruit crop
- 3 - First paddy + Vegetables
- 4 - Vegetables + Vegetables
- 5 - Paddy + Dairy farm
- 6 - Paddy + Poultry farm
- 7 - Paddy +
- 8 - Paddy + Vegetables + Upland crop + Fruit/Tree
- 9 - Paddy + Upland crop
- 10 - Paddy + Vegetables + Fruit/Tree + Fish/Animal
- 11 - Paddy + Vegetables + Fish/Animal
- 12 - Paddy + Fish/Animal
- 13 - Paddy + Fruits/Tree + Fish/Animal
- 14 - Paddy + Upland crop + Fruits/Tree
- 15 - Paddy + Upland crop + Fruits/Tree + Fish/Animal
- 16 - Paddy + Upland crop + Fruits/Tree + Fish/Animal
- 17 - Paddy + Upland crop + Vegt + Fruits/Tree + Fish/Animal
- 18 - Vegetables + Fruits/Tree + Fish/Animal
- 19 - Paddy + Upland crop + Vegetables + Fish/Animal
- 20 - Fruits/Tree + Fish/Animal

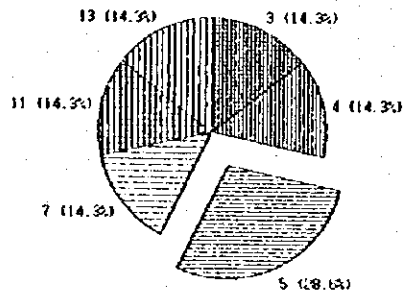
Intention to Farming Type
Nui Suai Upstream



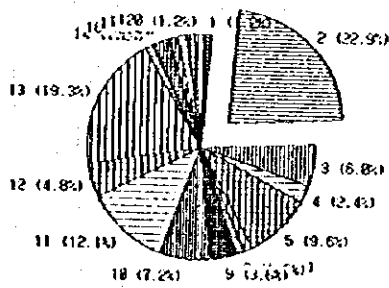
Intention to Farming Type
Nui Suai Downstream



Intention to Farming Type
Nui Suai Basin



Intention to Farming Type
Study Area



APPENDIX I. IRRIGATION AND DRAINAGE

APPENDIX I Irrigation and Drainage

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Table-I-1 Summary of Calculation of Evapotranspiration

Country: Thailand
 Project area: North-east Thailand
 Location: Latitude 17° -00' ~ 18° -00'
 Longitude 102° -00' ~ 103° -15'

VARIABLE	DESCRIPTION	UNIT	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
T _{mean}	Mean temperature	(°C)	22.20	24.70	27.60	29.30	28.50	28.20	27.90	27.50	27.20	26.70	24.60	22.10
R _{hmean}	Mean relative humidity	(%)	66.00	63.00	60.00	65.00	76.00	78.00	79.00	81.00	81.00	76.00	70.00	67.00
e _s from Tab-5	Mean saturation water vapour pressure	(mb)	26.40	30.00	37.80	40.10	40.10	37.80	37.80	37.80	35.70	35.70	31.70	26.40
e _a = e _s R _{hmean} /100	Actual saturation water vapour pressure	(mb)	17.40	18.90	22.70	26.10	30.50	29.90	29.90	30.60	28.90	27.10	22.20	17.70
e _a -e _d	Vapour pressure	(mb)	8.98	11.10	15.12	14.04	9.62	8.32	7.94	7.18	6.78	6.57	9.51	8.71
U	Wind run	(km/day)	84.00	96.00	103.20	110.40	105.60	98.40	105.60	98.40	88.20	92.60	82.40	88.30
f(u) = 0.27(1-U/100)	Wind function		0.50	0.53	0.55	0.57	0.56	0.54	0.56	0.54	0.51	0.52	0.54	0.51
(1-w) from Tab-8	Weighting factor		0.29	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.24	0.23	0.25	0.29
w from Tab-9	Weighting factor		0.71	0.75	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.75	0.71
R _a from Tab-10	Radiation received	mm/day	17.20	16.00	15.10	13.30	11.50	10.50	10.60	12.50	14.10	15.80	16.80	17.30
n	Actual sunshine hours	hr/day	8.28	8.58	7.53	7.83	6.75	5.55	5.13	4.67	5.24	6.54	7.19	7.37
n from Tab-11	Maximum sunshine hours	hr/day	13.00	12.50	12.20	11.70	11.20	11.00	11.20	11.50	12.00	12.50	12.90	13.10
n/N	Ratio		0.60	0.70	0.60	0.70	0.60	0.50	0.50	0.40	0.40	0.50	0.60	0.60
R _s = (0.25+0.5n/N) * R _a	Solar radiation	mm/day	9.80	9.50	8.40	7.80	6.30	5.30	5.10	5.70	6.60	8.10	8.90	9.50
R _s = (1-α) * R _s	Shortwave solar radiation	mm/day	7.30	7.10	6.30	5.90	4.80	4.00	3.80	4.20	5.00	6.10	6.70	7.10
f(T) from Tab-13	Temperature function f(T) on R _{nl}		15.00	15.40	16.30	16.30	16.40	16.30	16.30	16.30	16.00	16.00	15.50	15.00
f(ed) from Tab-14	Vapour pressure function f(ed) on R _{nl}		0.15	0.14	0.13	0.12	0.10	0.10	0.10	0.10	0.10	0.10	0.12	0.15
f(n/N) from Tab-15	Sunshine hours function f(n/N) on R _{nl}		0.60	0.70	0.60	0.70	0.60	0.60	0.60	0.50	0.50	0.60	0.60	0.60
R _{nl} = f(T) * f(ed) * f(n/N)	Net longwave radiation	mm/day	1.50	1.50	1.40	1.40	1.00	0.90	0.90	0.70	0.70	1.10	1.30	1.40
R _s - R _{nl}	Total net radiation	mm/day	5.80	5.60	5.00	4.40	3.70	3.10	2.90	3.50	4.20	5.00	5.40	5.70
c from Tab-16	Adjustment factor		1.00	0.98	1.00	0.99	0.97	0.95	0.97	0.97	0.97	1.02	1.00	1.01
E _T = c * (R _s - R _{nl}) * (1-w) * f(u) * (e _s -e _d)	Reference Crop Evapotranspiration	mm/day	5.4	5.6	5.8	5.3	4.1	3.4	3.4	3.3	3.6	4.0	5.4	5.4

Note: 1) Calculation was performed on the basis of FAO Irr. and Drainage paper no. 24 (revised edition)
 2) Meteorological data of Udon Thani (1961-90) were used

Table-1-2 Value of Crop Coefficient According to Growing Stage

Crop Name	Growing Stage	Kc Value
Paddy Rice(HYV)	Initial	0.91
	Middle	1.30
	Late	0.76
Paddy Rice(LV)	Initial	0.91
	Middle	1.30
	Late	0.76
Soybean	Initial	0.60
	Middle	1.20
	Late	0.65
Corn	Initial	
	Middle	
	Late	
Ground Nut	Initial	0.58
	Middle	1.00
	Late	0.46
Vegetables	Initial	0.60
	Middle	1.20
	Late	0.65

Table-I-3-1 Calculation of Unit Water Requirement

Months	MYU Paddy										Upland (Soy Bean)				Total seasonal Requirement
	① ETo mm/day	② Kc	③ ETa mm/day	④ Pe mm/day	⑤ L.P. mm	⑥ Total Requirement mm	⑦ Kc	⑧ ETa mm/day	⑨ L.P. mm	⑩ Total Requirement mm	⑪ Kc	⑫ ETa mm/day	⑬ L.P. mm	⑭ Total Requirement mm	
Jan	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Feb	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Mar	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Apr	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
May	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Jun	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Jul	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Aug	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Sep	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Oct	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Nov	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Dec	5.4	1.0	5.4	5.4	54.8	54.8	1.0	5.4	54.8	1.0	5.4	54.8	54.8	54.8	
Total					757									1325.8	

ETo = Potential Evapotranspiration
 Kc = Crop Coefficient
 ETa = Consumptive use
 L.P. = Land Preparation
 Pe = Percolation

Table-I-3-2 Calculation of Unit Water Requirement

Unit: mm

Months	MYU Paddy					LV Paddy					Total Seasonal Requirement	
	① Eto mm/day	② Kc	③ Eta mm/day	④ Pe mm/day	⑤ L.P. mm	⑥ Total Requirement mm	⑦ Kc	⑧ Eta mm/day	⑨ L.P. mm	⑩ Total Requirement mm		
Jan	5.4											
Feb	5.4											
Mar	5.6											
Apr	5.6											
May	5.8											
Jun	5.8											
Jul	5.3											
Aug	5.3											
Sep	4.1											
Oct	4.1											
Nov	5.4											
Dec	5.4											
Total					250.0	757			250.0	983	1740	

Eto = Potential Evapotranspiration
 Kc = Crop Coefficient
 Eta = Consumptive use
 L.P. = Land Preparation
 Pe = Percolation

Table-I-3-3 Calculation of Unit Water Requirement

(M. LUANG P/P AREA)		Second Paddy(LU) (dry Season)										Soybean(dry season)										Unit: mm				
Months	Eto mm/day	Kc	Eta mm/day	Pe	Kc	Eta mm/day	Pe	L.P. mm	L.P. mm	Total Requirement (①+②) (mm)	Kc	Eta mm/day	L.P. mm	L.P. mm	Total Requirement (③+④) (mm)	Kc	Eta mm/day	L.P. mm	L.P. mm	Total Requirement (⑤+⑥) (mm)	Kc	Eta mm/day	L.P. mm	L.P. mm	Total Requirement (⑦+⑧) (mm)	
																										①
Jan	5.4	0.91	4.9	1.5	1.5	4.9	1.5	21.4	49.3	93.7	1.20	5.4	54.9	54.9	54.9	1.20	5.4	54.9	54.9	54.9	1.20	5.4	54.9	54.9	54.9	126.2
Feb	5.4	1.00	5.4	1.5	1.5	5.4	1.5	42.8	29.4	82.0	1.20	5.4	71.3	71.3	71.3	1.20	5.4	71.3	71.3	71.3	1.20	5.4	71.3	71.3	71.3	133.3
Mar	5.6	1.30	5.6	1.5	1.5	5.6	1.5	71.8	87.8	159.6	1.20	5.7	87.2	87.2	87.2	1.20	5.7	87.2	87.2	87.2	1.20	5.7	87.2	87.2	87.2	155.0
Apr	5.6	1.38	5.6	1.5	1.5	5.6	1.5	70.2	70.2	140.4	1.20	5.7	53.8	53.8	53.8	1.20	5.7	53.8	53.8	53.8	1.20	5.7	53.8	53.8	53.8	124.0
May	5.8	1.00	5.8	1.5	1.5	5.8	1.5	90.4	30.4	120.8	1.20	5.8	30.9	30.9	30.9	1.20	5.8	30.9	30.9	30.9	1.20	5.8	30.9	30.9	30.9	148.4
Jun	5.8	0.98	5.2	1.5	1.5	5.2	1.5	73.0	30.0	103.0	1.20	4.6	30.9	30.9	30.9	1.20	4.6	30.9	30.9	30.9	1.20	4.6	30.9	30.9	30.9	103.9
Jul	5.3	0.76	4.0	1.5	1.5	4.0	1.5	49.3	18.4	67.7	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	63.1
Aug	5.3	0.76	4.0	1.5	1.5	4.0	1.5	18.4	18.4	36.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	63.1
Sep	4.1	1.1	4.1	1.5	1.5	4.1	1.5	18.4	18.4	36.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	63.1
Oct	4.1	1.1	4.1	1.5	1.5	4.1	1.5	18.4	18.4	36.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	1.20	3.8	13.8	13.8	13.8	63.1
Nov	5.4	1.30	5.4	1.5	1.5	5.4	1.5	35.0	35.0	70.0	1.20	3.2	26.7	26.7	26.7	1.20	3.2	26.7	26.7	26.7	1.20	3.2	26.7	26.7	26.7	109.4
Dec	5.4	1.30	5.4	1.5	1.5	5.4	1.5	77.2	77.2	154.4	1.20	4.3	47.5	47.5	47.5	1.20	4.3	47.5	47.5	47.5	1.20	4.3	47.5	47.5	47.5	151.4
Total	5.4	1.30	5.4	1.5	1.5	5.4	1.5	258	258	516	1.20	4.3	47.5	47.5	47.5	1.20	4.3	47.5	47.5	47.5	1.20	4.3	47.5	47.5	47.5	1488

Eto = Potential Evapotranspiration
 Kc = Crop Coefficient
 Eta = Consumptive use
 L.P. = Land Preparation
 Pe = Percolation

Table-I-3-4 Calculation of Unit Water Requirement

Unit: mm

Month	Sweet Corn					Baby Corn					Total Requirement	Total Seasonal Requirement	
	① Eto mm/day	② Kc	③ Eta mm/day	④ Pc mm/day	⑤ L.P. Requirement mm	⑥ L.P. Requirement mm	⑦ Total Requirement mm	⑧ Kc	⑨ Eta mm/day	⑩ L.P. Requirement mm			⑪ Total Requirement
Jan	5.4	0.35	1.9		12.6	26.7	39.3	0.35	1.89	6.3	26.70	33.03	85.70
Feb	5.4	0.50	2.7		27.0	26.7	53.7	0.35	1.89	12.6	26.70	39.30	74.94
Mar	5.4	0.70	3.9		39.2	26.7	65.9	0.50	2.80	28.0	26.70	54.70	93.90
Apr	5.4	1.18	6.2		61.6	26.7	88.3	0.50	3.36	33.6	26.70	60.30	95.20
May	5.4	1.10	6.2		49.3	26.7	76.0	0.70	3.92	28.7	26.70	55.40	78.03
Jun	5.4	1.10	6.4		57.8	26.7	84.5	1.10	6.38	21.3	26.70	51.08	85.97
Jul	5.4	1.18	6.4		63.8	26.7	90.5	1.10	6.38	21.3	26.70	51.08	85.97
Aug	5.4	1.00	5.8		63.8	26.7	90.5	1.00	5.80	21.3	26.70	51.08	85.97
Sept	5.4	0.90	4.8		31.8	26.7	58.5	1.00	5.80	21.3	26.70	51.08	85.97
Oct	5.4	0.90	4.8		15.9	26.7	42.6	1.00	5.80	21.3	26.70	51.08	85.97
Nov	5.4												
Dec	5.4												
Total	5.4	0.35	1.9		6.9	26.7	33.6			80	26.7	33.6	33.63
													762

Eto = Potential Evapotranspiration
 Kc = Crop Coefficient
 Eta = Consumptive use
 L.P. = Land Preparation
 Pc = Percolation

Table-I-3-5 Calculation of Unit Water Requirement

Unit: mm

Months	Groundnut						Vegetables					
	① Eto mm/day	② Kc	③ Eto mm/day	④ Pe	⑤ L.P. mm	⑥ Total Requirement mm	⑦ Eto mm/day	⑧ Kc	⑨ Eto mm/day	⑩ L.P. mm	⑪ Total Requirement mm	⑫ Total seasonal Requirement
Jan	5.4	0.58	3.1		20.9	26.7	47.5	0.90	48.5	26.7	75.3	132.9
Jan	5.4	0.70	3.8		27.8	26.7	54.0	1.00	54.0	26.7	80.7	118.5
Jan	5.4	0.80	4.3		47.5	26.7	74.2	1.20	71.3	26.7	98.0	148.8
Feb	5.6	1.00	5.6		56.0	26.7	82.7	1.20	81.2	26.7	107.9	163.2
Feb	5.6	1.00	5.6		56.0	26.7	82.7	1.20	81.2	26.7	107.9	163.2
Feb	5.6	1.00	5.6		56.0	26.7	82.7	1.20	81.2	26.7	107.9	163.2
Mar	5.8	1.00	5.8		58.0	26.7	84.7	1.00	84.7	26.7	111.4	170.2
Mar	5.8	0.90	5.2		52.6	26.7	79.3	0.90	79.3	26.7	106.0	164.1
Mar	5.8	0.80	4.6		51.0	26.7	77.7	0.65	77.7	26.7	104.4	161.1
Apr	5.3	0.55	3.4		25.3	26.7	51.7	0.65	51.7	26.7	78.4	126.8
Apr	5.3	0.66	3.4		29.9	26.7	56.6	0.65	56.6	26.7	83.3	136.6
Apr	5.3	0.66	3.4		29.9	26.7	56.6	0.65	56.6	26.7	83.3	136.6
May	4.1											
May	4.1											
May	4.1											
Jun	3.4											
Jun	3.4											
Jun	3.4											
Jul	3.3											
Jul	3.3											
Jul	3.3											
Aug	3.6											
Aug	3.6											
Aug	3.6											
Sep	4.0											
Sep	4.0											
Sep	4.0											
Oct	5.0											
Oct	5.0											
Oct	5.0											
Nov	5.4											
Nov	5.4											
Nov	5.4											
Dec	5.4											
Dec	5.4											
Dec	5.4											
Total	5.4	0.58	3.1		18.4	26.7	37.1	0.60	37.1	26.7	63.8	114

Eto = Potential Evapotranspiration
 Kc = Crop Coefficient
 Eto = Consumptive use
 L.P. = Land Preparation
 Pe = Percolation

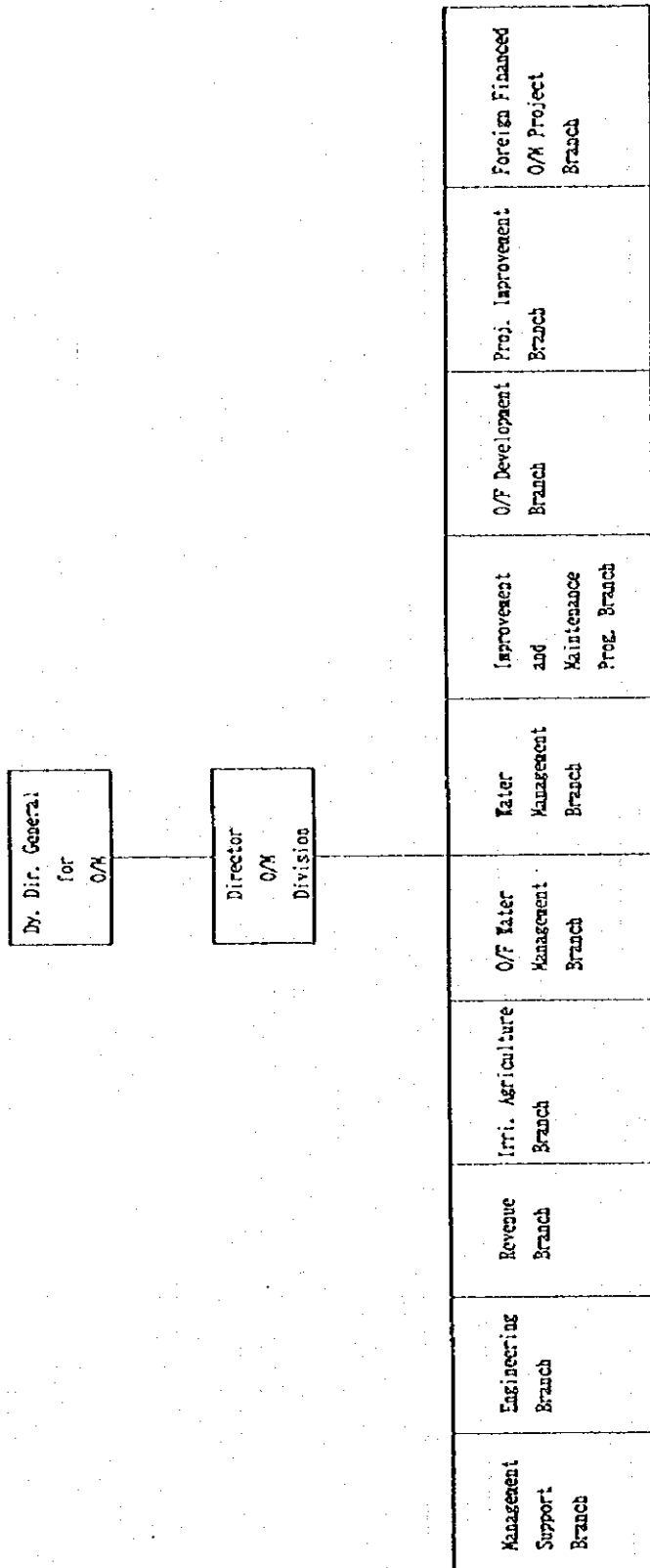


Figure I-1 Organization Chart of RID O/M Division

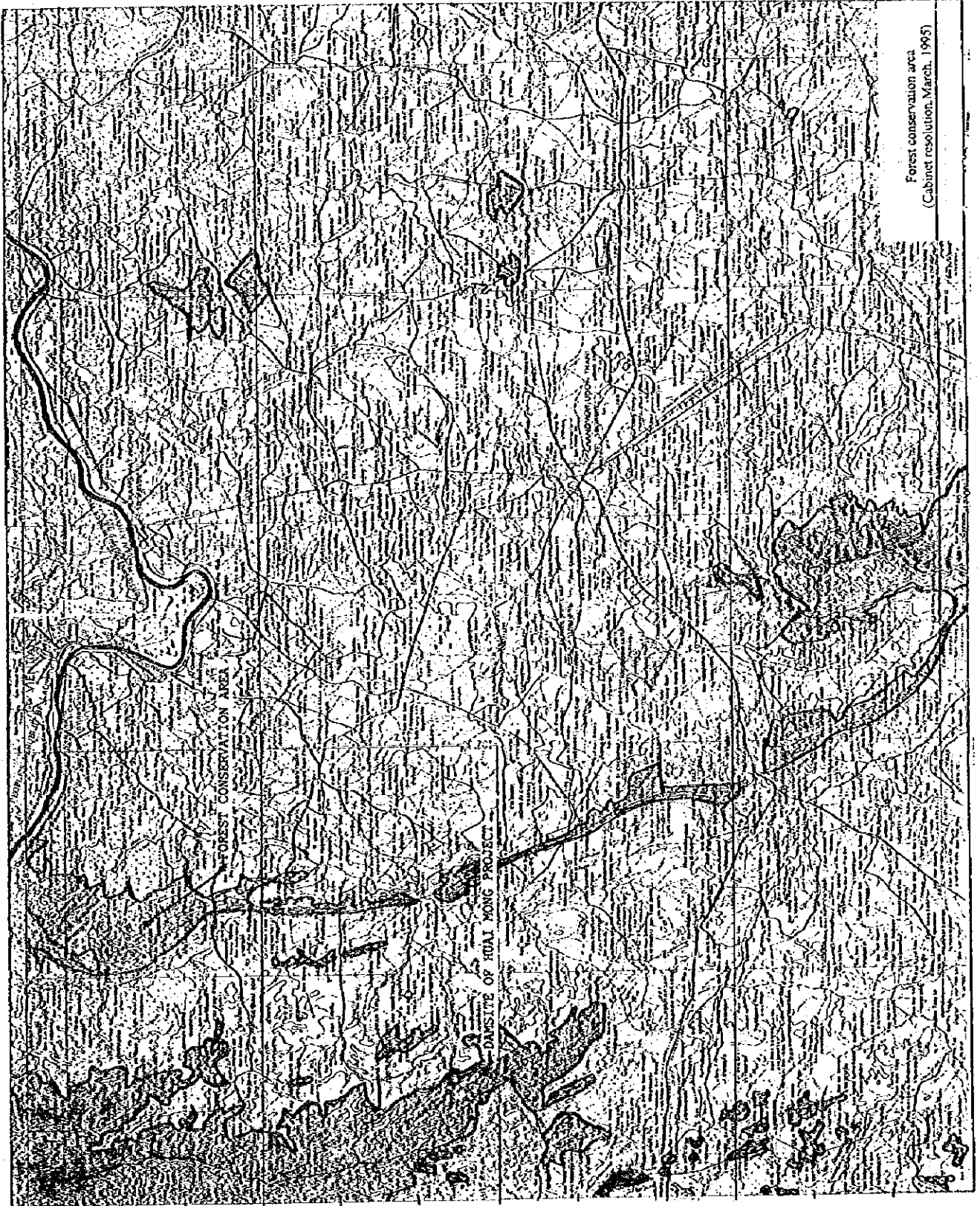
APPENDIX J. ENVIRONMENT

APPENDIX J. ENVIRONMENT

PART-1 MAP OF FOREST CONSERVATION AREA..... J-1

PART-2 OEPP-CHECKLIST FOR HUAI MONG PROJECT..... J-2

PART-1 MAP OF FOREST CONSERVATION AREA



PART-2 OEPP CHECKLIST FOR HUAI MONG PROJECT

1. Introduction

1.1 Project Name

Huai Mong Project

1.2 Project Proponent

The Royal Irrigation Department

1.3 Report Preparator

JICA Study Team
in Collaboration with the Project Proponent

1.4 Background

In coping with poverty and flood hazard in a large basin area of 8,600 km² covering Udonrthani, Nongkhai and Nongbua Lamphu province, an Integrated Agriculture and Water Resources Development has been studied under JICA's support.

By the Integrated Development Plan, a Dam/Reservoir of about 44 MB cost has been planned to be built on Huai Mong River. Since the proposed reservoir area is located in the Forest Conservation zone in which an Environmental Impact Checklist must be prepared and submitted to the RFD/OEPP for land use permission (Cabinet Resolution as of 15, 17 March 1992). Therefore this checklist is prepared and submitted.

1.5 Project Objective

To increase the agricultural production of an area of 1,000 ha for the purpose of poverty mitigation. In doing so a reservoir/dam must be built to detain water for irrigation.

1.6 Target

Economic Internal Rate of Return 12.3 %

The target is to be attained by developing the Irrigated Agriculture of about 1,000 ha in which water shall be supplied from a reservoir of 13.3 MCM capacity.

2. Project Feature

(Refer to a project map of 1:50,000 scale)

2.1 Location

The project area can be divided into two part. The upper part is the reservoir in Huai Mong basin Nongbua lamphu province; Dam is 28 m high of Suwan Khuhua, Nongbua Lamphu province. The lower part is the irrigation area of about 200 and 800 ha in Ban Bunthan and Ban Khok of Suwan Khuhua district, Nongbua lamphu province respectively.

2.2 Project Type

Integrated Agriculture and Water Resources Development

2.3 Project Feature

Huai Mong Project

(1) Irrigation Area		
Ban Than	200	ha
Ban Khok	800	ha
Total	1,000	ha
(2) Reservoir		
Catchment	57.1	Sq.km
Reservoir Capacity		
Effective Water	12.2	MCM
Dead Water	1.1	MCM

Total	13.3	MCM
Water Level		
Max. Water Level	269.0	m MSL
Design Water Level	268.0	m MSL
Dead Water Level	256.0	m MSL
Water Surface Area		
At Max. Water Level	178.0	ha
At Design Water Level	165.0	ha

(3) Dam

Type	Earth Fill	
Height	28.0	m
Length	150.0	m
Crest Width	7.0	m
Free Board	2.0	m
Elevation of Crest	271.0	m MSL
Downstream Slope	1:3.0	
Upstream Slope	1:2.5	

(4) Irrigation Canal

Total	32.0	km
-------	------	----

(5) Construction Cost

Dam	44.3	MB
Others	207.3	MB
Total	251.6	MB

2.4 Operating Period

The project economic life is set at 50 years after construction period of about 3 years.

2.5 Budgeting

Dam	44.3	MB
Total system	251.6	MB

3. Physical

Huai Mong basin of 2,711 km² is located in the Northeastern most of Thailand surrounding by the long 10° 40' E of 102°00' and Lat of 17°15'-18°00' N. The basin area is a part of Loei, Nong Khai, Udon thani and Nongbua Lamphu province. Based on the topography, flow regime, etc., the river basin may be categorized to the upper reaches with a drainage area of some 1,307 sq.km, the middle reaches with some 747 sq.km and lower reaches with some 657 sq.km.

a) Upper Reaches

The Huai Mong originates in the mountains in Na Duang District, Loei Province and runs to the east, joining with the tributaries of Huai So, Huai Yap, etc.. The river again joins with other 3 major tributaries, Huai Kholo, Huai Khana and Huai Nam Bon up to the vale of the Phuphankham mountain range which is the boundary between the upstream and middle stream areas of the Huai Mong river basin. For the evaluation of the water resource development potential, the upper reaches basin is sub-divided into two sub-basins, the Huai Mong upper sub-basin (M-2: some 785 sq.km) and the Huai Nam Bon sub-basin (M-1: some 522 sq.km), to the north and south of the Mong river respectively, taking into account the topography, rainfall, population density, farm size, etc..

Topography in the Huai Mong upper sub-basin is steep and declines to the east with a slope of 1/10 to 1/20 in the mountainous area, and moderate and undulated in the eastern area, declining to the east along Huai Mong and the southeast in the other parts with a slope of 1/150. The land elevations are about 600 m above M.S.L. in the top of mountains, and about 190 m above M.S.L. in the lower land. The farm lands distributes in strips along the rivers/streams. On the other hand, in the Huai Nam Bon sub-basin, the lands are undulated and gently slope down to the north with a gradient of about 1/300 to 1/500 and about 250 m to 190 m above M.S.L in the elevation of farm lands.

b) Middle Reaches

The middle reaches is bounded by the Phuphankham mountain range on the west, the Huai Luang river basin on the south and east, and the lower reaches of Huai Mong on the north. The stream of the Huai Mong turn toward

the north-northeast in its direction immediately after passing the of the said mountain range, and traverses the flood plain situated in the west of the middle reaches bifurcating and interconnecting each other. In the flood plain the Huai Mong joins with several tributaries, such as the Huai Nam Ngao, Huai Kradon, Huai sit, etc., from the left river side and a few tributaries from the right river side, interconnecting each other, and finally consolidate as on stream and runs to the lower reaches of the Huai Mong.

Topography in the flood plain is gentle and sloped down with a gradient of about 1/2,000 along the Huai Mong. Due to narrow span length of bridges along the road, route 7040, these low lands are currently flooded in the rainy season and developed to about 23 km in the distance and about 3 to 5 km in the width. On the other hand, topography in the hilly lands area moderate and undulated, and declines to the said flood plain with a slope of 1/40 to 1/400.

c) Lower Reaches

The Huai Mong traverse the flood plain meandering to the north-northeast and the northeast before reaching at the river-mouth in the direction, connecting with the Huai Thon and several streams on the right river side directly and several rivers/streams on the left river side through the flood plain, and finally contracts with the Mekong river at Tha BO, Nong Khai Province.

In terms of topographical features, the lower reaches of the Huai Mong consists of three areas, the hilly land area to the right river side, the flood plan area in the middle area and terrace land area to the left river side. Topography in the hilly land to the right river side is steep in the mountainous parts with a gradient of about 1/10 to 1/50 and moderate in the hilly parts with a slope of about 1/50 to 1/100. The land elevation are varied to 588 m above M.S.L. in the highest mountain and 170 a above M.S.L in the low land. The farm land area distributed in stripe along rivers/streams in the their low reaches.

The Flood plain extends to the left river side in the middle part of the Huai Mong lower reaches. The topography is flat. The land elevation is about 160 m to 170 m above M.S.L While, in the terrace land, topography is gently and undulated, and sloped to the flood plain with a gradient of 1/100 to 1/200, and 170 m to 190 m above M.S.L, in the land elevation.

d) Geology The Phuphankham mountain range is a boundary between the Basin of Huai Mong and Huai luang as well as a boundary of upstream and middle stream areas of Huai mong consists of Sandstone, Phase witan formation. Geology of the upstream reach comprises of the late Mesozoic to Palaeozoic rocks. Among other, the Phu nok formation consisting of Limestone and shale are distributed in the middle and east part of Suwankhuha District-Nongbua lamphu province. The Palaeozoic sandstone and Shale laid down in most area with Limestone distributed in some area, downstream.

The alluvial deposit consists of gravel, sand, silt and clay spread along the Huai mong downstream area.

e) Soil distribution in the Study Area is shown in figure classified by the USDA standard. As is shown in figure, the soil distributed in the Study Area are Skeletal Plinthustults (No. 53 in Figure) in Ultisols (mostly red-yellow podzolic soil), Loamy Paleustults (No. 54 in Figure, same order with No. 53, gray podzolic soil, mostly upland soil), Loamy Paleaquults (No. 43 in Figure, same order with No. 53, low humid gley soil, mostly paddy soil), Loamy Paleustults/Loamy Paleasquulta (No. 66 in Figure) in Ultisols, Skeletal Plinthaquults (No. 42 in Figure) and Loamy Ustifluvents (No. 8 in Figure) in Entisols (mostly low and soil) in Mekong river bank.

On the characteristics of these soil, some soil characteristics and shown on main Soil Series in Table, with the area in Udon Thani and Nong Khai provinces by the classification of Thailand.

As is shown in table, most of the soil in two provinces are gray or red-yellow podzolic soil with loam or sandy loam in texture. Soil organic matter are generally insufficient, available phosphate and potassium also low or moderately low, surface are low to moderately Low and soil pH are from 5 to 6. These are the characteristics of low fertile soil of Northeast, and it is main cause of low productivity of crops in the area.

The characteristics of these soil are loam or sandy loam in texture, red-yellow of dark brown in color, low in organic matter and CEC and low soil pH in general. However, affection by saline is not in the area, DLD has investigated saline soil in Northeast Thailand and divide into 7 categories as follows.

Degree of affection	Areas (ha)	Ratio (%)
1. Very severely salt affected soil area (Salt crust on the soil surface exceed 50 %)	37,655	0.22
2. Severely salt affected soil area (Salt crust on soil surface 10-50% of soil)	175,889	1.04
3. Moderately salt affected soil areas (Salt crust on soil surface 1-10%)	892,163	5.28
4. Slightly salt affected soil areas	3,699,373	21.91

Meteorology:

	<u>Nongkhai</u>	<u>Udon</u>
Annual rainfall (mm)	1543	1413
Temperature (°C)	5-42	5-42
R. Humidity (%)	13-96	12-93
Evaporation (mm/month)	127	148
Wind speed (km/k)	3.8	4.1

Annual Runoff of Huai mong 614.21 mcm
(All station of Drainage area 6,070 km²)

- f) Characteristic of Water Channels
(see 3-a) b) c))
- g) Flood and Drought condition
(blank)
- h) Groundwater

Metasediment aquifer, distributed in the Huai Mong upper reaches, consists of conglomerate, shale, sandstone, Limestone, phyllite, quartzite and schist in Devonian to Permian. The groundwater is mainly in joints and fractures. A yield of well is generally less than 5 cu.m/hr with good quality.

The upper Khorat aquifer, lies along the Phuphankham mountain range in the Huai Mong Upper reaches, consists of shale, siltstone and sandstone of Khok Kruat formation. The groundwater of good quality can be generally obtained from the depth of 30 m to 60 m at the pumping rate of 5 to 25 c.m/hr. Yield of water is only meager at deeper zones.

The lower Khorat aquifer, distributed in most of the Study Area, consists of Shale, mudstone, Siltstone sandstone of the Maha Sarakham and Khok Kruat formations. The salt rock is interbedded at the depth of 60 m to more than 290 m. The groundwater of this aquifer varies both in quality and quantity all over the place. A yield of well is from 3 to 10 cu.m/hr. Many wells produces brackish water.

The alluvial aquifer, is lying along the Huai Mong up to the middle reaches as a narrow strip, consists of alluvial gravel, sand, silt and clay. A yield of well give 10 to 30 cu.m/hr in the unconsolidated layer.

For the purpose of domestic water use, a number of wells were constructed by the various government agencies, as of September, 1993, as shown below:

Number of Wells Installed by Government Agencies

Province	DMR	ARD	PWD	DOH	NSC	PAO	Others	Total
Nong Khai	269	596	164	268	40	9	19	1,365
Udon Thani	1,292	462	8	314	40	33	176	2,325
Total	1,561	1,058	172	582	80	42	195	3,690

Source: Study of Potential Development in Mae Khong River Basin (ATT)

The groundwater potential in the Huai Mong river basin is less from the Matasediment aquifer and expected form the Lower Khorat aquifer with yield of 3-10 cu.m/hr in the upper reaches, and low in the middle reaches. In the lower reaches of Huai Mong as well as the Nam Suai, Huai Luang and other river basins, the groundwater are available from the upper Khorat aquifer with a yield of well 3-20 cu.m/hr or 3-5 cu.m/hr in the average of existing data. The groundwater potential is high in the area along the Mekong river.

i) Others

3.1 Biological

a) Flora: The watershed area as well as the proposed reservoir area has been proclaimed as a Forest conservation zone (Cabinet resolution as of 15 and 17 March, 1992). In addition, on the upper reach of the Basin where topography is of high sloping, the areas are generally under class I B of the watershed classification (Calmer resolution as JT 21 February, 1995).

For the proposed reservoir area of 178.0 ha, is located outside class ID name.

Local inhabitants report that in former days the floral community of the area was a mixed Deciduous Forest. The remaining parts of *Lasgerstroemia cacyculata*, at present, are evidence of mixed Deciduous Forest. Site survey during 30-31 of March 1996 shown that most of the proposed reservoir area has been heavily encroached, there is no tree of commercial size. The remaining large size trees are only of *Mangifera Pentandra* which are scatteredly stand beside those temporary shelters.

However, interview with local inhabitants revealed that the following species were once inhabited in the area:

<i>Irvingia</i>	<i>malayana</i>
<i>Anisoplessa</i>	<i>costata</i>
<i>Markhamia</i>	<i>pierrei</i>
<i>Crateva</i>	<i>adansonii</i>
<i>Manigifera</i>	<i>pentandra</i>
<i>Azadirachta</i>	<i>xylocarpa</i>
<i>Lasgerstroemia</i>	<i>Cacyculata</i>
<i>Musa</i>	<i>acuminata</i>
<i>Xylocarpus</i>	<i>Xylocarpa</i>
<i>Vitex</i>	<i>pennata</i>
<i>Bambusa</i>	<i>flexuosa</i>
<i>Melocanna</i>	<i>humilis</i>
<i>Dendrocalamus</i>	<i>strictus</i>

Besides some destroyed parts of *Lasgerstroemia cacyculata* the following species were found naturally:

<i>Musa</i>	<i>acuminata</i>
<i>Eupatorium</i>	<i>odoratum</i>
<i>Minosa</i>	<i>invisa</i>
<i>Ipomeas</i>	<i>reptans</i>
<i>Colocasia</i>	<i>esculenta</i>

Agricultural species are of:

Setaria	italica
Hevea	harasiliensis

b) Wild Fauna

Before 1975 several species of wildlife inhabited the basin area the basin was also rich in mammal as well as Aves. Those reported species are, for example:

Elephas	maseimus	(Asiatic elephant)
Muntiacus	muntjak	(Barking deer)
Cervus	unicolor	(Sambar deer)
Panthera	tigris	(Tiger)
Panthera	pardus	(Leopard)
Sus	serofa	(Wild pig)
Megalaima	lineate	(Lineata barbet)

However, interview with local inhabitants revealed that, it is now wild pig only available in the area.

It would be worthwhile noting that vegetation cover of the proposed reservoir area exists along Huai Mong's banks only by those under story and ground flora. In term of endangered/ rare threatened species of both flora and fauna, None have been found or reported.

c) Aquatic lifes

During site visit last March two small fishing activities were found. Interview with those fishermen were conducted together with investigation on caught fishes.

It is found that the following species are available in Huai mong river

Tilapia	nilotica	(Nile tilapia)
Cyprinus	carpio	(Common carp)
Cirrhenia	microlepis	(Small scale mud casp)

Channa	striatus	(Striped snake-leak fish)
Clarias	batrachus	(Batrachian walking catfish)

However, review over concerned reports of udon Thani shown that the following species are also available in the vicinity; there are of:

Trichogaster	putoralis	(Snake skin gourami)
Fluta		alba (Swamp cel)
Puntius	gonionotus	(Common silver basb)
Macrobrachium	lanchesteri	(Lanchester's Freswater praun)
Macobrachium rosenbergii		rosenbergii (G i a n g f r e s h w a t e r prawn)

It is obvious that, those mentioned aquatic lifes are of common species of Thailand. There is none of endangered/rare/threatened species.

3.2 Human Use Values

a) Purpose Water utilization

There are

Agricultural cropping	1,000 ha
Livestock raising	- individuals
Aquiculture	- ha
Domestic Water supply for	- individuals

b) Annual Water Demand

Agricultural cropping	12.2 MCM
Livestock raising	- MCM
Aquiculture	- MCM
Domestic Water supply for	- MCM

c) Public Health condition

Water supply is provided for both villages by the Ministry of Public Health, and operated by local organization.

Health care is under the responsibility of the Health office of Ban Kud Pung-Suwankhuha District, Nongbua lamphu province.

Field survey shown that Latilines/ Septic tank have been widely used in the areas.

There is no severe case of prevalent/ endemic diseases.

d) Communication

The road to the project area can be accounted from Udon thani through Banphu District of 80 km and another 110 km to Ban Namong where the asphalt paved surface is ended. Traveling from Ban Namong to Ban thnn, where the project Dam site is to be situated, can be done through the propose irrigation area by lateritic surface/ all season roads.

From Ban Bun than residential zone to the Dam site is about 2.5 km. of dry season road. The road in the proposed reservoir area is more or less the same as the road to Dam site, probably the road was originated by the reason of Timber logging.

e) Comparison of the utilization of existing natural Water sources and the after project condition

Existing Utilization :

The river of Huai mong is the main supply of domestic and agricultural demand.

Well water is used for drinking purpose, by hand or machine pumping.

After project utilization :

The Huai mong reservoir shall be the main source in which water shall be diverted through the existing river and the irrigation System later on. Thus both the Reservoir and the existing River shall be the sources of Water for people thought out a year.

3.3 Quality of life values

a) Population in the project area

Household in the project area are of Ban Boonthan and Ban khok-Suwankhuha district, Nongbua lamphu province, totally 140 households or 800 individuals.

b) Cultural/ Archaeological Values

They are of rural poor Comparison to the whole kingdom is assessed during the project planning of 1995/1996.

	Whole Kingdom	Nongbua lamphu
Net farm income (Baht)	11,230	6,063
Gross farm income (Baht)	35,042	19,026

The cultural phenomena is similar to other areas in Northeast region, and there is not any specific/local taboo or tradition.

There are 4 temples of contemporary period, in the vicinity of the Irrigation areas but none of them shown significant archaeological value.

4. Environmental Impact Assessment

4.1 Topography and Geomorphology

Actually the Dam as well as the irrigation area are of small-moderate sizes comparing to those existing projects in general. According to the project

schemes there is not any activity in which topography shall be significantly disturbed.

4.2 Soils

- a) Excavation, embankment and transportation of construction materials
- b) Construction can be done during a short period where cut/fill of materials can be undertaken mainly during dry season, thus avoid severe/high erosion condition.

The project is not of a large one thus disturbance to the existing natural condition is of a small scale only. In addition, construction material can also be found in.

4.3 Forestry

- a) As mentioned in the Biological item, the proposed reservoir area has been so encroached that most of the land is opened for Agri-uses. Those original trees/ bush remains only along riparian area of Huai mong. Therefore, inundation of the area shall affect only on the common plant/shrub along riparian area and of those agri-species.
- b) The proposed project will not affect to those rare/endangered species either it is Flora or Fauna
- c) The project might affect to riparian wild pigs. Since natural vegetation do exist only on small strips of the river banks, therefore impacts on habitat is of a very small scale.
- d) Simultaneous impacts to the vicinity area can be prevented/ mitigated by 2 main components as
 - 1) the existing enforcement of Forest protection.
 - 2) Planning/ coordination among RID, RFD, Local, LAD office and local villagers.

e) The project has nothing to do with wildlife feeding habitats, there aves in particular.

4.4 Hydrology and Water quality

a) As a consequence of project operation basin hydro regime shall be to be under control. Water in downstream area shall be harnessed to a more useful purposes while remain the watershed undisturbed Flow/ drainage regimes after the project shall be more uniform/ controllable.

b) After the project, stream water shall be detained and regulated flow to down stream area. during the first few years of impoundment concentration of Dissolved oxygen in

decomposition. Actually this phenomena depends on the extent of the remaining vegetation of the area, inflow and characteristic of Thermal stratification. As a result the condition of low oxygen content of water can be mitigated/ managed through the process of vegetation clearing before inundation as well as reservoir operation. In addition to this, experience elsewhere revealed that oxygen content of released water become higher in concentration after it is contracted to the atmosphere by a certain period, thus water quality in downstream area would be in normal condition finally.

Regarding the utilization of chemical product pesticides and fertilizer, the Project-Planning Division of RID had once monitored water quality. Pesticides in particular, of Return flow of several projects over the country in which most samples shown very low-not detectable concentration of pesticides. However, distribution of pesticides over land and water should be awared and long run monitoring must be undertaken.

It is obvious that hydro regime after the project comprises two main parts. The reservoir of still water and downstream of running water. Some kinds of aquatic lifes can adapted themselves to the new lentil ecosystem while the remaining species gradually become faded out. On downstream side the new condition of perential-lotic ecosystem provides a more healthy for fishing activities as well as aquiculture shall be better both on upstream and downstream areas.

4.5 Landuses

As mentioned earlier, the proposed reservoir area of 178 ha. must be embedded in the Forest conservation zone (Cabinet resolution as of 15 and 17 March 1992).

4.6 Communication/Transportation

The existing dry season road in the reservoir area is probably, a road for Forest encroachment (logging). Thus disturbance to transportation on this part is a positive effect to the remaining basin. During project operation the road shall be inundated, forever.

Access road must be built connecting the existing system to the Dam site. Since there is an existing road, at dry reason used only,

4.7 Population

a) Transportation during construction is probably disturb people in the vicinity at a certain extent in term of:

Dust, noise rafcty and traffic

b) To this day the project has not been against by any group/firm, but promoted by those beneficiaries.

4.8 Anesthetic Values

The proposed reservoir is to be embedded in a small encroached basin, there is nothing of significant Aeshetic values of the area, but nuded soil surface. However after the project the reservoir area of 178 ha. becomes water surface, open space and tranquility as provided shall be of Amenity value.

4.9 Historical/Archaeological

Ancient sites do exist far away, but there is none in the project area.

4. 10 Affected Public facilities

a) Protection of Forest fire

The project has nothing to do with Forest fire.

b) Waste desposal/ debris burning

It is common practice that Sanitation as well as waste disposal programs be adopted during construction/operation periods.

c) Water utilization

The project shall positively affected on water utilization by the provision of perennial water supply in a promising manner.

d) Electricity

The project shall not generate electrical power.

4. 11 Public facilities provided by the project

a) Electricity

- There are electrical power supplied to the nearby vicinity already.
- The project has nothing to do with that.

b) Water supply

- Water supply are available in the nearby villages already
- The project provides higher level of adequacy and promising

c) Road

It is recommended to improve the existing lateritic road to be of asphalt surface in order that effects by transportation shall be mitigated.

5. Environmental Impact Mitigation

5.1 Construction

It is recommended in having well planning and implementation regarding construction safety, sanitation, waste disposal, preservation of natural vegetation and the control of communicable diseases.

5.2 Renovation

Generally the undertakings of erosion control and slope protection are common practices. However landscape renovation/ improvement of borrow areas is recommended.

Transportation of construction materials must be controlled not only for public safety but also for public health condition.

Working areas as machinery maintenance, offices, camp and concrete plan shall be carefully located and maintained in a pleasant manner as much as possible. These programs can be found under the construction specification.

5.3 Environmental Monitoring

Relevant parameters of the following environmental components should be monitored by concerned Agencies

- Water quality of surface and ground water.
- Soil erosion / sedimentation
- Transportation
- Drainage
- Water borne diseases

6. Conclusion

Thousand of people in Ban Bun and Ban Khok of Suwan khuha district are of agrihousehold. Poverty is the main characteristic, they have less opportunity in earning. Provided that irrigation water is feed to their

farmland, their livings must be better off. In addition project investment and operation can also activate local economic.

On the negative side, however, there must be an opportunity loss of 237 MB investment and the alteration of landuse of 178 ha. of Forest conservation zone to be a reservoir area.

Huai mong project is a mechanism to upgrade the standard of living of poor villagers in Suwan khuha district by increasing agri. productions. there are some other things affected by the project both positive and negative effects, but those negative effects are of insignificant ones and mitigation measures can be done.

Thus it is rational to implement the project while maintain monitoring over project environment as aforementioned.

7. Reference

Report: "The Master Plan Study on the Integrated Agriculture and Water Resources Development Project of Huai Mong, Nam Suai and Huai Luang River Basins in the Kingdom of Thailand" prepared by JICA Study team in 1996.