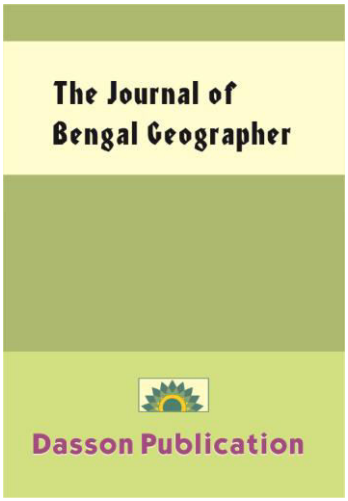
The Journal of Bengal Geographer



Dasson Publication
www.dassonpublication.com

Assessment of soil quality using soil organic carbon and its impact on agriculture productivity in Dakdhin Dinajpur district

Mr.Nibesh Barman
Assistant Teacher
Ektiasal Junior High School

Abstract

Assessment of soil quality is an invaluable tool in determining the sustainability and environmental impact of agricultural ecosystems. Soil carbon plays a key role in maintaining crop productivity in the soils. The study was conducted to assess the soil quality using soil organic carbon and its impact on agriculture productivity in Dakshin Dinajpur District. The soil of the study area is very fertile old alluvial soil. SOC is the main constituent of soil organic matter (SOM).Organic matter impacts on the physical, chemical and biological properties of soils. The amount of carbon in a soil is influenced by the balance between inputs (plant residues) and losses, mainly microbial decomposition and associated mineralization.

Keywords: *1.Soil Quality, 2.Soil organic carbon, 3.Agriculture Productivity, 4.Relation between Soil organic carbon and 5.Agriculture Productivity.*

Introduction

Dakshin Dinajpur district is mainly agro-economic based district. About 90.52% of the district's geographical area is under cultivable land. Agriculture of the district is depended on rainfall mainly SW monsoon. Only 34% of total cultivable area is irrigated. Soil of the study area is mainly highly fertile old alluvial fine loamy soil. Soil reaction are mainly acidic to neutral, ranges P^H 5.2-7,which are slightly effected on agriculture and its productivity.SOC,EC and AVP are also very low.

Soil quality is the capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality and promote plant and animal health and thus has a profound effect on the health and productivity of a given ecosystem and the environment related to it. The soil organic carbon (SOC) is used as a basic indicator in assessing soil quality.The key component of the active soil organic matter (SOM) pool and serves as a source and sink of soil nutrients. It has been used to understand soil nutrient dynamics and as an ecological marker. The SOM is the major determinant and indicator of soil quality and fertility and are closely related to soil productivity in an agricultural ecosystem. The reduction of SOC will lead to a decrease in soil fertility, soil nutrient supply, porosity and an increase in soil erosion.

Study area

The study is enclosed between latitudes 25°10'55″N and 26°35'15″N and longitudes 87°48'37″E to 89°00'30″E, covering an area of 2162 sq.km. It is surrounded on the three sides; north east and south, by Bangladesh, on the west by Uttar Dinajpur and Malda district. It is comprised of 2 subdivisions namely Balurghat and Banshihari. Population of the district is 1670931 as per the census of India 2011.Annual rainfall of the study area 1845.8 mm.

Data base and methodology

The present study is based on primary and secondary data. Primary survey was conducted by field observation and interview method and secondary data has been collected from different sources:-

1. District profile and District Agriculture Contingency Plan, Dakshin Dinajpur.
2. Data of agriculture productivity from West Bengal Marketing Board, W.B.

Some mapping and statistical calculation have been done by using GIS software (Glober mapper v 16.1 and MapInfo professional v 11.0) and MS office Excel 2007.

Results and discussions:

1) Soil quality: Dakshin Dinajpur district is situated in the old alluvial agro-climatic zone of west Bengal. Some parts of the district are also included under red and lateritic zone. The soils are light, medium and heavy in texture, upland being lighter and medium to low lands being heavier. About 83.33% of the study area are under fine loamy soil group and remaining portion are under fine to fine loamy soil (14.89%) and fine loamy to coarse loamy soil (1.78%). The soil are low in nitrogen, phosphorus and potassium(N,P,K).Soil of the study area are acidic to neutral in reaction(P^H ranges 5.2-7) and electric conductivity are low(0.01-1.42 dSm^{-1}).

Table-1
Major soil types of Dakshin Dinajpur District

Major soil	Area ('000 hectare)	% of total geographical
Very deep clay loam soil	54.30	24.50
Deep clay soil	42.90	19.30
Deep loamy soil	29.90	13.50
Sandy soil	26.70	12.00
Sandy loam soil	21.80	9.80

Source: Agriculture contingency plan, Dakshin Dinajpur district

Fig-1: Soil map of Dakshin Dinajpur district

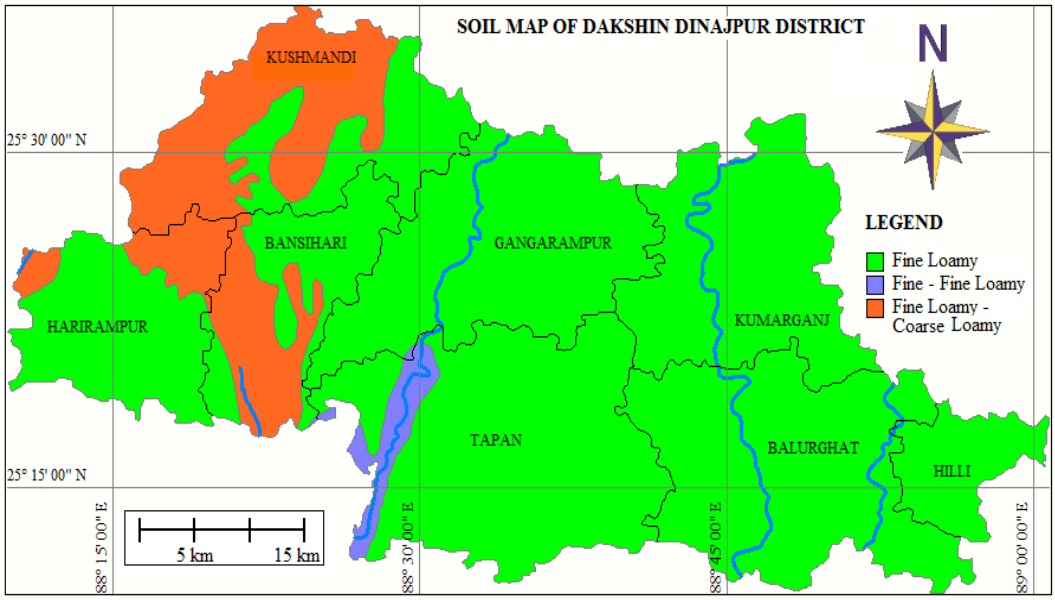


Table-2

Status of soil quality in Dakshin Dinajpur District

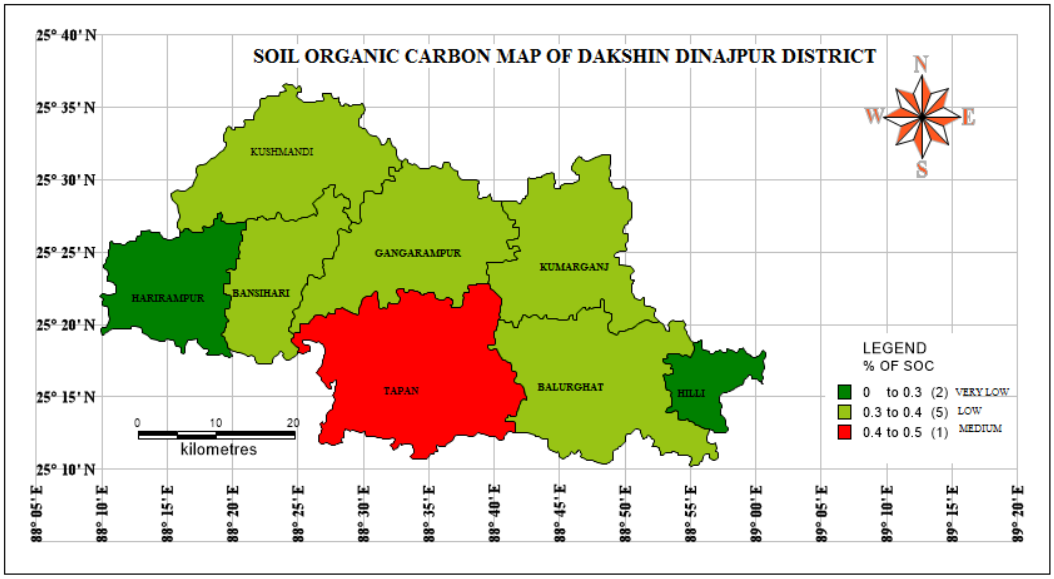
Name of Blocks	Soil P^H	EC(dSm^{-1})	SOC (%)		Mean SOC (%)
			Maxi	Mini	
Kushmandi	4.0-6.2	0.05-0.26	0.02	0.58	0.30
Bansihari	5.5-7.5	0.01-1.42	0.05	0.63	0.34
Harirampur	4.9-6.3	0.02-0.12	0.17	0.39	0.28
Gangarampur	5.5-7.5	0.01-1.42	0.05	0.63	0.34
Kumarganj	5.4-7.5	0.01-1.40	0.05	0.70	0.38
Tapan	5.3-6.7	0.02-6.80	0.05	0.92	0.49
Balurghat	5.5-7.0	0.01-1.40	0.05	0.65	0.35
Hilli	5.5-7.0	0.01-1.40	0.05	0.08	0.07

Source: District profile, Dakshin Dinajpur District

2) Soil organic carbon and soil organic matter: Soil organic carbon (SOC) is the carbon associated with soil organic matter. Soil organic matter is the organic fraction of the soil that is made up of decomposed plant and animal materials as well as microbial organisms, but does not include fresh and un-decomposed plant materials, such as straw and litter, lying on the soil surface. The importance of organic matter in the soil is implied in the definition of soil, which recognizes fertility status of the soil, as a unique feature distinguishing soil from the parent rock / other non-fertile soils. It increases the soil fertility / nutrient status and controls erosion and runoff of the soil and water, besides it is a major determinant of improved soil structure, moisture content and general nutrient status of the soil. The percentage of organic carbon ranged from 0.02 to 0.92 in the study area, indicating variable organic matter content and decomposition rates and the organic matter content varied from 0.12-0.84%. Depending upon the Organic carbon content (%), the quality of soil may be graded as very low, low and medium. In the district around 13.48 %(Harirampur and hilli block) of the area showed very low percent organic carbon (i.e., less than 0.30%). Soils of Balurghat,Kumarganj,Gangarampur,Banshihari and Kushmandi blocks (i.e., 67.09 % of total geographical area) appear to possess low percent organic carbon content(i.e.,0.30-0.40%) and only 19.43% of geographical area (i.e.,Tapan block)have medium soil organic carbon i.e., 0.40-0.50% and it is necessary to apply organic wastes as an important source of nutrient to these agricultural fields.

Fig-2:

Spatial variation of SOC in Dakshin Dinajpur district



3) Estimating soil organic matter and soil organic carbon stock: Estimating soil organic carbon and soil organic carbon stock in various block of the study area by using following equations-

a)Soil organic matter (%) =%organic carbon×1.724 (Allison, 1965)

b) SOC stock (tones C $Sqkm^{-1}$) =Depth (cm) ×Bulk Density (gcm^{-3}) × Carbon Content (%)

Table-3:
Estimating of SOM and SOC stock in Dakshin Dinajpur District

Blocks	SOC (%)	Estimated SOM (%)	Area (Sq km)	Mean bulk Density (gcm^{-3})	Depth(cm)	SOC stock (tones C $Sqkm^{-1}$)
Kusumandi	0.30	0.52	319	1.2	30	34.45
Bansihari	0.34	0.57	198	1.2	30	24.24
Harirampur	0.28	0.48	219	1.2	30	22.08
Gangarampur	0.34	0.57	336	1.2	30	41.13
Kumarganj	0.38	0.66	295	1.2	30	40.36
Tapan	0.49	0.84	439	1.2	30	77.44
Balurghat	0.35	0.60	369	1.2	30	46.49
Hilli	0.07	0.12	86	1.2	30	02.17

Calculated by author

4) Importance of soil organic carbon in agriculture: Soil organic carbon is the basis of sustainable agriculture.Soil organic carbon is the basis of soil fertility .Soil organic carbon is important for all three aspects of soil fertility, namely chemical, physical and biological fertility.

a)Nutrient availability- Decomposition of soil organic matter releases nitrogen, phosphorus and a range of other nutrients for plant growth.

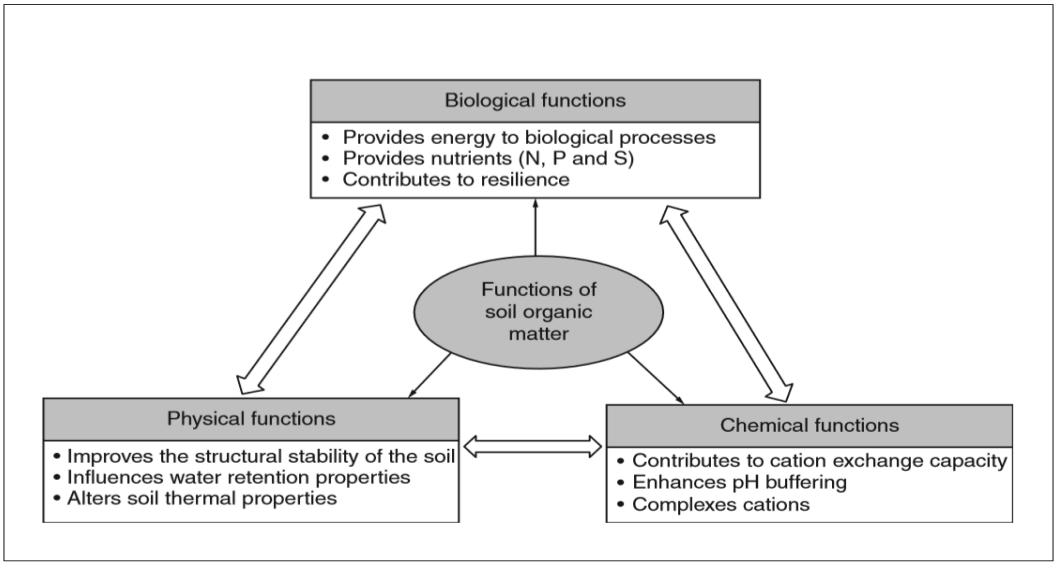
b)Soil structure and soil physical properties- SOC promotes soil structure by holding the soil particles together as stable aggregates improves soil physical properties such as water holding capacity, water infiltration, gaseous exchange, root growth and ease of cultivation.

Soil organic carbon (SOC) is an important parameter affecting soil quality and agriculture sustainability (Guangyu, et al., 2010). Globally crop productivity has generally resulted in the decline of soil organic matter (SOM) and thus decline in soil fertility status (Bot & Benites, 2005). The mean SOC content of the study area was (0.32%), it may be because of low use of local fertilizers like animal manure and dung.

c) Biological soil health- As a food source for soil fauna and flora, soil organic matter plays an important role in the soil food web by controlling the number and types of soil inhabitants which serve important functions such as nutrient cycling and availability, assisting root growth and plant nutrient uptake, creating burrows and even suppressing crop diseases.

Fig-3:

Functions of soil organic matter



Source: Baldock and Skjemstad, 1999.

5) Agriculture productivity: Agricultural productivity is a measure of the amount of agricultural output produced for a given amount of inputs. Agricultural productivity can be defined and measured in a variety of ways, including partial measures, such as the amount of a single output per unit of a single input (e.g., tones of wheat per hectare of land), or in terms of an index of multiple outputs divided by an index of multiple inputs (e.g., the value of all farm outputs divided by the value of all farm inputs).Economy of the study area is mainly agriculture based. Dakshin Dinajpur is one of the major paddy producing districts in West Bengal. The net area and gross area under cultivation is 188580 hectare and 326134 hectare respectively. About 68% of the land is utilized for cultivation of paddy. Except paddy, wheat, jute, mustard, maskalai, musur, potato crop, vegetable also grow there. Agriculture productivity of the principal crop is follows-

Table-4:

Block wise agriculture productivity in the study area

Block	Agriculture productivity (Kg/hectare)						
	Aus rice	Aman	Boro rice	Jute	Wheat	Potato	Mustard
Kushmandi	2111.71	1900.43	1847.03	10.45	2038.09	13506.62	266.56
Bansihari	1660.55	2127.55	2955.13	13.87	2874.10	24756.01	766.02
Harirampur	2115.69	3184.13	3896.77	13.00	3703.56	260929.82	1304.65
Gangarampur	1895.35	2267.63	2967.17	13.38	2130.63	10102.67	763.80
Kumurganj	2086.92	2318.89	2689.87	14.69	1698.57	34805.06	687.66
Tapan	2102.27	2686.34	3169.67	12.94	3099.24	12236.17	487.82
Balurghat	2044.18	2402.40	2842.34	12.15	255.99	27171.94	390.76
Hilli	1875.43	2182.39	2914.53	11.54	1995.43	25315.96	688.28

6) Relationship between soil organic carbon and agriculture productivity: Soil fertility and its nutrient management effect vegetable production, food security and livelihoods (Perveen, et al., 2010). Decline in the soil organic matter content (SOC), will decrease the nutrient value and also the exchangeable bases (Atiku & Noma, 2011).SOC are directly related with crop yeild.Relation between SOC and agriculture productivity are shown with the help of linear regression analysis(Least square method) method,viz....

a) If SOC increases one unit then the average production of Aus rice increases by 397.12 Kg/hectare.

b) If SOC increases one unit then the average production of Aman rice increases 695.66 Kg/ hectare.

c) If SOC increases one unit then the average production of Boro rice increases by 117.66 Kg/ hectare.

d) If SOC increases one unit then the average production of Jute increases by 5.11 Kg/ hectare.

e) If SOC increases one unit then the average production of Wheat increases by 533778.67 Kg/hectare.

f) If SOC increases one unit then the average production of Potato decreases by 109887.28 Kg/ hectare.

g) If SOC increases one unit then the average production of Mustard decreases by 571.34 Kg/ hectare.

Table-5:
Regrassion equation of agriculture productivity on SOC.

Productivity (Kg/hectare)	Regression equation of P on SOC	Co-efficient of determinant(R^2)
Aus	P=1895.93+397.12 SOC	0.08
Aman	P=2161.98+695.66 SOC	0.04
Boro	P=2872.81+117.66 SOC	0.00
Jute	P=11.12+5.11 SOC	0.20
Wheat	P= -129314.41+533778.67 SOC	0.34
Potato	P=86129.60-109887.28 SOC	0.02
Mustard	P=851.56-571.34 SOC	0.05

Calculated by author P=Productivity SOC=soil organic carbon

Conclusion

The agrarian society of the district is generally comparatively lazy. The soil of the district is mostly acidic which causes non-availability of essential plant nutrients to the crop, resulting in higher cost of cultivation. The application of properly developed organic manure is very little. The interest of the farming community to adopt suitable and scientific measures for soil health management is poor.

The area under irrigation is only 34%. The major portion of the annual precipitation (1549.8mm) is during a very short span between 1st week of June and 4th week of September. So agriculture for the remaining months is depended on poor irrigation system.

Small and fragmented landholdings which belongs to 80 percent of marginal (0-1hectare) and small (1-2hectare) farmers are a big hurdle towards the adoption of improved and mechanized farming system. The irrigation potential is not being used properly. The holdings are small and so the farm mechanization is difficult. As the farmers are poor, crop diversification and new tools and implements become difficult. Weak marketing facility leads to exploitation of farmers by the private marketing agents. Poor chains of cold storages where potato and other vegetable products face problem.

References

1) Wiebe, K. Linking Land Quality, Agricultural Productivity, and Food Security. Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Agricultural Economic Report No. 823.

2) Wang, Z.M., Zhang, B., Song, K.S., Liu, D.W., Li, F., Guo, Z.X. and Zhang, S.M. Soil organic carbon under different landscape attributes in croplands of Northeast China. Northeast Institute of Geography and Agricultural Ecology, Chinese Academy of Sciences, Changchun, P.R. China.

3) Adeboye, M. K. A., Bala, A., Osunde. A.O., Uzoma, A. O., Odofin, A. J., and Lawal, B.A. (2011). Assessment of soil quality using soil organic carbon and total nitrogen and microbial properties in tropical agro ecosystems. Agricultural Sciences, Vol.2, No.1, 2011, pp.34-40.

4) Ravikumar, P.and Somashekar, R. K. (2013). Evaluation of nutrient index using organic carbon, available P and available K concentrations as a measure of soil fertility in Varahi River basin, India. Proceedings of the International Academy of Ecology and Environmental Sciences, 2013, 3(4).pp. 330-343.

5) Emeterio, I.J and Garcia V. P. (1992). Relationships between Organic Carbon and Total Organic Matter in Municipal Solid Wastes and City Refuse Composts. Bio resource Technology 41 (1992).pp. 265-272.

6) Bationo, A., Waswa, B.S. and Kihara, J. Soil Carbon and Agricultural Productivity: Perspectives from Sub-Saharan Africa. CAB International 2015. Soil Carbon: Science, Management and Policy.

7) Chan, Y. (2008). Increasing soil organic carbon of agricultural land. Primefacts 735, January, 2008.

8)Ishaq,S.,Begum,F.,Ali,K.,Ahmed,S.,Ali,S.,Ali,H.,Baig,S.S.,Khan,M.Z and Ali,S(2015).Soil quality assessment using selected physico-chemical indicators in Altit Hunza, Gilgit, and Baltistan. Journal of Biodiversity & Environmental Sciences (JBES), vol.6, No 1, pp.454-459.

9) Stine, M.A and Weil, R.R. The relationship between soil quality and crop productivity across three tillage systems in south central Honduras. American journal of Alternative Agriculture.