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Soil fertility status of some selected villages in Lakhanpur block of Jharsuguda District under western-central table land agroclimatic zone of Odisha, India

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Abstract
A soil fertility status inventory work was carried out in some villages of Lakhanpur block of Jharsuguda district located in the Western Central Table Land Agro Climatic Zone of Odisha, India. Results show that soil pH ranged between 4.4 and 6.3 and electrical conductivity of the entire study area remained below 1 dSm^{-1}. Soil Organic Carbon (SOC) content ranged between 0.16 to 0.69%. Available nitrogen content in these soils was found to be varying between 78.0 to 347.0 kg ha^{-1}. Available Bray's phosphorus content varied from 6.0 to 36.0 kg ha^{-1}. Available soil potassium content varied widely from 110 to 370 kg ha^{-1}. $CaCl_2$ extractable soil sulphur varied from 0.347 to 10.063 mg kg^{-1}. DTPA extractable micronutrients (Fe, Mn, Cu and Zn) varied from 62.34 to 181.66, 35.76 to167.81, 1.66 to 4.66, and 0.58 to 4.68 mg kg^{-1} respectively. Hot water soluble boron content ranged from 0.18 to 0.86 mg kg^{-1}. All the figures in the lower range were found in upland soils while the higher values for all the parameters were found in low land soils.

Keywords: Soil fertility, agro-climatic zone, Jharsuguda, micronutrients

1. Introduction
Lakhanpur block of Jharsuguda district comes under the Western Central Table Land Agro Climatic Zone of Odisha (Nanda *et al.*, 2008) [20]. As per the modern system of soil classification "Soil Taxonomy" the soils of Jharsuguda district are classified under the *Alfisols*, *Inceptisols* and *Entisols* (Sahu and Mishra, 2005) [25]. Determination of soil available nutrient status of an area using the Global Positioning System (GPS) helps in formulating site-specific balanced fertilizer recommendations along with making critical decisions on nutrient management (Patil *et al.*, 2017) [22]. GPS-based soil fertility evaluation not only gives ideas about the fertility status of the soil but also helps in monitoring the soil health from time to time (Mishra *et al.*, 2016) [16]. Although soil fertility status and maps have been prepared for different areas of Odisha but no such intensive work had been done for the Lakhanpur block of Jharsuguda district. Therefore an attempt has been made in the present investigation to prepare the soil fertility status of five selected villages of Lakhanpur block of Jharsuguda district. As nitrogen, phosphorus and potassium are the three major primary macronutrients; sulphur is one of the most important secondary macronutrients and Fe, Mn, Cu, Zn and boron are the essential micronutrients, soil fertility status is evaluated focusing on these nutrients. Along with these parameters, chemical properties are also determined which include soil pH, EC and SOC. This study will help in finding out soil fertility related crop production constraints along with suggesting remedial measures for higher crop production.

2. Materials and Methods
2.1 Experimental site
Jharsuguda district is situated in the northwestern part of Odisha and is bounded between the 21° 34' North and 22°02' North latitudes and also between 83°25' East and 84°23' East longitudes. It is surrounded by Sundargarh district in the north, Sambalpur in the east, Bargarh in the south and Chhatisgarh state in the west. Extending over a geographical area of 2081.86 sq. km, it occupies 1.41% of the area of the state. It receives 1652 mm of average annual rainfall.

The district has only one sub-division (Jharsuguda) and five blocks (Jharsuguda, Lakhanpur, Kolabira, Laikera and Kirmira). It is one of the most important industrial districts of the state with a wealth of natural resources (mines and water). The most important rivers flowing through this district are Mahanadi and Ib, the water of which has been most helpful in setting up a number of industries in this district. The Mahanadi reservoir formed by Hirakud Dam is adjacent to Jharsuguda and Lakhanpur block.

Jharsuguda district falls under two agroecological zones i.e (i) West Central Table Land Zone and (ii) North Western Plateau. Laikera block falls under North Western Plateau while the rest of the blocks come under West Central Table Zone. The Minimum & maximum temperature of the district ranges from 26 to 40 °C during summer, 16.5 to 30.2 °C during winter and 25.3 to 32.5 °C during the rainy season. The district receives 1652 mm of average annual rainfall. Five villages were selected for studying the GPS-based soil fertility status namely Charpali (Lat. 21.73618° N, Long. 883.49928° E), Chantipali (Lat. 21.71525° N, Long. 83.49852°E), Dhulunda (Lat. 21.72107° N, Long. 83.51128° E), Muralipali (Lat. 21.70470° N, Long. 83.50091° E) and Remta (Lat. 21.69153° N, Long. 83.51235° E) is situated in Lakhanpur block of Jharsuguda district.

2.2 Soil Sampling and analysis

The landform of the study area was determined by traversing the area and elevations above MSL of different points were recorded using a GPS instrument (Garmin make; model: 76MAPCSx). Total 60 numbers of composite surface (0–15 cm) soil samples were collected from the study area which includes 12 samples from each village from different land types such as upland, medium land and low land. Composite soil samples were collected along with the latitude and longitude of the plots with the help of a GPS instrument. Soils were analyzed for their pH (1:2) (Jackson, 1973) [10], EC (1:2) (Jackson, 1973) [10], organic carbon (Walkley and Black, 1934) [28] as described by Page *et al*., (1982) [21], available nitrogen (Subbiah and Asija, 1956) [26], phosphorus (Bray and Kurtz, 1945) [5], potassium (Hanway and Heidel, 1952) [9] and sulphur (Chesnin and Yien, 1950) [6]. The micronutrients such as Fe, Mn, Cu and Zn were estimated using DTPA solution (Lindsay and Norvell, 1978) [13] and hot water extractable boron (John *et al*., 1975) [11].

3. Results and Discussion

3.1 Soil reaction

Soil pH (1:2) of surface soil samples of Charpali village were found to be varied in between 4.4 to 5.7 i.e. extremely acidic to moderately acidic with a mean value of 5.03; that of soils of Chantipali village varied between 4.6 to 5.7 i.e. very strongly acidic to moderately acidic with a mean value of 5.14; that of Dhulunda varied between 4.8 to 5.9 i.e. very strongly acidic to moderately acidic with a mean value of 5.3; that of soils of Muralipali village varied between 4.8 to 6.2 i.e. very strongly acidic to slightly acidic with a mean value of 5.35; that of soils of Remta village varied between 4.9 to 6.3 i.e. very strongly acidic to slightly acidic with a mean value of 5.53 (Table 1). Soil pH is significantly and positively correlated with OC (r=0.53*), N (r=0.54*), P (r=0.82**), S (r=0.56*) and B (r=0.63*). Similar findings have been observed by Mishra (2005) [23]. The data showed a gradual increase in soil pH value from the upland towards low land, which could be attributed to the removal of basic cations with runoff water from upland and medium land during intensive rainfall and their subsequent deposition in the low land. Hence, soil acidity appears to be a major crop production constraint in the study area. Similar findings have also been reported earlier by Priyadarshini *et al*., (2017) [24], Dash *et al*., (2018) [7] Swain *et al*., (2019) [27] and Mohapatra *et al*., (2020) [18].

3.2 Electrical conductivity

The Electrical Conductivity (1:2) of surface soil samples of the entire study area was found to be less than 1dS m^{-1} (Table 1). Hence, all the soils under the study area are safe for all types of crop production with respect to the soluble salt content.

3.3 Organic carbon

Soil Organic Carbon (SOC) of surface soil samples of Charpali village were found to be varied in between 0.26 to 0.57% i.e. low to medium content with a mean value of 0.43%; that of soils of Chantipali village varied between 0.24 to 0.48% i.e. belong to very low to low organic carbon content with a mean value of 0.35%; that of Dhulunda varied between 0.36 to 0.57% i.e. low to medium content with a mean value of 0.46%; that of soils of Muralipali village varied between 0.16 to 0.48% i.e. very low to low with a mean value of 0.30%; that of soils of Remta village varied between 0.44 to 0.69 i.e. ranged from low to medium soil organic carbon content with a mean value of 0.57%. The results clearly showed a gradual increase in SOC from upland towards low land surface soil samples which could be attributed to higher cropping intensity aided with more crop residue incorporation in the same. Again, due to the higher water table, the oxidation of organic matter is slower in low-land areas than that in upland areas. In the entire study area, organic carbon status was found to be low to medium range which enables the soil for growing a wide range of crops. Soil organic carbon is significantly and positively correlated with N (r=0.98**), S (r=0.67**), Zn (r=0.61**) and B (r=0.59*) (Table 4). Similar findings have also been reported by Mishra (2013) [14], Digal *et al*., (2018) [8], Swain *et al*., (2019) [27], Mohapatra *et al*., (2020) [18] and Jena *et al*., (2022) [29].

3.4 Available nitrogen

Available soil nitrogen content of surface soil samples of Charpali village were found to vary between 128 to 280 kg ha^{-1} with a mean value of 212.3 kg ha^{-1}; that of soils of Chantipali village varied between 119 to 215 kg ha^{-1} with a mean value of173.6 kg ha^{-1}; that of soils of Dhulunda varied between 178 to 273 kg ha^{-1} with a mean value of 226.6 kg ha^{-1}; that of soils of Muralipali varied between 78 to 217 kg ha^{-1} with a mean value of 155.3 kg ha^{-1}; that of soils of Remta village varied between 221 to 347 kg ha^{-1} with a mean value of 288 kg ha^{-1} (Table 2). The results clearly showed a gradual increase in average N content from upland to low land which could be attributed to the increased SOC in the low land than that of upland and medium land (as N is released from the soil organic matter by the activity of micro-organisms). Available N was found to be positively and significantly correlated with organic carbon (r=0.98**), S (r=0.64*), Zn (r=0.64*), and B (r=0.53*) (Table 4). In the entire study area available soil nitrogen content varied between low to medium. Similar results were reported by Behera *et al*., (2016) [4] and Swain *et al*., (2019) [27].

3.5 Available phosphorus

Available soil phosphorus content of surface soil samples of Charpali village was found to vary between 9 to 24 kg ha^{-1}

with a mean value of 16 kg ha^{-1}; that of soils of Chantipali village varied between 12 to 24 kg ha^{-1} with a mean value of 17 kg ha^{-1}; that of soils of Dhulunda varied between 6 to 21 kg ha^{-1} with a mean value of 12.5 kg ha^{-1}; that of soils of Muralipali varied between 18 to 36 kg ha^{-1} with a mean value of 26.7 kg ha^{-1}; that of soils of Remta village varied between 15 to 33 kg ha^{-1} with a mean value of 24.3 kg ha^{-1} (Table 2). The results clearly showed a gradual increase in average P content from upland to low land which could be attributed to the increased SOC in the low land than that of upland and medium land (as organic fractions of available phosphorus are mobilized to plant available form by the activity of micro-organisms). Available P was positively correlated with organic carbon B (r=0.26). In the entire study area, available phosphorus was found within the range of low to medium. Similar trends of available P were also observed by Barik *et al*. (2017) [3] and Swain *et al*., (2019) [27].

Table 1: Chemical Properties of Soil of the Study Area.

Name of Village	Land Type	pH		EC (dS m^{-1})		OC (%)	
		Range	Mean	Range	Mean	Range	Mean
Charpali	Upland	4.4-4.8	4.7	0.05-0.08	0.06	0.26-0.43	0.36
	Medium Land	4.9-5.2	5.0	0.06-0.09	0.07	0.38-0.44	0.40
	Low Land	5.3-5.7	5.4	0.09-0.12	0.10	0.48-0.57	0.52
Chantipali	Upland	4.6-4.9	4.8	0.10-0.12	0.11	0.24-0.32	0.29
	Medium Land	4.9-5.2	5.1	0.07-0.09	0.08	0.28-0.40	0.36
	Low Land	5.3-5.7	5.5	0.27-0.35	0.32	0.32-0.48	0.41
Dhulunda	Upland	4.8-5.1	4.9	0.05-0.10	0.08	0.36-0.40	0.38
	Medium Land	5.2-5.4	5.3	0.07-0.12	0.09	0.43-0.50	0.47
	Low Land	5.4-5.9	5.7	0.05-0.08	0.06	0.48-0.57	0.53
Muralipali	Upland	4.8-5.3	5.1	0.09-0.19	0.13	0.16-0.24	0.20
	Medium Land	5.4-5.7	5.6	0.18-0.23	0.20	0.28-0.36	0.33
	Low Land	5.8-6.2	6.1	0.08-0.12	0.10	0.32-.48	0.39
Remta	Upland	4.9-5.2	5.1	0.19-0.22	0.21	0.44-0.50	0.48
	Medium Land	5.3-5.7	5.5	0.15-0.23	0.19	0.57-0.63	0.59
	Low Land	5.7-6.3	6.0	0.28-0.31	0.30	0.62-0.69	0.65

Table 2: Available Nutrient Status of Soil of the Study Area.

Name of Village	Land Type	N		P		K		S	
		(kg ha^{-1})						(mg ha^{-1})	
		Range	Mean	Range	Mean	Range	Mean	Range	Mean
Charpali	Upland	128-201	178	09-15	12	190-230	215	0.34-1.38	0.86
	Medium Land	173-217	203	12-18	15	220-250	235	1.01-2.08	1.64
	Low Land	224-280	256	18-24	21	250-290	270	2.43-3.81	2.92
Chantipali	Upland	119-157	143	12-15	12.7	260-290	275	3.12-4.55	3.64
	Medium Land	136-197	175	15-21	18	290-340	320	4.55-5.55	5.03
	Low Land	158-215	203	18-24	20.2	340-370	350	5.20-6.24	5.72
Dhhulunda	Upland	178-201	192	06-12	7.5	110-140	125	0.34-1.38	0.86
	Medium Land	217-228	223	09-15	11.2	130-170	150	1.73-2.43	2.17
	Low Land	237-283	265	15-21	18.7	170-230	200	2.77-3.82	3.12
Muralipali	Upland	78-121	103	18-27	24	110-140	130	1.04-2.42	1.82
	Medium Land	140-178	165	21-30	26.2	140-180	155	2.77-4.51	3.38
	Low Land	158-217	198	24-36	30	190-240	210	3.82-5.20	4.59
Remta	Upland	221-256	244	15-24	18	200-260	240	6.24-7.28	6.76
	Medium Land	283-319	293	21-27	24	260-310	285	7.98-8.67	8.32
	Low Land	307-347	327	27-36	31	300-307	345	9.02-10.06	9.54

Table 3: Available Micronutrient Status of Soil of the Study Area.

Name of Village	Land Type	Fe		Mn		Cu		Zn		B	
		(mg kg^{-1})									
		Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Charpali	Upland	62.34-66.78	64.80	46.27-59.78	53.64	3.24-3.56	3.41	1.84-2.24	2.03	0.22-0.36	0.25
	Medium Land	68.26-71.64	70.68	58.92-69.18	63.40	3.46-3.84	3.64	2.10-2.24	2.14	0.22-0.43	0.38
	Low Land	70.36-76.08	74.56	66.47-77.08	72.02	3.68-3.94	3.81	1.96-2.64	2.28	0.46-0.66	0.51
Chantipali	Upland	68.42-70.96	69.26	35.76-65.28	52.78	2.00-2.16	2.09	0.84-1.16	0.99	0.26-0.40	0.34
	Medium Land	72.66-78.18	75.96	43.25-71.86	61.26	2.18-2.41	2.28	0.88-1.28	1.16	0.36-0.46	0.41
	Low Land	77.16-84.22	81.44	66.-74.35	69.07	2.26-2.48	2.36	1.14-1.30	1.21	0.43-0.54	0.46
Dhhulunda	Upland	76.92-81.56	79.48	49.62-67.15	61.37	1.66-1.98	1.81	0.58-1.06	0.86	0.22-0.43	0.27
	Medium Land	82.98-87.02	84.44	59.98-74.27	68.19	1.84-2.08	1.96	0.88-1.16	1.01	0.44-0.56	0.52
	Low Land	88.36-93.14	90.82	67.74-81.66	74.25	2.04-2.26	2.12	1.00-1.62	1.29	0.54-0.86	0.72
Muralipali	Upland	116.44-170.26	168.24	136.94-143.72	141.56	2.66-2.96	2.83	1.66-2.10	1.92	0.18-0.44	0.28
	Medium Land	169.40-174.22	172.42	146.45-159.22	154.02	2.82-3.06	3.00	1.84-2.24	2.08	0.24-0.54	0.40
	Low Land	174.72-181.66	178.56	151.06-167.81	158.08	3.12-3.22	3.16	2.12-2.68	2.32	0.46-0.68	0.56
Remta	Upland	69.26-80.72	74.16	46.30-62.57	53.60	3.58-3.88	3.73	2.96-3.48	3.28	0.24-0.36	0.32
	Medium Land	73.16-85.96	79.30	51.38-63.07	57.66	3.82-4.16	3.94	3.54-4.28	3.99	0.38-0.54	0.46
	Low Land	80.18-92.54	84.86	59.24-69.96	65.28	4.04-4.26	4.14	4.16-4.68	4.35	0.46-0.62	0.54

Table 4: Correlation Between Different Soil Properties of the Study Area.

	pH	EC	OC	Av N	Av P	Av K	Av S	Av Fe	Av Mn	Av Cu	Av Zn	Av B
pH	1											
EC	0.44	1										
OC	0.53*	0.37	1									
Av N	0.54*	0.35	0.98**	1								
Av P	0.82**	0.53*	0.26	0.29	1							
Av K	0.22	0.52*	0.43	0.45	0.30	1						
Av S	0.56*	0.74**	0.67**	0.64*	0.63*	0.71**	1					
Av Fe	0.47	0.06	-0.39	-0.39	0.60*	-0.47	-0.09	1				
Av Mn	0.47	0.03	-0.42	-0.4	0.60*	-0.45	-0.14	0.99**	1			
Av Cu	0.27	0.33	0.41	0.49	0.55*	0.35	0.48	-0.01	0.01	1		
Av Zn	0.42	0.49	0.61*	0.64*	0.64*	0.35	0.72**	0.03	0	0.9**	1	
Av B	0.79**	0.08	0.59*	0.60*	0.43	0.24	0.34	0.08	0.10	0	0.11	1

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed)

3.6 Available potassium

The available soil potassium content of surface soil samples of Charpali village were found to vary between 190 to 290 kg ha^{-1} with a mean value of 240 kg ha^{-1}; that of soils of Chantipali village varied between 260 to 370 kg ha^{-1} with a mean value of 315 kg ha^{-1}; that of soils of Dhulunda varied between 110 to 230 kg ha^{-1} with a mean value of 158.3 kg ha^{-1}; that of soils of Muralipali varied between 110 to 240 kg ha^{-1} with a mean value of 165 kg ha^{-1}; that of soils of Remta village varied widely between 200 to 370 kg ha^{-1} with a mean value of 290 kg ha^{-1} (Table 3). The results clearly showed a gradual increase in average K content from upland to low land which could be attributed to the increased clay content in the low land than that of upland and medium land (potassium ion being a cation present in the exchange site of negatively charged clay particles). The available potassium found to be positively correlated with organic carbon (r=0.43), S (r=0.71**), Cu (r=0.35), Zn (r=0.35) and B (r=0.24) but negatively correlated with Fe and Mn. In the entire study area available potassium was found within the range of low to high. Similar results were also observed by Mishra *et al*. (2017) [15] and Dash *et al*. (2018) [7].

3.7 Available Sulphur

Available soil sulphur content of Charpali village were found to vary between 0.34 to 3.81 mg kg^{-1} with a mean value of 1.81 mg kg^{-1}; that of soils of Chantipali village varied between 3.12 to 6.24 mg kg^{-1} with a mean value of 4.79 mg kg^{-1}; that of soils of Dhulunda varied between 0.34 to 3.81 mg kg^{-1} with a mean value of 2.05 mg kg^{-1}; that of soils of Muralipali varied between 1.04 to 5.20 mg kg^{-1} with a mean value of 3.26 mg kg^{-1}; that of soils of Remta village varied between 6.24 to 10.06 mg kg^{-1} with a mean value of 8.20 mg kg^{-1} (Table 2). The results clearly showed a gradual increase in average S content from upland to low land which could be attributed to the increased SOC content in the low land than that of upland and medium land (as S is released from the soil organic matter by the activity of micro-organisms). Available S was found to be positively and significantly correlated with organic carbon (r=0.67**), N (r=0.64*), P (r=0.63*) and K (r=0.71**) (Table 4). In the entire study area, the available sulphur was found to be in the range of low to medium. Similar results were also observed by Nahak *et al*. (2016) [19] and Mishra (2016) [16].

3.8 Available Micronutrients

3.8.1 DTPA Extractable (Fe, Mn, Cu & Zn)

DTPA extractable micronutrients content of Charpali village were recorded with Fe (ranging from 62.34 to 76.08 mg kg^{-1} with an average of 70.01 mg kg^{-1}), Mn (ranging from 46.27 to 77.08 mg kg^{-1} with an average of 63.02 mg kg^{-1}), Cu (ranging from 3.26 to3.49mg kg^{-1} with an average of 3.62 mg kg^{-1}), Zn (ranging from 1.84 to 2.64 mg kg^{-1} with an average of 2.15 mg kg^{-1}); that of soils of Chantipali village were recorded with Fe (ranging from 68.42 to 84.22 mg kg^{-1} with an average of 75.55 mg kg^{-1}), Mn (ranging from 35.76 to 74.35 mg kg^{-1} with an average of 61.02 mg kg^{-1}), Cu (ranging from 2.00 to 2.48 mg kg^{-1} with an average of 2.24 mg kg^{-1}), Zn (ranging from 0.84 to 1.30 mg kg^{-1} with an average of1.12 mg kg^{-1}), that of soils of Dhulunda village were recorded with Fe (ranging from 76.92 to 93.14 with an average of 84.91 mg kg^{-1}), Mn (ranging from 49.62 to 81.66 mg kg^{-1} with an average of 67.93 mg kg^{-1}), Cu (ranging from 1.66 to 2.26 mg kg^{-1} with an average of 1.96 mg kg^{-1}), Zn (ranging from 0.58 to 1.62 mg kg^{-1} with an average of 1.05 mg kg^{-1}); that of soils of Muralipali village were recorded with Fe (ranging from 116.44 to 181.66 with an average of 173.07 mg kg^{-1}), Mn (ranging from 136.94 to 167.81mg kg^{-1} with an average of 151.22 mg kg^{-1}), Cu (ranging from 2.66 to 3.22 mg kg^{-1} with an average of 2.99 mg kg^{-1}) Zn (ranging from 1.66 to 2.68 mg kg^{-1} with an average of 2.10 mg kg^{-1}); that of soils of Remta village were recorded with Fe (ranging from 69.26 to 92.54 mg kg^{-1} with an average of 79.27 mg kg^{-1}), Mn (ranging from 46.20 to 69.96 mg kg^{-1} with an average of 58.84 mg kg^{-1}), Cu (ranging from 3.58 to 4.26 mg kg^{-1} with an average of 3.93 mg kg^{-1}), Zn (ranging from 2.96 to 4.68 mg kg^{-1} with an average of 3.87 mg kg^{-1}) (Table 3). Considering 0.6 mg kg^{-1} as the critical limit of available Zn as suggested by (Lindsay and Norvell, 1978) [13], except an upland sample of Dhulunda, soils of all the villages were found to be sufficient in zinc status. Considering 4.5, 2.0 and 0.2 mg kg^{-1} are the critical limits of Fe, Mn and Cu respectively, all the soil samples were found to be adequate in Fe, Mn and Cu. Similar findings were also reported by Athokpam *et al*., (2016) [2], Khanday *et al*., (2017) [12], Athokpam *et al*., (2018) [1] and Mohanta *et al*., (2020) [17].

3.8.2 Available Boron

Hot water extractable boron content of the surface soil samples of Charpali village were found to vary between 0.22 to 0.66 mg kg^{-1} with a mean value of 0.38 mg kg^{-1}; that of Chantipali village varied between 0.26 to 0.54 mg kg^{-1} with a mean value of 0.40 mg kg^{-1}; that of Dhulunda varied widely between 0.22 to 0.86 mg kg^{-1} with a mean value of 0.50 mg kg^{-1}; that of Muralipali village varied between 0.18 to 0.68 mg kg^{-1} with a mean value of 0.41 mg kg^{-1}; that of Remta village varied between 0.24 to 0.62 mg kg^{-1} with a mean value of 0.44 mg kg^{-1} (Table 3). The results clearly showed a gradual land which could be attributed to the increased SOC content in the low land than that of upland and medium land. Available B was found to be positively and significantly correlated with organic carbon (r=0.62*) (Table 4.). This type of result is in close conformity with results obtained by Pattanayak (2016) [23], Swain *et al*., (2019) [27] and Jena *et al*., (2022) [29].

4. Summary
From the above study it was observed that (8%) of the total soil samples were of slightly acidic, (23%) of moderately acidic, (40%) of strongly acidic, (28%) of very strongly acidic and (2%) of the soil samples were detected to be extremely acidic. With regard to organic Carbon content, predominantly low organic carbon was recorded in (77%) of the area followed by a medium range of (23%). Most of the soil samples were reported as low in available nitrogen content (77%) followed by a medium range of (23%). The available phosphorus of the samples were chiefly recorded as of medium range (76%) followed by a low range of (24%). Available potassium was found to be in the low (3%), medium (62%) and in high range (35%). While 97 percent of the soil samples were investigated to be in low range of available sulphur and only (3%) of the samples were found to be in the medium range. The DTPA extractable iron and manganese content of the entire study area were found to be very high up to 181.66 mg kg^{-1} and 167.81 mg kg^{-1} respectively against the critical level 4 mg kg^{-1} for iron and 1.0 mg kg^{-1} for manganese [Table 4]. The high values of Fe and Mn may be explained as the soils of the area under study have been formed from river alluvium and are classified as *Typic Haplaquepts* and *Aeric Haplaquents* consisting of the sediments which originated from the weathered product of a rock system belonging mainly to the iron ore series containing garnetiferous gneiss, schist and rocks of Singhbhum granites. A similar observation has also been reported earlier by Nahak *et al*., (2016) [19]. The mean DTPA extractable zinc content was above the critical limit (0.6 mg kg^{-1}) and the copper content of the entire study area was found very high up to 4.26 mg kg^{-1},considering the critical limit (0.2 mg kg^{-1}) [Table 4]. However, the mean hot water soluble boron was found to have remained below the critical limit (<0.5 mg kg-1) [Table 4] which covers 80 percent of the investigation area. Similar finding was reported by Jena *et al*., (2022) [29].

5. Recommendations
Present study revealed that the entire soils of the area under investigation are being affected by different levels of soil acidity. Soil acidity has not only many adverse effects on soil physical, chemical, biological properties but also greatly impairs the availability of many nutrient elements to the plants. Since soil acidity was found to be the major crop production constraint, five quintals of well-grounded liming material (paper mill sludge) per hectare should be applied every year. Further, a huge swathe of the investigation area was found to be low in organic carbon content and thus five tones (50 Quintals) of well-decomposed farm yard manure per hectare should be applied every year. Addition of sufficient organic matter to the soils not only help in enhancing the organic carbon status of the soils but also enhance the microbial activity leading to increased release of plant nutrients into the soil solution. Most of the soils of the study area were found to be low with respect to available N content, which is one of the most important challenges for higher crop production. Hence, application of nitrogenous fertilizers along with organic manures and soil ameliorant (lime) is of great importance to deal with soil acidity and low N availability nitrogenous fertilizers. The available P status was mostly in low range, which constituted (97%) of the soil samples studied. Hence, application of soil test based phosphatic fertilizers along with organic manures and soil ameliorant (lime) is of great importance to increase P availability to crops. Since the available K status was mostly medium to high in range, application of only recommended doses of fertilizers will be sufficient to support optimum crop production. Even recommended doses of fertilizers can be reduced to 25%, where available K status is high. Almost all the soil samples were found to be rich in DTPA extractable micronutrients (Fe, Mn, Cu and Zn) but 80 percent of investigation area were found to have suffering from boron deficiency. Hence, (1–3 kg ha^{-1}) of borax or other soluble borates should be applied to the soil. An integrated application of soil test based fertilizer doses, along with sufficient organic matter and suitable ameliorants can optimize crop productivity along with sustaining soil health.

6. Conclusion
It can be concluded that this study on GPS-based soil sample collected from some villages of Lakhanpur block of Jharsuguda district could help to determine the nutrient status of specific sites and thus helps in site-specific nutrient management by balanced recommendation of fertilizer for various crops. Site-specific nutrient management not only reduces environmental pollution due to excessive fertilizers but also cut short the expenditure of farmers. By collecting and analyzing the geo-referenced soil samples at intervals, the change in soil fertility status can be monitored and remedial measures can also be suggested to maintain soil health for sustainable crop production.

7. References
1. Athokpam HS, Singh KS, Chongtham N, Devi KN, Singh NB, Sanatomba A, *et al*. Vertical distribution of micronutrient cations in Impal East and West district, Manipur (India). International Journal of Current Microbiology and Applied Sciences. 2018;7(8):4222-4227.
2. Athokpam HS, Zimik VS, Chongtham N, Devi KN, Singh NB, Watham L, *et al*. Profile distribution micronutrient cations in citrus orchard of Ukhrul district, Manipur (India). International Journal of Agriculture, Environment and Biotechnology. 2016;9(4):691-697.
3. Barik R, Saren S, Mishra A, Acharya BP. Soil fertility status of some villages in Astaranga bock of Puri District of East and South Eastern Coastal Plain Agro Climatic Zone of Odisha. Annals of Plant and Soil Research. 2017;19(4):408-412.
4. Behera S, Mishra A, Acharya BP, Saren S, Mishra J. Soil fertility status of some villages under East and South Eastern Coastal Plain agro climatic zone of Odisha. Journal of Indian Society of Coastal Agricultural Research. 2016;34(1):63-67.
5. Bray RH, Kurtz Lt. Determination of soils. Soil total, organic and available forms of phosphorus in Science. 1945;59(1):39-45.
6. Chesnin L, Yien CH. Turbidimetric determination of available sulphates. Proceedings of Soil Science Society of America. 1950;14:149-51.
7. Dash PK, Mishra A, Saren S, Revathi B, Sethy SK. Preparation of GPS and GIS Based Soil Fertility Maps and Identification of Soil Related Crop Production

Constraints of RRTTS and KVK Farm, Dhenkanal Located in the Mid-Central Table Land Agro Climatic Zone of Odisha, India. International Journal of Chemical Studies. 2018;6(5):934-943.
8. Digal M, Saren S, Mishra A, Dash PK, Swain N, Acharya BP. Soil Fertility Status of Some Villages in Phiringia Block of Kandhamal District under North-Eastern Ghat Agro Climatic Zone of Odisha, India. Journal of Pharmacognosy and Phytochemistry. 2018;7(6):659-662.
9. Hanway JJ, Heidel H. Soil analysis methods as used in Iowa State College Soil Testing Laboratory. Iowa State College Bulletin. 1952;57:1-31.
10. Jackson ML. Soil Chemical Analysis. Prentice Hall of India. Private limited, New Delhi; c1973.
11. John MK, Chuah HH, Ndufeld JH. Application of improved azomethine-H method to the determination of boron in soils and plants. Analytical Letters. 1975;8:559-568.
12. Khanday MUDD, Ram D, Wani JA, Ali T. Vertical distribution of nutrients of the soils of Namblansubcatchment of Jhelum basin of Srinagar district in Kashmir valley. International Journal of Current Microbiology and Applied Sciences. 2017;6(4):375-381.
13. Lindsay WL, Norvell WA. Development of DTPA soil tests for Zn, Fe, Mn and Cu. Soil Science Society of America J. 1978;42(3):421-428.
14. Mishra A, Das D, Saren S. Preparation of GPS and GIS Based Soil Fertility maps for Khurda district of Odisha. Indian Agriculturist. 2013;57(1):l 1-20.
15. Mishra A, Das D, Saren S, Dey P. GPS and GIS based soil fertility maps of Bhadrak District of Odisha. Ecology Environment and Conservation. 2017;23(1):207-213.
16. Mishra A, Das D, Saren S, Dey P. GPS & GIS based soil fertility maps of Nayagarh district Odisha, Annals of plant & soil research. 2016;18(1):23-28.
17. Mohanta A, Das SP, Santra G, Sethi D. Status of Micronutrients in Different Districts of Odisha, India. Int. J. Curr. Microbiol. App. Sci. 2020;9(07):3980-3984.
18. Mohapatra KK, Pradhan C, Saren S. Soil fertility status of some villages in Sader block of Balasore district under North Eastern coastal plain agro climatic zone of Odisha, India. International Journal of Chemical Studies 2020;8(2):381-386.
19. Nahak T, Mishra A, Saren S, Pogula S. GPS and GIS based soil fertility maps of Ranital KVK farm and identification of soil related production constraints. International Journal of Agricultural Science. 2016;8(51):2242-2251.
20. Nanda SK, Mishra A, Pradhan NK, Muralidharudu Y. Soil testing and fertilizer recommendation in Odisha. AICRP on Soil Test Crop Response, Department of Soil Science and Agricultural Chemistry, OUAT, BBSR; c2008.
21. Page AL, Miller RH, Keeney DR. Methods of Soil Analysis, part-2 (Edn.), Monograph No.9, American Society of Agronomy, Agronomy series ASA SSA. Publishers, Medision, Wisconsin, USA; c1982. p. 621-622.
22. Patil AH, Kumbhar AV, Nale VN. GIS-GPS based soil fertility maps of Agriculture College Farm, Kadegaon District, Maharashtra. International Journal of Engineering Science and Computing. 2017;7(11):15426-15430.
23. Pattanayak T. Preparation of GPS based soil fertility maps and identification of soil related crop production constraints for Dhenkanal District, Odisha, Ph.D. Thesis, Department of Chemistry, Institute of Technical Education and Research, Siksha „O" Anusandhan University, Bhubaneswar; c2016.
24. Priyadarshini P, Saren S, Mishra A, Acharya BP. Soil fertility status of some villages under North-Eastern Coastal Plain Agro climatic Zone of Odisha. Journal of Indian Society of Coastal Agricultural Research. 2017;35(2):42-47.
25. Sahu GC, Mishra A. Soils of Orissa and their management. Orissa Review, LXII. 2005;4:56-60.
26. Subbiah BV, Asija GL. A rapid procedure for the determination of available nitrogen in soils. Current Science; c1956. p. 25259-25260.
27. Swain N, Mishra A, Saren S, Dash PK, Digal M, Mishra BB. Soil Fertility Status of Some Villages in Khordha and Bhubaneswar Block of Khordha District under North Eastern Ghat Agro Climatic Zone of Odisha, India. Int. J. Curr. Microbiol. App. Sci. 2019;8(01):415-423.
28. Walkley AJ, Black IA. Estimation of soil organic carbon by the chromic acid titration method. Soil Science. 1934;37(1):29-38.
29. Jena A, Mishra S, Deepak P, Kumar-MP, Sharma A, Patel YI, *et al*. Response to SARS-CoV-2 vaccination in immune mediated inflammatory diseases: systematic review and meta-analysis. Autoimmunity reviews. 2022 Jan 1;21(1):102927.