Geospatial Approach to Assess the Impact of Nutrients on Rice Equivalent Yield Using MODIS Sensors'-Based MOD13Q1-NDVI Data

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***Abstract*— Crop productivity is a major concern all over the world to provide food security, resulting in the green revolution. It is noteworthy that the fertilizer implemented to farmland leads to more desirable cropping patterns. Utilization of agricultural land efficiently for the crop production requires the knowledge of the nutrient inconsistency. This paper has presented the power of geomatics, to retrieve the synoptic and substantial changes in cropping pattern. Results and interpretations lead to the evaluation of the contemporaneous cropping systems. After a major yield parameter scrutiny for crops (rice, wheat, sugarcane, and onion), the magnificent accelerations were suggested. Results demonstrated a correlation r^2 value of 0.834 with the estimated crop yield and normalized difference vegetation index. The Rice Equivalent Yield (REY) is highest at the range of 17–21 t/ha in the North, central and southern lower part, lowest at the western part ranging from 7–12 t/ha, with some part with 12–14 t/ha, while the most of the eastern part of the study site has shown the REY values ranging from 14 to 17 t/ha. The surveyed information, such as pH, electical conductivity, and organic carbon of the soil specimen, was used to examine the spatial discrepancies of rice-based cropping system's productivity. Ultimately, the spatial-temporal maps of fertilization pattern, yield parameters (e.g., *N*, *P*, and *K*), and relational REY observation were illustrated using spatial interpolation.**

***Index Terms*— Spatial interpolation, nutrient inconsistency, rice equivalent yield, environmental factors.**

I. Introduction

AGRICULTURE refers to the art of raising plants life from the soil, which is useful for mankind; it also includes the activity of livestock rising. Agriculture is the spinal column of the Indian economy and despite rapid industrialization in the last 40 years; it occupies the pride of place in the Indian economy and is often said as agriculture economy. India is acclaimed as a commendatory landscape for tenant farmers. Agriculture leads to the green revolution in terms of increased yields, better sustainability accessible to subordinate farmers as well as marketable producers. Agriculture is the most widely distributed economic activity on the earth's surface. The man has adopted agricultural practices to spatially differing environmental conditions that are reflected in the variety of crops produced by different techniques and methods and also the raising of livestock [1]–[8]. Embedded use of mineral fertilizers disturbed the equilibrium between localized productions and rising demand by the population for most agricultural products [9]–[11]. There is work related to REY using MODIS data for the normalized difference vegetation index (NDVI) MOD13A1 product of MODIS data by [11], derived wheat growth for monitoring purposes. MODIS data with temporal profile technology can be effectively used for yield assessment. The NDVI products derived from MODIS Terra Sensor shows that the vegetation index can be represented as a scalar quantity that accurately estimates the crop productivity on the basis of its spectral signatures. Also, the temporal phonological of Vegetation indices are used for monitoring changes in site-specific cultivated crops [12].

Wheat (*Triticum aestivum* L. Emend Fiori & Paol) and Rice (*Oryza sativa* L.) system (WRS) is one of the major agricultural manufacture systems in the world. There is three main "macro elements" nitrogen, phosphorous and potassium for crop productivity. Another element includes Magnesium (Mg), Sulphur (S), Calcium (Ca) and micronutrients like Boron (B), Copper (Cu), Iron (Fe), Molybdenum (Mo), and Zinc (Zn) needs to be well monitored otherwise crop growth will be reduced [13]–[17] describe crop yield as the major challenge that stabilizes crop growth in less predictable criteria. Crop production varies with availability of finite resources as well as minerals and non-agro-ecosystems [18].

The Geoinformatics based protocols made possible to optimize the crop yield and economic potential of any agricultural field that tends to precision farming. Remote sensing tools are used as a technology for studying cropping pattern by collecting pre and post-season imagery data [19].

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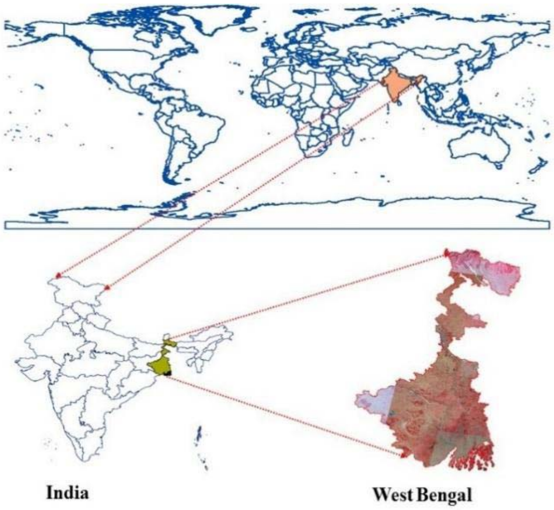

Fig. 1. The location map of the study area.

The passive remote sensing systems worth is quite well for agricultural settings.

II. Materials and Methods

A. Study Area

West Bengal, an agriculturally mediocre state of India is chosen as a study site for the assessment of nutrients using geospatial approach. In West Bengal, Most of the area is under cultivation, and every seasonal crop is produced each year. Therefore, this is an advantage of the study about carrying the analysis of Nitrogen, Potassium, and Phosphorous, and performing an analysis between Rabi and Kharif crops based on different cropping season West Bengal is located between 22° 68′- 22° 98′ N and 87° 27′- 87° 85′ E in the north part of the India (Figure 1). Calcutta port is situated on the left bank of the Hooghly river of West Bengal. The precipitation is not enough, particularly in the districts like as Calcutta and *kali*, but it also contributes to the life of growing crops, particularly the Kharif crops.

B. Field Based Investigations

The stratified random sampling has been performed for 18 villages of 9 districts and the 70% of the area composed by WRS. Sampling clearly defined following by the zero tillage Agri-plot, past fertilizer/soil amendment placement, and cropping patterns, perhaps old field boundaries like as old feedlots, altered stream beds, etc. The soil specimen has been sampled more comprehensively for getting the more accurate fertilizer and soil amendment information. Field cultivation of rice and wheat rotation in these villages for farmers' selection was a criterion more than ten years successively. This ensured the research finders who were relevant for long-term RWS did not confound by rotation and fertilizer management with other crops such as sugar cane (*Saccharum officinarum L.*), onion (*Allium cepa L.*) or potato (*Solanum tuberosum L.*). The Farmers of each experimental plot were interviewed for recording their current crop management practices, nutrient use, rice and wheat production levels during May-June 2012-13. All the surveyed farmers applied N, P and K fertilizer to both rice and wheat with considerable limits of pH, electical conductivity (EC), and OC residuals.

C. Chemical Perusal of Soil Specimen

Soil samples were collected at 0 to 15cm depth from five places in each of the 86 farmer's fields with the consideration of post wheat harvesting and before the commencement of the experiment in the year 2012-13. Soil samples collected from each field were composted and mixed; a subsample was pulverized, using a wooden pestle and mortar and passed through a 100 mm sieve. Soils were analyzed for extractable N by the alkaline KMNO4 method, extractable P (0.5 M NaHCO3, pH 8.5 extractions, exchangeable K (1 M NH4OAc, pH 7.0 extractions). Particle size analysis was conducted by the pipette method on initial soil samples. The N content was determined by the Kjeldahl method using an auto Analyzer, the vanadomolybdate yellow color method, has been used to determine the P, and total K content was determined by flame photometry.

D. Determination of Availability of Nitrogen (N)

Determination of available Nitrogen involves the soil with an alkaline potassium permanganate solution and determining the ammonia liberated. This serves as an index of the available (mineralizable) Nitrogen status of soil and was therefore proposed as a soil test for $N(\mathrm{Kgha}^{-1})$.

$$\boldsymbol{N_{soil}} = \frac{(\mathrm{S}-\mathrm{B}) \times 0.00028 \times 10^6}{\mathrm{Wt\ of\ soil\ sample}} \tag{1}$$

Where; S = sample reading; B = Blank reading.

E. Determination of Availability of OC(%) by Wet Digestion

The Organic matter in the soil oxidized with $K_2Cr_2O_7$ and concentrated H_2SO_4 utilizing the heat of dilution of H_2SO_4. Unused $K_2Cr_2O_7$ is back-titrated with ($FeSO_4.7H_2O$) or [$FeSO_4.(NH_4)_2.6H_2O$].

$$\boldsymbol{OC_{soil\%}} = \frac{10(\mathrm{B}-\mathrm{S}) \times 0.003 \times 100}{\mathrm{Wt\ of\ soil\ sample}} \tag{2}$$

Where, S = Sample reading; B = Blank reading.

F. Determination of Availability of Phosphorus (P)

The available content of soil consists mainly of Ca, Al and Fe-P in the neutral and alkaline soil particularly; Ca-p is the dominant fraction. Organic-P fraction also has considerable amount but is usually not included in the determination of available $P(\mathrm{Kgha}^{-1})$.

$$\boldsymbol{P_{available}} = \frac{\mathrm{Q} \times \mathrm{V} \times 2.24 \times 10^6}{\mathrm{A} \times \mathrm{S} \times 10^6} \tag{3}$$

Where; Q = quantity of P in (μ_g) on X- axis against a sample reading, V = volume of extracting reagent used (ml); A = volume of aliquot used for colour development (ml) and S = weight of soil sample taken (g).

TABLE I
FERTILIZER USE DURING "*Kharif*" AND "*rabi*" CROPS IN CROPPING PATTERN

Districts	Cropping System	Nutrient						REY(t/ha)
		Fertilizer Use (kgha^{-1}) in			Fertilizer Use (kgha^{-1}) in			
		N	P_2O_5	K_2O	N	P	K	
Birbhum	Rice-Wheat	59	37	12	81	56	31	7
Murshidabad	Aman Rice-Wheat	63	29	21	102	78	55	8
Birbhum	Aman Rice- Mustard	63	59	15	44	103	15	7
25 Pargana(n)	Rice- Mustard	49	36	44	37	35	30	7
Murshidabad	Aman Rice- Mustard	71	36	25	72	44	36	8
Midnapur(W)	Rice- Mustard	20	35	11	17	19	8	6
South Dinajpur	Rice- Mustard	45	35	26	56	45	32	6
West Dinajpur	Rice- Mustard	75	38	49	70	70	37	5
Jalpaiguri	Rice- Mustard	70	21	9	0	0	0	5
Malda	Rice- Mustard	105	70	91	84	56	73	10
North Dinajpur	Rice- Mustard	29	29	20	42	40	37	5
Birbhum	Rice- Potato	72	69	23	110	104	81	12
Hoogli	Rice- Potato	52	16	22	207	232	174	14
Murshidabad	Rice- Potato	79	36	36	156	126	128	14
Jalpaiguri	Rice- Potato	32	49	25	75	75	50	5
North Dinajpur	Rice- Potato	40	9	5	10	20	9	5
Burdwan	Rice- Rice	61	69	27	75	69	33	9
Malda	Rice- Rice	28	70	18	21	28	18	9
24 Parganas(s)	Aman Rice-Brinjal	77	30	11	185	158	59	18
Jalpaiguri	Rice-Chilli	25	42	18	42	56	18	9
Malda	Rice-Cabbage	14	7	9	70	98	36	9
24 Parganas(s)	Aman Rice- Tomato	77	62	16	116	91	66	13
Midnapur (E)	Rice - Lytharus	21	7	0	0	0	0	8

G. Determination of Availability of Potassium (K)

By recording the flame photo meter reading for each of the working standards of K after instrument adjusted to zero as blank. A standard curve has plotted against K concentrations in (Kgha^{-1}) by use of recorded readings.

$$\boldsymbol{K_{available}} = \frac{C \times 25 \times 10^6 \times 2.24}{5 \times 10^6} \tag{4}$$

Whereas; C = Concentration of K in the sample obtained on x-axis, against the reading.

H. Attainment to Rice Equivalent Yield (REY)

For easy comparison among different sequences, the economic product of the individual crop was converted to rice equivalent yield based on the local market prices as follows:

$$REY = \frac{\text{Crop yield } \times \text{ price of crop}}{\text{market price of rice}} \tag{5}$$

I. Data Image Processing

The study used MOD13Q1 (16-day composite NDVI image) with a spatial resolution of 250 m acquired on August 13th, 2012. A geometrical error has been rectified using pre-processing. To minimize the inherent noises in geometrical differences in the satellite image, the pixel match-up analysis with respect to the ground sample location was conducted using a 3 × 3 moving window method. The site-specific crop productivity is an assessed by the average pixel reflectance values of NDVI product.

III. RESULTS

In the course of reporting year 2012-13, the associated relational impacts have been synthesized among variability of fertilizer use, fertilizer availability pattern, pH, electrical conductivity and organic carbon in soil. The district wise spatial distributions of major soil quality parameters have been mentioned in the Table III. The accomplishment of the research reveals that Rice based cropping system is predominant, which occupies around 72.3% of the total agricultural area followed by 42.5 % under rice based cropping system. Whereas the rice-vegetable and rice-wheat are found as minor rice based cropping system in West Bengal. The conducted survey report discloses that experimented state has an enormous potential of fertilization. The Survey has proclaimed huge fertilization with micro elements (*e.g.* Zn) practices over the area. During "*Kharif*" season, the district-wise fertilizer use (NPK) per cropped area manifested the immense variability of N as 77 in 24 *Parganas(s)* and 72 kgha^{-1} in Birbhum. While during "*Rabi*" season, it varies from 261 to 259 kgha^{-1} in *24 Parngana(s)* and *Hoogli* sequentially (Table I). Consumption of K has varied during the *Rabi* season in 174 highest in the *Hoogli* districts of West Bengal (Table II).

A. Spatial Variation of Yield Response to Available N

Averaged over the locations, application of 189 kg N ha^{-1} increased the yield of rice equivalent by 18 tha^{-1}, whereas a yield increase at 186 kg N ha^{-1}was of 14 tha^{-1} (Figure 2). The locations in 186 to 189 kg N ha^{-1}, the yield response

TABLE II
TOTAL FERTILIZER USE AND ITS AVAILABILITY IN RICE-BASED CROPPING PATTERN

Districts	Cropping System	Nutrient						REY(t/ha)
		NutrientUse (Kg/ha)			Available (Kg/ha)			
		N	P_2O5	K_2O	N	P	K	
Birbhum	Rice-Wheat	140	94	44	193	11	184	7
Murshidabad	Aman Rice-Wheat	165	108	76	201	24	188	8
Birbhum	Aman Rice-	106	163	30	178	10	162	7
25 Pargana(n)	Rice- Mustard	86	71	74	175	12	176	7
Murshidabad	Aman Rice-	143	79	61	183	19	193	8
Midnapur(W)	Rice- Mustard	37	54	19	181	10	195	6
South Dinajpur	Rice- Mustard	101	80	58	162	14	180	6
West Dinajpur	Rice- Mustard	145	108	86	161	14	185	5
Jalpaiguri	Rice- Mustard	17	21	9	161	10	151	5
Malda	Rice- Mustard	188	125	164	176	13	186	10
North Dinajpur	Rice- Mustard	71	68	58	167	10	132	5
Birbhum	Rice- Potato	182	173	104	178	18	183	12
Hoogli	Rice- Potato	231	240	187	186	20	159	14
Murshidabad	Rice- Potato	235	163	164	186	13	193	14
Jalpaiguri	Rice- Potato	107	124	75	182	11	282	5
North Dinajpur	Rice- Potato	15	29	14	182	11	143	5
Burdwan	Rice- Rice	136	138	59	180	12	165	9
Malda	Rice- Rice	49	98	36	176	13	186	9
24 Parganas(s)	Aman Rice-Brinjal	261	187	70	189	25	130	18
Jalpaiguri	Rice-Chilli	67	98	36	176	11	133	9
Malda	Rice-Cabbage	84	105	45	180	10	195	9
24 Parganas(s)	Aman Rice-	193	153	81	182	18	190	13
Midnapur (E)	Rice - Lytharus	21	7	0	164	11	143	8

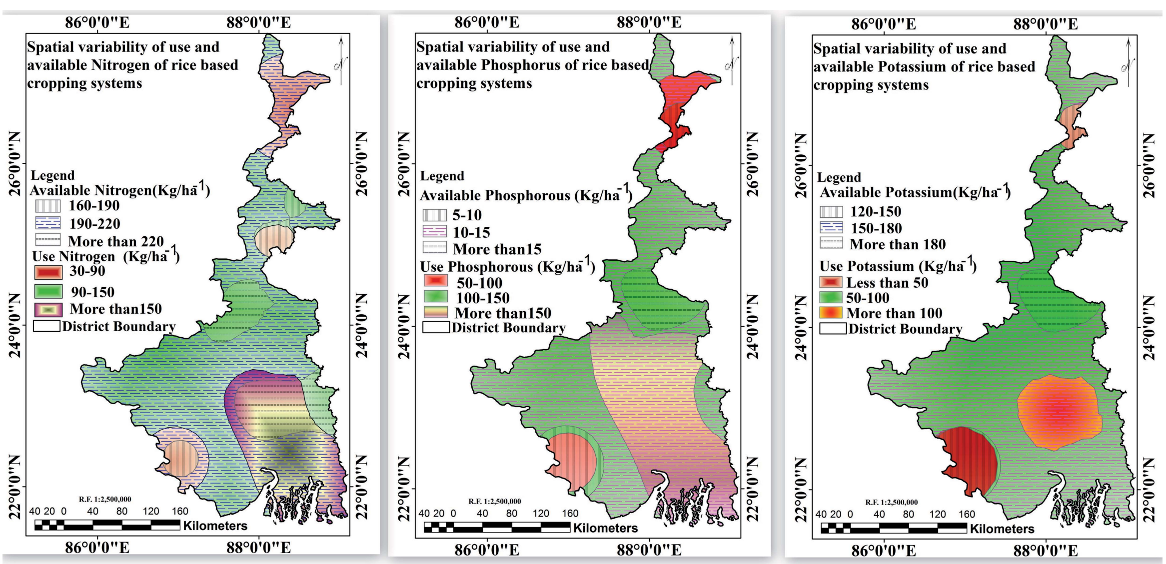

Fig. 2. Spatial variability of: (a) Nitrogen, (b) Phosphorous and (c) Potassium under rice-based cropping patterns.

ranged from 14 to 18 tha^{-1} at 3 locations. Raising N level from 182 to 189 kg N ha^{-1} gave 10 to 18 tha^{-1} additional rice equivalent at different locations responses varied widely the magnitude of response was among the locations. At 176 to 189 kg N ha^{-1}, the yield response ranged from averaged over the locations, application of 180 kg P ha^{-1} increased the yield of rice by 13.5 tha^{-1}, whereas a yield increase at 182 kg N ha^{-1} spatial variation of yield response to available N.

Averaged over the locations, application of 176 kg N ha^{-1} increased the yield of REY by 8.6 tha^{-1}. The responses varied widely the magnitude of response was among the locations. Increasing N rates from 176 to 189 kg N produced an additional REY of 10 to 18 tha^{-1}, which was ten tha^{-1}

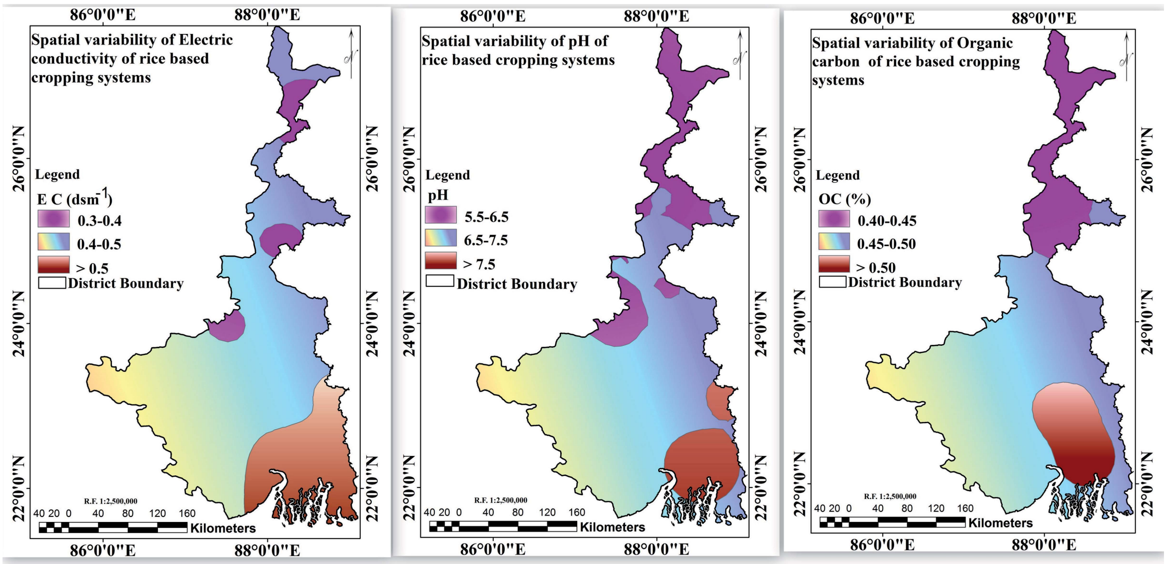

Fig. 3. Spatial variability of: (a) EC, (b) pH and (c) OC under rice-based cropping patterns.

TABLE III

EC, pH, OC AND REY (t/ha) OF CROPPING PATTERN

Districts	Cropping System	EC (dSm^{-1})	pH	OC (%)	REY (t/ha)
Birbhum	R-W	0.37	6.5	0.49	7
Murshidabad	Ar-W	0.50	6.5	0.48	8
Birbhum	Ar- M	0.42	6.4	0.47	7
25 Pargana(n)	R- M	0.67	6.9	0.48	7
Murshidabad	Ar- M	0.52	6.5	0.49	8
Midnapur(W)	R- M	0.49	6.6	0.45	6
South Dinajpur	R- M	0.38	6.9	0.47	6
West Dinajpur	R- M	0.70	5.7	0.47	5
Jalpaiguri	R- M	0.45	6.5	0.46	5
Malda	R- M	0.30	6.7	0.41	10
North Dinajpur	R- M	0.39	6.4	0.39	5
Birbhum	R- P	0.21	6.7	0.40	12
Hoogli	R- P	0.48	6.8	0.53	14
Murshidabad	R- P	0.52	6.7	0.46	14
Jalpaiguri	R- P	0.32	6.2	0.40	5
North Dinajpur	R- P	0.30	6.2	0.42	5
Burdwan	R- R	0.40	6.6	0.42	9
Malda	R R	0.30	6.7	0.41	9
24 Parganas(s)	AR-B	0.84	7.0	0.52	18
Jalpaiguri	R-C	0.30	6.1	0.38	9
Malda	R-C	0.90	6.5	0.48	9
24 Parganas(s)	AR-T	0.91	7.0	0.44	13
Midnapur (E)	R- L	0.47	5.7	0.68	8

Note: *R-W (Rice-Wheat); AR-M (Aman Rice Mustard); R-S (Rice-Mustard); R-O (Rice-Potato); R-R (Rice-Rice); AR-B (Aman Rice-Brinjal); R-C (Rice-Chilli); R-C (Rice-Cabbage); R-L(Rice - Lytharus); AR-B(Aman Rice-Brinjal)*

or greater at 6 locations. Ultimately the associated relations between REY's and rice based cropping system of the examined soils have been shown in Table IV.

B. Spatial Variation of Yield Response to Available P

At all locations, grain yields of rice equivalent yield were lowest in the control plots (OPT_{K0}). The mean increase in rice yield over P omission was 18 tha^{-1} at 25 kg K ha^{-1}, 14 tha^{-1} at 20 kg P ha^{-1}, and 13 tha^{-1} at 18 kg K ha^{-1} (Figure 3). The highest P response in rice equivalent at all the K rates was recorded at 24 Pargana(S) (18 tha^{-1}), whereas the same was lowest at Jalpaiguri (5 tha^{-1}).

Grain yields of wheat were increased with increasing rates of P, and the yield was maximum which was recorded at 25 kg ha^{-1} P application. At this P application rate, highest response was recorded at 24 Pargana(S) (18 tha^{-1}) followed by Hoogli (14 tha^{-1}) and Birbhum (12 tha^{-1}). The lowest P response to 10 kg K ha^{-1} was noticed at Jalpaiguri and North Dinajpur (5 tha^{-1}). Averaged over the locations, application of 13, 18 and 25 kg P application produced grain yield response of 10, 14 and 18 tha^{-1} respectively.

C. Spatial Variation of REY (tha^{-1})

The results for the site-specific investigations underlined the significance of improved nutrient management over farmlands, fertilizer practices, and local state recommendations, in enhancing crop yield and net returns.

After careful investigation of the relationship between REY's for experiment location, it has been derived that high fertilization especially the use of *N* component leads to optimal optimization for the rice equivalent yield (Figure 4). It is noteworthy that the other factors such as market prices and fertilization of other mineral chemicals may drastically influence the overall crop production capacity in the region. After the general observation over the Indian subcontinent usually in southern India, where these inputs were not assured, the results were negligible, leading to influential divergence in crop yields.

D. Crop Yield Estimation (REY) and Vegetation Index

The study suggests a Geoinformatics based appraisal; through a combination of MOD13Q1-NDVI, application rate discrepancies of nutrient fertilizers and soil quality parameters.

TABLE IV
RELATION BETWEEN REY UNDER RICE BASED CROPPING SYSTEM OF THE SOIL

REY Group	Avg.	Fertilizer						EC (dSm^{-1})	pH	OC %
		Use Kg/ha			Available Kg/ha					
		N	P	K	N	P	K			
<14	17	355	351	172	179	21	171	0.66	6.7	0.45
9-14	11	307	233	206	192	16	170	0.42	6.7	0.51
>9	6	109	97	58	186	15	177	0.49	6.6	0.46

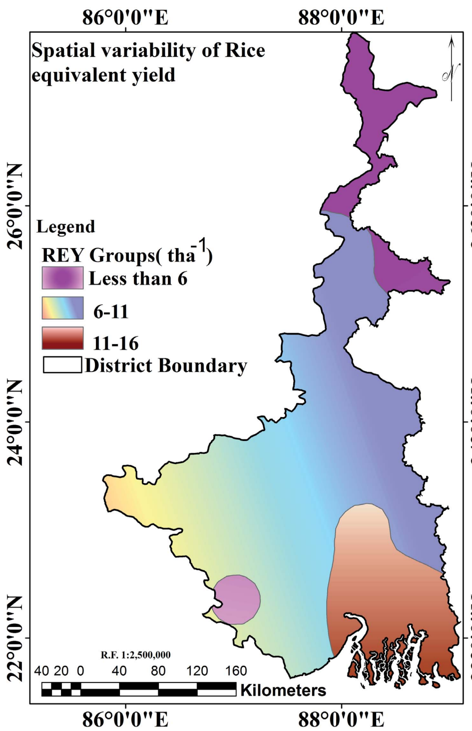

Fig. 4. Spatial variability of REY in West Bengal district.

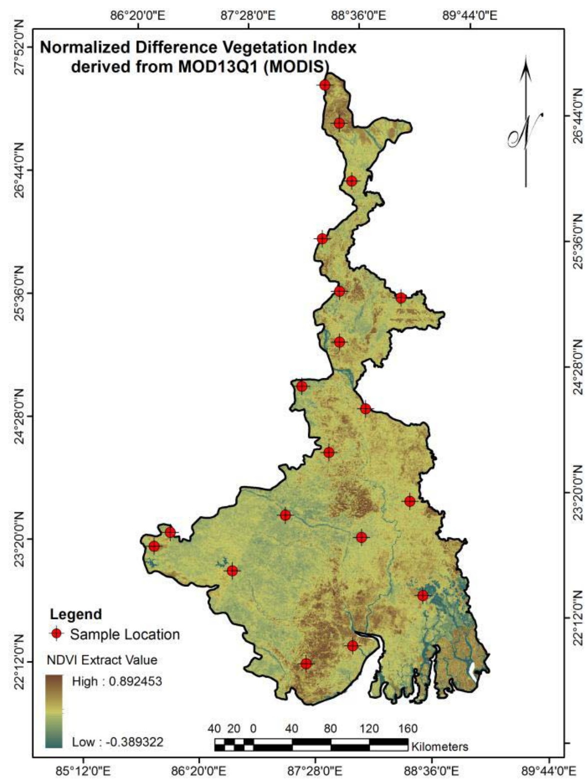

Fig. 5. Estimated NDVI from MOD13Q1 product of MODIS.

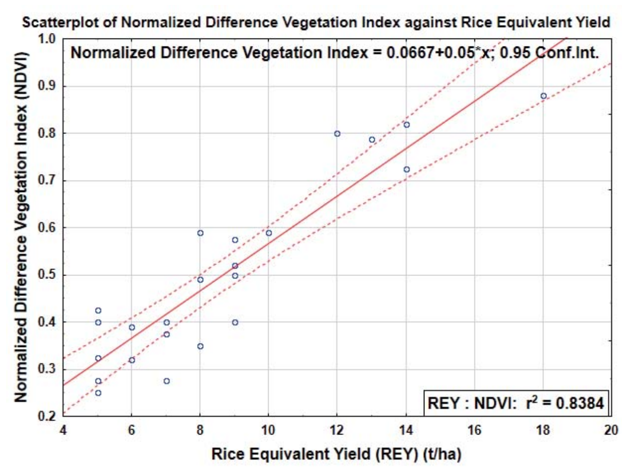

Fig. 6. Spatial co-linearity between REY and MOD13Q1.

Also, the one aspect of the study shows that the farmers can easily assess their farm crop yield using vegetation index (Figure 5) and the average pixel reflectance values have been correlated with final calculated REY, which was also based on the other market parameters and variable nutrient rates.

The relationship between final rice equivalent yield and NDVI was examined, based on satellite image reflectance values and integrated results of fertilizer applications in the experimental plots. The results, in turn, revealed the crop health pattern in terms of its canopy greenness. The relationship between REY and vegetation index was found positive, robust linear relationship with $R^2 = 0.838$ (Figure 6). The research suggests that both satellite sensor based vegetation index and in-field inventories can be used to develop crop yield prediction models for the assessment of site-specific nutrient fertilization discrepancies in rice-based and other cropping systems.

To overcome this, the 16 days composite MODIS-NDVI product was utilized, which responds to the crop dynamics very efficiently. The highest pixel reflectance value of 0.895 was experimental for NDVI product. The pixel reflectance value of 0.873, which was maximum estimated REY for the crop yield assessment period, was corresponded to

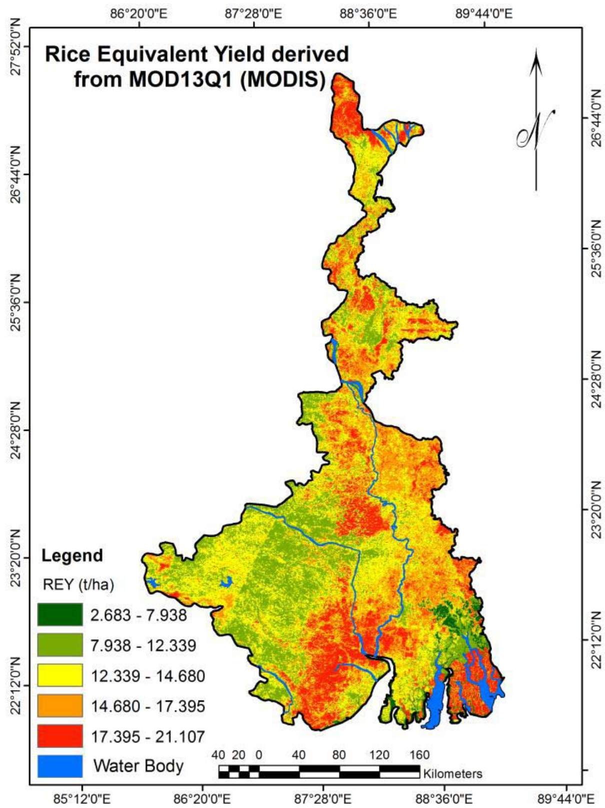

Fig. 7. REY using MODIS Sensors' Based MOD13Q1.

the REY = 18 tha^{-1}. The NDVI profile can be estimated and assessed, including economical productivity of the cultivated crop, by indicating the vegetation health in terms of crop green biomass and capacity to reduce the effects due to the surface topography and changing illumination conditions.

E. Rice Equivalent Yield (tha^{-1}) With Regression Analysis

An extensive research and rigorous statistical analysis have been conducted to explore the relationship between REY and vegetation index. That leads to the assessment of REY AGB from NDVI. Using STASTICA software, the NDVI values are linearly regressed to the REY (t/ha), to obtain Spatial co-linearity between REY and MODIS-derived NDVI product from the equation. Spectral transformation of NDVI has been used and modelled in ERDAS Imagine software, due to the increase in r^2, to generate the final REY map of the area using the linear equation (eq. 6).

$$\text{REY (t/ha)} = 0.0067 + 0.05 * \text{NDVI} \tag{6}$$

NDVI showed a better correlation with the estimated crop yield in linear fit with an r^2 value of 0.834 among the various spectral indices tried for the analysis. The ranges of yield are highest at range 17-21 t/ha in the North, central and southern lower part of the study site. The western part has found to be two zones, at range from 7-12 and 12-14 t/ha which presented the lower REY. The eastern part of the study site has shown the REY values ranging from 14 to 17 t/ha that has covered most of this part (Figure 7).

IV. Discussion and Conclusion

The foregone conclusions of the multi-site crop field underlined give an impression of improved nutrient management over farmer's fertilizer practice, and local state recommendations which enhance crop yield, and net returns estimates rice-wheat cropping system. The outcomes emphasis for the intensively cropped IGP prevails fertilization practices are skewed towards N indicates abundance use of N fertilizer and neglecting K, S and micronutrients. Further, optimization of fertilizer P and K input build upon crop demands and native supplies from soil nutrient pools at dislocations efficiently increases P and K, measured up agronomic efficiency and recovery efficiency. An increase in P use efficiency consequential to the inclusion of K in fertilizer planning and vice-versa implies that the necessity of both P and K application in adequate amounts to achieve volumetric efficiencies. The approach for improving the nutrient prescriptions as attempted in the presentable farmer's field needs to be further validated on management criteria, and same feedback can be used for further refinement if required.

The study results in the fine co-linearity relationship between MODIS-derived NDVI product and REY under different fertilizers application rates. The accuracy level of the yield of estimation is affected by the complexity of agriculture ecosystem; hence MOD13Q1-NDVI has been established as a significant indicator to determine the crop condition. Nowadays the number of technological ground-based sensors is accessible in the global market to determine the fertilizers application rate in crop fields, but geospatial technology provides a very cost-effective and satisfactory solution. The detailed study should be done at the farm level to study soil characteristics so that we can understand the effect on various nutrients available in soil and irrigation water holding capacity. The relationship between the various cropping terms like major nutrients, final crop yield and vegetation index should be calculated so that the optimum level of fertilizer use in that area can be determined and this study does not take into account any consideration of residual effect.

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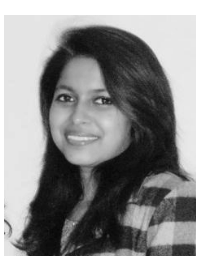

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