

APPENDICES

APPENDIX A

A.1 Hooghly district rainfall percentage of departure month wise during 2013-2017

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F	R/F
2013	2.1	8.9	2.4	56.5	93.7	223	221.4	287.0	186.6	282.8	0.0	0.0
2014	0.0	44.0	19.5	0.1	78.6	218.3	239.9	289.1	190.6	34.4	0.0	0.0
2015	9.1	4.1	16.0	62.4	54.0	299.5	671.6	188.0	215.3	27.2	0.1	1.8
2016	1.3	14.0	20.3	0.0	85.3	166.2	253.0	347.1	242.8	75.9	12.7	0.0
2017	0.0	0.0	23.9	11.8	115.2	186.6	434.6	227.0	180.8	212.4	25.2	19.9

Note :(1) The District Rainfall in millimeters (R/F) shown below are the arithmetic averages of Rainfall of Stations under the District; Source: Customized Rainfall Information System (CRIS),IMD, Ministry Of Earth Sciences, <http://hydro.imd.gov.in/hydrometweb/> (S(viy3l545fkfkek55worcgj55))/ DistrictRaifall.aspx

A. 2 Source-wise area irrigated in Hooghly district

Region	Canal Gross area (ha)	Tank		R.L.I.		S.T.W.					D.T.W.		
		No.	Gross Area(ha)	No.	Gross Area(ha)	State Owned	Private No.	Total	Net Area (ha)	Gross Area (ha)	No.	Net Area (ha)	Gross Area (ha)
Tarakeswar Block	6125	2390	2280	7	360	105	1405	1510	2393	4429	9	515	1063
Hooghly Dist.	82150	4148	37450	380	42880	1848	18988	20836	57480	153091	486	14321	27863

Note: R.L.I- River Lift Irrigation, S.T.W. –Shallow tube well, D.T.W.- Heavy Duty tube well

Source : A-I Division, Water Resources Investigation & Devet. Department, Hooghly District., CDAP Hooghly,2012

A.3 Crop season wise irrigation facilities in ha in Hooghly district during 2012

Season	Kharif	Rabi	Summer	Total
Tarakeswar Block	6493	6964	800	14257
Hooghly Dist.	147548	111316	84570	343434

Source : A-I Division, Water Resources Investigation & Devet. Department, Hooghly District., CDAP Hooghly, 2012

A. 4 Distribution of operational holdings in Hooghly district during 2011-2012

Size of land	2011-12	
	No of holdings	Area of holdings (ha)
Marginal	297969	131036
Small	40474	62345
Semi-medium	6299	17106
Medium	1166	5485
Large	-	-
Total	345908	215972

Note:- Marginal: Below 1.0 hectares, Small: 1.0 hectares and above but less than 2.0 hectares, Semimedium: 2.0 hectares and above but less than 4.0 hectares, Medium: 4.0 hectares and above but less than 10.0 hectares, Large:10.0 hectares and above.

Source: District Statistical Handbook, 2013 Bureau of Applied Economics & Statistics Government of West Bengal

A.5 Aus rice : May-June

Year	Tarakeswar		Hooghly	
	Area (ha)	Production (000 mt.)	Area (ha)	Production (000 mt.)
2013-14	250	0.75	6091	23.30
2012-13	200	1.1	5890	28.66
2011-12	200	1.09	6046	25.77
2010-11	200	1.01	5761	25.5
2009-10	200	0.93	5290	19.23
2008-09	200	1.05	8997	41.28
2007-08	150	0.13	8844	26.75
2006-07	200	0.72	9726	29.14
2005-06	175	0.856	10436	42.67
2004-05	200	0.834	14422	59.0

Source: Achievements of Rice Research Station, Chinsurah, Joint Director of Agriculture (Rice development), Department of Agriculture, Government of West Bengal, 2014.

A .6 Aman rice (July- August):

Year	Tarakeswar		Hooghly	
	Area (ha)	Production (000 mt.)	Area (ha)	Production (000 mt.)
2013-14	7000	33.96	185380	808.22
2012-13	7000	32.63	183190	804.36
2011-12	7010	42.26	183519	799.56
2010-11	7000	37.75	177548	821.61
2009-10	7000	35.66	187262	704.14
2008-09	7340	39.93	183537	840.59
2007-08	7250	93.45	176969	931.21
2006-07	7250	23.40	185410	753.31
2005-06	7180	37.94	182685	839.71
2004-05	7305	33.48	180471	819.66

Source : Achievements of Rice Research Station, Chinsurah, Joint Director of Agriculture (Rice development), Department of Agriculture, Government of West Bengal, 2014.

A.7 Boro rice :(december-april)

Year	Tarakeswar		Hooghly	
	Area (ha)	Production (000 mt.)	Area (ha)	Production (000 mt.)
2013-14	500	2.34	66385	34.915
2012-13	70	0.17	53523	285.66
2011-12	400	2.0	66034	327.69
2010-11	110	0.59	60500	309.51
2009-10	200	0.9	73739	374.08
2008-09	475	2.64	77029	380.66
2007-08	460	2.33	79257	441.16
2006-07	300	1.86	74745	417.0
2005-06	200	0.29	77058	320.0
2004-05	275	1.08	78215	374.67

Source : Achievements of Rice Research Station, Chinsurah, Joint Director of Agriculture (Rice development), Department of Agriculture, Government of West Bengal, 2014.

A.8 Jute :

Year	Tarakeswar		Hooghly	
	Area (ha)	Production (000 bells)	Area (ha)	Production (000 bells)
2004-05	3150	48.95	20540	335.80

2005-06	3500	48.65	20845	319.41
2006-07	3600	59.76	20756	334.18
2007-08	3550	56.09	21784	326.32
2008-09	3450	54.16	16612	249.92
2009-10	3350	51.25	16225	241.49
2010-11	3500	56.00	17193	283.30
2011-12	3000	48.00	17625	267.73
2012-13	2400	38.68	16609	255.733
2013-14	1150	19.68	14084	225.126

Source : Achievements of Rice Research Station, Chinsurah, Joint Director of Agriculture (Rice development), Department of Agriculture, Government of West Bengal, 2014.

APPENDIX B

QUESTIONNAIRE SURVEY

1. Block: Tarakeswar District: Hooghly
2. Village name: _____ House No. _____
3. Cadastral _____ JL. No. _____
3. Name of the owner: _____
4. Agricultural Area: _____ Bigha/Kata
5. Name of the crop: _____ Area: _____ Bigha/Kata Production: _____ kg/ton
6. Drainage Level: Yes/No Type _____

APPENDIX C

C.1 Specification GARMIN GPS e-Trex 20 receiver

The specification of the receiver is as follows:

- 2000 Waypoints
- 200 reversible routes
- 10,000 points, 200 saved tracks
- Transflective, 65-K color TFT display type
- 25 hour battery life
- 2 AA batteries
- USB interface

APPENDIX D

Metadata for Landsat 8 image on 08-03-2015 for study area

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APPENDIX E

E.1 Rank of individual parameters as per its importance for the crop

Elements	Soil Texture	pH	EC	O.C	N	P	K	Zn
Rank (1-8)								

E.2 Ground Control point (GCPs) of the study area

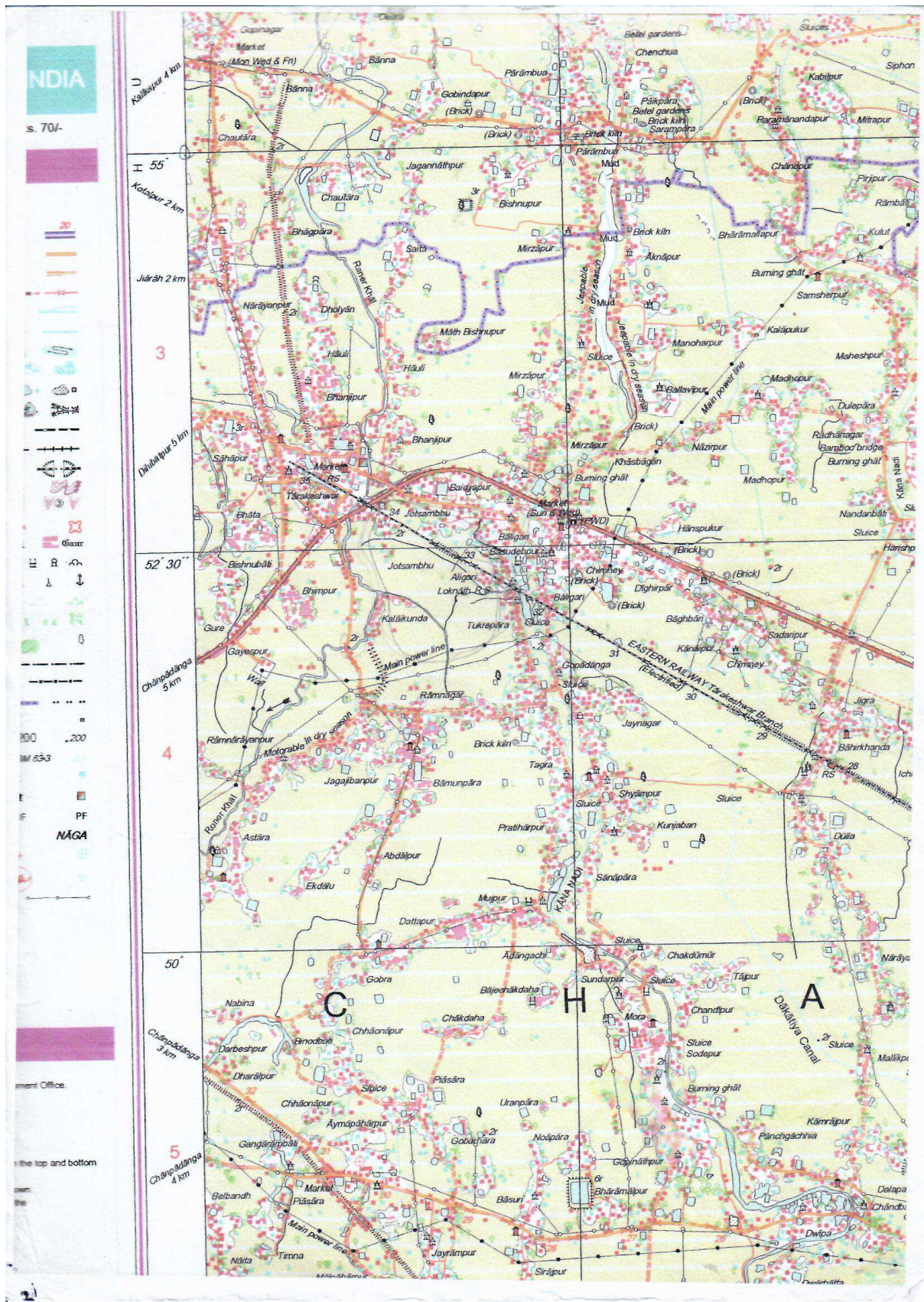
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A	Loknath Station	22.87110	88.03523
B	Basudevpur Choumatha	22.87528	88.03480
D	Loknath Mondir Crossing	22.88039	88.03642
E	Tarakeswar Choumatha	22.88131	88.02212
F	Rail Gate	22.87968	88.01899
G	Kolaikundu Crossing	22.87818	88.01622
H	Stadium+Canal	22.86493	88.01670
J	Ramnagar Crossing	22.85806	88.02476
K	Tagra Crossing	22.85863	88.03832

APPENDIX F

F.1 Yield information of the study area for rice and potato crop

SL.NO.	Key_ID	Latitude	Longitude	Name	Area_kata	Rice t/ha	Potato t/ha
1	A1	22.8728	88.031	Somoresch Upadhay	7	6.43	26.78
2	A2	22.8726	88.0309	Sufol Patra	8	5.63	32.81
3	A3	22.8722	88.0303	Ujjol Ghosh	6	7.50	31.25
4	A4	22.8719	88.0305	Montu Ghosh	10	5.25	19.5
5	A5	22.8714	88.0304	Sonjoy Ghosh	5	4.50	16.5
6	A6	22.8707	88.0306	Mrinmoy Jana	7	3.43	10.71
7	A7	22.8703	88.0302	Dino Jana	10	4.50	19.5
8	A8	22.8701	88.0305	Pradip Bhar	5	4.50	15
9	A9	22.8695	88.0305	Nimai Vumiz	5	4.50	14.4
10	A10	22.8697	88.0309	Montu Ghurui	5	4.50	14.55
11	B1	22.8751	88.0309	Kamal Lohar	10	3.60	22.5
12	B2	22.8755	88.0312	Mohadeb Lohar	15	4.20	13.5
13	B3	22.875	88.0306	Shyamal Lohar	15	4.20	13.5
14	B4	22.875	88.0303	Goutam Lohar	25	4.68	16.2
15	B5	22.8752	88.03	Gopinath Hembram	10	5.40	13.5
16	B6	22.8754	88.0302	Rita Lohar	12	4.50	13.125
17	B7	22.8756	88.0305	Sukumar Lohar	15	5.40	12.5
18	B8	22.8752	88.0306	Shiva Lohar	7	3.86	13.92
19	B9	22.8743	88.032	Gopinath Hembram	12	4.50	13.75
20	B10	22.8739	88.0327	Annata Ghosh	10	3.60	15
21	C1	22.8763	88.0299	Hira Ghosh	12	5.25	18.75
22	C2	22.8765	88.0298	Jaya Ghosh	12	5.31	18.87
23	C3	22.8763	88.0289	Nimai Ghosh	10	4.50	21
24	C4	22.8762	88.0289	Lata Ghosh	12	5.13	17.5
25	C5	22.876	88.0279	Kajol Murmu	10	4.65	16.5
26	C6	22.8758	88.028	Netai Ghosh	12	5.00	18.12
27	C7	22.8758	88.0279	Abhijit Hembram	10	4.50	18
28	C8	22.8755	88.0281	Horipoda Das	10	4.80	15
29	C9	22.8756	88.0278	Gourango Majhi	12	4.56	15
30	C10	22.8757	88.0282	Badol Ghosh	8	5.81	18.75
31	D1	22.874	88.0223	Utpol Patra	12	4.63	15
32	D2	22.8741	88.0232	Kobir Sekh	5	4.50	22.2
33	D3	22.8737	88.0231	Horipoda Jana	6	3.75	18.75
34	D4	22.8734	88.023	Kobir Das	5	4.50	22.2
35	D5	22.8732	88.0231	Dino Jana	6	3.75	18.75

36	D6	22.8734	88.0226	Komol Lohar	40	4.05	30
37	D7	22.8734	88.0222	Asish Roy	5	4.50	21.9
38	D8	22.8735	88.0224	Sonjit Khamrui	10	4.50	18
39	D9	22.8736	88.0225	Mohon Khamrui	12	5.00	18.12
40	D10	22.8738	88.0225	Noresh Jana	5	4.50	22.2
41	E1	22.8705	88.0219	Prabir Hazra	4	0.00	0
42	E2	22.8707	88.0213	Hironmoy Hazra	5	4.80	24
43	E3	22.8691	88.0221	Chandrasekhor Samonto	15	4.50	24
44	E4	22.869	88.0226	Jahor Bera	16	4.22	22.5
45	E5	22.8679	88.0239	Shamapado Samonto	6	4.00	20
46	E6	22.8675	88.0247	Debobrato Khan	6	4.00	20
47	E7	22.8666	88.0249	Laltu Bag	5	9.30	24
48	E8	22.8662	88.0254	Sailendra Nnath Samonto	10	4.50	24
49	E9	22.866	88.0252	Rabindranath Samonto	5	4.80	24
50	E10	22.8662	88.0252	Ramendra Samonto	5	4.80	24



F 2: Open series topographical map of the study area

APPENDIX G

G.1 Soil analysis result for the study area

Top layer (10 samples)

SL.No.	Key_ID	Latitude	Longitude	pH	EC	OC (%)	N(ppm)	P(ppm)	K(ppm)	Zn (ppm)	Soil Texture
1	A1	22.87283	88.03096	4.98	0.1	0.5	30.1056	45.408	25.896	1.16	Clay
2	A7	22.87029	88.0302	4.65	0.48	0.56	10.0352	49.808	78.352	1.48	Sandy clay loam
3	B6	22.87539	88.03023	4.4	0.55	0.45	25.088	50.688	73.04	2.46	Sandy clay
4	B9	22.87432	88.03197	4.7	0.43	0.57	20.0704	154.176	123.504	2.54	Clay
5	C3	22.87634	88.02892	4.71	0.57	0.48	30.1056	152.24	92.96	2.7	Sandy clay loam
6	C6	22.87578	88.02802	4.41	0.52	0.66	50.176	152.24	77.024	2.08	Sandy clay loam
7	D1	22.874	88.02229	4.76	0.4	0.59	25.088	152.328	46.48	1.4	Clay loam
8	D9	22.87364	88.02246	4.66	0.37	0.62	30.1056	86.68	29.216	1.98	Clay loam
9	E5	22.8679	88.02386	5.99	1.07	0.87	25.088	152.24	92.628	2.24	Clay
10	E7	22.86664	88.02493	5.88	1.05	0.9	30.1056	152.328	84.66	2.2	Clay

Shallow Layer (10 samples)

Sl.No.	Key_ID	Latitude	Longitude	pH	EC	OC (%)	N(ppm)	P(ppm)	K(ppm)	Zn (ppm)	Soil Texture
1	A1-1	22.87283	88.03096	5.24	0.09	0.43	25.088	29.392	31.208	1.14	Clay
2	A7-1	22.87029	88.0302	4.71	0.49	0.47	30.1056	64.24	45.152	1.83	Clay loam
3	B6-1	22.87539	88.03023	4.68	0.4	0.37	25.088	79.464	63.412	2.26	Sandy clay
4	B9-1	22.87432	88.03197	4.9	0.3	0.53	35.1232	66.088	83.664	2.48	Clay
5	C3-1	22.87634	88.02892	4.88	0.58	0.39	35.1232	152.24	76.028	2.46	Sandy clay loam
6	C6-1	22.87578	88.02802	4.92	0.25	0.67	20.0704	152.24	38.844	1.86	Sandy clay loam
7	D1-1	22.874	88.02229	5.04	0.2	0.59	30.1056	152.328	37.184	1.36	Clay loam
8	D9-1	22.87364	88.02246	4.54	0.59	0.45	30.1056	140.8	29.88	1.86	Sandy clay loam
9	E5-1	22.8679	88.02386	6.22	0.76	0.7	40.1408	152.24	68.392	2.12	Clay
10	E7-1	22.86664	88.02493	6.27	0.73	1.04	30.1056	152.24	56.44	2.8	Clay

Deep Layer (10 samples)

Sl. No.	Key_ID	Latitude	Longitude	pH	EC	OC (%)	N(ppm)	P(ppm)	K(ppm)	Zn (ppm)	Soil Texture
1	A1-2	22.87283	88.03096	5.11	0.1	0.32	25.088	44.704	32.536	1.12	Clay
2	A7-2	22.87029	88.0302	5.17	0.25	0.33	30.1056	68.64	60.756	1.36	Clay loam
3	B6-2	22.87539	88.03023	5.03	0.31	0.19	25.088	142.032	53.452	1.96	Sandy clay loam
4	B9-2	22.87432	88.03197	4.92	0.32	0.58	30.1056	154.528	140.436	2.54	Clay
5	C3-2	22.87634	88.02892	5.07	0.5	0.46	30.1056	152.24	78.02	2.48	Sandy clay
6	C6-2	22.87578	88.02802	5.07	0.29	0.46	40.1408	150.216	38.512	1.9	Sandy clay loam
7	D1-2	22.874	88.02229	5	0.26	0.45	15.0528	152.328	28.884	1.32	Sandy clay loam
8	D9-2	22.87364	88.02246	5.17	0.23	0.53	30.1056	103.84	47.144	1.76	Clay loam
9	E5-2	22.8679	88.02386	6.61	0.51	0.74	20.0704	152.24	44.82	2.2	Clay
10	E7-2	22.86664	88.02493	6.46	0.62	0.83	30.1056	152.24	55.776	2.3	Clay

G.2 Unit Conversion and Instrument Specification

Conversion of kg/ha to ppm

Conversion of kg/ha to ppm for calculation

Dept of soil	=18 cm
	= 0.18 m
Area	= 10000 m ²
Bulk Density	= 1.4 g/cc (for Hooghly, West Bengal)
(Source: Soil Survey and Classification, Land Development Department, 1999)	
Weight of Soil	= 0.18 x 10000x 1.4 x10 ³
	= 2.52 x 10 kg
	= 2.5 x 10 ⁶ (Approximately)
1kg/ha	= $\frac{1 \times 10^6}{2.5 \times 10^6}$ mg/kg
	= 0.4ppm
20 kg/ha	= 20× 0.4
	= 8 ppm

Conversion of kg /ha P₂O₅ to P in parts per million

Atomic Weight of P	= 32 unit
Atomic Weight of O ₂	= 16
So Molecular weight of P ₂ O ₅	
	= 32× 2 + 16×5
	= 144 unit
So ratio of Pin P ₂ O ₅	
	= $\frac{64}{144} = 0.44$
1 kg/ha	= 0.4 ppm (Source: Appendix B1)
1 kg/ ha of P ₂ O ₅ contains	
	= 0.44× 0.4 ppm of P
	= 0.176 ppm of P

Conversion of kg/ha K₂O to K in parts per million

$$\text{Atomic Weight of K} = 39 \text{ unit}$$

$$\text{Atomic Weight of O}_2 = 16 \text{ unit}$$

$$\begin{aligned} \text{Molecular Weight of K}_2\text{O} \\ &= 39 \times 2 + 16 \\ &= 94 \text{ unit} \end{aligned}$$

So ratio of K in K₂O

$$= \frac{78}{94} = 0.83$$

$$1 \text{ kg/ha} = 0.4 \text{ ppm (Source: Appendix B.1)}$$

$$\begin{aligned} 1 \text{ kg/ha of K}_2\text{O contains} \\ &= 0.83 \times 0.4 \\ &= 0.332 \text{ ppm of K} \end{aligned}$$

APPENDIX H

Output Grid Specification

Output Grid Extent Same As Area 4_final.shp

Output Grid Cell Size As Specified Below

CellSize 9.264868 Map Units

Number of Rows 227

Number of Columns 174

OK Cancel

H.1 Output grid specification in Arc GIS10.1

Interpolate Surface

Method IDW

Z Value Field K(ppm)

Nearest Neighbors Fixed Radius

No: of Neighbors 12

Power 2

Barriers No Barriers

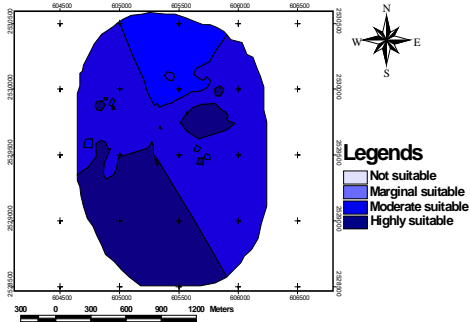
OK Cancel

H.2 Inverse distance weighted in Arc GIS 10.1

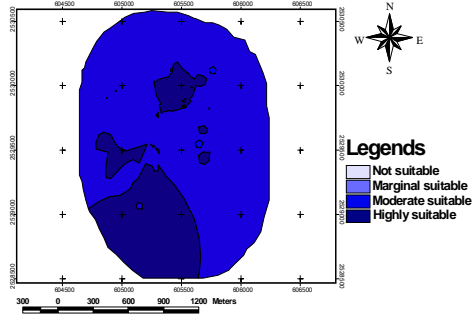
APPENDIX I

I.1 Individual Parameters suitability map for rice, potato, jute and lentil crop (Top layer)

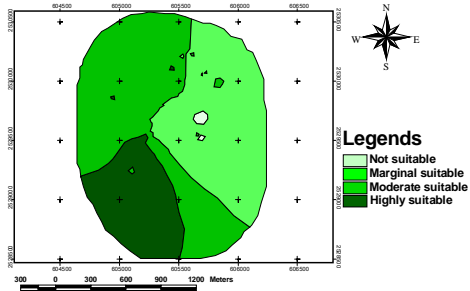
Rice Soil Texture Suitability Map



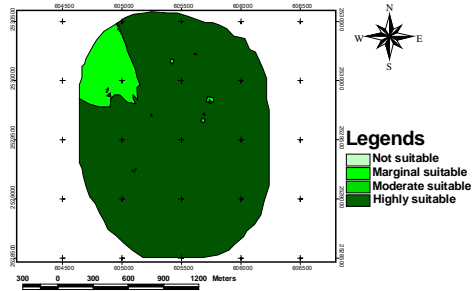
Rice Nitrogen Suitability Map



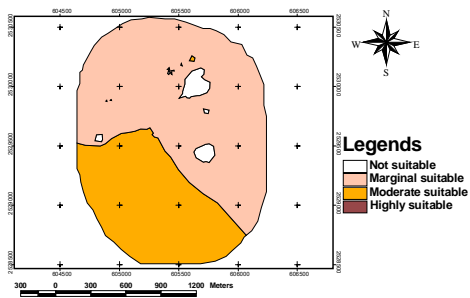
Potato Organic Carbon Suitability Map



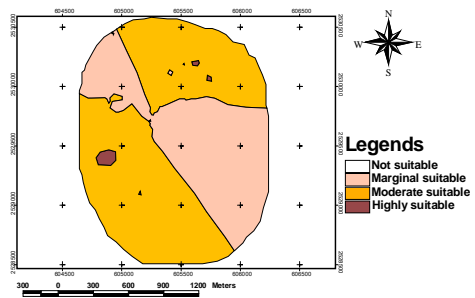
Potato Potassium Suitability Map



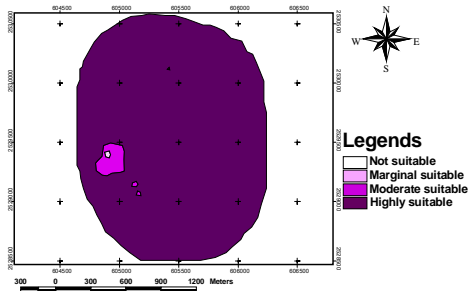
Jute pH Suitability Map



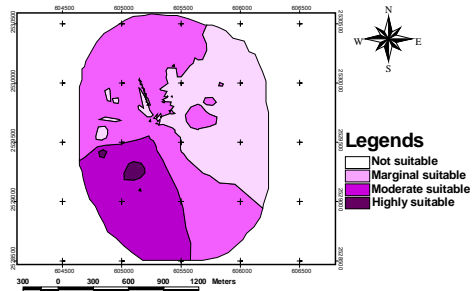
Jute Zinc Suitability Map



Lentil EC Suitability Map

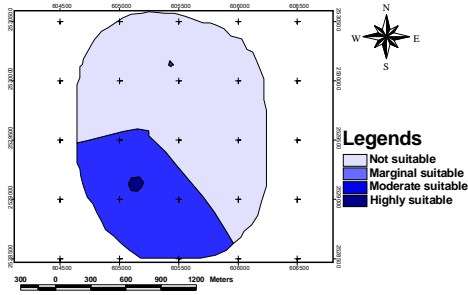


Lentil pH Suitability Map

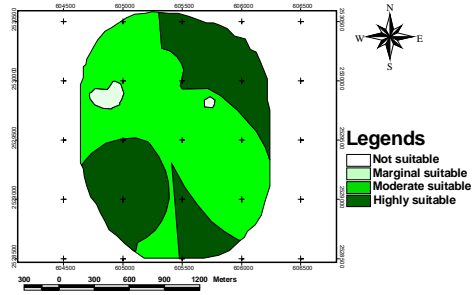


I.2 Individual Parameters suitability map rice, potato, jute and lentil crop (Shallow layer)

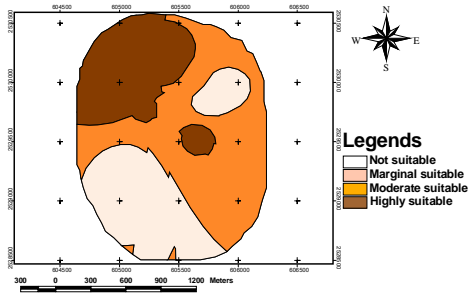
Rice Organic Carbon Suitability Map-Shallow Layer



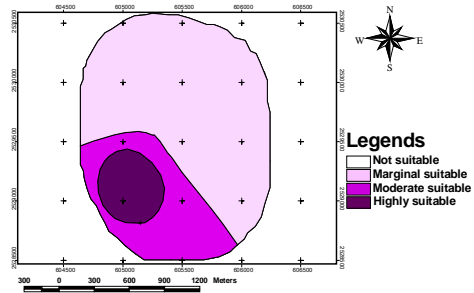
Potato Potassium Suitability Map-Shallow Layer



Jute Soil Texture Suitability Map - Shallow Layer

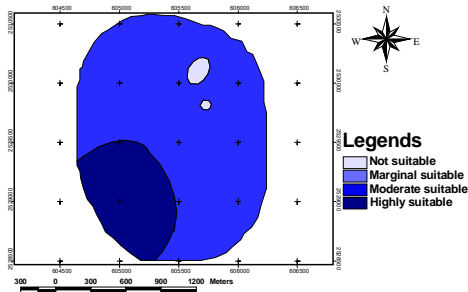


Lentil pH Suitability Map- Shallow Layer

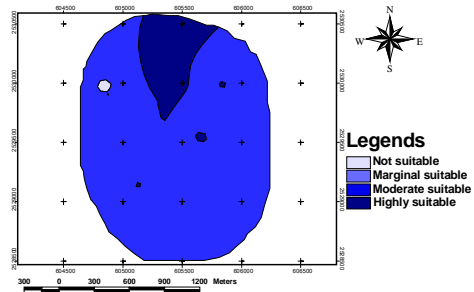


I.3 Individual Parameters suitability map rice, potato, jute and lentil crop (Deep layer)

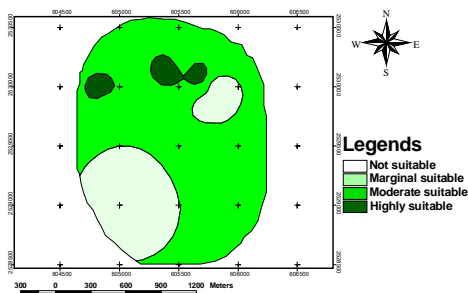
Rice Organic Carbon Suitability Map-Deep Layer



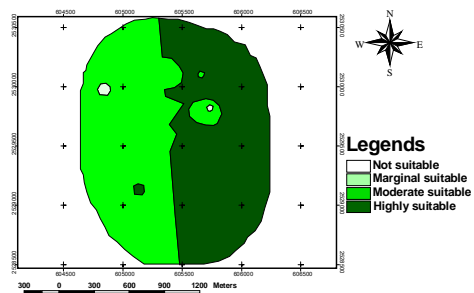
Rice Nitrogen Suitability Map-Deep Layer



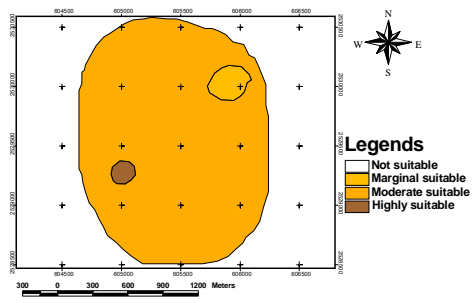
Potato Soil Texture Suitability Map-Deep Layer



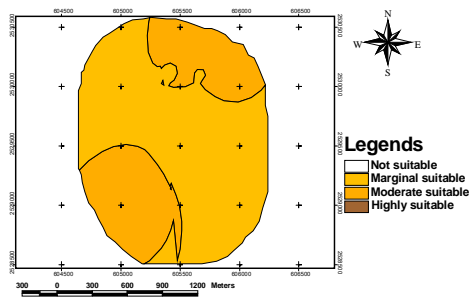
Potato Potassium Suitability Map-Deep Layer



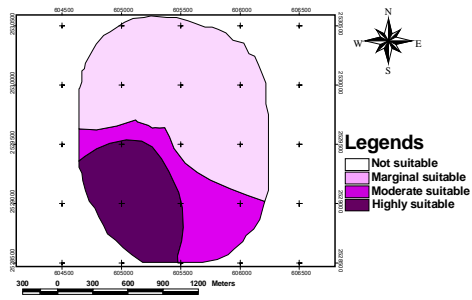
Jute pH Suitability Map-Deep Layer



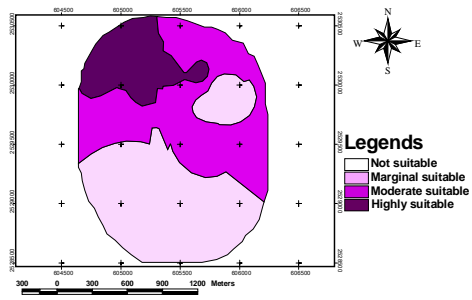
Jute Zinc Suitability Map-Deep Layer



Lentil pH Suitability Map-Deep Layer



Lentil Soil Texture Suitability Map-Deep Layer



APPENDIX H

H.1 Soil sample collection and drying

