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Original Research Article

Assessment of Boro Rice Areas of Meghalaya Using Geospatial Technology

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Abstract: Boro rice areas were delineated from Sentinel 2B images of March, 2021 by using standard visual interpretation technique. Soil fertility status of Boro rice feilds was evaluated by using soil sample analysis data collected from Soil Health Card dashboard and soil sampled collected from different rice fields in GIS environment. Soil sample location map was prepared from latitude and longitude information and soil analysis data was linked to it. The soil fertility maps were generated through Inverse Distance Weighted (IDW) interpolation technique using Spatial Analyst tools of Arc Toolbox. The study revealed that Boro rice is cultivated over 7647.9ha which is 15% of the total geographical area of the Selsella block. The soils of Boro rice fields are non-saline, slightly acidic, high to medium in organic carbon and sufficient in iron, manganese, zinc and copper content. The availability of phosphorus and potassium varies from medium to low and nitrogen availability is high to medium.

Keywords: Boro rice, Geospatial tools, Meghalaya, Soil fertility, Soil health card.

INTRODUCTION

Rice is a major food crop of Meghalaya occupying an average annual area of 1,10,997 ha with total production of 3,03,476 Metric Tons. Rice is grown in the state in a wide range of climatic conditions ranging from deep water to high altitudes. The rice that is grown in the state has been classified into three classes i.e. Boro or Spring/Summer rice, Sali or Kharif rice/Winter rice and Ahu or Autumn rice. Out of the total rice grown area, 63889 ha area is under sali rice alone that occupies 58% of the total rice cropped area producing an annual average of 162321 Metric Tons during the period 2019-20 [1]. The area under Boro and Ahu rice is 13628 and 33480 ha respectively. The average yield is the highest in Boro rice (4628 kg/ha) followed by Sali (2534 kg/ha) and Ahu rice (2335 kg/ha). The productivity of Boro rice is higher than Ahu and Sali rice which is sown in winter during November-December and harvested in spring/summer during April-May. Boro refers to a special type of rice cultivation on residual or stored water in low-lying areas after the harvest of Kharif (winter) rice or fallow land during kharif season. However, food security is uncertain, as current annual rice consumption has exceeded annual rice production. The annual shortfall of food grain is estimated to be of the order of 122 thousand tones [2]. It is therefore evident that the state is not self-sufficient in the production of food grain.

The information on spatial and temporal distribution of rice cultivation in a state helps to understand growing food supply and demand, water scarcity, etc. Accurate real time information on spatial distribution of rice would be useful for stakeholders like cultivators, fertilizer/pesticide manufacturers and agriculture extension agencies etc. to effectively plan supply of inputs and market activities. It also helps government agencies to plan and formulate policies regarding food security. In addition, the data on rice area is useful as an input to estimate crop health, water demand and crop yield at field/district/block/state and regional level [3]. Since problems with food security persist in the state of Meghalaya are robust, reliable tool for mapping and early forecasting of rice production are thus critical. Therefore reliable and timely estimates of rice crop areas and its production are essential for providing information for planners and decision makers to formulate policies in the case of shortfall or surplus. The most common and widely used methods for estimating rice cultivated areas are the use of agricultural statistical data acquired through field visits and interviewing the farmers. The methodology for mapping area under rice cultivation is basically done

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through annual/seasonal sample surveys based on a number of sample clusters that are constituted all over the country for measuring cultivated area during the crop growing season. Each cluster is visited many times and areas are recorded by the field staffs, checked, and then processed by regional statistical officers. Despite its invaluable ability for understanding historical trends in rice area, this method is extremely tedious, time consuming, less precise, costly, inconsistent and labour-intensive [4, 5]. Therefore scientific modern technology to be adopted for estimating rice cultivated areas. In this context, remote sensing- based methods have already been proven as an effective alternative for mapping rice area [6-8]. The benefits of remote sensing technology include: (i) spatial coverage over a large geographic area; (ii) availability during all seasons; (iii) relatively low cost; (iv) efficient analysis; (v) they provide information in a timely manner; and (vi) they are capable of delineating detailed spatial distributions of areas under rice cultivation. The user requires fast, reliable (accurate), less costly and least labour-intensive ways which can be achieved through remote sensing based method. Rice area mapping at field, district, regional and national scale has been carried out in the past using various approaches which involves use of single date or time series optical as well as microwave/Synthetic Aperture RADAR (SAR) data [9-15].

Meghalaya Rice Mission is a programmer to increase rice production and productivity in the state to meet the consumption requirement and to bridge the deficit between demand and availability to consumers. Directorate of Agriculture, Govt. of Meghalaya has taken up action on the recommendations of the State Consultant, State Rice Mission, Dr. Sushil Pandey, ex Rice Economist from IRRI, Manila, Philippines. One of his recommendations suggests that under Mini Mission 1, GIS and RS technology to be utilized for identification, mapping of rice areas and suitability analysis for extending the boro paddy areas in the State. Two actions already has been taken up by Directorate of Agriculture, Govt. of Meghalaya in the state on i) Mapping of Sali rice areas of Meghalaya, [16] and ii) Identification of suitable areas for expansion of Boro rice in Meghalaya, [17] which was executed by North Eastern Space Applications Centre (NESAC). The output of these two projects is being utilized by the user department for expansion of Boro rice in the identified suitable areas and introducing high yielding rice varieties in the identified large patches of Sali rice.

One of the key components of the State Rice Mission is to increase rice production and productivity in the state and reach the demand of rice requirement to feed 3.44 million people. Therefore, Directorate has proposed to create scientific database on rice and it is completed for Sali/Winter rice. There is a need to identify and map Boro and Ahu rice. Therefore a pilot study has been taken up at to identify Boro rice (Spring/Summer rice) areas and access soil fertility status utilizing Soil Health Card data, soil samples collected from boro rice areas and Geographic Information System (GIS) in Selsella block. The study area was selected based on the findings of the project on identification of areas suitable for expansion of Boro rice in Meghalaya [17]. From the study it was observed that more than 50% suitable areas are found in West Garo hills district and highest suitable areas are found in Selsella block of the district (Fig.1).

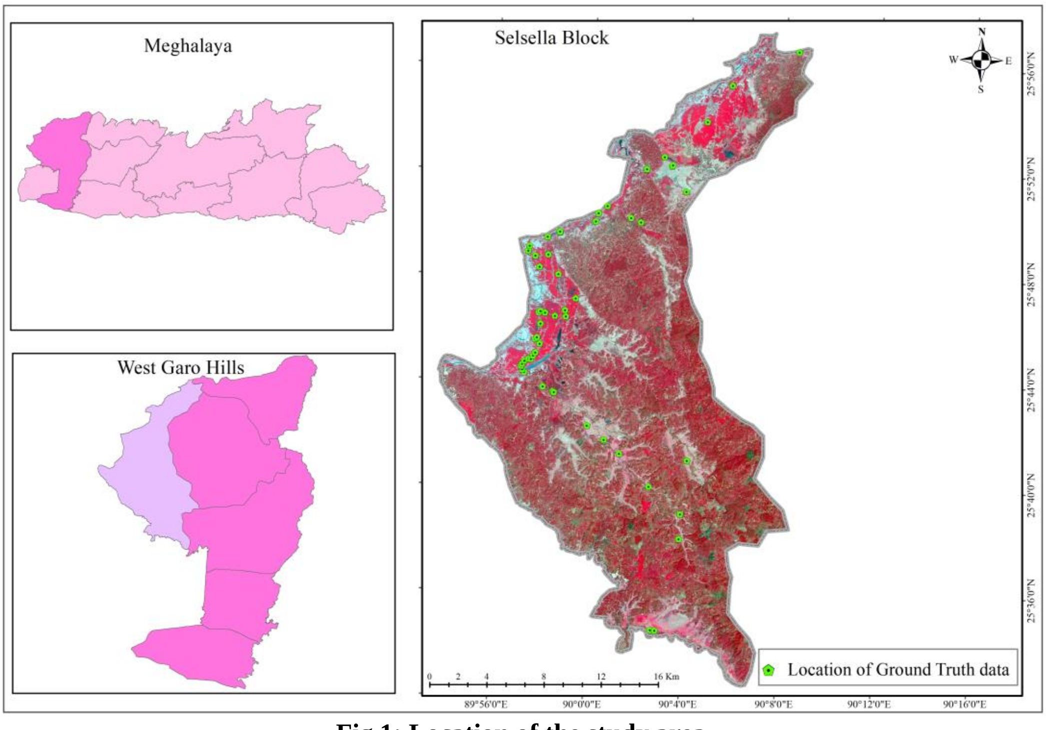

Fig.1: Location of the study area

Materials and Methods

Mapping of Boro Rice Areas Using Visual Interpretation Technique

False Color Composite of Sentinel 2B images of March, 2021 with band blue (B2), green (B3), red (B4) and near-infrared (B8) channels of 10-meter resolution were used to derive information on the spatial distribution of boro rice in Selsella block of West Garo hills district of Meghalaya. The methodology adopted consists of satellite data preparation, interpretation (on-screen visual), ground truth data collection, map finalization, quality checking of final maps and databases. The boro paddy areas as seen in the satellite data are delineated on screen using standard visual interpretation technique and prepared preliminary interpretation map. The preliminary interpreted map was used for collection of ground truth (GT) data from 75 locations covering the entire block. The map was finalized by using the GT data and high resolution Google earth images and incorporating field knowledge of block and district agriculture officers of the district.

Assessment of Soil Fertility Status of Boro Rice Areas

For preparation of soil fertility map for the study area, soil samples were collected from 40 locations and soil health card data has been collected from https//soilhealth.dac.gov.in. One point layer was generated by using soil sample location (latitude, longitude) information under GIS environment using ArcGIS software. The point layer contains soil sample numbers, village name and soil sample analysis results. Soil samples 184 soil samples have been collected from 45 villages. Soil fertility maps have been generated for ten parameters i.e. pH, EC, OC (Physical parameters); P, K, N (Macro-nutrients) and Zn, Fe, Cu, Mn (Micro - nutrients). The fertility maps have been generated by Inverse Distance Weighted (IDW) interpolation technique using Spatial Analyst tools of Arc Toolbox. The detail of the methodology is illustrated in (Fig.2).

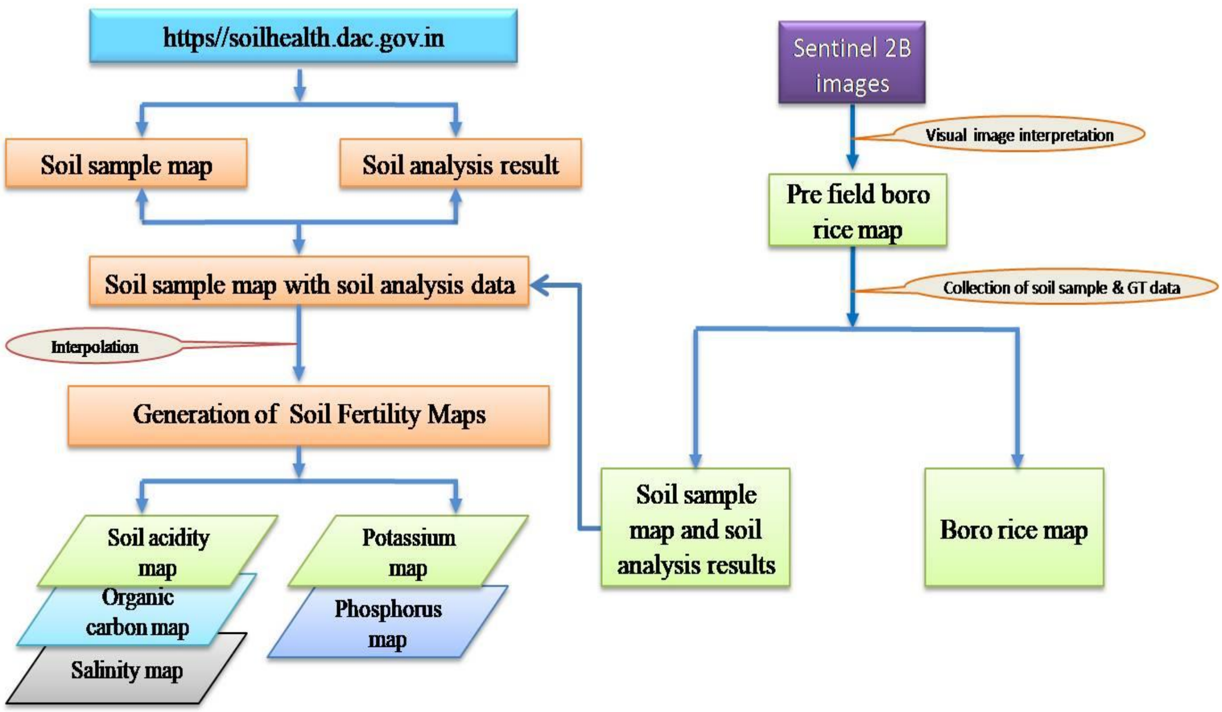

Fig.2: Flowchart of the methodology

Results and Discussion

Mapping of Boro Rice Areas

Boro rice areas were identified and mapped by using visual interpretation technique. From the study it is observed that boro rice is grown over 7647.9 ha area which is 15% of the total geographical area of Selsella block during 2020-21 (Fig.3). Boro rice fields are found on low lying areas near Brahmaputra River and valleys between hills. Pre field Ground Truth (GT) data has been collected during December, 2020 when field preparation and early transplantation of Boro rice was going on. Post field GT data was collected during April, 2020 at the time of harvesting of the crop. The GT data was collected with the guidance of field officer of Selsella Block Development Office.

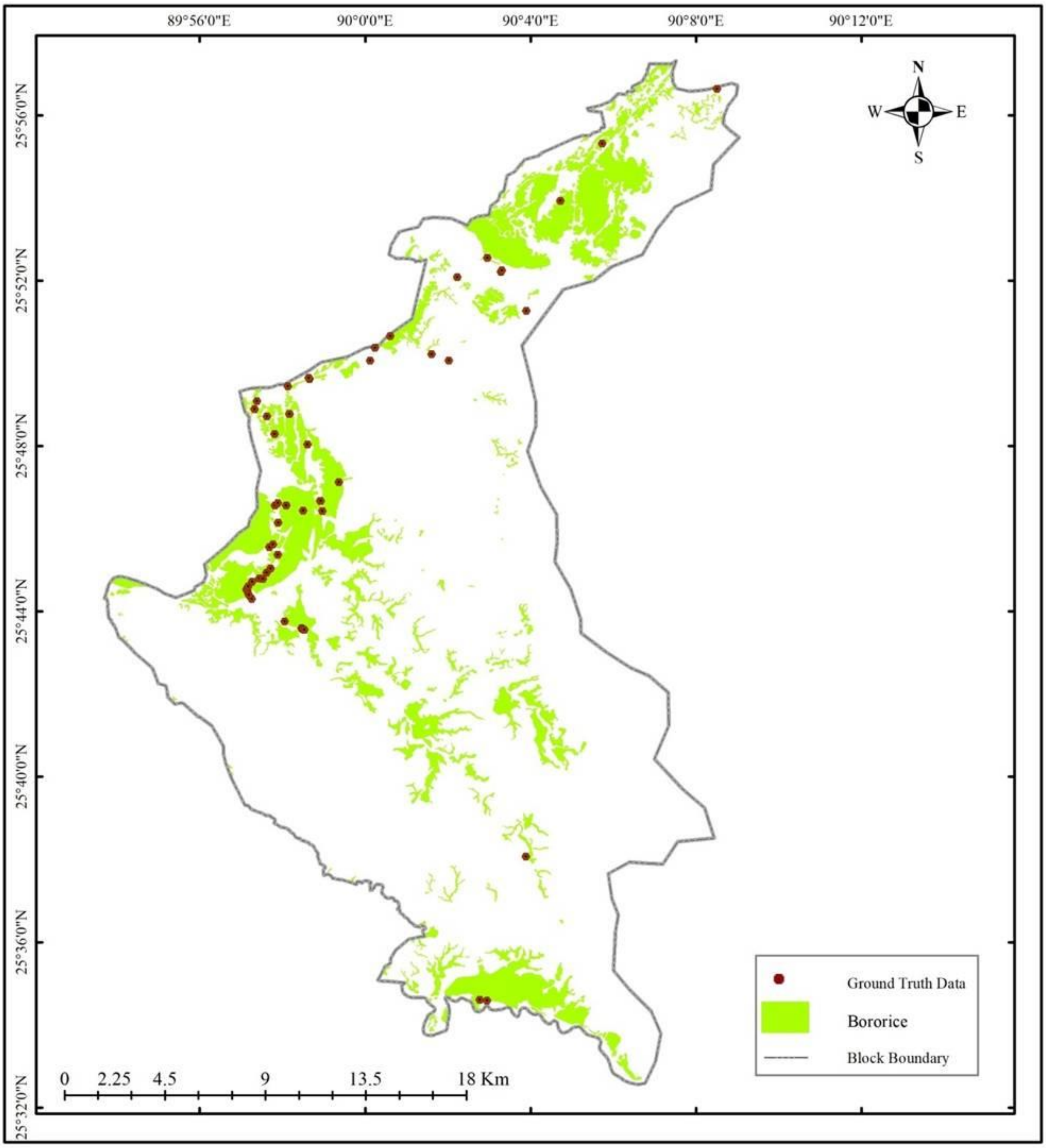

Fig.3: Boro rice map of Selsella block of West Garo hills district

Assessment of Soil Fertility Status of Boro Rice Areas

Ten fertility maps namely pH, EC, OC (Physical parameters) and P, K, N (Macro-nutrients) and Zn, Fe, Cu, Mn (Micro - nutrients) were generated for the study area (Table 1). From the study, it is found that soils are non-saline and slightly acidic in nature. Soils of the study area are found high to medium in organic carbon content that covers 61.9% and 38.1% area respectively. The availability of phosphorus and potassium in soils of the study area varies from medium to low. It is found that phosphorus availability is medium in 76.9% area and remaining 23.1% area is low in availability of phosphorus. Whereas it is observed that 70.8% area is having low potassium and 29.2% area is medium in potassium content (Fig.4). Soils of the study area are high in nitrogen availability and 79.4% and 20.6% area contains high and medium nitrogen respectively. The study revealed that soils of the entire study area contain high iron, manganese, zinc and copper.

Table 1: Area under different soil fertility classes

Fertility parameters	Class	Area(ha)	%area
EC	Non Saline	7647.9	100.0
Fe	Sufficient	7647.9	100.0
Mn	Sufficient	7647.9	100.0
Zn	Sufficient	7647.9	100.0
Cu	Sufficient	7647.9	100.0
Ph	Slightly acidic	7647.9	100.0
OC	High	4732.6	61.88
	Medium	2915.3	38.12
Phosporus	Low	1770.3	23.15
	Medium	5877.6	76.85
Potassium	Low	1770.3	23.15
	Medium	5877.6	76.85
Nitrogen	High	6074.4	79.43
	Medium	1573.5	20.57

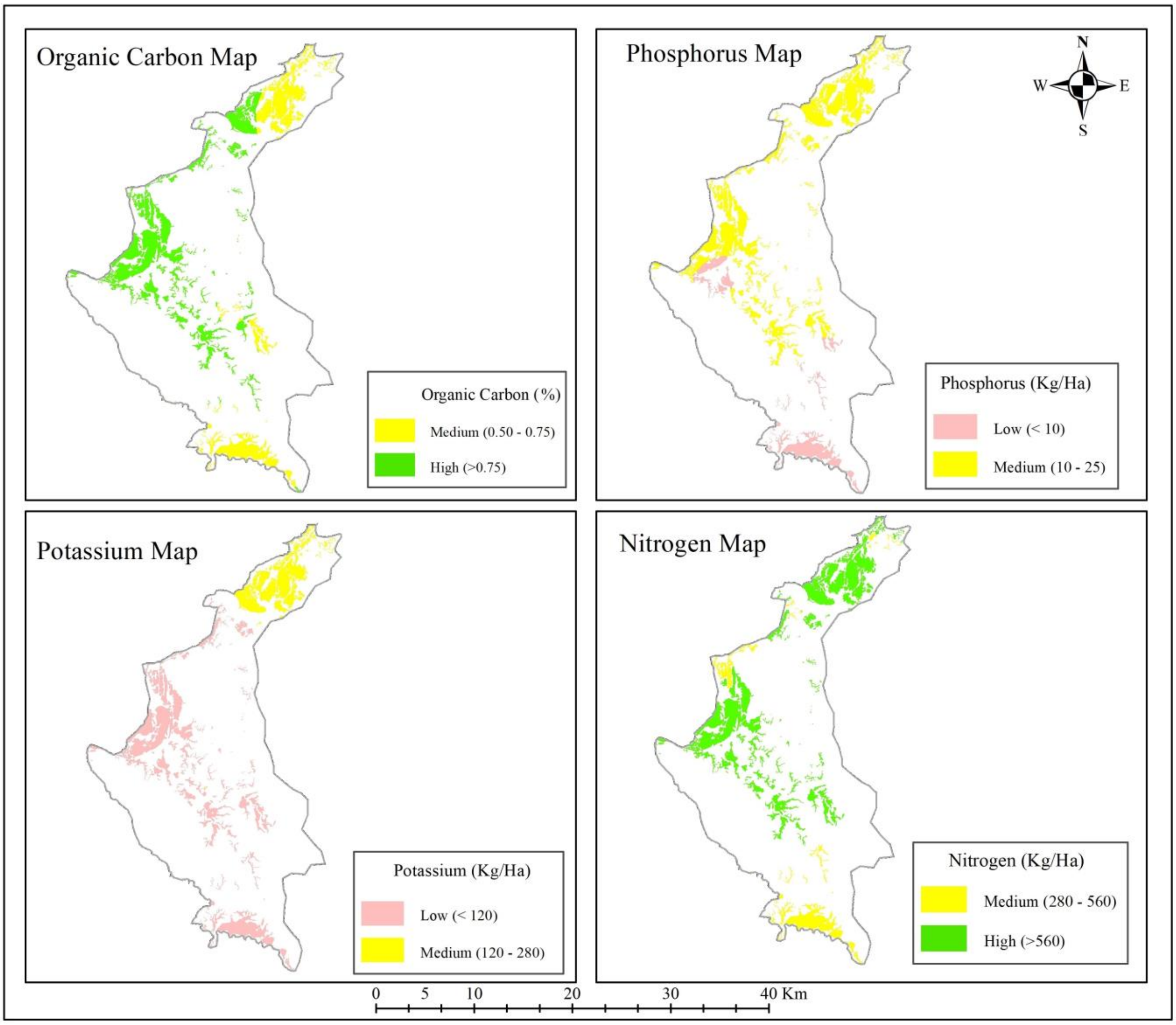

Fig.4: Soil fertility maps of Boro rice cultivated areas of Selsella block of Meghalaya

CONCLUSION

The present study revealed that visual interpretation of satellite image results more accurate crop map compared to digital classification. The output boro rice map will help the field officers to reach the farmers' fields and provide necessary scientific package and practices of rice cultivation. The soil fertility maps will be use full recommending proper soil fertilization and other nutrient management practices which will increase crop production, reduce soil degradation and helps in sustainable agriculture. The output maps are handed over to the user department for field level planning for increasing crop productivity and reduce the gap of supply and demand of food grains in the state.

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