C-1.4 Characteristics of Deposited Alluvial Soils

CHARACTERISTICS OF DEPOSITED ALLUVIAL SOILS
(Source : NIAPP , Hanoi)

Soil unit	pH_{KCl}	Organic matter (%)	Total (%)		Available (mg/100g soil)		Exchangeable (meq/100g soil)		CEC (meq/100g soil)
			P_2O_5	K_2O	P_2O_5	K_2O	Ca^{++}	Mg^{++}	
Deposited alluvial soils of the Red river	7-7.6	1.2	0.1	1.8	25-29	17-35	13-14	4-8	20-23
Deposited alluvial soils of the Thai Binh river	4-4.7	1.3	0.1	0.1	10	6	6-7	1	-

CHARACTERISTICS OF UNDEPOSITED ALLUVIAL SOILS
(Source : NIAPP , Hanoi)

Soil unit	pH_{KCl}	Organic matter (%)	Total (%)		Available (mg/100g soil)		Exchangeable (meq/100g soil)		CEC (meq/100g soil)
			P_2O_5	K_2O	P_2O_5	K_2O	Ca^{++}	Mg^{++}	
Undeposited alluvial soils of the Red river	4.7-7.7	1.2-2.7	0.03-0.12	0.7-2.2	3-38	6-18	3-18	1-10	6-30
Undeposited alluvial soils of the Thai Binh river	4.3-4.9	1-2.5	0.03-0.09	0.8-1.2	4-7	7-9	3-4	2-3	-

CHARACTERISTICS OF PERMANENTLY FLOODED ALLUVIAL SOILS
(Source : NIAPP , Hanoi)

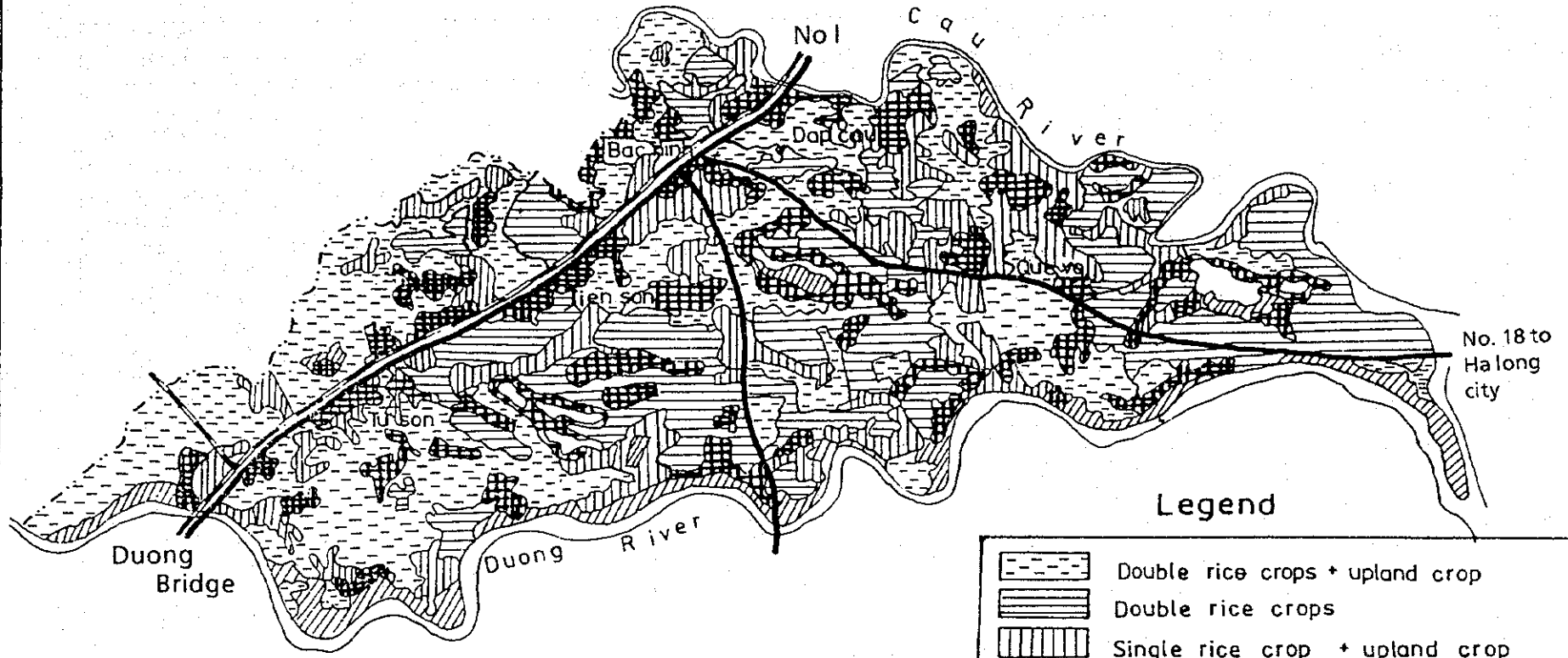
pH_{KCl}	Organic matter (%)	Total (%)		Available (mg/100g soil)		Exchangeable (meq/100g soil)		CEC (meq/100g soil)
		P_2O_5	K_2O	P_2O_5	K_2O	Ca^{++}	Mg^{++}	
4.9-6.5	1.9-4.0	0.06	1.4	Trace	10-30	3.2-9	0.4-2.6	11-13

CHARACTERISTICS OF DEGRADED SOILS ON OLD ALLUVIUM
(Source : NIAPP , Hanoi)

(1976-81)

pHKCl	Organic matter (%)	Total (%)			Available (mg/100g soil)		CEC (meq/100g soil)
		N	P_2O_5	K_2O	P_2O_5	K_2O	
4.8	1.0	0.08	0.03	0.3	3.5	6.2	5.6

C-1.5 Existing Land Use Map (the Study Area)



SCALE 1 : 200,000

C-1.6 Proposed Land-Use in the Study Area

Types of land	Total area	Ha bac					Ha noi		
		Subtotal	Tien son	Que vo	Bac ninh	Yen phong	Subttal	Gia lam	Dong anh
Total Area	42144	36814	15393	17161	2640	1620	5330	4240	1090
I. Agricultural land	27828	24598	10778	11124	1616	1080	3230	2576	654
1. Annual crop land	26371	23245	10199	10540	1522	984	3126	2501	625
2 rice + 1 subsidiary crop	1895	1741	1162	480	31	68	154	105	49
1 rice + 2 subsidiary crop	775	775	189	424	156	6			
2 rice	12888	10905	7131	2849	500	425	1983	1512	471
1 rice + 1 subsidiary crop	2116	1951	537	1180	155	79	165	165	
1 winter - spring rice	5126	4953	326	3769	570	288	173	116	57
1 summer rice	688	688	29	621	16	22			
Nursery land	1283	1158	420	604	65	69	125	77	48
Land under subsidiary crops and short-term industrial crops	1445	1018	364	606	21	27	427	427	
Land under vegetables	139	40	25	7	8		99	99	
Land under other annual crops	16	16	16						
2. Land under perennial crops	188	180	122	46		13	8	8	
Land under fruit trees	45	37	23	1		13	8	8	
Land under other perennial crops	121	121	94	27					
Nursery land	22	22	4	18					
3. Water superficies used in agriculture - apuaculture	1269	1173	458	538	94	83	96	67	29
II. Land for specialized uses	213	213	147	66					
Planted forest	208	208	142	66					
Nursery land	5	5	5						
III. Land for specialized uses (roads, irrigation-Drainage canals)	5889	4872	2252	1831	497	292	1017	828	189
IV. Built up area (Residential area)	3325	2846	1258	1226	278	84	479	352	127
V. Unused land	4888	4285	958	2914	249	164	603	484	119

C-1.7 Comparison of Sown Area, Yield and Rice Production in Ha Bac Province and in Red River Delta (RRD)

(Source : Statistical data of 1992)

Crop	Sown area (1000 ha)		Yield (T/ha)		Production (1000 tons)	
	Ha Bac	RRD	Ha Bac	RRD	Ha Bac	RRD
Spring rice	87.5	675.9	2.9	3.7	255.2	2,550
Autumn rice	98.7	717.5	2.7	3.6	271.6	2.613
Annually	186.2	1,393	5.7	7.4	526.8	5.163

Note: Rice is grown under both dryland and wetland conditions. Rice needs well-loosened land which is very hummers and requires a warm, humid climates. Rice can also thrive in flooded soil and such problem soils as acid soils with pH below 5. In Ha Bac province farmers have grown rice under these conditions for centuries possibly because no other crop will grow in such a soil-water system. But due to the aberrant weather and the soil related constraints the rice yield is still low and unstable. From 1980 to 1992 the per ha rice yield increased from 2 tons/ha to 3 tons/ha. In 1985 autumn rice yield decreased due to floods to 0.8 tons/ha.

In 1987 and 1991 there were also decreases in the rice yield in spring crops 1.8 tons/ha and 1.1 tons/ha respectively, due to the abnormal warm weather.

C-1.8 Effect of Phosphate on Rice on Problem Soils (Bui Dinh Dinh, ISF, 1982-1988)

Soil type	P_2O_5 kg/ha applied	Rice yield t/ha		Increase t/ha	kg paddy/ kg P_2O_5
		without P_2O_5	with P_2O_5		
Acid sulphate soils (Hai Phong Thismic Fluvisols)	90	3.2	4.4	1.2	13.3
Degraded soils (Ha Bac Plinthosols)	60	2.5	3.0	0.5	8.3

The majority of soils which having a relatively high content of total P_2O_5 (0.1%) have negligible trace content of available P_2O_5. Consequently, improvement of the P-status of soils must be regarded as one of the urgent problems in the farming of the study area for the improvement of all crop yields and soil fertility. A field experiment was conducted by N.V.Toan (Soil science journal No. 3, 1993) at Viet Doan commune, Tien Son district. The results showed that: the 60kg P_2O_5/ha was economically profitable for rice in this district, one kg P_2O_5 can produce 3.3-5 kg paddy. The highest yield of rice was obtained with N:P ratio 1:0.5. Response of P for rice variety CR203 in Viet Doan commune in 1993 is reflected below:

Treatment	Rice yield (T/ha)
10t FYM + 80N40K_2O (Check)	4.5
Check + 40 P_2O_5	4.6
- + 60 P_2O_5	4.8
- + 90 P_2O_5	4.9

C-1.9 Criteria for Defining Land Suitability of the Study Area

Gradient	Soil Name	Symbol	Area (ha)	Land Suitability			
				Rice	Rice + Upland Crop	Upland Crop	Perennial Crop
1	Fluvisols with Heavy Texture	Fl	6,326	S_1	S_2	S_3	S_2
2	Fluvisols with light Texture	Fl.ar	800	S_2	S_1	S_1	S_1
3	Gleysols	GL	8,372	S_2	S_3	S_3	N
4	Cambisols	Cm	5,998	S_1	S_2	S_2	S_3
5	Plinthosols	PT	2,171	S_2	S_2	S_2	S_3
6	Plinthosols with Gray Sand	PT.s	120	S_3	S_2	S_2	S_3
7	Gleysols with Water Logging	GL.d	5,338	S_3	N	N	N
8	Acrisols on Sandstone	AC	930	N	N	N	N
9	Leptosols	LP	816	N	N	N	N
Total			30,871				

Note : S_1 : Highly suitable S_2 : Moderately suitable

S_3 : Marginally N : Not suitable

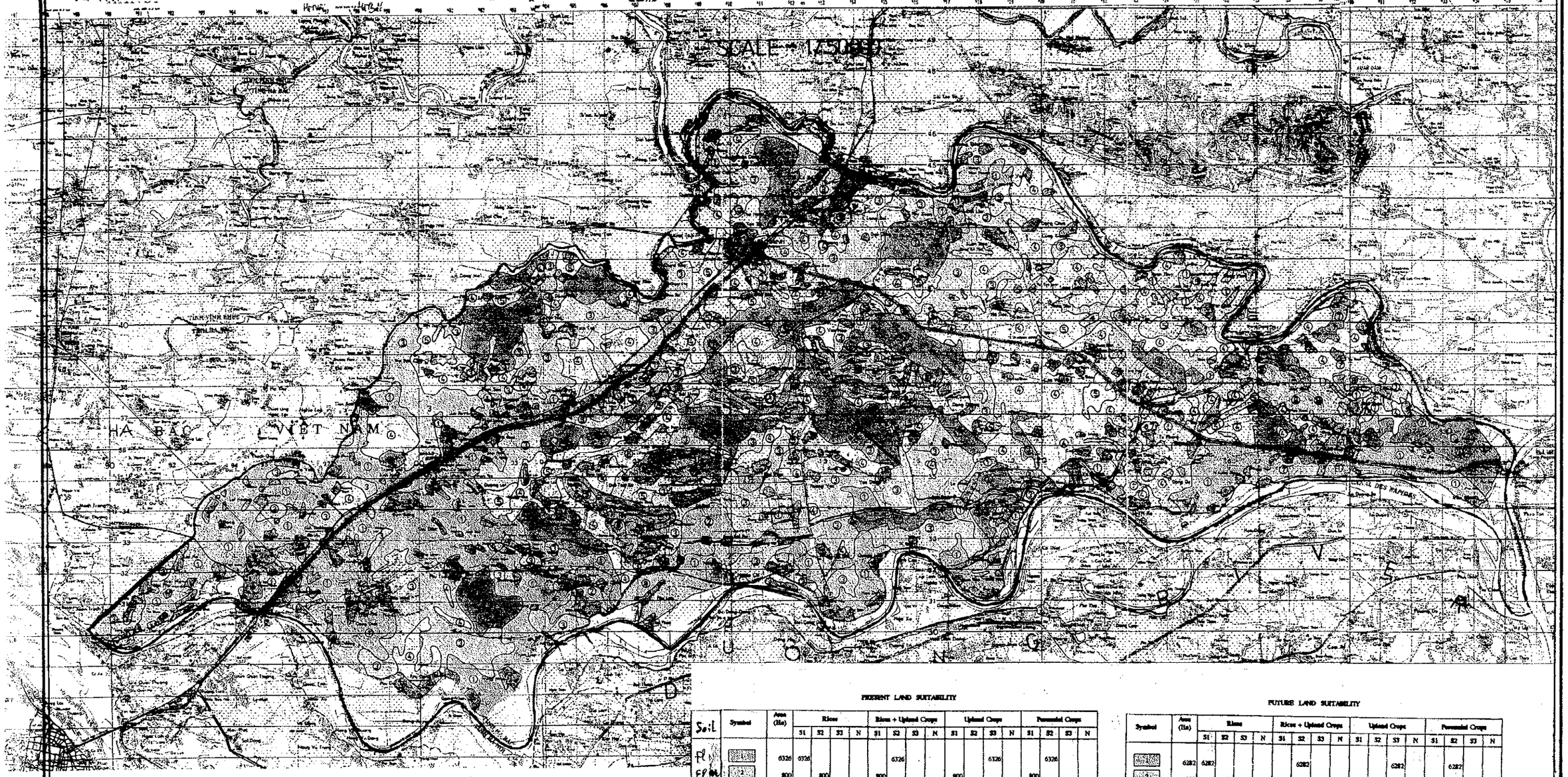
C-1.10 Proposed Land Use Plan in the Study Area by the Year 2010

Soil Units	Area (ha)	Ha Bac				Hanoi	
		Tien Son	Que Vo	Bac Ninh	Yen Phong	Gia Lam	Dong Anh
Fluvisols	7,049 (-77)	2,904 (-16)	1,053 (-43)	392 (-6)	209	1,836 (-12)	655
Gleysols	13,686 (-24)	5,154 (-4)	6,547 (-20)	754	465	686	80
Cambisols	5,992 (-6)	1,380	3,972 (-6)	420	220		
Plinthosols	2,269 (-22)	1,182 (-22)	870	67	150		
Acrisols	930		930				
Leptosols	816	678	12	126			
Sub-total	30,742 (-129)	11,298 (-42)	13,384 (-69)	1,759 (-6)	1,044	2,522 (-12)	735
Residential area + Specialized Uses	9,278 (+129)	3,552 (+42)	3,296 (+69)	781 (+6)	376	1,048 (+12)	225
Total	**40,020**	**14,850**	**16,680**	**2,540**	**1,420**	**3,550**	**960**

Note : – Decrease due to enlarging Expressway
+ Increase

C-1.11 Land Suitability of the Study Area

LAND SUITABILITY OF SOUTH BAC DUONG AGRICULTURAL AREA



PRESENT LAND SUITABILITY

Soil	Symbol	Area (Ha)	Rices				Rices + Upland Crops				Upland Crops				Perennial Crops			
			S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N
Pl	1	6326	6326					6326					6326			6326		
Fl,m	2	800		800			800				800				800			
Gl	3	8372		8372					8372				8372					9372
cm	4	5998	5998					5998				5998					5998	
Pl,	5	2171		2171				2171				2171					2171	
Pl,s	6	120			120			120				L20					120	
Gl,gl	7	5338			5338					5338				5338				5338
AC	8	930				930				930				930				
LP	9	816				816				816				816				816
		30871	12324	11343	5458	1746	800	14615	8372	7084	800	8289	14698	7084	800	6326	9319	14526

S1 : Highly Suitable S2 : Moderately Suitable S3 : Marginally N : Not Suitable

FUTURE LAND SUITABILITY

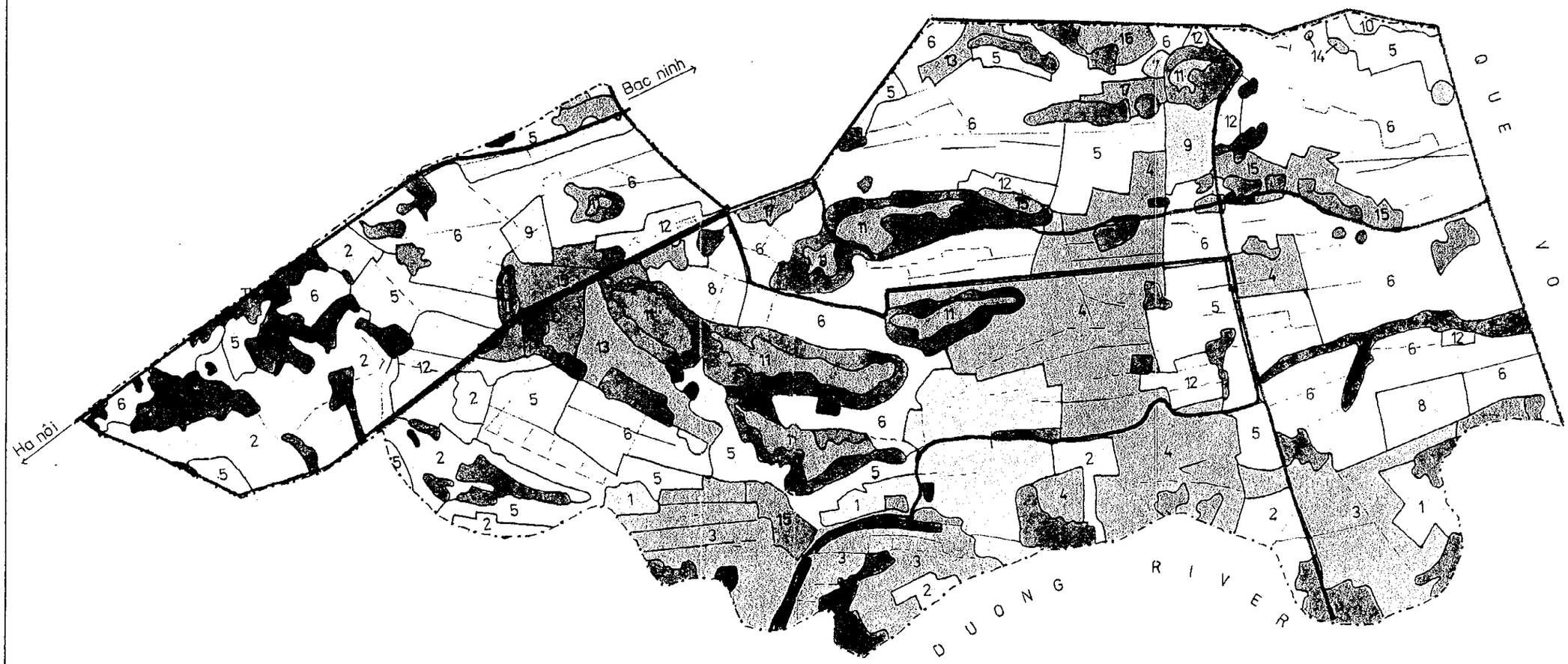
Symbol	Area (Ha)	Rices				Rices + Upland Crops				Upland Crops				Perennial Crops			
		S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N	S1	S2	S3	N
1	6282	6282					6282					6282			6282		
2	800		800			800				800				800			
3	8359	8359					8359					8359					8359
4	5972	5972				5972					5972					5972	
5	2149		2149			2149				2149						2149	
6	120			120			120				120					120	
7	5314		5314					5314				5314					5314
8	930				930				930				930			930	
9	816				816				816				816				816
	30742	20613	8263	120	1746	8921	14761	5314	1746	2949	6092	14661	7040	800	6282	9171	14489

S1 : Highly Suitable S2 : Moderately Suitable S3 : Marginally N : Not Suitable

C-2.1 **Soil Map of the Project Area**

SOIL MAP OF THE FEASIBILITY STUDY AREA

SOUTH BAC DUONG AGRICULTURAL AREA



1	Areni - Hypereutric Fluvisols
2	Anthraqui - Silti-Hypereutric Fluvisols
3	Anthraqui -Hypereutric Fluvisols
4	Hypereutri- Gleyic Fluvisols
5	Hypereutric Gleysols
6	Orthyeutric Gleysols
7	Epieutric Gleysols
8	Endodystric Gleysols
9	Dystric Gleysols
10	Orthieutric Regosols
11	Epilithi - Dystric Leptosols
12	Hypereutri - Gleyic Cambisols
13	Orthidystri- Gleyic Cambisols
14	Orthidystric - Acrisols
15	Hypereutric Plinthosols
16	Endoeutric Plinthosols
17	Endodystric Plinthosols

Residential Area — Road

Ponds, Lakes — Canal

SCALE : 1 / 50 000

C-2.2 Soil Classification of the Project Area

Major Soil Groupings	Soil Units	Soil Subunits
1. Fluvisols 1953.7 ha, 32,81%	1.1 Eutric Fluvisols 1357.7 ha, 22,8%	1.1.1. Areni-Hypereutric Fluvisols 343.7 ha ,5,77%
		1.1.2. Anthraqui - Silti - Hypereutric Fluvisols 475.2 ha, 7,98%
		1.1.3. Anthraqui - Hypereutric Fluvisols 538.8 ha, 9,05%
	1.2. Gleyic Fluvisols 596.0 ha, 10,01%	1.2.1. Hypereutric - Gleyic Fluvisols 596,0 ha, 10,01%
2. Gleysols 3133.2 ha, 52,61%	2.1. Eutric Gleysols 2945.4 ha, 49,46%	2.1.1. Hypereutric Gleysols 842.5 ha, 14,15%
		2.1.2. Orthieutric Gleysols 2097.8 ha, 35,22%
		2.1.3. Epieutric Gleysols 5.1 ha, 0,09%
	2.2. Dystric Gleysols 187.8 ha , 3,15%	2.2.1. Endodystric Gleysols 118.5 ha, 1,99%
		2.2.2. Dystric Gleysols 69.3 ha, 1,16%
3. Regosols 10.5 ha, 0,18%	3.1. Eutric Regosols 10.5 ha, 0,18%	3.1.1. Orthieutric Regosols 10.5 ha, 0,18%
4. Leptosols 275.0 ha, 4,62%	4.1. Dystric Leptosols 275.0 ha, 4,62%	4.1.1. Epilithi - Dystric Leptosols 275.0 ha, 4,62%
5. Cambisols 330.0 ha, 5,54%	5.1. Gleyic Cambisols 330.0 ha, 5,54%	5.1.1. Hypereutri - Gleyic Cambisols 227.1 ha, 3,81%
		5.1.2. Orthidystric - Gleyic Cambisols 102.9 ha, 1,73%
6. Acrisols 2.8 ha 0.05%	6.1. Dystric Acrisols 2.8 ha, 0,05%	6.1.1. Orthi - Dystric Acisols 2.8 ha, 0,05%
7. Plinthosols 250.3 ha, 4,2%	7.1. Eutric Plinthosols 225.0 ha , 3,78%	7.1.1. Hypereutric Plinthosols 185.7 ha, 3,12%
		7.1.2. Endoeutric Plinthosols 39.3 ha, 0,66%
	7.2. Dystric Plinthosols 25.3 ha, 0,42%	7.2.1. Endodystric Plinthosols 25.3 ha , 0,42%

C-2.3 Low Lying Relief of Soil Subunits

Unit : ha

Symbols on Soil map	Soil name	Area (★)	Hoan son	Viet doan	Hien van	Lac ve	Lien bao	Khac niem	Hap linh	Noi due	Han quang	Nam son
4	Hypereutri-Gleyic Fluvisols	16							16			
5	Hypereutric Gleysols	46							46			
6	Orthi- eutric Gleysols	476.8	8.5	64.8	49.2	70.2	60	85.6	20.5	22	44	52
	Total	538.8	8.5	64.8	49.2	70.2	60	85.6	82.5	22	44	52
Present land use :												
Winter spring rice per year 10 communes		83.5	1	25.2	7.7	46.1				1.5	2	

Note : - This area represents an area with annual frequently water logging.
- It is possible to drain off the excess water on the ground as much as possible to protect the cultivated plants in the area, but tremendous investment will be necessary.
- It may be better, as an ideal condition, to keep 30 cm water depth in rainy monsoon season above the soil surface for fish rearing after winter spring rice.

C-2.4 Density and Bulk Densities of Soil Subunits

Symbols on soil map	Number of profile	Commune	Soil Name	Depth (cm)	Density (g/cm3)	Bulk density (g/cm3)	Porosity (%)
1	562	Minh Đạo	Areni -	0-20	2.27	1.11	51.10
			Hypereutric	40-50	2.67	1.16	56.41
			Fluvisols	60-70	2.73	1.19	52.47
2	698	Tân Chi	Anthraqui-	10-20	2.51	1.07	57.37
			Silti -	30-40	2.58	1.11	56.97
			Hypereutric				
	118	Đồng Nguyên	Fluvisols	0-20	2.40	1.00	58.33
				25-30	2.65	1.16	56.23
5	244	Hoàn Sơn	Hypereutric	0-20	2.27	1.35	40.53
			Fluvisols	20-45	2.38	1.57	34.03
6	479	Liên Bảo	Orthi-	0-20	2.36	1.00	57.63
			eutric	25-85	2.57	1.18	56.42
	531	Hiên Vân	Gleysols	0-21	2.25	1.00	55.55
				21-43	2.35	1.13	51.91
	373	Nội Duệ	- " -	0-20	2.20	1.00	54.54
				40-50	2.27	1.10	51.54
7	634	Khắc Niệm	Epieutric	0-22	2.26	0.93	58.85
			Gleysols	22-50	2.46	1.00	59.35
15	314	Phật Tích	Hypereutric	0-25	2.71	1.59	41.33
			Plinthosols	50-60	2.83	1.60	43.46
	525	Hiên vân	- " -	0-18	2.58	1.48	42.63
				18-38	2.77	1.73	37.54

C-2.5 Soil Characteristics of the Project Area

SOIL Subunit	Profile	Depth (cm)	pH		C%	Total %			Available mg/100g soil		Exchangeable- mg/100g soil		CEC me/100g soil	Al 3+ mg/100g soil	Fe 3+ mg/100g soil	V%	Particle size (mm) %		
			H2O	KCl		N	P2O5	K2O	P2O5	K2O	Ca	Mg					2-0.02	0.02-0.002	<0.002
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Areni-hyper-Eutric Fluvisols	562+709	0-28	7.62	7.32	1.33	0.08	0.04	0.73	4.73	10.67	10.17	0.77	11.96			97.08	78.65	14.47	6.89
	+90	28-75	7.97	7.20	0.91	0.05	0.03	0.56	7.12	8.00	7.00	0.75	5.87			83.56	87.35	8.80	3.78
		75-125	8.13	7.30	0.84	0.04	0.04	0.91	1.83	9.83	9.50	1.27	11.82			97.32	76.03	17.12	6.85
2. Anthraqui Silti Hyper Eutric Fluvisols	118+113	0-19	6.13	5.03	1.97	0.11	0.04	0.90	1.67	10.00	8.03	0.83	11.16			85.31	29.47	50.24	20.29
	+688+12	19-47	7.89	6.51	1.09	0.06	0.04	1.36	3.14	9.13	9.70	2.93	13.80			97.32	30.14	44.45	25.41
		47-85	7.61	6.06	1.01	0.05	0.03	1.35	2.13	7.75	8.05	3.53	12.80			95.48	23.83	46.19	29.98
		85-125	6.32	4.92	1.08	0.06	0.03	1.52	2.17	7.00	7.43	5.13	14.08	0.72	3.40	91.45	11.84	49.49	38.67
3. Anthraqui Hyper Eutric Fluvisols	868+849	0-18	6.20	5.13	2.02	0.15	0.05	1.59	1.00	12.50	9.20	1.20	12.90			87.67	25.08	46.38	28.54
		18-57	8.29	7.63	0.90	0.07	0.05	1.57	4.50	9.25	15.60	1.55	18.47			99.78	29.09	46.19	24.73
		57-88	8.44	7.70	1.39	0.06	0.05	1.58	3.10	12.50	16.35	1.15	18.94			99.78	42.30	41.45	15.95
		88-125	7.40	5.97	0.85	0.05	0.02	1.09	2.60	8.50	7.40	1.90	10.49			93.58	28.31	31.96	38.05
4. Hypereutri-Gleyic Fluvisols	611	0-19	6.20	5.34	1.84	0.12	0.04	1.44	2.50	15.00	9.00	1.50	12.87			88.30	36.68	45.18	18.14
		19-42	8.10	7.60	1.08	0.16	0.04	1.56	7.50	12.50	12.20	1.80	15.08			100.00	29.12	51.90	18.98
		42-70	8.35	7.70	1.44	0.07	0.05	1.92	6.50	18.00	24.50	1.70	28.20			100.00	20.00	55.92	24.08
		70-90	6.46	5.55	0.68	0.04	0.02	0.54	3.00	7.00	5.50	0.50	6.92			87.57	56.62	23.78	19.60
		90-125	5.50	4.25	0.68	0.06	0.02	0.81	1.50	10.00	7.50	0.50	11.34			76.88	7.56	38.60	43.84
5. Hyper-Eutric Gleysols	37+379	0-20	5.71	4.66	2.45	0.15	0.04	1.26	3.07	13.52	7.05	0.80	10.93	0.72	1.80	80.24	24.97	38.27	36.76
	+244+199	20-46	6.68	5.54	1.28	0.08	0.02	1.33	2.55	10.45	6.62	1.60	9.77	1.38	5.50	90.41	21.57	35.12	43.31
		46-85	6.09	4.82	0.95	0.05	0.02	1.07	3.00	8.45	5.20	1.10	8.26	1.35	1.86	85.10	32.45	32.35	35.20
6. Orthi-Eutric Gleysols	479+373+769	0-19	5.46	4.39	1.99	0.14	0.03	0.88	2.50	11.05	5.57	0.83	7.67	1.93	4.11	71.91	29.19	37.45	33.36
	+492+206	19-48	5.22	4.21	1.65	0.10	0.02	0.88	1.90	8.83	5.36	0.89	9.40	2.57	6.47	73.72	27.73	33.32	38.95
	+531+405	48-91	5.20	4.15	1.36	0.06	0.01	0.97	1.47	7.89	5.84	1.22	10.75	5.27	8.16	71.25	22.69	31.98	45.33
	+652+357	91-125	5.14	4.14	0.79	0.05	0.01	1.04	2.06	9.64	5.89	1.10	11.63	5.42	19.55	67.66	24.24	34.04	41.76
7. Epi-Eutric Gleysols	634	0-22	5.00	4.05	2.72	0.21	0.04	1.26	1.25	16.60	6.50	0.50	12.11	1.80	6.20	63.77	29.36	34.10	36.54
		22-50	5.23	4.10	1.68	0.16	0.02	0.96	1.25	12.50	5.50	0.90	11.33	2.79	18.00	61.27	23.22	32.76	44.02
		50-70	5.07	3.82	1.72	0.17	0.01	0.90	1.00	10.00	5.00	0.80	13.07	2.79	3.80	48.35	32.34	35.64	32.02
8. Endo-Dystric Gleysols	351+717	0-19	5.26	4.40	2.74	0.12	0.03	1.27	3.25	13.75	6.10	1.15	10.45	1.22	9.50	75.89	24.05	38.92	37.03
		19-43	5.09	4.02	0.90	0.07	0.01	0.77	1.75	9.75	3.30	0.60	7.30	4.68	6.50	62.10	31.16	36.27	32.57
		43-95	4.54	3.53	0.94	0.05	0.02	1.29	1.75	6.90	2.00	0.55	11.36	9.77	5.30	26.21	26.04	35.15	38.81
		95-125	4.54	3.42	0.84	0.05	0.01	0.96	2.00	6.90	1.70	0.40	10.66	9.45	4.50	23.44	21.09	43.74	35.17
9. Dystric Gleysols	629	0-20	4.84	4.22	1.84	0.15	0.03	1.54	2.50	12.50	7.20	1.30	12.53	1.17	3.21	74.25	48.88	36.94	14.18
		20-35	5.15	4.50	1.82	0.12	0.02	1.56	2.50	12.50	8.00	1.80	12.89	0.81	2.61	81.65	21.00	41.46	37.54
		35_57	4.00	3.25	1.44	0.10	0.02	0.91	1.00	12.50	4.00	1.00	14.44	3.15	85.20	38.39	22.62	24.94	52.44
		57-95	3.90	3.10	1.36	0.07	0.01	0.95	1.00	18.00	5.00	1.20	15.30	6.75	86.30	45.18	22.88	34.98	42.14
		95-125	3.95	3.20	1.02	0.05	0.01	0.95	1.00	15.00	3.90	0.80	13.76	8.01	94.50	39.04	24.74	37.88	37.38
10. Orthi-Eutric Regosols	765	0-13	6.02	5.30	1.68	0.10	0.02	0.15	5.50	7.00	3.00	0.30	4.85			76.07	89.50	6.44	4.06
		13-27	6.60	6.10	1.44	0.12	0.01	0.12	2.50	7.00	2.60	0.40	3.82			64.48	93.50	2.22	4.28
		27-56	7.01	5.95	0.82	0.06	0.01	0.08	2.50	7.00	1.60	0.40	2.54	2.00	3.20	88.15	96.22	1.46	2.32
		50-85	4.98	4.00	0.82	0.06	0.01	0.04	9.00	7.00	2.40	0.20	5.58			50.79	72.96	13.10	13.24
11. Epilithi-Dystric Leptosols	668		4.90	4.04	1.04	0.08	0.04	0.52	2.50	10.00	1.20	0.20	6.57	6.93	6.23	26.65	74.16	9.16	16.68
12. Hypereutri-Gleyic Cambisols	723+470	0-16	5.60	4.57	2.34	0.13	0.03	0.50	1.00	12.50	5.90	0.70	9.34	1.71	11.26	77.45	43.74	35.86	20.21
		16-30	6.95	5.80	0.96	0.07	0.01	0.45	1.50	10.00	7.00	0.60	8.60			94.51	42.93	35.00	22.07
		30-75	7.02	5.70	0.80	0.05	0.01	0.44	2.50	10.00	7.70	1.20	10.00			95.65	45.27	27.40	27.33
		75-125	6.89	5.49	0.75	0.05	0.01	0.45	2.50	10.00	6.80	2.10	10.03			95.31	57.04	16.75	26.18
13. Orthi-dystri-Gleyic Cambisols	644a	0-18	5.80	4.40	2.52	0.13	0.03	0.41	5.50	12.50	5.00	1.00	8.91	1.26	6.23	73.44	40.54	41.30	18.16
		18-38	5.40	3.95	1.24	0.06	0.01	0.62	2.00	7.00	4.50	0.50	8.72	5.85	3.21	62.99	27.72	32.34	39.94
		38-60	4.95	3.78	1.04	0.10	0.01	0.60	1.00	7.00	2.50	0.30	9.97	8.55	3.64	31.88	23.28	28.80	47.92
		60-125	5.05	3.62	0.98	0.05	0.01	0.82	2.50	10.00	2.80	0.20	8.92	9.63	3.88	37.33	33.86	23.30	42.84
14. Orthi-Dystric Acrisols	644b	0-12	5.40	4.08	1.48	0.19	0.02	0.26	1.00	7.00	2.30	0.20	6.79	3.69	7.21	43.00	72.06	20.14	7.80
		12-37	4.95	3.80	1.04	0.04	0.02	0.31	2.50	7.00	0.90	0.10	5.34	12.15	2.91	23.43	45.40	32.20	22.40
		37-65	4.96	3.75	1.03	0.03	0.01	0.32	2.00	4.00	0.90	0.10	5.54	11.97	3.81	22.38	42.82	30.08	27.10
		65-90	4.81	3.90	1.12	0.05	0.01	0.33	1.00	4.00	1.00	0.20	5.78	11.25	5.56	24.90	48.12	30.54	21.34
15. Hyper-Eutric Plinthosols	746+525+314	0-18	6.32	5.43	1.50	0.09	0.04	0.23	4.70	7.75	5.20	0.38	6.97	0.81	6.20	88.16	62.80	29.68	8.63
	+222	18-35	7.30	6.23	0.78	0.04	0.01	0.18	2.75	7.70	4.08	1.03	5.82	0.63	3.50	91.80	57.95	31.07	10.99
		35-75	7.34	6.13	0.79	0.03	0.01	0.42	1.88	7.00	5.80	0.88	7.59	0.30	3.14	93.87	51.42	27.58	21.01
		75-125	6.46	5.30	0.74	0.05	0.01	0.69	1.38	7.00	5.75	1.08	8.44	3.45	2.77	87.72	45.12	25.49	29.40
16. Endo-Eutric Plinthosols	637	0-20	5.54	4.16	0.80	0.05	0.02	0.12	1.00	7.00	1.60	0.20	3.91	2.25	5.20	53.76	79.74	13.60	6.66
		20-45	4.81	3.88	0.60	0.06	0.02	0.26	1.00	10.00	1.40	0.10	5.74	6.39	2.21	30.32	62.18	18.56	19.26
		45-100	6.02	4.78	0.92	0.05	0.01	0.48	5.50	12.50	3.60	0.40	5.89	0.81	1.64	75.90	60.08	16.14	23.78
		100-130	5.42	4.14	0.60	0.05	0.01	0.57	2.00	10.00	2.30	0.20	5.96	4.50	2.12	48.02	58.18	15.44	25.88
17. Endo-Dystric Plinthosols	393+633	0-20	5.60	4.48	1.40	0.08	0.03	0.01	1.00	10.00	2.20	0.20	6.57	6.93	6.23	26.65	74.16	9.16	16.68
		20-40	7.13	5.87	0.83	0.05	0.01	0.17	1.75	8.50	4.10	0.50	5.60			90.46	59.98	22.38	17.34
		40-80	5.00	3.81	0.55	0.04	0.01	0.59	1.00	7.00	3.15	0.50	9.95	8.55	2.82	41.09	45.80	20.06	34.14
		80-130	5.10	3.82	0.38	0.04	0.01	0.46	2.50	7.00	3.50	0.30	7.86			55.12	47.34	23.22	29.44

C-2.6 Correlation between CEC and Rice Yield on Degraded Soils

CEC (meq/100 g soil)	Variety	Yield (t/ha)
<10	A3 NN-8 XS-2	3.6 4.2 5.0
>16 (soil well ploughed or enriched with organic fertilizers)	A3 NN-8 XS-2	4.2 4.8 6.0

Source : ISF, 1991

CEC in this soil is determined by Ca and Mg.

The Cation exchange capacity is in direct proportion with the rice yield. High yielding variety (HYV) is well grown on the high CEC soils. CEC is in high dependence on organic matter returned (1% O.M. can result in an increase of 3 meq in CEC).

C-2.7 Soil Fertility Appraisal

* Criteria used to appraise soil fertility is as follows:

1. Soil acidity
   - very limited pH KCl less than 3
   - moderately limited pH KCl =3-4
   - slightly limited pH KCl more than 4

2. Soil organic matter (%C×1.72)
   - Rich : more than 2.0%
   - Medium : 2.0-1.0%
   - Poor : less than 1.0%

3. Total Nitrogen Content
   - Rich : more than 0.2%
   - Medium : 0.2-0.1%
   - Poor : less than 0.1%

4. Phosphorus content :
   - • Total
     - Rich : more than 0.1%
     - Medium : 0.1-0.06%
     - Poor : less than 0.06%
   - • Available
     - Rich : more than 10 mg / 100 g soil
     - Medium : 10-5 mg / 100 g soil
     - Poor : less than 5 mg / 100 g soil

5. Potassium content :
   - • Total
     - Rich : more than 1.5%
     - Medium : 1.5-0.5%
     - Poor : less than 0.5%
   - • Available
     - Rich : more than 20 mg / 100 g soil
     - Medium : 20-10 mg / 100 g soil
     - Poor : less than 10 mg / 100 g soil

6. CEC :
   - High : more than 20 mg / 100 g soil
   - Medium : 20-10 mg / 100 g soil
   - Low : less than 10 mg / 100 g soil

C-2.8 Soil Analysis

The soil analysis have been performed in accordance with the methods specified below:

1. pH KCl by pH meter
2. Organic Carbon - Walkley black
3. N total % - Kjeldahl
4. Total and available P_2O_5 by Spectrophotometer
5. Total and available K_2O - Flamephotometer
6. Exchangeable Ca - Flamephotometer
7. Exchangeable Mg - Titration
8. Extractable Fe - Spectrophotometer
9. Extractable Al - Titration
10. CEC - Amoni-acetate (NH_4OAC) Schollenberger's method
11. Particle size analysis - Pipet

* Soil texture is classified below:

- Sandy - The texture of the fine earth is sand (0.05 to 2 mm in diameter) or loamy sand.
- Loamy - The texture of the fine earth is loamy very fine sand but the amount of clay is below 35%
- Clayey - The fine earth contains 35% or more clay by weight (Fine : 35-59% of clay (below 0.002mm in diameter) - very fine : 60% or more clay in the fine earth fraction)

12. Bulk density by core method

C-2.9 Area of Land Use Types in the Project Area

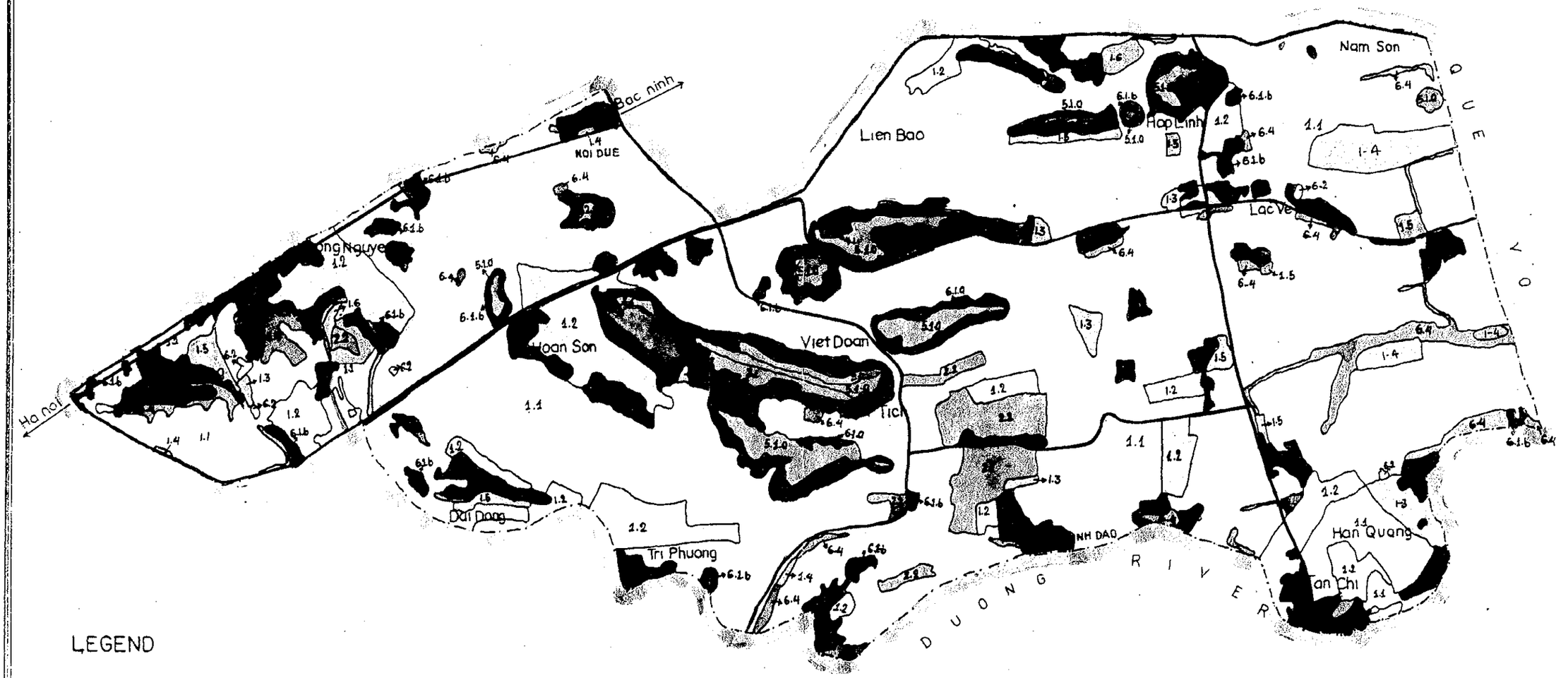
Unit : ha

No	Land Use Types	Mark	Total Area	%	Tien Son District																			Que Vo District		
					+	Tan hong	Hoan son	Viet doan	Phat tich	Hien van	Lac ve	Lien bao	Khac niem	Hap linh	Tan chi	Minh dao	Canh hung	Tri phuong	Dinh bang	Dong nguyen	Dai dong	Noi due	Tuong giang	+	Han quang	Nam son
A	Agricultural land		5,755	68.9	5204.4	341	413	538	312	284	762.4	203	197	260	428	285	225	237.6	174	209.6	177	91.5	68	551	352.6	198
1	2 rice	1.1	4,317.5	51.7	3815.9	218	216	371	210	221	565.5	177	168	220	322	165	194	158.7	157	180.1	114	89	68	502	303.6	198
2	2 rice + 1 subsidiary crop	1.2	660.5	7.91	649.7	119	139	3	19.8	10.8	24.6			30	90.5	51.8	4	78.9	4.2	25.4	48.8			10.8	10.8	
3	1 rice + 1 subsidiary crop	1.3	261.8	3.13	226.1			104	6.6	34.1	43.7	17.2	4.1	0.6	4.3	7.3			0.5	2.2	1.5			35.7	35.7	
4	1 rice	1.4	105.4	1.26	103.4		1	25.2	14.3	7.7	46.1						2.1		1.5	1.9	2.1	1.5		2	2	
5	Specialized nursery bed	1.5	139.6	1.67	139.6		12	6.5	4.1	5.1	65		7.1	9.3	10.4				10		10.1					
6	1 rice + 2 subsidiary crop	1.6	53.6	0.64	53.6	1.5	39.3						12.8													
7	Vegetable - Subsidiary crop - shortterm industrial crops		216.6	2.6	216.1	1.6	5.5	28.1	58	4.7	18	8.6	4.9			60.4	24.8				0.5	1		0.5	0.5	
	a. Mountainous land	2.1	77.3	0.93	77.3	1.6	5.5	14.6	50.3			6.9														
	b. Indyke detail land	2.2	139.3	1.67	138.8			13.5	7.7	4.7	18	1.7	4.9			60.4	24.8				0.5	1		0.5	0.5	
B	Forestry land		62.8	0.75	61.6			31.1	20.3	10.2														1.2		1.2
8	Planted forest	4.1	62.8	0.75	61.6			31.1	20.3	10.2														1.2		1.2
C	Unused land		137.7	1.65	130		26.6	30.5	44.2	11	2.5	3.3	1.1	10.8										7.7		7.7
9	Grass and brushes	5.1	137.7	1.65	160		26.6	30.5	44.2	11	2.5	3.3	1.1	10.8										7.7		7.7
D	Specialized use land		2,584.2	28.7	2226.5	157	208	238	123	133	254.6	109	92.3	124	210	137	115	60.5	111	42.9	70.8	33.4	8	174	132.4	41.1
10	Residential land		866.3	10.4	837.8	40.9	92	113	34.3	66.8	66.2	38.6	44.8	78.6	47	48.5	28.5	24.6	40	18	36	20.5		28.5	28.5	
	a. Mountainous residential	6.1.a	276	3.3	276		22.4	62.9	34.3	64.6	7.9	16.1	11.3	56.5												
	b. Indyke detail residential	6.1.b	590	7.06	561.8	40.9	69.6	49.6		2.2	58.3	22.5	33.5	22.1	47	48.5	28.5	24.6	40	18	36	20.5		28.5	28.5	
11	Cemetery	6.2	42.7	0.51	41.1	5.8	7.3	4.6	1	8.3	3.3	3	0.7		1.8	1.4	0.9		0.6	2.4				1.6	1.6	
12	Brick kiln	6.3	11.4	0.14	11.4	2.4	2.7	0.6	4.2	0.8										0.7						
13	Ponds, lakes	6.4	391.8	4.69	340.2	37.2	17.2	35	20.6	13.5	37.2	18.5	12.4	20	17.3	29	26	10.3	28	5.2	8.3	2.5	2	51.6	42.3	9.3
14	Other		1,272	13	980.2	70.6	88.7	99.5	82.7	73.4	47.9	79	34.4	55.3	44	58.1	59.6	25.6	41.9	46.6	56.5	10.4	6	291.8	160	131.8
	Total natural area		8,540	100	7606.7	498	647	852.5	520	468	919.5	346	290	425	538	413	340	298.1	284	282.5	278	125	76	933	585	348

C-2.10 Existing Land Use Map of the Project Area

EXISTING LAND USE MAP OF THE FEASIBILITY STUDY AREA

SOUTH BAC DUONG AGRICULTURAL AREA



LEGEND

A - AGRICULTURE

I - RICE

1.1 2 Rices

1.2 2 Rice 1 Subs crop

1.3 1 Rice 1 subs crop

1.4 Spring rice

1.5 Special seedbed

1.6 1 Rice 2 Subs crops

2. VEGETABLE SUBSIDARY INDUSTRIAL CROPS

2.1 Hill and mountain

2.2 Land inside of dike

B - FORESTRY LAND

Plantation

C - LAND NOT BEING IN USE

5.1 Hill and moutain

5.2 Land inside of dike

D - OTHER LAND

6.1 - LAND FOR HOUSING

Hill and mountain

Land inside of dike

6.2 Cemetery

6.3 Brick factory

6.4 Ponds - lake - swamp

Road

Canal

SCALE : 1 / 50000

C-2.11 Proposed Land Use of the Project Area

Soil Subunit	Area (ha)	Orientation of use	Measures
1. Areni - Hypereutric Fluvisols	343.7	Upland crops or perennial crops	Application of organic fertilizers and P, maintaining of humidity
2. Fluvisols (except light texture) and Cambisols	1940.0	Intensive double rice + winter crops	Application of P - fertilizers with NK combined
3. Gleysols	3133.2	Double rice, convert about 20% of area to new pattern : rice + fish	Rational regulation of water. Additional application of P - fertilizers
4. Plinthosols	250.3	Upland crops with rotation of rice + upland crops	Application of organic fertilizers, deep ploughing, balance application of NPK.
5. Acrisols and leptosols	277.8	Planting forest.Exploiting rock for construction material	Selection of drought resistant crops, protection of drinking water resources

APPENDIX D

AGRICULTURE AND INLAND FISHERY

APPENDIX D

Agriculture and Inland Fishery

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Table D-1 Cropping Area of the Districts in the Study Area (1993)

(ha)

Crop	G. Total	Ha Bac					Hanoi		
		S. Total	T. Son	Q. Vo	B. Ninh	Y. Phong	S. Total	Gia Lam*	D. Anh
Paddy	38006	34095	17667	12651	1959	1818	3911	2823	1088
Winter-Spring	21472	19604	9156	8277	1256	915	1868	1375	493
Summer	16534	14491	8511	4374	703	903	2043	1448	595
Sweet potato	3715	3472	1139	2154	66	113	243	64	179
Vegetable	2894	2691	862	1227	581	21	203	168	35
Maize	2062	1303	488	794	—	21	759	618	141
Groundnut	1265	983	445	488	26	24	282	239	43
Potatoes	935	809	541	238	3	27	126	82	44
Soybean	451	383	287	37	37	22	68	30	38
Fruit	24	24	23	1	—	—	—	—	—
Flowers	10	10	4	1	5	—	—	—	—
Cassava	91	91	10	81	—	—	—	—	—
Taro	137	137	27	110	—	—	—	—	—
Total	46590	43998	21493	17782	2677	2046	5592	4024	1568
Crop. Intensity		1.82	1.94	1.75	1.74	1.84		2.15	

Source : Province and District People's Committees
Note : *1992 data except cropping intensity

Table D-2 Crop Yield in the Districts in the Study Area (1993)

(t/ha)

Crop	Ha Bac				Hanoi	
	Tien Son	Que Vo	Bac Ninh	Yen Phong	Gia Lam*	Dong Anh
Paddy	3.8	3.1	3.3	3.1	—	4.0
(Winter-Spring)	3.7	3.1	3.1	3.1	—	4.2
(Summer)	3.8	3.1	3.4	3.1	4.1	3.7
Vegetable	13.9	11.4	11.7	12.8	12.9	12.7
Maize	2.6	2.0	—	1.6	2.2	1.8
Sweet Potato	7.4	9.5	8.7	8.7	7.2	7.0
Potatoes	10.4	10.5	8.7	9.4	9.5	6.6
Soybean	0.8	1.0	0.9	0.9	0.4	0.5
Groundnut	1.1	1.3	1.2	1.2	0.8	1.4
Cassava	10.0	10.2	—	13.0	—	—
Taro	18.0	9.5	—	19.0	—	—

Note : *… 1992 data

Source : People's committees concerned

Table D-3 Application of Fertilizer and FYM in Ha Bac Province (1993)

(kg/ha)

Crop	Name of Fertilizer*	Amount		Remarks
		Present	Recommended	
Winter-Spring Rice	(N) Urea	162	189	Because of high price of fertilizer, farmers can not use K.
	(P) Single superphosphate	190	220	
	(K) Sulphate potassium	30	81	
	(P/C) FYM	5,500	8,000	
Summer Rice	N	135	180	Microelement fertilizer not being used at present
	P	135	220	
	K	30	80	
	P/C	5,500	8,000	
Maize	N	200	270	
	P	300	400	
	K	80	130	
	P/C	8,000	10,000	
Sweet potato	N	60	80	
	P	300	400	
	K	80	460	
	P/C	8,000	10,000	
Potatoes	N	200	250	
	P	300	350	
	K	100	150	
	P/C	8,000	15,000	
Cassava	N	80	120	
	P	200	300	
	K	80	100	
	P/C	5,000	8,000	
Soybean	N	70	80	
	P	300	350	
	K	80	100	
	P/C	3,000	8,000	
Groundnut	N	20	30	
	P	300	400	
	K	80	80	
	P/C	8,000	10,000	
Taro	N	100	120	
	P	300	400	
	K	150	200	
	P/C	10,000	12,000	

Note : * percentage of N. P. K. content in each fertilizer
N ··· 46%, P ··· 16.5%, K ··· 50%

·Source : Ha Bac Province, Statistical Department

Table D-4 Main Rice and Maize Varieties in Ha Bac Province (1993)

Crop	Variety Name	Covering Area (ha)	Characteristics	Remarks
Rice	CR 203	22,500	Short duration, dwarf, BPH resistant, sheath blight and blast susceptible	For two seasons
	Moc Tuyen	6,500	Tall, late maturation, good quality, lodging, low yield,	For deep water
	Bao Thai		Resistant to brown plant hopper (BPH)	
	DT 10	3,800	High yield, BPH resistant, quality moderate	Winter-Spring crop
	Variety China	10,000	Short, high yield	For two seasons
	IR 352	2,500	Short, high yield	For two seasons Sticky rice
Maize	TSB 2	4,000	Short, low yield	
	Bioseed 19670	1,500	High yield	Wide adaptability

Source : MWR

Table D-5 Application of Pesticide in Ha Bac Province (1993)

(kg/ha)

Name	Present amount applied	Remarks
Wofa Tox	0.125	most popular insecticide
Dipterex	0.025	
Monitor	0.05	
Padan	0.15	most popular insecticide
Bassa	0.075	
Valida Cin	0.24	most popular fungicide
Fuji one	0.075	
Kitazin	0.125	most popular fungicide
Minosan	0.1	most popular fungicide

Source : Ha Bac Province, Statistical Department

Fig. D-1-(1) Cropping Calendar in the Study Area

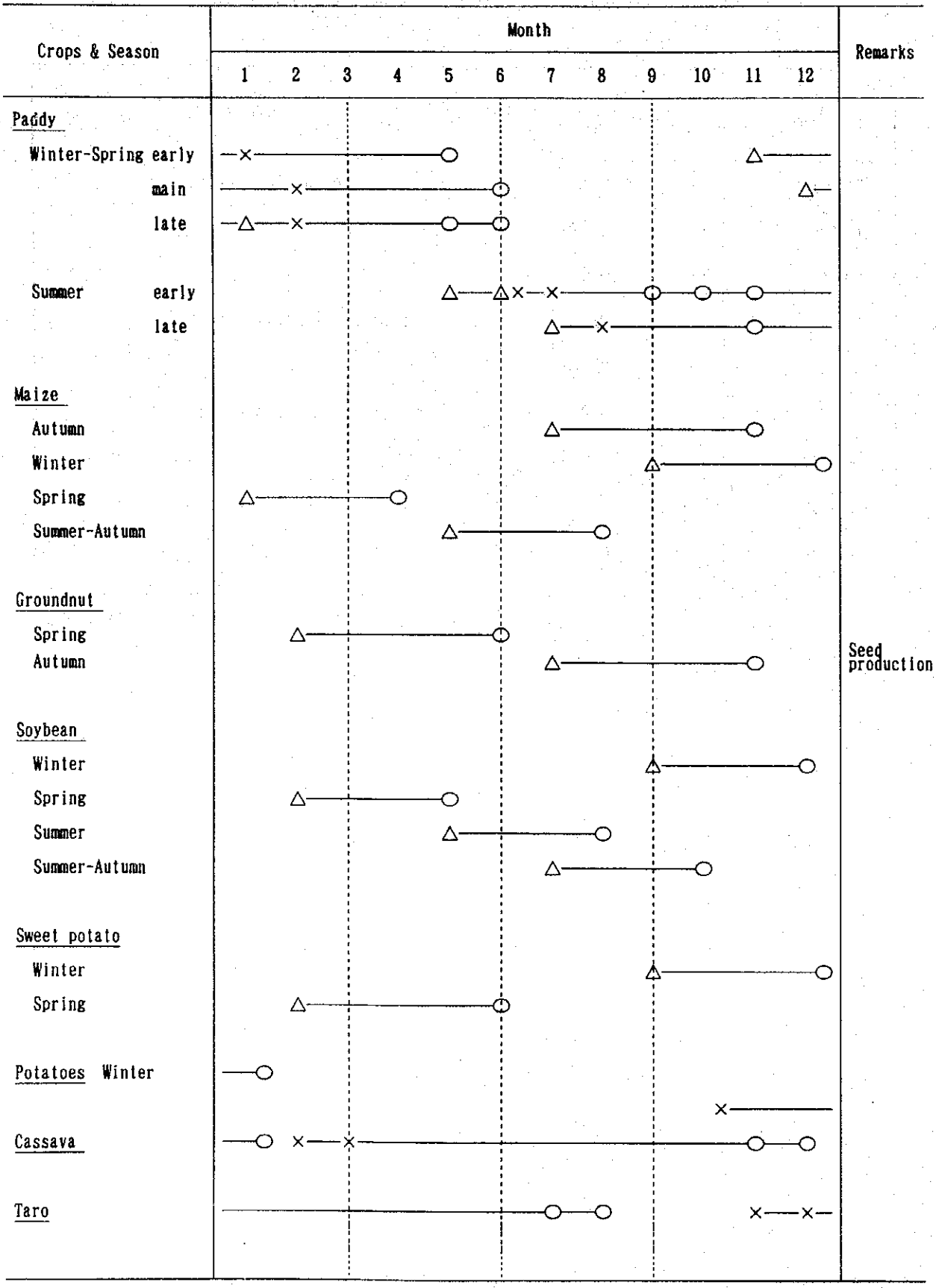
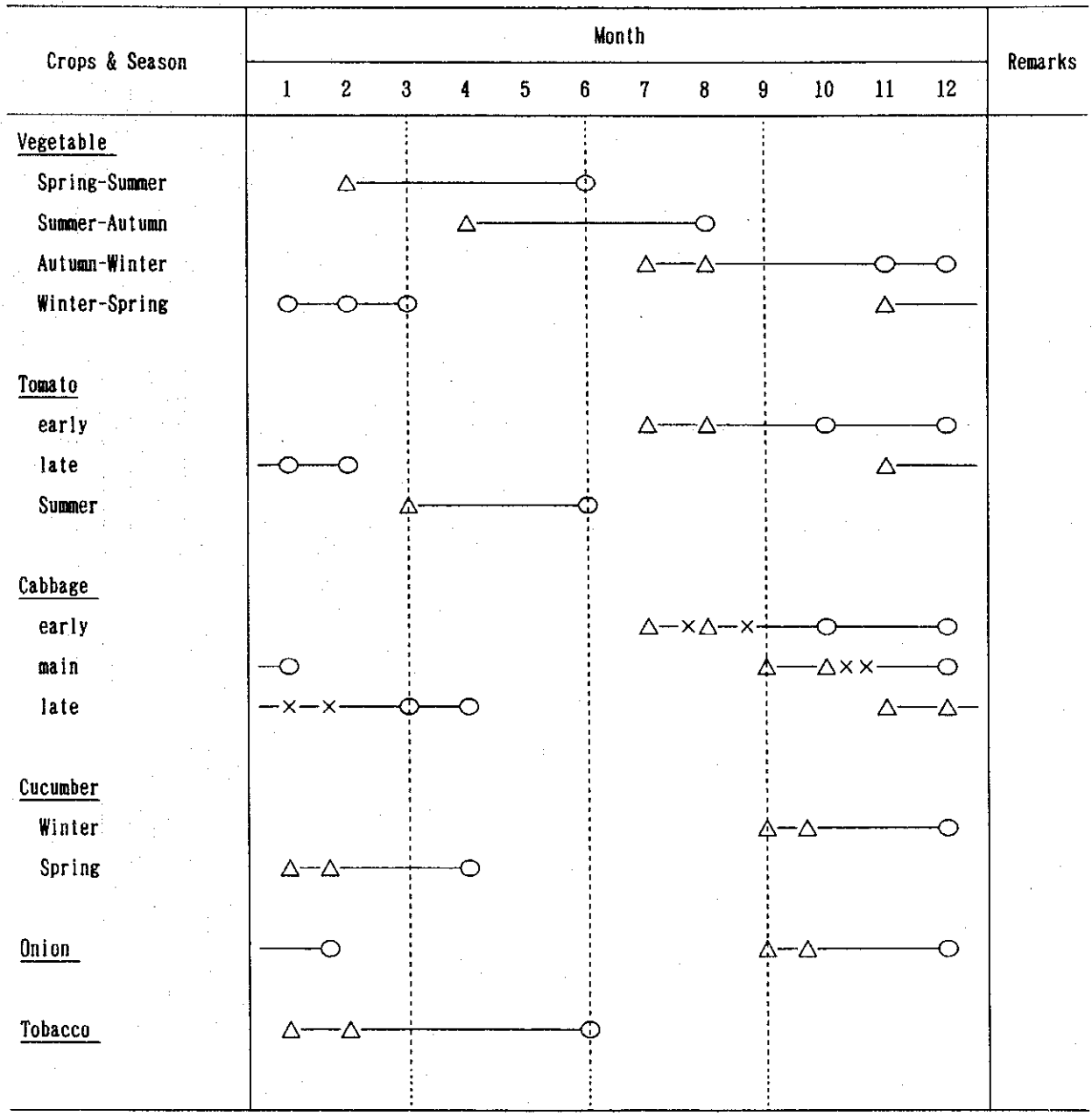
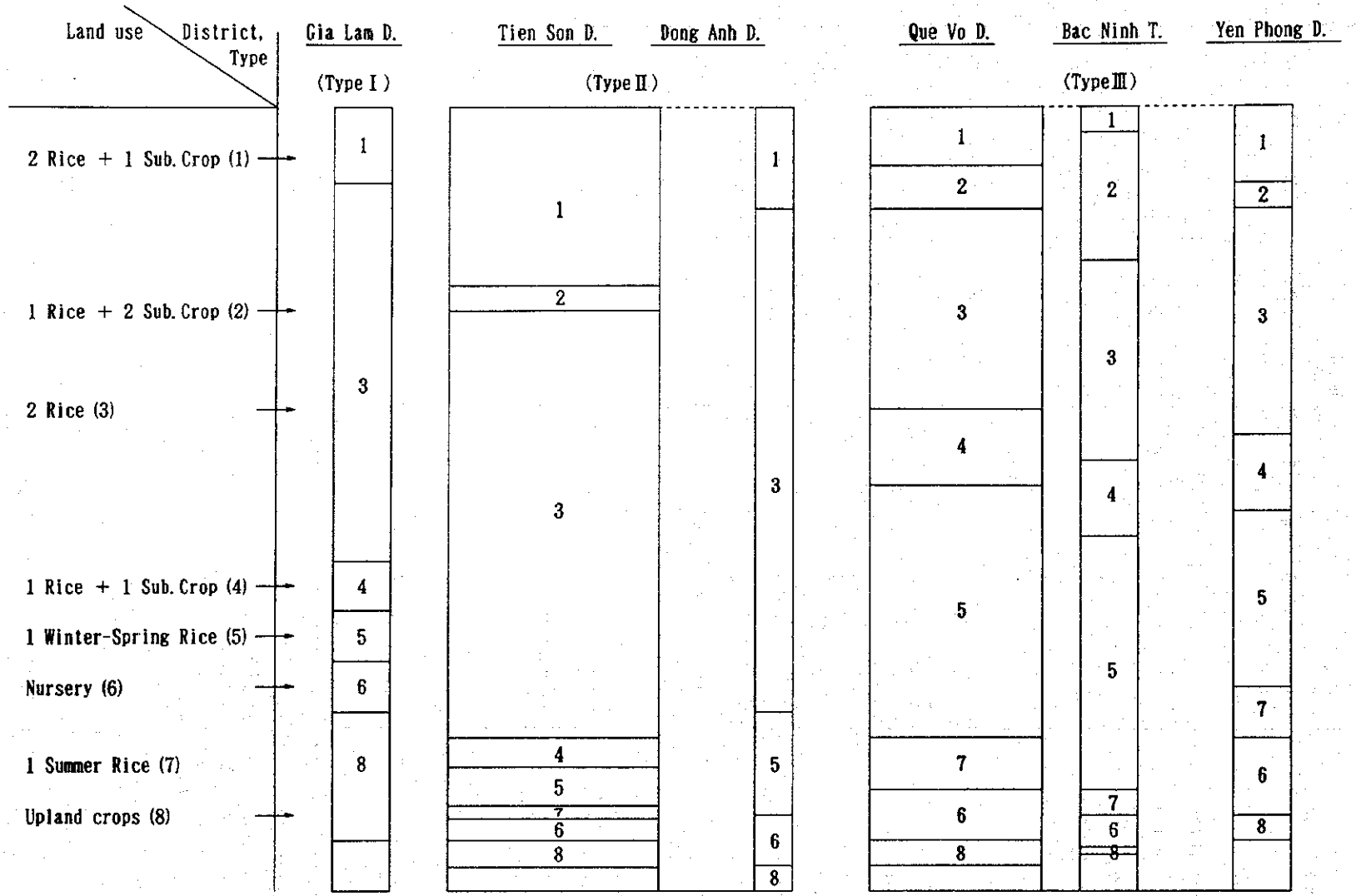


Fig. D-1-(2) Cropping Calendar in the Study Area



Legend : △ ····· sowing
× ····· transplanting
○ ····· harvesting

Figure D-2 Land Use in the Study Area (1993)



Source : NIAPP

Table D-6 Paddy Cultivation and Production in Viet Nam

Year	Sown Area of Rice ('000 ha)				Yield of Rice (ton/ha)				Production of Rice ('000 ha)			
	Total	Winter Spring	Summer Autumn	Monsoon	Average	Winter Spring	Summer Autumn	Monsoon	Total	Winter Spring	Summer Autumn	Monsoon
1976	5,297	1,394	615	3,288	2.23	2.68	2.49	2.00	11,827	3,730	1,531	6,566
1977	5,496	1,538	617	3,314	1.94	2.13	2.17	1.81	10,597	3,278	1,336	5,983
1978	5,463	1,620	687	3,516	1.79	2.20	1.60	1.63	9,790	3,559	1,100	5,131
1979	5,485	1,746	660	3,079	2.07	2.23	1.96	2.00	11,648	3,874	1,594	6,180
1980	5,600	1,707	681	3,212	2.20	2.27	2.34	1.92	11,648	3,874	1,594	6,180
1981	5,612	1,638	619	3,395	2.52	2.55	2.40	1.99	12,415	4,173	1,489	6,753
1982	5,711	1,623	704	3,384	2.63	2.79	2.78	2.33	14,390	4,526	1,959	7,905
1983	5,611	1,650	674	3,287	2.73	3.11	3.25	2.26	14,743	5,134	2,194	7,415
1984	5,675	1,658	797	3,220	2.78	3.35	3.30	2.27	15,506	5,561	2,632	7,313
1985	5,704	1,765	857	3,082	2.78	3.50	3.33	2.22	15,875	6,191	2,855	6,828
1986	5,689	1,829	915	2,945	2.81	3.34	3.23	2.33	16,003	6,118	3,009	6,876
1987	5,589	1,840	892	2,857	2.70	2.98	2.83	2.47	15,102	5,499	2,529	7,074
1988	5,726	1,882	994	2,850	2.97	3.70	3.40	2.34	17,000	6,974	3,379	6,647
1989	5,896	1,993	1,140	2,763	3.23	3.78	3.57	2.68	18,996	7,539	4,063	7,394
1990	6,028	2,074	1,216	2,738	3.19	3.78	3.38	2.65	19,225	7,846	4,110	7,269
1991	6,303	2,160	1,383	2,760	3.11	3.14	3.41	2.93	19,622	6,788	4,718	8,116
1992	6,475	2,279	1,448	2,748	3.33	4.01	3.39	2.73	21,590	9,153	4,910	7,527
1993	6,387	2,326	1,438	2,623	3.43	3.88	3.57	2.94	21,900	9,032	5,144	7,724

Source : Statistical Data of Viet Nam's Agriculture, Forestry, and Fishery
Note : Summer-Autumn is only for the South and the Central coast of North.
Monsoon rice is summer rice in the North.

Table D-7 Number of Livestock in the Study Area (1993)

(head)

Livestock	G. Total	Ha Bac					Hanoi		
		S. Total	Tien Son	Que Vo	Bac Ninh	Yen Phong*	S. Total	Gia Lam	Dong Anh
Buffalo	13,954	12,467	4,428	6,190	1,163	686	1,487	1,145	342
Cattle	20,096	17,816	6,860	9,591	735	630	2,280	1,365	915
Pig	133,452	120,000	55,795	42,893	16,390	4,922	13,452	7,759	5,693
Duck	74,391	74,391	39,000	32,000	3,000	391	—	—	—
Goose	43,021	—	—	—	—	—	42,021	—	42,021
Hen	805,918	805,918	590,000	32,700	140,000	43,218	—	—	—
Total	1,089,832	1,030,592	696,083	123,374	161,288	49,847	59,240	10,269	48,971

Note : — no record
* — adjusted

Source : District Report

Table D-8 Dietary Intake with and without VAC (1993)

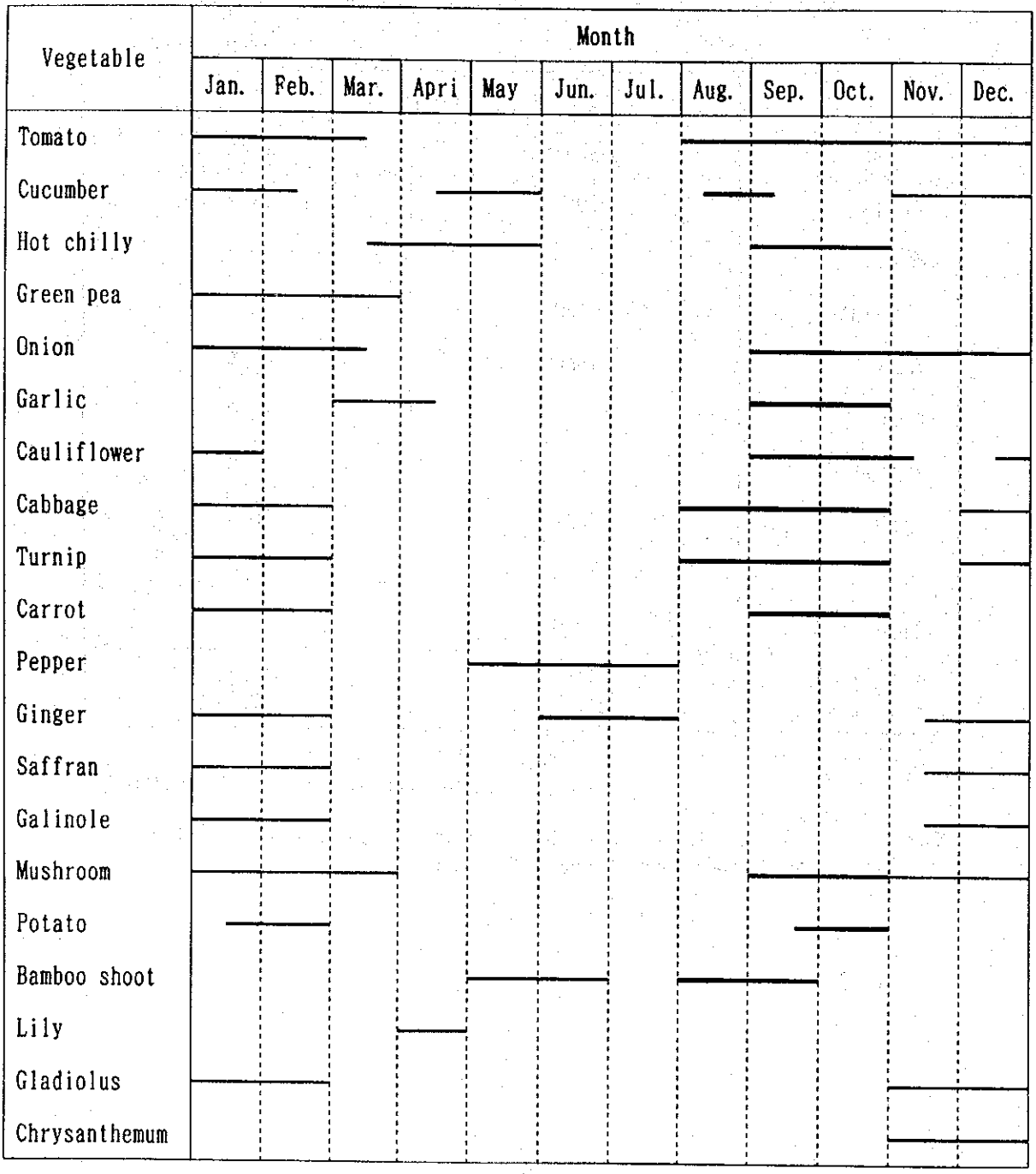
(g/person/day)

Food	VAC System	
	Without	With
Tubers	60.5	61.2
Beans	31.0	33.4
Oils/fats	4.0	8.9
Meat	18.6	43.4
Fish	—	2.0
Vegetables	253.7	373.0
Fruit	18.2	66.6
Sauce	11.9	7.4
Sugar	2.6	6.9
Energy provided (adult)	Kilocal 2175.2	Kilocal 2477.5

Source : "VAC and VACVINA"
"National Institute of Nutrition"

Note : Figures show the dietary intake for two groups of families having the same conditions of land and labour.

Fig. D-3-(1) Cropping Seasons of Some Vegetables and Fruit Trees



Source : Vegetexco brouchure

Sowing time
Harvesting Time

Fig. D-3-(2) Cropping Seasons of Some Vegetables and Fruit Trees

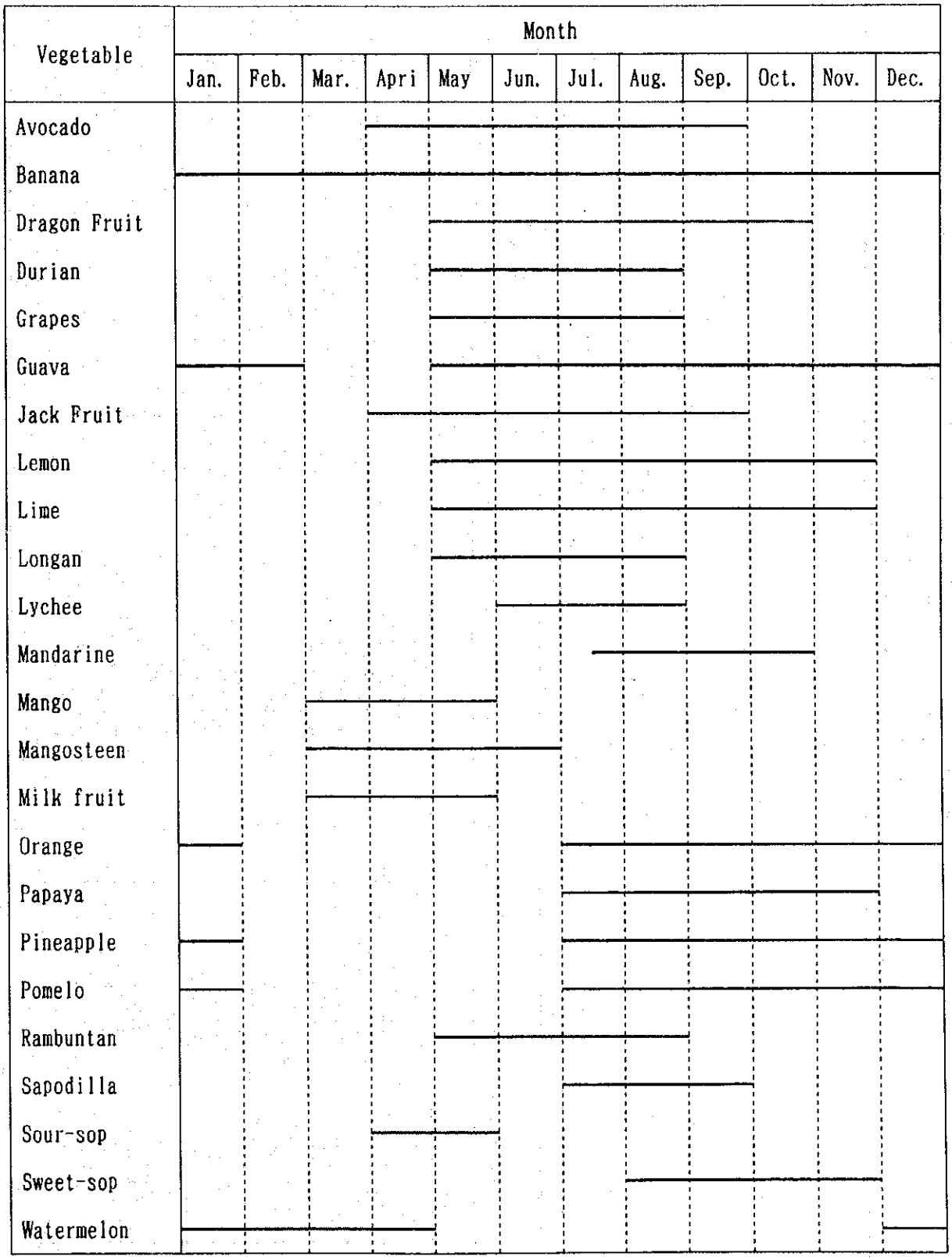
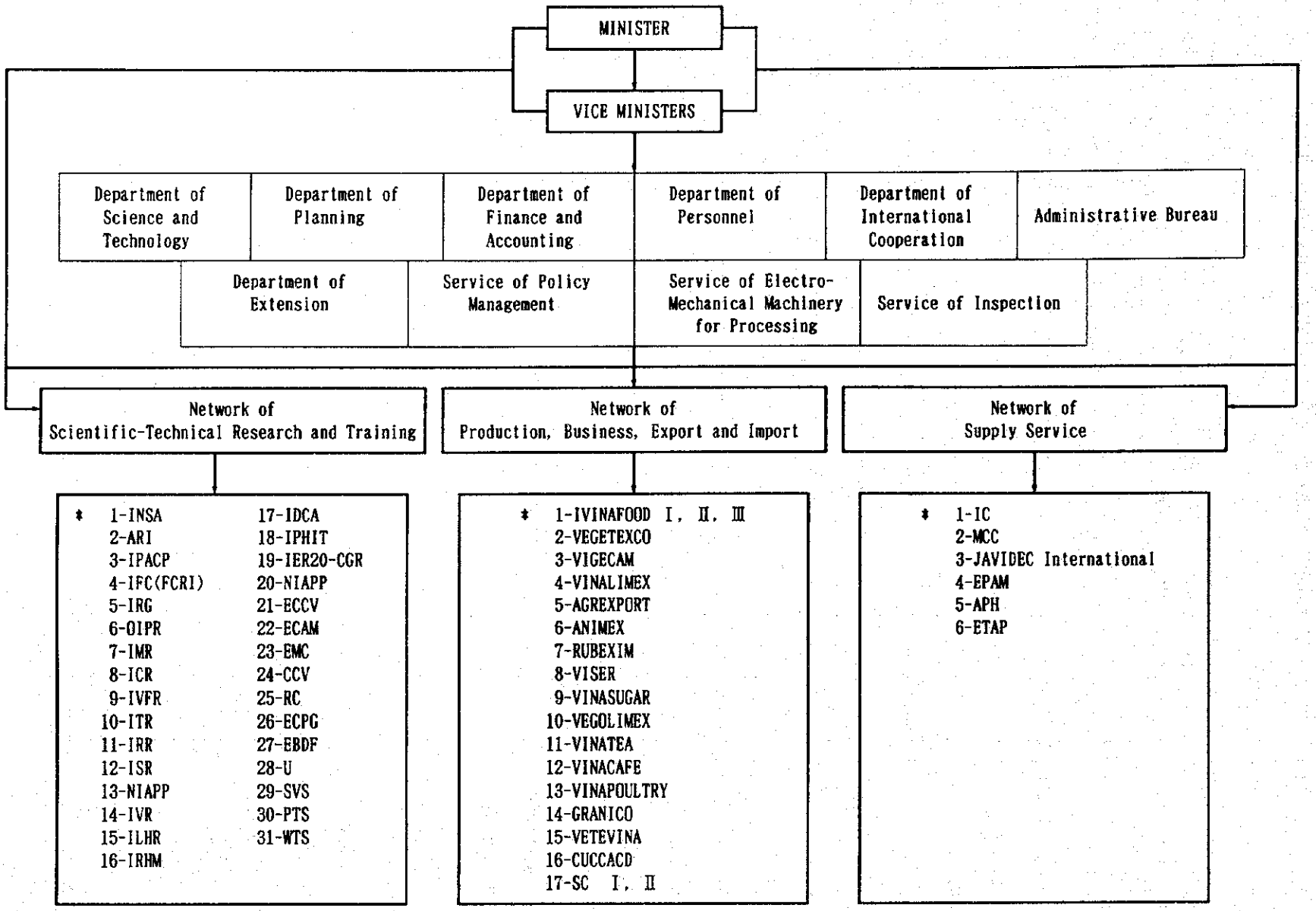


Fig. D-4—(1) Organization of Ministry of Agriculture and Food Industry



Note : * See Figure D-4-(2)~(4)

Fig. D-4-(2) Network of Scientific-Technological Research and Training

1. National Institute for Agricultural Research
2. Agricultural Research Institute of the South
3. Institute of Pedology and Agro-chemical Properties
4. Institute of Food Crop
5. Institute of Genetics Research
6. Omon Institute for Paddy Research
7. Institute for Maize Research
8. Institute for Coffee Research
9. Institute for Vegetable and Fruits Research
10. Institute for Tea Research
11. Institute for Rubber Research
12. Institute for Sugarcane Research
13. Institute for Agri-planning and Projection
14. Institute for Veterinary Research
15. Institute for Livestock Husbandry Research
16. Institute for Researching Hand Tools and Mechanization in the South
17. Institute for Post-harvest Industrial Technologies
18. Institute for Economic Research
19. Institute for Genetic Research
20. Centre of Genetic Research
21. Experimental Center of Crop Varieties
22. Experimental Center of Agricultural Machines
23. Electro Mechanical Centre of the South
24. Centre of Crop Varieties in the South
25. Research Centre of Bee Raising
26. Research Centre of Potato Growing
27. Experimental Buffalo Dairy Farm
28. Universities
29. Secondary Vocational Schools
30. Professional Training Schools
31. Worker Training Schools

Fig. D-4-(3) Network of Production, Business, Export and Import

1. Central Food Corporation
2. Vietnam National Vegetable and Fruit Corporation
3. General Corporation of Agricultural Materials
4. Vietnam National Foodstuffs Import and Export Corporation
5. Vietnam National Agricultural Produce Import-Export Corporation
6. The Vietnam National Animal and Poultry Products Import, Export corporation
7. General Rubber Corporation of Vietnam
8. Union of Sericulture Enterprises of Vietnam
9. The Vietnam Union of Sugarcane and Sugar I, II
10. The Vietnam Union of Vegetation Oil for Import - Export
11. The Vietnam Union of Tea Enterprisees
12. Union of Coffee Enterprises of Vietnam
13. Vietnam Union of poultry Enterprises
14. Grain Import-Export and Agro-investment Company
15. The National Veterinary Company NO.1
16. Union of Agricultural Construction and Rural Development enterprises
17. Seed Company I and II

Fig. D-4-(4) Network of Supply Services

1. Information Centre
2. Micro Company Centre
3. Japan - Vietnam Development Consultants International Co. Ltd.
4. Enterprise for Printing Agricultural Magazine
5. Agricultural Publishing House
6. Enterprise for Transport of Agro-products

Table D-9 Classification of Land Use for Annual Crops in the Study Area (1993)

Type	Characteristic	Future Prospect
I	* The main component is paddy area for both seasons but the area for subsidiary crops is also relatively big. Then paddy and subsidiary crop are two main factors to think of future pattern * Gia Lam District (near to Hanoi)	Near : Increasing of subsidiary crops for big cities. Changing paddy land to sub. crop or ornamental crop. Far : Increasing of industrial area and residential area. The base of fresh agricultural subsidiary products at the cost of paddy.
II	* The majority of cultivated land is for paddy for both seasons. The subsidiary crop area is still developing. Under transition stage to type I. * Tien Son and Dong Anh District are included	Near : Transition to type I by increasing sub. crop area Diversification of crops production, inland fishery and livestock industry will become more important. Far : Sub. crop will become main by setting up processing factory. Shortage of labor force will come up No diffence with type I.
III	* Paddy area for winter - spring crop and summer crop are in parallel condition The area for subsidiary crops is rather small and now on the way to type II * Que Vo, Bac Ninh, Yen Phong Districts are included	Near : Transition to type II but the main will be increasing of double cropping paddy area Far : Urbanization effect will be the same with type II and the problems of part time farmers, such as labor force shortage will come up.

Table D-10 Crop Cultivation in the Study Area with and without Project (proposed)

Crop	Without Project area ('93) (ha)	With Project Alternative			
		A		B	
		Area (ha)	Period (month)	Area (ha)	Period (month)
Paddy	38,006	38,271		30,000	
(Winter-spring	(21,472	(19,909	1～ 6	(15,000	1～ 6
(Summer	(16,534	(18,362	7～10	(15,000	7～10
Maize	2,062	2,300	9～12(800ha) 1～ 4(1500ha)	4,200	9～12(4000ha) 1～ 4(200ha)
Sweet potato	3,715	4,000	10～12	6,700	(10～12(4800ha) (2～ 6(1900ha)
Potatoes	935	1,000	11～ 2	2,100	11～ 2
Groundnut	1,265	1,800	2～ 6	2,600	2～ 6
Soybean	451	800	9～12	2,200	9～12(1200ha) 2～ 5(1000ha)
Vegetable	2,894	3,800	(10～ 1(300ha) (1～ 4(300ha) (7～ 9(1600ha) (11～ 1(1600ha)	6,000	(10～ 1(800ha) (1～ 3(1000ha) (7～ 9(2100ha) (10～12(2100ha)
Others	1,545	1,283		1,283	
(Misc. crop	(262 ha				
(& Nursery	(1,283 ha				
Total	50,873	53,254		55,083	
C. I.	1.93	2.02		2.32	

Table D-11 Breakdown of Crop Area in suggested Cropping Patterns in the Study Area

Alternative A (ha)

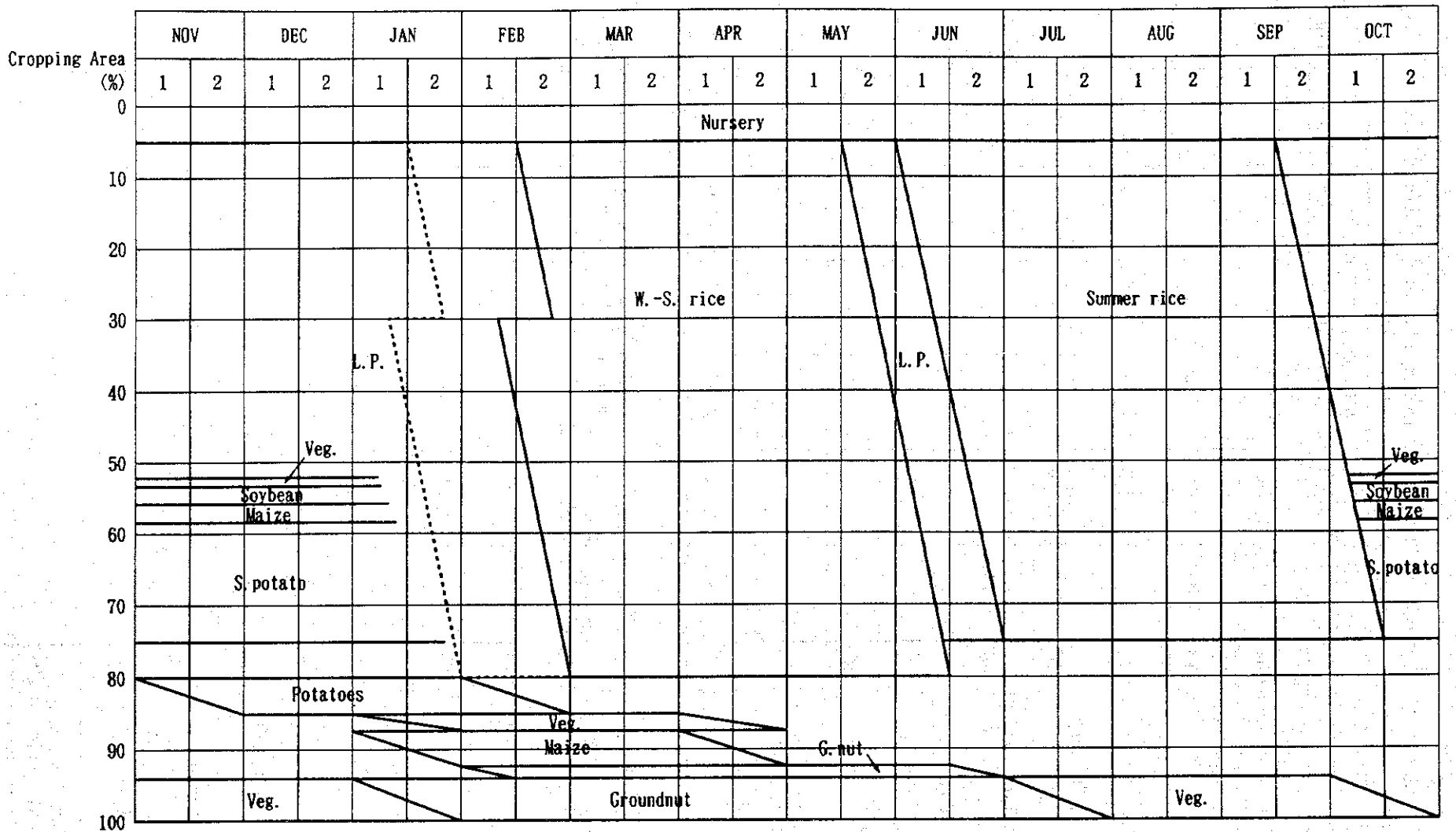
Present Land Use	Paddy		Veg., Sub. C. & indust. c.			Others		
	W. - S.	Summer	Winter	Spring	Non. Seas.	Fishery	Fruit	Other
1. 2 Rice 12,888ha	12,888	12,888	3,222					
2. 2 Rice+1 Sub. crop 1,895	1,895	1,895	1,895					
3. 1 Rice+2 Sub. crop 775		775	775	775				
4. 1 Rice+1 Sub. crop 2,116		2,116		2,116				
5. 1 Rice(Winter-spring) 5,126	5,126							
6. 1 Rice (Summer) 688		688						
7. Nursery land 1,283								1,283
8. Veg., Sub. c, & short industrial c. etc. 1,600					1,600			
Total 26,371	19,909	18,362	5,892	2,941	1,600			1,283

Alternative B (ha)

Present Land Use	Paddy		Veg., Sub. C. & indust. c.			Others		
	W. - S.	Summer	Winter	Spring	Non. Seas.	Fishery	Fruit	Other
1. 2 Rice 12,888ha	10,579	9,526	5,250 2,309	2,309				
2. 2 Rice+1 Sub. crop 1,895	1,895	1,895	1,895					
3. 1 Rice+2 Sub. crop 775		775	775	775				
4. 1 Rice+1 Sub. crop 2,116		2,116	2,116	2,116				
5. 1 Rice(Winter-spring) 5,126	2,526					2,600		
6. 1 Rice (Summer) 688		688						
7. Nursery land 1,283								1,283
8. Veg., Sub. c, & short industrial c. etc. 1,600					1,600			
Total 23,771	15,000	15,000	12,345	5,200	1,600	2,600		1,283

Fig. D-5-(1) Cropping Pattern of the Study Area (suggested)

Alternative A



Note : L.P. Land Preparation

Fig. D-5-(2) Cropping Pattern of the Study Area (suggested)

Alternative B

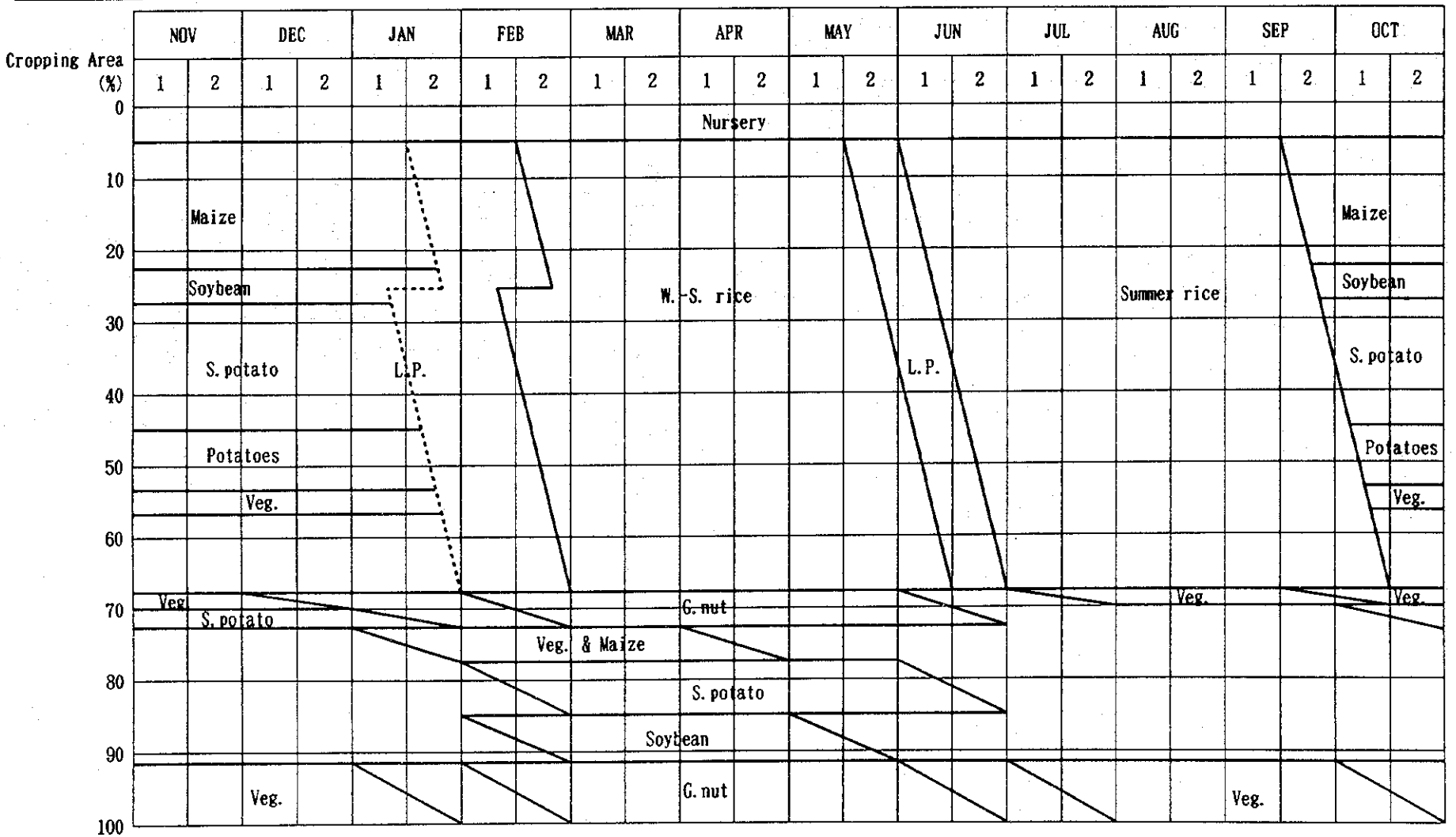
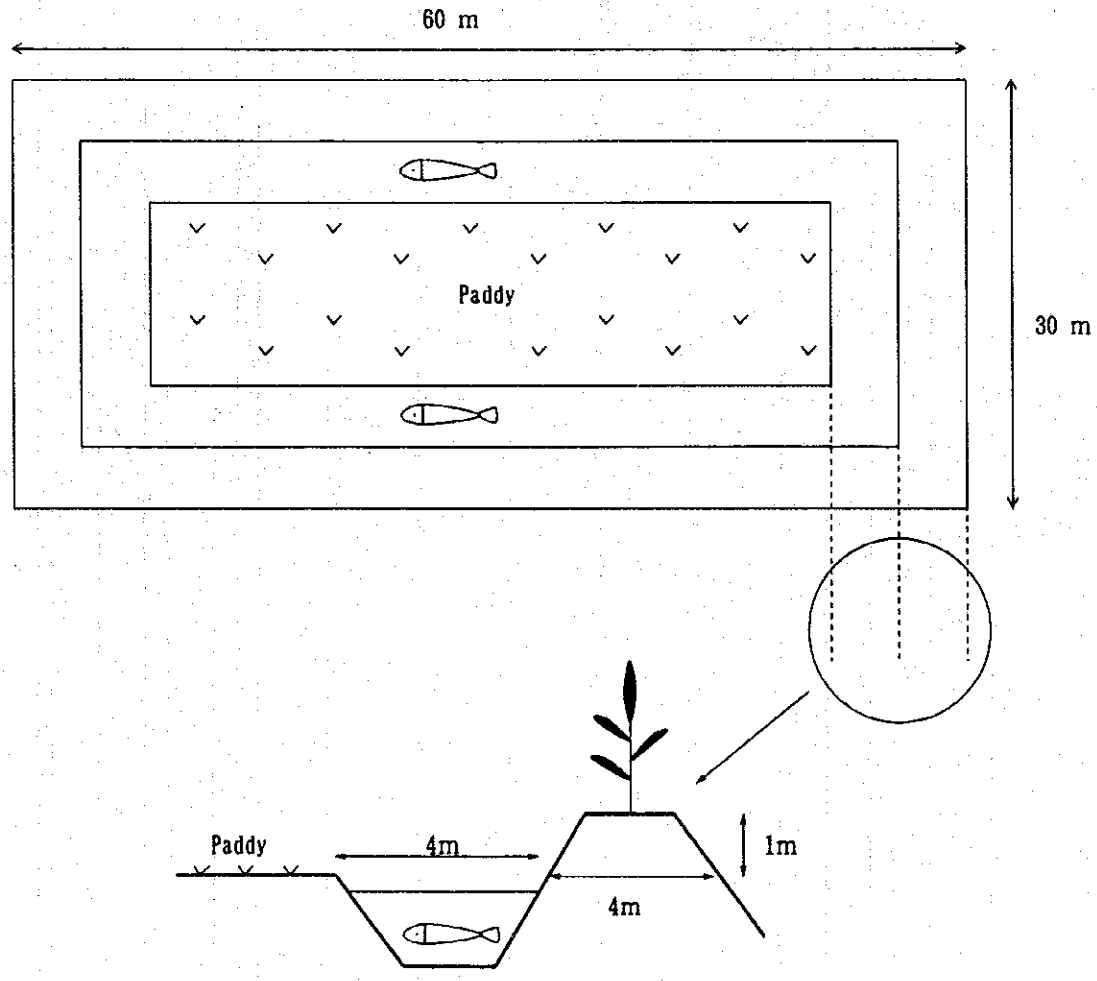


Fig. D-6 Rice + Fish + Fruit tree System



Size:land holding : 1,800 ㎡ (30m×60m)
of which :
Paddy : 600 ㎡
Fish pond : 500 ㎡
Fruit tree : 700 ㎡
Fruit tree : Lychee, Longan, Mandarin
Pond : fish breeding, water reservoir, keeping climate

Table D-12-(1) Crop Cultivation Area, Yield and Cropping Intensity in the Project Area (1992)

Crop \ Commune	1 Canh Hung		2 Dai Dong		3 Dong Nguyen		4 Dinh Bang		5 Hap Linh		6 Hien Van		7 Hoan Son	
	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha
Paddy, Win. -Spri.	58	3.7	160	3.2	190	4.0	120	3.9	186	2.8	226	3.0	321	3.2
Summer	60	3.5	162	2.5	186	2.9	158	3.1	161	2.4	252	3.2	400	3.6
Sweet potato	25	10.1	19	9.1	1	7.6	11	8.3	12	8.3	13	8.9	90	9.4
Maize	84	2.1	3	1.4	—	2.0	—	—	—	—	—	—	11	1.9
Groundnut	48	1.0	4	0.9	—	—	50	1.3	16	0.8	2	0.9	12	0.9
Potatoes	8	11.1	3	10.3	3	11.9	8	12.5	1	10.5	7	11.1	36	11.1
Soybean	1	0.1	1	0.4	1	0.4	—	0.4	7	0.4	2	0.5	18	0.5
Vegetable	1	13.9	3	14.5	27	14.0	4	13.8	13	14.0	15	14.0	32	14.0
Cassava													4	19.4
Taro							—	19.4						
Total	285		355		408		351		396		517		927	
Cropping Intensity	2.1		2.0		1.9		1.9		1.6		1.9		2.1	

Source : People's Committees concerned

Table D-12-(2) Crop Cultivation Area, Yield and Cropping Intensity in the Project Area (1992)

Crop \ Commune	8 Khac Niem		9 Lien Bao		10 Lac Ve		11 Min Dao		12 Noi Duc		13 Phat Tich		14 Tan Hong	
	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha
Paddy, win.-spri.	131	4.0	121	2.9	606	3.2	111	3.7	78	3.7	189	3.2	295	4.3
summer	170	3.0	331	3.1	575	3.6	165	3.4	88	2.5	225	2.8	255	4.4
Sweet potato	43	6.9	12	9.3	18	6.9	51	7.9	1	6.5	32	10.7	40	8.8
Maize	—	—	1	1.4	4	1.4	57	2.1	—	—	18	1.7	36	2
Groundnut	25		7	0.9	17	1.0	34	1.1	—	—	36	1.1	4	1.1
Potatoes	—	—	6	11.1	11	11.1	15	11.1	4	11.1	72	11.1	15	13.9
Soybean	1	0.4	1		8	0.4	2	0.5	—	0.6	1	0.5	2	0.6
Vegetable	20	14.0	21		17	14.2	19	13.9	4	13.8	7	13.8	68	14.0
Cassava			2	14.8							7	8.0		
Taro													11	19.4
Total	390		502		1256		451		175		587		726	
Cropping Intensity	2.0		2.0		1.7		1.9		1.9		2.2		2.1	

Table D-12-(3) Crop Cultivation Area, Yield and Cropping Intensity in the Project Area (1992)

Crop \ Commune	15 Tan Chi		16 Tri Phuong		17 Truong Giang		18 Viet Doan		19 Tu Son		20 Han Quang		21 Nam Son		Total, Average		Nat'l ave. 92
	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	ha	t/ha	t/ha
Paddy win.-spri.	401	3.7	168	3.5	51	3.5	320	3.0	3	3.9	218	2.3	99	2.6	4055	3.4	4.0
summer	317	3.7	170	3.3	55	2.8	386	3.0	2	3.3	197	2.8	62	3.0	4377	3.1	2.7
Sweet potato	80	8.3	50	8.5	8	7.0	83	8.9	—	—	21	10.3	21	12.5	631	8.7	6.4
Maize	83	1.9	15	1.9	1	1.7	101	1.8	—	—	76	1.9	0	0	490	1.8	1.6
Groundnut	27	1.1	—	—	—	1.1	54	1.0	—	—	29	1.0	2	1	367	1.0	1.0
Potatoes	18	11.1	9	11.1	4	11.1	32	11.1	—	—	2	12.2	3	12.4	257	11.4	10.1
Soybean	2	0.5	1	0.5	—	0.4	17	0.5	—	—	—	—	—	—	65	0.5	0.8
Vegetable	48		24	13.9	1	14.4	40	14.0	—	—	27		6	—	397	14.0	
Cassava															13	14.0	9.0
Taro	2	19.4		18.7		19.1	14								27	19.2	
Total	978		437		120		1047		5		573		193		10682		
Cropping Intensity	2.3		2.2		2.2		2.1		—		—		—			2.0	

Table D-13 Paddy Production in the South Bac Doung Area

Year	Area (ha)			Yield (t/ha)			Production (t/ha)		
	W - S *	S *	Total	W - S	S	Total	W - S	S	Total
1980	24,084	15,539	39,623	2.26	2.01	4.27	54,361	31,266	85,627
1981	24,494	23,203	47,697	2.48	2.48	4.96	60,787	57,505	118,292
1982	24,377	23,405	47,782	2.35	2.94	5.29	57,356	68,909	126,265
1983	24,260	21,629	45,889	2.85	2.12	4.97	62,955	45,909	108,861
1984	23,294	22,482	45,776	2.70	1.86	4.56	69,223	41,764	110,987
1985	24,571	22,243	46,814	3.22	0.81	4.03	79,209	18,003	97,212
1986	24,692	17,470	42,162	2.68	2.52	5.20	66,265	43,957	110,222
1987	24,267	23,317	47,584	1.85	3.02	4.87	44,942	70,344	115,286
1988	24,984	23,131	48,115	3.67	2.36	6.03	91,761	54,547	146,308
1989	25,250	23,045	48,295	3.45	3.18	6.63	87,110	73,290	160,400
1990	24,909	18,731	43,640	3.22	2.59	5.81	80,229	48,434	128,663
1991	24,999	24,639	49,638	1.14	3.47	4.61	28,597	85,422	114,019
1992	25,794	24,437	50,231	3.31	2.98	6.29	85,252	72,944	158,196

Note : W-S ..... Winter-Spring crop
S ..... Summer crop

Source : The South Bac Doung Irrigation Enterprise

Table D-14 The Trend of Fertilizer Application to Some Crops in Tien Son District

(kg/ha)

Crop	Fertilizer	1980	1985	1990	1992
Paddy	Urea	130	135	160	189
	Super Phosphate	220	216	250	270
	S. Potassium	15	27	33	42
Maize	Urea	210	220	243	270
	Super Phosphate	150	270	240	243
	S. Potassium	5	25	25	30

Source : People's Committee, Tien Son

Table D-15 Production of Maize and Groundnut in Tien Son District

Year	Maize			Groundnut		
	Area (ha)	Yield (t/ha)	Production (t)	Area (ha)	Yield (t/ha)	Production (t)
1981	335	1.00	328	352	0.90	347
1982	276	1.10	309	368	0.80	308
1983	221	1.00	229	397	0.90	375
1984	221	1.20	152	434	0.90	382
1985	114	1.90	91	553	0.90	553
1986	253	0.90	220	616	0.90	553
1987	307	—	1,228	742	1.10	846
1988	1,108	2.20	2,452	723	1.20	888
1989	1,656	2.10	3,452	711	1.10	782
1990	687	2.30	1,556	750	1.00	764
1991	610	1.90	1,179	582	0.90	544
1992	575	1.70	966	586	1.20	720
1993	488	2.60	1,268	445	1.10	480

Source : People's Committee, Tien Son

Figure D-7 Rice Yield in the South Bac Duong Area

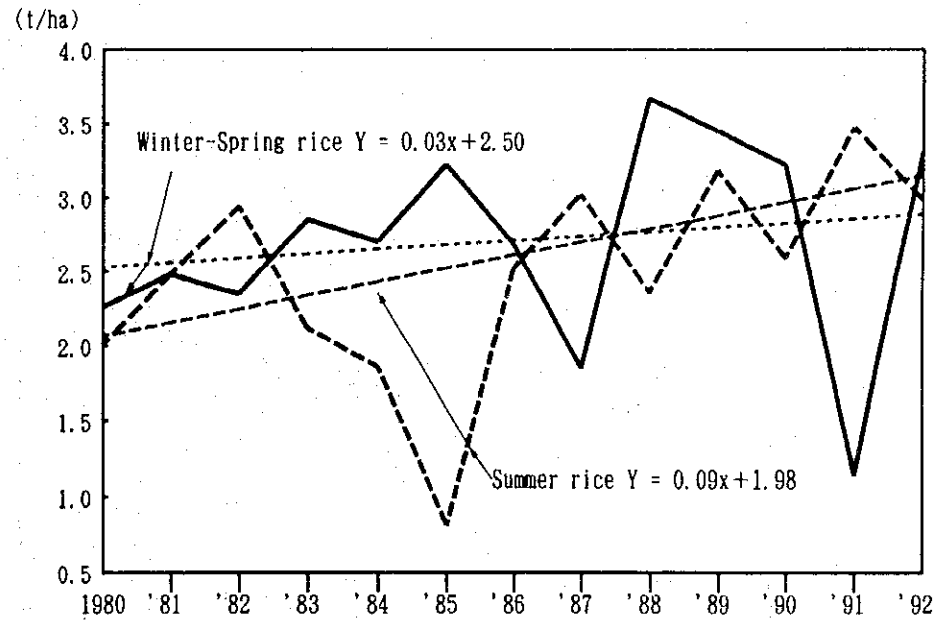


Figure D-8 Total (both sesason's) Rice Yield in the South Bac Duong Area

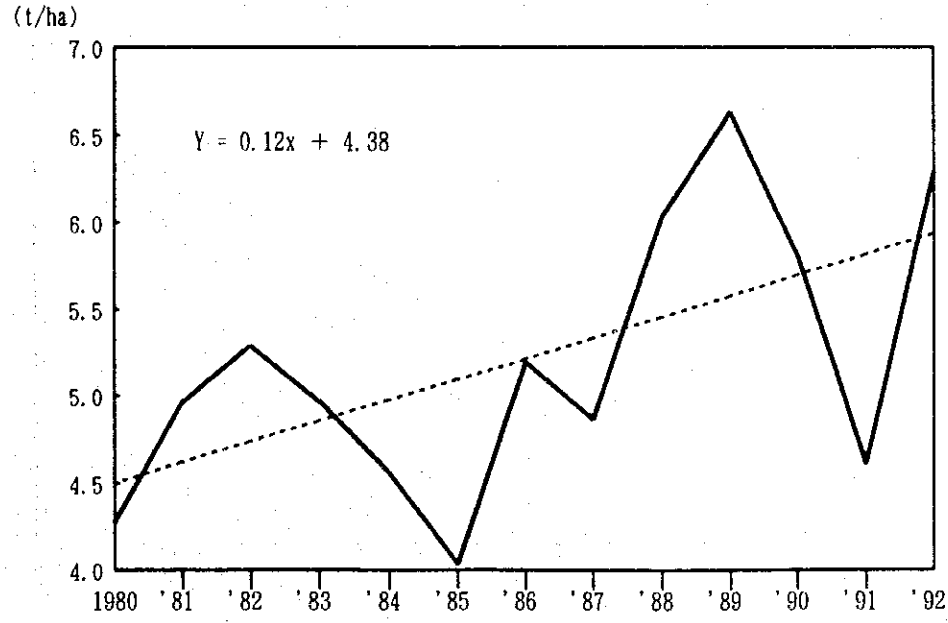


Figure D-9 Total Rice Production in the South Bac Duong Area

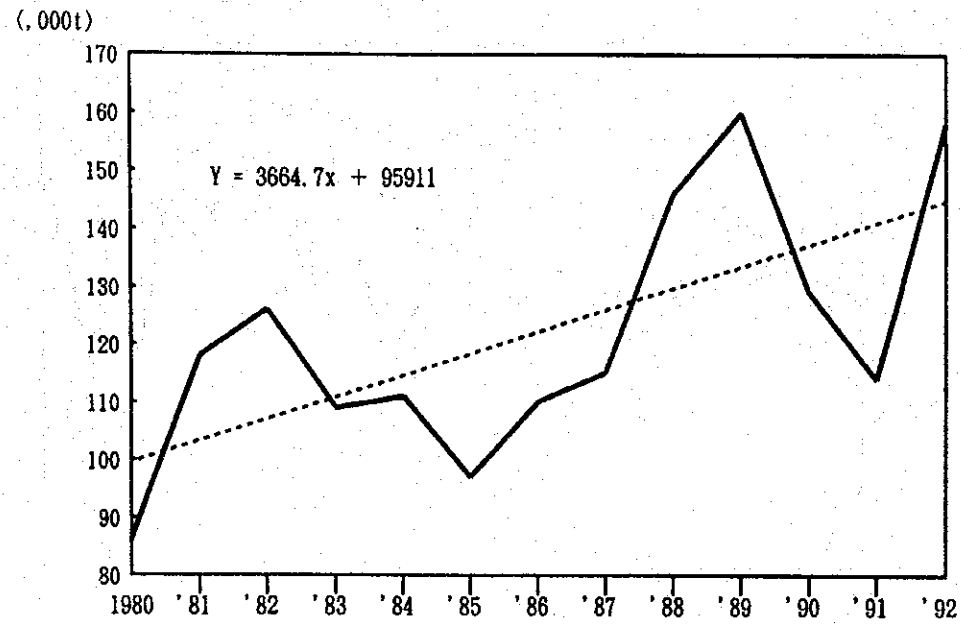


Figure D-10 Trend of N (Urea) Application to Paddy in Tien Son District

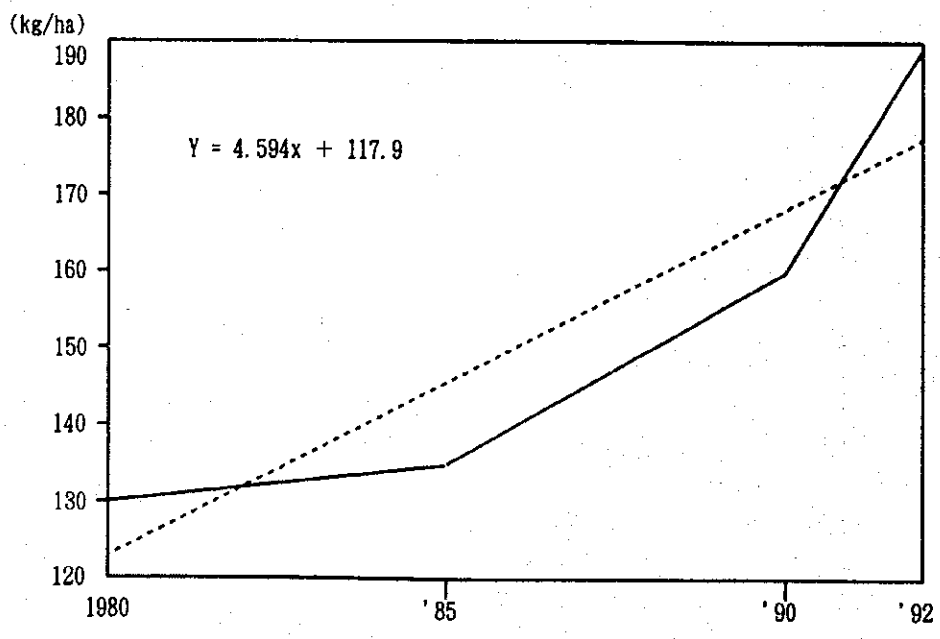


Figure D-11 Trend of P (S.phosphate) Application to Paddy in Tien Son District

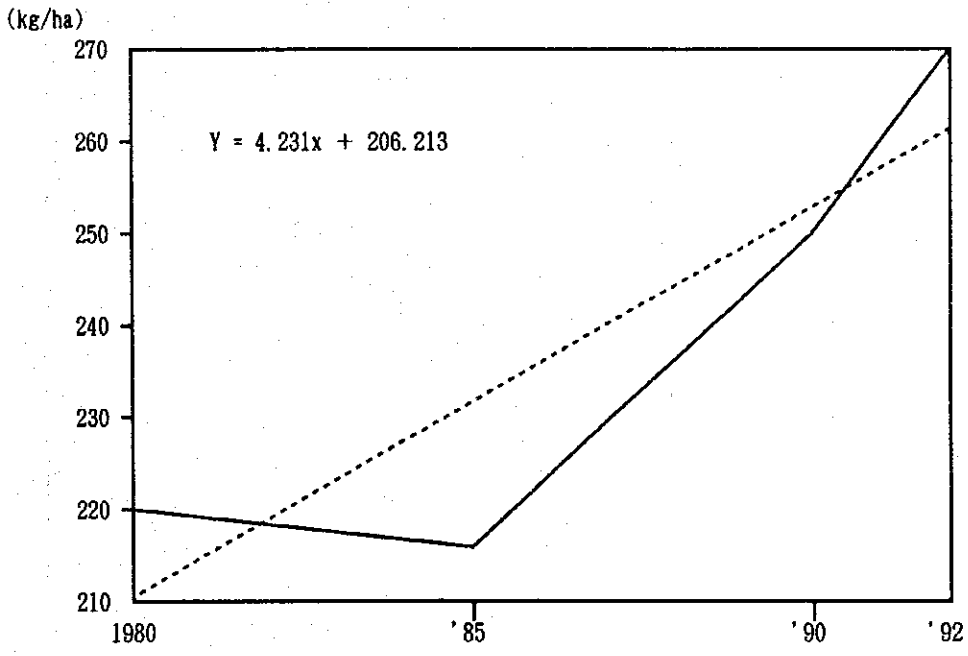


Figure D-12 Trend of K ((Sulphate pottassium) Application to Paddy in Tien Son District

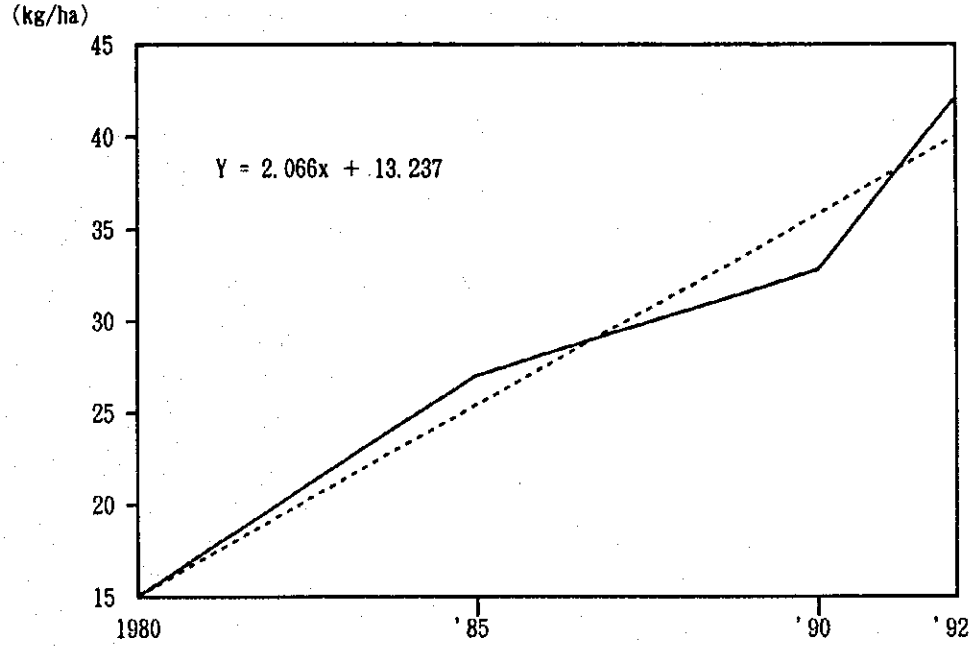


Figure D-13 Yield of Maize in Tien Son District

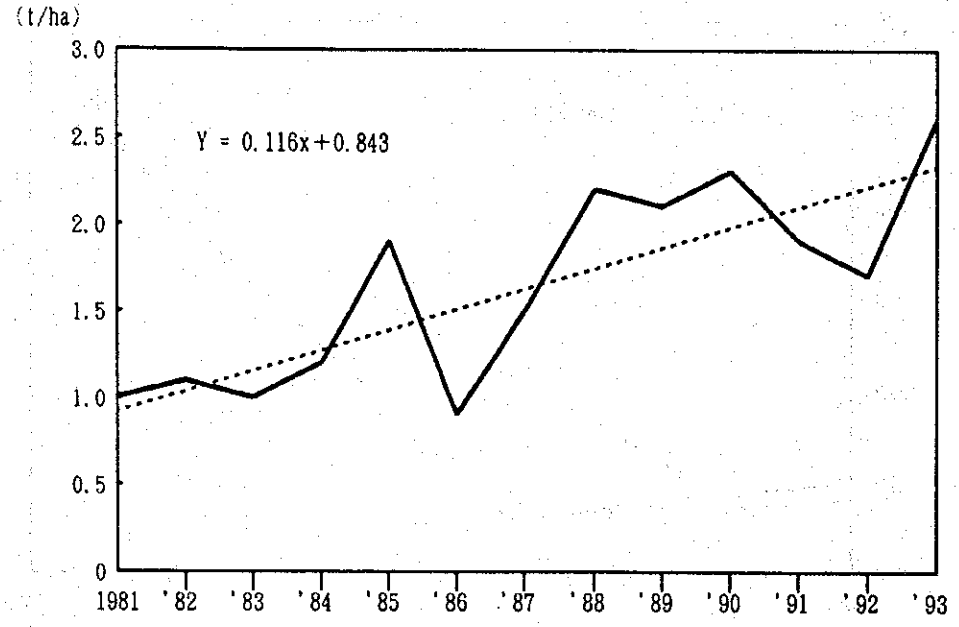


Figure D-14 Yield of Groundnut in Tien Son District

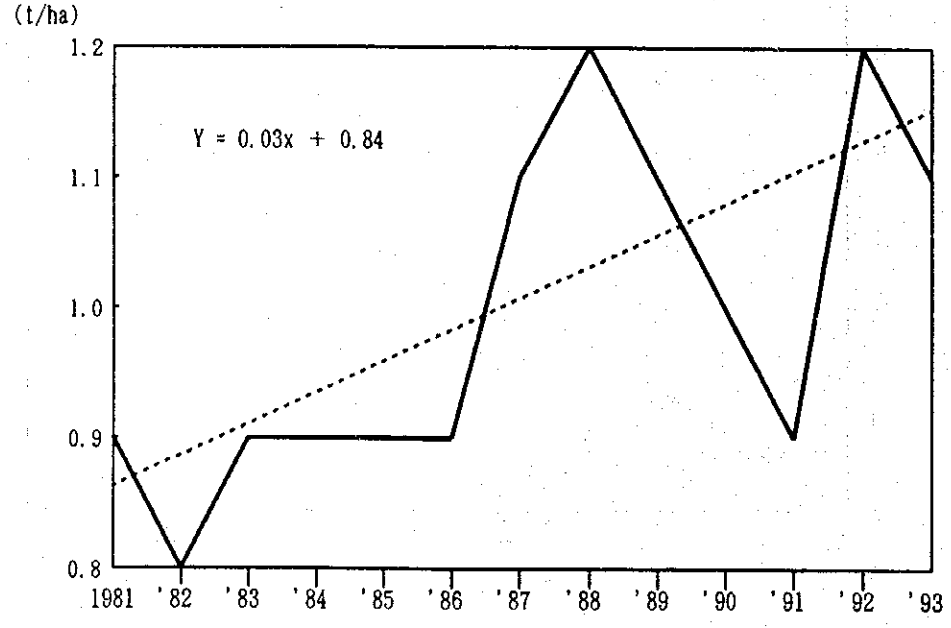
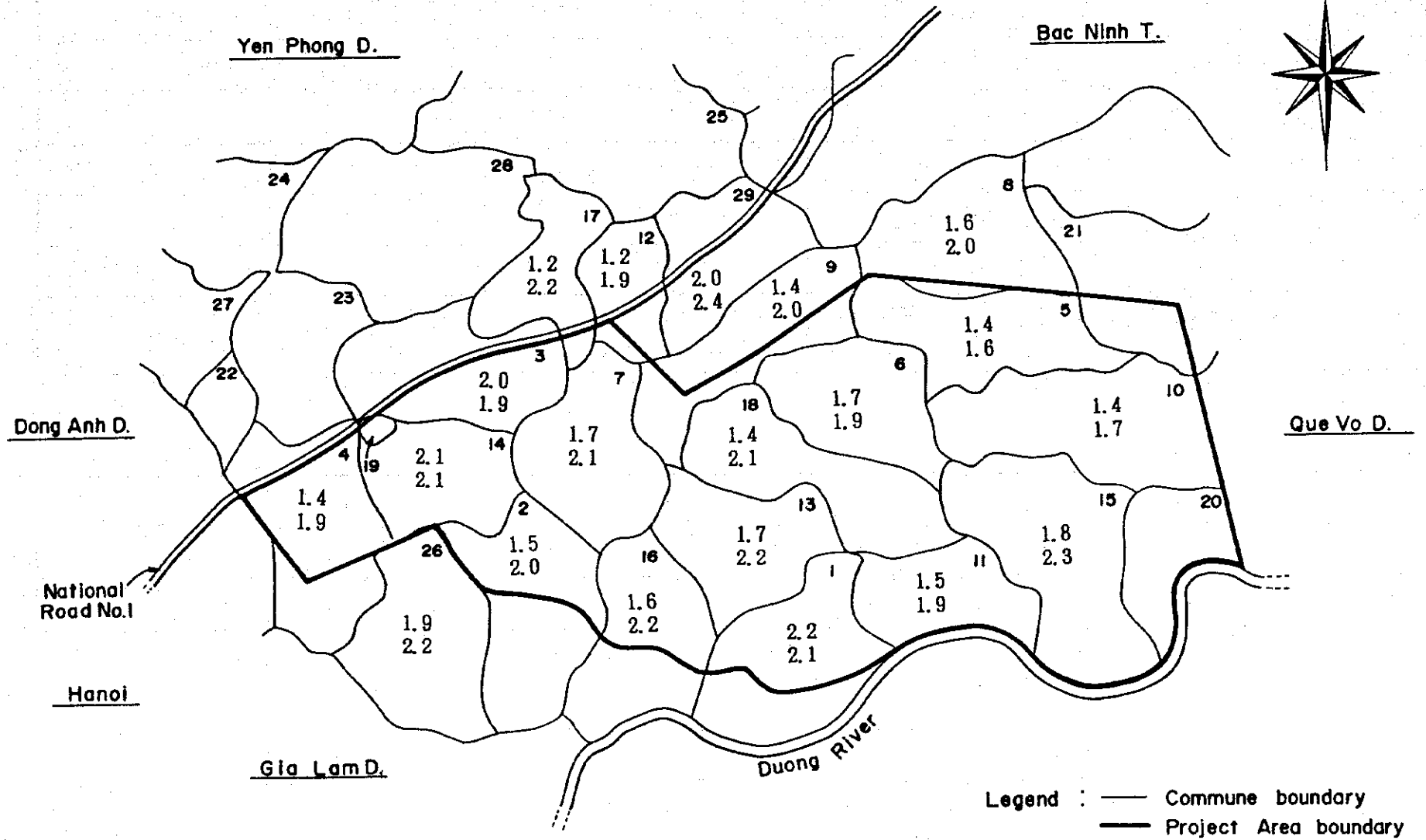


Fig. D-15 Cropping Intensity of the Communes of Tien Son District in 1990 and 1992



Legend : —— Commune boundary
—— Project Area boundary

Note : Upper Figures ··· 1990
Lower Figures ··· 1992

Source : Reople's Committee, Tien Son

Table D-16 Animal Husbandry in the Communes in the Project Area (1992)

(head)

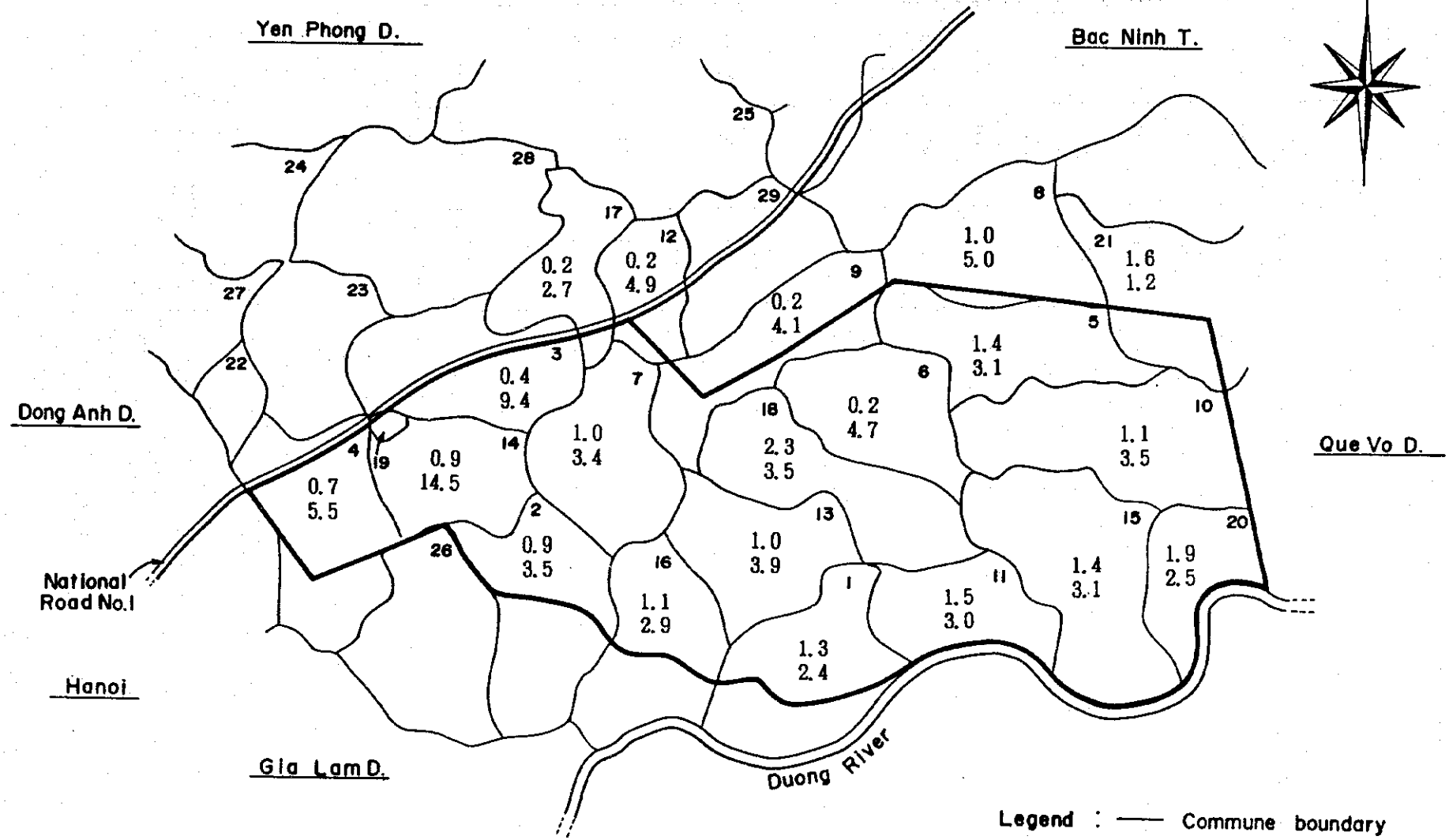
Animal \ Commune		1 Can Hung	2 Dai Dong	3 Dong Ngnyen	4 Dinh Bang	5 Hap Linh	6 Hien Van	7 Hoan Son	8 Khac Niem	9 Lien Bao	10 Lac Ve	11 Minh Dao
Buffaloes		37	35	74	111	173	41	120	54	53	512	117
Oxen		246	118	6	7	189	23	300	151	124	318	311
Pig		541	623	1,966	957	796	1,327	1,400	983	834	2,691	853
Total		824	776	2,046	1,075	1,158	1,391	1,820	1,183	1,011	3,521	1,311
Density No./Agri. land (ha)	Ruminant	1.3	0.9	0.4	0.7	1.4	0.2	1.0	1.0	0.2	1.1	1.5
	Pig	2.4	3.5	9.4	5.5	3.1	4.7	3.4	5.0	4.1	3.5	3.0

Animal \ Commune		12 Noi Duc	13 Phat Tich	14 Tan Hong	15 Tan Chi	16 Tri Phuong	17 TimongGiang	18 Viet Doan	19 Tu Son	20 Han Quang	21 Nam Son	Total
Buffaloes		13	53	170	224	35	15	181	—	668	319	3,005
Oxen		1	270	153	384	216	1	1,032	—			3,880
Pig		447	1,219	4,800	1,334	678	184	1,885	133	900	230	24,781
Total		461	1,542	5,123	1,942	929	200	3,098	133	1,568	549	31,666
Density No./Agri. land (ha)	Ruminant	0.2	1.0	1.0	1.4	1.1	0.2	2.3	—	1.9	1.6	1.0
	Pig	4.9	3.9	14.5	3.1	2.9	2.7	3.5	—	2.5	1.2	4.3

Note : Tu Son is included in Tan Hon in density.

Source : People's Committees concerned

Fig. D-16 The Density of Ruminant and Pig in the Project Area (1992)



Legend : —— Commune boundary
—— Project Area boundary

Note : Upper Figures ··· Ruminant
Lower Figures ··· Pig

Source : Reople's Committee, Tien Son

Table D-17 Main Aquaculture Parameters of the Project Area (1993, '94)

Commune	1*	2	3	4	5	6	7
Canh Hung	30	7.3	—	2.4	100	450	3.42
Dong Nguyen	10	6.4	2.3	—	80	1,300	5.68
Dinh Bang	17	18.8	—	—	100	120	2.25
Hap Linh	4	2.2	1.2	29.6	80	1,200	2.60
Hien Van	6.	5.4	1.3	2.2	100	602	3.25
Hoan Son	30	7.3	20.0	—	30	1,200	2.40
Lien Bao	12	40.5	—	—	33	800	10.04
Lac Ve	250	1.4	50.0	30.2	100	810	1.34
Minh Dao	40	1.4	30.8	—	100	400	1.50
Noi Duc	—	—	1.2	2.6	—	—	—
Phat Tich	17	3.6	—	—	100	1,350	4.86
Tan Hong	62	12.6	—	—	100	1,223	35.00
Tan Chi	20	2.4	—	—	100	450	1.08
Tri Phuong	89	13.4	41.3	30.7	100	1,000	13.60
Viet Doan	45	4.9	109.0	104.0	100	810	4.02
Han Quang	40	29.4	6.5	—	100		10.00
Nam Son	14	10.0	—	—	100	100	1.00
Total	686	167.0	263.6	201.7	—	—	102.04

Source : Survey in the Communes, 1994
Research Institute of Aquaculture No.1

Note : 1- The number of the farmer families involved in aquaculture
2- Total pond area (ha)
3- Total area of irrigation chanals and river crossing the commune (ha)
4- Total area of the low lying land of the commune (ha)
5- Percentage of the pond area used for aquaculture purpose
6- An average fish productivity in the pond (Kg/ha)
7- Total fish production per year (t/year)

Figure D-17 The Flow Chart of the New Agricultural Extension System, Viet Nam

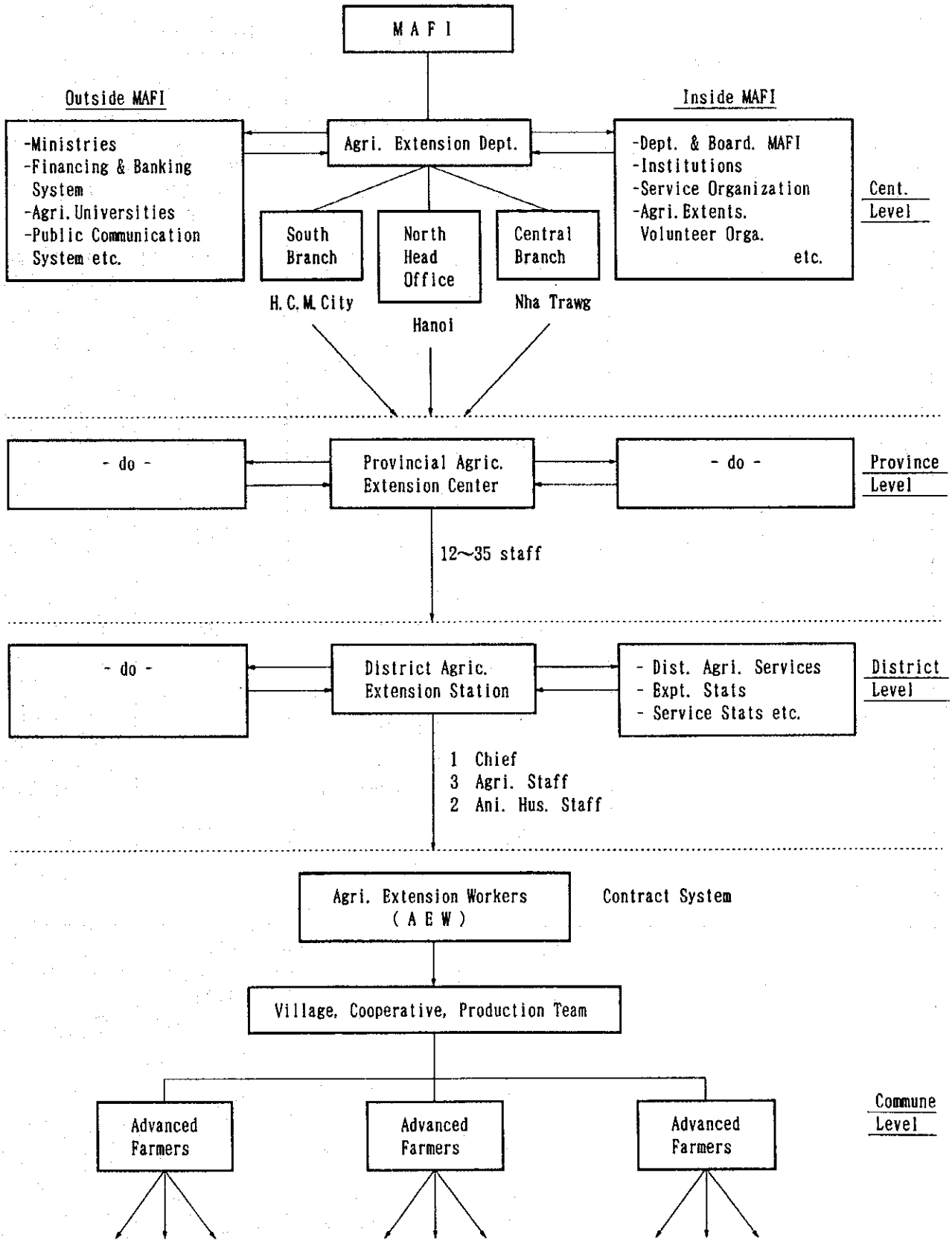


Table D-18 Crop Cultivation in the Project Area with and without Project

Crop	Without Project area ('92) (ha)	With Project Alternative			
		A		B	
		Area (ha)	Period (month)	Area (ha)	Period (month)
Paddy	8,432	10,379		8,000	
(Winter-spring	(4,055	(5,084	1～ 6	(4,000	1～ 6
(Summer	(4,377	(5,295	7～10	(4,000	7～10
Maize	490	600	9～12	1,000	(9～12 (600ha) (1～ 4 (400ha)
Sweet potato	634	600	10～12	1,050	10～12
Potatoes	257	300	11～ 1	800	11～ 2
Groundnut	367	456	2～ 6	900	2～ 6
Soybean	65	100	9～12	700	11～ 1
Vegetable	397	475	(9～12 (195ha) (7～ 1 (140ha×2)	1,097	(10～ 1 (367ha) (10～ 3 (450ha) (1～ 6 (140ha×2)
Others	180	140		217	
(Misc. crop	(ha				
(& Nursery	(ha				
Total	10,822	13,050		13,764	
C. I.	1.88	2.27		2.44	

Table D-19 Breakdown of Crop Area in suggested Cropping Patterns in the Project Area

Alternative A

(ha)

Land Use		Paddy		Sub. C. & Indust. C.			Others		
		W.-S.	Summer	Winter	Spring	No. Season	Fish	Fruit	Other
1. 2 rice	4318	4318	4318	1080					
2. 2 rice+1 Subsidiary Crop	661	661	661	661					
3. 1 rice+2 Subsidiary Crop	54		54	54	54				
4. 1 rice+1 Subsidiary Crop	262		262		262				
5. 1 rice	105	105							
6. Nursery	140								140
7. Vegetable, Sub. c, & short Ind. c.	217					217			
(Plain Area	140								
\Mount. Area	77								
Total	5757	5084	5295	1795	316	217			140

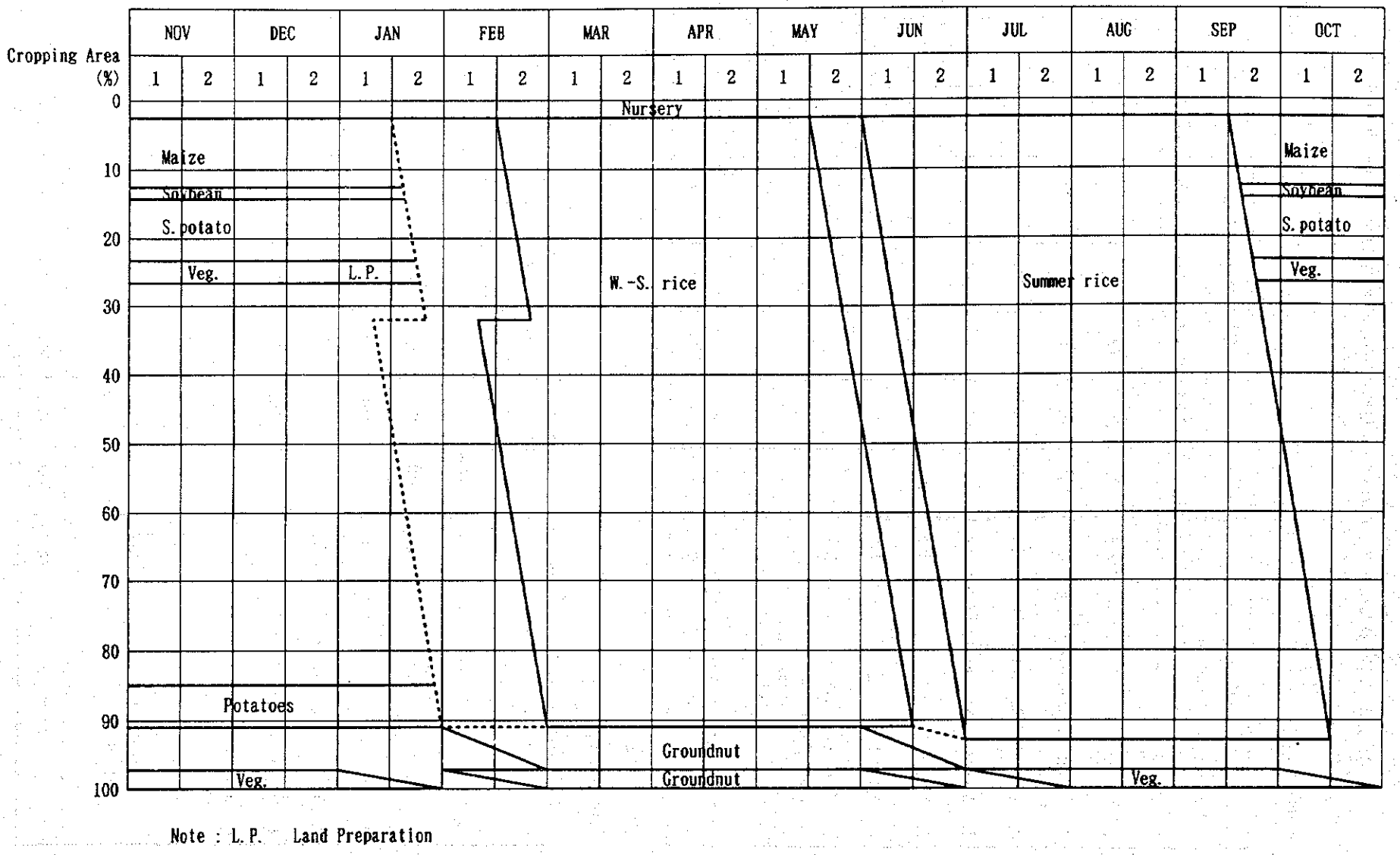
Alternative B

(ha)

Land Use		Paddy		Sub. C. & Indust. C.			Others		
		W.-S.	Summer	Winter	Spring	No. Season	Fish	Fruit	Other
1. 2 rice	4318	3339	3023	1113 979	979				
2. 2 rice+1 Subsidiary Crop	661	661	661	661					
3. 1 rice+2 Subsidiary Crop	54		54	54	54				
4. 1 rice+1 Subsidiary Crop	262		262	262	262				
5. 1 rice	0	0					105		
6. Nursery	140								140
7. Vegetable, Sub. c, & short Ind. c.	217					140		77	
Total	5652	4000	4000	3069	1295	140	105	77	140

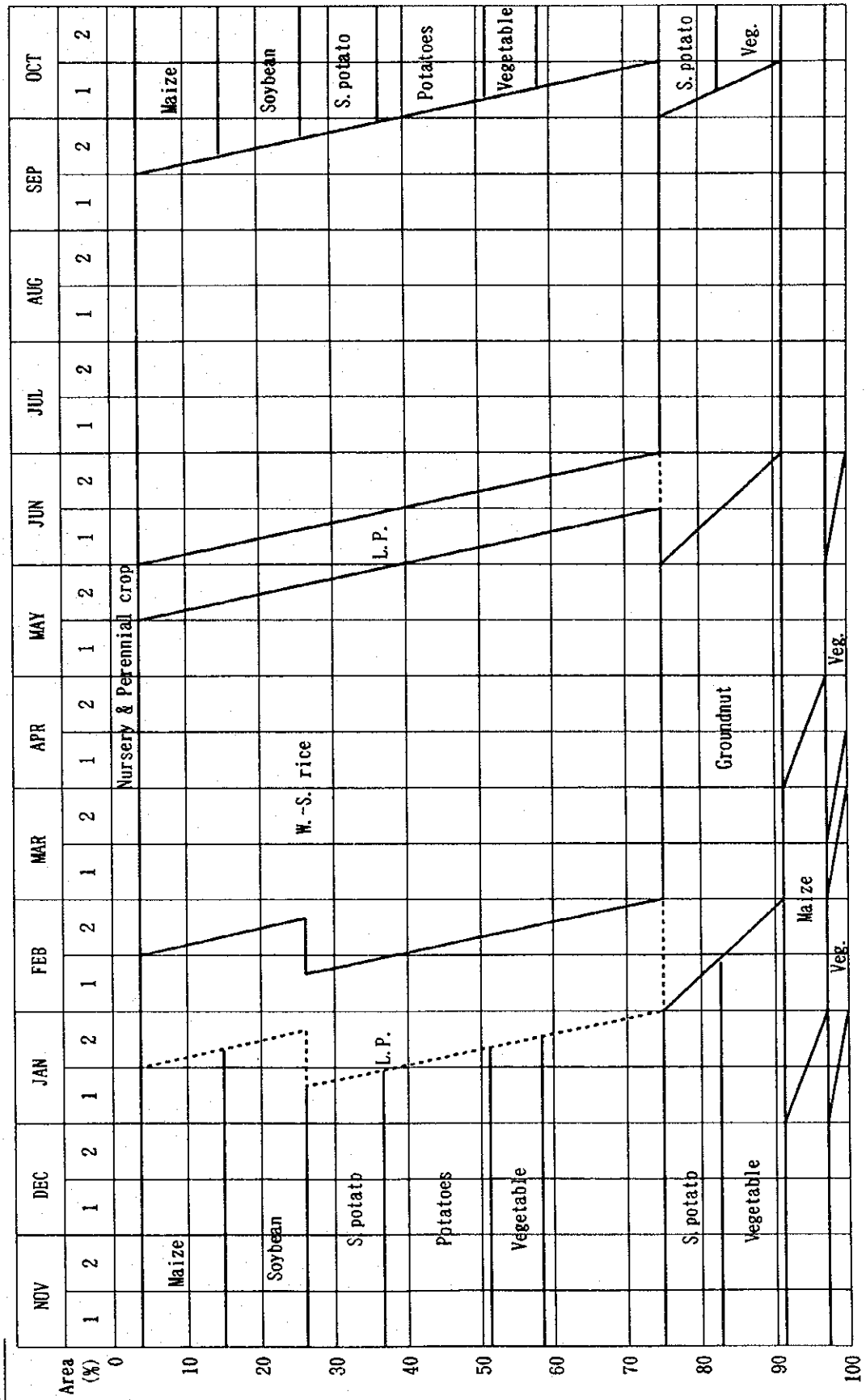
Fig. D-18 Cropping Pattern of the Project Area (proposed)

Alternative A



Note : L. P. Land Preparation

Fig. D-19 Cropping Pattern of the Project Area (proposed)



APPENDIX E

IRRIGATION AND DRAINAGE

APPENDIX E

IRRIGATION AND DRAINAGE

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APPENDIX E
IRRIGATION AND DRAINAGE

E-1. Irrigation System

E-1.1. Existing Irrigation System and Facilities

(1) Existing Irrigation System

General

The paddy field of the Study Area is served by the pumping system obtaining the water from three (3) rivers surrounding the area, because the river water levels are lower than the land elevation in time for the water supply required for crops. However, the waters, which are pumped up to the main canal, are again lifted up by two-stage pumps due to insufficient canal systems, ineffective water management and so on. The excess water within the area is also utilized as an irrigation water by using pump and/or manual water-proof scoop.

The irrigation systems in the Study area are grouped into three (3) systems in terms of the management system; namely, Bac Duong Irrigation System, Dong Anh Irrigation System and Gia Lam Irrigation System. Each irrigation system may be organized in a few systems based on the main water source for the facilities (See Figure E-1.1.1). Three (3) irrigation systems have a service area of some 21,120 ha and extend over about 85.3 % of the total area of paddy land including nursery field or about 80 % of cultivated land area, as shown below:

IRRIGATION SERVICE AREA AND RATIO

Irrigation Systems	Paddy Area	Service Area	Service Ratio
Bac Duong	22,170 ha	18,690 ha	84.3%
Dong Anh	625	540	86.4
Gia Lam	1,975	1,890	95.7
Total	24,770 ha	21,120 ha	85.3%

Bac Duong Irrigation System

The system has been developed to irrigate a land area of some 27,400 ha in 1960s, initiating the construction of Trinh Xa pumping station and Long Tuu diversion canal in 1960-62, which

serve to the northern and southern part of the area bounded by the Ngu Huyen Khe river through North and South main canals. The original irrigation system, however, was reviewed and modified to supply the water effectively since 1970s. The service area of Bac Duong Irrigation System reported to be some 32,000 ha at present.

The present service area within the Study Area is estimated to be a land area of some 18,690 ha based on the original irrigation and drainage planning map, and list of existing canals. The land area is consists of the service area (16,050 ha) originally planned for Trinh Xa south main canal system, and other service area (2,640 ha) included Xuan Vien area (970 ha), Dong Sai (570 ha), Xuan Thuy & Que Tan area (190 ha), Kieu Luong (710 ha) and Tri Phuong (200 ha) pumping areas, assuming these areas to be outside the area of original plan for Trinh Xa irrigation system.

The system is sub-grouped into Trinh Xa(A=10,270 ha), Kim Doi (A=6,880 ha), Xuan Vien (A=970 ha) and Dong Sai (A=570 ha) pumping irrigation areas by the main water sources and location of pumping stations, according to the Bac Duong Irrigation Enterprise, as shown in Table E-1.1.1.

Trinh Xa pumping irrigation area is involved into Trinh Xa irrigation system which is equipped with Trinh Xa pumping station constructed in 1960-62, as a main facility. The water source is the Ngu Huyen Khe river supplemented by the Duong river through Long Tuu intake in the drought, under the conditions stipulated in the Operation, Management and Development Rules for Bac Duong Irrigation System.

The water pumped up from the Ngu Huyen Khe river is diverted to North and South main canals to irrigate a planned land area of some 27,400 ha. South main canal (L=33.5 km), which serves the Study Area, traverse the middle part of the area from west to the east and convey the water to each irrigation block through the secondary canals constructed on the both side of the main canal. These main canal and major secondary canals were constructed under the previous project, while the minor canals were not properly provided, even though the farmers were responsible for construction.

In the current water supply, the land area irrigated directly from the canal system are very limited, due to poor mainte-

nance, deterioration of the facilities, the canals used dual purposes of irrigation and drainage. Particularly in the downstream area with insufficient water, the drainage pumps are used for an irrigation and/or the water is supplied by pumping up the water from the drainage canals and/or creeks, such as Noi Due pumping station to serve the downstream area of B2 secondary canal in the east, Phu lam station to the same secondary canal in the north-east, Tan Chi drainage pumping station to supplement the water to the downstream area of N6 secondary canal, Tri Phuong station serve the area in Canh Hung commune and Y Na station give the supplemental water to the downstream area of N1 secondary canal. In addition, there are a great number of small 2-stage pumps managed by the communes in addition to the pumps managed by the Enterprise.

Kim Doi pumping irrigation area, which has a total service area of some 6,880 ha, is classified into two (2) pumping irrigation areas to provide the supplemental water to the main and/or secondary canals of Trinh Xa irrigation system in the downstream area involved 4-station, Kim Doi, Thai Hoa, Cach Bi and Kieu Luong pumping stations and to serve the small independent pumping irrigation areas associated with four (4) pumping stations, such as Cau Tien, Cach Bi, Que Tan and Xuan Thuy pumping irrigation areas. However, the boundary of service area for each pumping station are uncertain, particularly in Kim Doi and Thai Hoa stations. Those pumping stations have been operated based on the pre-scheduled plan, reportedly.

Xuan Vien pumping irrigation area, located in the north-east of the Study Area, is served by Xuan Vien and Huu Chap pumping stations for a land area of some 70 ha and 900 ha, respectively. However, the land area currently irrigated are too small, which are reported to be about 13 % and 25 % of the planned area for the winter/spring season paddy and summer season paddy respectively, because of uncompleted irrigation canal system, specially in the higher elevation land. Those lands, not irrigated by Bac Duong Irrigation Enterprise, may be supplied the water from the drainage canals by using the pumps operated by the communes/villages and/or portable pump/manual drawing-up by farmers.

Dong Sai pumping irrigation areas obtain the water from the drainage canal and serve a land area of some 570 ha in Phu Lang commune in Que Vo district.

Dong Anh and Gia Lam Irrigation Systems

Dong Anh Irrigation System in the Study Area consist of three (3) pumping irrigation systems; that is, Dong Dau, Loc Ha and Lai DA systems, serves a land area of some 190 ha, 240 ha and 110 ha, respectively. Each system is equipped with pumping station to obtain the water from the Ngu Huyen Khe river and/or Long Tuu diversion canal. All pumps are used only for the irrigation purpose. The pumps (300 mm x33kw) in Dong Dau and Lai Da stations are used by moving to the different places, reportedly.

Gia Lam Irrigation System comprises two irrigation systems, Lien Dam and Cong Thon systems, serving a land area of some 490 ha and 140 ha, respectively. Lien Dam pumping station on the Ngu Huyen Khe river is utilized for the dual purposes of irrigation and drainage, while Cong Thon pumping station on the Duong river serves only for irrigation purpose. Cong Thon station is equipped with the intake to get the water from the Duong river in gravity, when the water level is higher. Thinh Lien pumping station is also used for the dual purposes to supplement the water to the downstream of Cong Thon irrigation system and to discharge the excess water to the Duong river.

(2) Irrigation Facilities

Intake Facility

Long Tuu Intake (B=2.30m x 3 bays) on the Duong river in Dong Ha commune, Dong Anh district is main intake facility to supplement the irrigation water to Trinh Xa pumping station through the Long Tuu diversion canal. Kim Doi pumping station on the Cau river, and Thai Hoa and Kieu Luong pumping station on the Duong river are also allowed to obtain the supplemental water through the respective drainage sluices except Kieu Luong station which is equipped with the intake only for irrigation in a drought from the respective rivers.

Cong Thon intake, which is built beside the pumping station on the Duong river in Yen Vien commune, Gia Lam district, can divert the water for the summer crops when the water level is high.

Pumping Stations

For the purpose of irrigation in the Study Area, twenty two (22) pumping stations with a total discharge of 37.2 cu.m/sec have been built and operated by the said irrigation enterprises, of which a half of stations are used only for irrigation purpose but account for about 23 % of the total discharge. The remaining are used for the dual purposes of irrigation and drainage. In addition, A great number of small pumping stations are built along the drainage canals and creeks and operated and maintained by the communes.

Trinh Xa pumping station has been equipped with eight (8) units of vertical axis axial flow pump, of which six (6) units are operational. On the other hand, A discharge capacity of pump per unit have been reported to be 2.5 cu.m/sec. However, this capacity may be slightly big, because the flow velocity in pump is big as estimated at about 4.2 m/sec based on a bore of 870 mm. The revolution per minute is also high. Those are resulted in high output of motor.

Others for irrigation are mostly horizontal axis volute type mixed flow pump with a bore of 300 mm and 33 kw motor, except Kim Doi pumping station equipped with the same type in Trinh Xa station. This volute type pumps are prevalent, which 93 units have been used for irrigation in the Study Area. Cong Thon station has also equipped with 11 units of the same type pump (300 mm x33kw), which has two floors for the pump installation to place the pumps on the floor depending on the varied water levels in the Duong river, because of less suction head and/or protection from submergence of pumps. This type pump is designed in a discharge capacity of 1,000 cu.m/hr with a total head of 9 m but reported to be 800 cu.m/hr in the actual discharge.

Canals and Structures

Both Long Tuu diversion canal and Trinh Xa south main canal are unlined and nearly flat in the canal slope. The flow capacities may not meet the requirement of water supply for the service area (See Table E-1.1.2.). The secondary canals are unlined with a density of 8.6 m/ha and generally low in the gradient of canal bed (See Table E-1.1.3.). Either of the canals are deteriorated and illegal in its section. Most of small canals are lower in its canal bed elevation and look like a drainage canal.

E-1.2. Present Water Supply

The irrigation in the Study Area is mainly served by pumping system, as stated previously. Most of canals are used for irrigation and drainage purposes except South Trinh Xa main canal. However, the water pumped up to the main canal mostly flow down to the creeks and drainage canals without any water head regulation so that it is necessary again to pump up to the field, due to underdeveloped on-farm ditches, insufficient and inoperative check structures and poor water management. Therefore, there are a great number of small scale pumping stations constructed along the drainage canals and creeks. In the area equipped without pump, the farmers obtain the water from the secondary/tertiary canals and/or the standing water in the drainage canals and farm drains by portable pump. As the number of portable pump unit is very limited, most farmers supply the water manually by using the water-proof scoop.

The irrigation systems in the area are operated mainly by Bac Duong Irrigation Enterprise, Dong Anh Irrigation Enterprise and Gia Lam Irrigation Enterprise. However, the quantity of water supply is not enough to irrigate the east part of the area, specially in the north east and east part of Que Vo district for the winter/spring crops. As a matter of fact, the water is scarcely available not only in the irrigation canals but also in the drainage canals and depressed areas. According to Bac Duong Enterprise, a land area of some 5350 ha or about 15 % of the total service area of Bac Duong irrigation system is reported to be insufficient in the water supply, as shown in Table E-1.2.1.

Under the operation of Bac Duong Irrigation Enterprise, A land area of some 13,800 ha for the winter-spring crops and 12,700 ha for the summer crops are currently irrigated on an average for the latest five years, except the area for the summer crops in 1990 because the farmers did not requested the water supply due to much rainfall. A rate of the irrigated area to the service area is about 71 % for a yearlong cropping, and about 74% and 68 % for the winter-spring crops and the summer crops, respectively (see Table E-1.2.2). These insufficient water have been caused by the deteriorated canals and structures due to shortage of fund and much use of the water in the upstream area due to poor discipline of farmers.

A rate of irrigated area to the service area is high in the area of Dong Anh irrigation system (89 % for the winter-spring crops) and Gia Lam irrigation system (95 % for summer crops), as shown in Table E-1.2.3. and E-1.2.4., respectively. It is reported that a land area of some 720 ha or about 57 % of the currently irrigated land area of some 1,125 ha are irrigated directly from Cong Thon main canal system and the remaining depend on 2-stage pumping system. This rate is quite high as compared to the other irrigation systems.

E-1.3. Irrigation Development in the Future

(1) Diversion Water Requirement

Net Water Requirement

The consumptive use of water for crops have been estimated by Blaney-Criddle method, in which monthly evaporation calibrated by Penman method and crop factors were applied depending on the crop growing stage, as shown below:

	Crop Factor (kc)	
Growing Stage	Wet S.Crop	Dry S.Crop
1-2 months after transplanting	1.1	1.1
Middle of growing stage	1.05	1.25
4-week before harvesting	0.95	1.0

Percolation in the field was assumed to be 1.5 mm/day, prevailing clay soils in the area.

Land preparation was estimated to take 15 days for the summer paddy with water requirement of 70 mm for paddling, and 30 days for the winter/spring paddy with water requirement of 190 mm, consisting of 120 mm for land soaking and 70 mm for paddling.

Nursery land would be required to take 30 days for both the seasonal paddies.

Effective Rainfall

Effective rainfall id defined as a quantity of water provided with rain for the water requirement at on-farm level. A quantity of effective rain water is reflected by the rain distribu-

tion and water management at on-farm level during/after rain, such as a standing water depth before/after rain, height of farm levees, storage capacity of farm lot, drainage of field water, irrigation method and so on.

The effective rainfall can be calculated based on the daily rainfall, in case the actual observation data are not available, which may be about 80 % of the values calculated by allowing to retain the water in an effective depth of 80 mm but ignore a daily rainfall of less than 5 mm. A rainfall in the successive days is added to the water quantity (standing water depth) in the previous day, subtracting the net water requirement. An effective depth of 80 mm have been determined by the field condition with a farm levee height of 100 mm and crop management water depth of 20 mm in the paddy lot. A lower limit of 5 mm and loss of 20 % are considered to be intercepted by leaves of plant and uncertain factors in rainfall distribution, farm water management and farm conditions.

The monthly effective rainfall have been calculated by using daily rainfall for the latest ten (10) years from 1983 to 1992, based on the above method (See Table E-1.3.2.). It is learned that about 46.5 % of annual rainfall may be effective, while the effective rainfall account for about 32.1 % and 62.5 % for the winter/spring and summer cropping seasons, respectively. On the other hand, the effective rainfall for the upland crops have also been calculated, taking effective retention of water in soil (See Table E-1.3.3.).

Field Water Requirement

The field water requirement, which is the water requirement at the field and computed by subtracting effective rainfall from the Net water requirement, with 1/5 year probability for each seasonal paddy at field were estimated by applying effective rainfall in 1992 and summarized below:

Water Requirement	Winter/Spring Crops	Summer Crops
Land Preparation	190 mm	70 mm
Crop Water Requirement	308 mm	478 mm
Percolation	128 mm	138 mm
Effective Rainfall	(-)70 mm	(-)383 mm
Field Water Requirement	556 mm	303 mm

Diversion Water Requirement

In general, the water, diverted from the intake facility (pumping station) is conveyed to a farm land, losing in its quantity due to evaporation from the water surface, seepage from the wetted perimeter of canal and leakage through crack/holes of canal (Conveyance Water Losses), and oversupplying the water due to improper operation of head works/turnouts and a time lag of water distribution between the intake/pumping station and farm lot (Operation Water Losses), and losing the water due to improper water distribution and application at the on-farm level (Farm Water Losses). Those losses are expressed in a percentage to a quantity of water supply (or diversion water requirement).

Irrigation efficiency is expressed in a percentage of the water used effectively to crop cultivation (Farm Water Requirement) to the water supply (Diversion Water Requirement). Overall irrigation efficiency have been generally applied to be about 45 % to 85 % in the planning stage but reported to be very lower in the actual operation. Taking into account the above view, overall irrigation efficiency have been suggested to apply 51 % in the summer season and 54.4 % in the winter/spring season based on farm losses 25 % of in the summer season and 20 % in the winter/spring season, conveyance losses of 20 % and water management losses of 15 % in the annual season, as follows:

Irrigation Efficiency	Winter/Spring S. (%)	Summer S. (%)
Farm Irrigation Efficiency	80	75
Conveyance Efficiency	80	80
Operation Efficiency	85	85
Overall Efficiency	54.4	51

The diversion water requirement for paddy were estimated every a half month, applying the above field water requirement and irrigation efficiency. The peak diversion water requirement was estimated to be 1.33 lit/sec/ha (third from the biggest one) for the last half month of August in the design year of 1992, as shown in Table E-1.3.4. and E-1.3.5. The diversion water requirement per ha for the design year of 1992 are shown in Table E-1.3.7. for the winter/spring paddy and Table E-1.3.8. for the summer paddy.

(2) Water Resources Planning

The Ngu Huyen Khe river is utilized for the water sources of Trinh Xa pumping station and others built on the river to irrigate the land in and out-side the Study Area. Even though the observed water discharge records are not available, the river water may not enough to serve the subject area because a drainage area at Trinh Xa station is small as a catchment area of some 100 sq.km. Specially in the dry season the discharge is not so stable, because the water is used for the irrigation in its upstream basin. Furthermore, the water at Trinh Xa station may become small in the available quantity when the water utilization development is progressed in the upstream basin. Although the irrigation water can be supplemented from the Duong river through Long Tuu intake, it is preferable in the future to obtain the water mainly from the Duong river which is comparatively rich and stable in the water quantity. In this occasion, the irrigation planning will be worked out, assuming the water sources is available in the quantity. Nevertheless, the water resources planning shall be reexamined, taking into account the water resources development in the entire Red River Delta, the water utilization planning in the upstream basin, and the irrigation water utilization planning in the downstream area of the Ngu Huyen Khe river.

The Duong river is rich in the discharge (75 cu.m/sec in 1/5 year drought) and available for a main water source of Cong Thon pumping station, for pumping discharge (2.52 cu.m/sec) is small. Moreover, Thai Hoa and Kieu Luong pumping stations obtain the water from the downstream reaches of the Duong river and have no question for pumping up the water because it is allow to obtain the water only in the high water discharge of the river in the summer season. The water quality is good involving no toxic materials to crops, while a sediment concentration is high and bring about siltation problem in the irrigation canals.

The Cau river is available for the water source of Kim Doi pumping station when the excess water in its drainage area is scarcely available. The river water discharge at the station is indefinite but may be available for a temporary water supply source in its quantity, reportedly. In the downstream area of Trinh Xa pumping irrigation system within Que Vo district, the pumping irrigation scheme to be supplied from the Cau river has been proposed but shall carefully be studied on the water utilization plan in the entire river basin rather than the establish-

ment of urgent implementation program.

The present water management has taken the strategy to use the excess water in the Study Area as much as possible. In other words, The excess water in the Study Area is one of the water source for the irrigation. The water supply from Trinh Xa pumping station may be saved for the summer crops, expecting effective rainfall (about 68 % of rainfall for the rainy season) and excess water to a certain extent. On the other hand, the water supply for the winter/spring crops depends on the operation of Trinh Xa pumps because rainfall and effective rainfall (about 24 % of rainfall for the dry season) are small, the runoff from the mountain and hilly land is not so expected and the standing water in the creeks and canal retained in the rainy season is limited in the quantity. In the above view, The utilization of excess water within the area for is involved in much uncertain factors, as to the irrigation water source.

(3) Irrigation System Improvement

Agriculture will be developed in the increase of cropped area and introduction of diversified crops expected marketability to Ha Noi through improvement of irrigation and drainage systems. The present irrigation shall be improved in order to timely supply the adequate quantity of water to the field, envisaging the future farming plan which aims at stable farming and incremental production. In line with these objectives, the restructuring of irrigation networks based on the said water resources plan, and rehabilitation/improvement of the timeworn pumps, deteriorated canals and structures, etc. are proposed.

The plan will be provided for a land area of 23,490 ha for paddy, 1,280 ha for nurseries and 1,600 ha for upland crops, as shown in E-1.3.9. However, the water supply plan has been worked out only for paddy in the short term plan, while the upland irrigation may be required in the long term plan. It is expected that the estimated water requirement may be enough to irrigate both paddy field and upland in the future. The water requirement for deign of irrigation facilities is uncertain at present. Thereby, the design water requirement has been estimated to be 1.2 lit/sec/ha in the design year of 1992 (equivalent to 20 % drought), taking into account proposed cropping pattern, water requirement for crop, percolation at the field, effective rainfall and irrigation efficiency.

The proposed irrigation systems will be discussed for Bac Duong, Dong Anh area and Gia Lam area irrigation systems, respectively. Bac Duong irrigation involves the commanded area of South Trinh Xa main canal, Xuan Vien, Kim Doi pumping, Que Tan and Dong Sai irrigation, as shown in Table E-1.3.6. In principal, the pumping irrigation system will be employed but 2-stage pumping station system will be diminished as much as possible. It is expected to reduce the operation and maintenance costs and relieve the farmers from heavy works for dipping up water to the field by serving the water directly from the farm ditches to the field.

The improvement schemes of Trinh Xa pumping irrigation system shall be studied for the entire area of Bac Duong Irrigation system through South and North main canals. Among others, South Trinh Xa South main canal system with the proposed land area of some 17,940 ha is herein discussed in relation to the Study Area. In principal the irrigation water will be conveyed from Trinh Xa pumping station through South main canal, secondary and tertiary canals. The design water levels in existing South main canal are enough to serve most irrigable area directly through the canals so that 2-stage pumping station will gradually be suspended for irrigation and operated only for drainage purpose. Where the water head is not enough and the improvement costs are expensive to irrigate the land through the canal, these lands, particularly in the downstream area, will be irrigated only by 2-stage pumps. Thereof, Tri Phuong, Thai Hoa and other 2-stage pumping irrigation areas have been included into the proposed Trinh Xa South main canal system in the total service area, considering that the water may be supplemented through South main canal in drought.

The design diversion discharge at Trinh Xa pumping station is estimated at 21.5 cu.m/sec, which is equivalent to the discharge of 6 units of vertical axis axial flow pump with a bore of 1,350 mm. The existing pumps had better replace with new ones, because it has been used for over 30 years, might be declined in its discharge capacity, and be high in the repair costs. Long Tuu diversion canal will be improved, since present flow capacity is insufficient as about 11 cu.m/sec, as well as the intake structure. It is suggested that the improvement plan of these main diversion facilities are reexamined by preparing the improvement plan of entire irrigation system included North main canal system.

South main canal will have enough capacity necessary to convey the design diversion water requirement through reshaping of cross-section and brick canal pavement. All check and turnout gates will be replaced with new ones, since most of them are missing, not operational, difficult in operation and large in leakage water. Those structures will also be restored/improved, according to the renewal of gates. In addition, the bridges and road crossing structures will be improved to have adequate flow capacity. The roads for operation and maintenance of canals and structures will be provided/improved by using the top of canal dikes. The roads will be paved by gravel and have an effective width of 5 m and 3 m in the right and left dikes, respectively. Those roads are expected to be effectively used as farm-to-market roads by farmers. The cross-section of major secondary canals will principally be trapezoid but allowed to be rectangular in the section with difficulty in land acquisition. The secondary canals will be paved by bricks up to the section commanded a service area of some 150 ha, and provide the operation and maintenance roads on the top of dikes in the one side. The roads with an effective width of 2-3 m will be paved by gravel and expected to be used for not only operation and maintenance but also main farm roads by farmers. The remaining and small canals will be unlined.

Xuan Vien pumping irrigation system area is low in an irrigated area rate of about 13 % to the planned service area. This low rate may result from that there are no adequate irrigation canals in the elevated land of the eastern area and the existing pumping stations, built for dual purposes of irrigation and drainage in the lower land of the north-eastern area, could be able to serve the very limited land area. Thereby, it is proposed that the irrigation system will be completely modified by constructing new pumping station to be supplied from the Ngu Huyen Khe river in the elevated land area.

Kim Doi area irrigation system is a general term, included Kim Doi, Que Tan and Dong Sai pumping irrigation system. These area shall be irrigated separately through each pumping station rather than the direct irrigation from South main canal, from an economic point of view. The water sources are an excess water in the respective drainage area and/or the upstream area and may be enough to serve these area because these are located in the end of downstream area and small in a service area. However, further

study will be required prior to the project implementation. The service area of each system will be the same as one at present, except Kim Doi area applied with the currently irrigated land area of some 1,340 ha. The pumps existing and/or improved under the drainage project will be utilized but the canals and structures shall be rehabilitated/improved.

Dong Anh area irrigation system, with a total service area of some 540 ha, consists of 3 irrigation systems of Dong Dau, Loc Ha and Lai Da areas, as it is, and be supplied with the water by pumps. The improvement of pumping station will be required for Loc Ha and Lai Da station. In general,the water level at each pumping station so enough in a water head that The canals and its structures shall be improved/upgraded in order to supply the water directly from the canals

Gia Lam area irrigation system will be the same at present. There is no special proposal on the main facilities, since the improvement of Lien Dam irrigation cum. drainage pumping station is on-going, Cong Thon pumping station is still new, as constructed in 1982, and renovation of Thinh Lien irrigation cum. drainage pumping station is also on-going. Only for Cong Thon pumping station in which the pumps are shifted from low floor to high floor depending on the water level of the Duong river, the building structure and type of pump shall be devised in the renovation so as to reduce the labor forces and costs and prevent mechanical trouble.

Speaking of common problems in this system as well as the other systems, the canals and its facilities are required to effectively convey the water to the field directly from the canals because the waters are expensive by pump operation costs.

A land area of some 410 ha located inside Duong river is included in the Study Area. This land, which is fertile and actively cultivated with the diversified crops, replying to the request of irrigation, is suggested to be irrigated by using the floating pump. In either way, the first to do is to promote a diversified crops irrigation to farmers, though the request on the said irrigation is reported.