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# Available nitrogen, phosphorus and potassium status in soils of Katihar district of Bihar

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**Abstract**
The soils are the sources of nutrient supply to the plants. Hence, all the cropping sequences are indirectly governed by the soil resources. In this context, the present research work was carried out to map the available Nitogen, Potassium and Potassium (NPK) in the soils of Katihar district of Bihar. Where, krigging technique was used to map the analyzed soil samples. Research findings revealed that the range of soil pH was neutral to slightly alkaline. However, EC was normal. However, in context of organic carbon, available N, avail $P_2O_5$ and $K_2O$, all these parameters were low to medium.

**Keywords:** Krigging, RS-GIS, soil resource and soil pH

## Introduction
The soils are valuable natural resources which are directly or indirectly associated with agricultural economics. Generally, clay, silty clay or sandy loam soils appear near low land ecology of river Ganges which was locally known as Tal, *Chour and Diara* in Bihar, India. Due to flood, single cropping system is the general phenomena and wet lands may be perceived in lower part of the river Ganges. (Sehgal, 1996) [8]. Reported that systematic study of soils provided an opportunity to understand the soil health to accelerate the land use planning in area of interest.
In this context, soil survey towards agricultural land use planning is an integral part, advocated for the sustainability of agriculture practices. Soil survey data provides adequate information in terms of land form; natural vegetation as well as characteristics of soils which can be utilized for land resources management and development (Manchanda *et al.*, 2002) [6].
Soil pH and EC are important parameters that affect the plant growth. (Buckman *et al*., 2002) [3]. Reported that if a soil is too sour or too sweet, plants cannot take up nutrients like nitrogen (N), phosphorus (P) and potassium (K). Soil pH is used as an indicator of the acidity or alkalinity presence in soils which controls the mobility and the availability of soil nutrients. Amacher *et al*., (2007) [1]. Reported that some nutrients such as nitrogen, phosphorus, and potassium are less available when pH is <6.0 (acidic condition). In same manner, if pH is very alkaline, Iron, manganese and phosphorus are less available. (Schepers *et al*. 2000) [7]. Reported that the chemical concentrations may be used by using geospatial mapping to plan the strategies of soil remediation and site specific fertilizers prescriptions. Hence, remotely sensed data is used to map the geospatial features, discrimination between cropping pattern and soil properties. (Breunig *et al.*, 2008) [2]. Reported that thermal Infra-Red (TIR) data have been used in combination with other spectral data to discriminate dark clayey soils and bright sandy soils in order to obtain a more accurate interpretation using satellite data. (Vimal *et al*., 2016) used IRS AWiFS data to capture the spectral signature of red soils and observed that the red soils were found in hilly terrain of Banka district of Bihar which is acidic in nature having low nitrogen. Vinay *et al*., (2013) reported that light textured soils visually interpreted as white by using visual interpretation keys of satellite image of *Diara* land of Bhagalpur district, Bihar. Mapping of soil pH, EC and available NPK of agricultural land of different blocks of Katihar district is current lacking and to fill this gap the present study was carried out.

## Materials and Methods
### Study area
Katihar district lies between $25^0$13’ N to $25^0$53’ N latitudes and $87^0$12’ E to $87^0$40’ E longitudes having an area of 3057 km2. (Fig.1). It is bounded by Purnea district in the north-

western side, Bhagalpur district, and Jharkhand in the south and in the east bounded by West Bengal. There are 16 community development blocks (Community development block is an administrative division of the district) and 1514 villages. Manihari and Katihar Sadar blocks come under lower Gangetic plain. Physiography of the district is affected by floods by the rivers of Kosi, Mahananda and Ganga. These rivers bring silt and alluvial soils along their way while southern part of the district is sandy to sandy loam in textural class. The slope is gentle and fewer short hillocks were found in the Manihari block. River Ganges drains the district in North-western and south eastern direction. Flood has great influence on the district due to its gentle slope and plain relief. (Fig. 2).

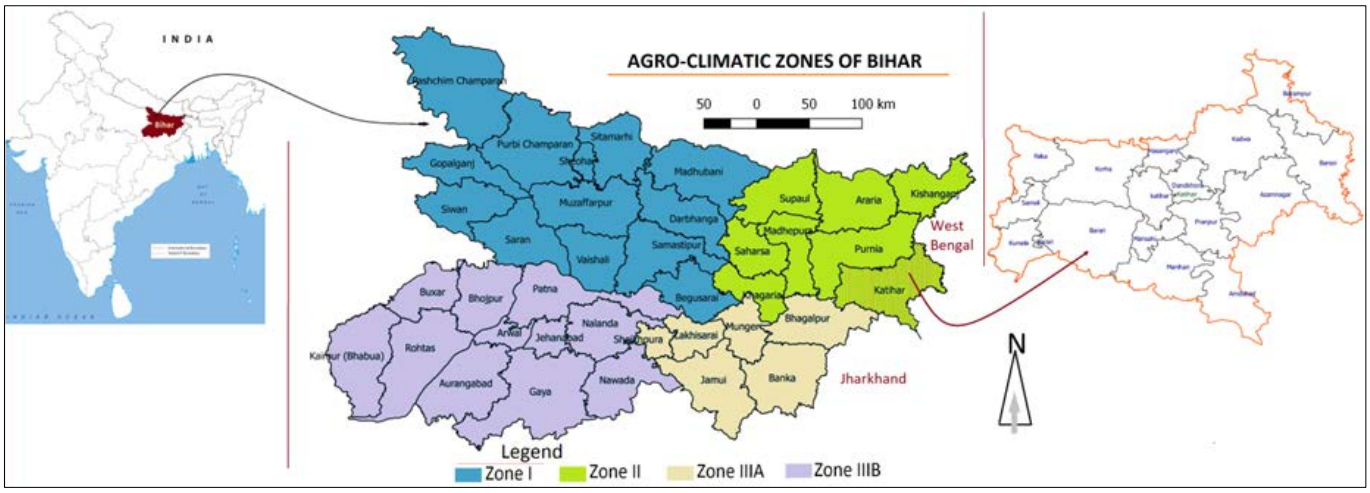


**Fig 1:** Location map of study area

**Hardware, software and satellite data**

Computer system (HP Pentium due core 5i processor), QGIS software, satellite image of AWiFS, 2018 were used for Digital Image Processing (DIP) and mapping. Toposheets, GPS receiver and ancillary data were also used for ground truthing and validation of derived data.

**Soil analysis procedure**

Collected soil samples from different location were air dried in shade, crushed and sieved from <mm sieve for the analysis of soil pH, EC, Organic carbon and N, P & K in the laboratory. Tested procedures and methods were used for the assigned parameters were tabulated. The soil reaction (pH) was determined in 1: 2.5 soil: water suspension by potentiometric method using glass electrode (Jackson, 1973) [5]. Electrical conductivity (EC) of the saturated soil water extract was measured using Elico conductivity bridge (Jackson, 1973) [5]. The organic carbon was estimated by Walkley and Black wet-oxidation method (Jackson, 1958) [11]. Available nitrogen content of the soil was determined by following alkaline potassium permanganate method (Subbaiah and Asija, 1956) [13]. In the available phosphorus determination, extraction was done by using Olsens's extractant (0.5 N Sodium bicarbonate; pH 8.5 Phosphorus in the extract was estimated by developing blue colour with ammonium molybdate using ascorbic acid as reluctant. Colour intensity was measured at 660 nm in Spectrophotometer (Jackson, 1973) [5]. In the available potassium determination, extraction was done by neutral normal ammonium acetate and subsequent estimation by atomic absorption spectrophotometer (Jackson, 1973) [5]

**Statistical analysis and soil fertility mapping**

Latitude, longitude and laboratory analysed data/results were inserted in attribute table (MS-Excel) and converted into csv. File to open in QGIS software towards generation of thematic maps of soil pH, EC Organic carbon, N, P & K. Interpolation technique (IDW) was used to map the spatial variability. (Hengl, 2009) [4]. Used Inverse Distance Methods (IDW) of interpolation to find out the soil fertility status and to separate it from an ordinary map because geo-statistical map is a predicted map which was created based on quantitative statistical methods.

**Methodology for digital mapping**

Satellite data of IRS AWiFS was used for visual interpretation of the different land use pattern of the study area and selection of the different location of the soil samples. However, topographical sheets were used to trace out the block and village boundaries on a plain sheet and traced boundaries were geo-referenced to digitize the boundaries in shape files (shp. File). Digitized files were used to subset the AWiFS data for visual interpretation, mapping and selection of the location of the soil samples. Based on analysed soil samples in the laboratory, interpolation technique was used to map the spatial variability of soil pH, EC Organic carbon, N, P and K and results were ground truth by using toposheets, GPS receiver and documented reports for the validation of data.

**Results and Discussion**

**Soil pH**

Based on visual interpretation of layer stacked bands of green, red and NIR of satellite image, whitish tone having high brightness values was observed in adjoining of river Ganges fallen under light textured soils where soil reaction was under 7.05 to 7.9 (Fig. 2). In north-west, tone of the soils was appeared as bluish in same bands where the range of soil pH (6.19-7.95) was slightly alkaline (Fig. 3a). In general, soils with near neutral reaction (pH 6.0-7.0) are the most fertile (LRMP, 1986) [12]. The pH of the soils of Katihar district describes that only 6.55% soils were moderately acidic due to high rainfall. 41.25% soil samples were slightly alkaline in reaction might be due to medium black soils and 52.50% soils were neutral soils. Soil had pH less than 8.0 might be due to soil were well drained and light in colour.

**Soil EC**

The Electric Conductivity of the analyzed soil samples was ranged from 0.10-0.36 $dSm^{-1}$ with an average mean of 0.20 $dSm^{-1}$ indicated all the soil samples (100%) were non saline nature. Similar results were observed by Pillai and Natarajan (2004) [14]. The result indicated that all the soils are normal in nature. The wide variation of EC has also been observed with low salt content because of inherent drainage capacity prevailed over respective Blocks.

**Organic Carbon**

The Soil organic carbon content ranged from 0.15- 0.49% with the mean of 0.33% and categories under low fertility status. It might be attributed low organic carbon content prevailed across in study area.

**Available Nitrogen (Avail. N)**

Avail. N content ranged from 133- 243 kg/ha with the mean of 214 kg/ha and categories under low fertility status. It might be attributed low organic carbon content prevailed across in study area.

**Available Phosphorus (Avail. $P_2O_5$)**

Avail. $P_2O_5$ content ranged from 33- 48 kg/ha with the mean of 34 kg/ha and categories under low fertility status. It might be attributed low organic carbon content prevailed across in study area. Similar results were observed by Sahu and Mishra (1997) [15].

**Available Potash (Avail. $K_2O$)**

Avail. $K_2O$ content ranged from 33- 48 kg/ha with the mean of 34 kg/ha and categories under low fertility status. It might be attributed low organic carbon content prevailed across in study area.

**Conclusion**

Research findings revealed that the study area was under flood affected where soil pH was neutral to slightly alkaline. However, EC was normal indicated safe for agricultural activities. In context of nutrient status, especially in available N, P & K, the study area had low to medium range of nutrient content which may be improved using nutrient management practices.

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