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PADDY FIELD ZONE DELINEATION USING APPARENT ELECTRICAL CONDUCTIVITY AND ITS RELATIONSHIP TO THE CHEMICAL AND PHYSICAL PROPERTIES OF SOIL

AIMRUN WAYAYOK.

ITMA 2006 6

PADDY FIELD ZONE DELINEATION USING APPARENT ELECTRICAL CONDUCTIVITY AND ITS RELATIONSHIP TO THE CHEMICAL AND PHYSICAL PROPERTIES OF SOIL

By

AIMRUN WAYAYOK

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor of Philosophy

March 2006

UPM

Dedication

From the depth of my heart, I dedicate this thesis to my beloved father Abdul Kimlee, mother Sapiyah, sisters Manisa and Warda, and brothers Mustafa, Sulaiman, Abdul Hadi and Anwar.

~Aimrun Wayayok~

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

PADDY FIELD ZONE DELINEATION USING APPARENT ELECTRICAL CONDUCTIVITY AND ITS RELATIONSHIP TO THE CHEMICAL AND PHYSICAL PROPERTIES OF SOIL

By

AIMRUN WAYAYOK

March 2006

Chairman: Professor Ir. Mohd Amin Mohd Soom, PhD

Institute: Advanced Technology

Spatial variability and temporal variability of soil chemical and physical properties within a field is unavoidable. Meanwhile, laboratory soil test is usually time consuming and laborious. To satisfy the concept of precision farming, rapid and intensive soil sampling is necessary for describing the uncertainty within a field. Apparent or bulk soil electrical conductivity (EC_a) technique for describing soil spatial variability is widely used. A sensor known as VerisEC can measure the average EC_a of 0-30 cm (shallow EC_a) and 0-90 cm (deep EC_a) depths and locate its position by Differential Global Positioning System (DGPS) at every second. EC_a includes soil salinity and soil texture. Soil texture has high correlation with soil cation exchange capacity (CEC) hence, soil nutrient contents. The main purpose of this study was to generate variability map of soil EC_a within rice cultivation areas using VerisEC sensor for three seasons. The EC_a values were then compared to some soil chemical and physical properties namely pH, EC, OM, OC, total S, total N, available P, CEC, Ca, Mg, K, Na, Al, Fe, total cation, BS, ESP, dry bulk density, moisture content, clay, silt, fine sand, coarse sand and sand, within classes after delineation. The study site was 145 ha paddy fields at Block C, Sawah Sempadan in

the Tanjong Karang Rice Irrigation Scheme, Malaysia. The sensor was pulled by a tractor in a U-shape pattern between the field drains (speed = 15 km h^{-1}). Disturbed and undisturbed of 236 sampling points were collected and recorded their positions by GPS (Trimble GeoExplorer3). Soil properties and EC_a data were mapped using kriging technique on GS+ and ArcGIS. SPSS and SAS were used for their statistical analysis. The study showed that the EC sensor can determine soil spatial and temporal variability, where it can acquire the soil information quickly with less labour. Most of the soil properties and EC_a changed from one season to other seasons, except total N. Much of the soil properties had the same mean values for seasons 1 and 3 such as K, moisture content, silt and coarse sand. Spatial variability of shallow and deep EC_a had the same pattern for different seasons even though the mean values were different. Deep EC_a showed the pattern of former canal routes clearly as continuous lines about 45 m wide at the northern and central parts of the study area. Low Na in zone 1 delineated by deep EC_a may be due to deep soil profile to reach the parent material of marine alluvial, where it was a former water route. High fine sand and sand in zone 1 were found for all the seasons. The models of soil properties estimation based on EC_a varied spatially and temporally from season to season and even from zone to zone. Most of them can be estimated better by deep EC_a except, soil K and ESP. The selected models showed that the highest significant R^2 was found in fine sand and sand models with the consistency of the model throughout the study seasons. The relationship between yield and deep EC_a was non significant for all the seasons.

PERPUSTAKAAN SULTAN ABDUL SAMAD
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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PEMBAHAGIAN ZON SAWAH PADI MENGGUNA KEBERKONDUKAN ELEKTRIK TANAH YANG TAMPAK DAN HUBUNGANNYA KEPADA CIRI KIMIA DAN FIZIKAL TANAH

By

AIMRUN WAYAYOK

Mac 2006

Pengerusi: Profesor Ir. Mohd Amin Mohd Soom, PhD

Institut: Teknologi Maju

Variasi ruang dan temporal bagi ciri kimia dan fizikal tanah dalam ladang tidak boleh dielakkan. Sementara itu, ujian tanah di makmal perlu banyak masa dan pekerja. Untuk memuaskan konsep perladangan persis, penyempelan tanah yang cepat dan giat adalah sangat perlu untuk menggambarkan ketidakpastian dalam ladang. Teknik keberkondukan elektrik tanah yang tampak atau seluruh (EC_a) bagi huraian variasi ruang tanah diguna secara meluas. Penderia yang dikenali sebagai VerisEC boleh mengukur purata EC_a pada kedalaman 0-30 (EC_a cetek) dan 0-90 sm (EC_a dalam) dan diletak posisinya oleh Sistem Kedudukan Global Perbezaan (DGPS) pada setiap satu saat. EC_a dikaitkan dengan saliniti dan tekstur tanah. Tekstur tanah berkorelasi tinggi terhadap Keupayaan Pertukaran Kation (CEC) maka, kandungan baja dalam tanah. Tujuan utama bagi kajian ini adalah untuk menjanakan peta variasi bagi EC_a tanah dalam kawasan tanaman padi dengan menggunakan penderia VerisEC bagi tiga musim. Nilai EC_a kemudian dibandingkan dengan ciri kimia dan fizikal tanah iaitu; pH, EC, OM, OC, S keseluruhan, N keseluruhan, P yang berguna, CEC, Ca, Mg, K, Na, Al, Fe, kation keseluruhan, BS, ESP, kepadatan kering, kelembapan, lumpur, lempung, pasir halus, pasir kasar dan pasir di dalam kelas selepas

dibahagikan. Kawasan kajian ini adalah di ladang padi seluas 145 ha terletak di Blok C, Sawah Sempadan dalam Skim Pengairan Padi Tanjong Karang, Malaysia. Penderia telah ditarik dengan traktor berbentuk U diantara parit tengah (kalajuan = 15 km j^{-1}). Titik sampel yang terganggu dan tidak terganggu bagi 236 sampel telah dikutip dan dirakamkan lokasinya oleh GPS (Trimble GeoExplorer3). Data ciri tanah dan EC_a telah dijanakan peta menggunakan teknik kriging diatas GS+ dan ArcGIS. SPSS dan SAS telah diguna untuk analisa statistik. Kajian ini menunjuk bahawa penderia EC boleh menentukan variasi ruang dan temporal tanah dimana ia boleh memperoleh maklumat tanah dengan cepat dengan kurang pekerja. Kebanyakan ciri tanah dan EC_a berubah dari satu musim ke satu musim yang lain melainkan, N keseluruhan. Banyak ciri tanah mengandungi nilai purata yang sama bagi musim 1 dan 3 seperti K, kelembapan, lempung dan pasir kasar. Variasi ruang bagi EC_a yang cetek dan dalam mempunyai bentuk yang sama bagi musim yang berbeza walaupun nilai puratanya berbeza. EC_a dalam menunjuk bentuk laluan sungai lama dengan jelas seperti garisan sambungan seluas 45 m di sebelah utara dan kawasan tengah bagi kawasan kajian. Na yang rendah di zon 1 yang dibahagikan oleh EC_a dalam munkin disebabkan oleh profil tanah yang dalam untuk mencapai bahan asas lanar laut. Kandungan pasir halus dan pasir yang tinggi dalam zon 1 terdapat pada semua musim. Model anggaran ciri tanah berasaskan EC_a berbeza secara ruang atau temporal dari satu musim ke satu musim yang lain atau satu zon ke satu zon yang lain. Banyak ciri tanah baik dianggar oleh EC_a dalam malainkan, K dan ESP. Model yang terpilih menunjukkan bahawa R^2 yang penting yang paling tinggi adalah terdapat pada model pasir halus dan pasir dengan model yang konsisten pada semua musim kajian. Hubungan diantara hasil dan EC_a dalam adalah tidak penting bagi semua musim.

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Lastly, I would like to extend my heartfelt thanks to my parents, brothers and sisters for their love, understanding and encouragement to complete this study.

~Aimrun Wayayok~

Safar1427

I certify that an Examination Committee has met on 27th March 2006 to conduct the final examination of Aimrun Wayayok on his Doctor of Philosophy thesis entitled "Paddy Field Zone Delineation using Apparent Electrical Conductivity and its Relationship to the Chemical and Physical Properties of Soil" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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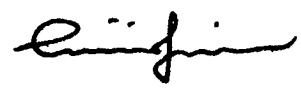

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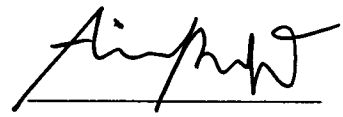
DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or currently submitted for any other degree at UPM or other institutions.



AIMRUN WAYAYOK

Date: 2 May 2006

TABLE OF CONTENTS

		Page
DEDICATION		ii
ABSTRACT		iii
ABSTRAK		v
ACKNOWLEDGEMENTS		vii
APPROVAL		viii
APPROVAL		ix
DECRALATION		x
LIST OF TABLES		xiv
LIST OF FIGURES		xx
LIST OF ABBREVIATIONS		xxv
CHAPTER		
1	**INTRODUCTION**	1.1
	1.1 Introduction	1.1
	1.2 Statement of the Problems	1.4
	1.3 Objectives	1.6
	1.4 Scope of the Study	1.6
2	**LITERATURE REVIEW**	2.1
	2.1 Introduction	2.1
	2.2 Basic Knowledge for Electrical Conductivity	2.2
	2.3 Global Positioning System	2.6
	2.3.1 GPS System Overview	2.7
	2.3.2 Basic Idea about GPS	2.12
	2.4 Geographical Information System and Geospatial Data	2.15
	2.4.1 The Importance of Geospatial Data	2.17
	2.4.2 GIS in Agriculture	2.19
	2.5. Precision Farming	2.20
	2.5.1 History of Precision Farming	2.20
	2.5.2 Precision and Accuracy	2.22
	2.5.3 Spatial Autocorrelation	2.23
	2.5.4 Management Zone	2.24
	2.5.5 Zone Delineation	2.25
	2.5.6 Interpolation Techniques and Variogram Analysis	2.27
	2.6 Electrical Conductivity Map and Its Uses	2.32
	2.7 Relationship between EC and Soil Properties	2.33
	2.7.1 Lab EC	2.33

	2.7.2 In-Situ or Field EC_a	2.35
2.8	Variable Rate Technology	2.40
	2.8.1 Map-based Technologies	2.40
	2.8.2 Sensor-based Technologies	2.43
2.9	Rice Cultivation	2.45
	2.9.1 Soil and Fertilizer management	2.45
	2.9.2 Water	2.46
2.10	Summary	2.48
3	**METHODOLOGY**	3.1
3.1	Study Area	3.1
	3.1.1 Location and Topography	3.1
	3.1.2 Soil Characteristics	3.2
3.2	Duration of Field Works	3.4
3.3	EC_a Data Acquisition and Map Generation	3.4
3.4	Soil Sampling, Lab Analysis and Soil Map Generation	3.6
	3.4.1 Physical Properties	3.7
	3.4.2 Chemical Properties	3.8
3.5	Yield Data	3.9
3.6	Classical Statistical Analysis for EC_a and Soil Data	3.10
3.7	Mapping of Soil Properties	3.10
3.8	Modeling of Soil Properties	3.11
4	**RESULTS AND DISCUSSION**	4.1
4.1	Introduction	4.1
4.2	Statistical Description	4.1
	4.2.1 Bulk Soil Electrical Conductivity	4.1
	4.2.2 Chemical Properties	4.8
	4.2.3 Physical Properties	4.12
4.3	Temporal Variability	4.20
	4.3.1 Bulk Soil Electrical Conductivity	4.20
	4.3.2 Chemical Properties	4.21
	4.3.3 Physical Properties	4.22
4.4	Geostatistics Description	4.23
	4.4.1 Bulk Soil Electrical Conductivity	4.24
	4.4.2 Chemical Properties	4.27
	4.4.3 Physical Properties	4.49
4.5	Spatial Variability	4.58
	4.5.1 Bulk Soil Electrical Conductivity	4.58
	4.5.2 Chemicals Properties	4.71
	4.5.3 Physicals Properties	4.120
4.6	Matrix Correlation of Soil Properties	4.138

4.7 EC_a Zonal Characteristics 4.145
4.7.1 Shallow EC_a Zones 4.145
4.7.2 Deep EC_a Zones 4.153
4.8 Model for Soil Property Estimations 4.161
4.8.1 For the Entire Study Area 4.161
4.8.2 For the Zones 4.163
4.9 Soil Properties Affecting EC_a 4.178
4.9.1 Entire Study Area 4.178
4.9.2 For the Zones 4.180
4.10 EC_a and Yield Characteristics 4.186

5 **CONCLUSIONS** 5.1

REFERENCES R.1
APPENDICES A.1
BIODATA OF THE AUTHOR B.1

LIST OF TABLES

Table		Page
1	Water Level during Growing Season for Direct Seeding System.	2.47
2	Descriptive Statistics for Three Seasons EC_a Data.	4.3
3	Summary of Shallow EC_a Data Points for Three Seasons Classified by DOA.	4.6
4	Summary of Deep EC_a Data Points for Three Seasons Classified by DOA.	4.7
5	Summary Statistics of Soil Chemical Properties for Season 1.	4.9
6	Summary Statistics of Soil Chemical Properties for Season 2.	4.10
7	Summary Statistics of Soil Chemical Properties for Season 3.	4.11
8	Summary Statistics of Dry Bulk Density and Moisture Content for Season 1.	4.13
9	Summary Statistics of Dry Bulk Density and Moisture Content for Season 2.	4.13
10	Summary Statistics of Dry Bulk Density and Moisture Content for Season 3.	4.14
11	Summary Statistics of Soil Particle Distribution for Season 1.	4.15
12	Summary Statistics of Soil Particle Distribution for Season 2.	4.16
13	Summary Statistics of Soil Particle Distribution for Season 3.	4.17
14	Mean of the EC_a for Seasons 1, 2 and 3.	4.21
15	Means of the Soil Chemical Properties for Seasons 1, 2 and 3 (n = 236).	4.22
16	Means of the Soil Physical Properties for Seasons 1, 2 and 3 (n = 236).	4.23
17	Summary of the Spatial Structure of Shallow EC_a for Three Seasons.	4.25
18	Summary of the Spatial Structure of Deep EC_a for Three Seasons.	4.26
19	Summary of the Spatial Structure of Soil pH for Three Seasons.	4.28
20	Summary of the Spatial Structure of Soil EC (dS m^{-1}) for Three Seasons.	4.29

21	Summary of the Spatial Structure of Soil OM (%) for Three Seasons.	4.31
22	Summary of the Spatial Structure of OC (%) for Three Seasons.	4.32
23	Summary of the Spatial Structure of Total S (%) for Three Seasons.	4.33
24	Summary of the Spatial Structure of Total N (%) for Three Seasons.	4.35
25	Summary of the Spatial Structure of Available P (ppm) for Three Seasons.	4.36
26	Summary of the Spatial Structure of CEC ($cmol_c\ kg^{-1}$) for Three Seasons.	4.37
27	Summary of the Spatial Structure of Ca ($cmol_c\ kg^{-1}$) for Three Seasons.	4.39
28	Summary of the Spatial Structure of Mg ($cmol_c\ kg^{-1}$) for Three Seasons.	4.40
29	Summary of the Spatial Structure of K ($cmol_c\ kg^{-1}$) for Three Seasons.	4.41
30	Summary of the Spatial Structure of Na ($cmol_c\ kg^{-1}$) for Three Seasons.	4.42
31	Summary of the Spatial Structure of Al ($cmol_c\ kg^{-1}$) for Three Seasons.	4.44
32	Summary of the Spatial Structure of Fe ($cmol_c\ kg^{-1}$) for Three Seasons.	4.45
33	Summary of the Spatial Structure of Total Cation ($cmol_c\ kg^{-1}$) for Three Seasons.	4.46
34	Summary of the Spatial Structure of BS (%) for Three Seasons.	4.48
35	Summary of the Spatial Structure of ESP (%) for Three Seasons.	4.49
36	Summary of the Spatial Structure of Dry Bulk Density ($g\ cm^{-3}$) for Three Seasons.	4.51
37	Summary of the Spatial Structure of Moisture Content (%) for Three Seasons.	4.51
38	Summary of the Spatial Structure of Clay (%) for Three Seasons.	4.56
39	Summary of the Spatial Structure of Silt (%) for Three Seasons.	4.56
40	Summary of the Spatial Structure of Fine Sand (%) for Three Seasons.	4.57

41	Summary of the Spatial Structure of Coarse Sand (%) for Three Seasons.	4.57
42	Summary of the Spatial Structure of Sand (%) for Three Seasons.	4.57
43	Summary of Kriged Shallow EC_a Maps for Three Seasons Classified by Standard DOA Rank.	4.60
44	Summary of Kriged Deep EC_a Maps for Three Seasons Classified by Standard DOA Rank.	4.61
45	Summary of Kriged Shallow EC_a Maps for Three Seasons Classified by Smart Quantiles.	4.66
46	Summary of Kriged Deep EC_a Maps for Three Seasons Classified by Smart Quantiles.	4.69
47	Summary of Kriged pH Maps for Three Seasons Classified by DOA Recommendation.	4.72
48	Summary of Kriged pH Maps for Three Seasons Classified by Smart Quantiles.	4.75
49	Summary of Kriged EC Maps for Three Seasons Classified by Smart Quantiles.	4.78
50	Summary of the Third Kriged EC Map Classified by Smart Quantiles based on Seasonal Values.	4.79
51	Summary of Kriged OM Maps for Three Seasons Classified by Smart Quantiles.	4.81
52	Summary of Kriged OC Maps for Three Seasons Classified by Smart Quantiles.	4.83
53	Summary of Kriged Total S Maps for Three Seasons Classified by Smart Quantiles.	4.86
54	Summary of Kriged Total N Maps for Three Seasons Classified by Smart Quantiles.	4.89
55	Summary of Kriged Avai. P Maps for Three Seasons Classified by Smart Quantiles.	4.92
56	Summary of Kriged CEC Maps for Three Seasons Classified by Smart Quantiles.	4.95
57	Summary of Kriged Ca Maps for Three Seasons Classified by Smart Quantiles.	4.98
58	Summary of Kriged Mg Maps for Three Seasons Classified by Smart Quantiles.	4.101
59	Summary of Kriged K Maps for Three Seasons Classified by Smart Quantiles.	4.104

60	Summary of Kriged Na Maps for Three Seasons Classified by Smart Quantiles.	4.107
61	Summary of Kriged Al Maps for Three Seasons Classified by Smart Quantiles.	4.109
62	Summary of Kriged Fe Maps for Three Seasons Classified by Smart Quantiles.	4.111
63	Summary of Kriged Total Cation Maps for Three Seasons Classified by Smart Quantiles.	4.114
64	Summary of Kriged BS Maps for Three Seasons Classified by Smart Quantiles.	4.116
65	Summary of Kriged ESP Maps for Three Seasons Classified by Smart Quantiles.	4.118
66	Summary of Kriged Dry Bulk Density Maps for Three Seasons Classified by Smart Quantiles.	4.121
67	Summary of Kriged Moisture Content Maps for Three Seasons Classified by Smart Quantiles.	4.124
68	Summary of Kriged Clay Maps for Three Seasons Classified by Smart Quantiles.	4.128
69	Summary of Kriged Silt Maps for Three Seasons Classified by Smart Quantiles.	4.130
70	Summary of Kriged Fine Sand Maps for Three Seasons Classified by Smart Quantiles.	4.132
71	Summary of Kriged Coarse Sand Maps for Three Seasons Classified by Smart Quantiles.	4.134
72	Summary of Kriged Sand Maps for Three Seasons Classified by Smart Quantiles.	4.136
73	Pearson Matrix Correlation Coefficient of Season 1 Soil Properties (n = 236).	4.142
74	Pearson Matrix Correlation Coefficient of Season 2 Soil Properties (n = 236).	4.143
75	Pearson Matrix Correlation Coefficient of Season 3 Soil Properties (n = 236).	4.144
76	Means of Soil Properties within Shallow EC_a Zones for Season 1.	4.147
77	Means of Soil Properties within Shallow EC_a Zones for Season 2.	4.148
78	Means of Soil Properties within Shallow EC_a Zones for Season 3.	4.149
79	Correlation of Soil Properties with Mean Shallow EC_a in the Zones Season 1 (n = 5).	4.150

80	Correlation of Soil Properties with Mean Shallow EC_a in the Zones Season 2 (n = 5).	4.151
81	Correlation of Soil Properties with Mean Shallow EC_a in the Zones Season 3 (n = 5).	4.152
82	Means of Soil Properties within Deep EC_a Zones for Season 1.	4.155
83	Mean of Soil Properties within Deep EC_a Zones for Season 2.	4.156
84	Mean of Soil Properties within Deep EC_a Zones for Season 3.	4.157
85	Correlation of Soil Properties with Mean Deep EC_a in the Zones for Season 1 (n = 5).	4.158
86	Correlation of Soil Properties with Mean Deep EC_a in the Zones for Season 2 (n = 5).	4.159
87	Correlation of Soil Properties with Mean Deep EC_a in the Zones for Season 3 (n = 5).	4.160
88	Significant Curve Fit Estimation Model for Soil Chemical Properties in the Entire Study Area (n = 236).	4.162
89	Significant Curve Fit Estimation Model for Soil Physical Properties in the Entire Study Area (n = 236).	4.163
90	The Best Curve Estimation for Soil Properties and Shallow EC_a (n=5).	4.165
91	The Best Curve Estimation for Soil Properties and Deep EC_a (n=5).	4.166
92	The Best Curve Estimation for Soil Properties and Shallow EC_a in Zone 1 Shallow EC_a for Three Seasons.	4.167
93	The Best Curve Estimation for Soil Properties and Shallow EC_a in Zone 2 Shallow EC_a for Three Seasons.	4.169
94	The Best Curve Estimation for Soil Properties and Shallow EC_a in Zone 3 Shallow EC_a for Three Seasons.	4.170
95	The Best Curve Estimation for Soil Properties and Shallow EC_a in Zone 4 Shallow EC_a for Three Seasons.	4.171
96	The Best Curve Estimation for Soil Properties and Shallow EC_a in Zone 5 Shallow EC_a for Three Seasons.	4.171
97	The Best Curve Estimation for Soil Properties and Deep EC_a in Zone 1 Deep EC_a for Three Seasons.	4.173
98	The Best Curve Estimation for Soil Properties and Deep EC_a in Zone 2 Deep EC_a for Three Seasons.	4.174
99	The Best Curve Estimation for Soil Properties and Deep EC_a in Zone 3 Deep EC_a for Three Seasons.	4.175

100	The Best Curve Estimation for Soil Properties and Deep EC_a in Zone 4 Deep EC_a for Three Seasons.	4.176
101	The Best Curve Estimation for Soil Properties and Deep EC_a in Zone 5 Deep EC_a for Three Seasons.	4.177
102	Summary of Three Season Yields for 118 Plots.	4.186

LIST OF FIGURES

Figure		Page
1	The System Components of Veris Soil EC Mapping-Model: Veris3100.	2.3
2	Schematic of Electrodes Configuration (a) Shallow and, (b) Deep Readings.	2.4
3	Contour Plots of the Measured Signal by Each Unit Soil Volume (Boydell et al., 2003).	2.5
4	GPS Satellite Constellation.	2.8
5	GPS Satellite.	2.8
6	GPS Signal Structure.	2.10
7	Control Segment Station Locations.	2.11
8	GPS User Segment.	2.12
9	Intersection of Three Imaginary Spheres.	2.13
10	Four Required Satellites to Obtain a Position and Time in 3 Dimensions.	2.13
11	Pseudo Random Code.	2.15
12	Steps of Precision Farming.	2.21
13	Concept of Accuracy and Precision.	2.23
14	A Typical Variogram Model.	2.29
15	Typical Ideal Water Management in Rice Cultivation (FAO, 1989).	2.48
16	Sawah Sempadan Compartment and Block C (a) Satellite Image for Tanjong Karang Rice Irrigation Scheme, (b) Satellite Image for Sawah Sempadan Rice Irrigation Compartment, and (c) Block C at Sawah Sempadan Rice Irrigation Compartment.	3.2
17	Soil Series Map of Block C, Sawah Sempadan (DOA, 2000).	3.3
18	VerisEC 3100 with DGPS was Pulled by a Tractor in a Paddy Field (a) 35HP Tractor was used in Season 1 and, (b) 80HP Tractor was used in the following Two Seasons.	3.5

19	Schematic of Study Steps.	3.11
20	The Distribution of Shallow EC_a (mS m^{-1}) Values within the Study Area (a) Season 1, (b) Season 2, and (c) Season 3.	4.4
21	The Distribution of Deep EC_a (mS m^{-1}) Values within the Study Area (a) Season 1, (b) Season 2, and (c) Season 3.	4.5
22	Typical Map of the Soil Chemical and Physical Sampling Points in Block C for Three Seasons.	4.8
23	Season 1 Soil Texture Distributed on Triangular Class.	4.18
24	Season 2 Soil Texture Distributed on Triangular Class.	4.18
25	Season 3 Soil Texture Distributed on Triangular Class.	4.19
26	Isotrophic Variograms of Shallow EC_a (mS m^{-1}).	4.25
27	Isotrophic Variograms of Deep EC_a (mS m^{-1}).	4.26
28	Isotrophic Variograms of Soil pH.	4.28
29	Isotrophic Variograms of Soil EC (dS m^{-1}).	4.29
30	Isotrophic Variograms of Soil OM (%).	4.30
31	Isotrophic Variograms of OC (%).	4.32
32	Isotrophic Variograms of Total S (%).	4.33
33	Isotrophic Variograms of Total N (%).	4.34
34	Isotrophic Variograms of Available P (ppm).	4.36
35	Isotrophic Variograms of CEC ($cmol_c$ kg^{-1}).	4.37
36	Isotrophic Variograms of Ca ($cmol_c$ kg^{-1}).	4.38
37	Isotrophic Variograms of Mg ($cmol_c$ kg^{-1}).	4.40

38	Isotrophic Variograms of K ($cmol_{c2,3}\ kg^{-1}$).	4.41
39	Isotrophic Variograms of Na ($cmol_c\ kg^{-1}$).	4.42
40	Isotrophic Variograms of Al ($cmol_c\ kg^{-1}$).	4.44
41	Isotrophic Variograms of Fe ($cmol_c\ kg^{-1}$).	4.45
42	Isotrophic Variograms of Total Cation ($cmol_c\ kg^{-1}$).	4.46
43	Isotrophic Variograms of BS (%).	4.47
44	Isotrophic Variograms of ESP (%).	4.49
45	Isotrophic Variograms of Dry Bulk Density ($g\ cm^{-3}$).	4.50
46	Isotrophic Variograms of Moisture Content (%).	4.51
47	Isotrophic Variograms of Clay (%).	4.54
48	Isotrophic Variograms of Silt (%).	4.54
49	Isotrophic Variograms of Fine Sand (%).	4.55
50	Isotrophic Variograms of Coarse Sand (%).	4.55
51	Isotrophic Variograms of Sand (%).	4.56
52	Kriged Map for Shallow EC_a ($mS\ m^{-1}$) Classified by Standard DOA EC Rank (a) Season 1, (b) Season 2, and (c) Season 3.	4.62
53	Kriged Map for Deep EC_a ($mS\ m^{-1}$) Classified by Standard DOA EC Rank (a) Season 1, (b) Season 2, and (c) Season 3.	4.63
54	Kriged Map for Shallow EC_a ($mS\ m^{-1}$) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.67
55	Kriged Map for Deep EC_a ($mS\ m^{-1}$) Classified by Smart Quantiles (a) Season 1, (b) Season 2, (c) Season 3, and (d) Soil Series Map.	4.70
56	Kriged Map for pH Classified by DOA (a) Season 1, (b) Season 2, and (c) Season 3.	4.73

57	Kriged Map for pH Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.76
58	Kriged Map for EC (dS m^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.79
59	Kriged Map for OM (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.82
60	Kriged Map for OC (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.84
61	Kriged Map for Total S (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.87
62	Kriged Map for Total N (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.90
63	Kriged Map for Avai. P (ppm) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3 Classified to Seasonal Smart Quantiles.	4.93
64	Kriged Map for CEC ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.96
65	Kriged Map for Ca ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.99
66	Kriged Map for Mg ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.102
67	Kriged Map for K ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.105
68	Kriged Map for Na ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.108
69	Kriged Map for Al ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.110
70	Kriged Map for Fe ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.112
71	Kriged Map for Total Cation ($cmol_c$ kg^{-1}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.115
72	Kriged Map for BS (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.117
73	Kriged Map for ESP (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.119
74	Kriged Map for Dry Bulk Density (g cm^{-3}) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.122
75	Kriged Map for Moisture Content (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.125

76	Kriged Map for Clay (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.129
77	Kriged Map for Silt (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.131
78	Kriged Map for Fine Sand (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.133
79	Kriged Map for Coarse Sand (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.135
80	Kriged Map for Sand (%) Classified by Smart Quantiles (a) Season 1, (b) Season 2, and (c) Season 3.	4.137
81	Thematic Maps for Yield (kg ha^{-1}) (a) Season 1, (b) Season 2, and (c) Season 3.	4.187
82	Relationship between Yield (kg ha^{-1}) and Shallow EC_a (mS m^{-1}) for all the Seasons.	4.189
83	Relationship between Yield (kg ha^{-1}) and Deep EC_a (mS m^{-1}) for all the Seasons.	4.189