C-4. Description of Soil Series

PHIMAI SERIES

Field Symbol: Pm

Setting: Phimai soils are formed from alluvium (recent or semi-recent) and occur on river basin and backswamp areas of flood plains. Relief is flat which slope is less than 1 percent.

Drainage, Permeability and Runoff: Poorly drained soils. They are flooded by river water and rainwater in the wet season. Ground water table falls below 1.5 meters, but is not deeper than 3 meters during the peak of the dry period. Permeability and surface runoff are slow.

Vegetation and Land Use : Mainly used for transplanted and broad casted rices and some are covered by grasses and shrubs.

Characteristic Profile Features: The Phimai series is a member of very fine clayey, mixed (probably Montmorillonitic), non acid family of Hydromorphic Alluvial Soils (National), Vertic Tropaquepts or probably Entic Pelluderts (USDA). They are characterized by a dark gray or very dark gray or dark grayish brown clay A horizon overlying a gray or light gray clay B horizon which inturn overlies a dark gray or gray or light gray C horizon. Mottles of strong brown yellowish brown and/or yellowish red colors occur throughout profile. Reaction is medium to neutral over neutral to alkaline.

The soils of Phimai series crack deeply and widely in the dry season and contain distinct slickenside and pressure faces.

Similar Soil Series:

Ratchaburi Series (Rb) - has browner color; chroma is 2 or higher.

Typifying Pedon:

Apg	--	0-18 cm.	Dark gray (10YR4/1) clay, many fine distinct yellowish red mottles along root channels; moderate medium and coarse subangular blocky structure; extremely hard, extremely firm, sticky, plastic; many fine and medium roots; medium acid (pH 6.0); clear smooth boundary to (B21g)
(B21g)	--	18-48 cm.	Gray (10YR5/1)-6/1) clay, many fine and medium dark yellowish brown, few fine yellowish red, few medium strong brown mottles and some dark brown material coating on ped faces; moderate coarse subangular blocky breaking into strong fine angular blocky structure; slightly firm, sticky, plastic; few soft iron nodules; many slickenside and pressure faces; common fine, few medium and large roots; slightly acid (pH 6.5); gradual slightly wavy boundary to (B21g).
(B21g)	--	48-94 cm.	Gray (10YR5/1-6/1) clay, many medium distinct yellowish brown, common medium distinct strong brown mottles and some patchy of dark gray coating on cracking faces; moderate coarse subangular blocky breaking into strong medium and fine angular blocky structure; slightly firm, sticky, plastic, common fine, few medium and coarse roots; many slickensides; slightly acid (pH 6.5); clear wavy boundary to C1g.
C1g	--	94-120 cm.	Dark gray (80% 5YR4/1) and gray (20% 10YR6/1) clay, common medium dark yellowish brown and reddish brown and few fine brownish yellow mottles; moderate coarse subangular blocky structure; slightly firm, sticky, plastic; few slickensides and pressure faces; few fine and medium roots; slightly acid (pH 6.5)

C2g -- 120-160+ cm. Dark gray (5YR4/1) clay with common medium strong brown mottles; firm, sticky, plastic; neutral (pH 7.0)

RATCHABURI SERIES Field Symbol: Rb

Distribution: Occupies moderate extent in the Central Plain and small extent in North East and North Thailand.

Setting: Ratchaburi soils are formed from recent alluvium and occur on the transition between levees and river basins. Relief is flat. Slopes are less than 1%.

Drainage and Permeability: Somewhat poorly drained. Permeability and runoff are slow. These soils are flooded by river water to depths of up to 50 cm. for four or five months during the rainy season. Groundwater level falls below 1.5m. from the soil surface during the dry season.

Vegetation and Land Use: Mainly used for broadcast rice cultivation.

Characteristic Profile Features: Ratchaburi series is a member of the fine clayey, mixed, nonacid family of Hydromorphic Alluvial Soils (National), Aeric Tropaquepts (USDA). They are deep, medium to slightly acid over slightly acid to neutral soils. They are characterized by a dark greyish brown or very dark greyish brown clay or silty clay A horizon, overlying a dark greyish brown, brown or dark brown clay or silty clay B horizon. These soils are mottled throughout with strong brown and yellowish brown coatings along root channels in the A horizon, and dark yellowish brown and yellowish brown mottles in the B horizon.

Similar Soil Series:

Phimai	- Poorly drained, with a dark grey A horizon and grey B horizon, is a member of the very fine clayey family and cracks deeply during the dry season.

Typifying Pedon:

Aplg	--	0-5/8 cm.	Dark greyish brown (10YR4/2), common, fine, distinct strong brown mottles; clay; moderate fine and medium subangular blocky, crumb in places; friable moist; common fine interstitial and few tubular pores; many roots; clear, wavy boundary; pH 5.5
Ap2g	--	5/8-20/25 cm.	Very dark greyish brown (10YR3/2), common, fine, prominent yellowish brown mottles; clay; weak coarse subangular blocky; firm moist; some clay movement along root channels and cracks; few fine and medium tubular and many fine and medium interstitial pores; many roots; clear, wavy boundary; pH 6.5.
B1g	--	20/25-85 cm.	Brown to dark brown (7.5YR4/2), many dark yellowish brown (50% of soil mass) and few yellowish brown mottles; clay; moderate fine and medium subangular blocky; firm moist; common fine tubular and many fine interstitial pores; common roots; clear, smooth boundary; pH 7.0.
B2g	--	85-100 cm.	Brown to dark brown (7.5YR4/2), many dark yellowish brown mottles (75% of soil mass), few yellowish brown and yellowish red mottles; clay; moderate fine subangular blocky; pores, roots and consistence as in B1g horizon; pH 6.5.

ROI ET SERIES

Field Symbol: Re

Distribution: Occupies large extent in Northeast Thailand.

Setting: Roi Et soils are formed from old alluvium and occur on the low terraces. They also occur to a limited extent in low-lying depressions of the middle terraces. Relief is almost flat which slopes are 2 or less.

Drainage, Permeability and Runoff: Poorly drained soils. Permeability is rapid over medium to slow. Runoff is slow. These soils are flooded by impounded rain water up to 30 cm. deep for 3 to 4 months. Ground water table is below 3 meters during the peak of the dry season.

Vegetation and Land Use: Used for transplanted rice in the wet season and for some upland crops such as corn, water melon and beans after rice harvesting.

Characteristic Profile Features: The Roi Et series is a member of the fine-loamy, Kaolinitic, acid family of Low Humic Gley Soils (National), Aeric Palequults (USDA). They are deep soils and are characterized by a variable colors, but dominant colors are grayish brown or light brown sandy loam A horizon overlying a light brown grading to pinkish sandy clay loam argillic B horizon which in turn overlies a light gray or whitish clay loam or clay C horizon. They are mottled throughout the profile with common to many strong brown or yellowish brown mottles at the surface and strong brown and/or yellowish brown or dark brown and some red mottles in the subsoil. Reaction is medium acid over strongly to very strongly acid.

Similar Soil Series:

Ubon Series	- sand or loamy sand textures extent below 80 cm.

Typifying Pedon:

Ap	--	0-19 cm.	Brown (7.5YR5/2) sandy loam, common fine and medium distinct yellowish brown (10YR5/6) mottles; weak fine subangular blocky structure; very friable, nonsticky, nonplastic; common fine tubular pores; some dark patchy decomposed organic matter and some spots of pinkish fine sand; strongly acid; aboupt wavy boundary to B1.
B1	--	19-38 cm.	Light brown (7.5YR6/4) sandy clay loam, many medium distinct strong brown (7.5YR5/6) and common fine yellowish red (5YR5/8) mottles; weak fine and medium subangular blocky structure; slightly firm, slightly sticky and slightly plastic; few medium interstitial and common very fine and fine tubular pores; some dark patchy decomposed organic matter along old root channels; strongly acid; abrupt smooth boundary to B21t.
B21tg	--	38-50 cm.	Pinkish gray (7.5YR7/2) sandy clay loam, common fine and medium distinct yellowish brown (10YR5/6) and strong brown (7.5YR5/6) mottles; weak medium subangular blocky structure; slightly sticky, slightly plastic; common very fine and fine tubular pores; some black spots of soft manganese concretions; few fine roots; strongly acid; clear smooth boundary to B22t.
B22tg	--	50-74 cm.	Pinkish gray (7.5YR7/2) sandy clay loam, many fine and medium yellowish brown (10YR5/8) mottles; weak medium subangular blocky structure; slightly sticky, slightly plastic; many fine tubular pores and few medium interstitial pores; very few fine roots; strongly acid; clear smooth boundary to B3g.

B3g	--	74-93+cm.	Light brownish gray (10YR6/2) sandy clay loam, many fine and medium distinct yellowish brown (10YR5/6) and few fine distinct strong brown (7.5YR5/6) mottles; weak fine subangular blocky structure; sticky, slightly plastic; thin layer of soft iron-manganese concretions at upper part of the horizon; many fine tubular pores; very few fine roots; strongly acid.

UBON SERIES

Field Symbol: Ub

Distribution: Occupies moderate extent in Northeast Thailand.

Setting: Ubon soils are formed from sandy alluvium and occur on the higher parts of the low terrace and the middle terrace. Relief is flat to gently undulating which slopes are 2 per cent or less.

Drainage, Permeability and Runoff: Ubon soils are naturally somewhat excessively drained or well drained but their drainage class are altered to moderately well drained or somewhat poorly drained at the present condition due to soils be used for submerged paddy rice cultivation. They, therefore, are flooded by impounded rainwater up to 20 cm. deep for 2 to 3 months, but dry out badly in the dry season when the ground water level drops to 4 meters or more below the surface. Permeability is rapid. Surface runoff is slow.

Vegetation and Land Use: Mainly used for transplanted rice. Small shrubs occupy abandoned areas.

Characteristic Profile Features: The Ubon series is a member of the coarse-loamy Siliceous, acid family of Hydromorphic Regosols (National), Aquic Dystropepts (USDA) ? They are deep sandy soils and characterized by a light brown or brown loamy sand A horizon overlying a pinkish, light brown, or light reddish brown loamy sand horizon, atlcast 60 cm. deep, and then grading to sandy loam B horizon which in turn overlies a light gray or gray sandy clay loam or sandy clay or clay IIO horizon. The abrupt boundary between sandy layer and clayey horizon usually occur below 80 cm. depth from the surface. Mottles of strong brown or reddish yellow and/or yellowish brown colors normally occur throughout the profile. Reaction is medium to slightly acid.

Similar Soil Series:

Roi Et series (Re)	- has finer texture and argillic B horizon
Nam Phong series (Ng)	- has a similar textural profile but is not used for transplanted rice. Their drainage class is somewhat excessively drained.

Typifying Pedon:

Ap	--	0-17 cm.	Light brown (7.5YR6/4) loamy sand; common pea sized spots of dark gray; weak coarse subangular blocky structure; friable, nonsticky, nonplastic; common fine tubular pores and many fine interstitial pores; medium acid (pH 6.0); gradual smooth boundary to A2.
A2	--	17-53 cm.	Pinkish gray (7.5YR7/2) loamy sand; very weak coarse subangular blocky structure; friable, nonsticky nonplastic; common tubular pores; medium acid (pH 6.0); gradual smooth boundary to (B1).
(B1)	--	53-71 cm.	Light reddish brown (5YR6/4) loamy sand; few faint reddish yellow mottles; weak coarse subangular blocky structure; slightly firm, nonsticky, nonplastic; common fine tubular pores; medium acid (pH 6.0); gradual smooth boundary to (B2)
(B2)	--	71-100+cm.	Light reddish brown (5YR6/4) sandy loam; common faint medium to coarse reddish yellow mottles; moderate coarse subangular blocky structure; slightly firm, slightly sticky, nonplastic; common fine tubular pores; medium acid (pH 6.0).

KORAT SERIES

Field Symbol: Kt

Distribution: Occupies moderate to large extent in Northeast plateau and small extent in North and Southeast.

Setting: The Korat soils are formed from old alluvium and occur on middle terraces. Relief is undulating which slopes range from 2 to 6 percent.

Drainage, Permeability, and Runoff: is moderately well drained soils. Permeability is moderate to rapid. Runoff is rapid.

Vegetation and Land Use: Originally dry dipterocarp forest and mixed diciduous forest. Parts are cleared for upland crops such as kenaf, water melon, corn, cotton, beans, castor bean, cassava, etc. and settlement areas.

Characteristic Profile Features: The Korat series is a member of the fine-loamy, siliceous, acid family of Gray Podzolic Soils (National), Oxic Paleustults (USDA). They are deep soils and are characterized by a grayish brown or very dark grayish brown sandy loam or loamy sand A horizon overlying a brown or light brown or pale brown sandy clay loam B horizon. Few to common fine faint strong brown and/or reddish yellow mottles occur in the deeper B horizon. Reaction is medium acid to strongly acid over strongly acid to very strongly acid.

Similar Soil Series:

Korat, Yellow variant	- similar in profile, but has yellower color with chroma more than 4 in the same hues.

Principal Associated Soils: These include Phon Phisai, Warin, Yasothon, Nam Phong, and Roi Et series. The Phon Phisai, Warin, Yasothon, and Nam Phong soils occur on the higher position while the Roi Et series occupies on the lower ones.

Remark: Some of Korat soils do not show evidence of clay translocation. In that case, they are classified as Ustoxic Dystropepts.

Typifying Pedon:

A1	--	0-13 cm.	Grayish brown (10YR5/2) sandy loam; moderate medium and coarse subangular blocky structures and thin crust at upper most layer; friable, slightly sticky slightly plastic; many very fine and fine interstitial pores; few fine animal holes; many very fine and fine, common medium, and few large roots; slightly acid; gradual smooth boundary to A2
A2	--	13-31 cm.	Pinkish gray (7.5YR6/2) sandy loam; moderate fine and medium subangular blocky breaking into fine granular structure in places; slightly firm, slightly sticky, nonplastic; many very fine and fine interstitial pores; and common fine tubular pores; few fine animal holes; many very fine and fine roots and common medium roots; strongly acid; gradual smooth boundary to B21t
B21t	--	31-66 cm.	Brown (7.5YR5/4) sandy clay loam with few fine reddish yellow (7.5YR6/8) mottles; weak coarse subangular blocky breaking into moderate medium subangular blocky structure; slightly hard, friable, slightly sticky, slightly plastic; few patchy thin clay coating on ped faces, clay bridging between sand grains; and thin discontinuous clay coating in pores; many very fine and few fine interstitial, common fine tubular, and few fine vesidular pores; few

			fine and large animal holes; common fine and medium, and few large roots; strongly acid; gradual smooth boundary to B22t
B22t	--	66-100+ cm.	Light brown (7.5YR6/4) sandy clay loam with common faint reddish yellow (7.5YR6/8) mottles; weak coarse subangular blocky strucutre; slightly hard, friable, slightly sticky and slightly plastic; few patchy thin clay coating on ped faces, clay bridging between sand grains, thin discontinuous clay coating in pores; many very fine and fine interstitial, few fine tubular, and common fine vesicular pores; few fine animal holes; common fine roots; very strongly acid.

PHON PHISAI SERIES

Field Symbol: Pp

Distribution: Occupies large extent in Northeast Thailand.

Setting: Phon Phisai soils are formed from old alluvium and occur on middle terrace. Relief is undulating which slopes range from 2 to 6 percent.

Drainage, Permeability and Runoff: Moderately well drained. Permeability is moderate over slow. Runoff is moderate to rapid. Ground water table falls below 3 meters during the peak of the dry period.

Vegetation and Land Use: Mainly in low open dipterocarp forest with some shrubs. Some shifting cultivation is carried out.

Characteristic Profile Features: Phon Phisai series is a member of the loamy - skeletal over clayey, mixed, acid family of Red-Yellow Podzolic soils (National), Plinthustults (USDA). They are shallow to a ironstone nodule layer and are characterized by a very dark grayish brown or dark brown sandy loam or loam (or gravelly) A horizon overlying a yellowish red or strong Brown gravelly clay loam or clay argillic B horizon which inturn overlies a gray clay with mottled C horizon. The loose or semi-consolidated ironstone layer formed as a continuous phase, thicker than 20 cm. up to 80 cm, occurs within 50 cm depth from the surface. Reaction is slightly acid to medium acid over strong acid to very strongly acid.

Typifying Pedon:

A1	--	0-5/6 cm.	Very dark gray to very dark grayish brown (10YR3/1-2) gravelly loam; moderate fine granular structures; friable, nonsticky, *nonplastic; gravels are hard ironstone nodules which make up* 40 percent of horizon; many fine roots; medium acid; abrupt smooth boundary to B1
B1	--	5/6-14 cm.	Strong brown (7.5YR5/6) gravelly light clay loam; slightly sticky, slightly plastic; gravels are hard ironstone nodules which make up 60 percent of horizon; medium acid; gradual smooth boundary to B21t
B21t	--	14-24 cm.	Yellowish red (5YR5/6) gravelly clay with many fine and medium *faint red mottles; sticky, plastic; common moderately thick* continuous clay coating on ped faces; gravels are hard ironstone nodules which make up 70 percent of horizon; few fine roots; medium acid; gradual smooth boundary to B22t
B22t	--	24-36 cm.	Yellowish red (5YR5/6) gravelly clay with many fine and medium faint red mottles; sticky, plastic; moderately thick continuous clay coating on ped faces; gravels are hard ironstone nodules which make up 70 percent of horizon; strongly acid; gradual smooth boundary to B23t
B23t	--	36-90 cm.	Red (10R4/8) gravelly clay with many fine and medium distinct yellowish brown mottles; sticky, plastic; moderately thick continuous clay coating on ped faces; gravels are hard ironstone nodules which make up 80 percent of horizon; strongly acid; clear smooth boundary to C1
C1	--	90-120 cm.	Light gray (10YR7/2) clay with many fine and medium prominent red and common fine and medium reddish yellow mottles; sticky, plastic; gravels are hard ironstone nodules which make up 5 percent of the horizon; strongly acid; gradual smooth boundary to C2

C2	--	120-160 cm.	Light gray (10YR7/2) clay with many fine and medium prominent red and common strong brown mottle; sticky, plastic; coarse fragments consist of 15 to 20 percent of weathering silt stone and 5 percent of ironstone nodules; strongly acid.
C3	--	120-140 cm.	Light gray (10YR7/1) clay with many medium and coarse prominent red mottles; coarse fragments consist of 50 percent of weathering siltstone; strongly acid.

PHEN SERIES

Field Symbol: Pn

Distribution: Occupies small to moderate extent in Northeast Thailand.

Setting: Phen soils are formed from old alluvium and occur in the shallow depressions of the middle terrace. Relief is flat to gently undulating. Slopes are 2 percent or less.

Drainage, Permeability and Runoff: Poorly drained soils. Flooded in the wet season by impounded rainwater up to 30 cm. deep for 3 to 4 months. Ground water table falls below 3 meters during the peak of the dry period. Permeability is moderate over slow. Surface runoff is slow.

Vegetation and Land Use: Transplanted rice with some scattered dipterocarp spp.

Characteristic Profile Features: The Phen series is a member of the loamy-skeletal over clayey, mixed, acid family of Low Humic Gley soils (National), Plinthaquults (USDA). They are shallow to layer of loose ironstone nodules which occur within 50 cm. depth of the surface. These soils are characterized by a grayish brown or brown loam or sandy loam (gravelly) A horizon overlying a brown or strong brown loam or sandy clay loam upper argillic B horizon and light brown or pinkish gray gravelly clay loam or gravelly sandy clay loam lower argillic B horizon which inturn overlies gray or light gray clay C horizon. They are mottled throughout the profile with colors of strong brown, yellowish brown and/or yellowish red at the surface and strong brown, dark brown, yellowish red and/or red in the subsoil. Reaction is medium to very strongly acid throughout the profile.

Typifying Pedon:

Ap	--	0-9/13 cm.	Grayish brown (10YR5/2) sandy loam; many fine distinct yellowish red mottles; weak medium and coarse subangular blocky structure; hard when dry, friable when moist, nonsticky, non plastic when wet; gravels are hard ironstone nodules which make up 5 to 10 percent of horizon; many old fine roots; medium acid; abrupt wavy boundary to B21tcn
B21tcn	--	9/13-23/25 cm.	Strong brown (7.5YR5/8) sandy clay loam; few medium red mottles; hard when dry, friable when moist, slightly sticky, non plastic; common moderately thick broken clay coating on ped faces; gravels are hard ironstone nodules which make up 70 percent of horizon; few fine roots; medium acid; gradual wavy boundary to B22tcn
B22tcn	--	23/25-45 cm.	Light brown (7.5YR6/4) clay; many medium prominent red and common distinct light gray mottles; firm, sticky, plastic; common moderately thick clay coating on ped faces; coarse fragments consist of 70 percent hard ironstone nodules; strongly acid; gradual smooth boundary to C1g
C1g	--	48-90 cm.	Light gray (10YR7/1) clay; many medium red mottles; moderate fine subangular blocky structures; firm, sticky, plastic; coarse fragments consist of 2-3 percent of hard ironstone nodules; strongly acid; gradual smooth boundary to C2g
C2g	--	90-150 cm.	Mottled red (70% 10R4/6), light gray (25% 10YR7/1), and yellowish brown (5% 10YR5/8) clay; very firm when moist, sticky, plastic when wet; strongly acid.

NAM PHONG SERIES Field Symbol: Ng

Distribution: Occupies moderate extent in Northeast and small in North Thailand.

Setting: Nam Phong soils are formed from sandy old alluvium and locally colluvium and occur on middle terraces and footslopes. Relief is undulating to rolling which slopes range from 3 to 10 percent.

Drainage, Permeability and Runoff: is somewhat excessively drained. Permeability and runoff are rapid.

Vegetation and Land Use: Mainly low open dipterocarp forest; Parts are cleared for shifting cultivation. Those crops are kenaf, water melon, and some corn.

Characteristic Profile Features: The Nam Phong series is a member of the sandy, siliceous family of Regosols (National), Ustoxic Quartzipsamments (USDA). They are deep sandy soils and are characterized by a dark grayish brown, grayish brown, or light brown loamy sand A horizon overlying a pinkish or light brown or light yellowish brown loamy sand or sandy loam C horizon which in turn overlies paler colored sandy clay loam or sandy clay II C or II B horizon. This horizon usually occurs at some depth below 80 cm. from the surface. Few to common strong brown and/or reddish yellow mottles occur at transitional zone between C horizon and II C or II B horizons. Reaction is medium to slightly acid over medium to very strongly acid.

Similar Soil Series:

Korat series (Kt) - Oxic Paleustults; heavier texture; contain argillic B horizon.

Typifying Pedon:

Ap	--	0-15 cm.	Dark brown (7.5YR4/2) loamy sand; weak fine granular and single grain; loose, nonsticky, and nonplastic; many fine interstitial pores; many fine and few medium roots; slightly acid; clear smooth boundary to C11
C11	--	15-42 cm.	Pink (7.5YR7/4) loamy sand; weak fine to medium granular structure and single grains; loose, nonsticky and nonplastic; many fine interstitial and tubular pores; medium acid; gradual smooth boundary to C12
C12	--	42-100 cm.	Pink (7.5YR7/4) loamy sand with common coarse distinct reddish yellow (5YR6/8) mottles; weak medium granular and single grain; many fine interstitial pores; few fine roots; medium acid; abrupt smooth boundary to II C or II B
II C or II B	--	100-120+ cm.	Pinkish gray (5YR6/2) sandy clay loam with many fine distinct yellowish red (5YR5/8) mottles; weak fine subangular blocky structure; firm, slightly sticky, slightly plastic; many fine tubular pores; few fine roots; sand spots occur in the horizon; very strongly acid.

SATUK SERIES

Field Symbol: Suk

Distribution: Occupies moderate to large extent in Northeast Thailand and small extent in North Thailand.

Setting: Satuk soils are formed from old alluvium and occur on the middle and high terraces. Relief is undulating to gently rolling which range of slope is 2 to 8 percent.

Drainage, Permeability and Runoff: Satuk soils are well drained. Ground water table falls below 1.5 m. most of the years. Permeability is moderate and surface runoff is rapid.

Vegetation and Land Use: Mainly dipterocarp and mixed diciduous forest with parts cleared for the cultivation of upland crops such as kenaf, water melon, beans corn, etc.

Characteristic Profile Features: Satuk series is a member of fine-loamy, Kaolinitic family of Red-Yellow Podzolic soils (National), Paleustults (USDA). They are deep soils and characterized by a very dark grayish brown, dark grayish brown or dark brown sandy loam A horizon overlying a strong brown or yellowish brown or reddish yellow sandy clay loam or clay loam argillic B horizon. Reaction is slightly acid to medium over strongly acid to very strongly acid.

Similar Soil Series:

Korat Series	- has chroma 4 or less in the same hue.
Warin Series	- has redder color in the subsoil usually in 5YR hue.

Typifying Pedon:

A1	--	0-4 cm.	Very dark grayish brown (10YR3/2) sandy loam; massive breaking into weak fine and medium subangular blocky structures; friable, nonsticky, nonplastic; few very fine and fine interstitial pores; few fine roots; slightly acid (pH 6.5); abrupt smooth boundary to A2
A2	--	4-12 cm.	Brown (7.5YR5/4) sandy loam; weak to moderates fine, medium, and coarse subangular blocky structures; slightly hard, friable, nonsticky, nonplastic; few very fine interstitial and tubular pores; common very fine and fine roots; medium acid (pH 5.8); clear smooth boundary to B1
B1	--	12-21 cm.	Strong brown (7.5YR5/6) sandy loam; moderate medium and coarse subangular blocky structures; firm, slightly sticky, slightly plastic; common very fine and fine roots; strongly acid (pH 5.3); gradual smooth boundary to B21t
B21t	--	21-33 cm.	Strong brown (7.5YR5/6) sandy clay loam; moderate medium and coarse subangular blocky structures; friable, slightly sticky, slightly plastic; patchy thin broken clay coating on ped faces and few moderately thick broken clay coating on ped faces; common very fine and fine interstitial pores, common fine and few medium tubular pores; common sand spots; common very fine and fine roots, few medium roots; strongly acid (pH 5.2); gradual smooth boundary to B22t
B22t	--	33-98 cm.	Reddish-Yellow (7.5YR6/8) sandy clay loam; moderate medium and coarse subangular blocky structures; friable, sticky, plastic; common moderately thick broken clay coating on ped faces; many very fine and fine roots; strongly acid (pH 5.3); gradual slightly wavy boundary to B23t

B23t	--	98-123+ cm.	Reddish-Yellow (7.5YR6/8) sandy clay loam with few yellowish-red mottles; moderate fine, medium and coarse subangular blocky structures; friable, sticky, plastic; common moderately thick broken clay coating on ped faces; many very fine and fine interstitial pores; few very fine and fine roots; strongly acid (pH 5.5).

WARIN SERIES

Field Symbol: Wn

Distribution: Occupies moderate extent in Northeast Thailand.

Setting: Warin soils are formed from old alluvium and occur on the middle and high terraces. Relief is undulating to rolling. Slopes range from 2 to 8 percent.

Drainage, Permeability and Runoff: Well drained soils. Permeability is moderate. Surface runoff is moderate to rapid. Ground water table falls below 5 meters during the peak of the dry period.

Vegetation and Land Use: Originally mixed diciduous forest and dipterocarp forest. Parts are cleared for upland crops such as corn, cotton, sugar cane, kenaf, water melon and some fruit crops such as pineapple, custard apple and kapok.

Characteristic Profile Features: The Warin series is a member of the fine-loamy, siliceous, acid family of Red-Yellow Podzolic Soils (National), Oxic Paleustults (USDA). They are deep soils which are characterized by a dark brown, brown or dark grayish brown sandy loam or loamy sand A horizon overlying a yellowish red or reddish yellow sandy clay loam B horizon. Reaction is medium to strongly acid very strongly acid to very strong acid.

Similar Soil Series:

Yasothon series (Yt) - Red-Yellow Latosol and has redder color in the B horizon.

Typifying Pedon:

Ap	--	0/10-14 cm.	Dark brown (7.5YR3/2) sandy loam with some patches of yellowish red (5YR4/8); massive; hard when dry, firm when moist, non sticky, non plastic when wet, few fine roots; few medium animal holes; common pieces of fine charcoal; strongly acid; clear wavy boundary to B1
B1	--	10/14-26 cm.	Yellowish red (5YR5/6) sandy loam; massive; hard when dry, firm when moist; slightly sticky, slightly plastic when wet; common fine tubular pores; few large termite holes; few large roots; very strongly acid; gradual smooth boundary to B21t
B21t	--	26-48 cm.	Yellowish red (5YR4/8) sandy clay loam; moderate medium subangular blocky structure; hard when dry, firm when moist, sticky, plastic when wet; thin broken clay coating in pores; common fine tubular pores; few large termite holes; few fine roots; very strongly acid; gradual smooth boundary to B22t
B22t	--	48-100 cm.	Yellowish red (5YR4/8) sandy clay loam; moderate medium subangular blocky and some strong fine granular structure; hard when dry, firm when moist, sticky, plastic when wet; moderately thick continuous clay coating in pores; common fine tubular and interstitial pores; very strongly acid.
B23t	--	100-120 cm.	Yellowish red (5YR4/8) sandy clay with common medium red (2.5YR4/8) and white (5YR8/2) mottles; sticky, plastic; very strongly acid.
B24t	--	120-150 cm.	Yellowish red (5YR5/8) sandy clay; hard when dry, firm when moist, sticky and plastic when wet; very strongly acid.

B3	--	150-175 cm.	Reddish yellow (7.5YR6/6) sandy clay with few fine yellowish red (5YR4/8) and light gray (10YR7/2) mottles; sticky, plastic when wet; very strongly acid.
	--	175-240 cm.	Yellowish brown (10YR5/8) and red (2.5YR4/8) clay with about 80 percent ironstone; very strongly acid.

YASOTHON SERIES Field Symbol: Yt

Distribution: Occupies moderate extent in Northeast and small extent in North Thailand.

Setting: Yasothon soils are formed from old alluvium and occur on the undulating to rolling slopes of the high terraces. Slopes range from 2 to 8 percent.

Drainage, Permeability and Runoff: Somewhat excessively drained. Permeability and surface runoff are rapid. Ground water table falls below 5 meters during the peak of the dry period.

Vegetation and Land Use: Originally, dipterocarp and mixed diciduous forests. Parts are cleared for upland crops such as kenaf, corn, castor bean, cotton, and some fruit trees - banana, mango, jack fruit.

Characteristic Profile Features: The Yasothon series is a member of the fine-loamy, oxidic, acid family of Red-Yellow Latosols (National), Typic Haplustoxs (USDA). They are deep soils which are characterized by a dark brown or dark reddish brown sandy loam or loamy sand A horizon overlying a yellowish red or red sandy loam or sandy clay loam B horizon which inturn overlies a red or dark red sandy clay loam or sandy clay oxic B horizon. Reaction is slightly acid to medium over strongly acid to very strongly acid.

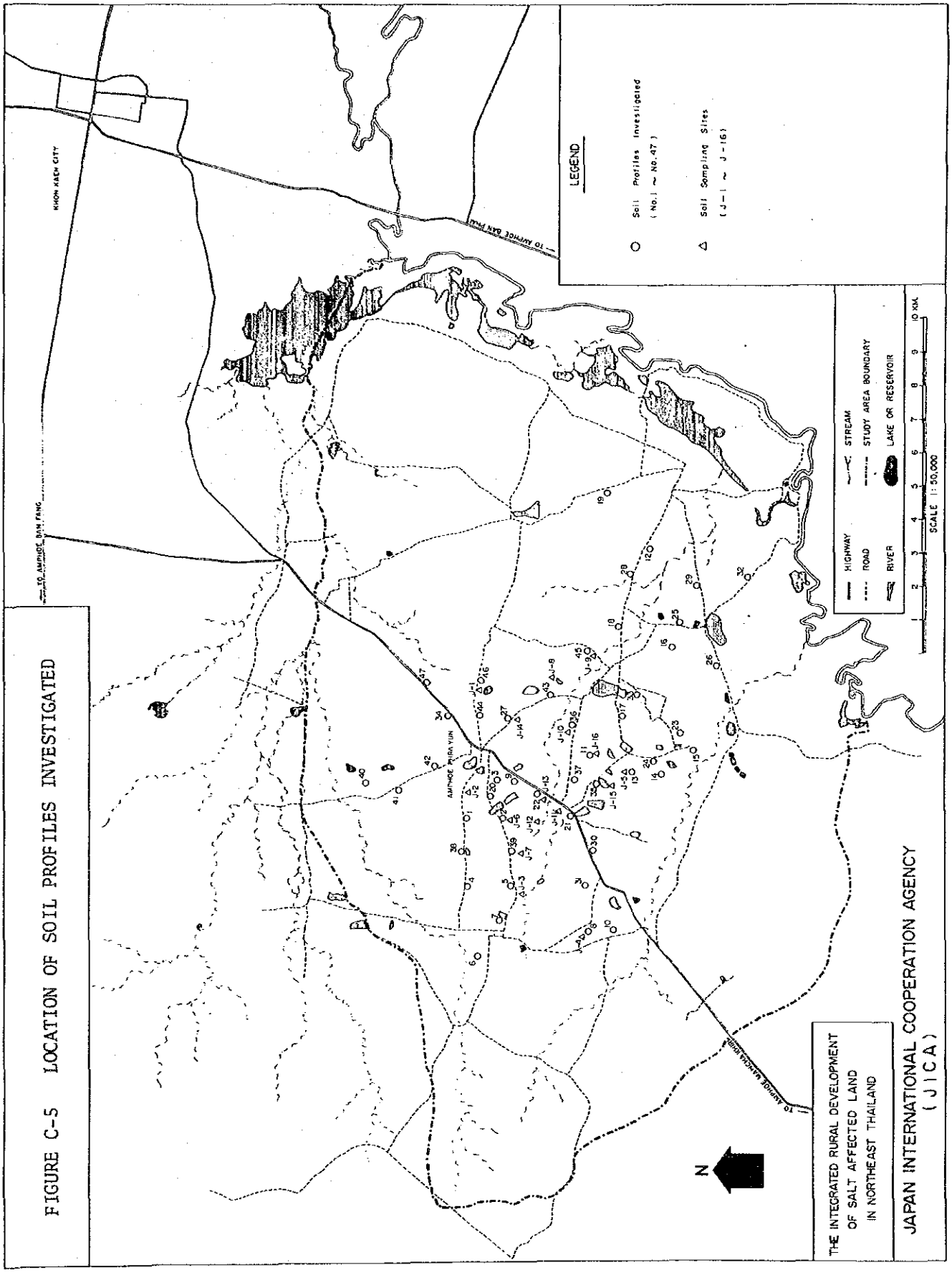
Similar Soil Series:

Warin series (Wn)	- Red-yellow Podzolic Soils and has 5YR hue in the B horizon.

Typifying Pedon:

A1	--	0-15 cm.	Brown to dark brown (7.5YR4/2) sandy loam; moderate medium to very coarse crumb structure; very friable, nonsticky, nonplastic; few fine tubular pores, many very fine interstitial pores; many very fine, medium, and few coarse roots; slightly acid; abrupt smooth boundary to AB
AB	--	15-40 cm.	Yellowish red (5YR4/8) sandy loam; weak very fine to medium subangular blocky structure; very friable, non sticky, nonplastic; few fine tubular pores, many very fine interstitial pores; many very fine, few medium and coarse roots; medium acid; gradual smooth boundary to B21ox
B21ox	--	40-90 cm.	Red (2.5YR4/6) sandy clay loam; weak to moderate fine and medium subangular blocky structure; very friable, slightly sticky, slightly plastic; thin patchy clay coating mainly around sand grains; common very fine tubular and many very fine interstitial pores; common very fine and medium roots; strongly acid; gradual smooth boundary to B22ox
B22ox	--	90-150+ cm.	Red (2.5YR4/8) sandy clay loam; weak to moderate fine and medium subangular blocky structure; very friable; slightly sticky, slightly plastic; thin patchy clay coating mainly around sand grains; common very fine tubular and many very fine interstitial pores; few small pieces of charcoal; few fine and medium roots; very strongly acid.

C-5 Location of Soil Profiles Investigated



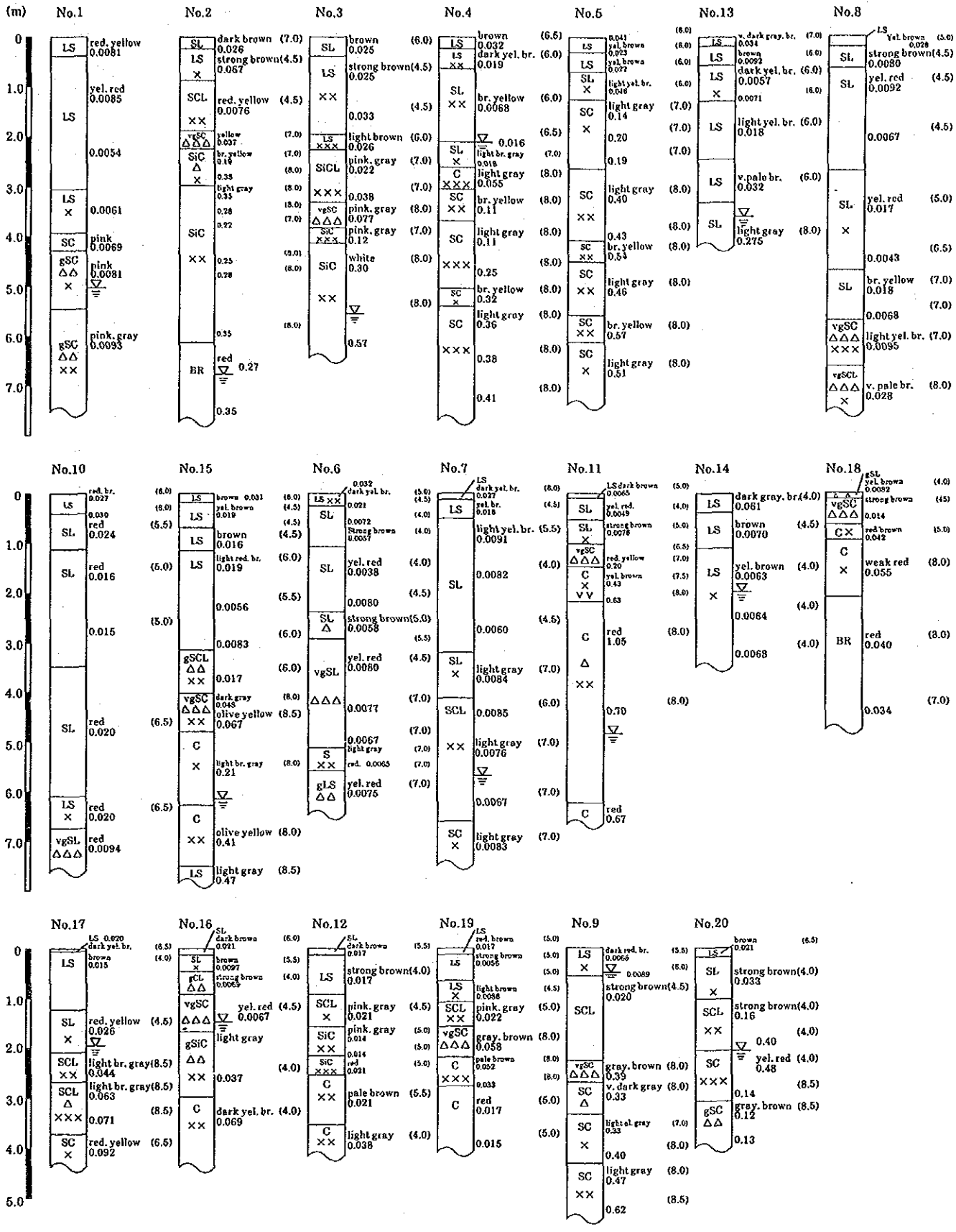
C-6 General Information of Soil Profiles Investigated

Table C-6 General Information of Soil Profiles Investigated

No	Location	Present Land Use
1.	About 2 km west of Ban Phra Yun	Grassland near cassava field
2.	About 1 km west of Amphoe Office	Forest
3.	North of Amphoe Office	Grassland near mulberry farm
4.	About 1 km east of Ban Nong Khu	Upland crop field (kenaf, cassava)
5.	Near Wat Thaowan, Ban Pa Mo	Mulberry farm
6.	Near Rong Rian Ban Pa Mo	Upland crop field (cassava, mulberry)
7.	Ban Pa Mo	Mulberry farm
8.	About 1 km west of Ban Pa San	Upland crop field
9.	About 1 km southwest of Ban Phra Yun	Barren land
10.	About 1 km west of Wat Sawang Chan, Ban Pa San	Cassava field
11.	About 1 km west of Ban Chat	Secondary forest
12.	About 2 km northwest of Ban Ton	Grassland near Eucalyptus plantation
13.	About 2 km north of Ban Thung Mon	Grassland near upland crop field
14.	About 1 km north of Ban Thung Mon	Grassland and cassava field
15.	Ban Thung Mon	Upland crop field (cassava)
16.	About 1 km west of Ban Kum Din	Shrubs near paddy field
17.	Near Ban Kham Pom	Grassland near mulberry farm
18.	Near Ban Chot	Dipterocarp forest
19.	About 2 km north of Ban Ton	Forest
20.	About 1 km weat of Ban Phra Yun	Grassland near cassava field
21.	West of Ban Bo Kae	Paddy field
22.	Between Amphoe Office and Ban Bo Kae	Barren, sparse salt-tolerant grass vegetation
23.	Northeast of Ban Tung Mon	Paddy field
24.	About 1.5km north of Ban Tung Mon	Paddy field
25.	South of Ban Kum Din	Paddy field
26.	West of Ban Han	Paddy field
27.	About 1 km southeast of Ban Phra Yun	Paddy field
28.	About 1 km east of Ban Chot	Paddy field
29.	About 1 km east of Ban Phra Bu	Paddy field
30.	Between Ban Bo Kae and Ban Pa San	Paddy field
31.	Northeast of Ban Pa San	Paddy field
32.	Between Ban Phra Bu and Ban Chot Noi	Paddy field
33.	Southwest of Ban Kham Pom	Paddy field
34.	About 1 km northeast of Ban Phra Yun	Paddy field
35.	About 1 km southeast of Ban Bo Kae	Paddy field
36.	West of Ban Chat	Paddy field
37.	About 1 km east of Ban Bo Kae	Paddy field
38.	About 2 km east of Ban Nong Khu	Paddy field
39.	About 2 km east of Ban Pa Mo	Paddy field
40.	East of Ban Non Bo	Paddy field
41.	About 1 km south of Ban Non Bo	Paddy field
42.	About 1 km north of Ban Hua Bung	Paddy field
43.	About 1 km north of Ban Chat	Paddy field
44.	About 1 km east of Ban Phra Yan	Paddy field
45.	About 1 km northeast of Ban Kham Pom	Paddy field
46.	East of Nong Bua	Paddy field
47.	About 1 km southwest of Ban Na Lam	Paddy field

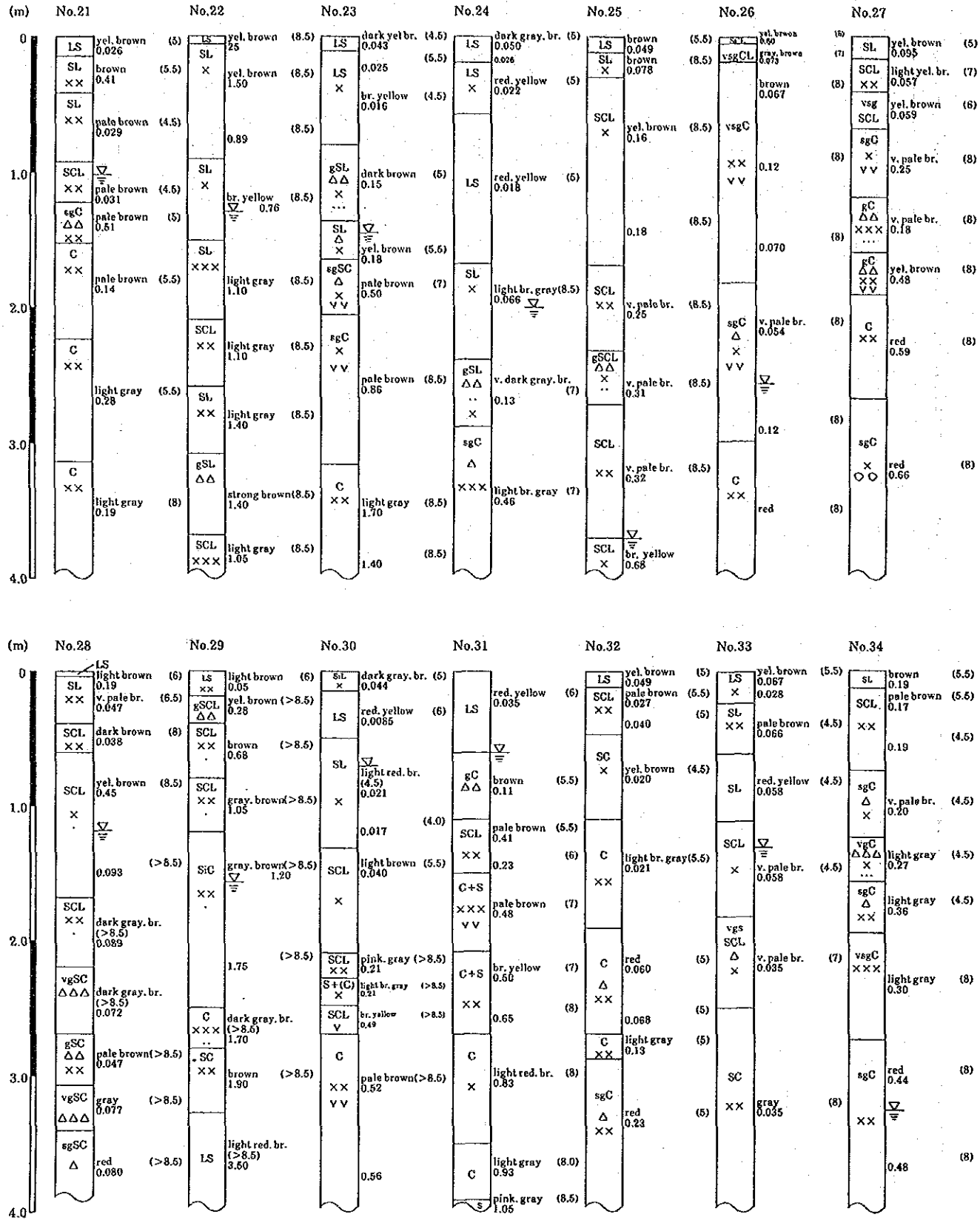
C-7 Soil Profiles in Upland Area

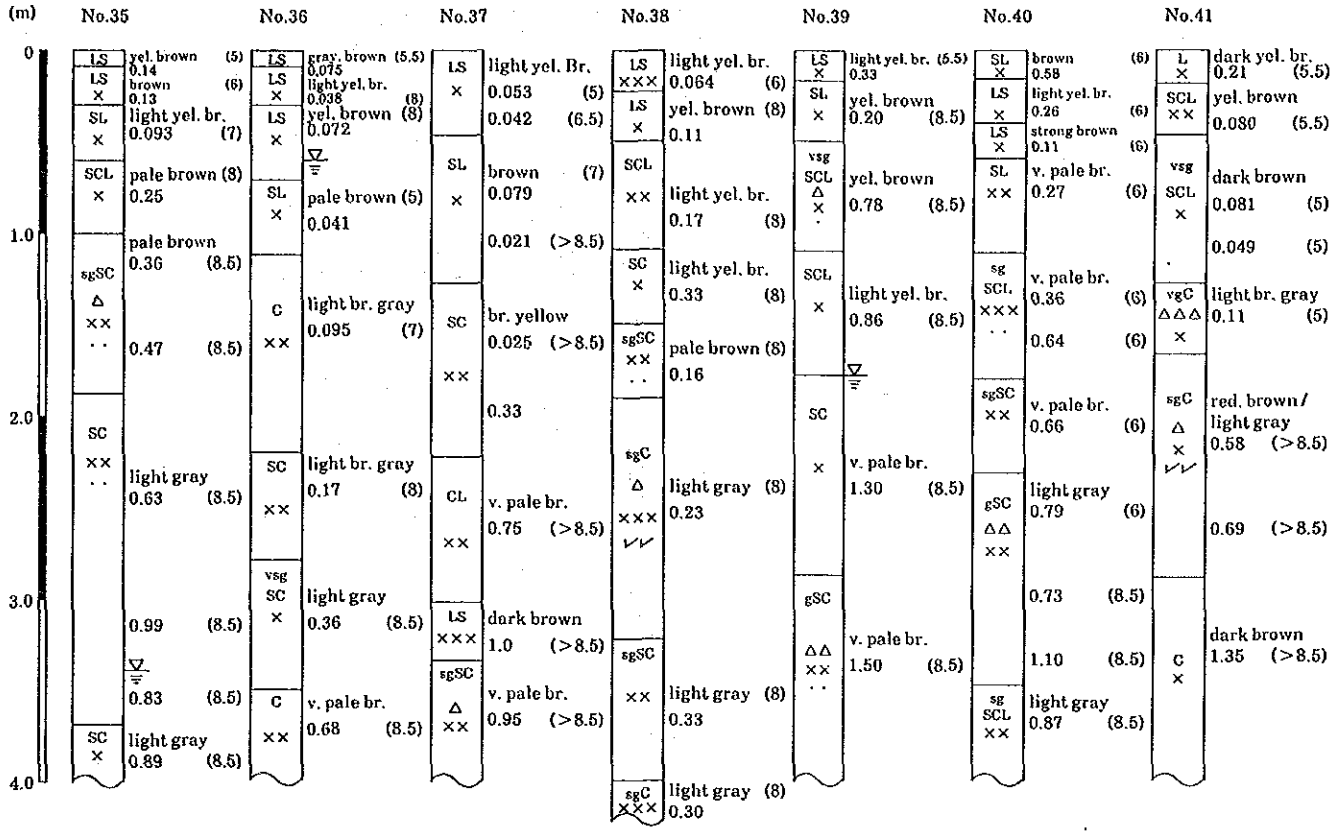
FIGURE C-7 SOIL PROFILES IN UPLAND AREA

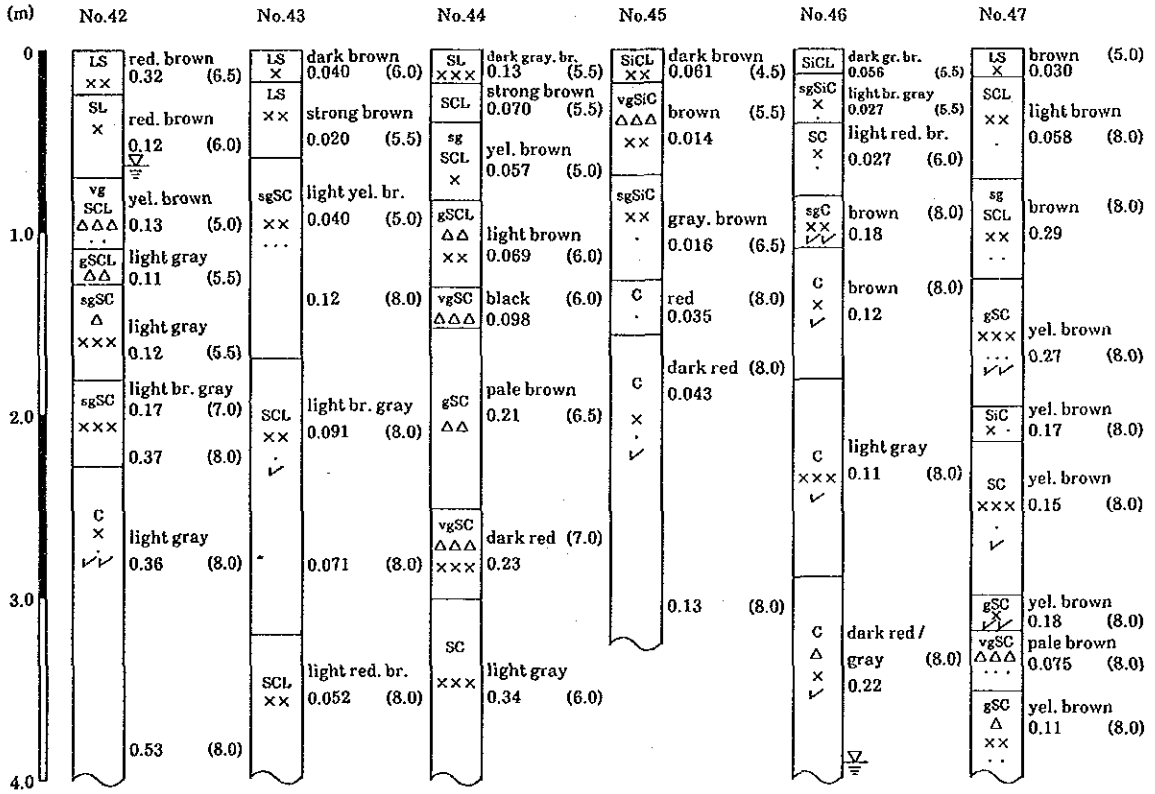


( ) shows pH, ▽ water table

FIGURE C-8 SOIL PROFILES IN LOWLAND AREA

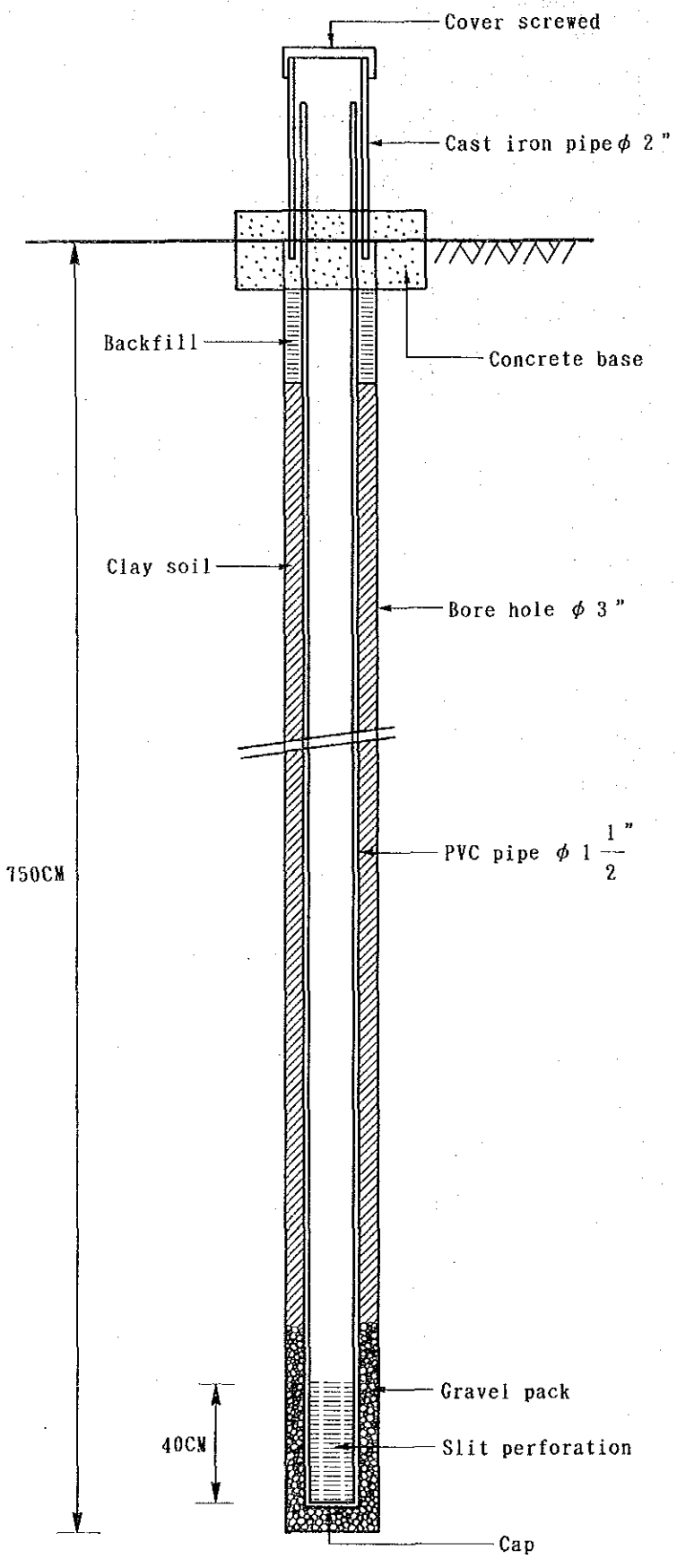



(m)
No.35
No.36
No.37
No.38
No.39
No.40
No.41
0
1.0
2.0
3.0
4.0
LS yel. brown (5) 0.14
LS brown (6) 0.13
SL light yel. br. 0.093 (7)
SCL pale brown (8) 0.25
pale brown 0.36 (8.5)
sgSC 0.47 (8.5)
SC light gray 0.63 (8.5)
0.99 (8.5)
0.83 (8.5)
SC light gray 0.89 (8.5)
LS gray. brown (5.5) 0.075
LS light yel. br. 0.038 (8)
LS yel. brown (8) 0.072
SL pale brown (5) 0.041
C light br. gray 0.095 (7)
SC light br. gray 0.17 (8)
vsg SC light gray 0.36 (8.5)
C v. pale br. 0.68 (8.5)
LS light yel. Br. 0.053 (5)
0.042 (6.5)
SL brown (7) 0.079
0.021 (>8.5)
SC br. yellow 0.025 (>8.5)
0.33
CL v. pale br. 0.75 (>8.5)
LS dark brown 1.0 (>8.5)
sgSC v. pale br. 0.95 (>8.5)
LS light yel. br. 0.064 (6)
LS yel. brown (8) 0.11
SCL light yel. br. 0.17 (8)
SC light yel. br. 0.33 (8)
sgSC pale brown (8) 0.16
sgC light gray (8) 0.23
sgSC light gray (8) 0.33
sgC light gray (8) 0.30
LS light yel. br. (5.5) 0.33
SL yel. brown 0.20 (8.5)
vsg SCL yel. brown 0.78 (8.5)
SCL light yel. br. 0.86 (8.5)
SC v. pale br. 1.30 (8.5)
gSC v. pale br. 1.50 (8.5)
SL brown (6) 0.58
LS light yel. br. (6) 0.26
LS strong brown 0.11 (6)
SL v. pale br. 0.27 (6)
sg SCL v. pale br. 0.36 (6)
0.64 (6)
sgSC v. pale br. 0.66 (6)
gSC light gray 0.79 (6)
0.73 (8.5)
1.10 (8.5)
sg SCL light gray 0.87 (8.5)
L dark yel. br. 0.21 (5.5)
SCL yel. brown 0.080 (5.5)
vsg SCL dark brown 0.081 (5)
0.049 (5)
vgC light br. gray 0.11 (5)
sgC red. brown / light gray 0.58 (>8.5)
0.69 (>8.5)
C dark brown 1.35 (>8.5)

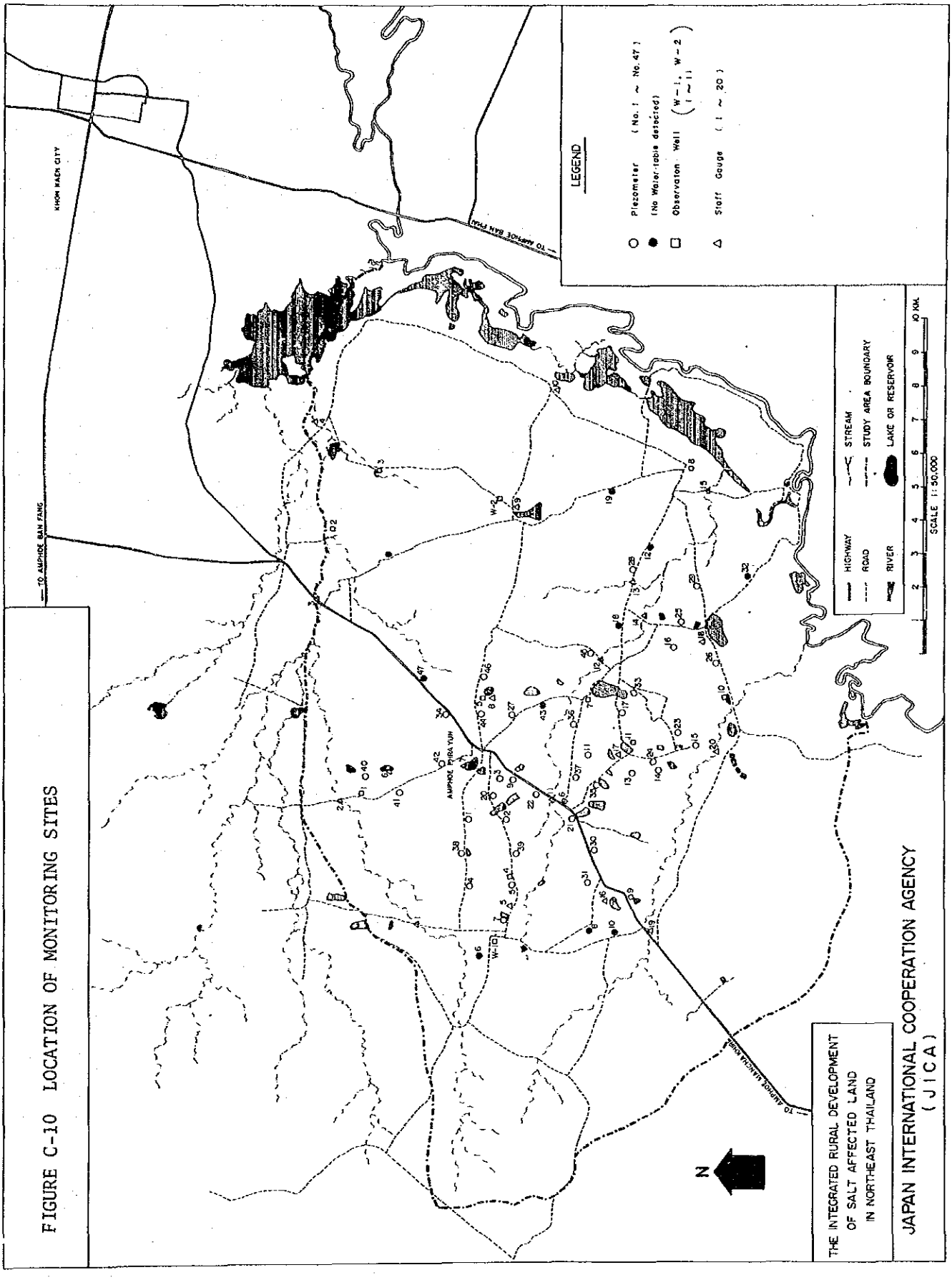

(m)
No.42
No.43
No.44
No.45
No.46
No.47
0
1.0
2.0
3.0
4.0
LS red. brown 0.32 (6.5)
SL red. brown 0.12 (6.0)
vg SCL yel. brown 0.13 (5.0)
gSCL light gray 0.11 (5.5)
sgSC light gray 0.12 (5.5)
sgSC light br. gray 0.17 (7.0)
0.37 (8.0)
C light gray 0.36 (8.0)
0.53 (8.0)
LS dark brown 0.040 (6.0)
LS strong brown 0.020 (5.5)
sgSC light yel. br. 0.040 (5.0)
0.12 (8.0)
SCL light br. gray 0.091 (8.0)
0.071 (8.0)
SCL light red. br. 0.052 (8.0)
SL dark gray. br. 0.13 (5.5)
SCL strong brown 0.070 (5.5)
sg SCL yel. brown 0.057 (5.0)
gSCL light brown 0.069 (6.0)
vgSC black (6.0) 0.098
gSC pale brown 0.21 (6.5)
vgSC dark red (7.0) 0.23
SC light gray 0.34 (6.0)
SiCL dark brown 0.061 (4.5)
vgSiC brown (5.5) 0.014
sgSiC gray. brown 0.016 (6.5)
C red (8.0) 0.035
dark red (8.0) 0.043
0.13 (8.0)
SiCL dark gr. br. 0.056 (5.5)
sgSiC light br. gray 0.027 (5.5)
SC light red. br. 0.027 (6.0)
sgC brown (8.0) 0.18
C brown (8.0) 0.12
light gray 0.11 (8.0)
C dark red / gray (8.0) 0.22
LS brown (5.0) 0.030
SCL light brown 0.058 (8.0)
sg SCL brown (8.0) 0.29
gSC yel. brown 0.27 (8.0)
SiC yel. brown 0.17 (8.0)
SC yel. brown 0.15 (8.0)
gSC yel. brown 0.18 (8.0)
vgSC pale brown 0.075 (8.0)
gSC yel. brown 0.11 (8.0)

C-9 Structure of Piezometer

FIGURE C-9 STRUCTURE OF PIEZOMETER



C-10 Location of Monitoring Sites



C-11 Results of Salinity Monitoring by Piezometer

Table C-11 Results of Salinity Monitoring by Piezometer

Water Table (meter from surface)

No.	Sep 5	Sep 20	Oct 5	Oct 21	Nov 7	Nov 23	Dec 11	Dec 26	Jan 8	Jan 26	Feb 10	Feb 26
1	3.00	2.69	2.43	2.14	2.09	2.27	2.51	2.64	2.85	3.01	2.94	3.14
2	4.35	4.57	4.00	3.88	3.89	4.01	4.62	4.93	5.00	5.19	5.09	5.16
3	1.55	1.38	1.14	0.93	1.00	1.64	1.45	1.61	1.77	1.91	1.93	2.16
4	2.70	2.42	2.45	2.37	2.35	2.48	2.61	2.77	2.86	2.86	2.83	2.82
5	6.20	6.61	6.81	6.91	6.91	7.05	7.11	7.22	7.25	7.14	7.00	>7.00
6	—	—	—	—	—	—	—	—	—	—	—	—
7	5.05	4.55	4.54	3.95	3.83	3.90	4.06	4.17	4.28	4.40	4.05	4.48
8	—	—	—	—	—	—	—	—	—	—	—	—
9	1.30	0.33	0.58	0.63	0.87	1.27	1.33	1.50	1.68	1.81	1.80	1.96
10	—	—	—	—	—	—	—	—	—	—	—	—
11	4.15	3.77	3.74	3.49	3.24	3.78	4.13	4.30	4.28	4.55	4.47	4.67
12	—	—	—	—	—	—	—	—	—	—	—	—
13	0.65	0.35	0.50	0.40	0.97	1.22	1.39	1.44	1.65	1.76	1.72	1.80
14	1.60	1.04	0.94	0.65	1.29	1.42	1.70	1.83	1.94	2.03	2.00	>2.00
15	4.50	4.14	3.63	3.46	3.41	3.64	3.90	4.16	4.15	4.26	4.17	4.46
16	0.60	0.57	0.67	0.50	1.16	2.43	3.14	3.42	3.50	>4.00	—	—
17	0.50	0.40	0.29	0.32	0.76	1.07	1.34	1.50	1.65	1.80	1.76	1.93
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	3.40	2.33	1.92	1.72	1.67	1.92	2.09	2.18	2.30	2.40	2.37	2.56
21							0.88	0.73	1.23	0.97	1.00	1.10
22							1.00	1.17	1.25	1.33	1.30	1.45
23							1.17	1.38	1.52	1.71	1.62	1.80
24							1.04	1.00	1.29	1.40	1.44	1.56
25							1.16	1.17	1.35	1.35	1.35	1.54
26							0.94	1.11	1.22	1.32	1.37	1.54
27							1.22	1.50	1.62	1.65	1.63	1.79
28							1.40	1.18	1.38	1.54	1.55	1.83
29							1.05	1.09	1.30	1.36	1.30	1.41
30							1.07	1.10	1.31	1.47	1.45	1.54
31							0.73	1.08	1.29	1.39	1.40	1.45
32							—	—	—	—	—	—
33							1.10	1.30	1.44	1.49	1.52	1.66
34							1.34	1.53	1.55	1.68	1.70	1.76
35							0.88	1.05	1.17	1.24	1.25	1.38
36							1.32	1.08	1.35	1.38	1.39	1.59
37							1.10	1.23	1.34	1.29	1.25	1.40
38							1.45	1.17	1.18	1.20	1.19	1.39
39							1.30	1.38	1.44	1.48	1.46	1.54
40								1.33	1.23	1.38	1.34	1.42
41								1.37	1.45	1.58	1.56	1.69
42								1.05	1.14	1.25	1.23	1.40
43								—	—	—	—	—
44								1.94	2.05	2.19	2.19	2.27
45								1.20	1.44	1.52	1.57	1.76
46								0.31	0.57	0.55	0.70	0.79
47								—	—	—	—	—

E C at 25°C

(mS/cm)

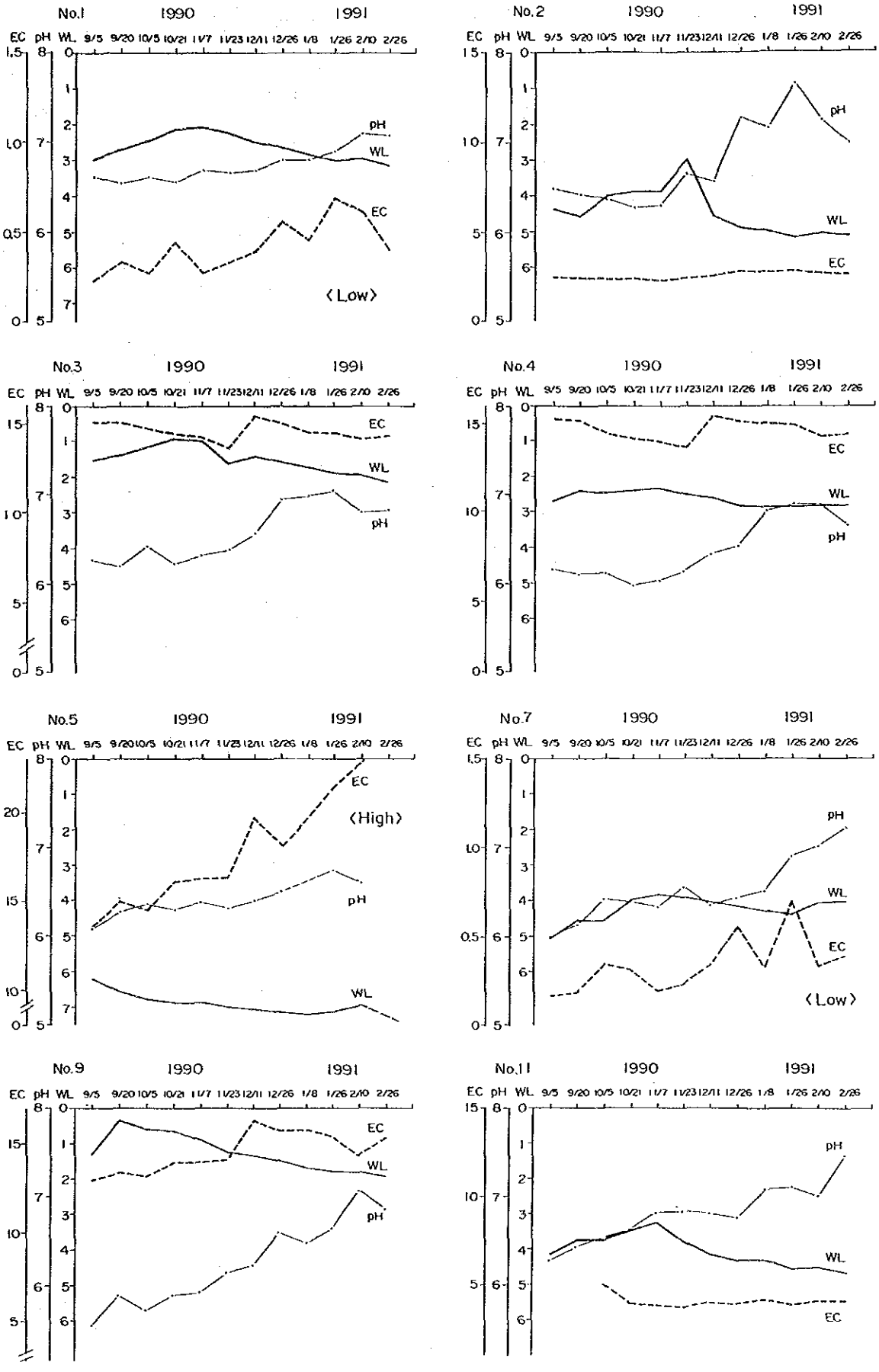
No	Sep 5	Sep 20	Oct 5	Oct 21	Nov 7	Nov 23	Dec 11	Dec 26	Jan 8	Jan 26	Feb 10	Feb 26
1	0.23	0.33	0.27	0.44	0.27	0.33	0.39	0.56	0.45	0.69	0.61	0.39
2	2.41	2.36	2.29	2.32	2.21	2.32	2.45	2.71	2.64	2.70	2.55	2.47
3	15.11	15.08	14.65	14.42	14.15	13.62	15.44	14.95	14.50	14.54	14.11	14.25
4	15.18	15.14	14.39	14.12	14.00	13.62	15.36	15.08	14.95	14.87	14.28	14.36
5	13.53	14.87	14.41	15.96	16.21	16.15	19.58	17.98	—	21.40	22.82	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	0.16	0.18	0.34	0.31	0.19	0.23	0.34	0.55	0.33	0.70	0.33	0.39
8	—	—	—	—	—	—	—	—	—	—	—	—
9	12.94	13.31	13.06	13.92	13.86	14.11	16.25	15.67	15.84	15.43	14.32	15.26
10	—	—	—	—	—	—	—	—	—	—	—	—
11	> 20	> 20	5.00	3.86	3.83	3.65	4.00	3.88	4.18	3.93	4.08	4.09
12	—	—	—	—	—	—	—	—	—	—	—	—
13	6.01	6.20	6.32	5.67	6.00	5.79	6.24	6.32	6.21	6.29	6.08	6.55
14	0.10	0.09	0.13	0.14	0.09	0.28	0.10	0.33	0.20	0.30	0.58	—
15	13.40	13.15	13.05	12.61	12.55	12.14	13.43	13.85	13.28	13.25	13.06	12.96
16	0.22	0.17	0.15	0.13	0.09	0.07	0.09	0.14	0.12	—	—	—
17	3.16	3.22	3.21	3.05	3.05	3.13	3.10	2.40	3.18	3.27	2.99	2.98
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	3.64	2.85	2.83	2.69	2.66	2.70	2.86	2.87	2.84	2.79	2.75	2.86
21							12.29	11.56	12.49	11.89	11.41	11.39
22							25.39	26.12	29.58	23.70	24.81	22.96
23							15.86	16.24	23.73	23.72	24.29	22.47
24							9.69	9.77	9.40	9.60	9.35	9.50
25							16.27	15.07	15.35	14.77	14.32	14.09
26							0.82	1.21	0.91	1.43	0.78	1.12
27							9.10	8.76	9.09	8.84	8.60	8.44
28							1.10	1.13	1.17	1.09	1.26	1.17
29							40.59	47.07	49.63	42.48	48.68	43.81
30							1.40	1.66	1.47	1.56	1.37	1.49
31							22.92	24.11	22.93	24.13	21.85	21.63
32							—	—	—	—	—	—
33							0.61	0.70	0.71	0.79	0.79	0.93
34							8.15	8.11	8.26	7.58	7.37	7.70
35							24.88	27.18	26.42	28.39	29.68	25.80
36							2.56	4.39	4.97	8.90	10.53	12.13
37							20.97	22.48	23.59	22.44	21.93	22.09
38							3.23	3.39	3.29	3.38	3.45	3.51
39							23.48	25.87	25.60	24.93	27.75	23.14
40								17.62	22.24	18.73	17.62	19.05
41								11.46	11.73	11.69	11.94	12.17
42								6.14	5.94	5.96	6.01	5.78
43								—	—	—	—	—
44								7.66	8.12	8.01	8.08	8.11
45								0.98	0.80	0.86	0.74	0.70
46								1.98	1.85	1.96	1.89	1.76
47								—	—	—	—	—

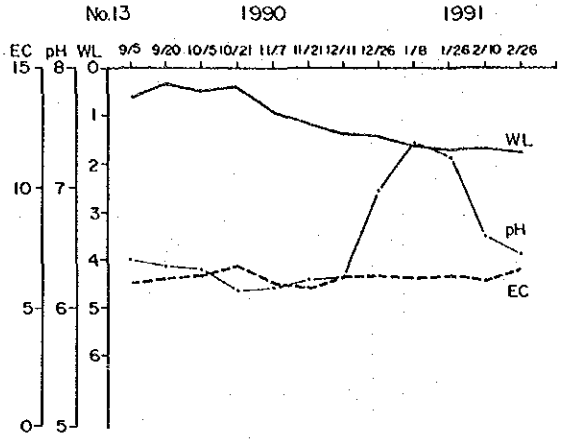
pH

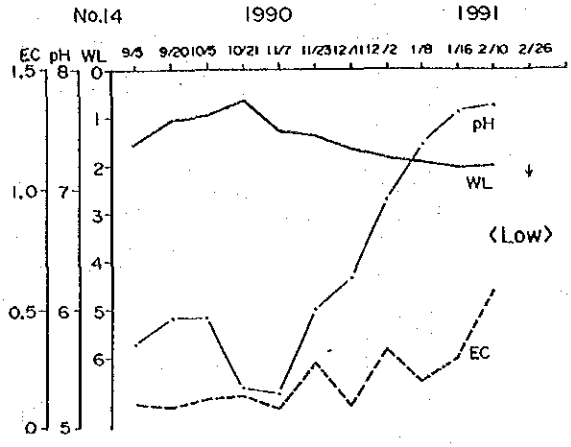
No.	Sep 5	Sep 20	Oct 5	Oct 21	Nov 7	Nov 23	Dec 11	Dec 26	Jan 8	Jan 26	Feb 10	Feb 26
1	6.62	6.54	6.59	6.54	6.68	6.65	6.68	6.79	6.81	6.91	7.09	7.07
2	6.48	6.41	6.36	6.26	6.28	6.63	6.55	7.27	7.16	7.64	7.24	6.97
3	6.27	6.20	6.42	6.23	6.32	6.38	6.56	6.94	6.97	7.04	6.81	6.83
4	6.17	6.11	6.12	5.98	6.04	6.14	6.34	6.43	6.81	6.88	6.89	6.67
5	6.19	6.27	6.35	6.29	6.37	6.30	6.38	6.48	—	6.72	6.58	—
6	—	—	—	—	—	—	—	—	—	—	—	—
7	6.01	6.14	6.42	6.40	6.34	6.56	6.36	6.44	6.52	6.90	7.02	7.23
8	—	—	—	—	—	—	—	—	—	—	—	—
9	5.54	5.88	5.70	5.88	5.91	6.13	6.22	6.58	6.47	6.63	7.05	6.85
10	—	—	—	—	—	—	—	—	—	—	—	—
11	6.27	6.43	6.52	6.62	6.81	6.82	6.81	6.76	7.08	7.10	7.00	7.46
12	—	—	—	—	—	—	—	—	—	—	—	—
13	6.39	6.33	6.31	6.14	6.15	6.21	6.23	6.95	7.36	7.26	6.58	6.43
14	5.71	5.93	5.93	5.34	5.30	5.98	6.27	6.91	7.37	7.65	7.69	—
15	6.86	6.85	6.87	6.76	7.07	7.11	7.12	7.26	7.29	7.09	7.62	7.04
16	6.28	5.99	5.95	5.69	5.74	6.12	6.01	6.87	6.82	—	—	—
17	6.15	6.16	6.28	6.00	6.09	6.16	6.28	6.75	6.92	6.80	6.67	6.57
18	—	—	—	—	—	—	—	—	—	—	—	—
19	—	—	—	—	—	—	—	—	—	—	—	—
20	6.09	6.25	6.53	6.41	6.54	6.60	6.55	6.94	6.96	7.29	6.98	6.96
21							6.47	6.81	6.50	6.81	7.35	6.82
22							7.03	7.18	7.29	7.25	7.19	6.95
23							6.80	6.76	6.95	6.86	7.40	6.81
24							5.93	6.47	6.82	6.35	6.17	6.25
25							6.87	6.85	6.76	7.07	6.95	7.02
26							7.08	7.35	7.20	7.30	7.46	7.47
27							6.78	6.85	7.02	7.04	7.11	7.20
28							7.28	7.54	7.34	7.43	8.01	7.57
29							7.12	7.23	7.32	7.30	7.04	7.32
30							6.37	7.41	6.85	7.47	7.54	7.62
31							6.62	7.23	7.00	7.09	6.94	7.06
32							—	—	—	—	—	—
33							6.24	6.83	7.34	6.95	7.17	7.01
34							6.37	6.85	6.50	6.80	6.74	6.59
35							6.52	7.48	7.38	7.33	7.33	6.89
36							6.26	6.62	6.68	6.55	6.66	6.46
37							6.85	6.99	7.18	7.18	7.14	7.49
38							6.94	7.12	7.15	7.36	7.26	7.32
39							6.83	7.21	7.38	7.73	7.09	7.16
40								6.94	7.17	7.48	6.91	7.13
41								7.21	7.43	7.46	7.12	7.42
42								6.88	6.90	6.96	7.13	6.87
43								—	—	—	—	—
44								6.21	6.24	6.42	7.08	6.77
45								7.25	7.77	7.56	7.72	7.46
46								7.17	7.14	7.28	7.24	7.12
47								—	—	—	—	—

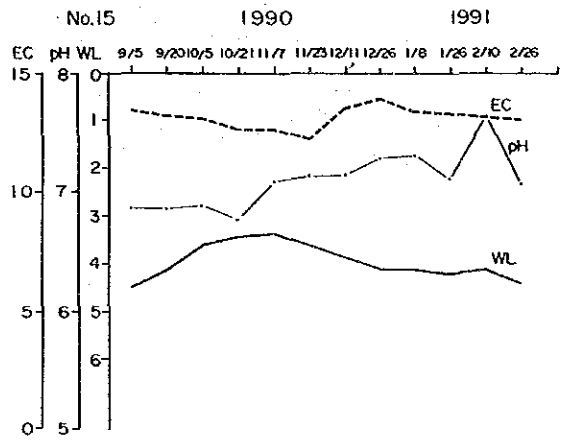
C-12 Changes in Water Table, EC, and pH in Piezometer

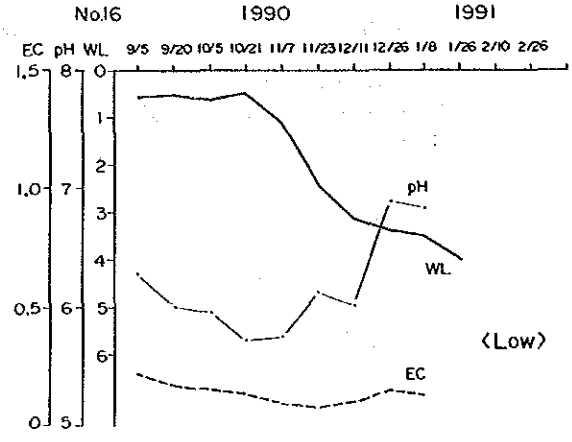
FIGURE C-12 CHANGES IN WATER TABLE, EC, AND PH IN PIEZOMETER

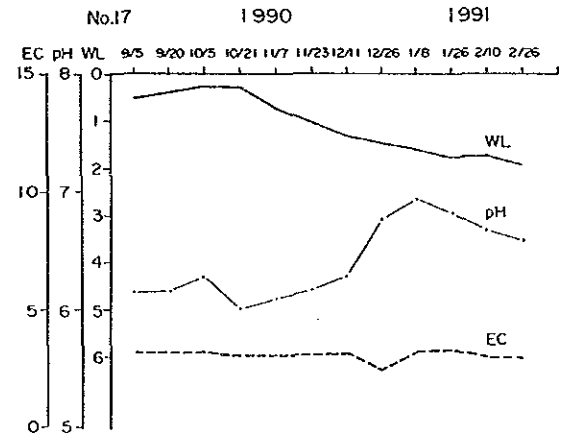


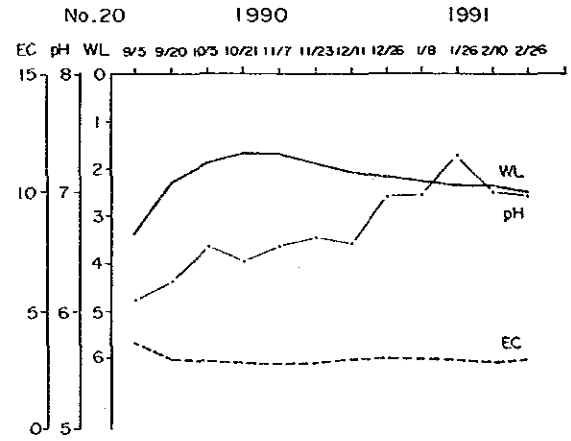

No.13
1990
1991
EC pH WL
WL
pH
EC

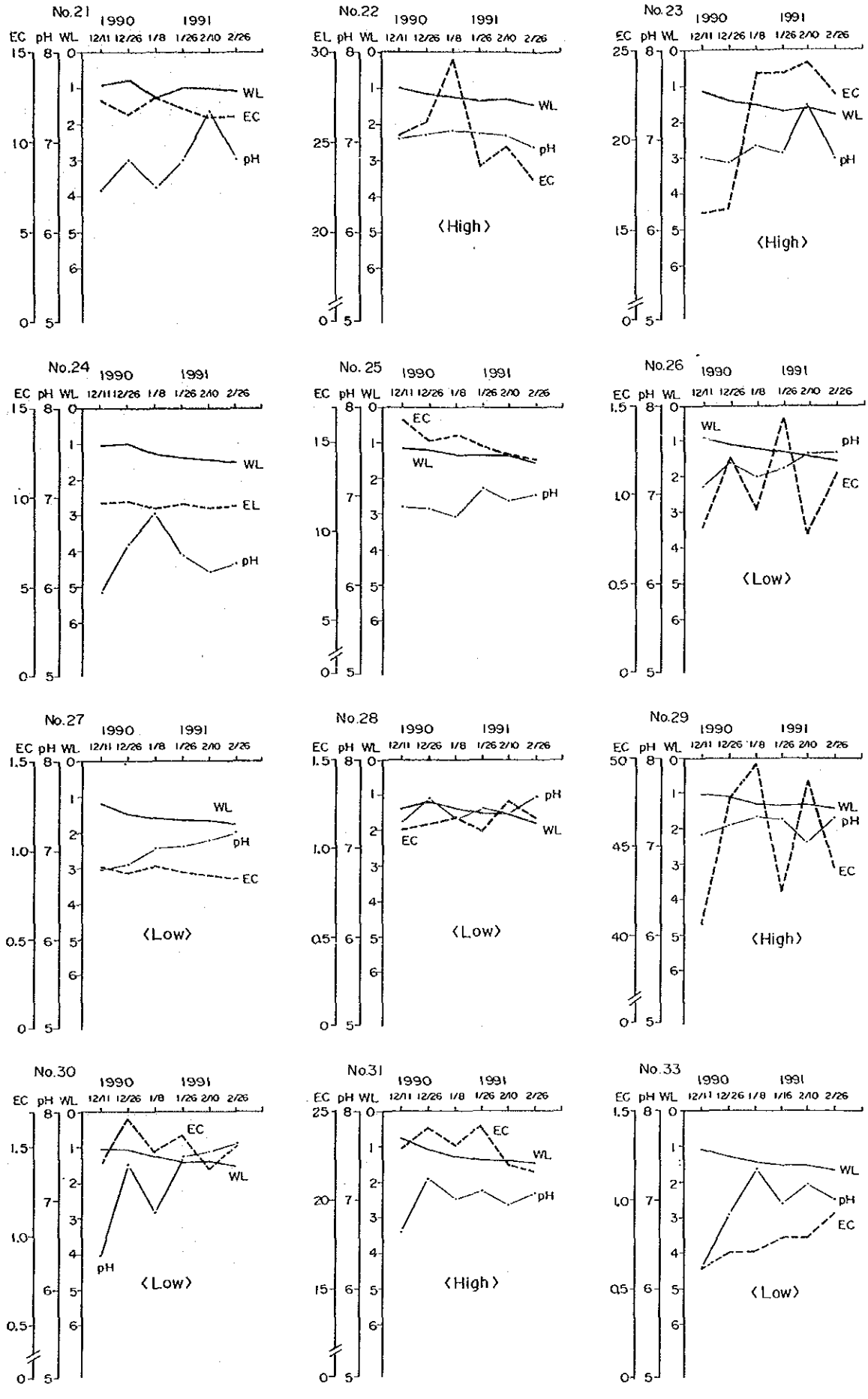

No.14
1990
1991
EC pH WL
pH
WL
〈Low〉
EC

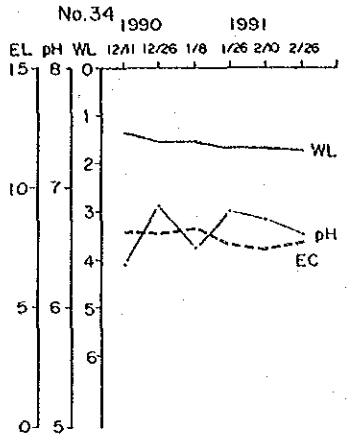

No.15
1990
1991
EC pH WL
EC
pH
WL

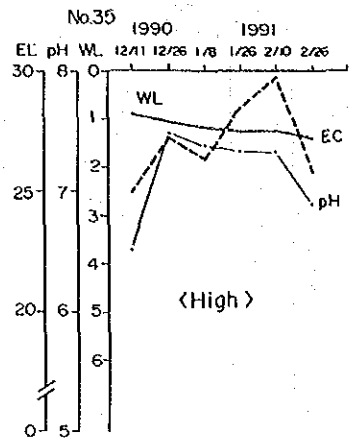

No.16
1990
1991
EC pH WL
pH
WL
〈Low〉
EC

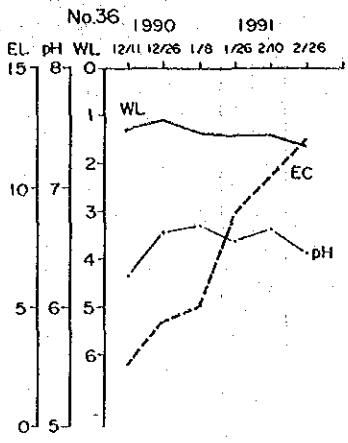

No.17
1990
1991
EC pH WL
WL
pH
EC

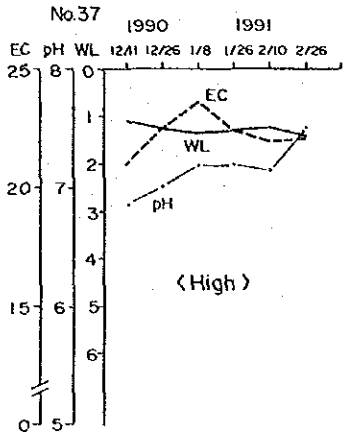

No.20
1990
1991
EC pH WL
WL
pH
EC

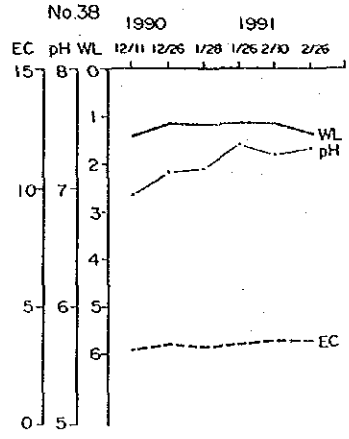

No.21
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
EC
pH
No.22
EL pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC
〈High〉
No.23
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
EC
WL
pH
〈High〉
No.24
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
EL
pH
No. 25
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
EC
WL
pH
No.26
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC
〈Low〉
No.27
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC
〈Low〉
No.28
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
pH
WL
EC
〈Low〉
No.29
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC
〈High〉
No.30
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
EC
WL
pH
〈Low〉
No.31
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
EC
WL
pH
〈High〉
No.33
EC pH WL 12/11 12/26 1/8 1/16 2/10 2/26
WL
pH
EC
〈Low〉

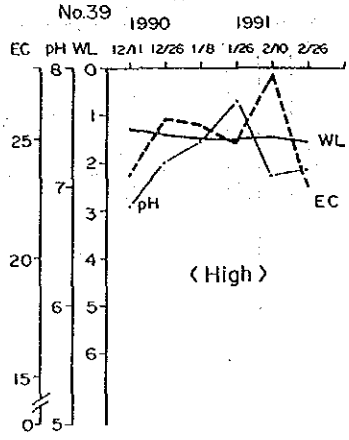

No.34
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC

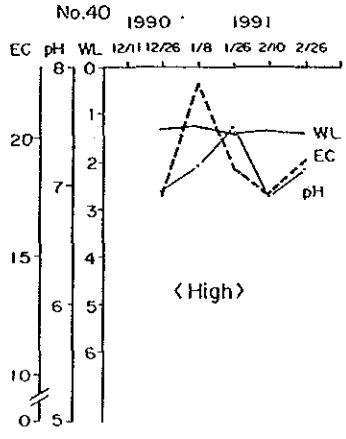

No.35
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
EC
pH
〈High〉

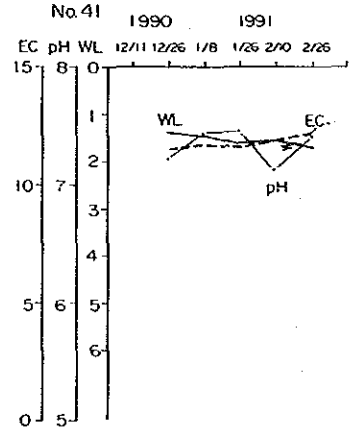

No.36
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
EC
pH

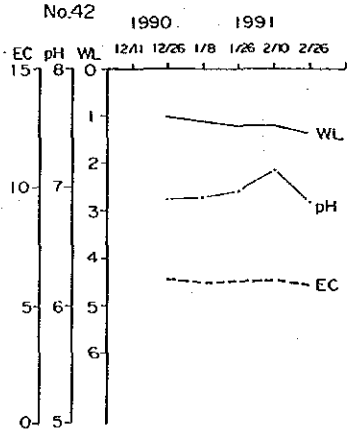

No.37
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
EC
WL
pH
〈High〉

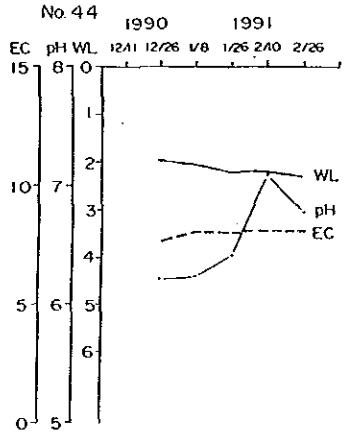

No.38
1990
1991
EC pH WL 12/11 12/26 1/28 1/26 2/10 2/26
WL
pH
EC

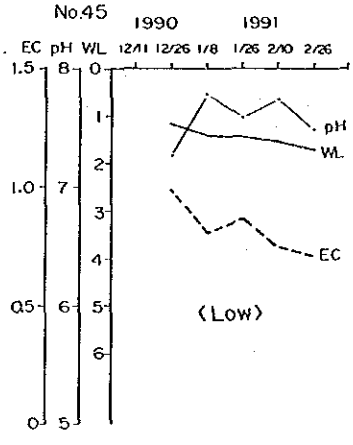

No.39
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC
〈High〉

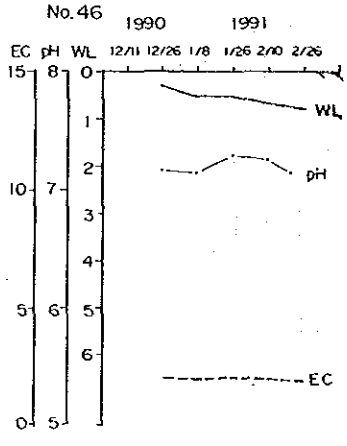

No.40
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
EC
pH
〈High〉


No.41
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
EC
pH


No.42
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC

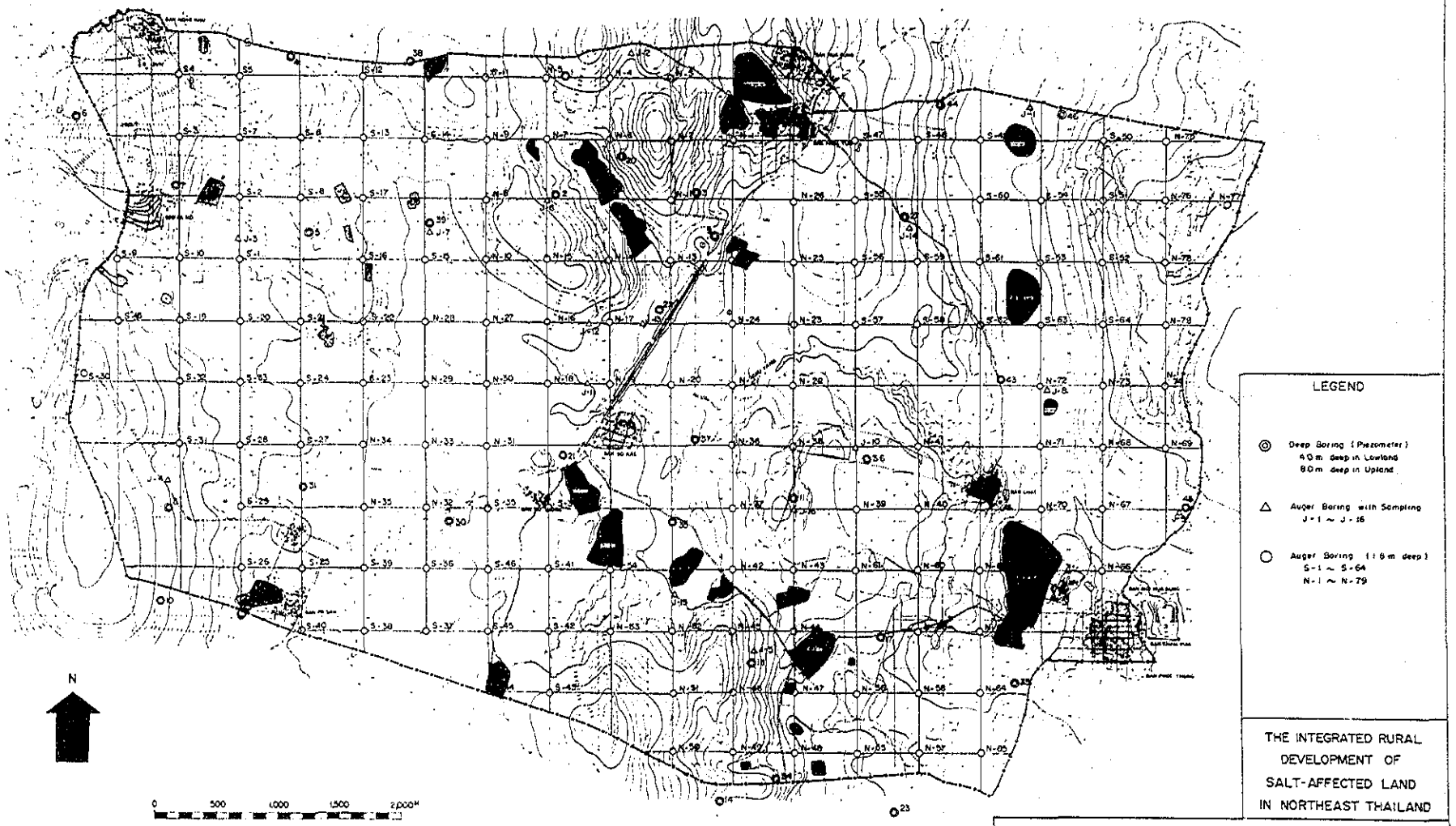

No.44
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC


No.45
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
pH
WL
EC
〈Low〉


No.46
1990
1991
EC pH WL 12/11 12/26 1/8 1/26 2/10 2/26
WL
pH
EC

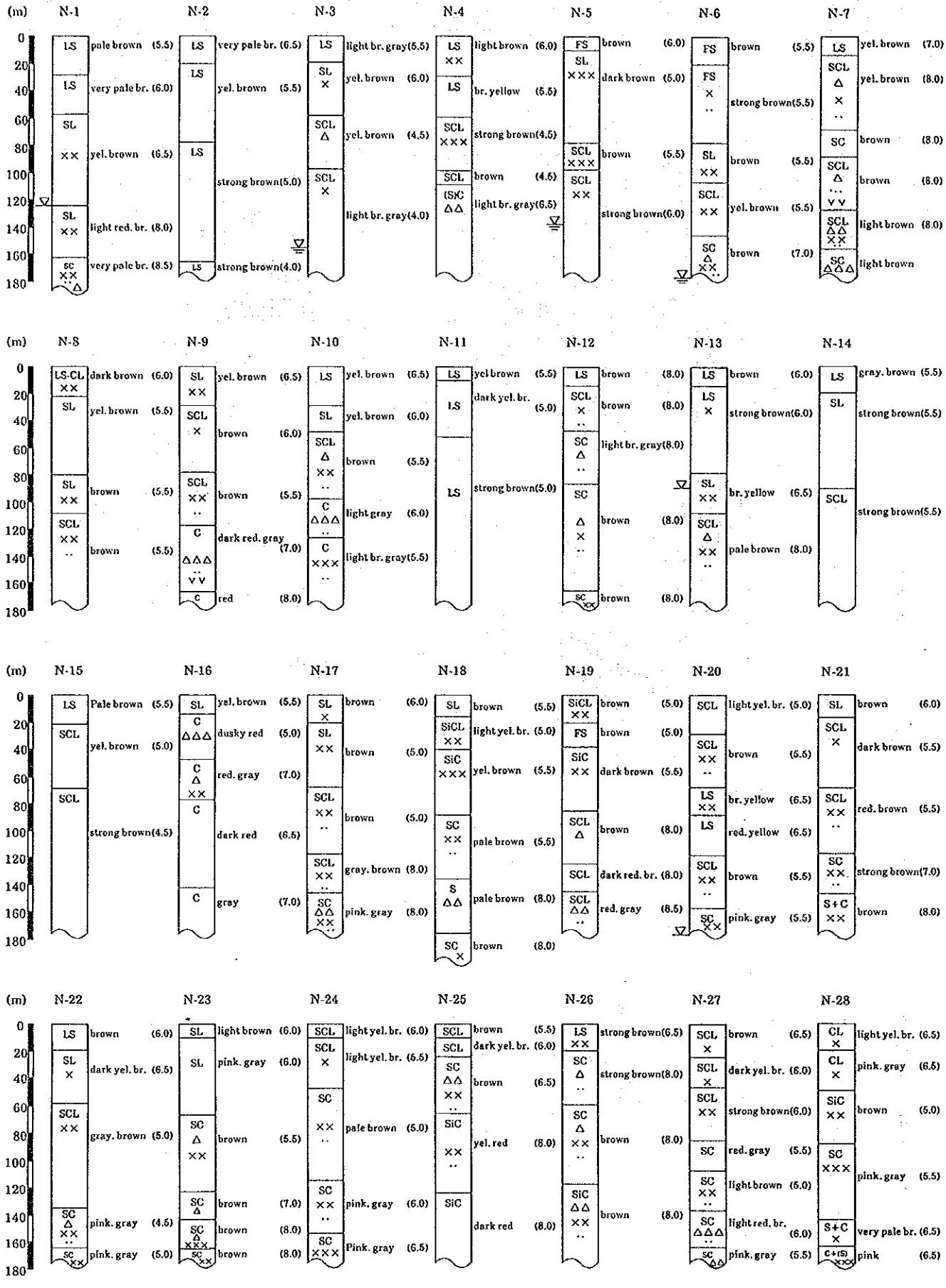
C-13 Location of Soil Profiles Investigated in the Pilot Area

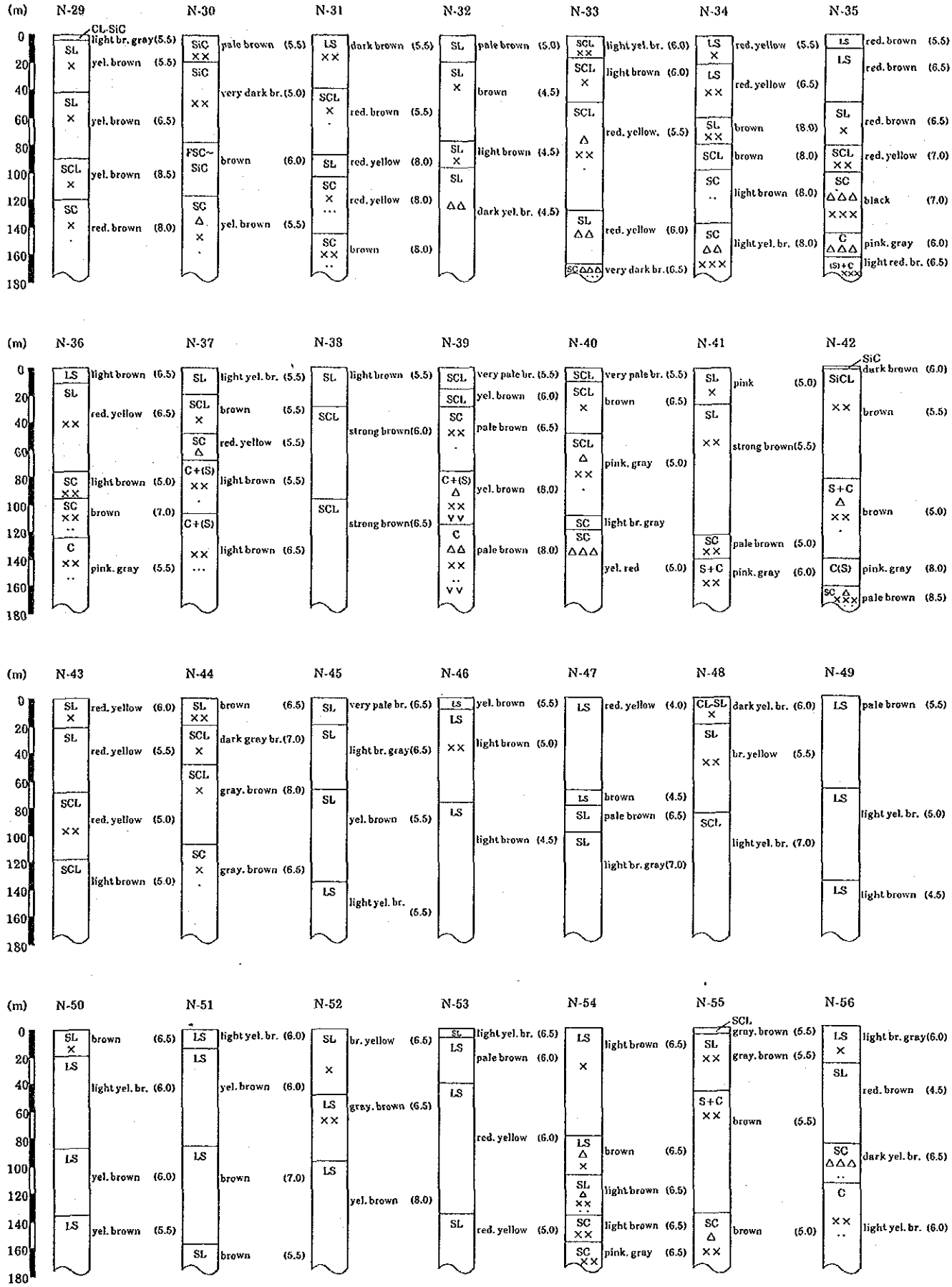
FIGURE C-13 LOCATION OF SOIL PROFILES INVESTIGATED IN THE PILOT AREA



C-14 Columnar Sections of Soil Profiles in the Pilot Area

FIGURE C-14 COLUMNAR SECTIONS OF SOIL PROFILES IN THE PILOT AREA

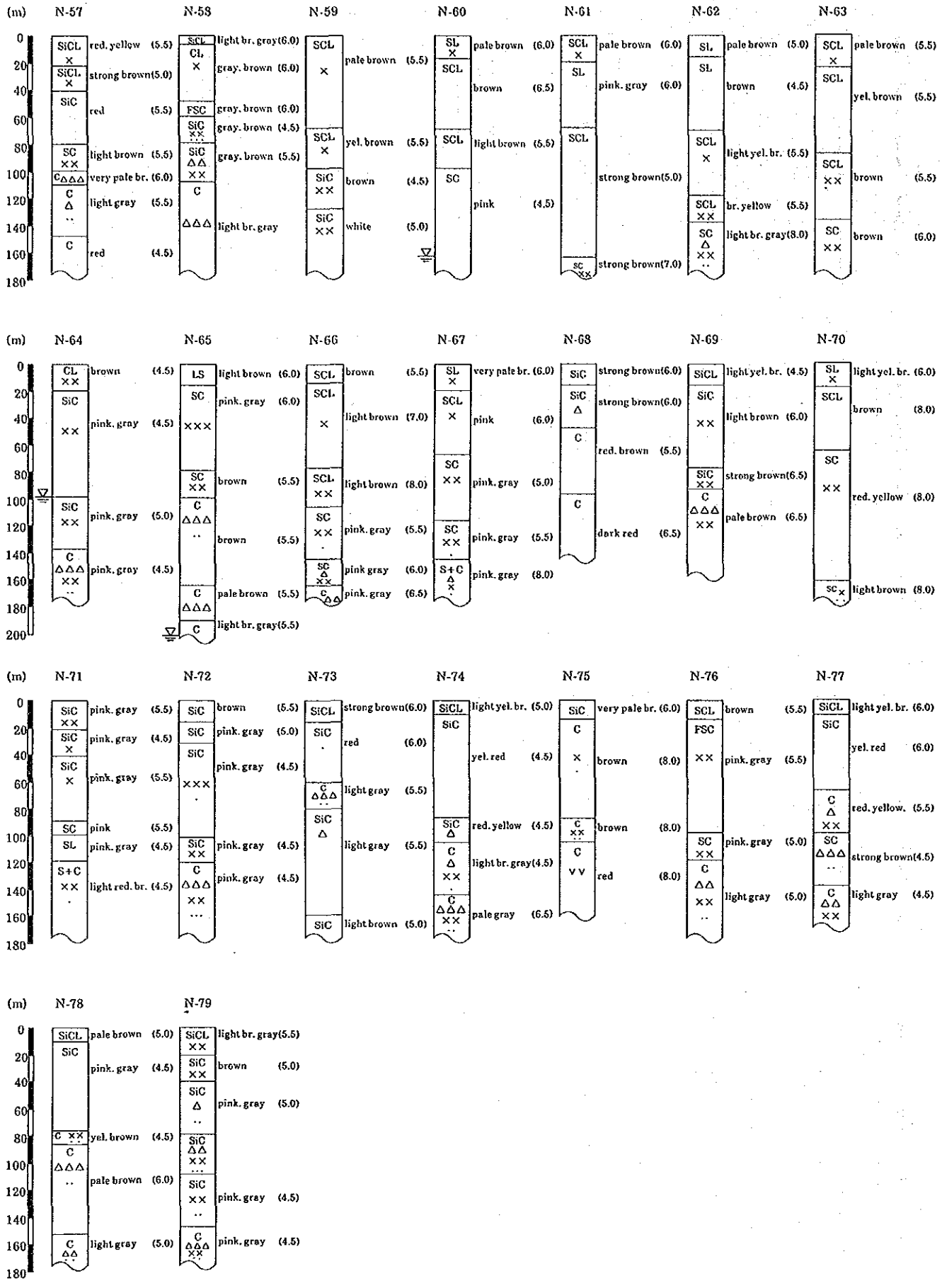


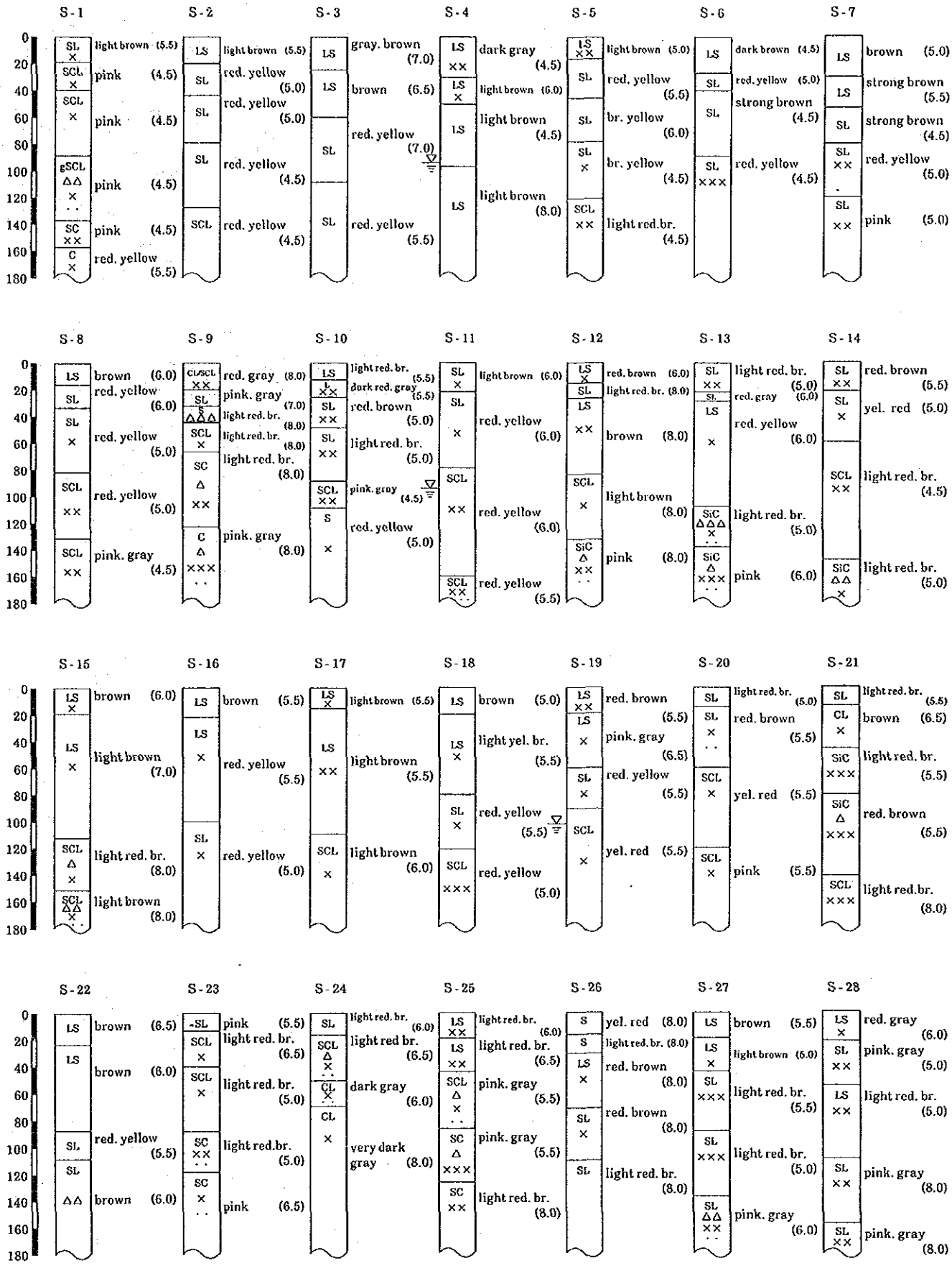

(m)
N-29
CL-SiC light br. gray (5.5)
SL yel. brown (5.5)
SL yel. brown (6.5)
SCL yel. brown (8.5)
SC red. brown (8.0)
N-30
SiC pale brown (5.5)
SiC very dark br. (5.0)
FSC~SiC brown (6.0)
SC yel. brown (5.5)
N-31
LS dark brown (5.5)
SCL red. brown (5.5)
SL red. yellow (8.0)
SC red. yellow (8.0)
SC brown (8.0)
N-32
SL pale brown (5.0)
SL brown (4.5)
SL light brown (4.5)
SL dark yel. br. (4.5)
N-33
SCL light yel. br. (6.0)
SCL light brown (6.0)
SCL red. yellow. (5.5)
SL red. yellow (6.0)
SC very dark br. (6.5)
N-34
LS red. yellow (5.5)
LS red. yellow (6.5)
SL brown (8.0)
SCL brown (8.0)
SC light brown (8.0)
SC light yel. br. (8.0)
N-35
LS red. brown (5.5)
LS red. brown (6.5)
SL red. brown (6.5)
SCL red. yellow (7.0)
SC black (7.0)
C pink. gray (6.0)
(S)+C light red. br. (6.5)
0
20
40
60
80
100
120
140
160
180

(m)
N-36
LS light brown (6.5)
SL red. yellow (6.5)
SC light brown (5.0)
SC brown (7.0)
C pink. gray (5.5)
N-37
SL light yel. br. (5.5)
SCL brown (5.5)
SC red. yellow (5.5)
C+(S) light brown (5.5)
C+(S) light brown (6.5)
N-38
SL light brown (5.5)
SCL strong brown (6.0)
SCL strong brown (6.5)
N-39
SCL very pale br. (5.5)
SCL yel. brown (6.0)
SC pale brown (6.5)
C+(S) yel. brown (8.0)
C pale brown (8.0)
N-40
SCL very pale br. (5.5)
SCL brown (6.5)
SCL pink. gray (5.0)
SC light br. gray
SC yel. red (5.0)
N-41
SL pink (5.0)
SL strong brown (5.5)
SC pale brown (5.0)
S+C pink. gray (6.0)
N-42
SiC dark brown (6.0)
SiCL brown (5.5)
S+C brown (5.0)
C(S) pink. gray (8.0)
SC pale brown (8.5)
0
20
40
60
80
100
120
140
160
180

(m)
N-43
SL red. yellow (6.0)
SL red. yellow (5.5)
SCL red. yellow (5.0)
SCL light brown (5.0)
N-44
SL brown (6.5)
SCL dark gray br. (7.0)
SCL gray. brown (8.0)
SC gray. brown (6.5)
N-45
SL very pale br. (6.5)
SL light br. gray (6.5)
SL yel. brown (5.5)
LS light yel. br. (5.5)
N-46
LS yel. brown (5.5)
LS light brown (5.0)
LS light brown (4.5)
N-47
LS red. yellow (4.0)
LS brown (4.5)
SL pale brown (6.5)
SL light br. gray (7.0)
N-48
CL-SL dark yel. br. (6.0)
SL br. yellow (5.5)
SCL light yel. br. (7.0)
N-49
LS pale brown (5.5)
LS light yel. br. (5.0)
LS light brown (4.5)
0
20
40
60
80
100
120
140
160
180

(m)
N-50
SL brown (6.5)
LS light yel. br. (6.0)
LS yel. brown (6.0)
LS yel. brown (5.5)
N-51
LS light yel. br. (6.0)
LS yel. brown (6.0)
LS brown (7.0)
SL brown (5.5)
N-52
SL br. yellow (6.5)
LS gray. brown (6.5)
LS yel. brown (8.0)
N-53
SL light yel. br. (6.5)
LS pale brown (6.0)
LS red. yellow (6.0)
SL red. yellow (5.0)
N-54
LS light brown (6.5)
LS brown (6.5)
SL light brown (6.5)
SC light brown (6.5)
SC pink. gray (6.5)
N-55
SCL gray. brown (5.5)
SL gray. brown (5.5)
S+C brown (5.5)
SC brown (5.0)
N-56
LS light br. gray (6.0)
SL red. brown (4.5)
SC dark yel. br. (6.5)
C light yel. br. (6.0)
0
20
40
60
80
100
120
140
160
180


(m)
N-57
SiCL red, yellow (5.5)
SiCL strong brown (5.0)
SiC red (5.5)
SC light brown (5.5)
very pale br. (6.0)
C light gray (5.5)
C red (4.5)
N-58
SiCL light br. gray (6.0)
Cl gray. brown (6.0)
FSC gray. brown (6.0)
SiC gray. brown (4.5)
SiC gray. brown (5.5)
C light br. gray
N-59
SCL pale brown (5.5)
SCL yel. brown (5.5)
SiC brown (4.5)
SiC white (5.0)
N-60
SL pale brown (6.0)
SCL brown (6.5)
SCL light brown (5.5)
SC pink (4.5)
N-61
SCL pale brown (6.0)
SL pink. gray (6.0)
SCL strong brown (5.0)
SC strong brown (7.0)
N-62
SL pale brown (5.0)
SL brown (4.5)
SCL light yel. br. (5.5)
SCL br. yellow (5.5)
SC light br. gray (8.0)
N-63
SCL pale brown (5.5)
SCL yel. brown (5.5)
SCL brown (5.5)
SC brown (6.0)
(m)
N-64
CL brown (4.5)
SiC pink. gray (4.5)
SiC pink. gray (5.0)
C pink. gray (4.5)
N-65
LS light brown (6.0)
SC pink. gray (6.0)
SC brown (5.5)
C brown (5.5)
C pale brown (5.5)
C light br. gray (5.5)
N-66
SCL brown (5.5)
SCL light brown (7.0)
SCL light brown (8.0)
SC pink. gray (5.5)
SC pink gray (6.0)
pink. gray (6.5)
N-67
SL very pale br. (6.0)
SCL pink (6.0)
SC pink. gray (5.0)
SC pink. gray (5.5)
S+C pink. gray (8.0)
N-68
SiC strong brown (6.0)
SiC strong brown (6.0)
C red. brown (5.5)
C dark red (6.5)
N-69
SiCL light yel. br. (4.5)
SiC light brown (6.0)
SiC strong brown (6.5)
C pale brown (6.5)
N-70
SL light yel. br. (6.0)
SCL brown (8.0)
SC red. yellow (8.0)
SC light brown (8.0)
(m)
N-71
SiC pink. gray (5.5)
SiC pink. gray (4.5)
SiC pink. gray (5.5)
SC pink (5.5)
SL pink. gray (4.5)
S+C light red. br. (4.5)
N-72
SiC brown (5.5)
SiC pink. gray (5.0)
SiC pink. gray (4.5)
SiC pink. gray (4.5)
C pink. gray (4.5)
N-73
SiCL strong brown (6.0)
SiC red (6.0)
C light gray (5.5)
SiC light gray (5.5)
SiC light brown (5.0)
N-74
SiCL light yel. br. (5.0)
SiC yel. red (4.5)
SiC red. yellow (4.5)
C light br. gray (4.5)
C pale gray (6.5)
N-75
SiC very pale br. (6.0)
C brown (8.0)
C brown (8.0)
C red (8.0)
N-76
SCL brown (5.5)
FSC pink. gray (5.5)
SC pink. gray (5.0)
C light gray (5.0)
N-77
SiCL light yel. br. (6.0)
SiC yel. red (6.0)
C red. yellow. (5.5)
SC strong brown (4.5)
C light gray (4.5)
(m)
N-78
SiCL pale brown (5.0)
SiC pink. gray (4.5)
C yel. brown (4.5)
C pale brown (6.0)
C light gray (5.0)
N-79
SiCL light br. gray (5.5)
SiC brown (5.0)
SiC pink. gray (5.0)
SiC pink. gray (4.5)
C pink. gray (4.5)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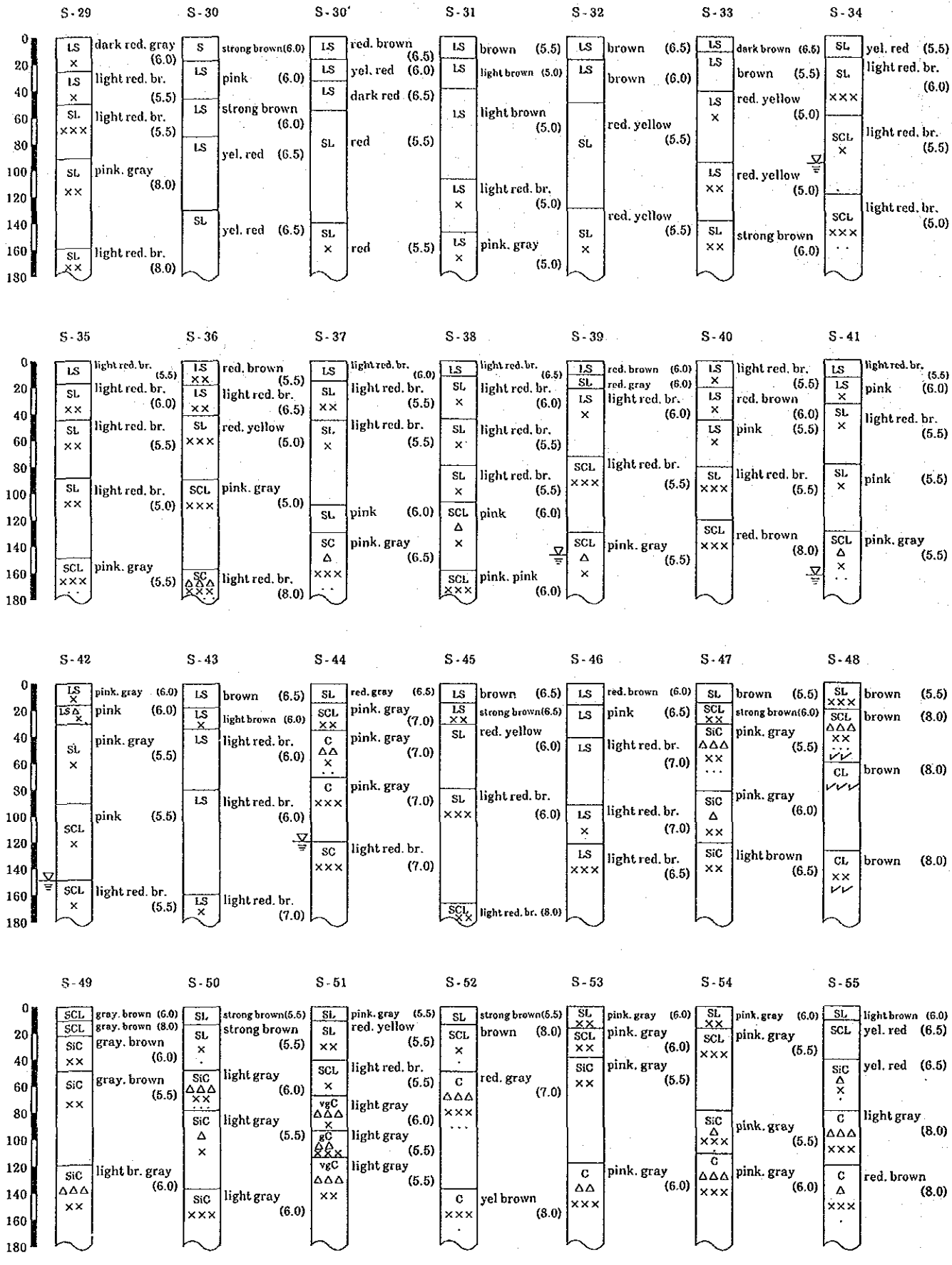
pink (4.5)
pink (4.5)
pink (4.5)
pink (4.5)
red. yellow (5.5)
S-2
light brown (5.5)
red. yellow (5.0)
red. yellow (5.0)
red. yellow (4.5)
red. yellow (4.5)
S-3
gray. brown (7.0)
brown (6.5)
red. yellow (7.0)
red. yellow (5.5)
S-4
dark gray (4.5)
light brown (6.0)
light brown (4.5)
light brown (8.0)
S-5
light brown (5.0)
red. yellow (5.5)
br. yellow (6.0)
br. yellow (4.5)
light red.br. (4.5)
S-6
dark brown (4.5)
red. yellow (5.0)
strong brown (4.5)
red. yellow (4.5)
S-7
brown (5.0)
strong brown (5.5)
strong brown (4.5)
red. yellow (5.0)
pink (5.0)
S-8
brown (6.0)
red. yellow (6.0)
red. yellow (5.0)
red. yellow (5.0)
pink. gray (4.5)
S-9
red. gray (8.0)
pink. gray (7.0)
light red. br. (8.0)
light red. br. (8.0)
light red. br. (8.0)
pink. gray (8.0)
S-10
light red. br. (5.5)
dark red. gray (5.5)
red. brown (5.0)
light red. br. (5.0)
pink. gray (4.5)
red. yellow (5.0)
S-11
light brown (6.0)
red. yellow (6.0)
red. yellow (6.0)
red. yellow (5.5)
S-12
red. brown (6.0)
light red. br. (8.0)
brown (8.0)
light brown (8.0)
pink (8.0)
S-13
light red. br. (5.0)
red. gray (6.0)
red. yellow (6.0)
light red. br. (5.0)
pink (6.0)
S-14
red. brown (5.5)
yel. red (5.0)
light red. br. (4.5)
light red. br. (5.0)
S-15
brown (6.0)
light brown (7.0)
light red. br. (8.0)
light brown (8.0)
S-16
brown (5.5)
red. yellow (5.5)
red. yellow (5.0)
S-17
light brown (5.5)
light brown (5.5)
light brown (6.0)
S-18
brown (5.0)
light yel. br. (5.5)
red. yellow (5.5)
red. yellow (5.0)
S-19
red. brown (5.5)
pink. gray (6.5)
red. yellow (5.5)
yel. red (5.5)
S-20
light red. br. (5.0)
red. brown (5.5)
yel. red (5.5)
pink (5.5)
S-21
light red. br. (5.5)
brown (6.5)
light red. br. (5.5)
red. brown (5.5)
light red. br. (8.0)
S-22
brown (6.5)
brown (6.0)
red. yellow (5.5)
brown (6.0)
S-23
pink (5.5)
light red. br. (6.5)
light red. br. (5.0)
light red. br. (5.0)
pink (6.5)
S-24
light red. br. (6.0)
light red br. (6.5)
dark gray (6.0)
very dark gray (8.0)
S-25
light red. br. (6.0)
light red. br. (6.5)
pink. gray (5.5)
pink. gray (5.5)
light red. br. (8.0)
S-26
yel. red (8.0)
light red. br. (8.0)
red. brown (8.0)
red. brown (8.0)
light red. br. (8.0)
S-27
brown (5.5)
light brown (6.0)
light red. br. (5.5)
light red. br. (5.0)
pink. gray (6.0)
S-28
red. gray (6.0)
pink. gray (5.0)
light red. br. (5.0)
pink. gray (8.0)
pink. gray (8.0)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S-30
S-30'
S-31
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S-41
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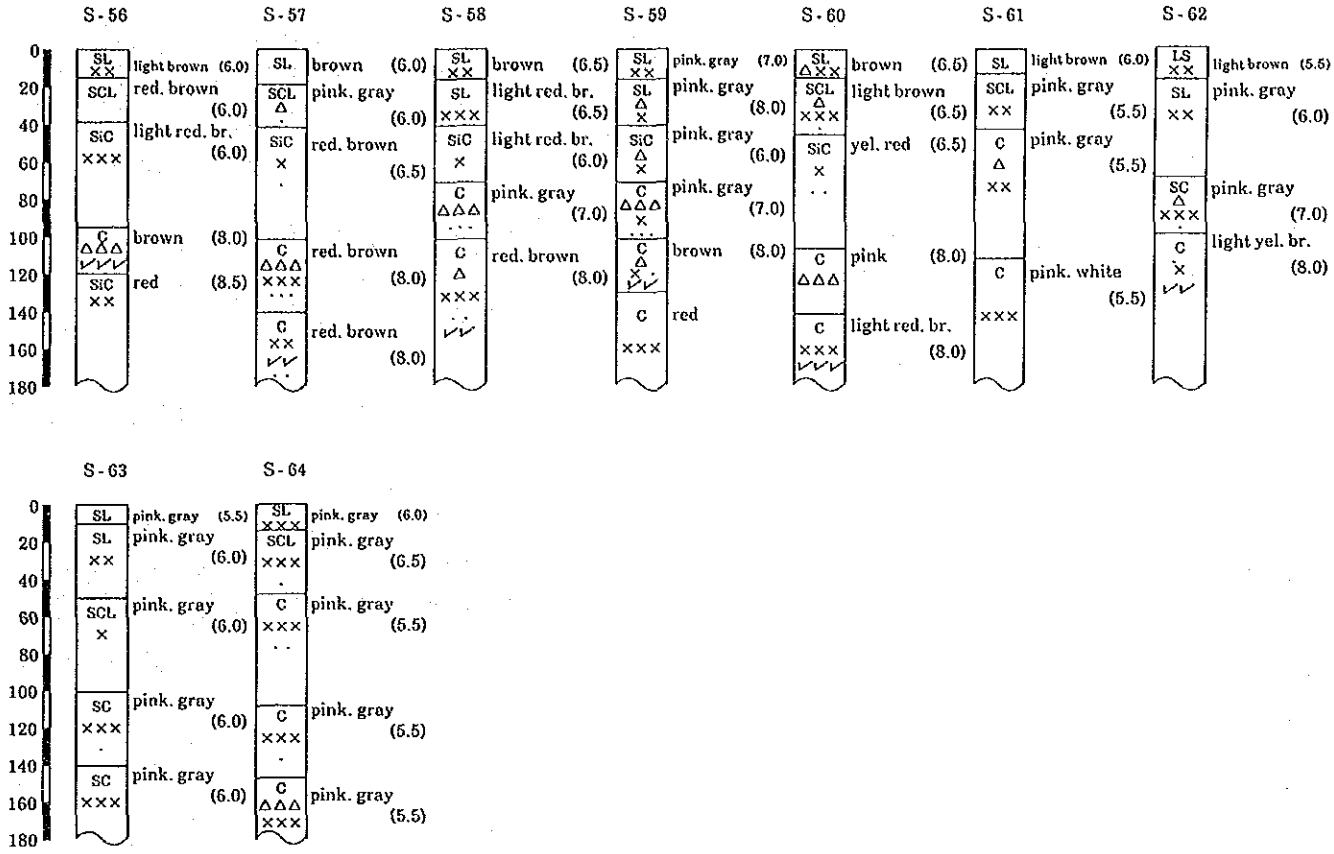
S-54
S-55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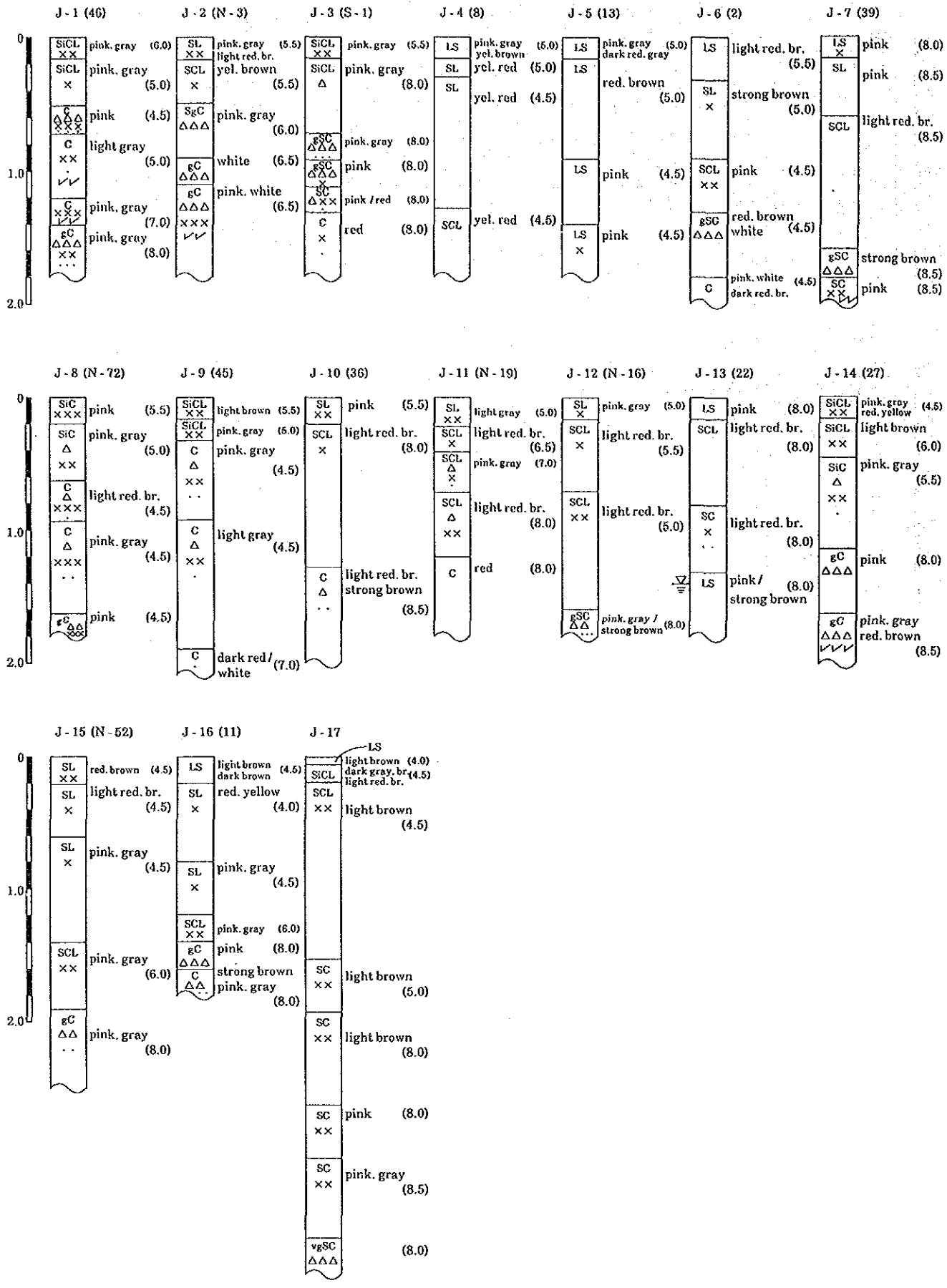
S-58
S-59
S-60
S-61
S-62
0
20
40
60
80
100
120
140
160
180
SL
SCL
SiC
C
SiC
light brown (6.0)
red. brown (6.0)
light red. br. (6.0)
brown (8.0)
red (8.5)
SL
SCL
SiC
C
C
brown (6.0)
pink. gray (6.0)
red. brown (6.5)
red. brown (8.0)
red. brown (8.0)
SL
SL
SiC
C
C
brown (6.5)
light red. br. (6.5)
light red. br. (6.0)
pink. gray (7.0)
red. brown (8.0)
SL
SL
SiC
C
C
C
pink. gray (7.0)
pink. gray (8.0)
pink. gray (6.0)
pink. gray (7.0)
brown (8.0)
red
SL
SCL
SiC
C
C
brown (6.5)
light brown (6.5)
yel. red (6.5)
pink (8.0)
light red. br. (8.0)
SL
SCL
C
C
light brown (6.0)
pink. gray (5.5)
pink. gray (5.5)
pink. white (5.5)
LS
SL
SC
C
light brown (5.5)
pink. gray (6.0)
pink. gray (7.0)
light yel. br. (8.0)
S-63
S-64
0
20
40
60
80
100
120
140
160
180
SL
SL
SCL
SC
SC
pink. gray (5.5)
pink. gray (6.0)
pink. gray (6.0)
pink. gray (6.0)
pink. gray (6.0)
SL
SCL
C
C
C
pink. gray (6.0)
pink. gray (6.5)
pink. gray (5.5)
pink. gray (5.5)
pink. gray (5.5)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J - 3 (S - 1)
J - 4 (8)
J - 5 (13)
J - 6 (2)
J - 7 (39)
J - 8 (N - 72)
J - 9 (45)
J - 10 (36)
J - 11 (N - 19)
J - 12 (N - 16)
J - 13 (22)
J - 14 (27)
J - 15 (N - 52)
J - 16 (11)
J - 17
0
1.0
2.0
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pink, gray (5.0)
pink (4.5)
light gray (5.0)
pink, gray (7.0)
pink, gray (3.0)
pink, gray (5.5)
light red. br.
yel. brown (5.5)
pink, gray (6.0)
white (6.5)
pink, white (6.5)
pink, gray (5.5)
pink, gray (8.0)
pink, gray (8.0)
pink (8.0)
pink / red (8.0)
red (8.0)
pink, gray (5.0)
yel. brown
yel. red (5.0)
yel. red (4.5)
yel. red (4.5)
pink, gray (5.0)
dark red. gray
red. brown (5.0)
pink (4.5)
pink (4.5)
light red. br. (5.5)
strong brown (5.0)
pink (4.5)
red. brown
white (4.5)
pink, white (4.5)
dark red. br.
pink (8.0)
pink (8.5)
light red. br. (8.5)
strong brown (8.5)
pink (8.5)
pink (5.5)
pink, gray (5.0)
light red. br. (4.5)
pink, gray (4.5)
pink (4.5)
light brown (5.5)
pink, gray (5.0)
pink, gray (4.5)
light gray (4.5)
dark red / white (7.0)
pink (5.5)
light red. br. (8.0)
light red. br. strong brown (8.5)
light gray (5.0)
light red. br. (6.5)
pink, gray (7.0)
light red. br. (8.0)
red (8.0)
pink, gray (5.0)
light red. br. (5.5)
light red. br. (5.0)
pink, gray / strong brown (8.0)
pink (8.0)
light red. br. (8.0)
light red. br. (8.0)
pink / strong brown (8.0)
pink, gray red. yellow (4.5)
light brown (6.0)
pink, gray (5.5)
pink (8.0)
pink, gray red. brown (8.5)
red. brown (4.5)
light red. br. (4.5)
pink, gray (4.5)
pink, gray (6.0)
pink, gray (8.0)
light brown dark brown (4.5)
red. yellow (4.0)
pink, gray (4.5)
pink, gray (6.0)
pink (8.0)
strong brown
pink, gray (8.0)
LS
light brown (4.0)
dark gray, br. (4.5)
light red. br.
light brown (4.5)
light brown (5.0)
light brown (8.0)
pink (8.0)
pink, gray (8.5)
(8.0)
vgSC

C-15 Location of Soil Sampling Sites for Laboratory Analyses

FIGURE C-15 LOCATION OF SOIL SAMPLING SITES FOR LABORATORY ANALYSES

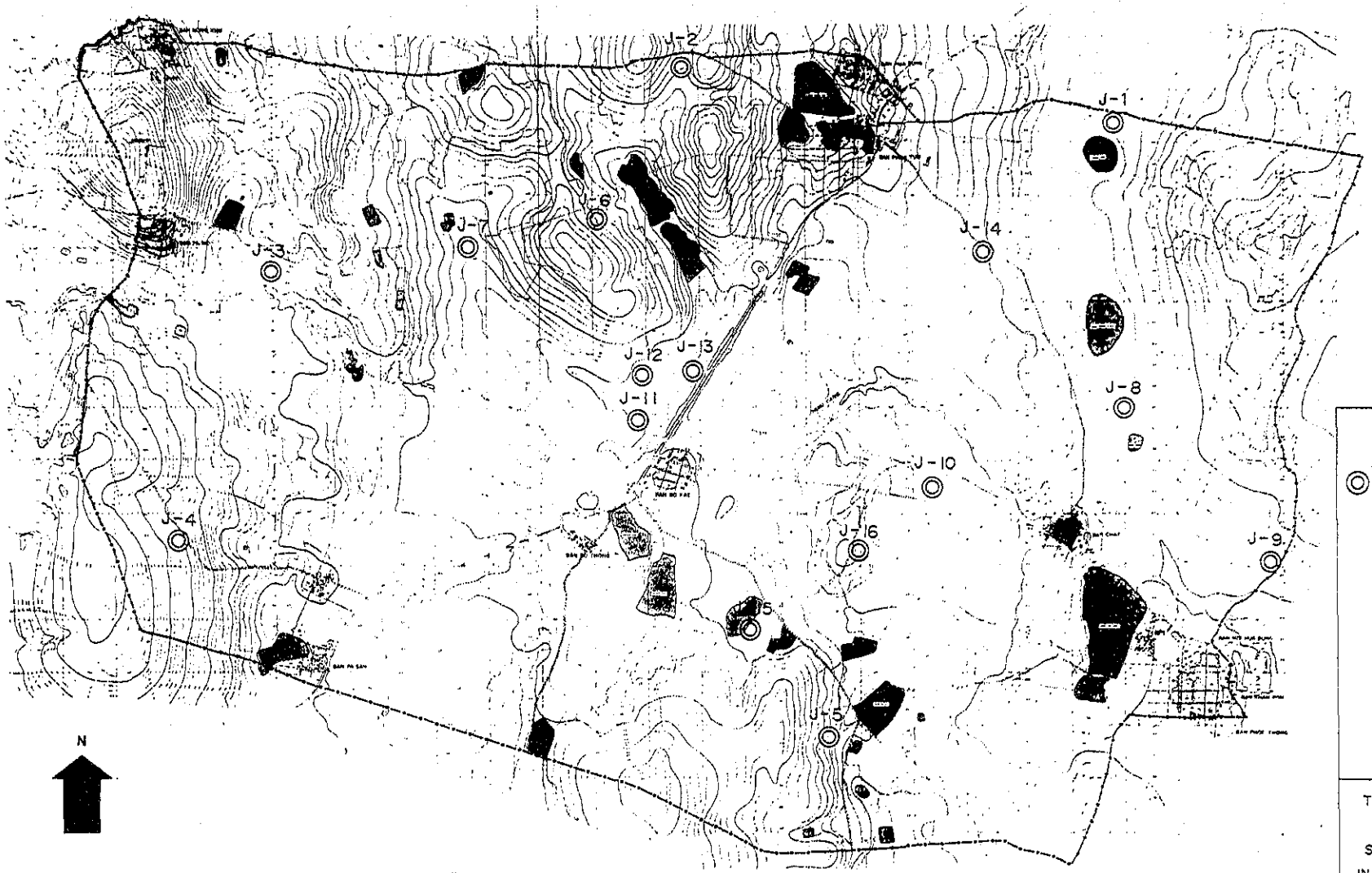


Table C-16 Results of Soil Analyses (Chemical Properties)

No.	Depth	Particle Size Distr.			Texture	pH	S. P	EC	Soluble Cations				Soluble Anions			ESP	CEC	Exchangeable Cations					Base	Org.	Extr.	Total
		Sand	Silt	Clay					Ca	Mg	Na	K	Cl	HCO_3	SO_4			Ca	Mg	Na	K	Sum	Satr.	Matter	P	N
	cm	%	%	%			%	mS/cm	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	%	me/100g	me/100g	me/100g	me/100g	me/100g	me/100g	%	%	ppm	%
1 – 1	0-16	30.2	55.1	14.7	SiL	5.1	28.8	0.13	0.11	0.10	0.65	0.04	0.98	0.30	0.31	1.61	6.82	1.58	1.01	0.11	0.10	2.80	41.1	0.89	4.85	0.069
1 – 2	16-50	26.5	45.1	28.3	L	5.6	34.9	0.05	0.07	0.03	0.30	0.02	0.49	0.16	0.13	2.54	8.65	1.17	0.59	0.22	0.07	2.05	23.7			
1 – 3	50-70	43.2	29.5	27.3	L	5.7	32.7	0.06	0.04	0.02	0.36	0.01	0.49	0.08	0.03	4.18	10.28	0.71	0.42	0.43	0.11	1.67	16.2			
1 – 4	70-120	22.1	31.5	46.4	C	5.4	87.0	0.05	0.06	0.02	0.38	0.01	0.49	0.24	0.03	8.71	15.38	2.14	1.18	1.34	0.14	4.80	31.2			
1 – 5	120-140	32.2	37.4	30.3	CL	5.3	83.0	0.06	0.04	0.02	0.44	0.01	0.49	0.32	0.03	14.14	11.10	3.51	1.77	1.57	0.11	6.96	62.7			
1 – 6	140-180	47.1	26.4	26.5	SCL	6.5	67.3	0.18	0.05	0.06	1.39	0.03	0.49	1.04	0.49	3.09	14.56	8.39	3.62	0.45	0.12	12.58	86.4			
2 – 1	0-18	66.6	25.9	7.5	SL	5.1	21.9	0.18	0.16	0.12	0.74	0.03	1.46	0.20	0.16	6.44	2.95	0.86	0.51	0.19	0.16	1.72	58.3	0.79	5.05	0.057
2 – 2	18-50	53.5	19.3	27.2	SCL	5.2	35.2	0.14	0.14	0.14	0.69	0.03	1.46	0.20	0.06	3.19	8.15	1.07	1.60	0.26	0.11	3.04	37.3			
2 – 3	50-90	60.4	18.4	21.2	SCL	5.3	37.5	0.07	0.04	0.04	0.44	0.02	0.49	0.16	0.03	3.82	9.16	1.47	2.19	0.35	0.13	4.14	45.2			
2 – 4	90-110	45.2	11.8	43.0	C	5.4	49.1	0.21	0.07	0.06	1.19	0.02	2.93	0.14	0.13	2.67	17.62	6.46	5.14	0.47	0.26	12.33	70.0			
2 – 5	110-180	22.9	27.2	49.9	C	7.2	80.1	0.51	1.38	0.34	2.75	0.02	1.95	2.43	0.19	5.70	20.87	6.35	9.02	1.19	0.23	16.79	80.5			
3 – 1	0-14	55.8	37.4	6.8	SL	6.6	58.3	1.76	1.31	0.50	10.82	0.02	13.18	1.10	0.81	1.78	3.97	1.54	0.42	0.07	0.10	2.13	53.7	1.12	6.41	0.082
3 – 2	14-70	58.1	29.7	12.2	SL	6.3	27.7	3.59	2.77	1.80	27.09	0.05	30.26	0.48	0.29	16.64	6.01	0.61	0.52	1.00	0.06	2.19	36.4			
3 – 3	70-90	61.4	24.0	14.5	SL	7.3	32.3	4.46	1.66	0.50	29.16	0.02	32.21	3.93	0.52	25.54	11.51	2.70	1.41	2.94	0.08	7.13	62.0			
3 – 4	90-110	54.3	25.7	20.0	SCL	7.5	42.8	4.93	1.46	0.42	34.03	0.02	39.53	2.75	0.46	35.77	13.14	6.20	1.08	4.70	0.08	12.06	91.8			
3 – 5	130-180	53.8	34.1	12.1	SL	7.3	42.8	7.97	2.47	0.33	53.44	0.03	63.44	1.60	0.19	61.90	10.08	8.54	1.42	6.24	0.12	16.32	100.0			
4 – 1	0-16	75.1	19.2	4.9	SL	5.9	20.3	0.19	0.40	0.33	0.17	0.22	0.98	0.72	0.26	7.69	2.34	2.00	1.42	0.18	0.09	3.69	100.0	0.79	11.17	0.052
4 – 2	16-30	73.4	18.7	7.9	SL	5.9	16.0	0.16	0.32	0.32	0.27	0.15	0.49	0.62	0.33	7.01	2.14	1.22	0.51	0.15	0.07	1.95	91.1			
4 – 3	30-130	63.3	17.3	19.4	SL	5.1	33.3	0.07	0.10	0.12	0.17	0.02	0.49	0	0.19	9.23	3.36	0.76	0.51	0.31	0.05	1.63	48.5			
4 – 4	130-180	58.2	20.5	21.3	SCL	4.8	36.5	0.10	0.12	0.21	0.25	0.03	0.98	0	0.03	5.06	3.56	0.46	0.84	0.18	0.06	1.54	43.3			
5 – 1	0-16	82.7	14.9	2.4	LS	4.5	20.3	0.08	0.10	0.06	0.09	0.17	0.98	0	0.46	11.92	1.93	0.10	0.93	0.23	0.08	1.34	69.4	0.54	11.69	0.041
5 – 2	16-90	77.9	18.7	3.4	LS	4.6	16.7	0.08	0.17	0.10	0.16	0.06	0.98	0	0.33	10.40	1.73	0.25	0.17	0.18	0.06	0.66	38.2			
5 – 3	90-110	78.5	18.6	2.9	LS	4.6	14.8	0.12	0.26	0.12	0.25	0.07	0.98	0	0.29	14.29	1.12	0.41	0.17	0.16	0.07	0.81	72.3			
5 – 4	110-180	81.1	17.2	1.6	LS	4.6	15.5	0.22	0.49	0.13	0.65	0.08	0.98	0	0.36	10.93	1.83	0.36	0.17	0.20	0.05	0.78	42.6			

No.	Depth	Particle Size Distr.			Texture	pH	S. P	EC	Soluble Cations				Soluble Anions			ESP	CEC	Exchangeable Cations					Base	Org.	Extr.	Total
		Sand	Silt	Clay					Ca	Mg	Na	K	Cl	HCO_3	SO_4			Ca	Mg	Na	K	Sum	Satr.	Matter	P	N
	cm	%	%	%			%	mS/cm	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	%	me/100g	me/100g	me/100g	me/100g	me/100g	me/100g	%	%	ppm	%
6 − 1	0-30	78.8	17.7	3.5	LS	5.4	15.9	0.10	0.18	0.15	0.22	0.09	0.49	0.26	0.29	2.21	8.15	0.20	0.10	0.18	0.06	0.54	6.6	0.72	9.66	0.033
6 − 2	30-90	63.1	19.0	17.9	SL	5.0	36.2	0.04	0.07	0.10	0.09	0.02	0.49	0	0.23	2.34	6.41	0.56	0.42	0.15	0.09	1.22	19.0			
6 − 3	90-130	58.2	17.9	23.9	SCL	5.1	37.0	0.05	0.06	0.06	0.18	0.02	0.49	0	0.16	1.09	8.25	1.12	1.94	0.09	0.10	3.25	39.4			
6 − 4	130-180	62.0	16.4	21.6	SCL	5.3	41.7	0.07	0.08	0.11	0.32	0.02	1.46	0	0.13	1.96	11.20	0.97	2.28	0.22	0.09	3.56	31.8			
6 − 5	180-200	30.5	25.9	43.6	C	4.5	69.4	0.12	0.14	0.12	0.51	0.04	1.46	0	0.46	2.82	22.71	2.04	3.03	0.64	0.28	5.99	26.4			
7 − 1	0-17	82.3	10.7	7.0	LS	6.1	18.7	50.20	1.31	10.02	434.51	0.64	53.92	0.46	3.38	≫	0.92	8.02	5.54	6.99	0.04	20.59	100.0	0.33	1.80	0.023
7 − 2	17-60	71.2	22.3	6.5	SL	6.3	20.4	30.50	18.75	2.00	22.66	0.16	317.20	0.30	2.56	≫	4.28	1.39	0.38	7.59	0.05	9.41	100.0			
7 − 3	60-160	72.5	17.5	10.0	SL	7.4	40.3	10.30	1.61	0.42	75.68	0.09	102.48	1.28	0.52	87.23	5.09	0.86	0.23	4.44	0.07	5.60	100.0			
7 − 4	160-180	64.2	19.4	16.4	SL	7.2	40.2	32.30	13.61	2.00	239.89	0.21	351.36	1.48	2.43	≫	8.86	0.62	0.26	11.99	0.08	12.95	100.0			
7 − 5	180-200	53.3	25.5	21.2	SCL	7.9	40.7	6.15	1.21	0.50	46.06	0.10	42.70	7.96	1.14	10.19	5.40	2.85	0.57	0.55	0.08	4.95	75.0			
8 − 1	0-17	45.3	44.9	9.8	L	5.1	26.4	0.34	0.54	0.32	1.05	0.04	2.44	0.08	0.23	6.31	4.28	6.40	0.76	0.27	0.07	7.50	100.0	0.63	5.55	0.052
8 − 2	17-60	31.4	41.0	27.6	CL	5.4	38.4	0.06	0.09	0.05	0.21	0.01	0.49	0	0.06	1.68	7.72	1.22	0.59	0.13	0.07	2.01	26.0			
8 − 3	60-90	31.9	41.7	26.4	L	5.1	36.1	0.06	0.07	0.03	0.20	0.02	0.49	0	0.13	1.25	7.22	1.93	0.84	0.09	0.08	2.94	40.7			
8 − 4	90-160	29.8	39.7	30.5	CL	5.0	46.7	0.05	0.06	0.03	0.12	0.01	0.49	0	0.10	0.95	9.47	2.80	0.76	0.09	0.08	3.73	39.4			
8 − 5	160-180	29.4	37.3	33.3	CL	5.2	43.8	0.04	0.05	0.02	0.11	0.02	0.49	0	0	1.00	9.98	3.56	1.01	0.10	0.10	4.77	47.8			
9 − 1	0-30	40.2	38.4	21.4	L	5.8	33.1	0.11	0.17	0.13	0.41	0.05	0.98	0.16	0.10	1.67	8.96	3.56	2.53	0.15	0.16	6.40	71.4	0.50	5.26	0.049
9 − 2	30-90	35.4	27.3	37.3	CL	5.3	52.2	0.04	0.04	0.03	0.17	0.02	0.49	0	0.03	2.85	13.34	2.49	2.44	0.38	0.18	5.49	41.2			
9 − 3	90-190	29.5	28.9	41.6	C	4.9	65.6	0.04	0.04	0.03	0.25	0.01	0.49	0	0	1.49	18.12	5.50	4.21	0.27	0.21	10.19	56.2			
9 − 4	190-210	17.8	31.2	60.0	C	4.9	105.4	0.05	0.08	0.04	0.33	0.01	0.49	0	0.03	1.35	34.82	16.54	10.20	0.47	0.31	27.52	79.0			
10 − 1	0-20	80.9	14.0	5.1	LS	4.4	19.9	3.89	7.00	3.09	14.93	0.11	33.18	0	0.23	9.35	2.14	0.92	0.44	0.20	0.04	1.60	74.8	0.53	2.07	0.040
10 − 2	20-130	75.4	13.0	11.6	SL	6.3	26.6	14.40	42.54	15.78	84.14	0.06	158.60	0.72	0.06	40.38	4.68	1.82	1.35	1.89	0.05	5.11	100.0			
10 − 3	130-200	62.4	18.3	19.3	SL	6.9	34.2	15.40	42.65	14.94	84.07	0.07	163.48	0.56	0.16	7.78	7.33	4.29	2.36	0.57	0.06	7.28	99.3			

≫ >100

No.	Depth	Particle Size Distr.			Texture	pH	S. P	EC	Soluble Cations				Soluble Anions			ESP	CEC	Exchangeable Cations					Base	Org.	Extr.	Total
		Sand	Silt	Clay					Ca	Mg	Na	K	Cl	HCO_3	SO_4			Ca	Mg	Na	K	Sum	Satr.	Matter	P	N
	cm	%	%	%			%	mS/cm	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	%	me/100g	me/100g	me/100g	me/100g	me/100g	me/100g	%	%	ppm	%
11－1	0-21	76.0	20.6	3.4	LS	5.0	18.4	1.71	0.76	0.50	11.55	0.15	14.64	0.58	0.46	14.39	1.32	0.35	0.16	0.19	0.05	0.75	56.8	0.36	2.31	0.030
11－2	21-40	64.4	26.2	9.4	SL	6.1	20.3	0.88	0.11	0.06	5.23	0.02	5.86	0.02	0.91	23.42	3.16	1.02	0.51	0.74	0.06	2.33	73.7			
11－3	40-70	53.4	26.9	19.7	SL	6.2	52.3	0.68	0.06	0.04	4.39	0.01	4.88	0	0.65	31.51	6.41	1.83	1.02	2.02	0.07	4.94	77.1			
11－4	70-120	60.3	29.3	10.5	SL	6.9	42.0	2.41	0.25	0.16	16.90	0.03	19.52	0.03	0.78	49.54	4.38	0.92	0.51	2.17	0.08	3.68	84.0			
11－5	120-180	14.2	58.2	27.6	SiCL	7.7	78.6	3.72	0.25	0.16	29.89	0.06	28.30	2.65	1.43	53.99	19.65	3.54	2.27	10.56	0.43	16.80	85.5			
12－1	0-17	59.2	31.1	9.7	SL	5.8	21.1	0.11	0.12	0.07	0.71	0.02	1.46	0.14	0.26	5.04	3.97	1.32	0.84	0.20	0.06	0.42	61.0	0.40	3.72	0.039
12－2	17-70	60.0	25.1	14.9	SL	5.5	27.7	0.10	0.05	0.04	0.75	0.01	1.46	0	0.36	4.64	5.60	0.76	1.18	0.20	0.09	2.29	40.9			
12－3	70-160	63.6	20.9	15.5	SL	5.8	28.7	0.13	0.06	0.04	0.87	0.02	1.46	0	0.25	8.59	4.89	0.86	1.52	0.42	0.08	2.88	58.9			
12－4	160-180	59.3	24.3	16.4	SL	6.2	39.9	0.22	0.04	0.04	1.49	0.01	2.44	0.18	0.29	17.25	7.13	1.94	3.12	1.23	0.08	6.37	89.3			
13－1	0-14	74.4	22.2	3.4	SL	7.9	18.7	8.90	0.50	0.33	79.26	0.07	84.18	3.99	0.71	21.79	5.60	0.51	0.25	1.22	0.04	2.02	36.1	0.28	5.13	0.021
13－2	14-80	62.3	25.3	12.4	SL	7.9	37.7	8.72	0.40	0.25	62.31	0.03	71.98	1.74	0.42	54.58	6.01	0.96	0.51	3.28	0.07	4.82	80.2			
13－3	80-130	63.6	23.2	13.0	SL	8.0	10.4	8.74	0.40	0.33	75.68	0.06	70.76	1.22	0.29	≫	5.19	0.92	0.76	6.05	0.11	7.84	100.0			
13－4	130-180	79.6	8.4	12.0	SL	8.1	43.3	9.50	0.60	0.58	81.62	0.12	91.50	1.28	0.33	45.02	7.33	0.92	0.74	3.30	0.12	5.08	69.3			
14－1	0-15	54.1	32.5	13.4	SL	5.5	29.7	0.60	0.07	0.04	2.42	0.06	4.88	0.02	0.16	3.01	9.98	2.70	1.60	0.30	0.09	4.69	47.0	0.80	5.73	0.051
14－2	15-45	46.4	32.9	20.7	L	6.1	35.8	0.12	0.06	0.04	0.74	0.01	1.95	0.24	0.19	7.71	9.47	3.29	2.70	0.73	0.09	6.81	71.9			
14－3	45-110	37.2	29.2	33.6	CL	5.9	49.8	0.17	0.06	0.04	1.39	0.01	1.95	0.22	0.06	7.94	20.77	8.45	6.32	1.65	0.15	16.57	79.8			
14－4	110-160	57.6	16.0	26.4	SCL	7.5	60.4	0.98	0.21	0.16	6.37	0.01	7.81	0.64	0.13	10.95	19.55	8.09	5.38	2.14	0.13	15.74	80.5			
14－5	160-200	26.8	42.4	30.8	CL	8.1	66.0	1.00	0.35	0.33	7.51	0.02	6.83	1.80	0.10	16.04	24.44	34.13	8.07	3.92	0.12	46.24	100.0			
15－1	0-20	75.7	20.1	4.2	LS	5.0	21.0	9.91	9.22	4.09	74.54	0.16	81.74	0.18	0.22	21.08	2.04	0.83	0.34	0.43	0.03	1.63	79.9	0.86	2.89	0.047
15－2	20-60	75.4	20.6	4.0	LS	4.7	17.0	3.61	2.67	1.00	23.77	0.05	28.77	0	0.13	12.59	1.43	0.37	0.16	0.18	0.02	0.73	51.1			
15－3	60-140	67.5	23.1	9.3	SL	4.1	23.2	2.17	1.11	0.58	14.93	0.05	19.52	0	0.13	12.00	2.75	0.28	0.16	0.33	0.04	0.81	29.5			
15－4	140-190	62.1	23.0	14.8	SL	5.2	53.3	1.63	0.25	0.25	11.15	0.02	14.15	0.20	0	43.15	4.89	0.75	0.33	2.11	0.06	3.25	66.5			
15－5	190-250	54.6	25.3	20.1	SCL	6.7	52.0	2.22	0.15	0.10	15.81	0.07	19.03	1.08	0.23	60.29	7.53	1.12	0.67	4.54	0.08	6.41	85.1			

No.	Depth	Particle Size Distr.			Texture	pH	S. P	EC	Soluble Cations				Soluble Anions			ESP	CEC	Exchangeable Cations					Base	Org.	Extr.	Total
		Sand	Silt	Clay					Ca	Mg	Na	K	Cl	HCO_3	SO_4			Ca	Mg	Na	K	Sum	Satr.	Matter	P	N
	cm	%	%	%			%	mS/cm	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	me/ℓ	%	me/100g	me/100g	me/100g	me/100g	me/100g	me/100g	%	%	ppm	%
16－1	0-20	79.6	16.1	4.3	LS	5.3	23.0	0.06	0.14	0.08	0.12	0.02	0.49	0.14	0.19	6.07	2.14	0.41	0.25	0.13	0.05	0.84	39.3			
16－2	20-80	71.0	16.6	12.4	SL	4.9	29.8	0.03	0.06	0.05	0.09	0.20	0.49	0	0.06	2.68	5.60	0.35	0.50	0.15	0.06	1.06	18.9			
16－3	80-120	68.0	19.3	12.7	SL	5.6	21.9	0.13	0.23	0.07	0.53	0.02	1.95	0.34	0.06	6.01	4.99	0.66	0.59	0.30	0.06	1.61	32.3			
16－4	120-140	60.1	21.5	18.4	SL	5.5	44.9	0.33	0.09	0.05	2.58	0.02	2.93	0.30	0.23	13.21	8.25	3.16	1.35	1.09	2.08	7.68	93.1			
16－5	140-160	67.5	16.8	15.7	SL	6.2	41.4	2.03	0.60	0.42	14.94	0.03	16.10	0.64	0.10	16.62	11.91	4.15	1.75	1.98	0.09	7.97	66.9			
16－6	160-180	33.3	30.9	35.8	CL	6.4	83.4	4.08	1.56	1.00	28.84	0.04	32.70	0.78	0.42	19.56	24.34	11.17	4.81	4.76	0.16	20.90	85.9			

C-17 Results of Soil Analyses (Physical Properties)

Table C-17 Results of Soil Analyses (Physical Properties)

No.	Depth	Moist. Retentian		Avail.	Bulk	3-Phases Analysis			Permeability	Particle
		1/3 bar	15 bar	Moisture	Density	Solid	Liquid	Gas	Coefficient	Density
	cm	% by wt			g/cu. cm	% by vol.			cc/hr	g/cu. cm
1－1	0－16	16.4	11.4	5.0	1.68	68.9	20.5	10.6	1.76×10^{-1}	2.43
1－4	70－120	21.8	13.5	8.3	1.67	60.1	31.6	8.3	3.12×10^{-7}	2.78
2－1	0－18	8.3	6.1	2.2	1.65	57.8	24.1	18.1	1.99×10^{-1}	2.85
3－2	14－70	10.0	7.0	3.0	1.64	56.2	25.7	18.1	2.76×10^{-1}	2.91
4－2	30－130	6.9	5.4	1.5	1.77	65.0	21.3	13.7	2.08×10^{-3}	
5－2	16－90	5.8	2.5	3.3	1.69	63.8	24.2	12.0	7.20×10^{-4}	
6－2	30－90	9.6	6.9	2.7	1.74	64.6	24.6	10.8	5.04×10^{-1}	
7－2	14－60	7.7	4.4	3.3	1.85	75.9	21.8	2.3	2.12×10^{-6}	
8－2	17－60	14.8	9.3	5.5	1.81	69.3	26.9	3.8	1.92×10^{-1}	
9－1	0－30	13.1	9.4	3.7	1.82	64.8	27.6	7.6	1.11×10^{-5}	
10－2	20－130	6.7	3.8	2.9	1.68	59.0	23.2	17.8	3.26×10^{-4}	
11－2	21－40	7.4	5.1	2.3	1.63	66.5	21.1	12.4	2.10×10^{-5}	
12－2	17－70	9.8	6.8	3.0	1.54	63.6	24.7	11.7	4.54×10^{-1}	
13－2	14－80	11.6	8.4	3.2	1.93	70.2	22.3	7.5	1.05×10^{-6}	
14－2	15－45	13.1	9.8	3.3	1.73	70.8	27.6	1.6	6.47×10^{-5}	
15－2	20－60	6.7	3.1	3.6	1.63	57.6	22.8	19.7	3.07×10^{-4}	2.83
16－2	20－80	8.3	6.5	1.8	1.58	55.0	26.5	18.5	6.88×10^{-1}	

Table C-18 Results of Soil Analyses (Clay Mineralogy)

No.	Depth (cm)	Mineralogy of the Clay Fraction (< 2 microns)	
		Major Minerals	Minor and Trace Minerals *)
J－1－1	0－16	Vermiculite, Kaolinite	Illite, Quartz
J－1－4	70－120	Kaolinite	Vermiculite
J－4－4	30－130	Kaolinite	Quartz Trace of 14Å group clay minerals

*) In order to abundance

APPENDIX D AGRICULTURE

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF REFERENCES

D-1 Outline of Farming Systems
D-2 Outline of Pa Mo Village
D-3 Salt Affected Land in Thailand and Its Agricultural Productivity

D-1. Present State of Agriculture in the Study Area

D-1-1. Outline of the Farm Management

Table D-1. Agriculture in Each Tambon

- Area of Grown Crops and Heads of raised Livestock and Fish -

Tambon Name	Total Area	Paddy Rice	Cassava	Mulberry	Other Crops	Buffalo	Cattle	Chicken	Others	Fish
	rai	rai	rai	rai	rai	head	head	head	head	kg
1-1 (40) ****	916	672 (73%)	148	32	watermel. 4.5 chili 0.25 onion 0.25 cantaloup 1.0	155	17	910	pig 92 duck 227	250* (0)**
1-2 (28)	905	574 (63)	138	26	kenaf 18.0 watermel. 4.0	76	12	262	duck 7	0 (170)
1-3 (24)	594	542 (91)	0	4	kenaf 23.0 pasture 8.0	83	47	35	pig 60	100 (726)
1-4 (24)	370	340 (92)	18	1	pasture 10.0 vegetables 1.0	16	9	55	duck 2	250 (830)
1-5 (20)	487	301 (62)	96	1	pasture 55.0 kenaf 1.0	29	18	113	-	0 (210)
2-1 (16)	300	293 (98)	0	2	tomato 0.75 watermel. 3.0 cowpea 1.0	41	13	32	pig 8 duck 78	900 (7)
2-2 (32)	629	421 (67)	159	8	sugarcane 24.0 pasture 4.0 tomato 1.1 mango 6.0	66	19	52	pig 77 horse 6 duck 7	550 (2798)
3-1 (40)	1345	724 (54)	596	12	-	125	34	21	pig 58	3195 (377)
Total	5546	3867	1155	86	165.9	591	159	1480	pig 295 duck 321 horse 6	5245 (5118)

Data Source ; Questionary Survey

Notes; * indicates cultured fish, **indicates caught fish

*** indicates number of sampled farmhouses

Table D-1 Agriculture in Each Tambon

- Area of Grown Crops and Heads of Raised Livestock and Fish Per Farmhouse -

Tambon Code	Total Area	Paddy	Cassava	Mulberry	Other Crops	Buffalo	Cattle	Chicken	Swine, (Others)	Fish (Caught)
	rai	rai	rai	rai	rai	head	head	head	head	kg
1-1	22.9	16.8	3.7	0.8	0.2	3.9	0.2	22.8	2.3 (5.7)	6.3 (0)
1-2	32.3	20.5	4.9	0.9	0.8	2.7	0.4	9.4	(0.3)	0 (6.1)
1-3	24.8	22.6	0	0.2	1.3	3.5	2.0	1.5	2.5	4.2 (30.3)
1-4	15.4	14.2	0.8	0	0.5	0.7	0.4	2.3	(0.1)	10.4 (34.6)
1-5	24.4	15.1	4.8	0.1	2.8	1.5	0.9	5.7	-	- (10.5)
2-1	18.8	18.3	-	0.1	0.3	2.6	0.8	2.0	0.5 (4.9)	56.3 (0.4)
2-2	19.7	13.2	10.0	0.3	1.1	2.1	0.6	1.6	2.4 (0.4)	17.2 (87.4)
3-1	33.6	18.1	14.9	0.3	-	3.1	0.9	0.5	1.5	79.9 (9.4)
Average	24.8	17.3	5.2	0.4	0.7	2.6	0.7	6.6	1.3 (1.4)	23.4 (22.8)

Source ; Questionary Survey

Note; * Amount of the caught fish

Table D-2 Present State of the Agriculture in Each Tambon

Amphoe	Tambon	No.of villages	Population and Households			Present land use (rai)			
			Population	household	Farmhouse	Agr.land	Paddy	Upland	No cropp.
Phra Yun	Phra Yun	10	10,464	1,948	1,749	32,044	24,239	5,772	2,033
						(18.3	13.9	3.3	1.2)
	Kham Pom	7	5,865	984	894	14,559	11,152	805	2,602
						(16.3	12.5	0.9	2.9)
	Phra Bu	6	4,182	689	661	13,348	12,530	543	275
						(20.2	19.0	0.8	0.4)
	Ban Ton	6	5,453	1,212	878	11,970	10,250	1,368	352
						(13.6	11.7	1.6	0.4)
	Nong Waeng	5	4,732	862	769	15,910	11,339	3,691	880
						(20.7	14.7	4.8	1.1)
Muang Khon Kaen	Ban Wa	4	2,469	490	445	6,619	4,174	58	2,387
						(14.9	9.4	0.1	5.4
	Don Chang	8	4,314	712	652	13,834	7,005	4,277	2,552
						(21.2	1027	6.6	3.9)
Ban Fang	Ban Lan	2	848	149	149	2,800	1,568	357	875
						(18.8	10.5	2.4	5.9)
	Pa Sanao	2	1,613	289	289	5,430	2,991	700	1,739
						(18.8	10.3	2.4	6.0)
Manchakiri	Tha Sala	10	6,475	1,200	1,025	32,055	12,742	10,277	9,036
						(31.3	12.4	10.0	8.8)
Total (rai)		60	46,415	8,535	8,116	148,569	97,990	27,848	22,731
						(18.3	12.1	3.4	2.8)
Total (ha)						23,771	15,678	4,456	3,637
						(2.9	1.9	0.5	0.4)

( ) ; Land area per farmhouse

Table D - 3 Agriculture in Each Village No. 1

Amphoe-Tambon-Muhban	Noumber of Farmhouses (1)	(2)**	Land Area (3)	Rice Pady Area (4)		Area/ Farmhouse Total-Paddy (3)/(1)	(4)/(2)	Area Ratio * Plant, Harvest		Rice Yield * based on Harv. A	Hold. A	Yield
	households		rai	rai	%		rai		%		kg/rai	kg/rai
1 Amphoe Phra Yun												
1-1 Tambon Phra Yun												
1-1-1 Phra Yun	250,	250	7,225	5,000	69	28.9	20.0	100	73	282	206	250
1-1-2 Hua Bing	169,	169	816	739	91	4.9	4.4	83	79	311	246	200
1-1-3 No Lom	115,	115	976	488	50	8.5	4.3	100	79	274	217	160
1-1-4 Non Boe	277,	218	1,567	1,207	77	5.7	5.5	82	32	228	73	270
1-1-5 Nong Ku	123,	121	2,852	1,773	62	23.2	14.7	100	64	327	209	200
1-1-6 Pa Moe	265,	250	3,610	2,500	69	13.6	10.0	93	65	432	281	110
1-1-7 Hin Hurb	280,	266	8,632	7,692	89	30.8	28.9	100	68	247	168	300
1-1-8 Kaen Pradu	117,	95	1,426	860	60	12.2	9.1	100	64	213	136	150
1-1-9 Pa San	106,	100	3,000	2,500	83	28.3	25.0	100	72	259	186	200
1-1-10 Pa San	78,	78	1,940	1,480	76	24.9	19.0	100	89	294	262	250
Total	1,780	1,662	32,044	24,239	726	181.0	140.9	958	685	2,867	1,984	
Average	178	166	3,204	2,424	73	18.1	14.1	96	69	287	198	209
1 Amphoe Phra Yun												
1-2 Tambon Kham Pom												
1-2-1 Kham Pom	226,	190	3,780	2,140	57	16.7	11.3	100	47	219	103	230
1-2-2 Noi Chuan Bung	93,	93	1,353	1,260	93	14.5	13.5	100	68	272	185	400
1-2-3 Chad	184,	—	3,314	3,200	96	18.0	4.0	99	47	192	90	200
1-2-4 Bo Kae	150,	150	2,237	1,737	78	14.9	11.6	100	73	260	190	300
1-2-5 Nong Thung	24,	24	375	315	84	15.4	13.2	52	20	240	48	400
1-2-6 Bo Thong	62,	62	1,500	1,000	67	24.1	16.1	100	87	270	235	100

1-2-7 Pho Tong	153	153	2,000	1,500	75	13.1	9.8	78	65	216	140	400
Total	892	672	14,559	11,152	550	116.7	92.9	629	407	1669	991	
Average	127	112	2,079	1,182	79	16.7	13.3	90	58	238	142	290
1 Amphoe Phra Yun												
1-3 Tambon Phra Bu												
1-3-1 Phra Bu	160	160	3,010	3,000	100	18.8	18.8	67	72	274	170	200
1-3-2 Phra Nao	165	165	3,550	3,500	99	21.5	21.2	79	71	278	220	250
1-3-3 Han	207	205	4,350	4,000	92	21.0	19.5	55	25	178	45	300
1-3-4 Jod Noi	59	59	950	950	100	16.1	16.1	100	86	369	317	300
1-3-5 Po Khum Din	57	57	1,100	800	73	19.3	14.0	100	88	302	266	350
1-3-6 Tha Ngam	15	15	388	280	72	25.9	18.7	100	90	355	320	200
Total	663	661	13,348	12,530	536	122.6	108.3	501	432	1,756	1,338	
Average	111	110	2,225	2,088	89	20.4	18.1	84	72	293	223	267
1 Amphoe Phra Yun												
1-4 Tambon Ban Ton												
1-4-1 Ton	344	344	3,600	3,420	95	10.5	9.9	100	76	395	300	320
1-4-2 Ton	241	241	1,975	1,400	71	8.2	9.9	100	69	324	224	550
1-4-3 Jad Yai	103	103	2,220	2,000	90	21.6	19.4	100	87	196	171	300
1-4-4 Dong Kao	78	70	530	400	75	6.8	5.7	100	71	334	237	400
1-4-5 Dong Klang	167	167	2,925	2,330	80	17.5	13.9	100	67	322	216	320
1-4-6 Hin Kong	30	30	720	700	97	24.0	23.3	83	55	210	116	400
Total	963	955	11,970	10,250	413	88.6	82.1	583	425	1,781	1,264	
Average	161	159	1,995	1,708	85	14.8	13.7	97	71	297	211	382
1 Amphoe Phra Yun												
1-5 Tambon Nong Waeng												
1-5-1 Nong Waeng	200	200	5,055	4,000	79	25.3	20.0	47	39	306	119	250
1-5-2 Nong Pho	170	170	3,368	2,800	83	19.8	16.5	100	83	493	409	300
1-5-3 Nong Ya Khao Nok	175	175	2,891	1,900	66	16.5	10.9	94	71	341	242	400
1-5-4 Non Tun	80	80	1,090	509	47	13.6	6.4	94	58	280	162	300

1-5-5 Nong Jik	144	144	3,506	2,130.	60	24.3	14.8	67	54	250	135	200
Total	769	769	15,910	11,339	335	99.5	68.6	402	305	1,670	1067	
Average	154	154	3,182	2,268	67	19.9	13.7	80	61	334	213	290
2 Muang Khon Kaen												
2-1 Tambon Ban Wa												
2-1-3 Nong Tum	30	30	715	714	100	23.8	23.8	100	38	288	109	250
2-1-5 Thong Lang	200	200	3,040	3,000	99	15.2	15.0	89	76	340	258	250
2-1-6 Thong Lang	151	80	2,324	400	17	15.4	5.0	88	76	242	184	350
2-1-9 Tan	48	30	540	60	11	11.3	2.0	96	37	171	63	250
Total	429	340	6,619	4,174	227	65.7	45.8	373	227	1,041	614	
Average	107	85	1,655	1,044	57	16.4	11.5	93	57	260	154	275
2 Muang KhonKaen												
2-2 Tambon Don Chang												
2-2-1 Don Chang	112	112	5,088	2,509	49	45.4	22.4	100	66	313	207	500
2-2-2 Pa Luam	91	91	1,520	300	20	16.7	3.3	100	68	224	152	300
2-2-3 Pa Sung	65	40	1,090	812	74	16.8	20.3	100	88	400	352	400
2-2-4 Nong Hi	109	109	2,675	1,073	40	24.5	9.8	100	83	392	325	300
2-2-5 Hua Bung	57	57	1,084	566	52	19.0	9.9	80	65	297	193	340
2-2-6 Hua Sra	34	15	526	275	52	15.5	18.3	100	72	529	381	400
2-2-7 Don Ya Nang	96	96	1,601	1,330	83	16.7	13.8	79	31	327	101	400
2-2-8 Ni khom	20	20	250	140	56	12.5	7.0	97	74	306	226	300
Total	584	540	13,834	7,005	426	167.1	104.8	756	547	2,788	1,937	
Average	73	68	1,729	876	53	20.9	13.1	95	68	349	242	368
3 Amphoe Mancha Khiri												
3-1 Tambon Tha Sala												
3-1-1 Sai Kai	159	117	8,117	1,157	14	19.6	9.9	31	24	210	50	250
3-1-2 Tha Sala	180	130	2,470	1,500	61	13.7	11.5	54	43	405	174	200
3-1-3 Non Tun	59	60	948	600	63	16.1	10.0	100	85	285	242	400
3-1-4 Non Khum	90	70	1,705	1,000	59	18.9	14.3	65	46	180	83	300

3-1-5 Don Keng	130	111	7,687	3,300	43	59.1	29.7	92	45	265	119	300
3-1-6 Hua Na Nua	102	99	2,294	800	35	22.5	8.1	68	49	282	138	250
3-1-7 Tha Sawan	215	180	2,511	2,000	80	11.7	11.1	92	21	249	52	300
3-1-8 Non Ngin	91	92	3,000	1,500	50	33.0	16.3	100	15	261	39	150
3-1-9 Hua Na Klang	93	50	2,700	510	19	29.0	10.2	76	65	167	109	200
3-1-10Tha Sala	53	52	623	375	59	11.9	7.2	94	68	263	179	250
Total	1,172	961	32,055	12,742	483	235.5	128.3	772	461	2,567	1,185	
Average	117	96	3,206	1,274	48	23.6	12.8	77	46	257	119	260
Total (rai)	7,252	6,192	140,339	93,431	3,791	1076.7	771.8	4,974	3,489	16,139	10,380	15,808
Average (rai)	130	112	2,506	1,668	68	19.2	13.8	89	62	288	185	282
Total (ha)			22,454	14,949								
Average (ha)			401	267		3.1	2.2			1.8t	1.2t	1.8t
Total, Pilot 14villages (rai)	2,000	1,735	35,428	26,004	1,060	252.7	195.1	1,305	913	3,787	2,517	3,390
Average, 〃 (rai)	143	133	2,530	1,857	75	18.1	13.9	93	65	271	180	242
Total 〃 (ha)			5,668	4,161								
Average 〃 (ha)			405	297		2.9	2.2			1.7t	1.1t	1.5t
Total, Pilot area (rai)	1100	954	19,485	14,302								
Average, 〃 (rai)												
Total, 〃 (ha)			3,117	2,289								
Average, 〃 (ha)												

Data Source; Village Survey 1988. * These items are quoted from the Questionary Survey

Notes; Whole or a part of underlined villages are included in the Pilot Area

** indicates rice cultivated farm households

Table D – 4 Agriculture in Each Village No.2

Amphoe-Tambon-Muhban	Field Crops (rai)			Tree Crops (rai)			Livestock (head)		
	Cassava (36)	Kenaf (29)	Others	(48)	(43)		Swine	Cattle	Buffalos
1 Amphoe Phra Yun									
1-1 Tambon Phra Yun									
1-1-1 Phra Yun	50						80	30	300
1-1-2 Hua Bing	49	30		10	10		30	7	169
1-1-3 No Lom							6	42	71
1-1-4 Non Boe	59						39	112	306
1-1-5 Nong Ku	673	400		4	3		23	10	146
1-1-6 Pa Moe	1000	48	(46) 50	20			100	50	250
1-1-7 Hin Hurb	400	225	(46) 100	100	15	(25) 1000	110	120	339
1-1-8 Kaen Pradu	560			3	3		92	18	319
1-1-9 Pa San	500						23	10	80
1-1-10 Pa San	460						12	35	245
Total	3,751	703	(46) 150	137	31	(25) 1000	515	434	2,225
Average									
1 Amphoe Phra Yun									
1-2 Tambon Kham Pom									
1-2-1 Kham Pom							40	114	217
1-2-2 Noi Chuan Bung	50	3	(45) 40				11	19	163
1-2-3 Chad							1	5	159
1-2-4 Bo Kae	500							103	470
1-2-5 Nong Thung	60								52
1-2-6 Bo Thong	150			1	1		25	29	85
1-2-7 Pho Tong	-	-					17	23	52

Total	760	3	(45) 40	1	1		94	293	1,198
Average									
1 Amphoe Phra Yun									
1-3 Tambon Phra Bu									
1-3-1 Phra Bu							80	400	600
1-3-2 Phra Nao							65	132	500
1-3-3 Han	350						100	123	279
1-3-4 Jod Noi							25	81	129
1-3-5 Po Khum Din			(99) 85						
1-3-6 Tha Ngam	25	75		7	1			5	28
Total	375	75	(99) 85	7	1		270	741	1,536
Average									
1 Amphoe Phra Yun									
1-4 Tambon Ban Ton									
1-4-1 Ton	54		(2) 13 (46) 22	11	4	(25) 4	45	975	1240
1-4-2 Ton	375	200					22	55	91
1-4-3 Jad Yai	120		(45) 100				6	108	200
1-4-4 Dong Kao	150						25	42	68
1-4-5 Dong Klang	222			73			154	170	230
1-4-6 Hin Kong	20						10	28	50
Total	941	200	(2) 13 (46) 22	84	4	(25) 4	262	1,378	1,879
Average			(45) 100						
1 Amphoe Phra Yun									
1-5 Tambon Nong Waeng									
1-5-1 Nong Waeng	765	140		150			50	134	357
1-5-2 Nong Pho	480	80		8			95	180	120
1-5-3 Nong Ya Khao Nok	991						55	275	372
1-5-4 Non Tun	370		(44) 91 (99) 90	30			27	76	120
1-5-5 Nong Jik	350	56	(4) 70	20			70	120	105

Total	2,956	276	(4) 70 (44) 91	208			297	785	1,074
Average			(99) 90						
2 Muang Khon Kaen									
2-1 Tambon Ban Wa									
2-1-3 Nong Tum				2	1			42	114
2-1-5 Thong Lang	30	10					30	30	200
2-1-6 Thong Lang	15						120	146	173
2-1-9 Tan								15	111
Total	45	10		2	1		150	233	598
Average									
2 Muang KhonKaen									
2-2 Tambon Don Chang									
2-2-1 Don Chang	250		(2) 50 (99) 20				40	75	800
2-2-2 Pa Luam	1200			20			50	250	150
2-2-3 Pa Sung	276			2			27	53	73
2-2-4 Nong Hi	1533	14	(46) 30				30	149	185
2-2-5 Hua Bung	430		(99) 40		1		19	14	58
2-2-6 Hua Sra	50						20	8	50
2-2-7 Don Ya Nang	246			20	5		25	23	150
2-2-8 Ni khom	90						6	12	30
Total	4,075	14	(2) 50 (46) 30	42	6		217	584	1,496
Average			(99) 60						
3 Amphoe Mancha Khiri									
3-1 Tambon Tha Sala									
3-1-1 Sai Kai	1900		(45) 50	2	1	(27) 7	8	149	175
3-1-2 Tha Sala	800			100			20	180	70
3-1-3 Non Tun	348						10	2	169
3-1-4 Non Khum	700			5			14	87	189
3-1-5 Don Keng	925						52	138	273

3-1-6 Hua Na Nua	1494						8	110	135
3-1-7 Tha Sawan	500		(38) 3 (2) 3	5			50	1200	135
3-1-8 Non Ngin	1500						30	125	106
3-1-9 Hua Na Klang	1656			15	5		15	227	179
3-1-10Tha Sala	250			6	1	(67) 1	50	7	28
Total	10,073		(2) 3 (38) 3	133	7	(27) 7 (67) 1	257	2,225	1,459
Average			(45) 50						
Total (rai)	22,976	1,281	857	614	51	1,012	2,062	6,673	11,465
(ha)	3,676	205	137	98	8	162			
			(2) 66 (4) 70			(25) 1004			
			(38) 3 (44) 91			(27) 7 (67) 1			
			(45) 190 (46) 202						
			(99) 235						
Total (14villages)	4,052	481	(45) 40 (46) 50	38	17	-	454	453	2,707
Total (Pilot area, rai)	2,229	265	50	21	9		250	250	1,489
Total (Pilot area, ha)	357	42	8	3	1				

Data Source; Village Survey 1988

Notes;Field Crops (2) Corn, (4) Sorghum, (38) Tobaco, (44) Truffle, (45) Mulberry, (46) Sugarcane, (99) Tree Crops (25) Castard apple (Bullocks heart) (27) Kapok and Red cotton tree (43) Cocconut (48) Mango (67) Citrus

Table D - 5 Present Situation of Land Use(Paddy) in Each Amphoe refered to the Study Area

Amphoe	Holding Area	Planted Area	Harvested Area	Production	Production /holding A.	Production /planted A.	Production /harvestedA	Population	Kg/person
	rai	rai	rai	ton	kg	kg	kg		kg
Muang Khon Kaen	228,544	181,616	173,914	53,911	236	297	309	193,043	279
	(100)	(79)	(76)						
Manchakiri	125,180	74,893	67,558	16,825	134	225	249	97,192	173
	(100)	(60)	(54)						
Ban Fang	107,583	33,749	32,213	7,249	67	215	225	50,086	145
	(100)	(31)	(30)						
Phra Yun	75,030	32,538	29,524	6,457	86	198	219	31,508	205
	(100)	(43)	(39)						

Source; Agricultural Economy Khon Kaen Province 1989

Table D - 6 Crop Production in Ampha Phra-yun

Paddy rice Area, Yield	1986				1987				1988			
	Holding	Planted	Harvest	Yield	Holding	Planted	Harvest	Yield	Holding	Planted	Harvest	Yield
	rai 75,030	rai 19,817	rai 7,256	t 1,845	rai 75,030	rai 38,887	rai 36.774	t 9,381	rai 75.030	rai 29,845	rai 26,841	t 6,469
Area index	100	26.4	9.7		100	51.8	49.0		100	39.8	35.8	
Yield, Prod./Holding A				24.6 kg/rai				125.0 kg/rai				86.2 kg/rai
Yield, Prod./Planted A				93.1 kg/rai				241.2 kg/rai				216.8 kg/rai
Yield, Prod./Harvest A				254.2 kg/rai				255.1 kg/rai				241.0 kg/rai
Upland rice		1,663	416	238 kg/rai		727	727	321		387	387	247
Cassava		2,413	2,413	2,150		3,135	3,135	2,100		6,771	6,771	1,120
Kenaf		2,426	2,426	1,150		1,400	1,400	1,135		1,017	1,017	1,120
Sugar cane		208	208	7,500		200	200	6,800		200	200	6,800
Mung bean		424	74	120		165	165	180		163	163	170
Castor bean		5	5	130		-	-	-		-	-	-
Sesame		15	15	80		14	14	70		12	8	70
Area of upland field	10,210	7,154	5,557		10,210	5,641	5,641		10,210	8,550	8,546	
Area index	100	70.0	54.4		100	55.2	55.2		100	83.7	83.7	
Precipitation Deviation (average 968.5 mm)	753.8 mm - 214.7 mm				1,140.6 mm + 172.1 mm				953.7 mm - 14.8 mm			

Table D-7 Utalization of Farming Machine in the Pilot Area

Code	Own Machine				Own Machine			Raising Animal
	Tractor	Sprayer	Car	Pump	Tractor	Sprayer	Car	
1-1-1		1000						1head
1-1-2		1500			2900			0
1-1-3						1200		2
1-1-4		1200						10
1-2-1					1520		1750	0
1-2-2			37000		2100			2
1-2-3								1
1-2-4					1700			0
1-3-1	11200	1200						0
1-3-2		160			2750			2
1-3-3								0
1-3-4								1
1-4-1					3700			0
1-4-2			300000					1
1-4-3	28000	220						0
1-4-4		180						2
1-5-1				3000				1
1-5-2	36000			1600				0
1-5-3		170						1
1-5-4								2
1-6-1		200			4000			4
1-6-2	18000							2
1-6-3					400			0
1-6-4		130						2
1-7-1					4400			3
1-7-2			180000					2
1-7-3					1300			2
1-7-4					2000			0

1-8-1					720			2
1-8-2	36000							1
1-8-3					5450			0
1-8-4					2175			0
1-9-1	350000	1200						1
1-9-2		1300						3
1-9-3								2
1-9-4					1200			0
1-10-1	34000	120					3600	1
1-10-2		130					3000	4
1-10-3					500		1500	3
1-10-4		120						3
2-1-1	28000							0
2-1-2					4000			0
2-1-3					3660			1
2-1-4								7
2-2-1	25000							3
2-2-2	28000	190						2
2-2-3					600			0
2-2-4					600			0
2-3-1		200	80000					2
2-3-2	36000							0
2-3-3		150			1920			0
2-3-4	25000							0
2-4-1	14200	210						0
2-4-2								2
2-4-3					2300			0
2-4-4					800			0
2-5-1								0
2-5-2								2
2-5-3								2

2-5-4								2
2-6-1								0
2-6-2	15000	150						2
2-6-3								2
2-6-4					1000			2
2-7-1	35000				2300			0
2-7-2	36000	190						0
2-7-3	40000						1450	0
2-7-4		160			450			3
No.of Farmhouses	17 25%	22 32%	4 6%	2 3%	26 38%	1 1%	5 7%	40 59%

Data Source ; Questionary Survey
Notes ; Figure shows the amount of paid money, Baht

Table D - 8 Number of Land Owned and Land Rented Farmhouses in Several Villages Included in the Pilot Area

Tambon	Village	No. of Farmhouse	Land owned Farmhouse	Partial land rented farm.	All land rented farm.
Phra Yun	Phra Yun	259	245	-	14
	Hua Bing	144	125	12	7
	No Lom	98	98	-	-
	Non Boe	237	210	11	16
	Nong Ku	101	98	3	-
	Pa Noe	257	240	14	3
	Hin Hurb	281	281	-	-
	Kaen Pradu	117	117	-	-
	Pa San	106	104	-	2
	Pa San	85	78	-	7
	Total	1,685	1,596	40	49
		100	95	2	3
Phra Bu	Phra Bu	167	157	3	7
	Phra Nao	166	156	-	10
	Han	207	207	-	-
	Jod Noi	59	59	-	-
	Po Khum Din	57	50	7	-
	Tha Ngan	16	14	-	2
	Total	672	643	10	19
		100	96	1	3
Ban Ton	Ton	297	258	21	18
	Ton	262	198	35	29
	Jad Yai	95	90	5	-
	Dong Kao	71	10	27	34
	Dong Klang	210	138	29	43
	Hin Kong	32	32	-	-
	Total	967	726	117	124
		100	75	12	13

Source; Area and Farmer 1999 . Amphoe Phra Yun Extension Office

Table D - 9 The Present State of the Fish Raising in Each Amphoe 1987-88

	A. Phra Yun		A. Muang Khon Kaen		A. Manchakiri		A. Ban Fang	
	Pond	Paddy	Pond	Paddy	Pond	Paddy	Pond	Paddy
Number of owners	1,127	45	1,457	239	350	59	135	50
Area (rai)	1,123	364	2,140	1,140	428	228	236	278
Number of growers	996	28	1,220	210	157	41	138	44
Raising area (rai)	996	252	1,540	970	273	170	145	253
Production (t)	261	8	59	11	9	3	23	40
Yield (kg/rai)	263	34	38	12	34	20	161	158

Source; Agicultural Economy in Khon Kaen Province 1989

D-1-2. Results from Farm Questionnaire Survey

FIGURE D－1 MAP OF VILLAGE CODE

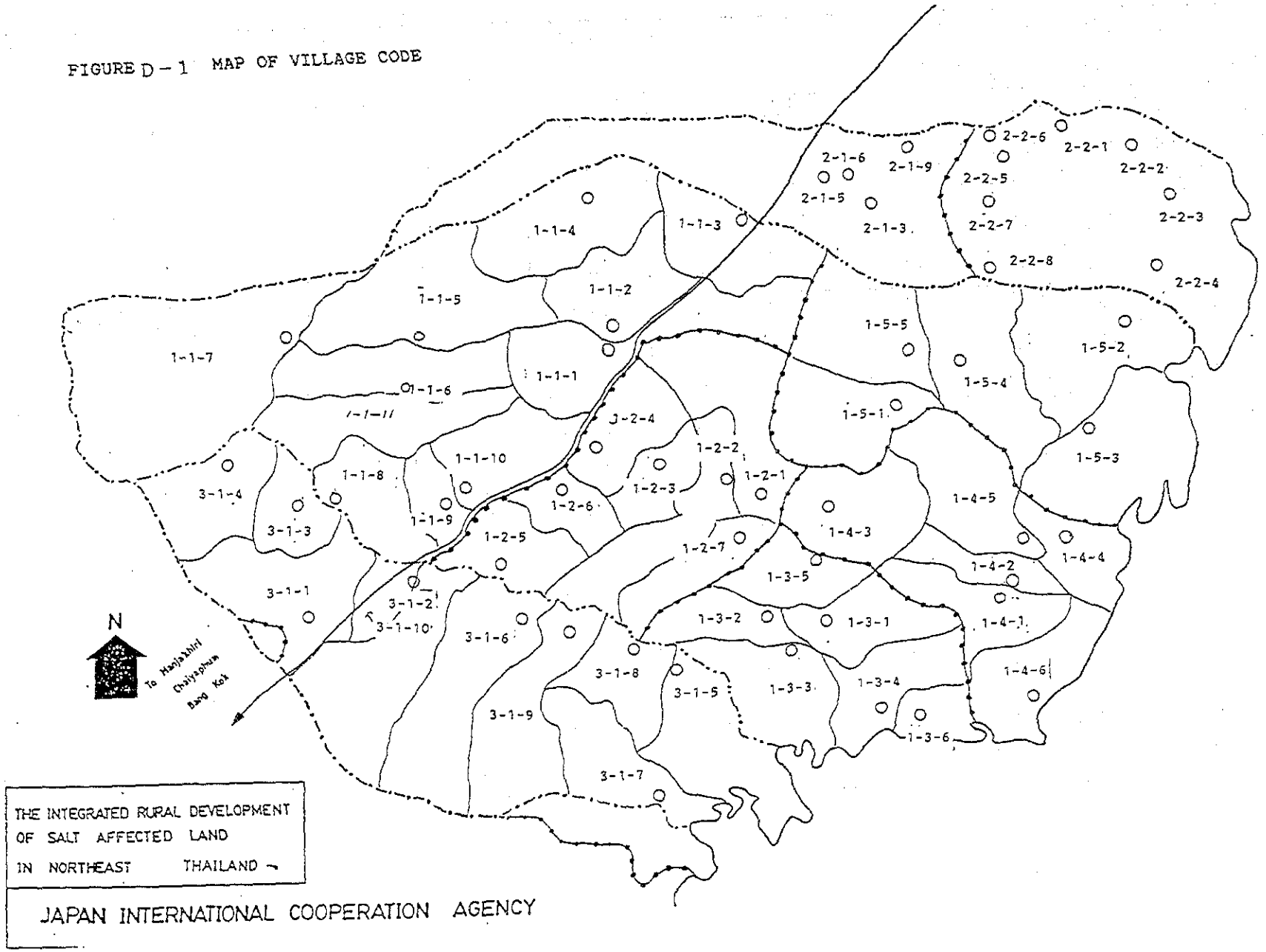


Table D-10 Results of the Questionary Survey - Actual State of the Paddy Rice Culture

Farmar Code	Area	Plant Area	Harv. Area	Salt Patch	Vari-etie	Planting Date	Harvesting Date	Fertilizer		Chemicals		Product	Yield	Yield	Trend
	rai	rai	rai	class	L/I			kg		kg		kg	kg	kg	
1-1-1	20	20	15	2	G I	L/7-M/9	M/12-M/1	16-20-0	250	Furadan	20	4,800	320	240	c/c
1-1-2	20	20	8	3	G I	E/7-L/8	L/12-M/1	〃	250	〃	20	2,000	250	100	c/c
1-1-3	17.3	17.3	16	1	G I	E/6-L/7	L/12-M/1	〃	360	〃	20	5,000	313	289	d/c
1-1-4	10	10	10	4	G I	E/6-L/7	M/11-L/12	16-16-8	150	〃	1	2,000	200	200	d/c
M.	16.8	16.8	12.3	2.5		E/6-M/9	M/11-M/1		253		15	3,450	271	207	
1-2-1	12.8	5	5	2	G I	E/6-E/7	E/12-M/1	15-15-15	250	Furadan	2	1,200	240	94	i/c
1-2-2	12	12	12	2	G I	E/6-E/7	E/12-M/1	〃	200			6,000	500	500	d/i
1-2-3	11	11	11	2	G I	E/6-E/7	M/11-E/12	16-20-0	400			3,000	272	272	c/c
1-2-4	10	10	8	3	G I	E/6-E/7	L/12-M/1	〃	200	〃	5	1,000	125	100	c/c
M.	11.4	9.5	9.5	2.3		E/6-E/7	M/11-M/1		263		1.8	2,800	284	242	
1-5-1	13	13	10	3	G I	E/7-L/8	E/12-M/1	15-15-15	100	〃	20	2,000	200	154	c/c
1-5-2	10.5	10.5	4	2	G I	L/7-M/9	E/12-L/12	〃	100			1,500	375	143	i/d
1-5-3	13	13	9	4	G I	L/7-L/9	L/1-M/2	〃	100			4,000	444	308	c/c
1-5-4	4	4	3	2	G I	M/8-E/10	L//1-M/1	〃	50			1,000	333	250	i/c
M.	10.1	10.1	6.5	2.8		E/7-E/10	E/12-M/2		88		5	2,125	338	214	
1-6-1	25	25	14	3	G/N I	E/6-L/7	L/12-E/1	16-16-8	350	〃	1.2ℓ	7,000	500	280	c/c
1-6-2	13	13	10	3	G I	E/7-E/8	L/11-E/12	16-20-0	250			4,050	405	312	i/c

1-6-3	7.5	4	3.5	2	G I	E/9-E/10	L/1-L/2	〃	50			1,440	411	192	i/i
1-6-4	5	5	3	2	G I	M/6-M/7	E/12-E/1	〃	150	Bicard	1ℓ	700	233	140	c/c
M.	12.6	11.8	7.6	2.5		E/6-E/10	L/11-L/2		200			3,298	387	231	
1-7-1	30	30	15	3	G I	E/8-E/9	M/12-E/1	16-16-8	500			4,000	267	133	c/c
1-7-2	38	38	25	4	G I	M/6-M/7	E/11-E/12	16-20-0	200			8,000	320	211	c/c
1-7-3	32	32	20	4	G I	E/8-E/9	M/12-E/1	〃	80			2,500	128	78	d/c
1-7-4	25	25	25	3	G I	L/6-L/8	E/12-L/1	〃	250			6,400	256	256	c/i
M.	31.3	31.3	21.2	3.5		M/6-E/9	E/11-L/1		257			5,225	243	170	
1-8-1	30	30	25	3	G L	L/7-L/9	M/12-L/1	16-20-0	150			5,400	216	180	c/c
1-8-2	25	25	18	3	G L	E/6-L/8	E/12-L/12	〃	350	Furadan	0.5	3,600	200	144	c/c
1-8-3	25	25	5	3	G I	E/7-L/8	E/12-L/12	〃	150			800	160	32	c/c
1-8-4	15	15	13	3	G I	E/5-L/8	E/12-L/1	16-16-8	100			3,200	246	213	i/i
M.	23.8	23.8	15.3	3		E/5-L/9	E/12-L/1		188			3,250	206	142	
1-9-1	30	30	20	2	G I	L/8-M/9	L/12-M/1	15-15-15	200	polidon	0.5ℓ	4,000	200	133	i/c
1-9-2	8	8	6	1	G I	L/7-L/8	E/12-L/1	〃	100	〃	0.15ℓ	1,600	267	200	i/c
1-9-3	6	6	5	2	G I	M/8-L/9	E/12-L/12	16-20-0	150			2,000	400	333	c/c
1-9-4	10	10	8	3	G I	M/6-E/9	E/12-E/1	16-8-8	250			2,500	312	250	i/d
M.	13.5	18.5	9.8	2		M/6-L/9	E/12-L/1		175			2,525	295	229	
1-10-1	10	10	8	3	G I	E/6-L/7	E/12	16-20-0	270	Furadan	60	2,000	250	200	c/c
1-10-2	7	7	7	2	G I	E/6-L/7	E/12	〃	150	〃	1	2,500	357	357	i/i
1-10-3	12	12	12	2	G I	E/6-L/7	L/1	〃	200			3,000	250	250	i/i

1-10-4	6	6	4	1	G I	M/6-M/7	M/12	15-15-15	300	〃 5	1,600	400	267	d/d
M.	8.8	8.8	7.8	2		E/6-L/7	E/12-L/1		230		2,275	314	269	
2-1-1	-	-	-	-	-	-	-	-		-	-	-	-	-
2-1-2	30	30	25	4	G I	L/5-L/6	L/10-E/11	16-16-8	500		6,000	240	200	c/c
2-1-3	35	35	34	1	G I	M/6-M/8	E/11-E/12	16-16-0	400		6,400	188	183	c/c
2-1-4	7	7	5	4	G I	E/6-M/9	E/12-M/1	16-20-0	300		1,600	320	229	i/i
M.	24	24	21.3	3		L/5-M/9	L/10-M/1		400		4,667	249	204	
2-2-1	21	21	21	4	G I	E/7-E/8	E/11-L/12	16-16-8	500		4,500	215	215	c/c
2-2-2	16	16	15	4	G I	E/6-E/7	L/11-E/1	〃	100	〃 0.1ℓ	1,800	360	113	c/c
2-2-3	6	6	4	3	G I	L/7-L/8	E/12-E/2	〃	250	〃 6	1,800	450	300	c/c
2-2-4	4	4	2	2	G I	L/6-E/8	E/12-E/1	〃	200		600	300	150	i/i
M.	11.8	11.8	8.0	3		E/6-L/8	E/11-E/1		263		2,175	331	194	
2-3-1	36	36	10	2	G I	E/8-L/9	E/12-L/12	15-15-15	350	〃 5	1,600	160	44	c/i
2-3-2	26	26	20	1	G I	E/7-E/8	E/1-E/2	〃	200		2,400	120	92	d/c
2-3-3	17	16	5	3	G I	L/8-L/9	L/12-E/2	16-20-0	350	〃 600	3,000	600	176	d/i
2-3-4	8	8	6	4	G I	E/7-E/8	E/11-E/1	15-15-15	100	〃 0.1ℓ	900	150	113	c/c
M.	21.8	21.5	10.3	2.5		E/7-L/9	E/11-E/2		250		1,975	258	106	
2-4-1	40	40	30	1	G I	M/6-M/7	L/11-L/12	16-16-8	300	Polidon 1.5ℓ	10,000	333	250	i/d
2-4-2	30	30	23	3	G I	L/7-E/9	L/11-L/12	15-15-15	200		3,000	130	100	d/i
2-4-3	20	20	12	1	G I	L/6-M/8	L/11-L/12	〃	450	Furadan 60	2,400	200	120	c/c
2-4-4	10	10	8	1	G I	E/8-E/9	L/12-E/1	46-0-6	300		3,600	450	360	c/i

M.	25	25	18.3	1.5	G I	M/6-E/9	L/11-E/1	200		4,750	278	208	
2-5-1	28	-	-	-	-	-	-	-	-	-	-	-	-
2-5-2	18	13	4	1	G I	M/9-E/10	L/11-E/1	15-15-15 170		800	200	44	d/d
2-5-3	16	16	6	1	G I	E/8-E/9	L/12-M/1	〃 260		1,600	267	100	c/d
2-5-4	7	7	4	1	G I	E/7-E/9	L/12-M/1	〃 200	polidon 1ℓ	960	240	137	d/i
M.	17.3	12	4.7	1		E/7-E/10	L/11-M/1	210		640	235	94	
2-6-1	30	30	25	2	G I	E/7-E/8	M/11-M/1	16-20-0 200	〃	6,400	256	213	c/i
2-6-2	26	26	25	3	G I	E/8-E/9	M/12-L/1			7,200	288	277	c/c
2-6-3	10	10	8	2	G I	E/7-E/8	E/11-L/11	15-15-15 150	〃	1,840	230	184	i/i
2-6-4	10	10	8	3	G I	E/6-E/7	L/11-E/12	16-20-0 350	Furadan 1	2,400	300	240	c/c
M.	19	19	16.5	2.5		E/6-E/9	E/11-L/1	175		4,600	269	229	
2-7-1	50	32	30	3	G I	L/6-L/9	L/12-E/2	16-20-0 500		6,400	213	128	c/i
2-7-2	26	26	19	3	G I	M/9-L/10	E/1-L/1	15-15-15 600	〃 1	2,400	126	92	d/i
2-7-3	22	22	20	4	G I	E/5-E/7	M/11-L/11	16-20-0 200		7,000	350	318	d/i
2-7-4	24	15	10	2	G I	E/8-M/9	M/11-L/12	〃 150		1,300	130	54	c/c
M.	30.5	23.8	19.8	3		L/5-L/10	M/11-E/2	363		1,275	205	148	

Table D-11 Results of the Questionary Survey

- Actual State of the Field Crops Cultivation in the Pilot Area -

Farmer Code	Crop	Planted Area	Harvested Area	Planted Date	Harvested Date	Fertilizer	Chemicals	Product	Yield
		rai	rai			kg	kg	kg	kg/rai
1-1-1-1	cassava	6	6	L/4	L/4	-	-	10,000	1,667
1-1-2-1	cassava	5	5	E/2	E/3	15-15-15 200	-	7,000	1,400
1-1-5-1	watermelon (seed)	1.5	1.5	E/2	E/5	〃 100	Furadan 25kg	33	22
1-1-5-2	〃	1.0	1.0	E/2	L/3	〃 150	〃 500cc	21	21
1-1-5-3	〃	1.0	1.0	M/2	M/4	〃 75	-	48	48
	chili	0.25	0.25	E/11	L/3	〃 75	〃 1000cc	10	10
1-1-6-1	cassava	7	5	E/3	E/3	16-16-18 210	-	5,000	1,000
	onion	0.25	0.10	E/1	L/3	15-15-15 20	〃 5000cc	50	50
1-1-8-1	cassava	6	6	L/4	E/1	16-20-0 100	-	3,500	583
1-1-8-2	cassava	10	5	M/4	M/1	〃 150	-	5,500	1,100
1-1-8-3	cassava	6	1	M/5	E/4	15-15-15 50	-	1,600	1,600
1-1-8-4	cassava	6.75	5	E/5	E/4	16-16-8 100	-	5,000	1,000
1-1-9-1	cassava	4	4	L/3	M/11	15-15-15 100	-	6,000	1,500
1-1-9-2	cassava	4	4	L/3	L/12	〃 100	-	4,000	1,000

1-1-9-3	cassava	5	5	E/4	M/2	-		-		3,000	600
1-1-10-1	cassava	12	11	E/4	L/12	16-20-0	350	-		14,400	1,310
1-1-10-2	cassava	10	10	L/5	M/4	〃	100	-		12,000	1,200
1-1-10-3	cassava	5	5	E/5	L/4	〃	100	-		6,000	1,200
1-1-10-4	cassava	7	5	M/4	E/5	15-15-15	300	-		10,000	2,000
1-2-1-1	kenaf (pulp)	8	4	M/1	L/3	-		-		7,000	1,750
1-2-1-2	kenaf (pulp)	10	10	E/3	L/11	16-16-8	150	-		16,954	1,695
1-2-4-2	cassava	2	2	E/5	E/2	-		-		2,000	1,000
1-2-4-3	cassava	7	7	E/5	E/5	15-15-15	100	-		8,000	1,143
1-2-6-2	watermelon (seed)	4	2	E/6	E/8	〃	100	furadan	25kg	140	70
1-2-7-1	cassava	60	48	L/2	M/3	〃	750	-		53,000	1,104
1-2-7-2	cassava	40	40	E/6	E/4	〃	300	-		59,000	1,475
1-2-7-3	cassava	23	23	M/3	E/2	-		-		29,000	1,261

Legend ; Farmer Code, Amphoe-Tambon-Muhban-Farmer

Table D-12 Results of the Questionary Survey

- Actual State of the Livestock Raising in the Pilot Area -

Farmar Code	Kind of Livestock	Use	Raising Heads Young / Adult	Born / Dead / Bought	Sold Head / Baht	Kind of Feed	Yield
1-1-1	buffalo	work	2 / 1	3 / 0 / 0	2 / 18,000	w	d / i
	chicken	meat	3 / 24	27 / 0 / 0		cr	d / i
1-1-2	chicken	m	0 / 30	30 / 0 / 0		cr	d / i
1-1-3	buffalo	w	0 / 2	1 / 2 / 0		w	i / i
1-1-4	buffalo	w	0 / 10	9 / 0 / 1		w	i / i
1-2-1	chicken	m	10 / 5	15 / 0 / 0		c	i / i
1-2-2	buffalo	w	0 / 2	2 / 0 / 0	2 / 20,000	c,w	c / i
1-2-3	buffalo	w	0 / 1	1 / 0 / 0		w	i / d
1-2-4	chicken	m	0 / 27	27 / 0 / 0		c	i / d
1-5-1	buffalo	w	0 / 1	1 / 0 / 0	2 / 2,900		
	swine	m	0 / 4	0 / 0 / 4		co	
1-5-3	buffalo	w	0 / 1	1 / 0 / 0		c	c / i
1-5-4	buffalo	w	1 / 2	3 / 0 / 0		w	d / i
1-6-1	buffalo	w	0 / 4	4 / 0 / 0		w	c / c

	swine	m	0 / 1			co	c / c
	duck	m	80 / 0	0 / 60 / 0		co	c / c
	chicken	m	80 / 0	0 / 30 / 0		co	c / c
1-6-2	buffalo	w	1 / 2	1 / 0 / 2		c,w	d / i
1-6-3	chicken	m	0 / 30	30 / 0 / 0		c	d / i
1-6-4	buffalo	w	1 / 1	2 / 0 / 0		p,w	c / c
1-7-1	buffalo	w	3 / 3	6 / 0 / 0		w	i / d
1-7-2	buffalo	w	0 / 50	30 / 0 / 20	3 / 19,000	c	c / i
	swine	m	35 / 47	35 / 7 / 40	75 / 60,000	co	c / c
1-7-3	buffalo	w	0 / 2	2 / 0 / 0		c	d / i
	chicken	m	0 / 6	6 / 0 / 0		c	d / i
1-7-4	swine	m	41 / 20	13 / 11 / 7	6 / 17,000	co	d / i
	chicken	m	40 / 10	50 / 0 / 0		c	d / i
	duck	m	0 / 60	60 / 0 / 0		c	d / i
1-8-1	buffalo	w	1 / 1	2 / 0 / 0		w	d / i
1-8-2	buffalo	w	1 / 1		1 / 12,000	w	d / i
1-8-3	chicken	m	0 / 50	50 / 0 / 0		c	d / d
1-8-4	chicken	m	0 / 3	3 / 0 / 0		c	d / d
1-9-1	buffalo	w	1 / 0	1 / 0 / 0		w	i / i

1-9-2	buffalo	w	2 / 3	5 / 0 / 0		w	i / i
1-9-3	buffalo	w	1 / 2	3 / 0 / 0		w	c / c
1-10-1	buffalo	w	0 / 1	0 / 0 / 1		c	i / i
	duck	m	7 / 0	0 / 0 / 7		c	i / i
	chicken	m	10 / 0	10 / 0 / 0		c	i / i
1-10-2	buffalo	w	1 / 7	7 / 0 / 0		w	i / i
	chicken	m	20 / 5	25 / 0 / 0		c	i / i
1-10-3	buffalo	w	0 / 3	3 / 0 / 0		w	c / c
2-1-1	duck	m	0 / 7	7 / 0 / 0		c	i / i
	chiken	m	50 / 50	100 / 0 / 0		c	i / i
2-1-2	cattle	w	0 / 4	4 / 0 / 0		w	i / i
2-1-3	buffalo	w	1 / 1	1 / 0 / 1		c,w	d / i
2-1-4	buffalo	w	4 / 3	7 / 0 / 0		c,w	d / i
2-2-1	buffalo	w	4 / 2	1 / 0 / 6	1 / 10,000		c / c
2-2-2	buffalo	w	1 / 2	1 / 0 / 2	1 / 8,000		c / c
	cattle	w	2 / 1	0 / 0 / 3	1 / 1,000		c / c
	chicken	m	3 / 8	0 / 11 / 0		c	c / i
2-2-4	chicken	m	0 / 10	10 / 8 / 0		c	c / i
2-3-1	buffalo	w	1 / 1	0 / 0 / 0		w	d / i

2-3-4	chicken	m	8 / 4	0 / 11 / 12		c	c / c
2-4-2	buffalo	w	4 / 2	6 / 0 / 0		w	c / c
2-5-2	buffalo	w	1 / 2	0 / 0 / 2		w	d / i
2-5-3	buffalo	w	2 / 2	3 / 0 / 1		c,w	d / i
2-5-4	buffalo	w	1 / 1	2 / 0 / 0		w	d / i
2-6-1	buffalo	w	4 / 8	12 / 0 / 0		c,w	i / i
2-6-2	buffalo	w	7 / 9	16 / 2 / 0	2 / 20,000	p	d / i
	chicken	m	9 / 10	7 / 5 / 9	5 / 150	c	d / i
2-6-3	buffalo	w	2 / 1	2 / 0 / 1		c,w	i / i
2-6-4	buffalo	w	1 / 2	2 / 1 / 0	1 / 18,500	p	c / c
	chicken	m	30 / 50	0 / 20 / 80	10 / 500	c	c / c
2-7-1	cattle	m	1 / 4	3 / 0 / 1		w	c / i
2-7-2	chicken	m	0 / 30	0 / 20 / 30		c	c / i
2-7-3	buffalo	w	2 / 1	2 / 0 / 0		w	c / c
2-7-4	buffalo	w	1 / 2	1 / 0 / 2		w	c / i

Legend ; Use-w.work, m.meat
Kind of Food-w.weed, c.crop residue, co.comercial feed, p.pasture
Trend-i.increase, d.decrease, c.constant

Table D-13 Results of the Questionary Survey

- Actual Situation of Sericulture in the Pilot Area -

Farm Code	Mulb. Field	Mulb. Leaves sold/bought	Silkworm Variety	Egg	Rearing From-To	Cocoon Produce	Raw Silk Produce	Sold Amount	Income	Sold Amount
	rai	kg Baht								
1-1-1-1	2	-	local	s	L/7 - L/2	24	6	6	4,200	i/i
1-1-1-2	2	/100kg200B	improved	p	M/5 - E/8	10	-	10	7,000	i/i
1-1-1-3	0.25	-	1	s	M/5 - E/8	4	1	1	600	i/i
1-1-1-4	2	-	i	s	E/7 - M/7	10	3	3	1,800	i/i
1-1-2-1	0.25	-	1	p	E/5 - E/8	24	6	6	3,600	c/c
1-1-2-2	1	-	1	p	E/1 - E/12	48	12	12	8,400	i/i
1-1-2-3	0.75	/150kg150B	i	s	M/6 - L/11	9	-	9	4,500	c/i
1-1-2-4	0.50	/75kg240B	i	s	M/5 - E/8	6	-	6	4,800	i/i
1-1-5-1	2	12kg120B/	i	p	L/5 - L/6	24	-	24	10,800	i/i
1-1-5-2	4	120kg600B/	1	s	E/6 - L/8	60	15	15	10,500	i/i
1-1-5-3	2	-	i	p	E/6 - L/8	24	-	24	12,150	d/i
1-1-5-4	1.25	-	1	s	E/12 - L/2	66	1.5	1.5	900	d/i
1-1-6-1	4	-	1	s	M/5 - E/10	200	50	50	30,000	c/c
1-1-6-3	0.5	-	1	s	L/5 - E/12	24	6	6	4,200	c/i

1-1-6-4	2	/300kg4500B	1	s	E/2 - E/11	48	12	12	7,200	d/i
1-1-8-2	0.5	-	1	s	L/10 - L/8	12	3	3	1,800	i/i
1-1-8-4	0.5	-	1	s	E/10 - E/1	20	5	5	3,000	c/i
1-1-9-3	0.25	-	1	s	E/7 - E/9	4	1	1	600	c/c
1-1-10-1	0.5	/50kg2500B	i	s	M/6 - M/12	20	5	5	2,500	i/i
1-1-10-2	1	-	i	s	L/6 - L/9	12	3	3	1,800	i/i
1-1-10-3	0.25	-	1	s	E/5 - E/6	10	2	2	1,200	c/c
1-1-10-4	1	-	1	s	M/5 - M/10	20	5	5	3,000	d/i
1-2-1-1	2	-	1	s	M/6 - E/9	16	4	4	2,400	i/i
1-2-1-3	2	-	1	s	E/4 - E/12	8	3.5	3.5	2,100	d/i
1-2-1-4	0.5	-	1	s	E/6 - E/9	16	4	4	1,200	c/c
1-2-2-1	1	-	1	s	E/7 - E/12	20	5	3	1,800	i/i
1-2-2-2	2	-	i	s	E/6 - E/9	16		10	7,000	i/i
1-2-2-3	0.25	/350kg	1	s	M/1 - E/12	16	4.2	4.2	2,500	c/i
1-2-3-1	2	600kg/	1	s	E/1 - E/12	20	5	5	3,000	c/c
1-2-3-2	3	-	1	s	E/5 - E/8	12	3.2	3.2	1,320	d/i
1-2-3-3	1	-	1	s	E/1 - M/8	48	12	textile	-	c/i
1-2-4-1	1	-	1	s	E/7 - E/10	18	4.5	4.5	2,700	d/i
1-2-4-2	1		1	s	E/8 - M/10	18	4.5	4.5	2,700	c/c
1-2-4-3	0.25	-	1	s	E/9 - L/12	3	1	1	600	i/i

1-2-5-1	0	/400kg	1	s	E/7 - E/12	3.6	0.9	0.9	450	c/i
1-2-6-1	1.25	-	1	s	L/10 - E/12	10	2.4	textile	12,900	d/i
1-2-7-1	2	-	1	s	E/7 - E/12	30	7.5	7.5	3,375	c/c
1-2-7-3	0.5	-	1	s	E/5 - E/8	3	2	2	980	c/c
1-2-7-4	2	375kg/	1	s	M/10 - M/11	8	2.2	2.2	2,000	c/c

Legend ; Egg - p.purchased, s.self supplied

Table D-14 Result of the Questionary Survey

- Actual State of the Aquaculture in the Study Area -

Farmer Code	Pond Size rai	Pond Size m	Kind of Fish	Raising Period	Feed	Produce kg	Sold kg/Baht	Fly Number/Baht	Trend	Obstacles
1-1-4-2	1	1	carp	L/6 - E/12	co	250	-	1,500 / 3,000	d/i	extension
1-1-6-1	4	3	dace, carp	E/5 - E/5	co	-	-	3,000 / 1,000	c/c	
1-2-1-1	6.5	2	dace, snakehead	M/6 - E/12	co	500	250 / 6,250	25,000 / 3,000	d/i	drought
1-3-2-3	2.0	1.5	dace, crarp	E/6 - E/12	co	100	30 / 750	2,000 / 200	d/i	
1-4-2-2	1	1	chinese carp	E/5 - M/2	co	250	110 / 2,200	/ 500	d/i	drought
2-1-5-1	0.25	2.5	chinese carp	E/6 - E/1	co	900	150 / 4,000	23,000 / 300	i/d	drought
2-2-4-4	0.75	1.5	dace, carp	E/6 - E/12	co	150	130 / 2,600	500 / 150	c/i	desease
2-2-5-3	1.25	1.0	dace, milkyfish	E/6 - E/1	co	50	20 / 500	3,000 / 300	c/i	
2-2-6-1	2	1.5	carp, snakehead	E/8 - L/2	co	200	150 / 3,750	3,000 / 300	i/d	drought
3-1-3-1	1	1.5	dace, chinesecarp	E/4 - E/4	co	100	-	4,000 / 400	d/i	
3-1-3-2	1	2	dace, chinesecarp	E/6 - E/3	cr	40	30 / 750	300 / 30	c/i	
3-1-5-2	2	1.2	dace, chinesecarp	L/5 - E/11	co	1,500	1,250 / 25,000	2,000 / 200	c/c	drought
3-1-7-1	3	1.2	carp, snakehead	E/5 - E/4	cr	315	250 / 11,000	/ 1,440	d/i	extension
3-1-7-2	2	1	dace, snakehead	L/6 - M/3	co	300	200 / 6,000	4,040 / 440	c/i	
3-1-7-4	0.5	1.2	dace, chinesecarp	E/6 - E/9	co	180	80 / 2,000	2,000 / 200	c/c	drought
3-1-9-2	1.5	2	dace, carp	E/6 - E/9	co	500	350 / 10,500	800 / 200	c/c	drought
3-1-9-3	3	1.2	dace, carp, clibming fish	E/6 - E/2	cr	175	150 / 3,000	3,000 / 300	d/i	drought

Legend; Feed co. commercial feed, cr. crop residue, animal dung

Table D-15 Results of the Questionary Survey

- Actual Situation of the Cash Crop Culture -

Village Code	Crop, Growing Period	Area	Produce	Income	Land Cost	Seed	Fuel, Machine	Fertilizer	Pesticide	Wage
		rai	kg	Baht	Baht	Baht	Baht	Baht	Baht	Baht
1-1-5	watermelon seed	11.5	356	70,700	343	211	740	4,400	3,112	250
1-2-6	E/2-E/5	(2.3)	(71)	(14,140)	(69)	(42)	(148)	(880)	(622)	(50)
2-1-5	E/6-E/8							15-15-15	Furadan	
5 farmers								875kg(175)		
2-1-5	Tomato seed	1.5	12.9	38,800	2	685	483	1,650	850	480
2-2-7	L/10-E/4	(0.38)	(3.2)	(9,700)	(0.5)	(171)	(121)	(413)	(213)	(120)
4 farmers								15-15-15	Furadan	
								330kg(83)	Polidon	
1-3-2	Pasture seed	73.5	5,368	210,080	1,212	5,475	5,698	13,000	116	9,300
1-3-5	E/6-E/1	(3.7)	(268)	(10,504)	(61)	(274)	(285)	(650)	(6)	(465)
1-4-3								15-15-15	2 farmers	
1-5-1								2,291kg(115)		
1-5-4										
1-5-5										
20 farmers										

1-2-1	kenaf	41	2,927	65,150	2,672	1,405	3,975	855	-	10,578
1-3-1	E/5-E/2	(6.8)	fibre	(10,858)	(445)	(234)	(663)	(143)		1,763
			32,667					1 farmer		
1-3-6			stalk							
6 farmers			547							
			seed							
2-2-4	sugarcane	24	151,637	90,850	100	10,570	29,700	8,225	550	10,578
3 farmers	E/2-E/4	(8)	(50,546)	(30,283)	(33)	(352)	(9,900)	(2,741)	(183)	(1,763)
	E/7-M/10							15-15-15	Furadon	
								1,430kg(477)		
2-2-4	mango	6	3,000	10,500	30	2,500		750	150	100
1 farmers	3rd year							15-15-15	sodin	transport
								150kg	1,000cc	

Table D-16 Number of farmers who have intension of increasing production on each grep

village code/crops	1	2	3	4	5	6	7	8	A	B	C	D
											%	%
rice	11/40	13/26	8/13	11/23	6/18	3/16	4/32	6/34	62	202	31	92
cassaba	2/5	2/5	1/3	1/4	7/14	-	3/16	7/31	23	78	29	3
kenaf	-	1/2	0/4	-	1/1	-	-	-	2	7	29	3
sericulture	20/25	11/17	3/6	0/1	0/2	1/2	1/2	1/9	37	64	58	29
buffalo	17/25	10/16	8/13	4/8	4/11	8/15	8/24	10/27	69	139	50	63
cattle	1/1	2/3	4/9	1/4	4/5	3/5	6/9	3/6	24	42	57	19
chicken	8/12	4/6	-	2/3	3/5	2/2	2/3	1/2	22	33	67	15
swine	2/4	1/1	1/2	-	-	1/1	1/3	0/4	6	15	40	7
hourse	-	-	-	-	-	-	2/2	-	2	2	100	1
duck	-	1/1	-	-	-	-	1/1	-	2	2	100	1
fish	1/2	1/1	1/1	1/1	-	0/1	2/3	5/8	11	17	65	8
pasture seed	-	-	0/2	2/4	6/11	-	1/2	0/1	9	20	45	9
watermelon	2/3	0/1	-	-	0/2	-	-	-	2	6	33	3
chili	0/1	-	-	-	-	-	-	-	0	0	-	1
tomato	-	-	-	-	-	0/2	1/2	-	1	4	25	2
onion/vegetable	0/1	-	-	0/1	-	-	-	-	0	2	0	1
sugarcane	-	-	-	-	-	-	0/3	-	0	3	1	0
mango	-	-	-	-	-	-	0/1	-	0	1	0	-

Notices; 1-8 Tambon No. Numerator shows the number of farmers who intend to increase production, Denominator shows number of growing farmers of each crop, A; total of numerators, B; total of denominators, C; A/B, D; B/total farmhouse (220 farm houses).

Table D-17 Obstacles in the Farm Management

	Obstacle	Paddy	Paddy nursery	Upland srops	Livestock	Seri -culture	Raising fish
Study area except Pilot area	Pest	20	12	10	16	1	-
	Droght	105	79	30	-	-	6
	Saline s.	47	17	1	-	-	-
	Others	-	-	1	6*	-	1
Pilot area	Pest	7	6	-	10	1	-
	Drought	40	24	5	1	1	1
	Saline s.	28	7	-	-	-	-
	Others	-	-	-	1	-	-
Total	Pest	27	18	10	26	2	-
	Drought	145	103	35	1	1	7
	Saline s.	75	24	1	-	-	-
	Others	-	-	1	7	-	1

Source; Questionary survey

Notes; Figures- Number of the answered farmer

*-Shortage of feedstuf

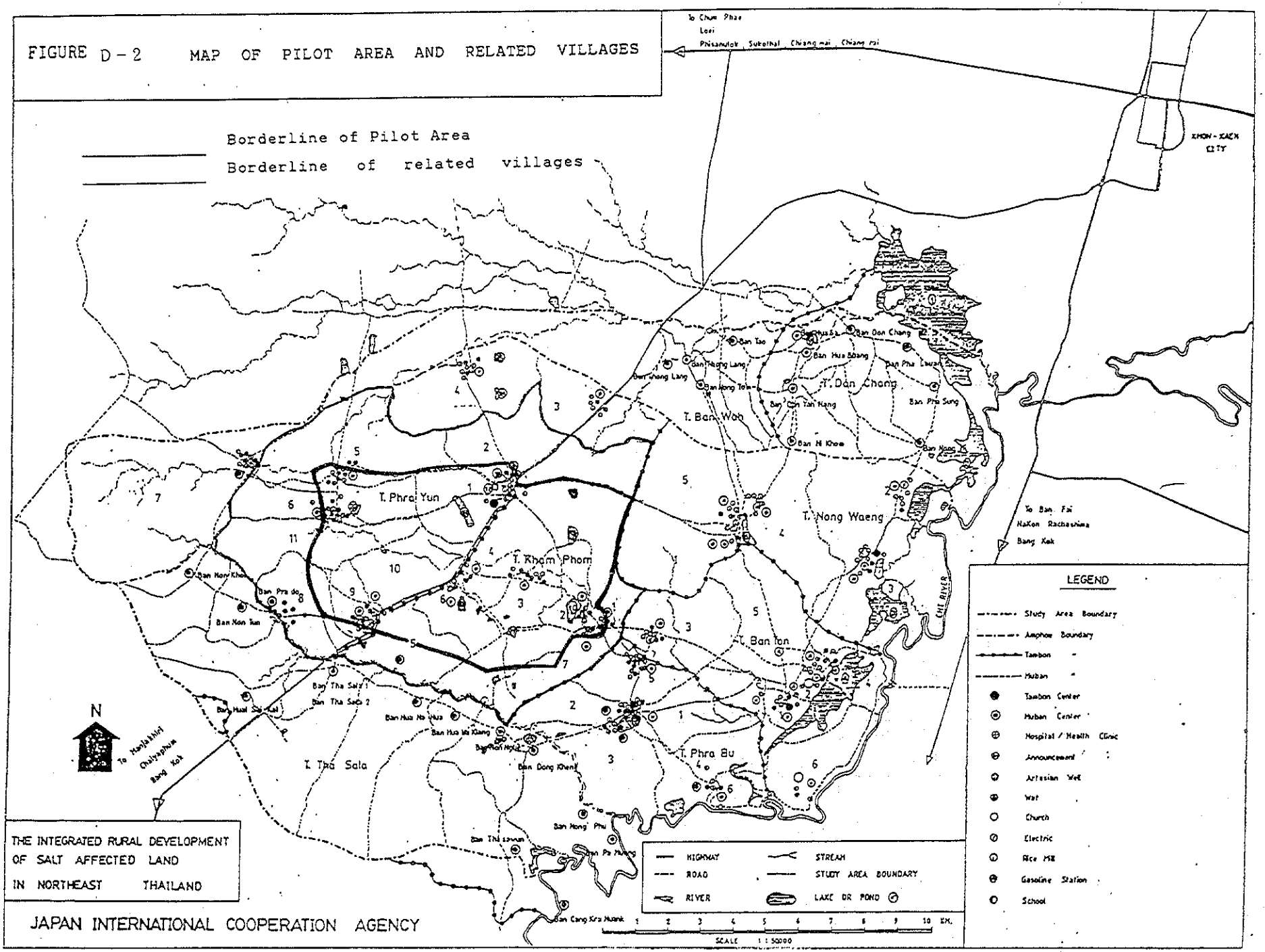


FIGURE D - 2 MAP OF PILOT AREA AND RELATED VILLAGES
Borderline of Pilot Area
Borderline of related villages
To Chum Phae
Loei
Phisanulok Sukothai Chiang mai Chiang rai
KHON - KAEN CITY
T. Phra Yun
T. Ban Wan
T. Dan Chang
T. Nong Waeng
T. Kham Phom
T. Ban Ton
T. Tha Sala
T. Phra Bu
To Ban Fai
NaKon Ratchasima
Bang Kok
To Nakhonsi Chaiyaphum Bang Kok
CHI RIVER
N
LEGEND
Study Area Boundary
Amphoe Boundary
Tambon "
Muban "
Tambon Center
Muban Center
Hospital / Health Clinic
Announcement
Artesian Well
Wat
Church
Electric
Rice Mill
Gasoline Station
School
HIGHWAY
ROAD
RIVER
STREAM
STUDY AREA BOUNDARY
LAKE OR POND
SCALE 1 : 50000
THE INTEGRATED RURAL DEVELOPMENT OF SALT AFFECTED LAND IN NORTHEAST THAILAND
JAPAN INTERNATIONAL COOPERATION AGENCY

D-2. Agricultural Development Plan

D-2-1. Development Strategy

Table D－18 Identified Market Opportunities

For Local Consumption	For Rest of Thailand	For Export (1)	For Local Processing
Fish/Meat Sugar	Meat	Meat	Meat Sugar Cassava Animal Feed Alcohol Glucose
Fruit Vegetables	Fruit Maize	Fruit Vegetables Maize	Fruit Canning Vegetables Canning Maize Animal Feed
Fuelwood	Poles	Poles	
Timber	Timber		
Rice		Rice	Rice
Soya	Vegetable Oil		Soya
Dairy Products		 Silk	Dairy Products

(1) Quality control procedures will form an important part of implementation to ensure that acceptable standards are maintained.

D-2-2 Crop and Yield

Table D – 1 9 Production and consumption of major food commodities in the North East this year and in 2002

	1987			2002		
	Production	Consumption	Shortfall	Production	Consumption	Shortfall
Paddy Rice	7,356	5,544	-	8,712	6,535	-
Protein:	54	191	137	62	316	254
Fish	64	68	4	74	113	39
Vegetable	32	69	37	40	114	74
Total	150	328	178	176	543	367
Fruit/ Vegetables	624	571	-	709	744	35
Edible Vegetable Oil	48	76	28	56	126	70

Unit: '000 Tonnes per Annua

Table D-20 Supply and Demand of Silk in Thailand

		1986	1987	1988	1989
Warp	Domestic production (t)	60	86	140	225
	Import amount (t)	131	267	310	352
	Import value (million baht)	184	374	443	493
	Import price (10,000 baht)	140	140	143	140
	Production + Import (t)	191	353	450	577
Woof	Domestic production (t)	949	990	1,022	1,100
	Import amount (t)	360	742	760	673
	Import value (million baht)	252	519	532	471
	Import price (10,000baht)	70	70	70	70
	Production + Import (t)	1,309	1,732	1,782	1,773
	Warp/warp+woof (%)	13	17	20	25

Source; Department of Agriculture, Sericultural division

Table D-21 Export Value of Silk Fabrics (1,000baht)

Year	Amount of money
1983	163,349
1984	159,019
1985	202,934
1986	251,751
1987	317,435

Source; Sericulture in Thailand, 1990

Table D-22 Salt and Drought Tolerance of Crops

Crops	Salt	Drought
Rice	M	W
cassava	M	S
soybean	W	W
groundnut	W	S
corn	M	S (W)
sugar cane		S
tomato	S	S (W)
asparagus	S	S
watermelon	M	S
chili	M (W)	
mulberry		S
tamarind	S	
mango	M	S
cashew	M	S
papaya	M	S
hamata		S
ruzi grass		
sesbania	S	
atriplex	S	S
Leucaena		S

S; strong M; medium W; weak

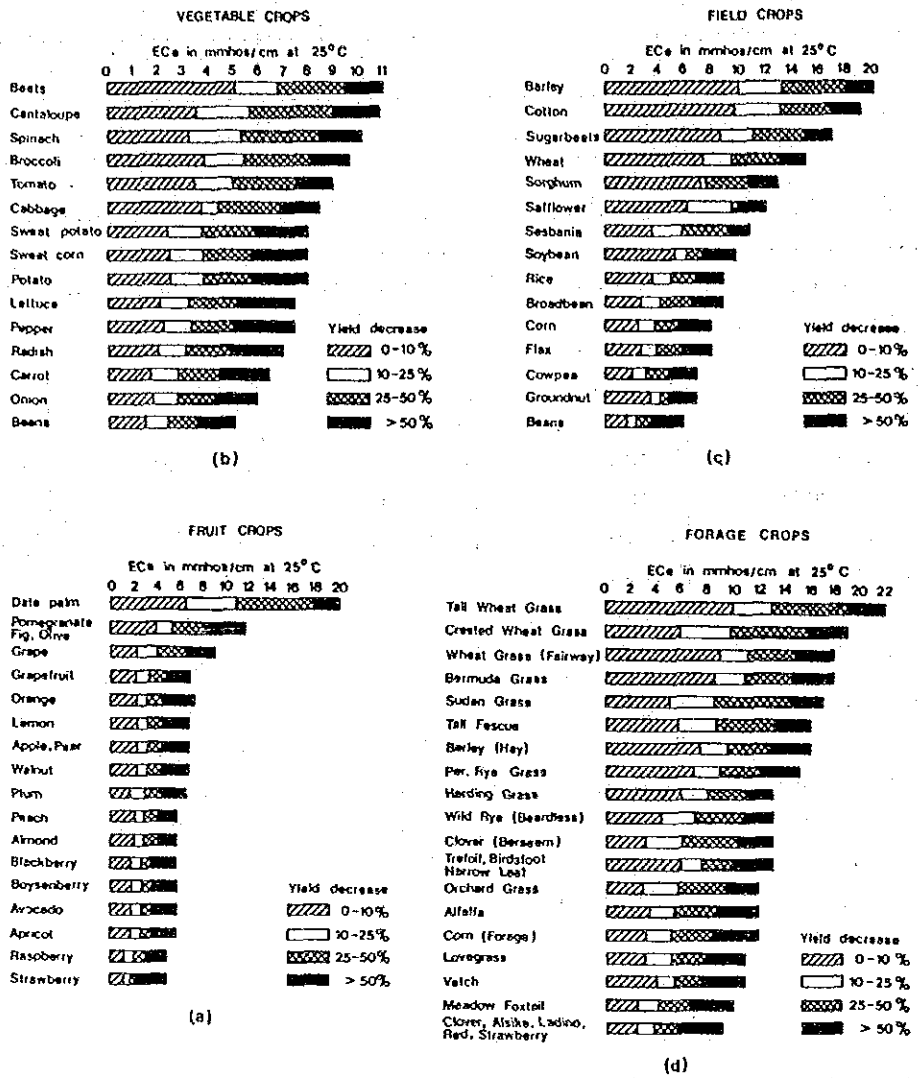
Table D-23 Salt Tolerance of Crops

EC(mmho/cm)	2.....4	8		12	16
Salt %	0.12.....0.25			0.5 0.75	1.0
Salinity	Slightly S.	Moderately Saline		Highly Saline	
Symptoms	Some crops show symptoms	All crops show symptoms		Only salt tolerant crops can grow	
Vegetables	Yard long bean Lettuce Celery Bell pepper Radish Cucumber Cucurmis (melon)	Squash Sweet pepper Garden pea Guard Onion Maize Grape	Cauliflower Cabbage Potato Garlic Shallot Musk melon Water melon	Spinach Braccoli Chinese radish Carrot Tomato Cowpea	Asparagus Kale Sweet basil Beetroot Ipomea spp. Coriander
Field and Foliage crops	Mung bean Goundnut Green pea Broadbean Sesame Soy bean Red bean Black bean	Rice Flax Sunflower Corn Sorghum Butterfly	Jute Mulberry Pineapple Cassava Safflower Pea	Sesbania Speciosa Sesbania spp. Coastalbermuda grass S. aculeata Salt tolerant rice* Sweet potato	Cotton Nipa palm Sedge Bermuda grass Hybrid napier grass
Fruit and fastgrowing	Avocado	Banana Lychee Lemon Orange Mango	Pomegranate Jambule Olive Guava Sesbania spp. Fig Eucalyptus Cashew nut Otaheite Gooseberry Teminalia spp.	Sapodila Jojoba Tamarind Coconut Oil palm	Acacia Date palm Causorina spp. Neem Camachile

Source; Soil Salinity Research Organization DLD

* Khao Dawk Mali 105, RD-6, RD-8 RD-7

FIGURE D - 3 SALT TOLERANCE OF VARIOUS CROPS TO SALINITY AS MEASURED IN THE SATURATION EXTRACT ECe



Source: Maas and Hoffmann 1977; James et al 1982.

Table D-24 The Canopy Area of Tree in Hedgerow Intercroping
(in the case of 40 x 40m)

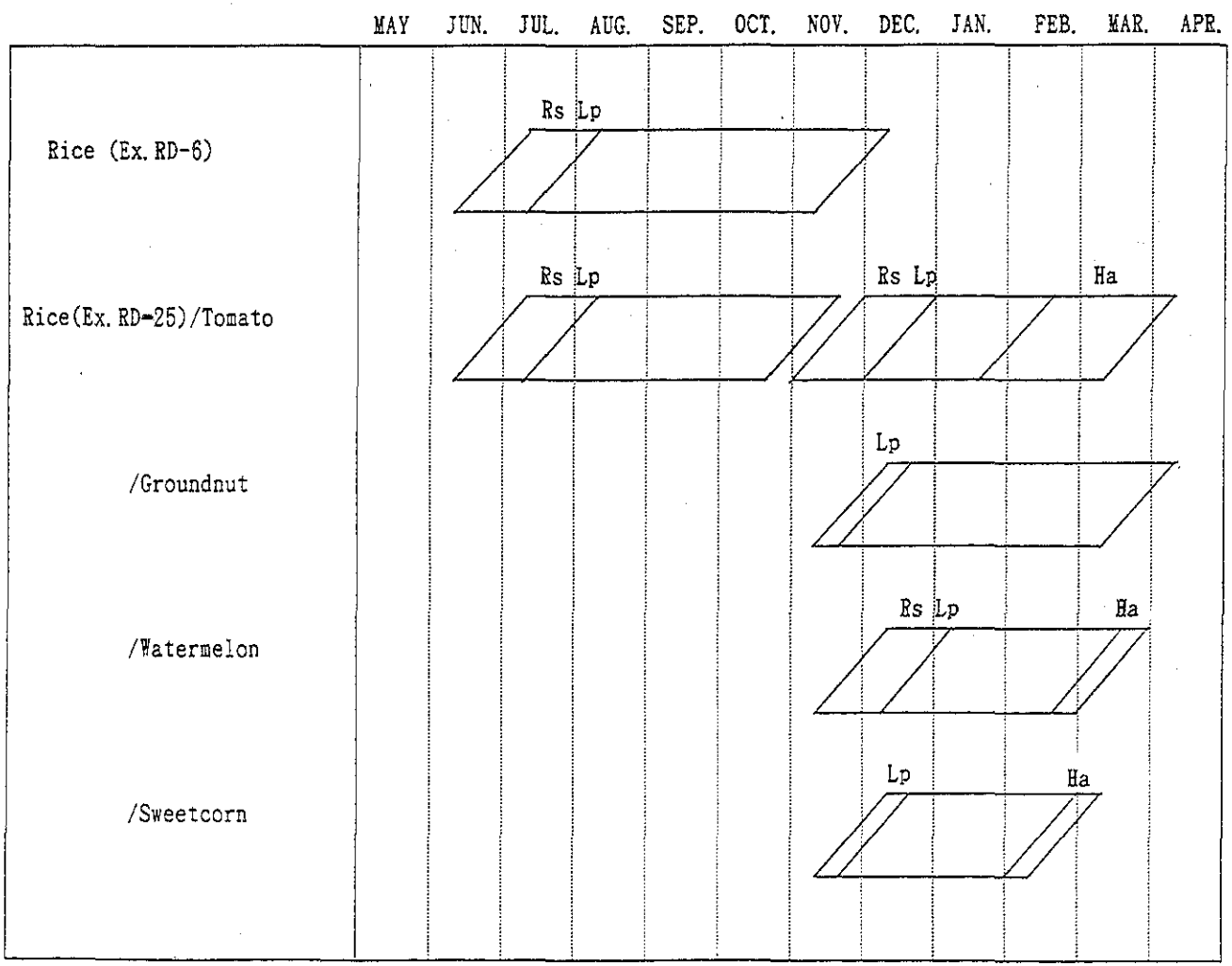
	Rows distance 10m			Rows distance 4m		
Number of rows*	7	7	7	11	11	11
Length of row (m)	40	40	40	40	40	40
Width of row (m)	1.0	1.5	2.0	0.75	1.0	1.5
Area of row (m2)	280	420	500	330	440	660
Area of row (% in rai)	18	26	30	21	28	41

* Field is enclosed with tree rows

FIGURE D-4 Major Crops and Their Cropping Calender in Each Amphoe

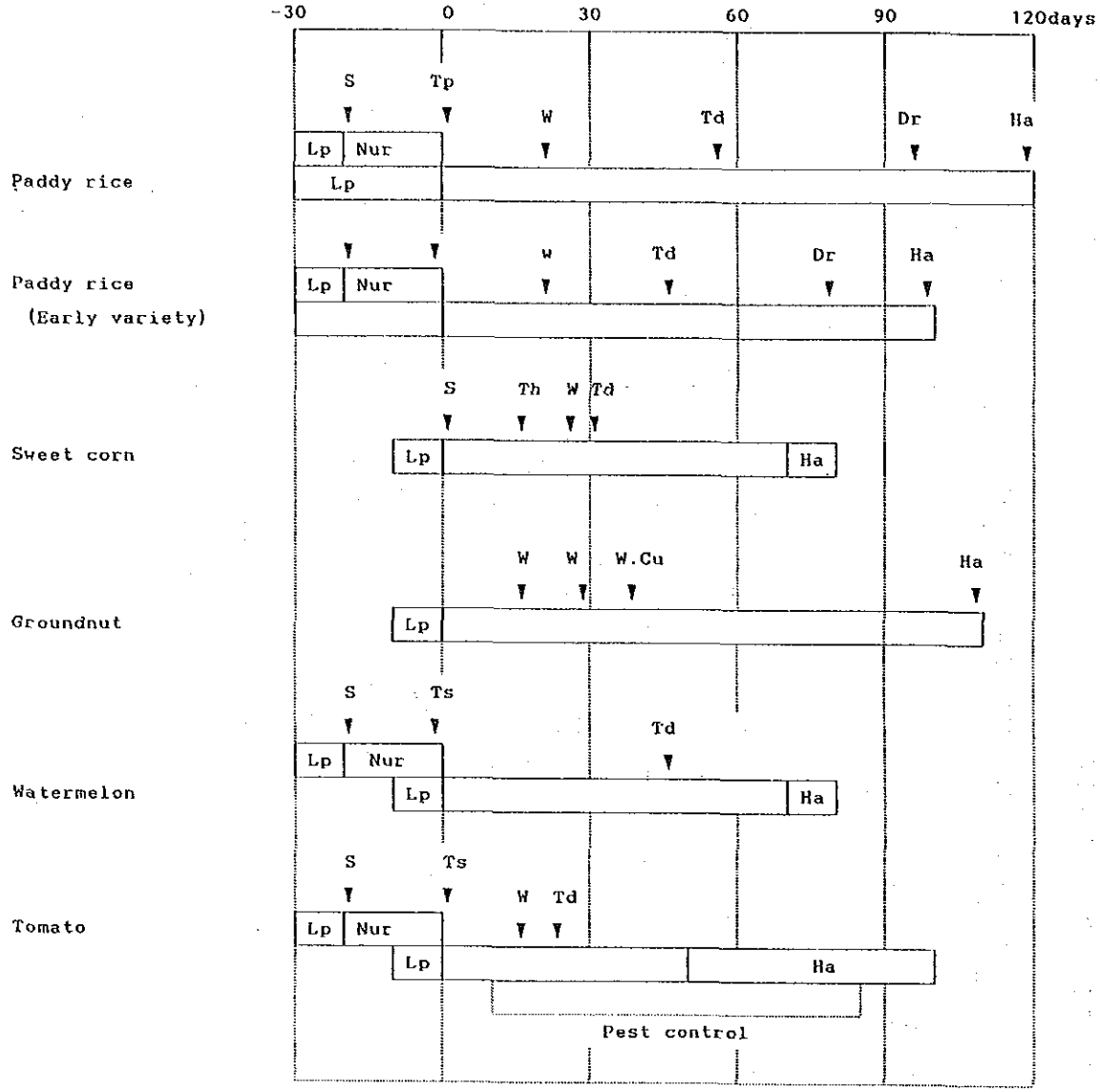
Anpha	crop	1	2	3	4	5	6	7	8	9	10	11	12
Phra-yun	rice												
	cassava												
	kenaf												
	buffalo												
	sericulture												
Phra Bu	rice												
	kenaf												
	buffalo												
	sericulture												
Ban Ton	rice												
	cassava												
	Sericulture												
	buffalo/cattle												
Nong Waeng	rice												
	cassava												
	kenaf												
	ruzi grass												
	chicken												
	fish												
Ban Wa	rice												
	cassave harvest												
	tilage												
	growing												
	livestock												
Don Chang	rice												
	cassave												
	rice (second)												
	corn (dry)												
	house industry												
Mancha Khiri	rice												
	cassave												
	(harvest)												
	Buffalo/chicken												
	sericulture												
	fish												
	vegetables												
	fruits												

FIGURE D - 5 CROPPING PATTERN IN THE PILOT AREA



Notes, Lp-land preparation, Rs-Raising of seedling, Ha-harvesting

FIGURE D - 6 CALENDER OF FARMING PRACTICES



Notes; Lp;Land preparation, Nur;Nursery, Ha;Harvest, S;sowing, Tp;Trans planting, W;Weeding, Td;Topdressing,Th;Thinning, Cu;Cultivation,Dry; Dry up

FIGUR D – 7 LABOR REQUIREMENT (MAN.DAY/RAI)

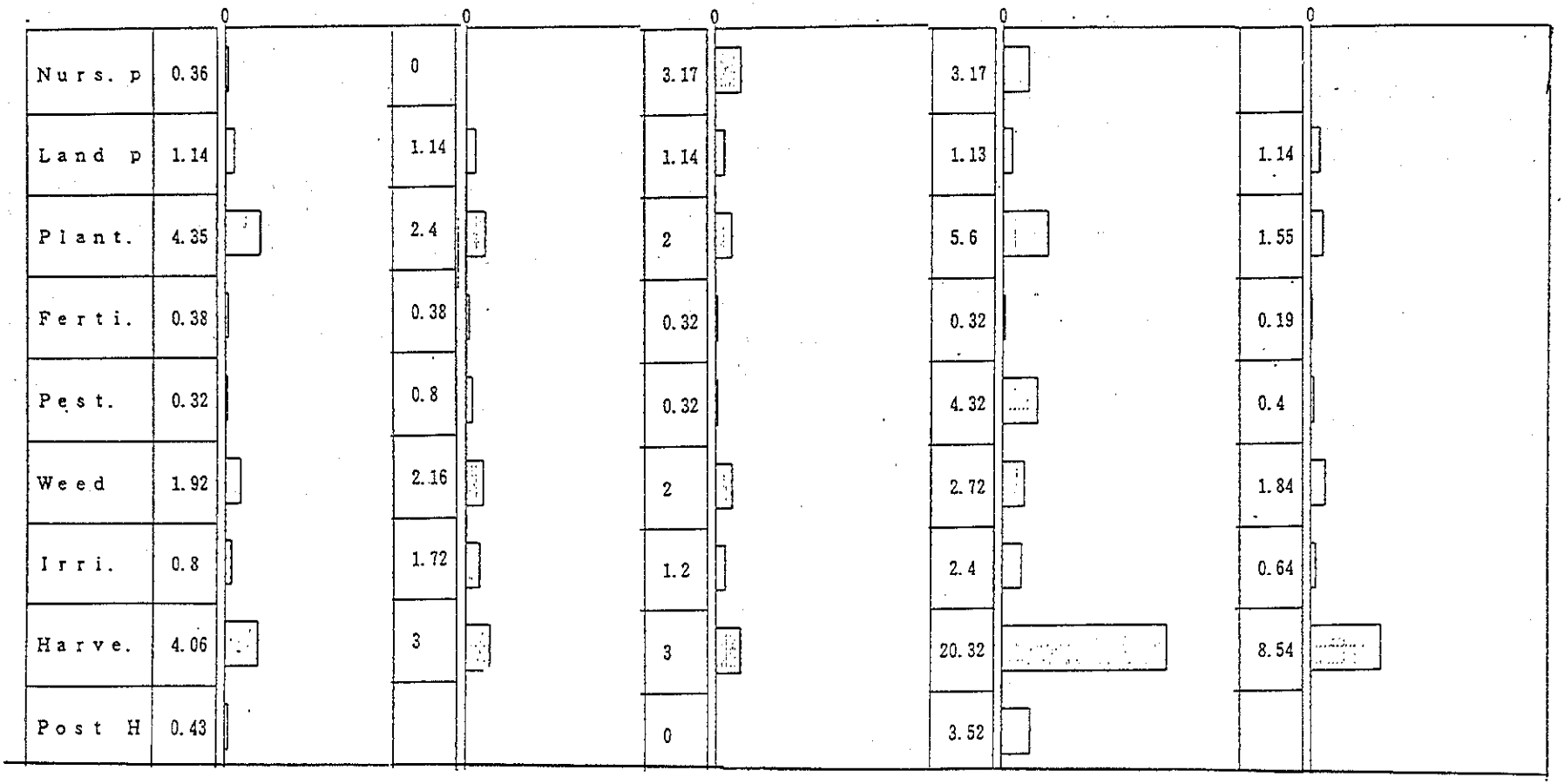


Table D-25 Input Material and Labor (per rai)

Crop	Fertilizer	Pesticide	Others	Manpower
Paddy rice (under irrigation)	basal dressing 16-20-0 20kg Topdressing 45-0-0 7kg	Seed disinfection e.g. Ditane 0.25kg Insecticide e.g. Furadan 0.1l	Seed 16kg	14 man day Period 150 days
Tomato	For seedbed Urea 2kg Compost,Lime Basal d. 15-15-15 20kg Ammonium sulfate 33kg Comost 2ton topd. 15-15-15 20kg	Insecticide e.g. Furadan 5kg e.g. Malathion 0.5l Fungicide e.g. Difoltan 1.2kg	Seed 30g	44 man day Period 130 days
Watermelon	Basal d. 15-15-15 50kg Top d. 13-13-21 50kg	Insecticide e.g. Furadan 5kg	Seed 50g	13 man day Period 110 days
Sweet corn	Basal d. 16-16-8 40kg Top d. 16-16-8 20kg	Seed disinfection e.g. Abpron 20g	Seed 3-4kg	12 man day Period 90 days
Groundnut	Ammonium sulfate 15kg Superphosphate 45kg Potassium chloride 10kg	Insecticide Monocrotophos 40-50%, 30-50cc	Seed 20kg	15 man day Period 120 days

Table D－26 Labor Requirement for Cropping in Dry Season (Man-Day)

Crop	NOV.		DEC.		JAN.		FEB.		MAR.		Total
Tomato	nurse	3.17	plant	5.6	pest	2.00	pest	1.32	irri.	0.60	
(for 1 rai)	land p.	1.13	fertiliz.	0.32	irri.	0.60	irri.	0.6	harvest.	7.00	
			weed	2.72	harvest.	3.32	harve.	10.0	post h.	3.52	
			pest	1.00							
			irri.	0.60							
Total/rai		4.30		10.24		5.92		11.92		11.12	43.5
For 3 rai		12.90		30.72		17.76		35.76		33.36	130.5
Groundnut	land p.	1.14	fertiliz.	0.19	pest	0.20	irri	0.20	harvest	8.54	
(for 1 rai)	plant.	1.55	weed	1.84	irri	0.24					
			pest	0.20							
			irri	0.20							
Total/rai		2.69		2.43		0.44		0.20		8.54	14.3
For 7 rai		18.83		17.01		3.08		1.40		59.78	100.1
Tomato3rai Groundnut7rai		31.73		47.73		20.84		37.16		93.14	230.6

Table D－27　Estimation of the Storage Water in the Small Farm Pond (mm)

Month	Received Water ①			Lost Water ②		① - ②	Storage Water
	Rain Fall	Catchment	Total	Evaporate.	Leakage		
May	139.1	379.7	518.8	196.5	289.5	229.3	229.3
Jun.	145.1	396.1	541.2	171.4	261.4	279.8	509.1
Jul.	126.1	344.3	470.4	165.5	258.5	211.9	721.0
Aug.	151.7	414.1	565.8	150.0	243.0	322.8	1043.8
Sep.	226.5	618.3	844.8	137.0	227.0	617.8	1661.6
Oct.	71.1	194.1	265.2	152.3	245.3	19.9	1681.5
Nov.	11.4	31.1	42.5	151.0	241.0	▲ 198.5	1483.0
Dec.	2.2	6.0	8.2	152.4	245.4	▲ 237.2	1245.8
Jan.	3.4	9.3	12.7	154.2	247.2	▲ 234.5	1011.3
Feb.	13.2	36.0	49.2	161.4	245.4	▲ 196.2	815.1
Mar.	23.9	65.2	89.1	211.7	304.7	▲ 215.6	599.5
Apr.	54.6	149.1	203.7	216.6	306.6	▲ 102.9	496.6

Prerequisite; Make a 0.5rai pond in 7rai field,
30% of rain fall run off on the ground,
70% of run off water flow into the pond,
Leakage from pond is 3mm/day,
Evaporation from the pond is same as the vale of meteorological oobservation.

Table D-28 The Livestock Raising Plan in the Pilot Area

Land use plan	Area	Feeding ability		Max. Feed heads		Present state
		Dry seas.	Wet seas.	Dry seas.	Wet seas.	
	ha	head/ha	head/ha	head	head	head
Paddy (irrigated)	322	0.53		172		
Paddy (rainfed)	1,792	0.35		627		
Grazing land (saline)	210	0.53	1.86	111	391	
Fruit+Tree	180					
Mulberry+Tree	360					
Upland crops+Tree	500	0.47		235		
Grazing land+Tree	800	1.04	3.7	832	2,960	
Total				1,977	3,351	1,570

Notes; Average live weight was estimated at 400kg, TDN requirement was 1460kg/year. TDN of rice straw and pasture (include fodder tree) was estimated at 38%, 50% of dry matter repectively.

Reference D-1 Outlines of the Proposed Farming Systems

(1) Stabilization of rice production and introduction of double cropping under irrigation.

In the study area, 56% of the cultural land are for paddy fields, but because of water shortage a half of them remain without planting even in usual years.

The annual rice production is very unstable due to the irregular rainfall pattern. In a drought year most farmers can not harvest rice enough for their self consumption In the dry season there is no agricultural works for crops except for peennial crops such as cassava and mulberry. Farmers, therefore, have to go for migrant works in towns.

Practice :

Introduction of the irrigation system to paddy fields,

- Stabilization an increasing of the rice yield by supplemental irrigation in the rainy season

- Application of planting field crops under irrigation after rice harvest in the dry season.

Kinds of expected growing crops and corresponding growing practices are shown in Figures D-3,4,5. Protection from the salt affect should be considered for the cropping in dry season.

Effect :

By the supplementary irrigation.

- The ratio of rice planting area will be raised to 100% from the present level of 40%.

- With these intensive farming practices the growth and yield will be increased to 1.7-2.0 times of the present yield.

By the irrigation in dry season,

- By the diversification of crops, the creation of job-oppotunities in dry season can be obtained.

- The development of intensive agriculture, therefore, will be applied.

(2) Integrated farming with small farm pond(s)

In the study area there are many places where farmers can not receive the merit of a irrigation system. In this case the small farm pond will be usefull,

Practice :

Usually the size of pond approximately 1 rai. Its depth, is approximately 2 m, depending on farmers choice. A catchment area should be made to store full water in the pond.

This water will be used for following purposes:

- Supplementary irrigation to rice nursery.
- To grow fruit trees and vegetables around the pond,
- To raise fish.

Effects :

The small farm pond will accelerate the diversification of crops and the integrated agriculture.

(3) The sustainable field crop production

In the study area upland crops, mainly cassava, are grown without fertilizer. Its yield is decreasing year by year. The effet of fertilizer, however, is confirmed by various experiments. But the low price of cassava could not permit the payment for fertilizer. A low input method, therefore should be introduced to sustain the land productivity and crop yield for a long term.

Practice :

Intercropping of manure trees and shrubs such as leucaena and sesbania is adopted. The in trimed branches will be used for mulching the soil surface.

Fruit trees (mango, tamarind, jack fruit) planting in mixed, dispersed methods and around the fields is adopted upon farmers'choice.

Effect:

- Level up of the soil fertility and yield, decreasing of soil erosion
- Increasing of the land utilizing ratio in the upland
- Diversification of crop, increasing and stabilization of the farmers income

(4) Development of sericulture

In the study area, the introduction of profitable cash crops is expected mulberry is one of these candidate crops. At present the traditional type of sericulture using polyboltine silkworm is practiced in this area. Local women reel raw silk from cocoon tread at home. Another type of sericulture using bivoltine silkworm is increasing rapidly in the Northeast.

Practice:

Both types of sericulture will be developed.

Standards for bivoltine sericulture are proposed that the mulberry field is 4 rai, rearing time is 5 a year and the production of cocoon is 240 kg in a year.

Standards for polyvoltine sericulture are proposed that the mulberry field is 1.5 rai, rearing time is 5-6 a year, production of cocoon is 60 kg and 10 kg of raw silk reeled from the cocoon.

Effect :

Sericulture will bring-job opportunities for women, a higher income per land area. and - a value added to products by reeling and weaving. Besicles, mulberry trees are considered tolerant to drought.

(5) Production of animal feedstuff in the agroforestry system

In the study area buffalo and cattle are feeded by wild grass and residues of agricultural production such as rice straw etc. Farmers want to increase the number of cattle heads but this is restricted by the feedstuff shortage. In order to increase their animal heads the production of more feedstuff is necessary.

There is a wide salt affected land area without cropping in the study area proper for this purpose.

Practice :

In the proposed agroforestry system, the establishment of grazing land for meat cattle, and the introduction of fodder and shade trees combined with pasture is adopted.

By this utilization of the salt affected waste land, the introduction of some salt torelant crops such as Atriplex spp. for feedstuff is adopted.

Effect :

Development of live stock for meat production in this area.
Utilization of salt affected waste land.

Reference D-2 Outlines of Ban Pa Mo

- Present situation of the Agriculture in Pa Mo village - -

(1) Population; 1651 (Male 722, Female 935)
Household; 255 (6.5 persons/household)

Total area; 4.731

Cultivated land	-	4,481 (17.5 rai/household)
Paddy field	-	2,500 rai
Upland field	-	1,500
orchard	-	276
living land	-	250
communal land	-	205

(2) Average agricultural income per household

From major crops (cassava, rice)	5,000-10,000	baht/year
From livestock	2,000	baht/year
From sericulture	5,000	baht/year

(3) Group and organization in the village

Farm agricultural group
House-keeping group
Sericultural farmer group
Mulberry growing group
Rice bank
Cattle/Buffalo group
Young farmer group (4H club)
Marketing demonstration center
Rural chicken raising farmer group
Weaving group
Nutrition group
Agricultural production group
Agriculture equipment service group
Fertilizer group
Mobile farmer group

(4) supply of materials to farmhouses

Fertilizer; from Agricultural Cooperative Association
Herbicide; from the store supported by the government
Seed; from the store supported by the government

Feed for livestock- from the stores and rice-mills

(5) Present situation of rice production

Popular varieties;
Glutinous rice-K.Kh 6
White rice-Sanpatono, 105 Pok Mali,K.Kh 15
Native variety-Ehuang Hai,Kaw lamplang choedang
(K.Kh 6 planted area is about 1500 rai)

Farming practices;
Transplanting and direct seeding
Fertilization-manure and chemical fertilizer
16-20-0, 16-16-8, 18-12-6 15kg/rai
46-0-0 is used for top dressing
Insecticide- Furadan, Foridol, Marathon, Asodarin

Yield

Nonglutinous rice	upper area	200-250 kg/rai
	lower area	300-400
Glutinous rice	upper area	200-250
	lower area	300-400

Consumption;

Total rice production	100 %
Home consumption	50-70 %
Sold amount	30-50 %

50% of farmers are selling rice through middle-man

(6) Obstacles and countermeasures in the rice production

Obstacles;
Low fertility and salt affected soils
Insect damage and disease injury
Shortage of rainfall amount
Native variety

Countermeasures
Application of fertilizer and manure
Training of rice growing technique and Enlightenment
Extension of upland rice culture
Extension of good varieties
Maintenance of the Nursery bed

(7) Upland crops

Fertilizer;	cassava	16-20-0 15kg/rai
	kenaf	15-15-15 15kg/rai

sugercane 13-13-12 15kg/rai

Expected yield; cassava 2-3t/rai
Obstacles; For cassava, Furactuation of the price

For kenaf, shortage of water for the processing and lower price

For sugarcane, much labor, transportation and lower price

Countermeasure; To replace upland annual croups with mulberry and fruit tree

(8) Fruit trees

Kind of Fruit; mango, juckfruit, coconut, papaya, lemon banana
Growing practice of mango

Varieties : Khuo-Sawoci, Nong Sang, Rad, Thong Dam are recommended.
: Some farmers carry out irrigation, application of fertilizer and pesticide but no trimming.

Consumption ; Almost of the produce fruits are consumed in their home.

Obstacles ; Lack of the knowledge on the fruit tree culture
Damage by disease and insect pest
(For papaya, spot-leaf disease spread)
Shortage of the good varieties
Shortage of the water

Countermeasures: Enlightenment and training
Formation of the demonstration garden
Supply of the good variety

(9) Mulberry

240 farmers (95% of total farmhouse) are growing mulberry tree, average area per farmhouse is 3 rai

Recommended varieties; Noi, Ta Dam
Maintenance; Chemical fertilizer 15-15-15, 46-0-0, 16-20-0
Harvested leaves: Used for their silkworm rearing
Sometimes sell to the others (3 Baht/kg)
Obstacles; Root rot disease and trunk boller damage

(10) Sericulture

Farmers grow silkworm and produce the handmade raw silk and silk textile.

Native variety (polivoltine silkworm) are grown.

Rearing practices; Silkworm rearing is carry out 6 times a year (20-25 trays per one rearing time) from May to next March.

Feeding is carry out three times a day.

Production; 2.5kg cocoon per one rearing time 15kg per year
3kg raw silk/year/farmhouse
1kg raw silk is 600-700 baht

Farmers Request; Good silkworm variety
Control of Taoe disease
Improvement of the reeling machine
Training for the Mudmee Silk manufacture

Obstacles; Shortage of the mulberry leaves
Epidemic diseases of the silkworm
Low efficiency in the reeling process

(11) Wood

Farmers get fuel wood from the forest located in their own land, at a part of community land 2,000 Eucalyptus trees are planted, at present more tree planting is no necessary for fuel wood.

(12) Vegetables

Main grown vegetables are Chili, Onion, Garlic, Egg plant, Chinese cabbage, Cucumber and String Bean.
They are grown at the irrigatable place and mainly used for self consumption. At the Water Source Project Area the soil is clayey and not suitable for vegetable culture.

(13) Swine

12 farmers are raising swine, 4 of them have their rice mill. By the high feed price some farmers gave up the swine raising.

Poultry:

Average raising number; Duck 5/farmhouse
Chicken 10-15

They are grown in outdoor and fed on leftovers and rice bran.
Cost of vaccine; Duck 40 baht/head
Chicken 40-60 b/h

Obstacles; Damage by epidemic disease happen every year
Lack of the raising technique and vaccine

(14) Aquaculture

54 farmers have their ponds and now 13 new ponds are constructing.

(15) Training for farmers

Already various training were carried out as follows, Fruit tree culture, mulberry tree culture, aquaculture, weaving, raw silk and Mudmee Silk making, livestock
There are public news-room and three information centers.

Request for training
Artificial insemination technique for cattle and buffalo
Disease control of poultry
Growing method of native chicken
Sericultural technique
Introduce of the new variety of fruit
Herbicide and chemical utilization

(16) Serious obstacles

High death rate of poultry
Shortage of mulberry leaves
Lack of technician of artificial insemination
Lack of expert of Mudmee Silk processing
Lack of efficient machine for raw silk reeling

Reference D-3

(1) Native vegetation

A few reports have described the native pasture species, trees and shrubs of salt affected land in the north-east. In a study of salt tolerant native pasture species beside one of the saline reservoirs in Khon Kaen, the botanical composition was affected both by the salt concentration and the extent of waterlogging (Wilaipon et al., 1978). The electrical conductivity of samples from the top 0-5 cm of soil ranged from 124 dS m^{-1} at 1 m from the edge of the dam, to 0.1 dS m^{-1} at 11 m from the dam. In the waterlogged saline area, the grass Panicum repens seemed most salt tolerant, whereas in the drier saline area, Fimbristylis bisumbellata was the most tolerant species. Other native pasture species that showed salt tolerance included Cyprus polystachyos, Chloris barbata and Eragrostis elongata. Other plants which were common included Vernonia cinerea, Azima sarmentosa, Streptocaulon sp., Erioglossum sp., and seedlings of Shorea telura and Dipterocarpus obtusifolia (Wilaipon et al., 1978).

Native species observed in a salt affected area in Korat (El Swaify et al., 1983) include Streblus asper, Xantonnea spp., Dipterocarpus spp., Acacia spp., Strychnos spp., Coataeva spp., Buchanania spp., Shorea obtusa, Pectame siamensis, Adina cordifolia, Xylia kerrii, and other species associated with an undergrowth of the bamboo Arundinaria ciliata. Halophytic species (Maytenus mekongensis, Carissa cochinchinensis and Azima sarmentosa) occurred on termite mounds in areas that were severely affected.

Tree and shrub species observed in one of the saline areas in the north-east include Buchanania siamensis, Shorea obtusa,m Salacia macrophylla, Manilkara hexandra, Acacia harmandiana, Crateva adansonii, Azima sarmentosa, Semecarpus conchinchinensis, Carissa cochinchinensed, Tamarindus indica and Memecylon edule (K. Chankaew, personal communication, 1984). Many of these wee also found in Korat (El Swaify et al., 1983).

(2) Food, fuel and forage plants

Almost all vegetation on moderately to severely salt affected land is slow growing and rarely produces enough biomass for any practical purposes; biomass production is greater in the rainy than in the dry season. Only a limited number of native pasture species occur on moderate to severely salt affected land. Furthermore, it is not known how significant these species are to animal grazing as their palatability and nutritive value have never been studied.

Only a few of the native trees and shrubs (such as tamarind) are edible; some (such as Azima sarmentosa) can be used for medicinal purposes, and almost all can be used for fire wood. The Department of Land Development is testing the suitability of a number of salt tolerant trees for revegetation. Criteria chosen for the selected species are salt tolerance, rate of growth and utility. The species have been divided into three categories:

(a) Native species; Dipterocarpus alatus, D. intricatus, D. tuberculatus, D. obtusifolius, Anisoptera glaba, Melia azedarach L., Cassia siamea Britt., Afzelia xylocarpus Craib., peltophorum dasyrachis, Pterocarpus macrocarpus Kurz. and Azadirachta indica A. Juss.

(b) Food species; Leucaena leucocephala (Lam.) de Wit., Sesbania grandiflora, Cassia siamea Britt., Tamarindus indica L., Pithecellobium dulce(Roxb.) Benth., Moringa oleifera Lam,. Azadirachta indica A. Juss., and Anacardium occidentale Linn.

(c) Utility species; Leucaena leucocephala (Lam.) de Wit., Azadirachta indica A. Juss., Gliricidia sepium, Tamarindus indica, Pithecellobium dulce, Moringa oleifera, Eucalyptus camaldulensis, Melia azedarach, Melia dubia, Melia toosendan, Acacia catechu, Casuarina equisetifolia, Cassia siamea, Casuarina junghuhniana, Acacia auriculiformis, Acacia mangium, Cassia fistula and Peltophorum pterocarpum.

Leucaena spp. may also be planted on the recharge areas of catchments with potential salinity problems to decrease groundwater levels.

Source;

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SALT AFFECTED LAND IN THAILAND AND ITS AGRICULTURAL PRODUCTIVITY

V. LIMPINUNTANA[1] and S. ARUNIN[2]

1. Faculty of Agriculture, Khon Kaen University, Khon Kaen, 40002, Thailand.

2. Department of Land Development, Pahonyotin Road, Bangkhen, Bangkok, Thailand.

APPENDIX E FORESTRY

CONTENTS

LIST OF TABLES

LIST OF FIGURES

E-1 The Northeast Region and Changwat Khon Kaen

E-1-1 Forest Resources

The northeast of Thailand in the past has the second greatest forest area in 1967. The important forest types are Moist Evergreen, Dry Evergreen, Hill Evergreen, Mixed Deciduous, Dry Dipterocarp and Savannah forest. Most of each forest type carries the lowest volume per unit area and is the most "open" of Thailand forests. And, within the Mixed Deciduous type, the forest of the northeast carries just over half the stem density of the same forest type of south and northwest.

Basing on the study of Wacharakitti and Sabhasri (1989), the area of each forest ecotype in 1987 can be shown as follows:

Forest type	Hectare	Rai	Percent
Deciduous Dry Dipterocarp	692,363	4,327,268.7	29.1
Mixed Deciduous	65,227	401,668.8	2.7
Dry Evergreen	1,399,511	8,746,943.7	58.7
Moist Evergreen	195,500	1,221,875.0	8.2
Hill Evergreen	28,240	175,500.0	1.2
TOTAL	2,380,841	14,880,256.0	100.0

From the study, the forested area in northeast in 1987 is 2,380,841 hectares or 14.10 percent of the total land area. Compared with the study of the Royal Forest Department in 1985 which shows the forest area of 2,482,833 hectare, it reveals that the forested area decreased 101,992 hectares within two years. The rate of forest depletion compared with the past is getting less to 0.12 percent per annum because of landscape limitation. The other factor is that most of the existing forested areas are in national parks and wildlife sanctuaries which have effective forest protective measures.

The average standard density in the northeast forest is 390 trees per hectare where Deciduous Dry Dipterocarp has an average of 376 trees per hectare, Mixed Deciduous has 348 trees per hectare, Dry Evergreen has 422 trees per hectare, Moist Evergreen has 371 trees per hectares and Hill Evergreen has 432 trees per hectare. The average commercial volume is 160.4 cubic meters per hectare. The total forest dry weight biomass is 563,749,881.2 tons. The average commercial volume, forest

production, average dry weight biomass, and forest biomass of each forest type are tabulated in the following table.

Forest type	Hectare	Trees /ha	m^3 /ha	Total m^3	ton /ha	Total ton
Dec. Dry Dipterocarp	692,363	376	44.6	30,879,389.8	162.6	112,578,223.8
Mixed Deciduous	65,227	348	131.4	8,570,827.8	109.1	7,116,265.7
Dry Evergreen	1,399,511	422	190.6	266,746,796.6	256.7	359,254,473.7
Moist Evergreen	195,500	371	214.9	42,012,950.0	381.3	74,544,150.0
Hill Evergreen	28,240	432	220.3	6,221,272.0	353.2	9,974,368.0
Total	2,380,841	390	160.4	354,431,236.2	252.6	563,467,481.2

It is obviously seen that the average commercial volume per hectare of each forest type is considerably low especially in the Deciduous Dry Dipterocarp and Mixed Deciduous forests there are only 44.6 and 131.4 cubic meters per hectare respectively.

E-1-2 Forestry Problems

Of many common problems relating to forest lands in the region, forest land encroachment, shifting cultivation, illegal log poaching and illegal firewood collection and charcoal burning are major ones. The devastation of the forest is primarily a consequence of expanding human population and their needs for cultivable lands to feed themselves and for fuelwood, rather than a consequence of industrial forest explotation. The real effects of forest destruction lie in its negative impact on agricultural production by creating, for instance, intermittent flood and famine. The forest land encroachment happens in any region of Thailand, but it seems to be heavily in the northeast because of its landscape.

Shifting cultivation is one of the major forest destruction. In particular to northeast, it occured in low land which include undulating grounds in between the plains and the foot-hills. In the areas of poor soils, high salinity or low moisture content, the most economical form of land use should probably be to put agriculture under Deciduous Dipterocarp forests.

Decreasing of the forest lands through shifting cultivation and deforestation is found to be very significant. The comparison of forested areas in 1961, 1973, 1985, 1987 and 1985 is shown in the following table.

Region/forest area	sq. km.	Percent
Total area of northeast	168,854	100
Forested area in 1961	70,904	41.99
Forested area in 1973	50,671	30.00
Forested area in 1985	24,224	14.35
Forested area in 1987	23,808	14.10
Forested area in 1988	23,693	14.03

E-1-3 Situation of Forestry Reserved Land

Declared reserved forest land accounts for 31 % of the total area of northeast region or about 52,345 sq.km. Categories of reserved forest include national parks, wildlife sanctuaries, protected watershed headlands, and economic forest.

The dimension of the deforestation problem in northeast suggest the difficulty of enforcing a strict regulatory approach beyond the most critical protected area. More than half of the land declared as reserved forest is now deforested. Reserved forest boundaries are often very poorly marked, resulting in much local confusion about the status of particular parcels of land. Conversion to paddies and upland crop fields is extensive and widely distributed.

However, people encroaching upon national forest reserve seeking to earn a living have neither ownership nor security in possessing the land. This has led to deterioration in the condition of the land and to different types of soil problems, such as the spread of brackish soil and saline soil conditions. Encroachment on steep slopes has caused soil erosion and considerable loss of top soil.

In case of forest conservation, the government has proclaimed the forest lands on the watershed catchment areas as national park, forest park, wildlife conservation area, no hunting area, wildlife park, botanical garden and arboretum. These forest lands are not used only for environmental protection but provided opportunities to common people used as the study of nature and wilderness and recreational purposes. These lands are strictly protected by forestry law, no

cutting trees, no hunting and no taking any things out of the lands are allowed. Therefore, these kinds of forest land are prevented effectively rather than those reserved for economic purpose.

E-1-4 Wood-using Industry

The statistics of saw mills and wood products factories in northeast region are shown in the following table,

Item	Number of Factories
Saw mills	73
Sawn timber by man power	13
Wood working by machinery	443
Wood working by man power	166
Sawn timber shop	315
Wood products shop	271
Pulp and paper	1

Source : Planning Division, RFD (1986)

At present, imported pulp mixed with bamboo, rice straw, or some kind of grass are used by paper factories which operate on industrial scale, many of the small factories cycle waste paper. Therefore, government has a plan to encourage private from building up pulp and paper factories using wood as the principal raw material.

In northeast region, the pulp and paper mill of Phoenix company was established in Nam Phong District, Khon Kaen Province. The mill currently uses raw material purchased within a 50 kilometer distance from the factory, including the following:

Kenaf	30,000	tons
Bamboo	250,000	tons
Eucalyptus	70,000 - 100,000	tons

According to the discussion with peoples concerned, the company is planning to construct a new mill beside the present mill, which will double current total production, increasing by 100,000 tons per year. The future projected annual raw material needs will total as follows:

Kenaf	30,000 - 150,000	tons
Bamboo	300,000 - 350,000	tons
Eucalyptus	300,000 - 400,000	tons

Estimated area needed for production of raw materials is 150,000 rai of bamboo and 150,000 rai of eucalyptus.

E-1-5 Reforestation Situation

The Royal Thai Government, through the responsible departments : Royal Forest Department and Forest Industry Organization (FIO) have attempted to plant valuable species in the log over areas. Nowadays, selection of fast growing species to replant in different land conditions is made.

In northeast region, almost 50% of the species is *Eucalyptus camaldulensis*, the other species are *Leucaena leucochephala, Melia azedaracth, Casuarina equisetifolia, Acacia auriculaeformis, Acacia mangium, Pterocarpus macrocarpus, Tectona grandis* and so on.

The reforestation area in the region classified by species are presented as follows,

Species planted (1975-1988)	Rai	%
Eucalyptus sp.	309,943	49.2
Leucaena sp.	43,421	6.9
Acacia sp.	12,280	2.0
Others	263,737	41.9
TOTAL	629,381	100.0

From the total area of 629,381 rai, they are supervised by the Royal Forest Department, Forest Industry Organization (FIO) and Private sectors about 387,069 rai (61.5%), 74,267 rai (11.9%) and 168,045 rai (26.7%) respectively.

With respect to *E. camaldulensis*, it become currently disputable species for reforesting all over the country in spite of high marketing demand. The largest area of Eucalyptus plantation exist in northeast region since soil in the region is generally poor and unsuitable for other species. But Eucalyptus has adapted will. The protest against them are mainly on environmental effects such as:

- eucalypts remove too much water from streams or underground water supplies,

- their leaf litter has adverse effects on soil humus, nutrient supply or the prevention erosion,
- they inhibit the growth of other vegetation,
- they do not provide food supplies or adequate habitat for wildlife species.

In term of management, the judgements regarding the relative merits and demerit of them must be specific to each case and based on accurate appraisal of biological, physical and human factors.

Resulting from the protest in the countrywide, the national commission on forestry planning has currently directed the Royal Forest Department stop using Eucalyptus to be reforesting species from now on. Nevertheless, they are being planted solely by the private sector for commercial purpose.

E-2 The Study Area

E-2-1 Forest Reserved

Forest reserved land occupies a few portion of the project area at about 12,575 rai or 20.12 km^2 (6.3%) which is relatively small as compared to agricultural land of 93,090 rai or 148.9 km^2 (46.5%). According to the forestry legislation, this forest land means those which has not been claimed legally ownership. It may not actually present a dense stand of tree community. Therefore the area in this category may possibly differ from those obtained by the aerial photograph interpretation.

Forest reserve land lies along the edge of project area from the southmost toward the mountain in the west direction (see APPENDIX E-1). It is in Tambon Tha Sala of Amphoe Manjakhiree. This forest reserve is named "Pa Khok-Laung" covering the total area of 129,619 rai or about 207 km^2 which overlap the project area only 10,788 rai or 9.7 %. Since this forest is not the watershed headland, the whole area id designated to be economic forest. It was declared as the national forest reserved by National Forestry Bill in 1964.

The natural vegetations belong to Deciduous Dipterocarp forest which have been degraded. The most species found are Teng (*Shorea obtusa*), Rang (*Pentacme siamensis*), Plaung (*Dipterocarpus tuberculatus*), Daeng (*Xylia kerrii*), Pra-du (*Pterocarpus macrocarpus*), Haeng (*Dipterocarpus obtusifolius*), Kra-bok (*Irvingia malayana*) and other dipterocarp species. It is observed that Yang-na (*Dipterocarpus alatus*), which is an economic species does not appear in this area. Teak (*Tectona grandis*) is not the native species in

this area either. Ground vegetations are mostly Yakha (*Imperata cylindrica*) and Ya phek (*Arundinaria pusilla*).

This forest was permitted concession to the Khonkaen Provincial Logging company in 1976 and was given up the concession by the cabinet resolution in 1986. Some compartment of the concession was not subjected to logging operation, since the stock production was extremely low due to forest encroachment of adjacent villagers.

Forest reserve can be classified into two main categories as far as the presence of trees in the area is concerned. They are 1) abundant forest and 2) degraded forest. The abundant forest means the area having standing trees of over 100 cm. in girth size at least 2 stems per rai or of between 50-100 cm. in girth size at least 8 stems per rail. While the degraded forest, of course, means the area having less number of trees than the mentioned.

However, the degraded forest can be delineated further into 2 types with respect to the situation and existing use. They are so-called "Pa Setha-Kit 1" and "Pa Setha-Kit 2";

- Pa Setha-Kit 1 or Economic Forest Zone 1 is those presence of existing permanent community and agricultural land (but no legal ownership)

- Pa Setha-Kit 2 or Economic Forest zone 2 is those suitable for reforestation purpose.

The area of Pa Khok-Laung reserve foreset estimated from the availble maps is shown as follows:

Pa Khok-Laung Forest	Rai	%
Total area	129,619	100
Area extending in the project area	10,788	8.37
Abundant	-	-
Degraded	10,788	100
Economic Forest Zone 1	3,644	33.8
Economic Forest Zone 2	7,144	66.2

Economic Forest Zone 1 is in the west of the project, while Economic Forest Zone 2 is in the south where large scale reforestation project of Forest Industry Organization exists (see Figure 3-1).

If only the forest area extending in the project area is considered, it covers only about 10,788 rai (6.3%) out of 200,000 rai of project area (100%). Trees density in this forest vary from place to place depending upon the use of the land.

Basing on the aerial photograph taken in 1976 (as available), tree density of this degraded forest within the project ara is about 3,049 trees/sq.km or 30.5 trees/ha. It is lower than the average dry dipterocarp forest in northeast about 10 times. The comparison between other forest types in northeast can be considered as the followings:

Forest type	Trees/ha	m^3/ha	ton/ha
Dry Dipterocarp	376	44.6	162.6
Mixed Deciduous	348	131.4	109.1
Dry Evergreen	422	190.6	256.7
Moist Evergreen	371	214.9	381.3
Hill Evergreen	432	229.3	363.2
* Pa Khok-Laung	31	3.7	13.4

Note: Data on forest in the northeast derived from Wacharakitti and Sabhasri (1987)

The comparison shows the approximate figures that the degraded forest of Pa Khok-laung is very unproductive. However, the density of Pa Khok-laung was obtained by roughly counting the number of trees appearing in the aerial photographs. So, the errorness may exist whether more or less. Basing on this results, the potential supply of wood from this natural forest can be estimated as follows:

Forest Area (Rai)	Volume (m^3)	Biomass (ton)
10,788	6,386.5	23,129.5