Study on Fertility Status of Soil in Different Agro-climatic Zones of South Bengal

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for the Partial Fulfillment of the Degree of
Master of Science (Agriculture) in Agronomy

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Declaration

I do hereby declare that the present Master thesis entitled ‘Study on Fertility Status of soil in Different Agro-climatic Zones of South Bengal’ embodies the original research work carried out by me in the Department of Agriculture Sciences, Midnapore City College, Paschim Medinipur, West Bengal, India under the supervision of Ms. Shreyosi Roy, Assistant Professor, Department of Agriculture, Midnapore City College, Paschim Medinipur, West Bengal, India. No part thereof has been submitted for any degree or diploma in any University.

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Abstract

This investigation is aim to conduct a delineation study on fertility status of soil in 4 different agro-climatic zones (old alluvial zone, new alluvial zone, red and laterite zone &coastal and saline zone) of South Bengal. Improvement and maintenance of soil fertility is essential for sustainable crop production as well as for utilizing the soil adequately. The gradual decline in the fertilizer use efficiency has been attributed to several factors by different Scientist. With this perspective in mind, the primary goals of this study were to determine the soil's pH, electrical conductivity, organic matter, and NPK status. Soil sample was collected through prescribed method. Assessment of available nutrient status, for three major nutrient N,P,K are based on soil analysis. Within these four agro-climatic regions there was variation of soil fertility status as well as cropping pattern practiced by the farmers. In old and new alluvial zone, all soil samples were found showing soil electrical conductivity value (0.15 to 0.39 $dS.m^{-1}$) is suitable for crop growth and germination. The soils of those zones are characterized by low in organic carbon, it means the available nitrogen status also low and low in available phosphate and high in available potash. There is a large scope of increasing productivity and ultimately the economic return of the farmers by improving the soil fertility status. After analysis of those chemical properties it was found that the Coastal zone was more saline than other three zones; indicating EC value of more than 0.4 $dS.m^{-1}$. In other three zones salinity was negligible. Red Lateritic zone acidic (mean pH 5.8) and Old Alluvial zone was slightly acidic (mean pH 6.15). Some blocks of Costal zone have shown higher pH while soil of New Alluvial zone was neutral in nature. Organic carbon content was around 0.4-0.65 % in all over the study area, among which some blocks of Old Alluvial Zone have shown comparatively higher Organic Carbon content. Highest nitrogen content was found in Old Alluvial zone, for other three zones Nitrogen content were around 200-260 kg/ha mostly, except some blocks of Costal zone where nitrogen availability were low (<200 kg/ha). Phosphorus and Potash were found abundant in all over the study area except some blocks of Costal zone, where Phosphorus content were comparatively low. Thus, there will be a large scope of this study by detailing all four agro-climatic zones of South Bengal; utilizing proper soil fertility, increasing productivity and ultimately the economic return of the farmers by suggesting them for proper crop management.

***Keyword* :** Soil fertility, Agro-climatic zone, Productivity.

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Chapter 1: Introduction

1. Introduction

In present day agriculture, there is increasing concern about the sustainability in productivity of soils as a resource base to meet the demand of the escalating human population. The problem is more intense for a densely populated country like India where man has been exploiting the soil nutrients from time immemorial. Commensuration to huge requirement of food grain to feed ever expanding population of India, the country has adopted several mechanisms for increasing the quantum of food production. Since such high levels of production cannot be attained without external supply of adequate amount of nutrients.

West Bengal can be divided into six agro climatic zones. West Bengal is a cluster of varied physical features. The climate of West Bengal is hot and wet tropical monsoon in summer and cool-dry winter. Someplace suffer severe cold climate which did not support profitable agriculture of that region. Some places may suffer hot and arid climate which leads to the crop failure. This caused the gradual decrease in cropping area as well as reduction in productivity of that region. In present time, application of sub-optimal or more than optimum dose of fertilizers not only affect the productivity but also hazardous for soil and environment (Savic, 2012).

Successful agriculture requires the sustainable use of soil resources because soils can quickly lose their quality and quantity within a short period for many reasons (Kiflu and Beyen, 2013). Therefore, Agricultural practice requires basic knowledge of sustainable use of the land. Furthermore, soil management's success in maintaining soil quality depends on an understanding of how soils respond to agricultural practices over time (Tufa et al., 2019)

In recent years, the crop productivity has decelerated or shown a trend of deceleration. The productivity improvement has not been able to keep pace with time since our attention of fertilization of crops has primarily been on three basic major nutrients, namely, NPK. The problems of secondary and micronutrients application have not received the desired attention. With increasing cropping intensity, high yielding crop varieties grown in recent period and increasing use of secondary and micronutrient free fertilizers, the process of exhaustion of native soil sources of secondary and micronutrients have been accelerated. It is therefore imperative that there an immediate

need to generate database relating to their status distribution and their deficiency in soils as well as crop responses their application (Debnath, 2005).

Nasim Aktar (2015) stated in his article that agriculture productivity for all crops related with district wise productivity region, West Bengal. Soil is the basic natural resource on which the very existence of mankind depends and therefore the optimum utilization of soil needs adequate attention. To utilize the soil adequately we must have to know about the chemical properties of soil. Soil survey helps to identify the extent of problems and potentials which in turn helps to work out suitability of land for agricultural and non-agricultural uses.

On the other hand, feeding the ever increasing human population is most challenging in developing countries because of soil degradation. This challenge will continue as population pressure increases and the degradation of soil resources is aggravated. Reversing this trend lies in enhancing the sustainable development of the agricultural sector; however, the basis of sustainable agricultural development is good soil quality since maintenance of soil quality is an integral part of sustainable agriculture (Liu et al., 2010). Climate and geological history are also important factors affecting soil properties on regional and continental scales (Wang et al., 2001).

Soil fertility is the inherent property of soil which determines the nutrient availability for plant growth. In India, soil degradation due to inappropriate land-use systems is threatening the livelihood of millions of people. Removal of permanent vegetation, loss of organic matter (OM), and decrease in water-stable aggregates (WSA) and mean weight diameter (MWD) in the process of the conversion of the forest and pasture areas into cultivated land have contributed to the increase in soil erodibility. Land-use change greatly influences many soil properties, primarily through its effect on soil organic matter. Productivity of soil highly depends upon soil chemical properties (Kekane et al., 2015). Soil pH controls the population of microorganisms (Wang et al., 2019). Most of the soil organisms and beneficial bacteria need neutral to slightly alkaline pH (Schinner et al., 2012). So the productivity will be reducing with reduction of soil pH. Except that an acidic soil is favorable for fungus, thus increased acidity adversely affect the plant (Clarholm et al., 2017). Acidity also creates unavailability of plant nutrient such as N & P (Wright et al., 2019).

Soil organic matter is the source of energy for soil microorganisms (Tranvik, 2018). Increased organic matter of soil indicates more microbial activity and better properties of soil. N, P & K are three macro nutrients among 17 essential nutrients, which are used in great quantities. The use of fertilizers in the country has thus increased consistently. However, in spite of the significant contribution of mineral fertilizers to the increased food production, a steady decline in fertilizer use efficiency for production of agricultural crops has now become a matter of serious concern. Crop production in any particular zone is based on the application, uptake and efficient utilization of plant nutrients by the crops under specified condition. Sometimes non-judicious application of plant nutrients hampers the uptake process of a particular nutrient or combination as a whole (Das, 2019). The gradual decline in the fertilizer use efficiency has been attributed to several factors by different workers (Selladurai et al., 2016). Some workers consider lack of use of sufficient amount of organic matter in the nutrient management programme to be a major reason for such decline in fertilizer use efficiency (Bourguignon, 2005).

However, many others have attributed this behavior to use the plant nutrients below the required levels and also to imbalanced application of fertilizers. Understanding the soil physic-chemical properties and fertility status is necessary to keep soils at its maximum performing level. Soil Chemical tests are one of the effective tools commonly used to assess the fertility status of soil. This also helps to get a clear idea of soil condition of a particular zone and to contribute effectively in making and handling soil properly.

Table No.1 STATEMENT OF PROBLEMS:

Old and New Alluvial Zone of West Bengal	Poor in plant nutrients and organic matter, Unscientific and inequality uses of irrigation system and other agricultural materials like seeds. Fertilizer, Chemicals, substance, agricultural loan and scarified etc. Increase Net Sown Area and low level of productivity, Over depend on ground water and misuse it. Lack of knowledge to reclaim the land.
Red Lateritic Zone	Undulant topography. Soil is light textures, porous, acidic in nature (pH 5.5 to 6.2), Erosion prone area, Small nodules of iron concretion are found in the surface layer, Poor in organic matter, Low nitrogen and phosphate, Deficiency of irrigation system, Uses agricultural materials are very low, Sporadic deficiency of micro nutrients, Not support agriculture, Rain-fed region, depend on irrigation system, Soil is hardy, fertility level is low.
Coastal Zone	Soils are mostly saline and heavy in texture with high clay content, poor in plant nutrients and organic matter, low in phosphorus and nitrogen, fertility level is low, irrigation problem.

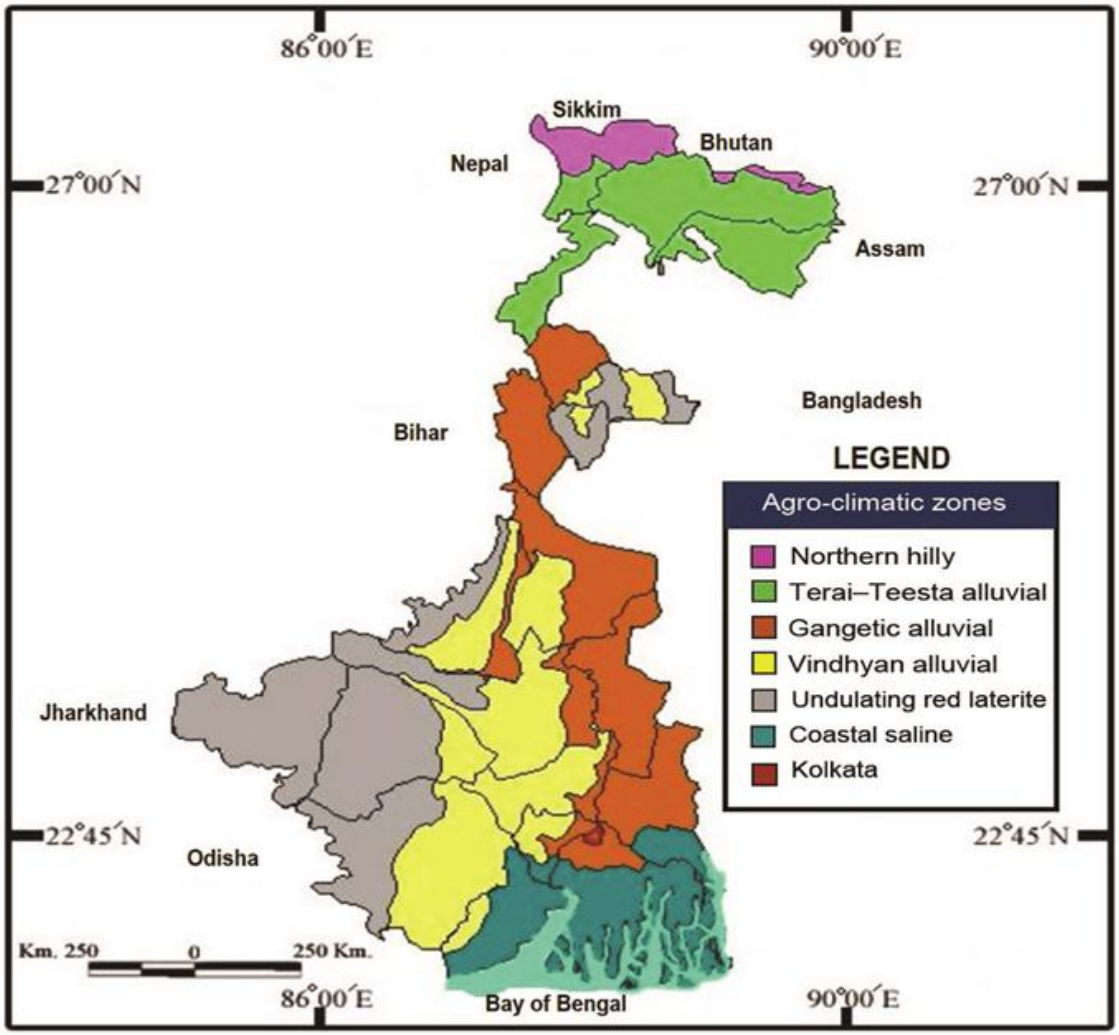

Fig.1 Agro-climatic zone of West Bengal

Map showing six different agro-climatic zones of West Bengal, India (source: Policy perspectives on agricultural water management and associated technologies suitable for different agro-climatic zones of West Bengal, India. (Mandal et al., 2022)

Chapter 2: Literature Review

2. Literature Review

Reviewing the existing literature on any proposed research is very important for any researcher to have a clear-cut idea on the selected research problem and it is very useful in analysing and interpreting the data for drawing some meaningful conclusions. An attempt has been made to present the studies conducted by various issues relating to organic farming and conventional farming with this view, the review of literature is presented under with the following headings.

They investigated an evaluation of Physico-chemical properties of 27 soil samples from 3 different blocks of Malda district (West Bengal) in different depths (0–15, 15–30 and 30–45 cm) was carried out during the year of 2020– 2021. Soil pH is slightly acidic to slightly alkaline with a mean value range of and the Electrical Conductivity suitable for all crops and free from salinity with a mean value of 0.12–0.37 $dS.m^{-1}$. Soil Organic Carbon was medium to high rang than standard, due less decomposition of organic matter of the soil. Available Nitrogen is medium; Phosphorus low and Potassium medium are adequate (Raja et al., 2021).

This investigation is aimed to conduct a delineation study to know the spatial distribution of available cationic micronutrients (Zn, Cu, Fe and Mn) in red and lateritic soils of Jhargram district of West Bengal and their relationship with soil chemical properties. We want to study about soil pH, soil organic carbon, NPK status in different district of this region content. The pH, organic carbon content, the lowest zinc content has been recorded from the soils of Gopiballavpur- 2 block (Das et al., 2020).

Soil fertility is the ability of the soil to provide the plant nutrients in adequate amount and balance proportion for maximum growth and yield of crops. To find out the effect of spatial variability of soil parameters between fields at the village scale in red lateritic zone of south bengal. This has helped in strategizing appropriate management of nutrients in a rice-potato-sesame cropping sequence leading to better yield. This method can help to do away with the expensive plot-to-plot soil testing leading to better ease and economics of implementing SSNM with associated increase in production and productivity. However, considerably higher yields were obtained under the soil test-based and the various grid-based recommendations. No significant differences in yield were observed between soil test and GIS-based fertilization (Iftikar et al., 2020).

The experiment was conducted to study soil fertility status of some selected soils of Birbhum district of West Bengal with one hundred soil samples collected from five blocks viz., Mayureswar, Nalhati-1, Bolpur, Md Bazar and Rajnagar. The soils of this zone are characterized by sandy loam to sandy clay loam in texture and strong to moderately acidic in reaction. Total soluble salt content (EC as dS.m-1) was found to be under very low level (Sahu et al., 2020).

The Terai and Teesta agro climatic zone has been conducted a positive co-relation between main worker and marginal worker but negative impact on economic condition. The Gangetic New Alluvial agro climatic zone has been conducted a poor strongest negative co-relation between main worker and marginal worker but condition on economic development is medium. And Undulating Red and Lateritic agro climatic zone negative co-relation between main worker and marginal worker. However, it shouldn't be a natural phenomenon. So, if properly use the economic variable of three agro climatic zone, then change economic structure and developed economic condition and positive infrastructure of West Bengal (Dutta, 2018).

In Dakshin Dinajpur district of the old alluvial zone is characterized by acidic pH with no salinity or no sodic properties, low organic carbon, low in available phosphate and high in available potash. However, this study was conducted to basically in narrow area of Dakshin Dinajpur of old alluvial zone, a finding that allow us to be investigate elaborately in this zone (Pandit and Mookherjee, 2016).

The Purba Medinipur district has a vast expanse of younger alluvial soils. It is divided into three parts. First, there is a strip of purely deltaic country composed of younger alluvial soils or Entisols bordering the Rupnarayan River and the Hugli River. The second division consists of the coastal alluvial soils of Entisols group. Much of the tract is salifereous and has to be protected from the incursions of the sea by embankments. There is a long narrow and elongated strip of saline and alkali soils of Aridisols group, stretching from Digha to the east of the Haldi River. The remaining portion consists of older alluvium belonging to Alfisols group along the Western portion near Egra and in a very small part to the North West along the river Kangsabati. The present paper basically deals with the status of soil and related problems in Purba Medinipur district (Das et al., 2016).

From the book “Geography of India” by R.C.Tiwari has analyzed physical, geological, biological, agricultural, economical and others aspects of India. Specific details in agro-Climate zone with agro-eco region which are can divide agro-climate zone and agro-eco-region of West Bengal. This book is used for all purpose. The study was conducted to coastal zone of Sundarban, the soils of this region are naturally saline and agriculture is severally constrained. This study produced high quality spatial soil nutrient maps to apply the site-specific management for crop cultivation in villages of coastal Sundarbans. The available N, P and Zn content showed low content which significantly increased with increase in organic C. On the other hand, organic C was negatively correlated with the soil salinity level. They investigated only the 3 villages of Sundarbans (Mitran et al., 2014).

The soil of the experimental site of old alluvial zone in west bengal was sandy loam in texture with predominance of illitic type of clay minerals which taxonomically categorized under the great group Typic Haplustepts. Soil of experimental field had low in N, P. The old alluvial zone contains medium levels of potassium and 0.43% organic carbon. Soil pH is 8.0 and slightly alkaline in nature. Electrical conductivity of old alluvial zone is 0.43 dS/m (Mahajan et al., 2013).

Understanding the soil physic-chemical properties and fertility status is necessary to keep soils at its maximum performing level. Soil Chemical tests are one of the effective tools commonly used to assess the fertility status of soil. This also helps to get a clear idea of soil condition of a particular zone and to contribute effectively in making and handling soil properly. The works which were done previously by different scientist were confined in a relatively smaller area and also did not study elaborately on varying soil chemical properties of different agro-climatic zones have done yet.

Chapter 3: Aims and Objectives

3. Aims and Objectives

3.1 Aims

The works which were done previously by different scientists were confined in a relatively smaller area and also did not study elaborately on varying soil chemical properties of different agro-climatic zones have done yet. Thus, there will be a large scope of this study by detailing all four agro-climatic zones of South Bengal; utilizing proper soil fertility, increasing productivity and ultimately the economic return of the farmers by suggesting them for proper fertility management.

3.2 Objectives

- To determine the value of soil pH and Electrical conductivity in different agro-climatic zones of South Bengal.
- To determine organic carbon content in soil of different agro-climatic region.
- To determine the NPK status of soil of different agro-climatic zones of South Bengal.
- To compare the soils of different agro-climatic regions of South Bengal.

Chapter 4: Materials and Methods

4. Materials and Methods

Period of study: - Total period of study may be approx. 60 days.

Study area: - The study area held on four agro-climatic zones of South Bengal. The state West Bengal can be divided into six broad division of agro climatic zone. Four of them such as - (1) The old alluvial region of south Bengal (17.537 lakh ha), (2) The Gangetic new alluvial region (15.304 lakh ha), (3) The lateritic red or gravely undulating region in south Bengal (24.842 lakh ha) and (4) Coastal and Saline region (14.569 lakh ha). River, soil, natural vegetation, biological diversity (flora and fauna), climate, agriculture, are natural resources of west Bengal. Agriculture of West Bengal depends on soil and climate. Agriculture, soil and climate are interrelated. Depending on soil and climate variation west Bengal can divide six Agro Climatic Zones. Our study area based on four agro climatic regions. Soil chemical properties and nutrient status of soil are assessed in different agro-climatic region of South Bengal. Among which south Bengal contains 4 agro-climatic zones, those are old alluvial zone, new alluvial zone red laterite zone and coastal and saline zone.

Table 2. FOUR AGRO CLIMATIC ZONES OF SOUTH BENGAL AS A STUDY AREA

Agro-climatic Zones	**Districts and no. of Blocks**	**Area (Lakh Ha)**
Old alluvial zone	1. Murshidabad (26). 2. Purba Bardhaman (23).	17.537
Gangetic new alluvial zone	1. Nadia (17). 2. North-24-Pargana (22) 3. Howrah (14). 4. Hooghly (18).	15.304
Red and laterite zone	1. Paschim Birbhum (19). 2. Bankura (22). 3. Purulia(20). 4. Jhargram (8). 5. Paschim Bardhaman (8).	24.842
Coastal and saline zone	1. South-24-Pargana (29). 2. Purba Midnapure (25).	14.569

Table 3. Questionnaire: - <u>Personal information of the farmers</u>

SL. NO.	Name of the Farmer	No. of Family Members	Gender		Address	Educational qualification of the farmers
			Male No	Female No		
1.	Arup Ghosh	7	2	5	Vill - Mundalika, Hooghly, WB.	Under Graduate
2.	Sudip Ghorai	5	3	2	Vill – Ramchandrapur, purbamedinipur, WB.	Under Graduate
3.	Gopal Mondal	4	3	1	Vill – Sodepur, Hooghly, WB.	12th
4.	Sujit Biswas	8	4	4	Vill – Gopalpur, Nadia, WB.	12^{th}

Same as data were collected by 100 farmers.

Table 4. <u>Total land own & cropping pattern of the farmers</u>

Sl. No.	Own land (Bigha)	Lease land (Bigha)	Total area of the land (Bigha)	Type of soil	Crops grown					
					Kharif		Rabi		Zaid	
					Crop	Area	Crop	Area	Crop	Area
1.	5	No	5	clay	Rice	5	Mustard	3	Rice	5
2.	4	2	6	clay	Rice	6	Rice	4	fallow	
3.	2	3	5	Sandy loam	Rice	5	mustard	5	Cowpea	2
4.	4.5	5	9.5	Clay loam	Rice	9.5	Rice	4.5	Jute	4.5

Same as data were collected by 100 farmers.

Soil samples will be collect as per prescribe techniques describe in the figure: 1 and sample collection from field described in figure: 2. Soil samples will be collected from the different parts of the districts in different agro-climatic zones in 10-15 cm depth in V shape with the help of Khurpi. Each soil sample will be mix thoroughly and about a half kilogram of the composite sample. The soil sample will be dry under shady area, powder using wooden pestle and mortar and passed through 2mm sieve and preserve in polythene bags for further analysis (Jackson et al., 1973).

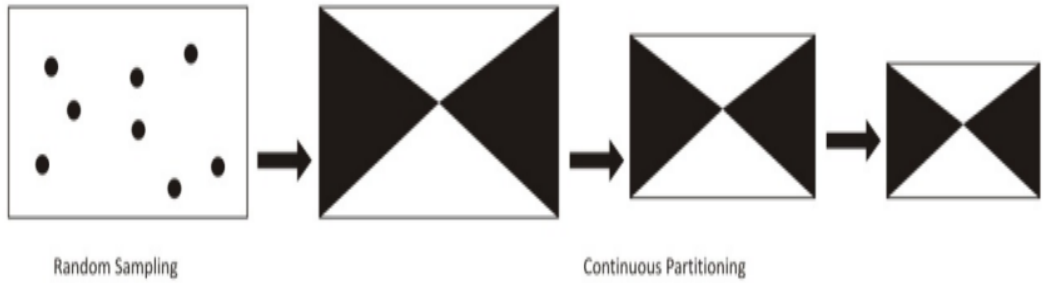

Fig – 2: Sample collection technics (Pandit & Mookherjee, 2016)

The importance of having a true representative sample can be very well realized from the fact that only a minute fraction of huge soil mass of the field is actually used for the analysis in the laboratory to find out the quantity of essential nutrients available to plants and other relevant physical and chemical characteristics. Therefore, while collecting soil samples the following aspects should be carefully considered.

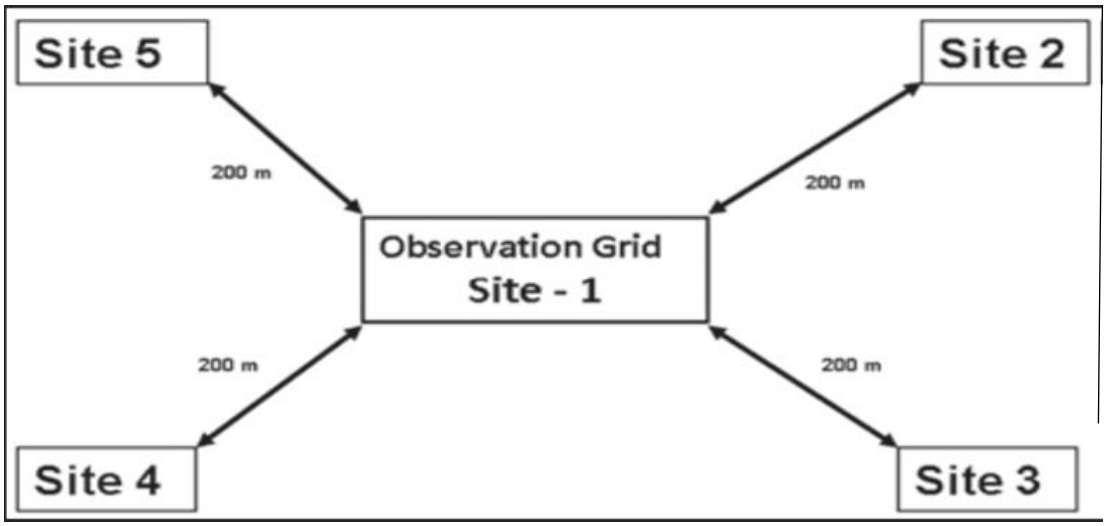

Fig -3: Sample collection site (Sen, 2020)

Soil pH and EC ($dS.m^{-1}$):

10 g soil was taken in 50 ml beaker and mixed with 20 ml distilled water. It was allowed for 30 minutes for collection of EC reading and for pH readings were taken by pH meter (Model: Systronics) and EC by conductivity meter (Smith et al., 1997).

Organic Carbon (%):

It was estimated by the method as stated by Walkley and Black, (1934). 0.5 g Soil were mixed with 10 ml 1 (N) $K_2Cr_2O_7$ and 20 ml concentrated H_2SO_4 (96% pure). It was allowed for 30 minutes for completion of reaction. Then 200 ml water and 10 ml orthophosphoric acid was added and stirred. Then 1 ml diphenylamine was added and stirred. After that it was titrated by 0.5(N) Ferrous ammonium sulphate [Fe $(NH_4)_2(SO_4)_2$] solution until the blue colour just changes on to green colour. One blank reading was also taken for calculation of value.

Available N (kg/ha):

A known weight of the soil is mixed with excess of alkaline KMnO4 and distilled. Ammonia gas released by distillation is absorbed in a known volume of standard sulphuric acid excess of which is titrated with standard alkali using methyl red as an indicator.

Available P_2O_5 (kg/ha):

Several methods are used for the determination of available phosphorus in soils. Generally two methods are common. Olsen's method is used for neutral and alkaline soil whereas the Bray's method is used for acid soils.

In Olsen's method available phosphorus in soil is extracted by shaking the soil with 0.5 M sodium bicarbonate solution adjusted at pH 8.5. Later on the method involved formation of chlorostannous reduced molybdophospheric blue colour.

In Bray and Kurtz Method (1949), 2.5 g soil was taken and was mixed with 25 ml NH_4F solution and 1 g of Darco G-60 and shaken for 5 minutes. Then it was filtered. 5 ml of extract was taken in 25 ml volumetric flask and was mixed with 5.0 ml of ammonium molybdate solution. 10 ml distilled water was then added to it and stirred. The mixture was kept 10 minutes for completion of reaction process. Now, 1 ml of $SnCl_2$ working solution were added to it and made up to 25 ml mark of the flask by distilled water. It was allowed to stand for 3 minutes and readings were taken by Spectophotometer.

Available K_2O (kg/ha):

Following Jackson (1973) method 5 g of soil was taken in 100 ml conical flask and was mixed with 25 ml of 1 (N) ammonium acetate solution. It was shaken for 5 minutes and filtered. 5 ml of extract was taken in a 25 ml funnel top test tube and was made up to 25 ml by distilled water. Reading was taken by flame photometer.

Chapter 5: Results

5. Results

Coastal Zone

Soil reaction (pH):

The pH of soil coastal zone of West Bengal ranges from 6.8-7.6 with mean value of 7.24, standard deviation 0.21 and coefficient of variation 2.90% (Table 5). Out of 61 soil samples most soil samples were neutral in pH.

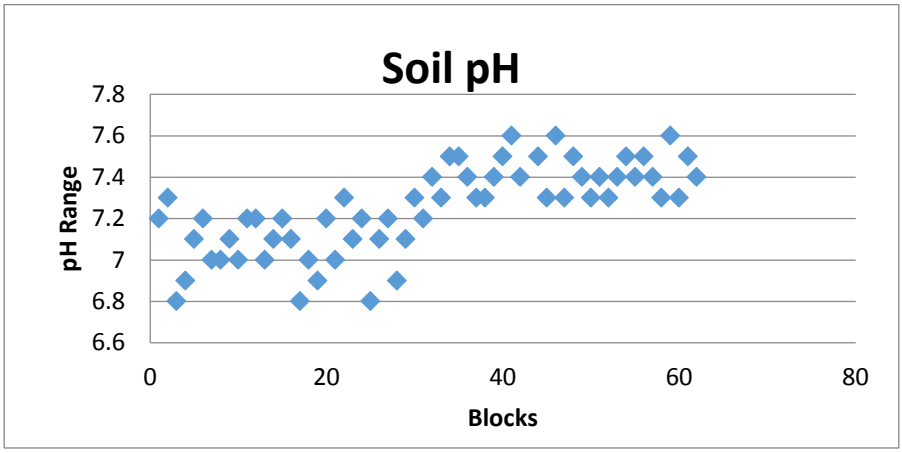

Fig-4: Soil pH of Coastal Zone

Electrical Conductivity (dS.m^{-1}):

The EC values of the costal zone's samples were varied from 0.40 to 0.70 ds m^{-1} with a mean value of 0.46 dsm^{-1}, standard deviation 0.08 and CV 17.55 (Table 5). Most of the soil samples were normal for total salt concentration.

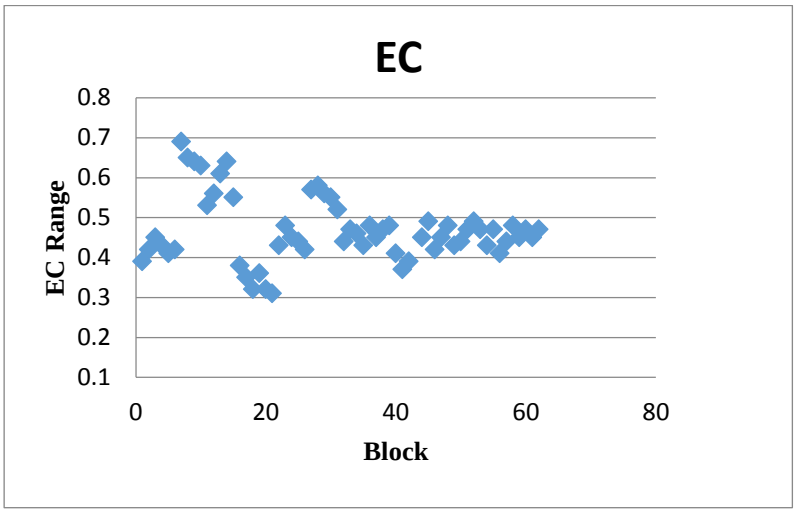

Fig-5: Soil EC of Coastal Zone

Organic Carbon (%):

The available organic carbon content (Table 5) of soil of coastal zone of West Bengal ranged from 0.31-0.70% with an average value of 0.59%., standard deviation 0.07% and coefficient variation 11.97%.

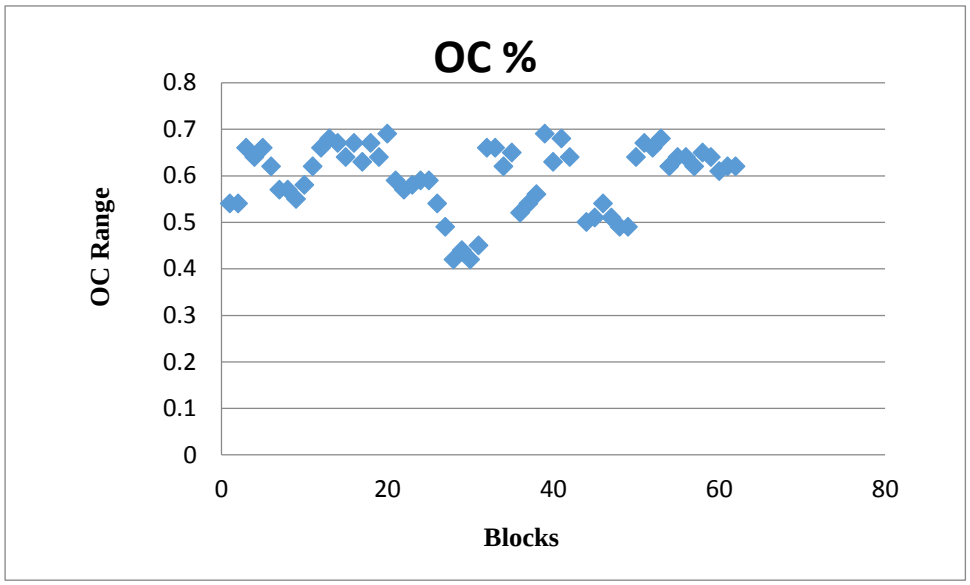

Fig-6: Organic Carbon of Coastal Zone

Available nitrogen (kg/ha):

Considering the soil test rating for available N (<250 as low, 250-400 as medium and >400 as high in the status of N) the soil of coastal zone fall under low status (<250 kg ha) in available N content with mean value of 230.95 kg ha, standard deviation 22.37 kg ha and coefficient of variation 9.68%.

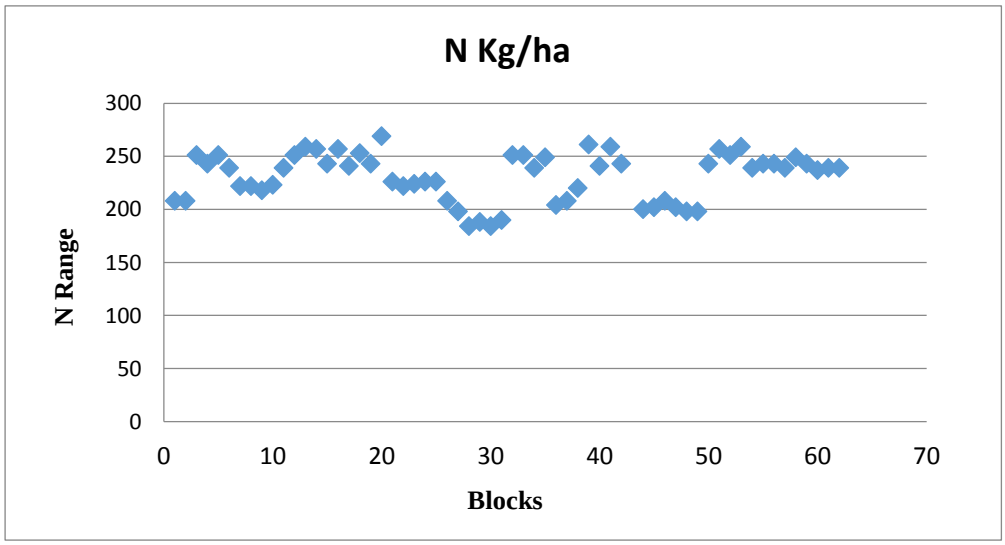

Fig-7: Nitrogen of Coastal Zone

Available phosphorus (kg/ha):

The available P content (Table 5) 0f the soil of coastal zone ranged from 10.12 to 24.48 kg/ha with an average value of 18.61 kg/ha. Considering the soil test rating for available P (<12.5 kg/ha as low, 12.5-25.0 kg/ha as medium and >25.0 kg/ha as high in the status of P). The general statistics calculated from 61 samples revealed that the available P content ranged from 10.12 to 24.48 kg/ha with a mean value of 18.61 kg/ha, standard deviation 3.32 kg/ha and coefficient of variation 17.88%. The variation in available P content is quite large which might be due to variation in soil properties viz pH, organic matter content, texture and various soil management and agronomic practices adopted by the farmers of the region.

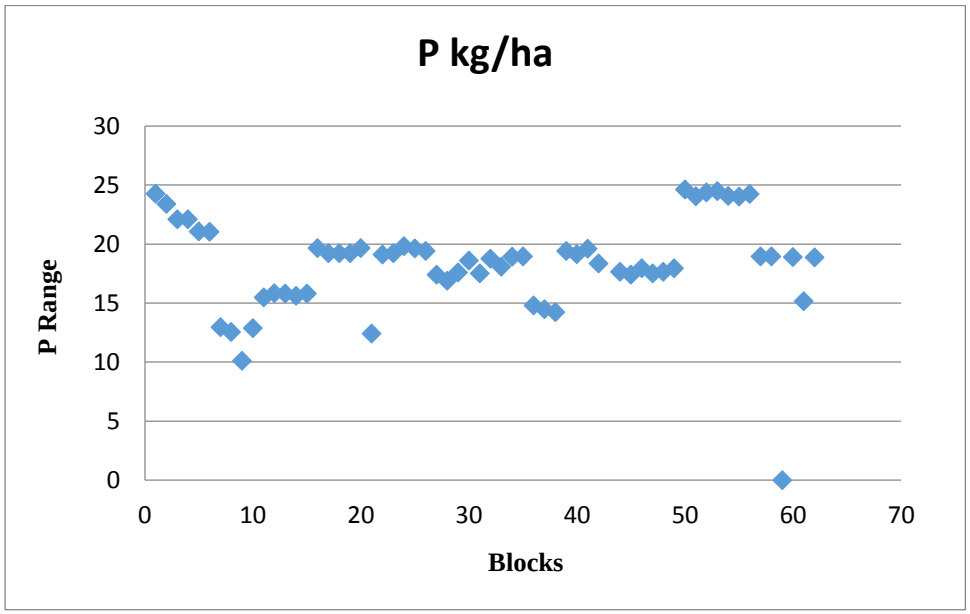

Fig-8: Phosphorus of Coastal Zone

Available Potash (kg/ha):

The available K content (Table 5) of the soil of coastal zone ranged from 215 to 391 kg/ha with an average value of 303.72 kg/ha. Considering the soil test rating for available K (<135 kg/ha as low, 135-335 kg/ha as medium and >335 kg/ha as high in the status of K) the soil of coastal zone fall under medium and high status in available K content. The general statistic calculated from 61 soil samples revealed that the available K content ranged from 215 to 391 kg/ha with a mean value of 303.72 kg/ha, standard deviation 36.05 kg/ha and coefficient of variation 11.86%.

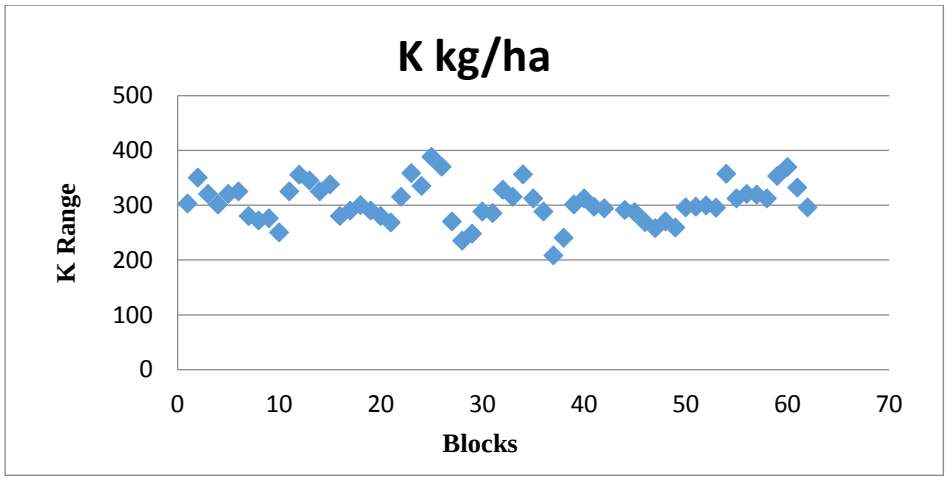

Fig-9: Potash of Coastal Zone

Table5: Chemical properties of soil samples collected from coastal zone of South Bengal

Sample no.	Block Name	Village Name	Latitude (N)	Longitude (E)	P^H	OC (%)	EC ($ds\ m^{-1}$)	N ($Kg\ ha^{-1}$)	P ($kg\ ha^{-1}$)	K ($kg\ ha^{-1}$)
S1	Bhagwanpur-1	Asadpur Saidpur	22.51112	86.95835	7.2	0.54	0.39	208	24.3	303
S2	Bhagwanpur-1	Bihari	22.51807	88.37675	7.3	0.54	0.42	208	23.4	350
S3	Chandipur	Dalbar	22.13795	87.79914	6.4	0.66	0.45	251	22.1	320
S4	Chandipur	Habichak	22.08485	87.89188	6.7	0.64	0.43	243	22.1	301
S5	Chandipur	Jalpai	22.15917	87.87954	7.1	0.66	0.41	251	21.1	320
S6	Chandipur	Kulbari	22.05194	87.87957	7.2	0.62	0.42	239	21	325
S7	Contai-2	Abasberia	22.07835	87.78376	7	0.57	0.69	222	13	280
S8	Contai-2	Baghapur	21.76981	87.84146	7	0.57	0.65	222	12.6	272
S9	Contai-2	Chak Gobindaberia	21.81186	87.81014	7.1	0.55	0.64	218	10.1	276
S 10	Contai-2	Dakshin Deulopota	21.80003	87.81751	7	0.58	0.63	223	12.9	250

S 11	Deshpran	Ghoraghata	22.45807	87.94395	7.2	0.62	0.53	239	15.5	325
S 12	Deshpran	Haripur	22.67713	87.19409	7.2	0.66	0.56	251	15.8	355
S 13	Deshpran	Jagannath Chak	21.91781	87.88197	7	0.68	0.61	259	15.8	345
S 14	Deshpran	Kajla	21.81954	87.76773	7.1	0.67	0.64	257	15.6	325
S15	Deshpran	Mahammadpur	22.15480	87.74067	7.2	0.64	0.55	243	15.8	338
S16	Egra-2	Khagda	21.77395	87.59396	7.1	0.67	0.38	257	19.7	280
S 17	Egra-2	Basudevpur	22.11236	88.01236	6.8	0.63	0.35	241	19.2	290
S18	Egra-2	Bathuary	22.12047	88.00063	7	0.67	0.32	253	19.2	300
S 19	Egra-2	Deshbandhu	22.11779	87.99442	6.9	0.64	0.36	243	19.2	290
S 20	Egra-2	Dubda	22.07647	88.02475	7.2	0.69	0.32	269	19.7	280
S 21	Haldia	Brajalal Chak	22.09306	88.04413	7	0.59	0.31	226	12.4	268
S 22	Khajuri-2	Nankar Gobindapur	21.80675	87.93235	7.3	0.57	0.43	222	19.1	315
S 23	Khajuri-2	Oashil Chak	21.81277	87.93235	7.1	0.58	0.48	224	19.2	358
S 24	Khajuri-2	Pacharya	21.81258	87.92006	7.2	0.59	0.45	226	19.8	335
S 25	Khajuri-2	Radha Nagar	22.44884	88.47198	6.8	0.59	0.44	226	19.6	388
S 26	Khajuri-2	Sahapur	22.51725	88.17064	7.1	0.54	0.42	208	19.4	370
S 27	Mahishadal	Amritberia	22.28601	87.73924	7.2	0.49	0.57	198	17.4	270
S 28	Mahishadal	Betkundu	22.28401	87.74471	6.9	0.42	0.58	184	16.9	235
S 29	Mahishadal	Garhkamalpur	22.28655	87.73391	7.1	0.44	0.56	188	17.6	248
S 30	Mahishadal	Itamogra	22.27824	87.72281	7.3	0.42	0.55	184	18.6	288

S 31	Mahishadal	Kismat-Naikundi	22.30465	87.75476	7.2	0.45	0.52	190	17.5	285
S 32	Nandakumar	Kumar Chak	22.23327	87.84768	7.4	0.66	0.44	251	18.8	328
S 33	Nandakumar	Dakshin Damodarpur	22.21725	87.87588	7.3	0.66	0.47	251	18.1	315
S 34	Nandakumar	Fatepur	22.28468	88.23256	7.5	0.62	0.46	239	18.9	356
S 35	Nandakumar	Hansgere	22.19987	87.91265	7.5	0.65	0.43	249	18.9	312
S 36	Nandigram-2	Tentul Bari	22.08387	87.93235	7.4	0.52	0.48	204	14.8	288
S 37	Nandigram-2	Thakur Chak	22.04677	87.38445	7.3	0.54	0.45	208	14.5	208
S 38	Nandigram-2	Amdabad	21.99244	87.88931	7.3	0.56	0.47	220	14.2	240
S 39	Ramnagar-1	Digha	21.62037	87.51003	7.4	0.69	0.48	261	19.4	301
S 40	Ramnagar-1	Deuli	21.66693	87.49509	7.5	0.63	0.41	241	19.1	312
S 41	Ramnagar-1	Mirgoda	21.72181	87.48006	7.6	0.68	0.37	259	19.6	297
S 42	Ramnagar-1	Tikra	21.66755	87.54344	7.4	0.64	0.39	243	18.4	294
S 43	Kakdwip	Akshyanagar	21.84195	88.27048	7.5	0.5	0.45	200	18	291
S 44	Kakdwip	Bamangar	21.85635	88.22425	7.3	0.51	0.49	202	17	287
S 45	Kakdwip	Bhubannagar	21.85354	88.24138	7.6	0.54	0.42	208	18	269
S 46	Kakdwip	Gobindarampur	21.86515	88.21205	7.3	0.51	0.45	202	18	258
S 47	Kulpi	Fatikbaria	22.04495	88.11658	7.5	0.49	0.48	198	18	270
S 48	Kulpi	Garankati	21.63868	88.21208	7.4	0.49	0.43	198	18	259
S 49	Namkhana	Baliara	21.72228	88.22188	7.3	0.64	0.44	243	25	296
S 50	Namkhana	Debnagar	21.56485	88.27775	7.4	0.67	0.47	257	24	297

S 51	Namkhana	Fedric Island	22.41748	88.62909	7.3	0.66	0.49	251	24	299
S 52	Namkhana	Iswaripuri	21.56315	88.25718	7.4	0.68	0.47	259	24	295
S 53	Namkhana	Lakshmipur Abad	21.74945	88.25839	7.5	0.62	0.43	239	24	357
S 54	Namkhana	Madanganj	21.76998	88.23155	7.4	0.64	0.47	243	24	312
S 55	Namkhana	Namkhana	21.75788	88.11656	7.5	0.64	0.41	243	24	320
S 56	Sagar	Haradhanpur	21.75784	88.11653	7.4	0.62	0.44	239	19	319
S 57	Sagar	Harinbari	21.40135	88.50218	7.3	0.65	0.48	249	19	312
S 58	Sagar	Krishnanagar	21.68935	88.07669	7.6	0.64	0.45	243	18.o3	353
S 59	Sagar	Natendrapur	21.78974	88.12678	7.3	0.61	0.47	237	19	369
S 60	Sagar	Mahendraganj	21.86347	88.12789	7.5	0.62	0.45	239	15	332
S 61	Sagar	Sagar Fulbari	21.86349	88.12789	7.4	0.62	0.47	239	19	296
				SD	0.21	0.07	0.0822	22.38	3.33	36.1
				MEAN	7.246	0.6	0.4684	231	18.6	304
				CV	2.901	12	17.551	9.689	17.9	11.9

Red lateritic zone

Soil reaction (pH):

Soil of Red Lateritic zone was acidic in nature in most of the blocks. The mean pH of 65 samples was 5.8. Highest acidity was found in the soil of Manbazar 1 block of Purulia district, indicating a pH of 4.9. Highest pH was found in Onda block of Bankura district which was 6.7, indicating a neutral pH. Except Onda; Patrasayer, Ranibundh, Gangajalghati, Haribundh and Taldangra block of Bankura district had shown a neutral pH; which was just above 6.5. All blocks of Purulia and Birbhum district were acidic.

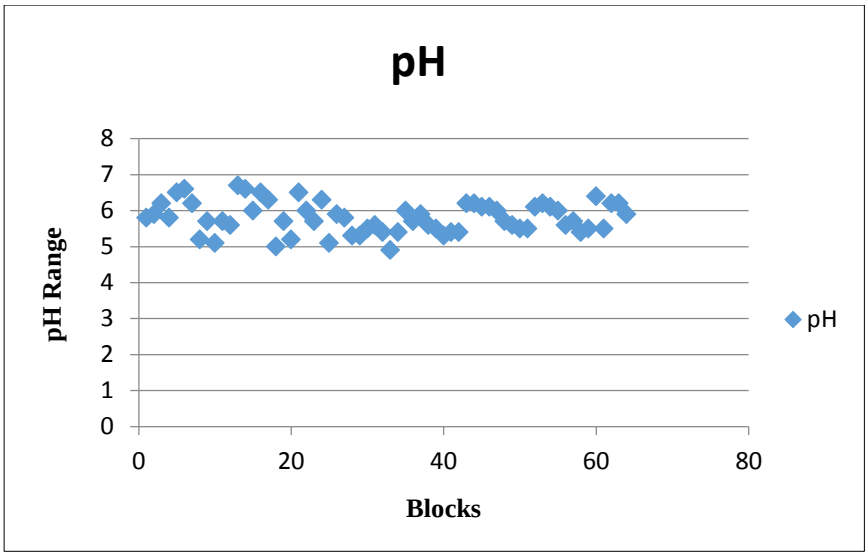

Fig-10: Soil pH of Red lateritic Zone

Electrical Conductivity (dS.m^{-1}):

Highest EC was found in Kharagpur 2 block of Paschim Midnapore district, which was 0.2dsm $^{-1}$. Mean EC value for Red lateritic zone was 0.14 dSm $^{-1}$. Salinity was low for almost every block. Lowest salinity was found in Sonamikhi block of Bankura district, which was 0.1 dSm $^{-1}$.

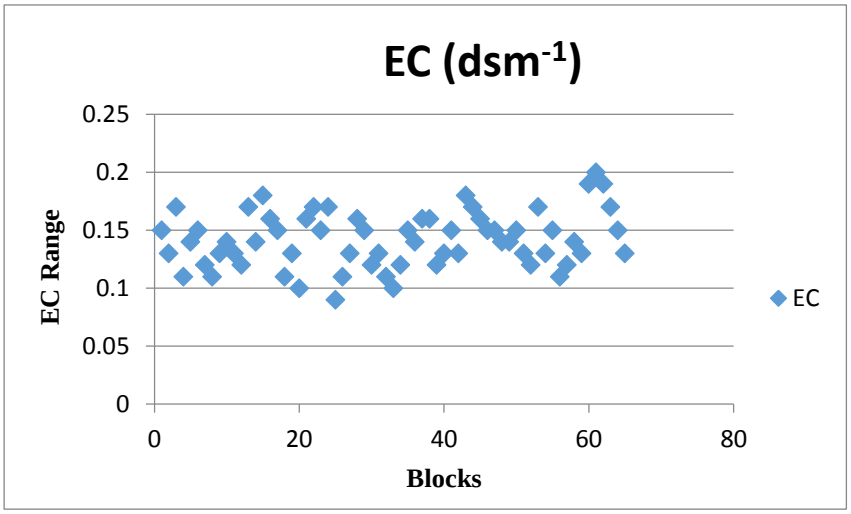

Fig-11: Soil EC of Red lateritic Zone

Organic Carbon (%):

The mean organic carbon content in Red lateritic zone was 0.53%. Highest organic carbin content was found in both Garbeta block of Paschim Midnapore and Kashipur block of Purulia district, indicating an organic carbon content of 0.65%. Lowest organic carbon content was shown by the Narayangarh block and Bankura2 block, which were 0.42%.

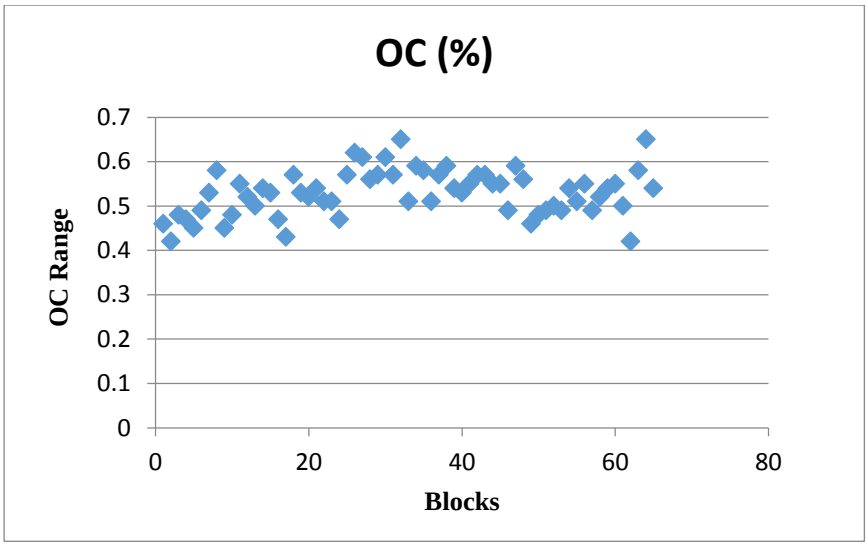

Fig-12: Organic Carbon of Red lateritic Zone

Available nitrogen (kg/ha):

For Red lateritic zone highest Nitrogen content was shown by Shimlapal block of Bankura district which was 259.55 kg/ha. Nitrogen content was low in Bankura2, Jaypur, Rampurhat1 blocks. The mean Nitrogen content in Red lateritic zone was 252.082 kg/ha.

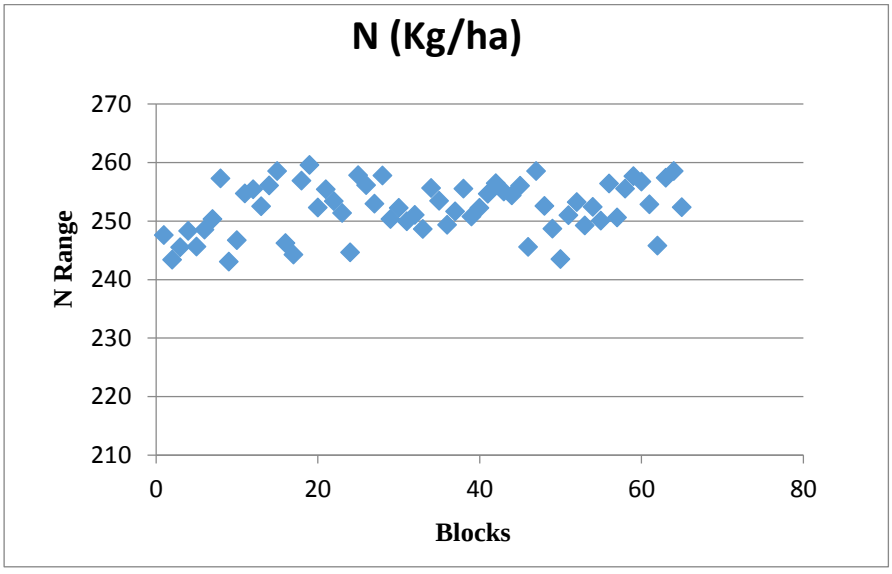

Fig-13: Nitrogen of Red lateritic Zone

Available Phosphorus (kg/ha):

Barjora and Saltora blocks of Bankura have shown highest Phosphorus content in Red lateritic zone, which were 24.2 kg/ha and 24kg/ha respectively. Lowest Phosphorus content was found in Balarampur and Manbazar1 blocks of Purulia district, which was 16.5kg/ha. Mean Phosphorus content of Red lateritic zone was 20.134 kg/ha.

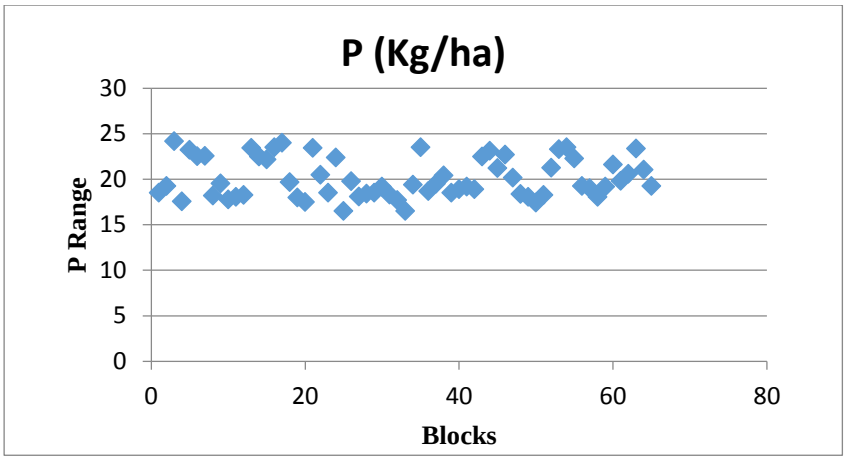

Fig-14: Phosphorous of Red lateritic Zone

Available Potash (kg/ha):

For Red lateritic zone Potash was abundant in all the blocks. Patrasayer block of Bankura district and Labpur block of Birbhum district have shown highest availability of Potash which were 292.15 kg/ha and 292.12 kg/ha respectively. The mean of Potash availability was 258.596 kg/ha.

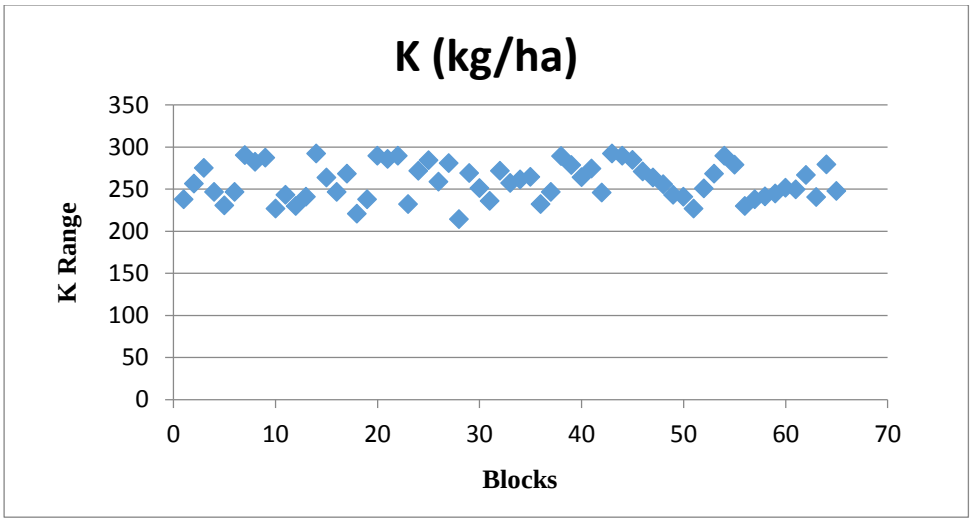

Fig-15: Potash of Red lateritic Zone

Table6: Chemical properties of soil samples collected from Red lateritic Zone of South Bengal

Sample	Blocks	Latitude (N)	Longitude (E)	pH	OC	EC	N	P	K
S1	Bankura 1 (Bankura)	23.253091	87.021226	5.8	0.46	0.15	247.55	18.5	237.89
S2	Bankura 2 (Bankura)	23.267761	87.100317	5.9	0.42	0.13	243.32	19.27	256.35

S3	Barjora (Bankura)	23.436467	87.281246	6.2	0.48	0.17	245.45	24.2	274.97
S4	Chhatna (Bankura)	23.316575	86.974978	5.8	0.47	0.11	248.24	17.56	246.39
S5	Gangajal Ghati (Bankura)	23.425613	87.118577	6.5	0.45	0.14	245.56	23.24	230.5
S6	Hirbandh (Bankura)	23.07028	86.81357	6.6	0.49	0.15	248.46	22.54	246.65
S7	Indpur (Bankura)	23.168941	86.937434	6.2	0.53	0.12	250.27	22.55	290.35
S8	Indus (Bankura)	23.153845	87.007276	5.2	0.58	0.11	257.25	18.2	282.38
S9	Jaypur (Bankura)	23.065439	87.437015	5.7	0.45	0.13	243	19.52	287.04
S10	Khatra 1 (Bankura)	22.974307	86.862306	5.1	0.48	0.14	246.65	17.76	226.6
S11	Kotulpur (Bankura)	23.014953	87.584996	5.7	0.55	0.13	254.65	18.07	243.25
S12	Mejhia (Bankura)	23.560383	87.115007	5.6	0.52	0.12	255.35	18.27	229.67
S13	Onda (Bankura)	23.1517858	87.213059	6.7	0.5	0.17	252.45	23.43	240.65
S14	Patrasayer (Bankura)	23.197399	87.52573	6.6	0.54	0.14	256	22.5	292.15
S15	Raipur 1 (Bankura)	22.798791	86.939954	6	0.53	0.18	258.5	22.18	263.5
S16	Ranibundh (Bankura)	22.869225	86.779952	6.5	0.47	0.16	246.2	23.5	246.65
S17	Saltora (Bankura)	23.525529	86.929929	6.3	0.43	0.15	244.21	24	268.25
S18	Sarenga (Bankura)	22.778979	87.019784	5	0.57	0.11	256.87	19.66	220.54
S19	Simlapal (Bankura)	22.917343	87.075008	5.7	0.53	0.13	259.55	18	237.89
S20	Sonamukhi (Bankura)	23.303221	87.431207	5.2	0.52	0.1	252.26	17.5	289.32
S21	Taldangra (Bankura)	23.019884	87.095385	6.5	0.54	0.16	255.35	23.44	285.55
S22	Bishnupur (Bankura)	23.081088	87.298684	6	0.51	0.17	253.35	20.5	289.32
S23	Arsha (Purulia)	23.329022	86.167002	5.7	0.51	0.15	251.3	18.5	232
S24	Bagmundi (Purulia)	23.200113	86.058266	6.3	0.47	0.17	244.6	22.4	271.5
S25	Balarampur (Purulia)	23.103187	86.210813	5.1	0.57	0.09	257.8	16.5	284.3

S26	Barabazar (Purulia)	23.03506	86.353076	5.9	0.62	0.11	256.1	19.8	258.8
S27	Bundwan (Purulia)	22.876216	86.50415	5.8	0.61	0.13	252.9	18.1	280.8
S28	Hura (Purulia)	23.306216	86.654376	5.3	0.56	0.16	257.7	18.4	214.2
S29	Jaipur (Purulia)	23.418251	86.142669	5.3	0.57	0.15	250.3	18.5	268.8
S30	Jhalda 1 (Purulia)	23.371247	85.995484	5.5	0.61	0.12	252.2	19.2	251.2
S31	Jhalda 2 (Purulia)	23.402441	86.069633	5.6	0.57	0.13	249.9	18.3	235.8
S32	Kashipur (Purulia)	23.430022	86.666923	5.4	0.65	0.11	251	17.7	271.5
S33	Manbazar 1 (Purulia)	23.058884	86.636209	4.9	0.51	0.1	248.6	16.5	257.3
S34	Manbazar 2 (Purulia)	23.057399	86.671483	5.4	0.59	0.12	255.6	19.4	261.3
S35	Neturia (Purulia)	23.663438	86.826429	6	0.58	0.15	253.4	23.5	264.2
S36	Para (Purulia)	23.510203	86.517395	5.7	0.51	0.14	249.3	18.7	232
S37	Puncha (Purulia)	23.164872	86.643564	5.9	0.57	0.16	251.6	19.5	246.6
S38	Purulia 1 (Purulia)	23.257147	87.045113	5.6	0.59	0.16	255.5	20.4	289
S39	Purulia 2 (Purulia)	23.358078	86.355041	5.5	0.54	0.12	250.7	18.5	278.5
S40	Raghunathpur 1 (Purulia)	23.53244	86.66105	5.3	0.53	0.13	252.2	18.9	263.8
S41	Raghunathpur 2 (Purulia)	23.561461	86.686919	5.4	0.55	0.15	254.6	19.2	274.2
S42	Santuri (Purulia)	23.518622	86.863494	5.4	0.57	0.13	256.4	18.9	245.8
S43	Labpur (Birbhum)	23.824727	87.797859	6.2	0.57	0.18	255	22.5	292.12
S44	Dubrajpur (Birbhum)	23.802835	87.36462	6.2	0.55	0.17	254.35	23.14	289.55
S45	Khayrasole (Birbhum)	23.79255	87.25824	6.1	0.55	0.16	255.95	21.22	284.5
S46	Suri1 (Birbhum)	23.903159	87.506943	6.1	0.49	0.15	245.55	22.7	270.7
S47	Mayureswar 1 (Birbhum)	23.993192	87.760283	6	0.59	0.15	258.5	20.18	263.5
S48	MD.Bazar (Birbhum)	23.912796	87.510359	5.7	0.56	0.14	252.55	18.37	255.5

S49	Mayureswar 2 (Birbhum)	23.976933	87.770031	5.6	0.46	0.14	248.65	18.07	243
S50	Rampurhat 1 (Birbhum)	24.183238	87.773621	5.5	0.48	0.15	243.45	17.43	240.65
S51	Rampurhat 2 (Birbhum)	24.141449	87.840 84	5.5	0.49	0.13	250.95	18.26	226.6
S52	Sainthia (Birbhum)	23.938597	87.694681	6.1	0.5	0.12	253.2	21.25	250.54
S53	Bolpur Shriniketan (Birbhum)	23.677231	87.657251	6.2	0.49	0.17	249.21	23.3	268.25
S54	Illambazar (Birbhum)	23.630285	87.550602	6.1	0.54	0.13	252.35	23.5	289.32
S55	Nanoor (Birbhum)	23.712403	87.859899	6	0.51	0.15	250	22.29	278.7
S56	Nalhati 1 (Birbhum)	24.288854	87.849818	5.6	0.55	0.11	256.35	19.27	229.67
S57	Nalhati 2 (Birbhum)	24.294214	87.939392	5.7	0.49	0.12	250.55	19.01	237.89
S58	Murari1 (Birbhum)	24.442122	87.874305	5.4	0.52	0.14	255.5	18.05	241.25
S59	Murari 2 (Birbhum)	24.4388	87.841446	5.5	0.54	0.13	257.64	19.18	244.5
S60	Sabang (Paschim Midnapore)	22.194077	87.601222	6.4	0.55	0.19	256.68	21.63	251.55
S61	Kharagpur 2 (Paschim Midnapore)	22.385713	87.447961	5.5	0.5	0.2	252.8	19.83	249.63
S62	Narayangarh (Paschim Midnapore)	22.148583	87.391072	6.2	0.42	0.19	245.75	20.61	266.5
S63	Binpur (Paschim Midnapore)	22.57921	86.916659	6.2	0.58	0.17	257.35	23.38	240.56
S64	Garbeta (Paschim Midnapore)	22.863479	87.350002	5.9	0.65	0.15	258.5	21.05	279.15
S65	Mohanpur (Paschim Midnapore)	22.567244	88.765209	5.6	0.54	0.13	252.32	19.25	247.65
			MEAN	5.8015	0.5295	0.1418	252.0822	20.13477	258.596
			SD	0.4274	0.0519	0.0239	4.406798	2.165592	21.21505
			CV	7.3667	9.7923	16.854	1.748159	10.75548	8.203935

New alluvial zone

Soil reaction (pH):

For New alluvial zone of West Bengal, the soil was deep, mostly neutral in reaction (pH 6.5-7.5) and fertile. The mean pH of the 33 blocks of new alluvial zone is 7.07. This soil is very fertile as new organic material is deposited during floods that make the soil more fertile and the lowest pH found in the blocks of Howrah district like Domjur, highest in Hooghly like Khanakul, Bagnan Blocks and North-24- Pargona like Bongao, Habra, Bagda blocks. The SD and CV value of this zone is 0.29 and 4.05 respectively.

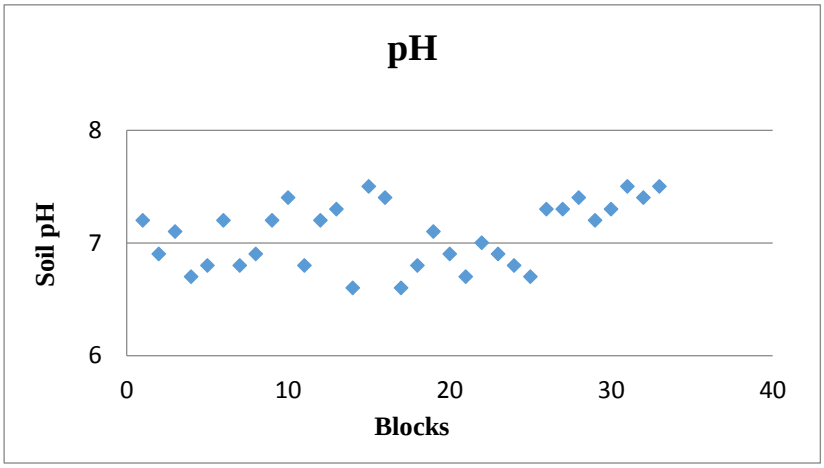

Fig-16: Soil pH of New Alluvial Zone

Electrical Conductivity ($dS.m^{-1}$):

In case of New Alluvial Zone the EC value was normally below 0.25. EC values of all blocks were from 0.15 to 0.27, indicating that salinity is not a problem here. The mean value of EC is 0.21 and SD value is 0.03.

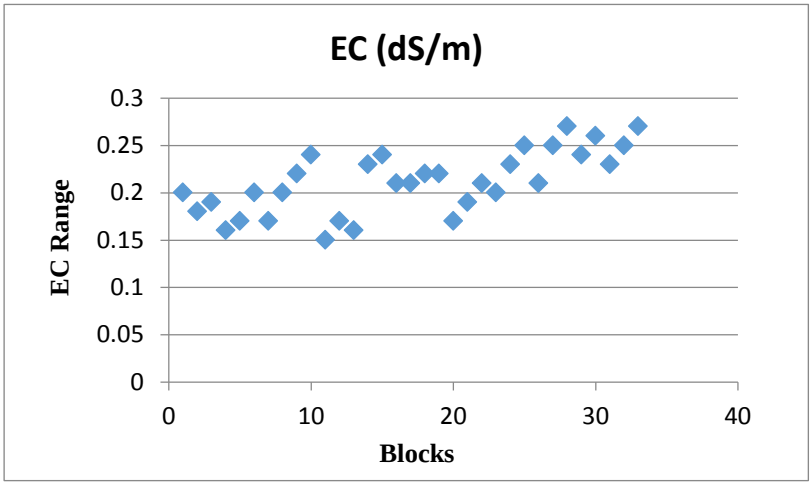

Fig-17: Soil EC of New Alluvial Zone

Organic Carbon (%):

In the case of New alluvial zone organic carbon content was around 0.42 – 0.51 mostly blocks of Hooghly district. In Nadia district the Organic Carbon content was 0.46 to 0.53. In North 24 pargona district the highest organic carbon content was found in the block Bagda (0.45%) and the lowest was 0.41 percent in Bongaon block.

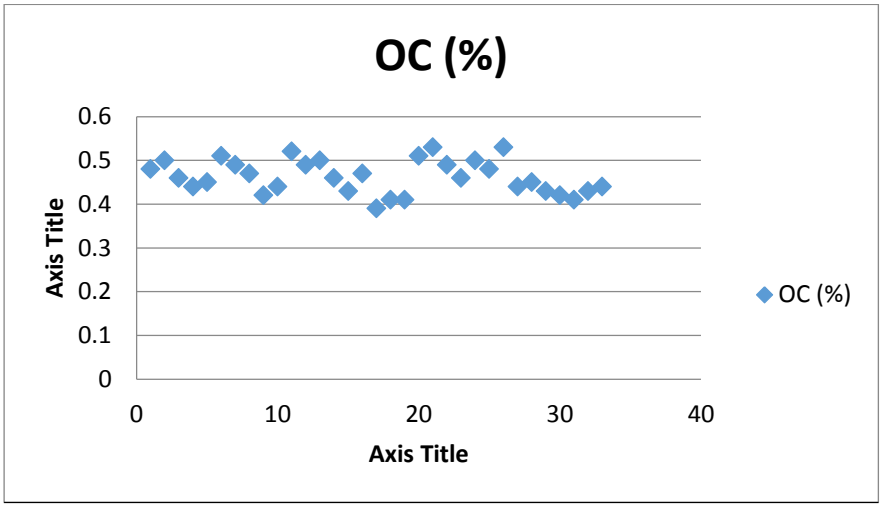

Fig-18: Organic Carbon of New Alluvial Zone

Available Nitrogen (kg/ha):

For the New alluvial zone the Nitrogen content was also low for Howrah district comparatively higher in N-24-Parganas and Hooghly district, nitrogen levels between 235-265 kg/ha. Haripal block from Hooghly and Kaliganj block from Nadia district have showed the highest availability of nitrogen per hectare.

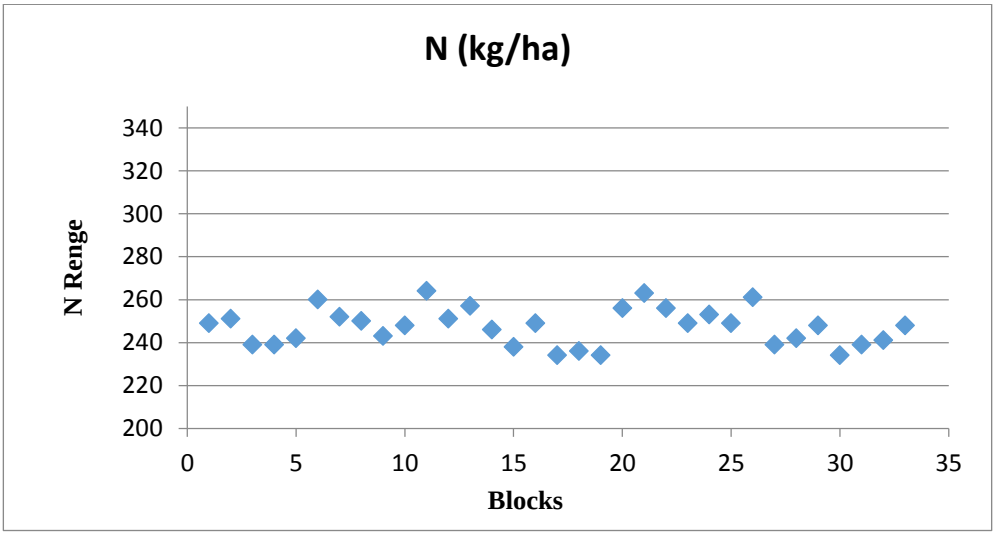

Fig-19: Nitrogen of New Alluvial Zone

Available phosphorus (kg/ha):

In New alluvial zone phosphorus content 15-25 kg/ha in blocks of Hooghly district. In Howrah district the phosphorus content was <20 kg/ha. Phosphorus content in N-24-Parganas district was variable. Ranging from 17 kg/ha in Barasat 1 block to 25kg/ha in Habra 2 block.

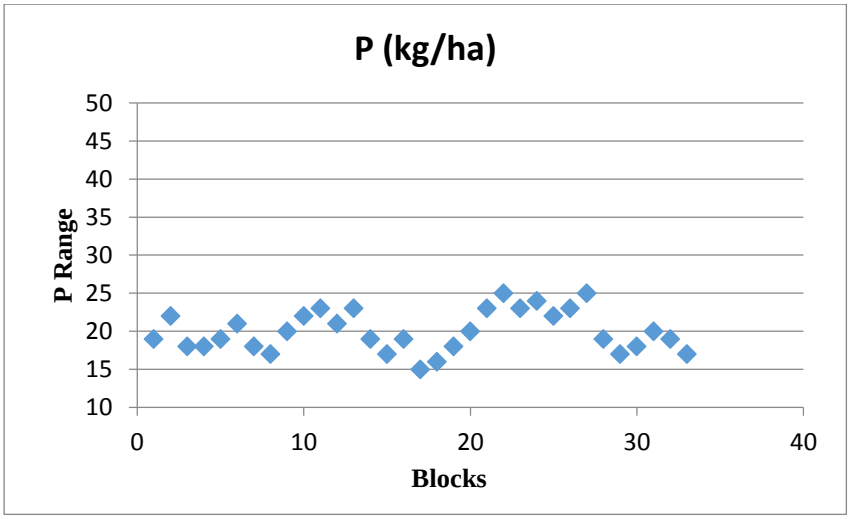

Fig-20: Phosphorous of New Alluvial Zone

Available Potash (kg/ha):

For New alluvial zone potassium content of the soils of Hooghly, Howrah, Nadia, North 24 Pargona district varied from 280-315 kg/ha. Among the highest potassium content Kaliganj block in Nadia district and the lowest potassium content found in Domjur block.

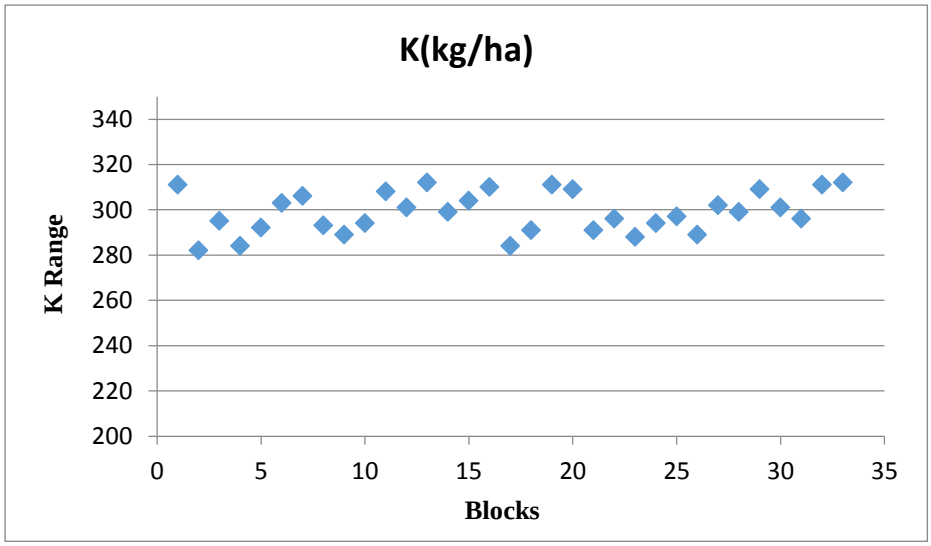

Fig-21: Potash of New Alluvial zone

Table 7: Chemical properties of soil samples collected from New Alluvial Zone of West Bengal

Sl. No.	Block Name (District)	Latitute (N)	Longitude (E)	pH	EC (dS/m)	OC (%)	N (kg/ha)	P (kg/ha)	K(kg/ha)
S1	Jangipara (Hooghly)	22.7065338	88.1343503	7.2	0.2	0.48	255	19	311
S2	Singur (Hooghly)	22.8519817	88.2678891	6.9	0.18	0.5	251	22	306
S3	Pandua (Hooghly)	23.053078	88.335047	7.1	0.19	0.46	239	18	295
S4	Goghat 1 (Hooghly)	23.494198	86.679252	6.7	0.16	0.44	239	18	284
S5	Goghat 2 (Hooghly)	23.874177	87.939283	6.8	0.17	0.45	242	19	292
S6	Haripal (Hooghly)	22.579486	88.215786	7.2	0.2	0.51	262	21	303
S7	Amta 1 (Hooghly)	22.31282	88.265179	6.8	0.17	0.49	252	18	306
S8	Amta 2 (Hooghly)	22.575846	87.932215	6.9	0.2	0.47	250	17	293
S9	Bagnan 1 (Hooghly)	22.668293	86.942311	7.2	0.22	0.42	243	20	289
S10	Bagnan 2 (Hooghly)	22.460055	87.919345	7.4	0.24	0.44	248	22	294
S11	Tarakeswar (Hooghly)	22.835136	87.976192	6.8	0.15	0.52	264	23	308
S12	Pursurah 1 (Hooghly)	22.843923	87.929969	7.2	0.17	0.49	251	21	301
S13	Pursurah 2 (Hooghly)	22.005127	88.268519	7.3	0.16	0.5	257	23	312
S14	Arambagh (Hooghly)	23.088682	86.22142	6.7	0.23	0.46	246	19	299
S15	Khanakul 1 (Hooghly)	22.669647	87.842685	7.5	0.24	0.43	238	17	304
S16	Khanakul 2 (Hooghly)	22.631609	87.816342	7.4	0.21	0.47	249	19	310
S17	Domjur (Howrah)	22.6030901	88.2096023	6.6	0.21	0.39	234	15	280
S18	Sankrail (Howrah)	22.5727346	88.2371755	6.8	0.22	0.41	236	16	291
S19	Udayanarayanpur (Howrah)	22.717983	87.975811	7.1	0.22	0.41	234	18	311
S20	Chakdah (Nadia)	23.005078	88.461445	6.9	0.17	0.51	256	20	309
S21	Kaliganj(Nadia)	23.69105	88.192535	6.7	0.19	0.53	263	23	315
S22	Krishnagar 1 (Nadia)	23.409368	88.424514	7	0.21	0.49	256	25	296

S23	Krishnagar 2 (Nadia)	23.62506	88.349726	6.9	0.2	0.46	249	23	288
S24	Ranaghat 1 (Nadia)	23.159721	88.497559	6.8	0.23	0.5	253	24	294
S25	Ranaghat 2 (Nadia)	23.514023	88.552756	6.7	0.25	0.48	249	22	297
S26	Santipur (Nadia)	23.295007	88.475503	7.3	0.21	0.53	261	23	289
S27	Amdanga (N-24-P)	22.865522	88.523092	7.3	0.25	0.44	239	25	302
S28	Bagda (N-24-P)	23.143493	88.875559	7.4	0.27	0.45	242	19	299
S29	Barasat 1 (N-24-P)	22.724479	88.436272	7.2	0.24	0.43	248	17	309
S30	Barasat 2 (N-24-P)	22.651908	88.541457	7.3	0.26	0.42	234	18	301
S31	Bongaon (N-24-P)	23.047702	88.580019	7.5	0.23	0.41	239	20	296
S32	Habra 1 (N-24-P)	22.789468	88.376214	7.4	0.25	0.43	241	19	311
S33	Habra 2 (N-24-P)	22.845467	88.601688	7.5	0.27	0.44	248	17	312
			SD	0.28644	0.033425	0.038245	8.58514	2.66927	9.082117
			MEAN	7.07273	0.211212	0.462424	247.273	20	298.8788
			CV	4.04986	15.82535	8.27057	3.47193	13.34635	3.038729

Old Alluvial Zone

Soil reaction (pH)

For old alluvial zone of West Bengal, the soil was most neutral in reaction (pH 5.5-7.0). There are some lowland soils in the Raninagar block that range from neutral to mildly acidic (pH 5.5–6.0).

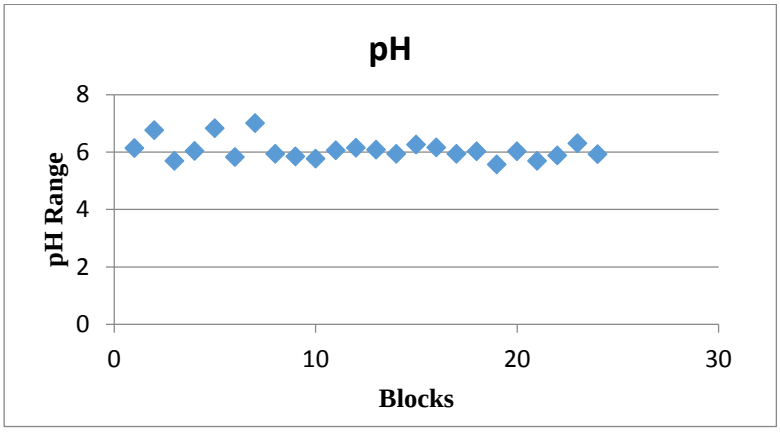

Fig-22: Soil pH of Old Alluvial zone

Electrical Conductivity (ds.m^{-1})

Soil EC is an indicative character of soil health. Actually it is the measure of the amount of salts in the soil. Measuring EC can be an indicative factor for determining amount of available nitrogen is none saline soil. Like pH, soil EC is also affects the activity of soil microorganism which ultimately put a mark in the plant nutrient availability. The EC values of the Old alluvial zones sample were varied from 0.37 to 0.11 ds m^{-1} indicating the soil samples are slightly saline. Some block of Murshidabad soil is where EC value is 0.11 to 0.20.

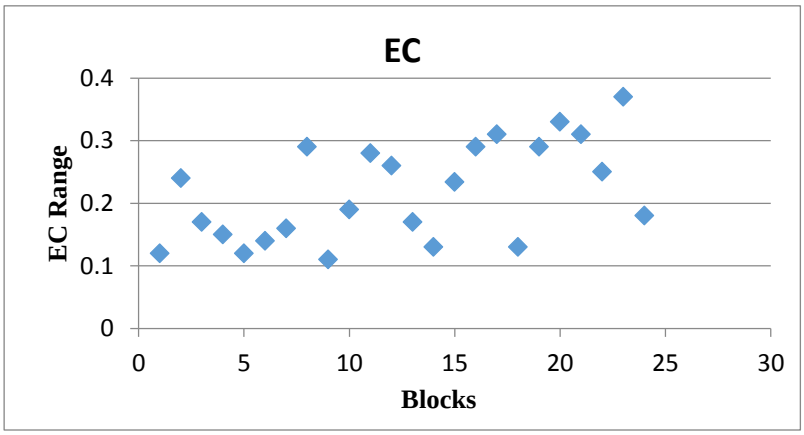

Fig-23: Soil EC of Old Alluvial Zone

Organic Carbon (%):

In the case of Old alluvial zone organic carbon content was around 0.55-0.73 mostly blocks of Murshidabad district. In suti-1 block the highest Organic Carbon was 0.73. In Sagar Dighi blocks the lowest Organic Carbon content was found in the Murshidabad district.

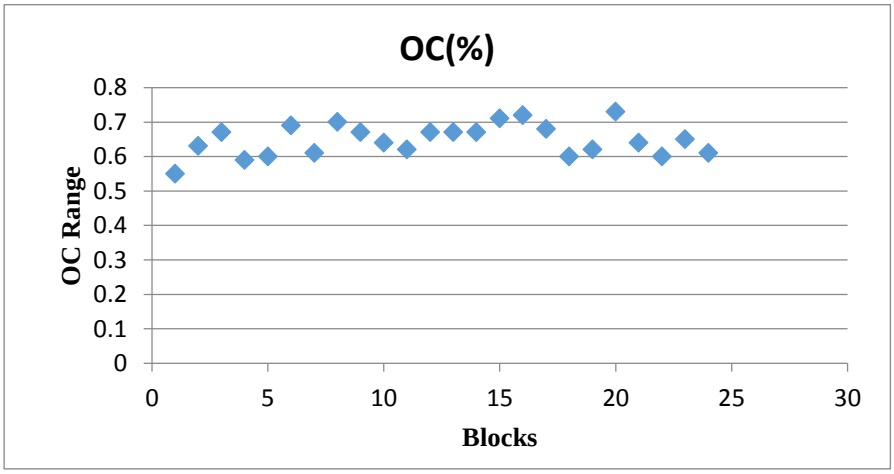

Fig-24: Organic Carbon of Old Alluvial Zone

Available Nitrogen (kg/ha):

For Old alluvial zone the Nitrogen content was low to medium in Murshidabad district. Jiaganj block have showed the highest availability of nitrogen per hectare (431.2) and Nowda block sown lowest availability of nitrogen (201) per hectare.

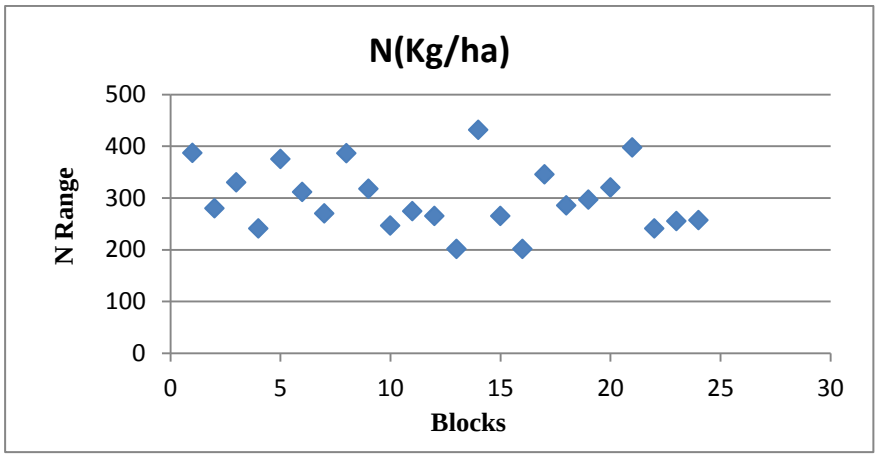

Fig-25: Nitrogen of Old Alluvial Zone

Available Phosphorus (kg/ha):

When compared to blocks in Murshidabad district where phosphorus status is low to medium, the Old Alluvial Zone had Phosphorus levels of 8.93 to 25 kg/ha. Except Suti-1 block where Phosphorus content was almost 27 kg/ ha where available Phosphorus status is High.

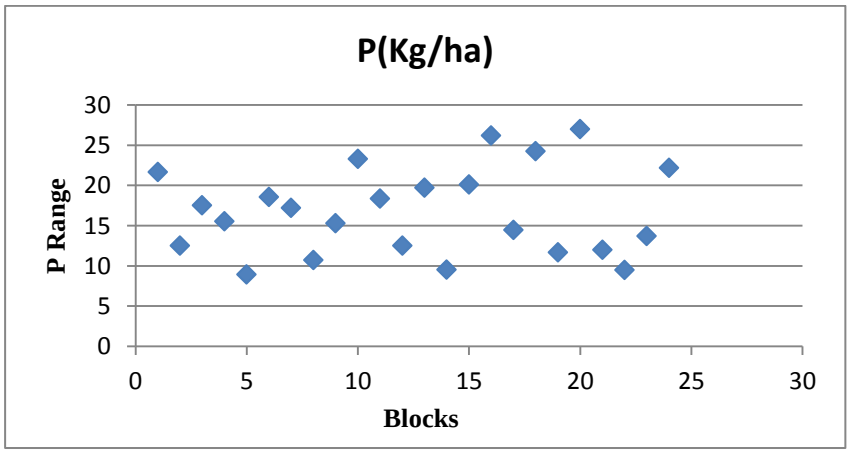

Fig-26: Phosphorous of Old Alluvial Zone

Available Potash (kg/ha):

For old alluvial zone the solubility and mobility of the plant nutrients in the soil are similar in some respect but very in an extent depending on soil minerals plays an important role in building characteristics of plant nutrient in the soil. Though most

mineral soils contain great extent of potassium is in soil minerals become available to the plants very slowly. Potassium does not have too the soil much role in organic matter plant combination like nitrogen. A very small extent of potassium is associated to soil organic matter. For old alluvial zone content of available potassium in soil is low to medium in most of the parts of Murshidabad district.

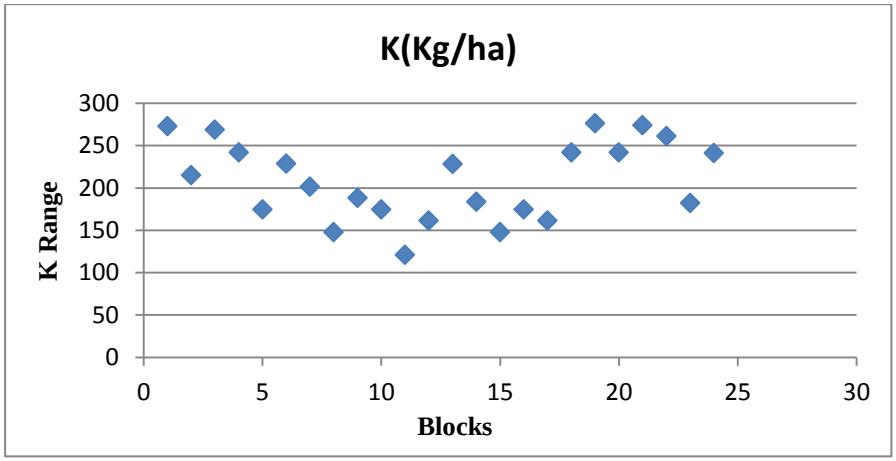

Fig-27: Potash of Old Alluvial Zone

Table 8: Chemical properties of soil collected from Old alluvial zone of West Bengal

Sl. No.	Block Name	Latitude (N)	Longitude (E)	pH	EC	OC (%)	N(Kg/ha)	P(Kg/ha)	K(Kg/ha)
S1	Sagar Dighi	24.2924268,	88.0851909	6.13	0.12	0.55	387	21.67	273.1
S2	Bharatpur	24.8310466,	87.9071229	6.75	0.24	0.63	280	12.53	215
S3	Farakka	24.7797393,	87.9166676	5.68	0.17	0.67	330	17.53	268.8
S4	Samsherganj	24.2063945,	88.2832182	6.03	0.15	0.59	240.8	15.53	241.9
S5	Raghunathganj -1	24.4455963,	88.0133042	6.82	0.12	0.6	375	8.93	174.7
S6	Raghunathganj-2	24.4604455,	88.0995761	5.81	0.14	0.69	311.7	18.55	228.6
S7	Khargram	24.0266978,	87.9849242	7	0.16	0.61	270	17.21	201.6

S8	Kandi	23.9468005,	88.0497145	5.93	0.29	0.7	386	10.73	147.8
S9	Bhagwangola-1	24.2962013,	88.3448997	5.84	0.11	0.67	317.3	15.32	188.2
S10	Bhagwangola-2	24.2771712,	88.3706729	5.76	0.19	0.64	246.4	23.31	174.7
S12	Hariharpara	24.0437012,	88.4234245	6.05	0.28	0.62	274.4	18.35	121
S13	Nabagram	22.2972855,	88.5226886	6.14	0.26	0.67	265.1	12.53	161.3
S14	Nawda	23.8957690,	88.407582	6.07	0.17	0.67	201.6	19.71	228.5
S15	Jiganj	24.2441053,	88.2680172	5.93	0.13	0.67	431.2	9.54	183.7
S16	Jalangi	24.1279467,	88.6904272	6.25	0.234	0.71	265.1	20.1	147.8
S17	Domkal	24.1213899,	88.5445562	6.15	0.29	0.72	201.6	26.2	174.7
S18	Lalgola	24.4133349,	88.2607188	5.93	0.31	0.68	345.4	14.45	161.3
S19	Raninagar-1	24.1544672,	88.493998	6.02	0.13	0.6	285.6	24.26	241.9
S20	Raninagar-2	24.0865576,	88.2525179	5.56	0.29	0.62	296.8	11.68	276.3
S21	Suti-1	24.6183921,	88.0243394	6.02	0.33	0.73	320.2	27	241.98
S22	Suti-2	24.6219381,	88.0056371	5.68	0.31	0.64	397.1	12	273.9
S23	Beldanga-1	23.9255628,	88.234558	5.87	0.25	0.6	240.8	9.5	261.3
S2	Beldanga-	23.88032	88.1931	6.3	0.37	0.6	255	13.7	182.3

4	2	01,	47			5			
S25	Berhumpore	24.098260 7,	88.268411	5.91	0.18	0.61	257.1	22.2	241.1
			SD	0.3552	0.0788	0.046	62.116	5.43039	46.34428
			MEAN	6.13	0.12	0.55	387	21.67	273.1
			CV	5.7948	65.655	8.345	16.051	25.0595	16.96971

Chapter 6: Discussions

6. Discussions

Rational utilization of our "finite" soil resources for sustained productivity needs information on nature and extent of distribution of different kinds of soils of an area, such as problems, potentials, capabilities and their suitability for various uses of the land. All the above information could be available through systematic characterization and classification of soils of an area. Hence, in the present study, 100 samples were studied in four agro climatic zone of south Bengal. These samples are examined systematically for morphological features in the field and horizon wise samples were analyzed in the laboratory for physical-chemical properties. Based on these characters, the soil was evaluated for growing different crops. The results obtained in the present study are discussed below.

Soil reaction (pH):

In agro climatic zone of south Bengal soils, pH ranged from acidic to slightly alkaline. High pH in study samples due to their calcareous nature and the accumulation of bases in the solum as they were poorly leached. The pH was high at surface and then showed decreasing trend with depths. This may be attributed to high base status of these horizons resulting from the recycling of bases. Similar observations were made by Sing et al., 2009 of district Gajipur, UP. Higher pH values were also recorded by Balpande et al., 1996. This increase in soil reaction down the slope could be due to leaching of bases from higher topography and getting deposited at lower elevations (Sitanggang et al., 2006). While the pH in the C horizon was higher, this contributed to the buildup of bases. Similar types of results are reported by Tripathi and Najif et al., 2006. Shilpa et al., 2007 and Sing et al., 2009, also reported the similar type of results in soil UP and MH.

Electrical Conductivity ($dS.m^{-1}$):

The soil surface to lower EC was safe range in south Bengal which indicated the soil pedons were less leached. In agro climatic zone of South Bengal the EC values of the soils ranged from 0.19-0.86 in the soil studied, the EC generally increased with depths. The upper solum was relatively low in salts than in the lower solum. This might be due to leaching of salts from depths due to irrigation and their accumulation in lower depths. Even at the time when irrigation was introduced the distribution of salts showed a concentration of salts in the lower solum (Dasog and Hadimani, 1980) in Malaprabha project area. Similar types of results are reported by Bali et al., 2008 and Ved et al., 2010

in soil of Panjab and UP states. The normal EC may be ascribed to leaching of salts to lower horizons due to the light textured nature of the soil. The average value of EC of the soil was found minimum i.e. 0.19 dS/m in the village and maximum 0.86 dS/m in village. All the soil samples have safe range of EC with respect to crop growth and development.

Organic Carbon (%):

OC content of south Bengal soils ranged from 0.30-0.70 % respectively, which in general accumulated in surface layers. The lower contents of OC apparently resulted because of high temperature which induced rapid rate of organic matter oxidation, while the declining trend towards to accumulation of crop residues every year, without substantial downward movement. Observations in the line with the present findings have been reported in Nazif et al., 2006, showed the majority of the soil sites were medium amount of organic matter. The OC content of surface soil was greater than the sub- surface soils in most of the pedons due to high amount of litter and the crop residues at the surface. In all the pedons, there is a declining tendency in the OC concentration of the soils with depth. Its effects the rapid rate of organic matter mineralization in these soils. Similar results were found by Lathwal, 2006, in the Haryana district of Kurukshetra and Sharma et al., 2008, in the soils of the Amritsar District.

The major proportion of the study was low to medium in organic carbon low organic carbon in the soil is due to low input of FYM and crop residues as well as rapid rate of decomposition due to high temperature. The organic matter degradation and removal taken place at faster rate coupled with low vegetation cover thereby leaving less changes of accumulation of organic matter in the soil. The High temperature and good aeration in the soil increased of oxidation of organic matter resulting reduction of organic carbon content. The high temperature prevailing in the area is responsible for the rapid burning of organic matter, thus resulting in medium organic carbon content of these soils. Similar results were also noted by Sharma et al., 2008, in soil of Amritsar district and Lathwal, 2006, in soil of shshbad & Thaneshwar block.

Available Nitrogen (kg/ha):

The available nitrogen content was low in major portion of the study area which might be due to low organic matter content in this soil. The reason for low content of available nitrogen might be due to the fact that N is lost through various mechanism like ammonium volatilization, nitrification, denitrification, chemical and microbial fixation,

leaching and runoff (Datta and Buresh, 1989) which result in low amount of available N in soil. Only few samples available nitrogen was medium. The variation in N content may be related to soil management, application of FYM and fertilizer to previous crop etc. (Kumar, 2001). The total nitrogen content in the soil is dependent on temperature, rainfall and altitude. Another possible reason may also be due to low organic matter content in these areas due to low rainfall and low vegetation facilities faster degradation and removal of organic matter leading to nitrogen deficiency. The medium nitrogen status was noticed in some area may be due to application of n fertilizer couple with high vegetative cover. Kumar et al., 2009 in Dumka and Lachimpur series, Ashok et al., 2006 in Auriya district of Maharashtra observed a similar trend of nutrient status in study area.

Available Phosphorus (kg/ha):

The available p content was medium in major parts of the village, but it was medium in the soil of coastal zone phosphorus is present in soil as solid phase with varying degree of solubility. When water soluble p is added to the soil, it is converted very quickly to insoluble solid phase by reacting with soil constituents. These may include calcium carbonate, Fe and AI oxides (Deean and Rubi, 1947) and partly organic matter. These reactions affect the availability of P and as a result of these reactions, a very small amount of total P is present in soil solution at any time reflected by soil testing. However, a low to medium range of soil available P under study area may be mostly affected by past fertilization, pH, organic matter content, texture various soil management and agronomic practices (Verma et al., 2005). The present finding are in line with those of Mostara, 2002 who reported that majority of soils in Karnataka and more so in Malprabha command were medium in P conten. Bhoyar et al., 2023 and Kumar et al., 2009 stated that in Dumka and Lachimpur series of Jharkhand were medium in P content.

Available potassium (kg/ha):

The available potassium content in major portion of the study area was under medium to high category of the village. Show medium to higher values due to predominance of K rich micaceous and feldspars minerals in parent material. Smilar results were observed by Varma et al., 2005 in soil of Sardulgarh, Bhikhi and Budhlada blocked Nirawar et al., 2009, in soil of Ahemedpur tahsil of Latur district.

Comparison between different Agro-climatic Zones

The Red Lateritic zone is more acidic than the other three agro-climatic zones of South Bengal, according to the results of chemical analyses of the several agro-climatic zones in that region. Contrarily, the coastal zone is more salinized than the other three agro-climatic zones. From the table-9, we can see that the mean pH value of Red Lateritic zone is lowest, which is 5.8 indicating moderate acidity. Old Alluvial zone has shown a slightly acidic soil having a pH of 6.15, while Costal zone and New Alluvial zone have shown neutral pH indicating mean pH values of 7.2 and 7.07 respectively. Although Costal zone has shown a overall mean neutral pH some blocks such as Ramnagar-1, Kakdwip were slightly alkaline. From the table-9, it is clear that EC of Costal zone is significantly higher than other three Agro-climatic zones. Mean EC of Costal zone is 0.46dsm^{-1}. While Red Lateritic zone, New Alluvial zone and Old Alluvial zone have mean EC of 0.14, 0.21 and 0.18 respectively. Thus among four Agro-climatic zone only Costal zone was salt affected while in other zones salinity were negligible. There was no significant difference in Organic Carbon percentages of different agro-climatic zones. Mean Nitrogen content was highest in Old Alluvial zone (331 kg/ha) except that in other three zones there were no significant difference in Nitrogen content. Phosphorus content was slightly lower in Coastal zone, mean availability of phosphorus was 18.6 kg/ha. Mean Potash content was slightly lower in Red Lateritic zone than other three zones.

Table 9: Soil fertility status of different agro-climatic zone at a glance

Agro- climatic Zones	pH	OC (%)	EC(dS.m^{-1})	N(kg/ha)	P(kg/ha)	K(kg/ha)
Coastal Zone	7.2±0.2	0.6±0.1	0.46±0.1	231±22.3	18.6±3.3	304±36
Red Lateritic Zone	5.8±0.4	0.52±0.05	0.14±0.02	252±4.4	20.1±2.2	258±21
New Alluvial Zone	7.1±0.3	0.5±0.03	0.21±0.04	247.3±8.6	20±2.7	299±9.1
Old Alluvial Zone	6.1±0.3	0.6±0.1	0.18±0.05	331±62	20.2±5.4	284.2±46

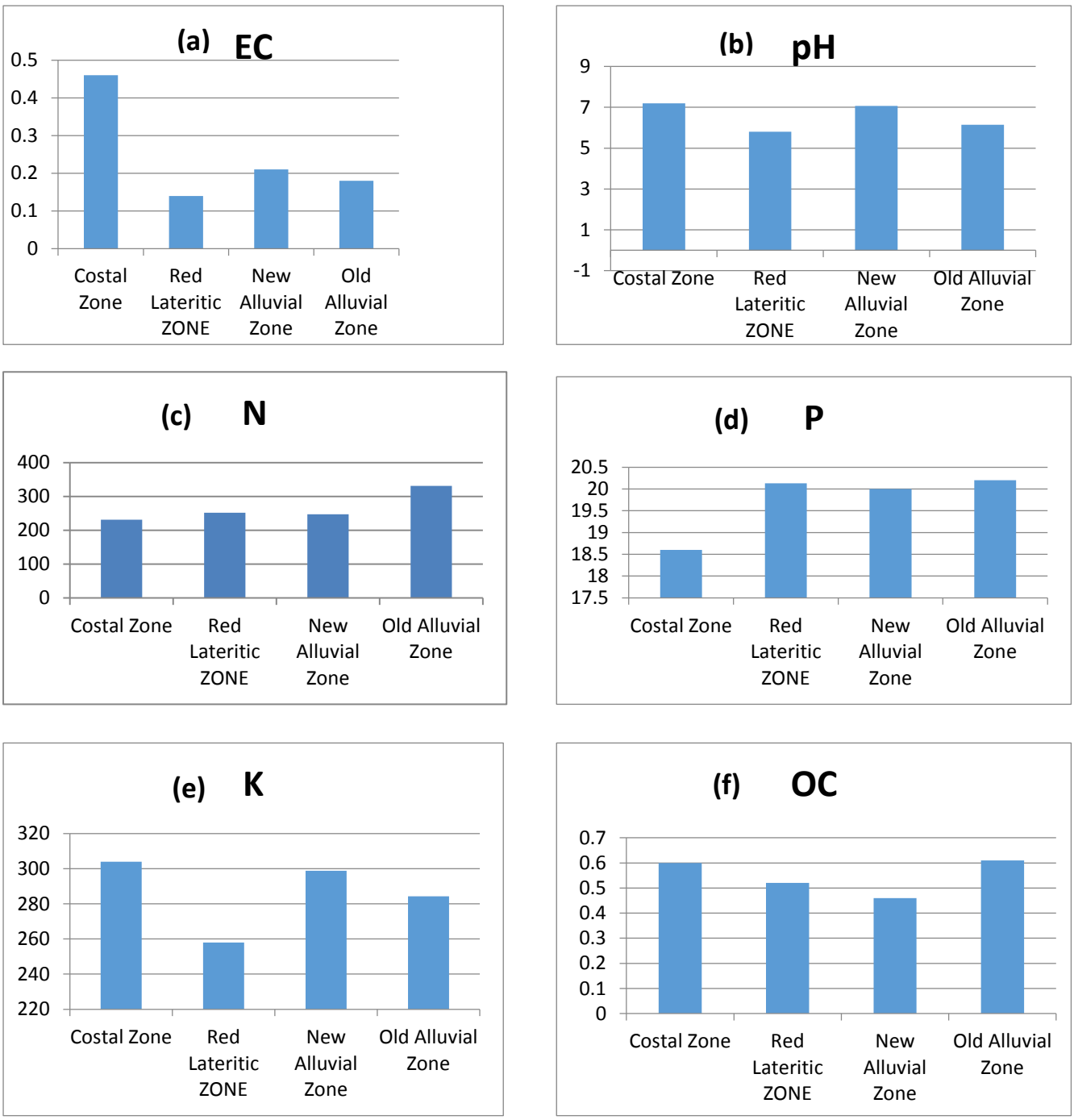

Fig-28: Soil fertility status of different agro-climatic zones (a) EC status of different agro-climate zones, (b) pH status of different agro-climatic zones, (c) N status of different agro-climatic zones, (d) P status of different agro-climatic zone, (e) K status of different agro-climatic zones & (f) OC status of different agro-climatic zones.

Chapter 7: Conclusion

7. Conclusion

From the study of the chemical properties of different agro-climatic zones of south Bengal it can be concluded that the red lateritic zone is more acidic than other three agro-climatic zones of South Bengal. Except that it can also be concluded that coastal zone has a saline soils and salinity is absent in other three agro-climatic zones. Due to presence of acidity in lateritic zone, phosphorus availability is relatively low to the plants in red lateritic zone. The phosphorus unavailability is due to fixation of phosphorus by creating aluminium and iron oxides. Availability of potash is also low as the acidic nature induces the leaching of cations. On the other hand in the costal zones the soil shows salinity. Due to presence of Bay of Bengal from which nearby soil gets excess neutral soluble salt which led to the poor productive soil. Soil pH and EC don't determine the soil's fertility directly, but they control the availability of nutrients to the plants. Thus low pH in Red lateritic zone and high EC in Coastal zone reduce the availability of nutrients to plants and make the soils less fertile than other two agro-climatic zones. Because of these, it is advised for these areas to adopt reclamation techniques such as acid reclamation, salt reclamation, resistant crop types, and considerably greater doses than the actual recommended amount. While lime application in acidic soil of Red Lateritic zone, the amount of lime applied should be according to the strength of acidity. Rice, Tomato, Sweet potato, Watermelon etc. acid loving crops and vegetables can be grown there. Reclamation of salinity on Costal zone may be done by flooding method or by phytoremediation. Besides salt reclamation, cultivation of salt tolerant crops and vegetables like Cereals, Sugar Beet, Turnip is also recommended for Costal zone. Salt tolerant variety of crops like Nona Borka, Nona Swarna for rice would be ideal for this region. While talking about both new alluvial and old alluvial agro-climatic zone, we can conclude that they both have neutral PH and no effect of salinity. All major nutrients N, P, K are available there in sufficient quantity along with organic carbon content. Due to availability of all major nutrients at sufficient amount, intensive cropping can be practiced and fertilizers shouldn't be applied more than recommended dose to avoid fertilizer loss and environmental pollution.

Chapter 8: Future Scope

8. Future Scope

(a) The soil test results so obtained under study can be translated into digital map at village level as well as block level for balanced fertilizer application guide. These guidelines will help to the farmers to obtain the balanced fertilizer doses prescribed for different crops and soils.

(b) Refinement of general recommendations based on soil fertility index of an area as an intermediate approach is to be under taken.

(c) Soil test crop response correlation studies are needed for nitrogen, phosphorous and potassium for rain/dry land crops. Correlation of crops responses to applied nutrients with varying moisture regime is required.

(d) Further studies can be carried out to identify location specific conditions in small unit like villages, blocks etc. i.e. physic-chemical characteristics of soils that modify or promote the nutrients deficiencies.

Chapter 9: Appendix

9. Appendix

Table No.-10: Characterization of soil test values for N,P,K and OC

Parameter	Available N_2(kg/ha)	Available P_2O_5(kg/ha)	Available K_2O(kg/ha)	Organic Carbon (%)
Low	<250	<20	<125	<0.50
Medium	250-500	20-50	125-250	0.50-0.75
High	>500	>50	>250	>0.75

Table No.-11: Characterization of soil test values for pH

pH (1:2 soil water suspension)	Nature of the soil
< 6.5	It is acidic soil
6.5-8.0	Soil is fit for all crops grown in the region and need no treatment.
8.0-9.3	Soil is moderately alkaline and need small amount of amendments or even organic manures like green manuring and FYM.
>9.3	Gypsum requirement of soil sample should be determined and applied according to the requirement of the soil on the hectare basis.

Table no.-12: Characterization of EC

EC of saturation extract (dSm-1 at 25 0C)	Nature of the soil
<2	Salinity effects mostly negligible
2-4	Yield of very sensitive crops may be restricted
4-8	Yield of many crops restricted
8-16	Only tolerant crops yield satisfactorily
>16	Only few tolerant crops yield satisfactorily

Table No. -13: Characterization of soil test values for EC

ECe of saturation extract (dSm-1 at 25 0C)	Nature of the soil
<0.8	Normal
0.8-1.6	Critical for salt sensitive crops

1.6-2.5	Salt tolerant crops can be grown
>2.5	Injurious to all crops

Table No.-14: List of chemicals use

List of chemicals	
Potassium dichromate ($K_2Cr_2O_7$)	Potassium permanganate ($KMnO_4$)
Con Sulfuric acid (H_2SO_4)	Sodium hydroxide (NaOH)
Orthophosphoric acid	Sodium bicarbonate ($NaHCO_3$)
Diphenylamine	Ammonium hydroxide (NH_4OH)
Ferrous ammonium sulphate [Fe $(NH_4)_2(SO_4)_2$]	Acetic acid (CH_3COOH)
Ammonium fluoride (NH_4F)	Potassium chloride (KCl)
Darco G-60 (Activated charcoal)	Hydrochloric acid (HCl)
Ammonium molybdate	Sodium carbonate ($NaCO_3$)
Stannous chloride ($SnCl_2$)	Methyl Red indicator
Ammonium acetate	
Distilled Water	

Table No.-15: List of instruments

Sl. No.	**Name of the instrument**
1	Soil pH meter
2	Lysimeter
3	Field spectrometer
4	Spectroradiometer
5	Auger or Spade
6	Khurpi

7	Core sampler
8	Sampling bag
9	Plastic tray or bucket
10	Colorimeter
11	Flame photometer

Chapter 10: References

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