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Soil fertility status of organic carbon and available nitrogen in soil through soil fertility mapping using GPS and GIS techniques of Dharmaur micro-watershed Jagdalpur block, Bastar district of (C.G.) state

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Abstract
The present study on "Soil fertility status of organic carbon and available nitrogen in soil through Soil fertility mapping using GPS and GIS techniques of Dharmaur micro-watershed Jagdalpur block, Bastar district of C.G. state" was carried out during 2017. The objective of the study were to quantify the soil fertility status of organic carbon and available nitrogen in the soils of Dharmaur micro-watershed through soil fertility mapping using GPS and GIS techniques. Soil fertility maps were adapted by using the Kriging technique of geostatistical interpolation method. Soil fertility mapping of the study area will be conducted on 1:10000 scale. Grid point based surface soil samples (0-15 cm) will be collected, dried, ground, and stored for laboratory analysis.Total 382 soil samples are collected from the area covers the majority of the part of Kumhrawand and Tekameta villages and is surrounded by Kumhrawand village to the east, Tekameta village to the west, Indravati river to the north, and Bhadisgaon & Biringpal villages to the south at the distance of 100 metres.

Keywords: Soil fertility mapping, GPS, GIS

Introduction
Soil fertility can be defined as the inherent ability of soil to supply nutrients to the plants in an adequate amount, suitable proportion, and free from toxic substances. Thus a fertile soil might or might not be productive depending upon crops, marketing condition and several other factors (i.e., excessive acidity or alkalinity, the presence of toxic substances, poor physical properties or an excess or deficiency of water. However, every productive soil has to be fertile. In this study, we are dealing with a significant problem of low production and low productivity in agriculture. The farmers, due to lack of awareness, do not use the right amount of fertilizer and stick to conventional methods of cultivation; and irrigation is mostly from rain due to inadequate facilities. These all factors result in limited cultivated land for crops, which result in a reduction in productivity. All these practices can lead to a decrease in soil fertility. There is a need to improve productivity and soil fertility. A map showing soil fertility in different areas of a region needs to be developed, which would then help us better understand the situation of soil fertility and tackle the same more efficiently, and improve productivity in agriculture. GIS and GPS techniques are used for making soil fertility map of this block. GIS and GPS are components of precision farming. GIS is a computer-based software system which stores, analyses, and displays spatial data variability in maps. (ISSS Book, 2015)

Material and Methods
Study Area
Chhattisgarh state is divided into 3 Agro-climatic zones – Chattisgarh plains, Bastar Plateau, and Northern Hill zone, each covering 51%, 28%, and 21% of the total geographical area respectively. Bastar district comes under the Bastar Plateau zone. The study area is the Dharmaur Micro-Watershed in Jagdalpur block, Bastar, Chhattisgarh, which is located between 19° 2′ 30″ to 19° 07′ 30″ N latitude and 81° 55′ to 81° 57′ 30″ E longitude with the altitude ranging from 540-562m above MSL (Mean Sea Level).The study area covers the majority of the part of Kumhrawand and Tekameta villages and is surrounded by Kumhrawand

village to the east, Tekameta village to the west, Indravati River to the north, and Bhadisgaon & Biringpal villages to the South.

Geographical Situation

The study area has a total geographical area about 426.0 ha (Fig 1) out of which about 62.0 ha (15.08%) area is covered by fairly dense to dense forest and 25.0 ha (6.08%) area is covered by dense scrub. The study area falls under Garjat Hills, Dandakaranya and the Eastern Ghats, hot moist sub-humid ESR, with deep loamy red and lateritic soils, low to medium AWC and LGP 180-210 days with average annual rainfall 1295 mm out of which 70% rainfall during June-September.

Climate and Weather Conditions

The region comes under sub-humid climate. The average annual rainfall observed in the area is 1544 mm. A significant amount of precipitation occurs between June to September (about 3-4 months), which is the main rice growing seasons. Rice is the major crop of the study area; other important crops are minor millets, maize, Niger, horse gram, black gram, green gram, and vegetables. Farmers adopt traditional methods of cultivation with a little use of chemical fertilizers and plant protection measures. Irrigation facilities are negligible (about 8% of the cultivated area) hence; mono-cropping "rice-fallow" is prevalent.

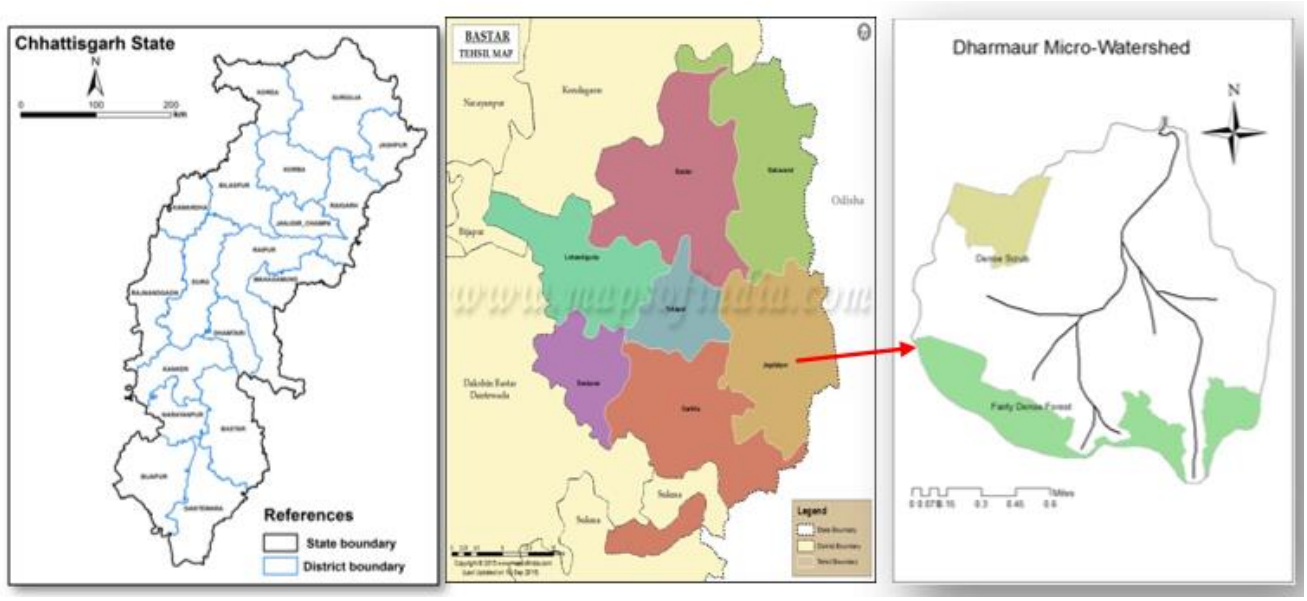

Fig 1: Location Map of the Dharmaur Micro-Watershed in Bastar district of Chhattisgarh

Method of soil sampling and soil fertility mapping

Grid sampling is used for soil sampling. Soil fertility maps were adapted by using the Kriging technique of geostatistical interpolation method. Kriging is a geostatistical interpolation method which deals with both the distance and the degree of variation between known data points when estimating values in unknown areas. It is shown in Fig 2.

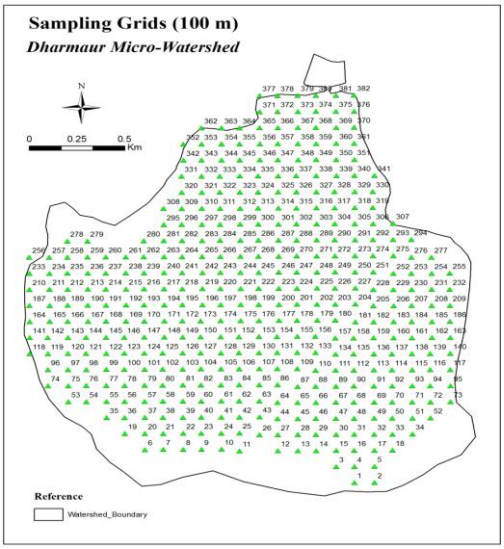

Fig 2: Grid point map by using kriging technique of geostatistical interpolation in Dharmaur Micro-Watershed in Bastar district of Chhattisgarh

Method of estimation of Organic carbon and Nitrogen

Organic carbon content in soil was estimated by Walkley and Black's rapid titration method, 1934. Five gram of soil sample was taken to which 10 ml potassium dichromate ($K_2Cr_2O_7$) and 20 ml commercial sulphuric acid (H_2So_4) were mixed. The mixture was kept as such for about ½ an hour. Then 200 ml tap water, 10 ml phosphoric acid and 2 ml diphenylamine indicator was added. The colour of the solution turned into ink blue. Now this solution was titrated against 0.5 N ferrous ammonium sulphate till the solution became green in colour indicating the end point of the titration. The value at end point was noted down from the burrette and organic carbon content was estimated by using the formula.

$$O.C.(\%)= \frac{B-S}{2} \times 0.003 \times 100$$

Where B= Blank reading S= Titrated value

Available Nitrogen

It was determined by alkaline permanganate method (Subbiah and Asija, 1965) [4]. Twenty gram of soil samples were taken in one litre flask and to it added 100 ml of 0.32% $KMno_4$ and 2.5% NaoH each. The flask was immediately connected to distillation assembly and heated. The distilled ammonia was collected in 0.1N H_2So_4 using methyl red indicator. The excess of sulphur acid was titrated against 0.1N NaoH. Results have been expressed in N kg/ha.

Result and Discussion

Organic Carbon

The organic carbon content of the soils of Dharmaur micro-watershed in Jagdalpur block ranged from 0.20-1.27 %with an average value of 0.59%. Considering the soil test rating for available - OC (0.25 – 0.50 as low; 0.50 – 0.75 as medium and >0.75 as high in the status of organic carbon), the soils of Dharmaur comes under all the three rating classes of available OC content. In general, out of 382 samples, 15.7% samples comes under the high category, 23.8% samples comes under the low category, 60% samples comes under the medium category of OC content in soils. The data shown in Table 1 revealed that OC Content of this area is medium in soils shown in Fig. 3. Similar to results, Bali *et al.* (2010) [6] characterized the soils of Punjab and presented the data agro-eco-Sub region wise. The descriptive statistics on soil characteristics indicated that the available OC ranged from 0.11 to 1.55%.

Shukla (2011) [5] found that the variation in organic carbon of the soils varied from 0.09 to 1.1 percent (mean-0.57%). In Inceptisol, Alfisols and Vertisols orders of Pamgarh block in Janjgir-Champa district (C.G.).

Table 1: Distribution of available OC status in the soils of Dharmaur micro- watershed

Available OC%	No. of Samples	% Samples	Nutrient Index	Fertility Rating
Low (<0.50)	91	23.8	1.90	Medium
Medium (0.50-0.75)	231	60		
High (>0.75)	60	15.7		

Available Nitrogen in soils

The available N content of the soils of Dharmaur micro-watershed in Jagdalpur block ranged from 110.5 to 257.7 kg ha^{-1} with an average value of 202.3 kg ha^{-1}. Considering the soil test rating for available N (<280 as low, 280-560 as medium and >560 as high in the status of N) the soils fall under low status (<280 kg ha^{-1}) in available N content. The nutrient index value of available nitrogen in soil of the study area falls under the low category. Status of available N in soils of the study area shown in the form of soil fertility map in Fig. 4.

The reason for low content of available nitrogen might be because N is lost through various mechanisms like volatilization, nitrification, denitrification, microbial fixation, leaching and runoff which resulted in a low amount of available N in the soil. Similar to results by Awanish Kumar (2017) studied that the content of major and micronutrients and their availability to crop vary widely depending upon soil types, nature of crops, ecology, and agro-climatic variability. A study was undertaken to assess the nutrients status of rice-chickpea grown areas of Chhattisgarh plain region of Chhattisgarh and revealed that soil was low in available nitrogen.

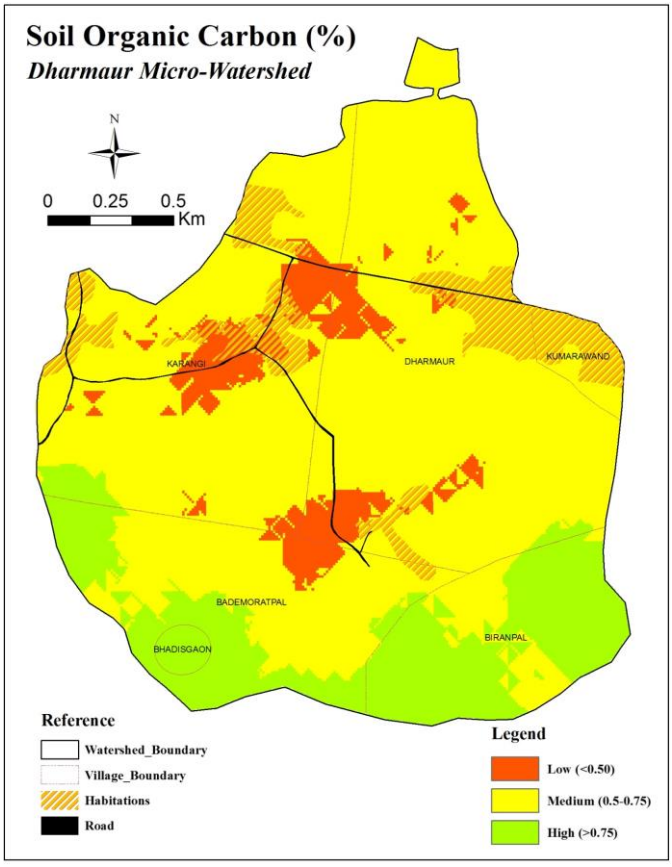

Fig 3: Status of OC in soils of Dharmaur micro-watershed in Bastar district of Chhattisgarh

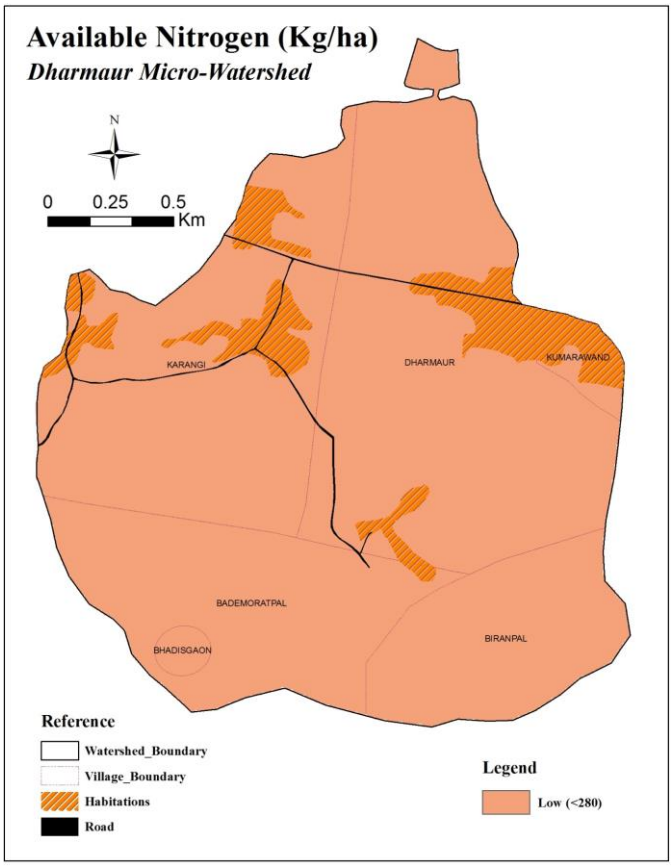

Fig 4: Status of Available Nitrogen in soils of Dharmaur micro-watershed in Bastar district of Chhattisgarh

Descriptive Statistics Analysis

The descriptive statistics of soil Organic Carbon and available Nitrogen are shown in Table 2 which suggested that they were all normally distributed. Kriging is a widely used method of geo-statistical interpolation that assumes no regional trend exists in the data. This method utilized the co-regionalization structure of soil properties and provided unbiased estimates and minimum variance (Ali and Malik, 2010). Skewness is the most common form of departure from normality. If a variable has positive skewness, the confidence limits on the variogram are wider than they would otherwise be, and consequently, the variances are less reliable. A logarithmic transformation is considered where the coefficient of skewness is greater than one (Webster and Oliver, 2001) [3].

Table 2: Descriptive statistics of OC and available N (0-15 cm) depth of 382 soil Samples

Descriptive Statistics	OC (%)	N(Kg/ha)
Minimum	0.20	110.50
Maximum	0.47	181.28
1st Quartile	0.55	210.50
Median	0.59	202.39
3rd Quartile	0.70	225.50
Mean	1.27	257.70
Standard deviation	0.20	32.53
Skewness	1.05	-0.58

Correlation between OC and availble N

The Soil Organic Carbon showed positive correlations with available N (r=0.66) in soils of Dhamaur micro-watershed of Jagdalpur block. Similar findings found by Shukla (2011) [5] in Janjgir-Champa district (C.G.).

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