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Appendices

APPENDIX A

1 Nitrogen Determination

a. NH_4-N is determined by macro kjeldahl method which is esstially a wet oxidation procedure. The NH_4-N is determined from the amount of ammonium liberted by distillation of samples with borate buffer in order to adjust to pH 9.5 and trapped NH_3 by using indicating boric acid solution as absorbent for the distillate. Then titrated them with standard H_2SO_4 Ø.ØØ2N and calculate NH_3 concentration as fellows:

$$\text{mg } NH_3\text{-N/L} = \frac{(A-B)\times 14 \times Ø.ØØ2 \times 1ØØØ}{\text{ml sample}}$$

b. total nitrogen in the sample is convertd to NH_4-N by digesting with mixed sulferic acid (H_2SO_4 + Se). Then distillation of the digest with alkaline and determined them as procedure of NH_4-N.

c. NO_3-N is determined by using Nitrate Eletrode Orion Model 4Ø7A.

2. Phosphorus determination

a. Orthophosphate is determined by colorimetric method using Vanadate-molybdate reagent to develope yellow color and optical density was read from spectophotometer Shimizu Model at 42Ø nm.

b. Total-P was digested by suferic acid solution and ammonium persulfate in autoclave at least 3Ø mins. The phosphorus in solution was then determined colorimetrically as same as orthophosphate.

3 Cation Determination

a. Na and K were determined by filtration and suitable dilution before injection to Flame Photometer Corning Model 400 at Ecology Section, Chemical Soil Analysis Division, Land Developement Department of the Minitry of Agriculture.

b. Ca and Mg were determined by Atomic Absorption Spectrophotometre Shimadzu Model 670 at the same place of (a). These solution use strontium chloride solution to enhancing the radiation.

5 Anion Determination

a. Cl was determined by titration with standardize $AgNO_3$ solution using potassium chromate reagents to develope colour.

b. SO_4 was determined by turbidimetric method using $CaCl_2.2H_2O$ crystals. Optical density was read from Spectrophotometer Shimizu Model at 420 nm.

6. E. coli

0.1 ml of dilution influent or effluent were spread on EMB* selective media (EMB;Difco, Detroit). These were incubated about 24 hours at 44.5°C. After that picked metallic sheen colony only and confirmation test by using biochemical of E.Coli. in IMViC test.

Formular and Preparation of these EMB media and IMViC test from Determination of Bacteriology

APPENDIX B

1. Particle size distribution is determined by pipette method. A subsample of soil was broken up by physical means followed by chemical treatment to remove binding and flocculating agents of soil clods and aggregates. The chemical treatment included the adding of hydrogen peroxide to remove organic matter and the addition of normal sodium acetate at pH 5 to remove salts such as calcium carbonate. The mixing solution of sodium hexameta phosphate and sodium carbonate was then aded to disperse soil particles. Sand fractions was separated by wet seiving. The silt and clay percentages were determined by pipette method which depend upon their rate of settling from suspension. The textural name of the soils were obtained from soil texture triangle (Appendix C).

2. The pH of 1:1 suspensions of soil with $CaCl_2$ Ø.ØlN were determined by pH meter Beckman Zero Model IV.

3. Organic carbon was determined by Walkley-Black method which is wet-combustion procedur.

4. Total nitrogen was determined by macro Kjeldahl method, in Distilling Unit Kjeltec System II Tecator. Which is essential a wet oxidation procedure. The nitrogen in the same sample is convertd to NH_4-N by digesting with mixed sulferic acid (H_2SO_4 + Se) in Digestion system DS 2Ø Tecator. The NH_4-N is determined from the amount of NH_3 liberated by distillation of the digest with alkali.

5. NH_4-N was determined by treated with using MgO reagent and immediately with distilled. The distillate is collected in boric acid indicator.

6. NO_3-N was detected by treated with Devada alloy reagent after collecting NH_4-N from the distillation and distilled immediately, The distillate was collected in boric acid indicator.

7. Extractable phosphorus is determined by ascobic acid method. Acid soluble form of phosphorus in the soil samples was extracted by the combination of dilute HCl and H_2SO_4. The phosphorus in solution was then determined colorimetrically method. It use ascobic acid reduction of the ammonium phosphomolybdate complex and develope blue color. Optical density was read from Spectrophotometer 21 Model Bausch & Lomb at 880 nm.

8. Total phosphorus is determined by fusion with Na_2CO_3 anhydrous in furnace as temperature 800°C. It determined colorimetric method as procedure as (6).

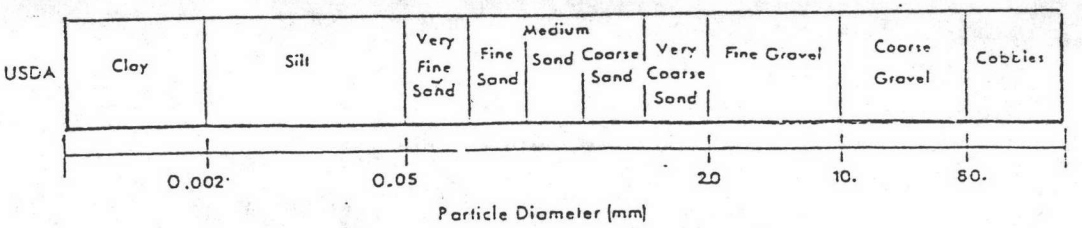
9. Exchangeable cations (Na, K, Ca, Mg) were obtained by extracting soil samples with neutral NH_4OAc. These cations were determined as same as cations determination in **Appendix A.**

10. Water soluble anion (Cl, SO_4) was determined by tirating 1:5 soil/water extraction with standard $AgNO_3$ solution and turbidity method using $BaCl_2$ crystal. The method is same as procedure in **Appendix B.**

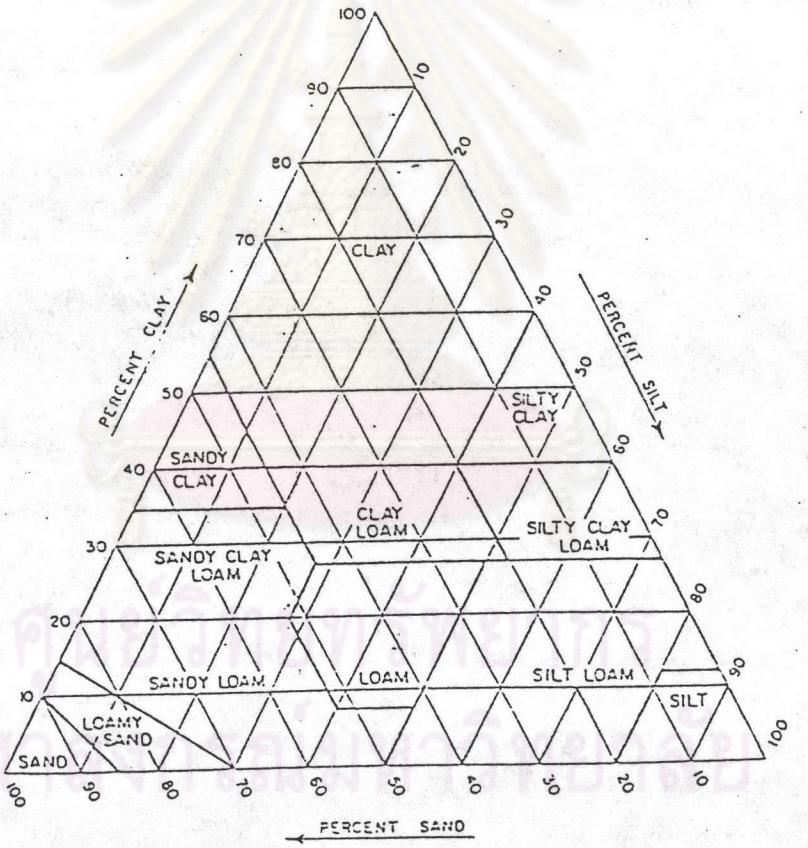
11. Organic Carbon is determined by oxidation under standardized condition with $K_2Cr_2O_7$ in sulphamic acid medium.

12. 10 g of soil were extracted with 90 ml. sterilized distilled water and shaking at 350 rpm at least 30 min. Then, were determined E.coli colony as same as **appendix A.**

Appendix C Guide for textural classification



USDA System for Categorizing Mineral Particle Sizes in Soil



Proportions of Sand, Silt and Clay for Different Soil Textures
(U.S. DEPARTMENT OF AGRICULTURE, 1964)

APPENDIX D

PAK CHONG SERIES

Distribution :

Occupies moderates extent in Central Highlands and small extent in North Thailand.

Setting :

Pak Chong soils are formed from residuum and local colluvium from shalle in association with limestone and occure on the dissected erosion surface or partial peneplain. Relief is undulating to rolling which slopes range from 2 to 8 percent. Elevation is variable above sea level, but mainly not above 400 m. The climate is Tropical Savanna (Koppen 'Aw'). Average annual precipitation varies from 1,100 mm. to 1,400 mm. Mean annual air temperature is from 25°C to 28°C.

Drainage, Permeability and Runoff :

Pak Chong series consisted of well drained soils. Permeability is moderate to slow. Runoff is rapid to medium.

Vegetation and Land Use :

Originally mixed diciduous forest, but mainly cleared for upland crop cultivation such as corn, cotton, beans, sorghum, castor bean and some fruit crops.

Characteristic Profile Features :

The Pak Chong series is a member of the very fine clayey, Kaolinitic, acid family of Peddish Brown Lateritic soils (National), Oxic Paleustults ? (USDA). They are deep soils and are characterized by a dark reddish clay upper argillic B horizon

Which in turn overlies red or dark clay lower argillic B horizon. Reaction is slightly acid to neutral over madium to very strongly acid.

Typifying Pedon :

A profile taken from 200 m. northwest of Kasetsart University Train Farm, Ban Pang Sok, Amphoe Pak Chong, Nakorn Ratchasima Province; Profile Code NE-S 20/30. (miost colors unless otherwise stated).

Ap -- 0-30 cm. Dark reddish brown (2.5YR3/4) clay; moderate medium subangular blocky structure; friable, slight sticky, plastic; common moderately thick continuous clay coating on ped faces; many fine roots; very strongly acid; gradual smooth boundary to B21t.

B21t -- 30-60 cm. Dark reddish brown (2.5YR3/4) clay; moderate medium subangular blocky structure; friable, slightly sticky, plastic; common moderately thick continuous clay coating on ped faces; many fine roots; very strongly acid; gradual smooth boundary to B22t.

B22t -- 60-100 cm. Red (2.5YR4/6) clay; moderate medium subangular blocky structure; friable, sticky, plastic; many moderately thick continuous clay coating on ped faces; few fine roots; very strongly acid.

KHAMPHAENG SAEN SERIES

Distribution :

Occupies large extent in the southwestern part of the Central Plain.

Setting :

Khamphaeng Saen soils fromed from semi-recent alluvium and occure on old leaves and breach deposits of the semi-recent terrace. Relief is flat to nearly flat, with a slightly undulating micro-relief. Slopes are 1% or less. Elevation ranges from 6 to 20 m. above sea level. The climate is Tropical Savanna (Koppen 'Aw'). Mean annual precipitation ranges from 800 to 1,600 mm. Mean annual temperature is 27°C.

Drainage and Permeability :

Well drained. Permeability is moderate and runoff is slow. Groundwater levels below 1.5 m. from the soil surface throughout the year.

Vegetation and Land Use :

Mainly used for settlement sites, gardens and orchards ; or are put to upland crops such as maize, cotton and sugar cane.

Characteristic Profile Features :

Khamphang Saen series is a member of the fine loamy, mixed family of Nan Calcic Brown Soils (National), Udic Haplustalfs (USDA). They are characterized by a brown or dark brown loam or clay loam A horizon, overlying a brown or strong brown clay loam, weakly develoved, argillic B horizon. Fine mica flakes occur in all horizons ; but not enough for the micaceous family.

Typifying Pedon :

Khamphaeng Saen clay loam - Orchard from Amphoe Muang, Nakhon Pathom province-Code SW 53/6 (type Location) (moist colours unless otherwise stated)

Ap -- 0-30 cm. Brown to dark brown (10YR4/3) ; clay loam ; weak coarse subangular blockly ; nonstickly and nonplastic, friable moist, hard dry ; many very fine interstitial and tubular pores ; common very fine roots ; diffuse, smooth boundary ; pH 6.5.

B2t -- 30-65 cm. Dark yellowish brown (10YR4/4) ; clay loam to clay ; weak to moderate medium subanguar blocky ; slightly sticky and slightly plastic, friable moist, hard dry ; thin, broken, brown to dark brown clay coatings in pores and on ped faces ; many fine and very fine tabular and interstitial pores ; few mica flakes ; many fine and medium and common very fine roots ; gradual, smooth boundary; pH 7.5.

B3 -- 65-90 cm. Brown to dark brown (7.5YR4/4) ; clay loam ; moderate medium and fine subangular blocky ; slightly sticky and slightly plastic, friable moist ; thin patchy clay coatings ; many fine and very fine interstitial and tabular pores ; many white lime pseduo-mycelites ; common fine and very fine roots ; gradual, smooth boundary ; pH 8.0.

C -- 90-130 cm. Strong brown (7.5YR5/6) ; loam ; moderate medium subangular blocky nonsticky and nonplastic, friable moist ; many very fine interstitial mycelia, many mica flakes ; few very fine roots ; pH 8.0.

MUAK LEK SERIES

Distribution :

Occuplies small to moderate extent in the Central Highlands, and North Thailand.

Setting :

The Muak Lek soils are formed from residium and colluvium from light colored shale, slates and other equivalent rocks and occure on the undulating to hilly topography of erosion surfaces and footslopes. The range of slopes is from 4 to 20 percent. Elevation above sea level is from 180 m. upto 400 m. The climate is Tropical Savana (Koppen 'Aw'). Average annual precipitation varies from 1,100 mm. upto 1,400 cm. Mean annual air temperature is around 27°C.

Drainage, Peameability and Surface Runoff :

The Muak Lek series consists of well drained soils. Peameability is moderate. Surface runoff is rapid. Ground water level during the dry season is very deep (several meters).

Vegetation and Land Use :

Mainly in Mixed Diciduous and Dry evergreen Forest. Parts are cleared for upland crop cultivation (Shifting cultivation).

Characteristics Profile Features :

The Muak Lek series is a member of the loamy skeletal, mixed family of Non-calcic Brown Soils (National). Lithic Haplustalfs (USDA). They are shallow soil to parent rock and characterized by a dark brown or dark grayish brown loam or silt loam A horizon overlying a brown or dark brown or dark yellowish brown gravelly (or very gravelly) clay loam or silty clay loam argillic B horizon which in turn overlies parent rock fragments at

some depth within 50 cm. of the surface. Reaction is medium acid to neutral over strongly acid to slightly acid.

Typifying Pedon :

Muak Lek loam-Dry evergreen forest. A profile from near Ban Nam Ron, Wichianburi District, Petchabun Province. Profile Code is Nc-47/92. (colors are for moist soil unless otherwise stated).

A1 -- 0-4 cm. Dark brown (7.5YR3/2) loam ; moderate fine and medium subangular blocky structure ; slightly hard, slightly stickly, slightly plastic ; many fine interstitial and common very fine tabular pores ; common fine and medium roots ; neutral (pH 7.0) ; clear smooth boundary to B1.

B1 -- 4-16 cm. Dark yellowish brown (10YR4/4) silt loam ; moderate medium subangular blocky structures ; friable, sticky, platic ; many very fine interstitial and common very fine and fine tubular pores ; few fine and medium roots ; strongly acid (pH 5.2) ; clear smooth boundary to B21t.

B21t -- 16-29 cm. Brown to dark brown (7.5YR4/4) clay loam ; moderate fine and medium subangular blockly structure ; friable sticky, plastic ; many fine interstitial and tubular pores ; patchy thin cutan ; few very fine and fine roots ; strongly acid (pH 5.5), clear smooth boundary to B22t.

B22t -- 29-50 cm. Brown to dark brown (7.5YR4/4) gravelly clay loam with common fine faint reddish brown mottles, weak fine and medium subangular blocky structure, friable, sticky, slightly plastic ; patchy thin cutans ; many fine interstitial and common very fine tubular pores ; many quartz and shale fragment few very fine roots ; strongly acid (pH 5.2) ; clear smooth boundary to C.

C -- 50-75 cm. This horizon consists of multicolored weathering shale and few quartz gravels (colors are dark yellowish brown, strong brown, reddish brown and dark red) ; very strongly acid (pH 4.5).

BAN BUNG SERIES

Distribution

Occupies moderate extent in Southeast east of Thailand.

Setting :

Ban Bung soils are formed from sandy alluvial derived from granite and quartzite origin and occure on the low and middle terraces. Relief is flat to nearly flat. The slope is 2 percent or less. Elevationis from 10 to 40 metres above sea level. The climate is transitional zone between Tropical savana and Tropical Monsoon. Average annual precipitation is from 1,100 mm. to 1,800 mm. Mean annual air temperature is 27°C.

Drainge, Permeability, and surface runoff :

Moderately well drained to somewhat poorly drained soils. Permeability is rapid. Surace runoff is slow. Ground water table fall below 1.5 meters during the peak of the dry season.

Vegetation and Land Use :

Mainly used for sugar cane and cassava cultivation.

Characteristic Profile Features :

The Ban Bung series is a member of the sandy, selicious, non-acid family of Hydromorphic Gray Podzolic Soils (National), Aquic Arenic Eutrochrepts (USDA). They are deep, slightly acid to moderately alkaline soils characterized by a grayish brown or brown, or dark brown sandy loam or loamy sand A or Ap horizons overlying a pinkish gray or light brown or light reddish brown sandy loam or loamy sand camic B or C horison. Mottles occure brown, yellowish brown and/or dark yellowish brown colors. The sand fraction consists of medium and coarse in size.

Typifying Pedon :

Ban Bung sandy loam to loamy sand-cassava field from Amphoe Ban Bung, Chon Buri Province-code SE 15/21 (Type location) (moist colors unless otherwise stated).

Ap -- 0-20 cm. Grarish brown (10YR5/2) sandy loam; weak coarse subangular blocky structures ; Friable, non sticky,non plastic ; many fine interstitial pores, few fine and medium tubular pores ; common fine roots ; moderately alkaline (pH 8.0) ; clear smooth boundary to A21

A21 -- 20-42 cm. Very pale brown (10YR7/3) loamy sand with common coarse brown to dark brown mottles ; massive ; slightly firm, non sticky, non plastic ; many fine interstitial pore, few fine and medium tabular pores ; more compact than above horizon ; few fine roots ; moderate alkaline (pH 8.0) ; gradual smooth boundary to A22.

A22 -- 42-95 cm. Very pale brown (10YR7/3) loamy coarse sand with many coarse and medium brown and dark brown mottles; very weak coarse subangular blocky breaking into single grains ; fraiable, non stickly, non plastic ; many fine and medium interstitial pores, common fine tubular pores ; no roots ; moderately alkaline (pH 8.0) ; gradual smooth boundary to B1.

B1 -- 95-130 cm. Light brown (7.5YR6/4) loamy coarse sand with many medium and coarse strong brown mottles ; very weak coarse subangular blocky structure ; friable, non sticky, non plastic ; many fine and medium interstitial pores, few fine tabular pores ; common slightly hard, few hard iron nodules ; moderately alkaline (pH 8.0) ; gradual smooth boundary to B2.

B2 --130-150 cm. Pinkish gray (5-7.5YR7/2) sandy loam with common medium and coarse brownish yellow and few coarse strong brown mottles ; weak coarse subangular blocky structures ; firm ; slightly stickly, non plastic ; many fine and medium interstitial pores, few fine tabular pors ; common slightly hard iron nodules ; moderately alkaline (pH 8.0).

APPENDIX E

Characteristics of Influent and Effluent.

Appendix E.1 The Characteristics of waste water used in this experiment

DATE	pH	COD	Nitrogen			Phosphorus		Na	K	Ca	Mg	Anion		E.coli
		(mg/l)	NH4-N (mg/l)	NO3-N (mg/l)	TN (mg/l)	PO4 (mg/l)	TP (mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	Cl (mg/l)	SO4 (mg/l)	(col/ml)
4/11	7.80	633.77	51.79	*	56.80	7.54	10.49	67.28	8.79	32.97	9.34	96.59	40.79	8.25E+06
7/11	7.84	678.50	47.23	*	52.67	6.96	9.74	-	-	-	-	-	45.75	6.00E+06
11/11	7.89	658.77	51.22	*	55.00	6.39	9.42	-	-	-	-	90.43	-	-
18/11	7.79	552.38	41.89	*	47.11	6.11	9.77	63.25	8.79	39.59	9.57	84.00	-	1.30E+06
25/11	-	-	-	*	-	-	-	-	-	-	-	71.00	39.55	-
27/11	-	656.82	56.10	*	60.60	8.14	10.10	74.18	9.78	40.80	10.01	-	-	6.00E+05
6/12	-	-	-	*	-	-	-	78.20	10.75	41.85	10.43	-	-	-
9/12	7.81	548.56	56.91	*	61.43	7.86	8.72	79.35	11.73	45.27	10.70	107.56	-	4.03E+05
12/12	7.78	446.09	57.74	*	61.22	6.10	8.32	-	-	-	-	-	30.01	1.50E+06
17/12	7.84	715.97	53.19	*	55.87	8.25	10.51	71.30	9.78	42.59	10.46	90.00	33.52	4.00E+05
25/12	8.00	664.93	53.02	*	58.46	8.21	11.00	72.45	9.78	42.59	10.46	-	-	6.50E+05
5/1	8.10	498.55	50.00	*	52.31	9.11	11.93	64.40	8.31	42.19	10.27	110.74	29.81	7.00E+05
19/1	8.00	616.44	52.00	*	55.00	9.11	11.07	78.20	10.75	41.93	11.63	85.18	-	5.50E+05
2/2	8.00	636.29	40.37	*	44.38	7.35	9.93	79.35	14.66	43.93	11.14	-	40.58	2.50E+06
6/2	8.00	593.28	44.73	*	48.49	9.68	10.33	80.50	11.73	46.00	11.92	92.70	39.26	2.00E+06
11/2	8.00	666.77	48.46	*	54.21	7.56	8.88	74.18	14.55	33.11	10.22	81.59	-	7.00E+05
18/2	7.90	692.30	45.39	*	55.97	7.28	9.81	74.18	11.51	41.68	11.98	82.08	44.65	-
25/2	7.80	533.33	45.83	*	55.82	7.49	8.72	74.18	10.57	36.42	9.70	120.06	42.15	7.00E+05
5/3	7.83	655.19	43.91	*	45.39	9.11	9.67	-	-	-	-	105.18	38.88	7.50E+05
14/3	7.89	668.83	40.25	*	45.83	6.96	7.99	72.45	10.53	31.97	8.74	83.58	38.19	1.20E+06
28/3	7.23	590.99	41.03	*	45.07	6.77	10.32	66.41	16.62	31.61	8.24	100.07	31.34	-

Note * inmeasurable low value

Appendix E.2 The characteristics of effluent from Pak Chong series

DATE	pH	COD (mg/l)	Nitrogen NH4-N (mg/l)	Nitrogen NO3-N (mg/l)	Phophorus PO4 (mg/l)	Cation Na (mg/l)	Cation K (mg/l)	Cation Ca (mg/l)	Cation Mg (mg/l)	Anion Cl (mg/l)	Anion SO4 (mg/l)	E.coli (col/ml)
4/11	-	190.63	-	-	-	-	-	-	-	72.91	-	-
5/11	8.10	156.65	0.40	0.000	0.28	-	-	-	-	77.01	43.58	290
7/11	-	-	-	-	-	52.40	1.08	119.30	11.23	79.43	16.29	-
8/11	-	-	-	-	-	-	-	-	-	72.18	-	-
10/11	8.30	158.95	-	-	0.20	67.28	3.91	116.27	11.97	-	-	-
11/11	8.20	-	20.75	0.000	-	-	-	-	-	73.87	18.29	-
12/11	-	-	-	-	-	68.79	4.16	90.54	12.96	73.39	-	-
17/11	8.33	185.39	-	0.000	0.21	-	-	-	-	-	-	-
18/11	-	-	19.58	-	-	66.42	7.82	95.97	11.48	-	15.45	-
23/11	8.80	-	-	-	-	70.66	9.77	85.13	10.27	68.08	11.59	-
24/11	-	154.17	20.50	0.190	0.23	-	-	-	-	-	-	120
26/11	-	-	22.05	-	-	65.27	10.75	63.54	8.56	-	14.49	-
28/11	-	-	-	-	-	66.42	13.44	67.33	9.19	-	-	-
1/12	-	96.19	19.55	0.550	0.00	-	-	-	-	58.05	8.79	75
2/12	-	-	-	-	-	-	-	-	-	60.48	-	-
5/12	8.12	-	-	-	-	65.99	13.93	64.52	9.29	59.48	-	-
10/12	8.30	72.66	19.00	1.400	0.13	-	-	-	-	60.26	3.87	20
11/12	-	-	-	-	-	64.40	16.86	61.17	9.72	58.54	-	-
12/12	-	-	-	-	-	-	-	-	-	-	1.07	-
16/12	-	-	-	-	-	63.68	17.35	59.30	9.54	-	-	-
17/12	-	-	-	-	-	-	-	-	-	54.08	-	-
21/12	-	71.69	17.13	1.950	0.06	63.68	17.35	63.87	9.50	-	-	-
22/12	7.80	-	-	-	-	-	-	-	-	62.02	-	-
27/12	-	-	-	-	-	62.97	17.11	48.01	8.51	-	-	-
31/12	7.75	55.68	-	2.900	0.36	-	-	-	-	-	-	10
4/1	-	-	15.56	-	-	62.10	16.62	49.57	8.50	71.94	1.02	-
11/1	-	-	-	-	-	57.79	15.39	44.71	7.42	69.21	1.56	-
13/1	7.98	50.00	14.00	4.200	0.48	-	-	-	-	-	-	-
20/1	-	51.54	10.42	5.200	-	68.57	15.89	49.81	8.36	64.99	1.84	5
12/2	8.00	-	8.50	6.000	0.20	79.35	15.16	43.55	7.96	60.00	0.50	-
28/2	-	49.70	-	-	-	-	-	-	7.50	-	-	-
15/3	8.15	46.00	7.48	6.500	0.00	81.08	16.62	44.28	7.71	65.73	1.50	-
28/3	8.48	36.54	6.22	7.000	0.00	-	-	-	-	73.92	2.24	nil

Appendix E.3 The Characteristics of Effluent from Khamphaeng Saen series

DATE	pH	COD (mg/l)	Nitrogen NH4-N (mg/l)	NO3-N (mg/l)	Phosphorus PO4 (mg/l)	Cation Na (mg/l)	K (mg/l)	Ca (mg/l)	Mg (mg/l)	Anion Cl (mg/l)	SO4 (mg/l)	E.coli (col/mol)
4/11	-	131.48	26.12	‡	-	-	-	-	-	-	-	-
5/11	-	102.78	-	‡	-	30.50	20.70	90.00	20.70	178.60	20.83	60
6/11	8.44	-	2.81	‡	<0.2	-	-	-	-	-	-	-
10/11	-	-	-	‡	-	-	-	-	-	-	-	-
11/11	-	-	-	‡	-	-	-	-	-	126.22	-	-
12/11	-	97.57	-	‡	-	-	-	-	-	-	-	10
15/11	-	-	3.68	‡	-	-	-	-	-	-	-	-
18/11	8.80	-	0.58	‡	-	-	-	-	-	-	-	-
20/11	7.90	68.41	1.93	‡	<0.2	46.72	19.55	77.60	18.28	-	17.15	5
21/11	-	-	-	‡	-	-	-	-	-	94.72	-	-
23/11	8.50	-	-	‡	<0.2	-	-	-	-	-	-	-
2/12	-	-	-	‡	-	-	-	-	-	69.05	-	-
3/12	8.50	50.37	-	‡	<0.2	-	-	-	-	-	15.06	nil
9/12	8.40	-	3.16	‡	-	-	-	-	-	83.81	-	-
14/12	8.70	52.83	0.77	‡	-	-	-	-	-	-	-	-
15/12	-	-	-	‡	-	-	-	-	-	-	-	-
18/12	-	43.64	1.29	‡	-	75.59	25.66	41.21	28.43	-	-	nil
21/12	-	-	0.46	‡	<0.2	-	-	-	-	-	-	-
24/12	9.00	-	-	‡	0.25	82.66	28.11	41.61	30.60	-	14.10	-
28/12	-	-	-	‡	-	-	-	-	-	-	-	-
29/12	8.70	-	2.09	‡	-	-	-	-	-	-	-	-
31/12	-	-	-	‡	<0.2	79.06	31.77	41.62	30.42	-	-	nil
2/1	-	-	-	‡	-	-	-	-	-	76.05	-	-
5/1	-	-	-	‡	-	-	-	-	-	-	11.15	-
13/1	-	48.78	1.77	‡	-	85.53	29.33	29.36	31.74	-	-	-
20/1	-	-	-	‡	-	95.59	26.39	42.60	34.37	80.70	9.44	-
23/1	8.50	-	1.10	‡	<0.2	-	-	-	-	-	-	nil
30/1	-	-	0.36	‡	-	99.99	30.30	40.50	40.62	-	-	-
20/2	8.30	50.5	0.50	‡	-	102.06	30.79	28.27	39.63	79.87	7.00	-
12/3	-	-	0.50	‡	-	94.88	22.49	28.22	42.38	-	-	-
22/3	8.20	47.27	0.44	‡	-	94.01	24.93	30.25	45.00	89.29	5.93	-

Note ‡ immeasurable low value

Appendix E.4 The Characteristics of Effluent from Muak Lek series

DATE	pH	COD (mg/l)	Nitrogen NH4-N (mg/l)	Nitrogen NO3-N (mg/l)	Phosphorus PO4 (mg/l)	Cation Na (mg/l)	Cation K (mg/l)	Cation Ca (mg/l)	Cation Mg (mg/l)	Anion Cl (mg/l)	Anion SO4 (mg/l)	E.coli (col/ml)
4/11	-	-	16.24	‡	-	-	-	-	-	56.26	5.00	-
5/11	7.59	200.00	-	‡	-	48.07	0.73	126.99	4.27	55.13	12.52	-
6/11	-	85.30	29.22	-	<0.2	-	-	-	-	52.57	5.07	-
7/11	-	-	-	-	-	-	-	-	-	57.73	4.70	4500
8/11	-	-	-	-	-	-	-	-	-	60.13	5.00	-
9/11	-	-	-	-	-	-	-	-	-	-	-	-
10/11	7.68	99.94	-	-	<0.2	50.17	5.42	103.90	3.97	-	-	-
13/11	7.89	-	-	-	-	-	-	-	-	54.45	-	-
14/11	8.08	-	22.27	‡	<0.2	-	-	-	-	64.83	-	-
15/11	8.24	-	-	‡	-	-	-	-	-	-	-	3000
17/11	7.78	128.56	24.47	‡	-	-	-	-	-	-	0.00	-
18/11	7.88	-	-	-	0.04	-	-	-	-	-	-	-
20/11	-	-	-	‡	-	-	-	-	-	56.79	0.00	-
22/11	8.24	156.34	-	-	-	62.11	13.19	77.30	2.95	62.11	-	-
24/11	8.20	-	35.03	0.34	-	-	-	-	-	-	5.04	2000
25/11	-	-	-	-	-	-	-	-	-	66.65	-	-
27/11	8.36	-	42.97	0.55	<0.2	-	-	-	-	-	5.95	-
29/11	-	-	-	-	-	62.68	13.69	67.36	2.45	63.04	-	-
1/12	8.28	-	-	0.45	-	-	-	-	-	-	-	-
2/12	-	-	-	-	-	69.43	14.42	68.97	3.15	71.19	-	1400
3/12	7.66	119.05	-	-	-	-	-	-	-	-	-	-
4/12	-	-	-	-	-	70.73	14.67	65.43	3.31	69.29	4.88	-
9/12	7.97	61.37	-	1.03	0.36	-	-	-	-	-	5.40	-
11/12	7.66	-	45.97	1.60	-	-	-	-	-	65.64	-	-
12/12	-	59.48	-	-	-	-	-	-	-	65.40	7.06	-
14/12	-	-	-	-	-	72.89	16.13	64.43	3.87	-	4.25	750
18/11	8.08	67.03	46.59	1.71	-	-	-	-	-	-	-	-
20/12	-	-	-	-	-	73.31	17.40	59.16	4.79	69.54	6.70	-
22/12	7.74	-	43.69	-	-	-	-	-	-	72.19	-	-
23/12	-	-	-	1.88	-	-	-	-	-	66.25	-	-
25/12	-	-	-	-	-	72.02	18.33	57.38	5.32	-	-	100
27/12	8.00	50.47	36.27	1.90	2.27	-	-	-	-	-	-	-
31/12	8.30	-	-	-	-	-	-	-	-	70.89	-	-
1/1	-	-	-	-	-	-	-	-	-	64.41	-	-
2/1	7.80	60.45	31.78	1.46	-	72.02	18.00	53.31	5.62	-	-	-
3/1	-	-	-	-	-	-	-	-	-	63.83	-	-
5/1	8.00	-	-	-	3.48	-	-	-	-	-	6.53	120
8/1	-	-	-	-	-	-	-	-	-	59.15	-	-
11/1	-	-	-	-	-	-	-	-	-	60.71	-	-
12/1	-	-	-	-	-	-	-	-	-	59.67	-	-
15/1	7.70	-	33.19	3.77	4.00	-	-	-	-	55.24	-	-
16/1	7.63	-	-	-	-	-	-	-	-	54.19	-	-
17/1	7.70	61.34	-	-	-	67.28	18.82	46.23	6.33	-	-	-
19/1	7.95	-	30.08	4.82	-	-	-	-	-	-	7.31	-
21/1	-	-	-	-	-	-	-	-	-	53.01	-	-
22/1	-	-	-	-	-	66.85	19.31	51.78	8.05	-	-	-
23/1	-	-	-	-	-	-	-	-	-	56.8	-	40
26/1	8.00	47.27	27.91	-	-	-	-	-	-	63.99	-	-
27/1	-	-	-	7.69	-	-	-	-	-	-	6.19	-
28/1	-	-	-	8.85	-	74.99	19.31	51.78	8.05	73.65	-	-
29/1	-	-	-	-	-	-	-	-	-	-	3.25	-
30/1	7.85	36.61	-	-	-	-	-	-	-	73.17	-	15
2/2	8.00	-	-	12.00	4.40	-	-	-	-	-	-	-
3/2	-	-	20.35	-	-	72.450	19.060	52.390	8.25	-	7.11	-
5/2	-	-	-	-	-	-	-	-	-	-	8.08	-
6/2	-	-	-	11.00	4.51	-	-	-	-	-	-	-
8/2	-	43.11	-	-	-	-	-	-	-	73.87	6.69	-
10/2	8.40	-	-	-	-	74.61	20.04	51.77	8.17	-	-	-
11/2	8.00	-	-	-	3.74	-	-	-	-	-	-	-
12/2	7.90		19.03	13.50	-	-	-	-	-	76.76	-	5
18/2	-	-	-	14.00	5.25	-	-	-	-	-	-	-
19/2	-	-	-	-	-	75.47	20.04	59.57	8.86	-	6.75	-
20/2	7.94	-	17.19	-	-	-	-	-	-	-	-	-
24/2	-	-	-	-	-	-	-	-	-	72.02	-	nil
25/2	-	40.00	-	17.01	-	-	-	-	-	-	-	-
27/2	8.00	-	12.81	17.00	-	-	-	-	-	-	6.38	-
2/3	-	30.00	-	-	-	72.45	19.06	58.13	7.67	-	-	-
5/3	-	-	-	18.10	7.37	-	-	-	-	78.39	-	-
6/3	-	-	-	-	-	-	-	-	-	-	-	-
9/3	8.04	-	13.17	18.10	-	72.45	21.51	53.33	7.74	67.67	-	-
11/3	-	30.72	-	-	-	-	-	-	-	-	-	-
14/3	8.20	-	11.48	20.50	6.67	-	-	-	-	60.15	2.54	nil
15/3	-	-	-	-	-	72.02	19.55	61.92	9.11	-	-	-
20/3	-	-	-	-	-	71.59	19.55	46.48	8.56	-	-	-
21/3	-	-	-	-	-	-	-	-	-	58.54	-	-
25/3	-	-	-	17.00	6.58	-	-	-	-	-	-	-
26/3	8.00	-	11.48	17.00	-	68.57	19.55	46.21	7.99	60.41	2.00	nil

Note ‡ immeasurable low value

Appendix E.5 The Characteristics of Effluent from Ban Bung series

DATE	pH	COD (mg/l)	Nitrogen NH4-N (mg/l)	Nitrogen NO3-N (mg/l)	Phophorus PO4 (mg/l)	Cation Na (mg/l)	Cation K (mg/l)	Cation Ca (mg/l)	Cation Mg (mg/l)	Anion Cl (mg/l)	Anion SO4 (mg/l)	E.coli (col/ml)
4/11	7.50	296.55	16.61	-	-	30.00	0.29	47.96	0.89	64.70	-	6500
5/11	7.94	-	-	-	0.49	-	-	-	-	-	-	-
6/11	-	-	-	-	-	-	-	-	-	-	33.15	-
7/11	-	98.62	-	-	-	65.12	0.44	44.30	1.61	-	28.82	-
8/11	-	-	-	-	-	-	-	-	-	-	-	-
10/11	8.18	115.68	-	-	<0.2	-	-	-	-	66.00	28.82	-
11/11	8.00	-	22.65	-	-	-	-	-	-	67.52	-	4000
13/11	-	-	-	-	-	73.32	4.40	55.26	0.89	69.29	19.59	-
15/11	8.07	-	35.38	-	-	-	-	-	-	74.84	-	-
16/11	-	-	-	-	-	-	-	-	-	71.31	-	-
17/11	-	89.56	-	-	-	-	-	-	-	65.14	-	600
18/11	8.29	-	38.00	-	-	-	-	-	-	-	-	-
19/11	-	-	-	-	-	70.73	9.29	49.16	0.90	-	-	-
20/11	8.80	-	68.08	-	<0.2	-	-	-	-	-	-	-
23/11	8.80	-	63.05	-	-	-	-	-	-	65.66	-	-
25/11	8.70	63.64	37.20	-	-	71.59	15.15	48.12	1.20	63.57	14.47	-
26/11	-	54.16	-	-	-	-	-	-	-	63.83	-	-
28/11	8.60	-	-	-	<0.2	-	-	-	-	59.60	-	500
1/12	-	-	-	-	-	-	-	-	-	59.11	-	-
4/12	-	-	-	-	-	-	-	-	-	60.19	-	-
5/12	-	-	-	-	-	-	-	-	-	60.98	-	-
6/12	-	-	-	-	-	-	-	-	-	58.10	9.40	-
8/12	8.50	49.66	41.76	0.17	0.51	69.43	17.59	45.03	2.62	54.19	-	300
10/12	-	-	-	-	-	-	-	-	-	55.76	-	-
12/12	8.30	46.15	-	-	-	-	-	-	-	-	-	-
13/12	8.40	51.37	-	0.11	-	-	-	-	-	-	5.25	-
14/12	8.30	-	39.21	-	-	-	-	-	-	48.97	4.25	-
15/12	-	-	-	-	-	-	-	-	-	-	-	-
16/12	-	-	-	-	-	64.41	19.06	46.79	4.18	52.51	4.25	-
19/12	8.45	43.64	39.59	0.17	-	-	-	-	-	59.65	-	100
20/12	-	-	-	0.17	-	-	-	-	-	-	4.71	-
21/12	8.50	-	-	0.30	-	71.59	19.06	44.25	5.85	72.44	-	-
22/12	-	55.36	-	-	-	-	-	-	-	64.06	4.51	-
25/12	8.00	-	-	0.55	0.74	73.32	19.06	42.84	7.15	-	-	-
26/12	-	-	42.83	0.55	-	-	-	-	-	-	-	150
27/12	-	-	-	-	-	-	-	-	-	76.05	-	-
28/12	-	-	-	-	-	-	-	-	-	-	6.69	-
29/12	8.40	-	-	0.65	1.32	-	-	-	-	-	-	-
30/12	-	-	-	-	-	-	-	-	-	79.46	-	-
31/12	-	55.18	-	-	-	-	-	-	-	75.81	6.69	-
2/1	8.70	-	-	-	-	73.75	19.06	38.45	7.63	-	-	40
3/1	8.50	-	39.00	2.50	2.09	-	-	-	-	73.88	-	-
4/1	8.50	-	-	-	-	75.04	19.55	35.85	7.85	-	-	-
10/1	8.34	-	-	1.75	3.02	-	-	-	-	-	11.20	-
11/1	-	-	-	-	-	-	-	-	-	-	-	-
12/1	-	-	-	-	-	-	-	-	-	-	-	-
17/1	8.04	50.00	27.68	3.00	4.20	-	-	-	-	74.03	-	10
19/1	-	-	-	-	-	-	-	-	-	69.21	10.06	-
22/1	-	-	-	-	-	75.04	20.53	33.03	7.65	-	-	nil
25/1	-	-	-	3.90	5.73	-	-	-	-	79.13	-	-
26/1	-	-	-	-	-	65.12	18.33	41.92	8.54	-	-	-
29/1	-	-	-	-	-	-	-	-	-	-	-	-
31/1	-	42.86	-	-	-	-	-	-	-	63.10	-	nil
3/2	-	-	20.87	2.70	5.43	-	-	-	-	63.05	5.12	-
4/2	-	-	-	-	-	69.01	20.29	29.43	9.15	-	-	-
10/2	8.09	-	-	-	-	65.98	20.04	29.39	9.45	55.07	-	-
14/2	8.25	-	18.00	7.00	6.39	-	-	-	-	60.03	-	-
15/2	7.86	39.50	-	-	-	-	-	-	-	-	-	-
22/2	7.31	-	-	7.80	6.84	-	-	-	-	-	-	-
26/2	-	-	-	-	-	65.55	18.09	28.29	7.92	63.01	6.00	-
6/3	-	-	-	-	-	-	-	-	-	-	-	-
8/3	-	-	21.56	10.50	7.94	-	-	-	7.43	-	5.00	-
15/3	8.02	34.00	-	7.50	-	-	-	-	-	58.79	1.42	nil
17/3	-	-	0.47	7.50	-	-	-	-	-	-	-	-
28/3	-		8.61	10.20	6.7	80.65	15.64	31.26	8.27	58.79	-	-

APPENDIX F

The Properties of Soils Before and After Passing with Wastewater

Appendix F.1 The properties of soil section before treatment with wastewater

Soil Serie	Soil Section	Particle Size Distribution (%) Sand	Silk	Clay	Texture	Moisture Content (%)	pH 1:1 0.01 N CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	NO3-N	TN	Phosphorus (ppm) Extract-P	TP	Exchangeable Cation (meq/100g) Ca	Mg	K	Soluble Anion (meq/100g) Na	SO4	Cl
	A	15.2	27.8	57.0	C	14.07	6.20	18.93	0.854	0.0006	0.0002	0.1436	19.76	31.88	13.490	1.387	0.070	0.205	0.0156	0.0336
	B	-	-	-	-	14.24	6.20	18.94	0.850	0.0006	0.0000	0.1359	19.72	31.06	13.480	1.445	0.108	0.205	0.0211	0.0336
Pak	C	-	-	-	-	17.06	6.15	18.93	1.062	0.0006	0.0000	0.1499	18.82	22.56	13.370	1.531	0.097	0.193	0.0200	0.0279
Chong	D	-	-	-	-	17.47	6.15	19.82	1.162	0.0006	0.0000	0.1485	18.64	27.00	13.540	1.527	0.075	0.171	0.0154	0.0279
(Pc)	E	-	-	-	-	17.81	6.30	17.18	0.954	0.0004	0.0000	0.1484	21.12	27.50	14.660	1.815	0.075	0.161	0.0198	0.0279
	F	-	-	-	-	16.71	6.10	16.49	0.969	0.0002	0.0000	0.1401	19.92	26.50	13.530	1.671	0.075	0.168	0.0182	0.0336
	G	15.5	25.0	59.5	C	18.72	6.10	16.17	0.892	0.0002	0.0000	0.1394	19.56	27.38	12.390	1.528	0.089	0.170	0.0198	0.0336

Soil Serie	Soil Section	Particle Size Distribution (%) Sand	Silk	Clay	Texture	Moisture Content (%)	pH 1:1 0.01 N CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	NO3-N	TN	Phosphorus (ppm) Extract-P	TP	Exchangeable Cation (meq/100g) Ca	Mg	K	Soluble Anion (meq/100g) Na	SO4	Cl
	A	31.8	42.5	25.7	L	22.07	6.05	8.29	0.727	0.0004	0.0040	0.0658	9.72	64.00	11.750	2.960	0.268	0.256	0.0314	0.1008
	B	-	-	-	-	20.97	6.05	8.28	0.726	0.0004	0.0059	0.0658	9.60	65.75	11.740	2.960	0.268	0.251	0.0292	0.1000
Khan-	C	-	-	-	-	20.94	6.20	8.81	0.723	0.0000	0.0008	0.0729	9.80	66.25	11.900	2.859	0.306	0.276	0.0334	0.0839
phaeng	D	-	-	-	-	21.17	6.05	8.80	0.720	0.0004	0.0042	0.0757	9.50	66.50	11.910	3.350	0.306	0.275	0.0275	0.0839
Saen	E	-	-	-	-	21.87	6.05	8.27	0.762	0.0008	0.0046	0.0757	9.76	66.30	10.180	3.400	0.319	0.299	0.0282	0.0839
(Ks)	F	-	-	-	-	21.06	6.25	8.30	0.746	0.0004	0.0059	0.0749	9.60	66.50	11.520	3.340	0.336	0.254	0.0335	0.0952
	G	35.9	40.2	23.9	L	22.98	6.25	9.37	0.745	0.0006	0.0042	0.0785	10.32	72.25	11.510	3.440	0.336	0.255	0.0309	0.0952

Soil Serie	Soil Section	Particle Size Distribution (%) Sand	Silk	Clay	Texture	Moisture Content (%)	pH 1:1 0.01 N CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	NO3-N	TN	Phosphorus (ppm) Extract-P	TP	Exchangeable Cation (meq/100g) Ca	Mg	K	Soluble Anion (meq/100g) Na	SO4	Cl
	A	71.5	16.2	12.3	SL	6.31	7.50	7.89	0.392	0.0000	0.0002	0.0476	5.80	20.25	17.860	0.320	0.159	0.586	0.0146	0.0728
	B	-	-	-	-	6.17	7.50	7.76	0.423	0.0000	0.0000	0.0490	5.86	27.50	17.180	0.369	0.142	0.558	0.0147	0.0839
Muak	C	-	-	-	-	7.02	7.50	8.84	0.365	0.0000	0.0000	0.0385	7.54	20.25	18.210	0.423	0.153	0.219	0.0162	0.0728
Lek	D	-	-	-	-	6.71	7.50	8.57	0.408	0.0004	0.0000	0.0392	7.58	19.25	15.670	0.411	0.153	0.198	0.0189	0.0279
(Ml)	E	-	-	-	-	7.95	7.50	8.84	0.300	0.0000	0.0000	0.0364	6.68	25.75	16.610	0.386	0.176	0.394	0.0224	0.0279
	F	-	-	-	-	7.94	7.50	8.90	0.330	0.0000	0.0000	0.0364	4.84	16.00	18.560	0.414	0.161	0.335	0.0207	0.0279
	G	73.3	14.2	12.0	SL	9.10	7.50	8.57	0.362	0.0000	0.0000	0.0420	4.88	16.00	18.130	0.415	0.165	0.336	0.0229	0.0279

Soil Serie	Soil Section	Particle Size Distribution (%) Sand	Silk	Clay	Texture	Moisture Content (%)	pH 1:1 0.01 N CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	NO3-N	TN	Phosphorus (ppm) Extract-P	TP	Exchangeable Cation (meq/100g) Ca	Mg	K	Soluble Anion (meq/100g) Na	SO4	Cl
	A	79.2	13.2	7.6	LS	8.01	6.70	2.85	0.181	0.0000	0.0000	0.0119	5.92	12.50	5.980	0.059	0.035	0.171	0.0367	0.0224
	B	-	-	-	-	8.09	6.70	2.85	0.194	0.0000	0.0000	0.0119	5.72	12.00	5.990	0.058	0.030	0.196	0.0357	0.0168
Ban	C	-	-	-	-	8.95	6.70	2.89	0.172	0.0000	0.0000	0.0119	5.22	12.00	5.560	0.057	0.030	0.206	0.0318	0.0168
Bung	D	-	-	-	-	8.71	6.75	2.90	0.101	0.0000	0.0000	0.0112	5.40	10.75	6.610	0.058	0.030	0.205	0.0300	0.0168
(Rb)	E	-	-	-	-	8.15	6.75	2.88	0.101	0.0000	0.0000	0.0112	5.44	11.75	5.730	0.073	0.038	0.181	0.0318	0.0168
	F	-	-	-	-	7.89	6.90	3.30	0.099	0.0000	0.0000	0.0119	5.20	11.00	4.990	0.054	0.035	0.181	0.0290	0.0168
	G	80.1	13	6.9	LS	7.76	6.90	3.39	0.083	0.0000	0.0000	0.0119	5.28	11.00	4.900	0.053	0.035	0.143	0.0270	0.0168

Appendix F.2 The properties of soil section after treatment with wastewater

Soil Serie	Soil Section	pH 1:1 0.01 M CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	Nitrogen (%) NO3-N	Nitrogen (%) TN	Phosphorus ppm Extract-P	Phosphorus ppm TP	Exchangeable Cation meq/100g Ca	Exchangeable Cation meq/100g Mg	Exchangeable Cation meq/100g K	Exchangeable Cation meq/100g Na	Soluble Anion meq/100g SO4	Soluble Anion meq/100g Cl	E.coli col/g *100
Pak chong (Pc)	A	6.50	22.77	2.919	0.0544	0.0015	0.2428	20.36	142.81	19.840	3.470	0.590	0.970	0.713	0.114	32.20
	B	6.71	20.68	2.363	0.0510	0.0013	0.2203	23.62	118.75	17.550	2.990	0.560	0.890	0.260	0.143	27.00
	C	6.40	19.51	2.252	0.0489	0.0010	0.2056	23.88	93.13	16.280	2.310	0.510	0.840	0.254	0.181	14.20
	D	6.45	20.78	2.168	0.0488	0.0014	0.2084	23.00	45.00	15.500	1.880	0.470	0.750	0.064	0.167	6.10
	E	6.50	17.64	2.168	0.0477	0.0015	0.2088	25.04	56.56	15.390	1.910	0.468	0.840	0.056	0.350	5.25
	F	6.55	17.53	2.196	0.0456	0.0016	0.2053	25.08	51.88	15.780	1.830	0.460	0.810	0.029	0.400	3.80
	G	6.30	16.29	2.418	0.0449	0.0018	0.2091	22.80	46.56	16.760	1.790	0.470	0.800	0.021	0.308	2.70

Soil Serie	Soil Section	pH 1:1 0.01 M CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	Nitrogen (%) NO3-N	Nitrogen (%) TN	Phosphorus ppm Extract-P	Phosphorus ppm TP	Exchangeable Cation meq/100g Ca	Exchangeable Cation meq/100g Mg	Exchangeable Cation meq/100g K	Exchangeable Cation meq/100g Na	Soluble Anion meq/100g SO4	Soluble Anion meq/100g Cl	E.coli col/g *100
Kampang-San (Ks)	A	6.55	9.57	1.279	0.0116	0.0044	0.1303	11.40	102.19	14.535	2.084	0.608	0.680	0.1083	0.1286	100.00
	B	6.60	9.78	1.070	0.0102	0.0036	0.1174	10.96	70.00	14.339	1.974	0.512	0.600	0.1029	0.1668	80.00
	C	6.40	9.10	1.053	0.0157	0.0028	0.1135	10.64	72.51	14.057	1.783	0.460	0.530	0.0763	0.1740	43.00
	D	6.50	9.67	1.032	0.0070	0.0006	0.1058	9.52	71.88	14.305	1.709	0.420	0.490	0.0629	0.1739	19.00
	E	6.60	10.27	1.051	0.0035	0.0005	0.1083	9.88	73.47	15.939	2.002	0.400	0.440	0.0546	0.1524	5.80
	F	6.50	9.91	1.244	0.0014	0.0008	0.1177	9.68	77.50	15.687	1.951	0.390	0.425	0.0683	0.1619	1.00
	G	6.80	10.86	1.411	0.0046	0.0002	0.1330	10.72	77.50	15.898	2.253	0.505	0.520	0.0623	0.1953	0.37

Soil Serie	Soil Section	pH 1:1 0.01 M CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	Nitrogen (%) NO3-N	Nitrogen (%) TN	Phosphorus ppm Extract-P	Phosphorus ppm TP	Exchangeable Cation meq/100g Ca	Exchangeable Cation meq/100g Mg	Exchangeable Cation meq/100g K	Exchangeable Cation meq/100g Na	Soluble Anion meq/100g SO4	Soluble Anion meq/100g Cl	E.coli col/g *100
Muak Lek (Ml)	A	7.65	11.05	0.867	0.0223	0.0014	0.1100	4.55	48.35	30.640	2.080	0.520	0.650	0.5350	0.0480	23.00
	B	7.90	9.70	0.601	0.0203	0.0010	0.0860	4.51	48.35	29.050	2.070	0.493	0.670	0.2940	0.2910	3.70
	C	7.80	10.00	0.516	0.0209	0.0011	0.0860	4.99	40.62	27.640	1.770	0.456	0.590	0.1310	0.3090	3.00
	D	7.78	10.04	0.427	0.0236	0.0010	0.0890	5.30	40.00	26.010	1.580	0.430	0.590	0.0450	0.1760	8.30
	E	7.70	9.09	0.406	0.0280	0.0010	0.0990	7.96	39.75	20.400	1.500	0.443	0.590	0.0230	0.1860	2.00
	F	7.70	9.98	0.445	0.0301	0.0014	0.0990	6.26	42.20	19.970	1.390	0.445	0.590	0.0208	0.1760	1.50
	G	7.60	10.42	0.467	0.0248	0.0020	0.0960	8.20	46.75	18.550	1.170	0.382	0.585	0.0200	0.2430	0.90

Soil Serie	Soil Section	pH 1:1 0.01 M CaCl2	CEC	Organic Carbon %	Nitrogen (%) NH4-N	Nitrogen (%) NO3-N	Nitrogen (%) TN	Phosphorus ppm Extract-P	Phosphorus ppm TP	Exchangeable Cation meq/100g Ca	Exchangeable Cation meq/100g Mg	Exchangeable Cation meq/100g K	Exchangeable Cation meq/100g Na	Soluble Anion meq/100g SO4	Soluble Anion meq/100g Cl	E.coli col/g *100
Ban Bung (Pb)	A	7.80	3.21	0.200	0.0073	0.0009	0.0315	7.99	17.83	3.195	0.604	0.140	0.360	0.2608	0.0739	22.00
	B	7.85	3.18	0.200	0.0071	0.0005	0.0329	9.12	29.82	3.391	0.666	0.159	0.365	0.2225	0.0953	10.00
	C	7.80	3.38	0.162	0.0068	0.0002	0.0277	9.61	23.06	3.258	0.642	0.138	0.355	0.1983	0.0619	9.00
	D	7.90	3.29	0.169	0.0057	0.0003	0.0258	12.38	29.15	3.284	0.566	0.135	0.350	0.0992	0.0715	4.00
	E	7.70	3.21	0.177	0.0036	0.0005	0.0234	12.15	29.69	2.869	0.501	0.125	0.320	0.0908	0.1334	3.33
	F	7.70	4.35	0.215	0.0057	0.0007	0.0237	7.92	29.75	7.157	0.647	0.134	0.340	0.0788	0.2334	2.50
	G	7.65	4.76	0.215	0.0055	0.0006	0.0242	11.95	37.50	7.634	0.585	0.126	0.335	0.0671	0.1953	2.70

Appendix P.3 Average and after/before ratio of some characteristics in soil section

section	series	Na (meg/100 g)			K (meg/100 g)		
		before	after	A/B ratio	before	after	A/B ratio
section A	Pc	0.21	0.97	4.62	0.07	0.59	8.43
	Ks	0.26	0.68	2.62	0.27	0.61	2.26
	Ml	0.59	0.65	1.10	0.16	0.52	3.25
	Bb	0.17	0.36	2.12	0.04	0.14	3.50
section B	Pc	0.21	0.89	4.24	0.11	0.56	5.09
	Ks	0.25	0.60	2.40	0.27	0.51	1.89
	Ml	0.56	0.67	1.19	0.14	0.49	3.50
	Bb	0.20	0.37	1.85	0.03	0.16	5.33
section C	Pc	0.19	0.84	4.42	0.10	0.51	5.10
	Ks	0.28	0.44	1.89	0.31	0.46	1.48
	Ml	0.22	0.59	2.68	0.15	0.46	3.07
	Bb	0.21	0.35	1.71	0.03	0.14	4.67
section D	Pc	0.17	0.75	4.41	0.08	0.47	5.88
	Ks	0.28	0.49	1.75	0.31	0.42	1.35
	Ml	0.20	0.59	2.95	0.15	0.45	3.00
	Bb	0.21	0.35	1.67	0.03	0.14	4.67
section E	Pc	0.16	0.84	5.25	0.08	0.47	5.88
	Ks	0.30	0.44	1.47	0.32	0.40	1.25
	Ml	0.39	0.59	1.51	0.18	0.44	2.44
	Bb	0.18	0.32	1.22	0.04	0.13	3.25
section F	Pc	0.17	0.81	4.76	0.08	0.46	5.22
	Ks	0.25	0.43	1.72	0.34	0.39	1.50
	Ml	0.34	0.59	1.74	0.16	0.45	2.24
	Bb	0.18	0.34	1.89	0.04	0.13	3.25
section G	Pc	0.17	0.80	4.71	0.09	0.47	5.22
	Ks	0.26	0.52	2.00	0.34	0.51	1.50
	Ml	0.34	0.59	1.74	0.17	0.38	2.24
	Bb	0.14	0.34	2.43	0.04	0.13	3.25
average	Pc	0.18	0.84	4.63	0.09	0.50	5.91
	Ks	0.27	0.53	1.98	0.31	0.47	1.55
	Ml	0.38	0.61	1.67	0.16	0.46	2.90
	Bb	0.18	0.35	1.84	0.04	0.14	3.99

section	series	Ca (meg/100 g)			Mg (meg/100 g)		
		before	after	A/B ratio	before	after	A/B ratio
section A	Pc	13.49	19.84	1.47	1.39	3.47	2.50
	Es	11.75	14.54	1.24	2.96	2.08	-1.42
	Ml	17.86	30.64	1.72	0.32	2.08	6.50
	Bb	5.98	3.20	-1.87	0.07	0.60	8.57
section B	Pc	13.48	17.55	1.30	1.45	2.99	2.06
	Es	11.74	14.34	1.22	2.96	1.97	-1.50
	Ml	17.18	29.05	1.69	0.37	2.07	5.59
	Bb	5.98	3.39	-1.77	0.06	0.67	11.17
Section C	Pc	13.37	16.28	1.22	1.53	2.31	1.51
	Es	1.90	14.06	1.18	2.85	1.78	-1.64
	Ml	18.21	27.64	1.52	0.42	1.77	4.26
	Bb	5.56	3.26	-1.71	0.06	0.64	10.67
section D	Pc	13.54	15.50	1.14	1.53	1.88	1.23
	Es	11.91	14.31	1.20	3.35	1.71	-1.96
	Ml	15.67	26.01	1.66	0.41	1.58	3.85
	Bb	6.61	3.28	-2.02	0.06	0.57	9.50
section E	Pc	14.66	15.39	1.05	1.82	1.91	1.05
	Es	10.18	15.94	1.57	3.40	2.00	-1.70
	Ml	16.61	20.40	1.23	0.39	1.50	3.85
	Bb	5.73	2.87	-2.01	0.07	0.50	8.13
section F	Pc	13.53	15.78	1.17	1.67	1.83	1.17
	Es	11.52	15.69	1.36	3.34	1.95	-1.53
	Ml	18.56	19.97	1.08	0.41	1.39	2.79
	Bb	4.90	7.16	1.46	0.08	0.65	7.38
section G	Pc	12.39	16.76	1.35	1.53	1.79	1.52
	Es	11.51	15.89	1.38	3.44	2.25	-1.63
	Ml	18.13	18.55	1.02	0.42	1.17	4.32
	Bb	4.90	7.63	1.56	0.08	0.59	8.94
average	Pc	13.49	16.73	1.24	1.56	2.31	1.52
	Es	11.50	14.96	1.31	3.19	1.96	-1.63
	Ml	17.46	24.61	1.42	0.39	1.65	4.32
	Bb	5.67	4.40	-1.29	0.07	0.60	8.94

section	series	pH			Organic Carbon (%)			CEC (meq/100g)		
		before	after	A/B ratio	before	after	A/B ratio	before	after	A/B ratio
section A	Pc	6.20	6.50	1.05	0.854	2.919	3.42	18.93	22.77	1.20
	Ks	6.05	6.55	1.08	0.727	1.279	1.76	8.29	9.57	1.15
	Ml	7.50	7.65	1.02	0.392	0.867	2.21	7.89	11.05	1.40
	Bb	6.70	7.80	1.16	0.181	0.200	1.11	2.85	3.21	1.13
section B	Pc	6.20	6.71	1.08	0.850	2.363	2.78	18.94	20.68	1.09
	Ks	6.05	6.60	1.09	0.726	1.070	1.47	8.28	9.78	1.18
	Ml	7.50	7.90	1.05	0.423	0.601	1.42	7.76	9.70	1.25
	Bb	6.70	7.85	1.17	0.194	0.200	1.03	2.85	3.18	1.12
section C	Pc	6.15	6.40	1.04	1.062	2.252	2.12	18.93	19.51	1.03
	Ks	6.20	6.40	1.03	0.723	1.053	1.46	8.81	9.10	1.02
	Ml	7.50	7.80	1.04	0.365	0.516	1.41	8.84	10.00	1.13
	Bb	6.75	7.80	1.15	0.172	0.162	0.94	2.89	3.38	1.17
section D	Pc	6.15	6.45	1.05	1.162	2.168	1.87	19.82	20.78	1.05
	Ks	6.05	6.50	1.07	0.720	1.032	1.43	8.80	9.67	1.09
	Ml	7.50	7.78	1.04	0.408	0.427	1.05	8.57	10.04	1.17
	Bb	6.75	7.90	1.17	0.101	0.169	1.68	2.90	3.29	0.34
section E	Pc	6.30	6.50	1.03	0.954	2.168	2.27	17.18	17.64	1.03
	Ks	6.05	6.60	1.05	0.762	1.051	1.38	8.27	10.27	1.24
	Ml	7.50	7.70	1.03	0.300	0.406	1.35	8.84	9.09	1.03
	Bb	6.75	7.70	1.14	0.101	0.177	1.76	2.88	3.21	1.11
section F	Pc	6.10	6.55	1.07	0.969	2.196	2.27	16.49	17.53	1.06
	Ks	6.25	6.50	1.04	0.746	1.244	1.67	8.30	9.91	1.19
	Ml	7.50	7.70	1.03	0.330	0.445	1.35	8.90	9.98	1.12
	Bb	6.80	7.70	1.15	0.100	0.215	2.15	3.30	4.35	1.32
section G	Pc	6.10	6.30	1.03	0.892	2.418	2.71	16.17	16.29	1.01
	Ks	6.25	6.80	1.09	0.745	1.411	1.89	9.37	10.86	1.16
	Ml	7.50	7.60	0.98	0.362	0.467	1.29	8.57	10.42	1.22
	Bb	6.80	7.65	1.13	0.083	0.215	2.59	3.39	4.76	1.40
average	Pc	6.17	6.50	9.05	0.963	2.355	2.45	18.07	19.31	1.07
	Ks	6.13	6.65	1.08	0.734	1.016	1.38	8.59	9.88	1.15
	Ml	7.50	7.73	1.03	0.368	0.533	1.45	8.48	10.04	1.18
	Bb	6.75	7.77	1.15	0.133	0.191	1.44	3.01	3.63	1.21

section	series	Total-N (%)			NH4-N (%)			NO3-N (%)		
		before	after	A/B ratio	before	after	A/B ratio	before	after	A/B ratio
section A	Pc	0.1436	0.2428	1.68	0.0006	0.0544	90.60	0.0002	0.0015	7.5
	Ks	0.0658	0.1303	1.98	0.0004	0.0116	45.50	0.0004	0.0044	1.1
	Ml	0.0476	0.1100	2.31	0.0000	0.0223	increase	0.0000	0.0014	7.0
	Bb	0.0119	0.0315	2.65	0.0000	0.0073	increase	0.0000	0.0009	increase
section B	Pc	0.1359	0.2203	1.62	0.0006	0.0510	85.00	0.0000	0.0013	increase
	Ks	0.0658	0.1174	1.78	0.0004	0.0182	45.50	0.0059	0.0036	-0.61
	Ml	0.0490	0.0860	1.76	0.0000	0.0203	increase	0.0000	0.0010	increase
	Bb	0.0119	0.0329	2.76	0.0000	0.0071	increase	0.0000	0.0005	increase
section C	Pc	0.1499	0.2056	1.37	0.0006	0.0489	81.50	0.0000	0.0010	increase
	Ks	0.0729	0.1135	1.56	0.0000	0.0157	increase	0.0038	0.0028	-0.74
	Ml	0.0385	0.0860	2.23	0.0000	0.0209	increase	0.0000	0.0011	increase
	Bb	0.0119	0.0277	2.33	0.0000	0.0068	increase	0.0000	0.0002	increase
section D	Pc	0.1485	0.2084	1.40	0.0006	0.0488	81.30	0.0000	0.0014	increase
	Ks	0.0757	0.1058	1.39	0.0004	0.0070	1.75	0.0042	0.0006	-0.14
	Ml	0.0392	0.0890	2.27	0.0004	0.0236	59.00	0.0000	0.0010	increase
	Bb	0.0112	0.0258	2.30	0.0000	0.0057	increase	0.0000	0.0003	increase
section E	Pc	0.1484	0.2088	1.41	0.0004	0.0477	119.30	0.0000	0.0015	increase
	Ks	0.0757	0.1083	1.43	0.0008	0.0035	4.38	0.0046	0.0005	-0.11
	Ml	0.0364	0.0990	2.72	0.0000	0.0280	increase	0.0000	0.0010	increase
	Bb	0.0112	0.0234	2.09	0.0000	0.0056	increase	0.0000	0.0005	increase
section F	Pc	0.1401	0.2053	1.47	0.0002	0.0456	228.00	0.0000	0.0016	increase
	Ks	0.0749	0.1177	1.57	0.0004	0.0014	3.50	0.0059	0.0008	-0.14
	Ml	0.0364	0.0990	2.72	0.0000	0.0301	increase	0.0000	0.0014	increase
	Bb	0.0119	0.0237	1.99	0.0000	0.0057	increase	0.0000	0.0007	increase
section G	Pc	0.1394	0.2091	1.50	0.0002	0.0449	224.50	0.0000	0.0018	increase
	Ks	0.0785	0.1330	1.69	0.0006	0.0046	7.67	0.0042	0.0002	-0.05
	Ml	0.0420	0.0960	2.29	0.0000	0.0248	increase	0.0000	0.0020	increase
	Bb	0.0119	0.0242	2.03	0.0000	0.0056	increase	0.0000	0.0006	increase
average	Pc	0.1437	0.2143	1.49	0.0005	0.0488	130.03	0.0000	0.0014	-
	Ks	0.0728	0.1180	1.63	0.0004	0.0089	22.25	0.0047	0.0018	-
	Ml	0.0413	0.0810	2.33	0.0000	0.0243	-	0.0000	0.0013	-
	Bb	0.0117	0.0270	2.31	0.0000	0.0063	-	0.0000	0.0005	-

		Total Phosphate (ppm)			Extractable Phosphate (ppm)		
section	series	before	after	A/B ratio	before	after	A/B ratio
section A	Pc	31.88	142.81	4.48	19.76	20.36	1.03
	Ks	64.00	102.18	1.59	9.72	11.40	1.17
	Ml	20.25	48.25	2.38	5.80	4.54	-1.28
	Bb	12.50	17.83	1.43	5.92	7.99	1.35
section B	Pc	31.00	118.75	3.82	19.72	23.62	1.19
	Ks	65.75	70.00	1.06	9.60	10.96	1.14
	Ml	27.50	42.25	1.54	5.86	4.51	-0.77
	Bb	12.00	29.81	2.48	5.72	9.12	1.59
section C	Pc	22.56	93.12	4.13	18.82	23.62	1.27
	Ks	66.25	72.51	1.09	9.80	10.66	1.09
	Ml	20.25	40.62	2.01	7.54	4.99	-1.51
	Bb	12.00	23.06	1.92	5.22	9.61	1.84
section D	Pc	27.00	45.00	1.67	18.64	23.00	1.23
	Ks	66.50	71.87	1.08	9.50	9.52	1.00
	Ml	19.25	40.00	2.08	7.58	5.30	-1.43
	Bb	10.75	29.15	2.71	5.40	12.38	2.29
section E	Pc	27.50	56.56	2.06	21.12	25.04	1.18
	Ks	66.30	73.43	1.11	9.76	9.88	1.01
	Ml	25.75	39.75	1.54	6.67	7.96	1.19
	Bb	11.75	29.69	2.53	5.44	12.15	2.23
section F	Pc	26.50	58.17	1.96	19.92	25.08	1.26
	Ks	66.50	77.50	1.16	9.60	9.62	1.00
	Ml	16.00	42.20	2.64	4.84	6.26	1.29
	Bb	11.00	29.75	2.70	5.20	7.92	1.52
section G	Pc	27.38	46.56	1.70	19.56	22.80	1.17
	Ks	72.25	77.50	1.07	10.32	10.72	1.04
	Ml	16.00	46.75	2.92	4.88	8.20	1.68
	Bb	11.00	37.50	3.41	5.28	11.95	2.26
average	Pc	27.68	79.24	2.83	19.64	23.39	1.19
	Ks	66.79	77.85	1.17	9.75	10.39	1.06
	Ml	20.71	42.83	2.16	6.16	5.95	-1.03
	Bb	11.56	28.11	2.45	5.45	10.16	1.87

section	series	SO4 (meq/100 g)			Cl (meq/100 g)		
		before	after	A/B ratio	before	after	A/B ratio
section A	Pc	0.02	0.71	35.50	0.03	0.11	3.60
	Ks	0.03	0.11	3.67	0.10	0.13	1.30
	Ml	0.01	0.54	27.00	0.07	0.05	-1.40
	Bb	0.04	0.26	6.50	0.02	0.07	3.50
section B	Pc	0.02	0.26	13.00	0.03	0.14	4.60
	Ks	0.03	0.10	3.33	0.10	0.17	1.70
	Ml	0.01	0.29	29.00	0.08	0.29	3.60
	Bb	0.04	0.22	5.50	0.02	0.09	4.50
section C	Pc	0.02	0.25	12.50	0.03	0.18	6.00
	Ks	0.03	0.08	2.67	0.08	0.17	2.10
	Ml	0.01	0.13	13.00	0.07	0.31	4.40
	Bb	0.03	0.20	6.67	0.02	0.06	3.00
section D	Pc	0.02	0.06	3.00	0.03	0.17	5.60
	Ks	0.03	0.06	2.00	0.08	0.17	2.10
	Ml	0.02	0.05	2.50	0.03	0.18	6.00
	Bb	0.03	0.10	3.33	0.02	0.07	3.50
section E	Pc	0.02	0.06	3.00	0.03	0.35	11.67
	Ks	0.03	0.05	1.67	0.08	0.15	1.87
	Ml	0.02	0.02	0.00	0.03	0.19	6.30
	Bb	0.03	0.09	3.00	0.02	0.13	6.50
section F	Pc	0.02	0.03	1.50	0.03	0.40	13.30
	Ks	0.03	0.07	2.30	0.10	0.16	1.60
	Ml	0.02	0.02	0.00	0.03	0.18	6.00
	Bb	0.03	0.08	2.60	0.02	0.23	11.50
section G	Pc	0.02	0.02	0.00	0.03	0.31	10.30
	Ks	0.03	0.06	2.00	0.09	0.19	1.90
	Ml	0.02	0.02	0.00	0.05	0.24	8.00
	Bb	0.03	0.07	2.30	0.02	0.20	0.00
average	Pc	0.02	0.20	9.79	0.03	0.27	8.97 0.00
	Ks	0.03	0.08	2.52	0.10	0.17	1.49
	Ml	0.02	0.15	10.21	0.03 0.05	0.20	4.00 ✓
	Bb	0.03	0.15	4.27	0.02	0.12	4.64

Appendix G The quantities of COD decrease after setting 24 hours

NO	COD	COD (after setting 24 hr)	%COD decrease
1	413.60	255.06	38.33
2	558.70	242.97	56.51
3	406.64	302.54	26.15
4	630.52	216.00	65.74
5	540.00	284.55	47.31
6	613.82	232.92	62.04
7	490.00	299.70	38.84
8	500.15	273.60	36.55
9	480.67	281.00	41.54
10	433.50	300.00	30.79
11	426.40	309.10	27.51
12	514.00	367.50	28.50
13	460.50	300.70	34.70
14	446.70	322.00	27.92
15	452.00	316.00	30.09
Average	491.15	286.91	35.76

VITA

Miss Pitsamai Rummavas was born at Ayudhaya on Febuary 28, 1960. She was graduate with a B.Sc. in Microbiology from Chulalongkorn University in 1981.