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ANALYSIS OF SOIL TEXTURAL CHARACTERISTICS FOR MANGO CULTIVATION IN MALDA DISTRICT, EASTERN INDIA

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Abstract: Malda is very famous for mango (Mangifera indica L.) production based on suitable conditions of soil. Mango has long been a major agricultural product in the district. In this paper, analysis has been made on suitable soil condition sustaining mango productivity based on soil textural analysis by sieve method and secondary data. (Comprehensive District Agricultural Plan (C-DAP) -Malda prepared by NABCONS- XIth Plan Period). Soil textural analysis for cultivation of mango has been computed between block wise mango productivity and different soils. The soil type of the district is predominantly sandy (9225 ha.), sandy loam (21430 ha), loam (8013 ha.), sandy clay loam (38780 ha), clay loam (14500ha.) and clay (71563ha) (NBSS-LUP). Three physiographic regions can be identified in the Malda District: Barind, Diara and Tal. The Barind soil of this tract is red in colour implying old alluvium formation. It is composed of still clay containing iron. The soil in this tract is mostly acidic and micro-nutrient deficient. These soils, therefore, result into low to medium mango productivity in the district. In the Diara Region, the soil is sandy clay loam called do-ash. This region is most fertile part of the district, possessing higher to medium mango productivity. The soil of Tal region is old alluvium with shallow black colour and the mango productivity of this region is medium to higher productivity. For this purpose, sample villages (Mouza) were selected from different physiographic as well as different soil suitability for mango cultivation an intensive field-based study. Block wise grid-based soil samples from Mango orchard fields have been collected and analyzed in the laboratory for extracting soil parameter mainly in soil texture. The final part of the paper deals with correlation between soil texture and mango production in this district. The results show that the area for mango cultivation can be turned into highly productive zone through integrated nutrient management practices including leguminous intercrops or cover crops.

Key Words: Mango, Soil Texture, Physiographic region, Mango Productivity, Suitable, correlation.

1. Introduction:

The mango (Mangifera indica L.) makes up a significant horticultural blessing of Malda. This district in West Bengal is historically known for mango cultivation, especially varieties like Fazli, Langra, and Himsagar. The king of fruits of mango is a major agricultural produce of Malda district. The soil quality plays a key role in the productivity and health of mango orchards. The mango orchard was established here before 400 years (Mukherjee,1967). This analysis focuses on evaluating the soil properties and their suitability for mango cultivation in the district. Soil textural characteristics determine the inherent potential of the soil and constraints for crop production information about different soil properties (Sys et al., 1991). Soil textural characteristics of

Malda District consist of alluvium deposited by the rivers viz., the Ganga, the Mahananda, the Tangon and the Kalindri, the dominance being of the Ganga and the Mahananda Rivers. In the eastern part of the district the influences of the Tangon and the Punarbhaba rivers are more pronounced. The rivers flowing north and south roughly divide the district into two equal parts, corresponding to the local tradition of the old boundary line of the Rahr and Barendra. The part of the Malda District to the east of the Mahananda River is locally called the Barind Region (Sengupta, 1969). It is characterized by relatively highlands dominated by red clay soils of the old alluvium. In this district, soils are neutral in nature and characterized by low to medium fertility status and thus needs recommended doses of balanced fertilizer in addition to assured irrigation for sustained increase in agricultural production. This shows that the texture of Malda District is having great potential for a variety of crops and horticultural practices especially mango cultivation. Therefore, its chemical and physical characteristics are crucial for both production and the healthy growth of mango plants in this district. The fertility quality of soil has a positive correlation with its capacity to sustain plant development and productivity. The characteristics of the soil have a major role in determining the farming system and cropping pattern of any given area. As a result, the soils give crops mechanical anchoring, suitable tilth, and a reservoir of water and nutrients. In this study area mangoes can be grown in a variety of soil types, however only a select set of soil types can be used for economic cultivation. It needs loamy soils that are deep and well-drained for optimal performance (Singh, 1967). It can be grown from alluvial to lateritic soils including red soils, medium black soils and deep red loam (Pandey & Dinesh, 2010). Its favors somewhat acidic soil, just like the majority of other fruit crops. It doesn't work well on soils with a pH higher than 7.5. Profitable mango farming is not possible in sandy, clay, alkaline, or black cotton soils. Nonetheless, the productivity of large-scale mango cultivation is significantly impacted by the soil characteristics of the Malda District. This study of Mango cultivation analysis is based on soil textural characteristics. The main objective of this paper is to ascertain the spatial distribution of soil texture in the district. The nature of soil texture relationship between block-wise mango production. Finally, analysis, soil textural maps have been systematically prepared in order to look into the spatial variation of the soil characteristics as well as the subsequent mango cultivation. In this district mango cultivation is grown in 26400 hectares and total mango production in 325000 metric tons. Total manpower involved is 425000 and the average size of mango orchard is 0.23 hectare (District Statistical Handbook-2014). Fifteen Blocks in Malda District out of which ten major blocks display medium to high Mango productivity and other five blocks low productivity of mango.

2. Location of the Study Area:

The district of Malda is located in the Indian state of West Bengal. Situated at a distance of about 330km from the state capital of Kolkata, the district lies between the latitudes 24˚40′20″ N to 25˚32′08″ N and longitudes 87˚45′50″ E to 88˚28′10″ E, encompassing a total area of about 3733 km^2 (Census of India, 2011). The district is bounded to the south, north and north-east by those of Murshidabad, Uttar Dinajpur and Dakshin Dinajpur, respectively in the state of West Bengal (Fig.1. A). To the east, it shares an international boundary with Bangladesh, whereas the Indian states of Bihar and Jharkhand lie to the west and southwest, respectively.

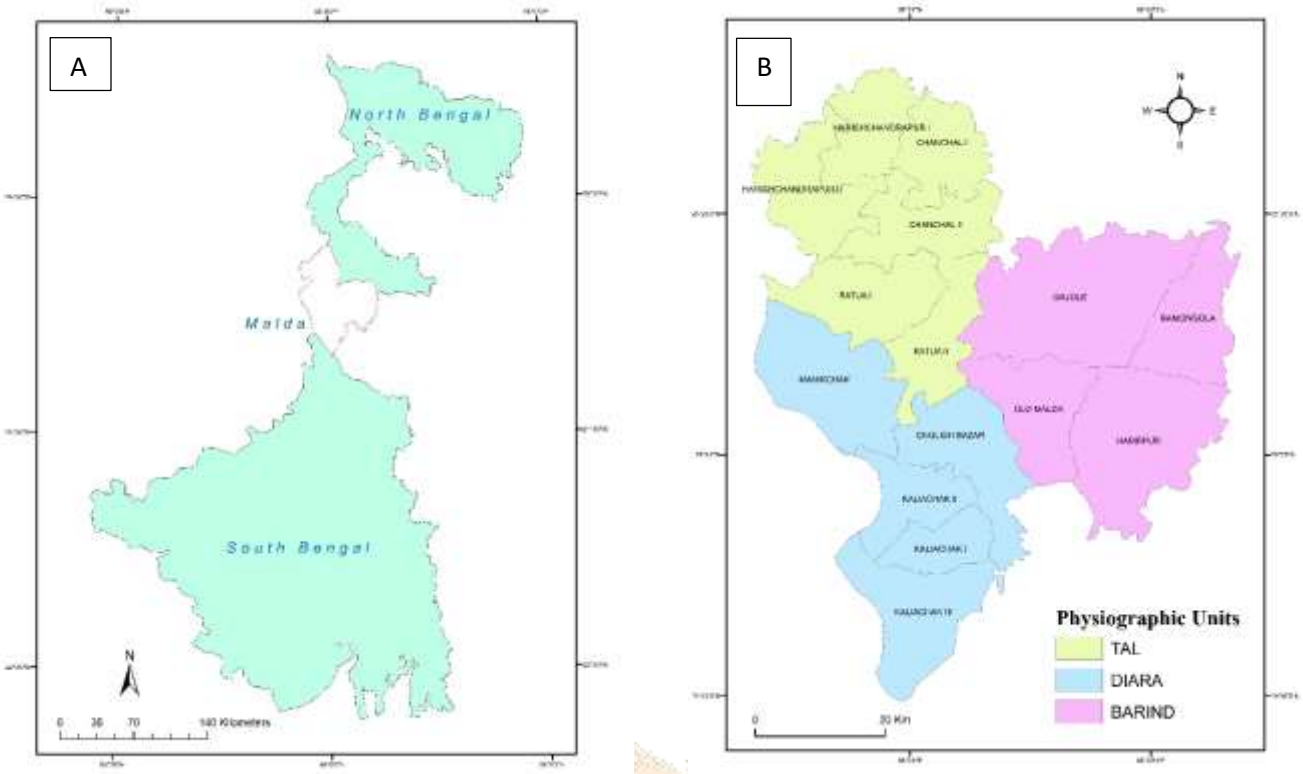


Fig-1: Location of the Study Area: A) West Bengal B) physiographic Units of Malda

The district was formed with an outlying portion of the erstwhile pre-Independence Purnea and Dinajpur districts in 1813, though it did not formally become an independent administrative unit till 1859 (Sengupta, 1969). Three major physiographic units locally called Tal, Barind and Diara (Fig.1.B) comprise this district. The entire district is divided into fifteen Community Development (CD) Blocks, which are Harishchandrapur-1, Harishchandrapur-II, Chanchal- I, Chanchal- II, Ratua- I, Ratua-II, Gazole, Bamongola, Habibpur, Old Malda, English Bazar, Manikchak, Kaliachak-I, Kaliachak-II and Kaliachak, III. In Malda district, agriculture is the most prominent economic activity, and the region is particularly well known for its mango production. In this district, mango production is a significant agricultural activity, with the district being renowned for its high-quality mangoes, including varieties like Himsagar, Langra, Lakkhanbhog, and Fazli. Annually, Malda produces approximately 3.5 lakh metric tonnes of mangoes, cultivated across about 31,650 hectares of land (District Statistical Handbook 2014).

3. Data Base and Methodology:

The study has used the available data and information from primary and secondary sources. The relevant data and information have been collected from research journals, articles, books, Agricultural Development Office (ADO), Land and Land Revenue Office, Horticulture Office, District Soil Conservation Office, National Bureau of Soil Survey (NBSS-LUP). The data on mango productivity were gathered from Deputy Director of Agriculture (Fruits), Malda. The data on block wise soil texture were collected from the final report entitled Comprehensive District Agricultural Plan (C-DAP). The next part analyzed concentrate on the real-world scenario as observed in the field. For this purpose, sample villages (Mouza) were selected from different physiographic as well as different soil suitability for mango cultivation. In this research analysis with the help of an intensive field-based study. Block wise grid-based soil samples from agricultural fields has been collected and analyzed the results in the laboratory for extracting various soil texture parameters such as sand, silt and clay. The soil texture database was processed in a GIS platform (ArcGIS 10.3) and individual soil texture characteristics map were generated by using the Inverse Distance Weightage (IDW) algorithm in the Spatial Analyst Toolbox in a GIS platform. Finally, the spatial distribution map has also been prepared to depict the block wise variation in

mango productivity. To investigate the nature of the relationship between the variables of mango productivity and soil texture, as well as between mango productivity, the correlation coefficient (r) has been computed.

4. Result and Discussion:

Soil texture plays a crucial role in the successful cultivation of mango (Mangifera indica), as it directly affects water retention, drainage, root development, and nutrient availability. In the district of Malda, soil textural classes are classified in terms of the content and percentage of sand, silt and clay (Table-1). The sub-groups of soil characteristics belong to sandy, coarse loamy, fine loamy and fine textural groups.

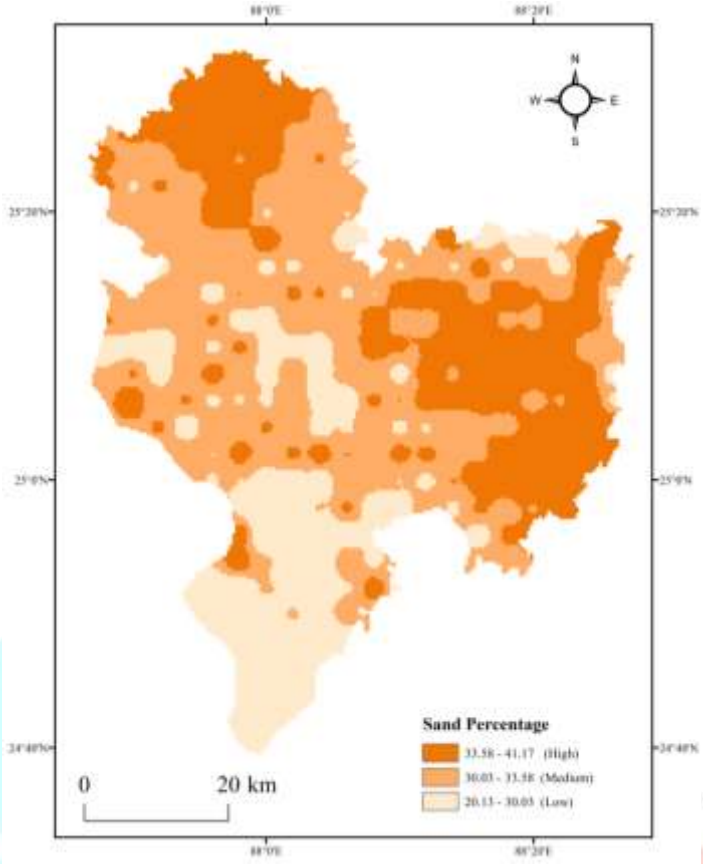
Table:1: Soil textural Characteristics and their representative proportion in Malda district

Light		Medium		Heavy	
Sandy (ha)	**Sandy loam (ha)**	**Loam(ha)**	**Sandy clay loam (ha)**	**Clay loam(ha)**	**Clay(ha)**
11988	23875	73222	38780	60572	71563

Sources: Comprehensive District Agricultural Plan (C-DAP)-2014

4.1.Sandy soils texture Characteristics in Malda District:

The study indicates that the percentage of sand is predominantly high in the eastern and some part of the northern section of Malda District. The concentration of sand appears to be high in Bamongola, Habibpur and Gazole Blocks in the Barind Region (eastern part) and Harishchandrapur-I Block in the Tal Region (northern part). The Kaliachack-I Block in the Diara Region is identified as the block with relatively lower concentration of sand (Fig.2). In the Barind Region comprises the Moribund (inactive) deltaic part dominated by older alluvium whereas the Diara Region of the south encompasses the active deltaic part with newer alluvial deposits (Bagchi, 1944). This explains the spatial variation in the concentration of sand in Barind and Diara Regions. The high concentration of sand in the blocks of the Barind Region make it unsuitable for mango production. In this district, northern part of Sandy soils drains water quickly pass, which is beneficial for mango trees as they don't like waterlogged conditions. Mango roots benefit from well-aerated soil, which sandy soil provides, helping in better root development. Sandy soils can support healthy mango growth if properly managed. Enhancing the organic content and ensuring balanced nutrition are key to successful cultivation in such soils.



Fig;2 Malda District: Spatial Variation in the percentage of sand

4.2.Silt soils texture Characteristics in Malda District:

The silt group includes soils with at least 80% silt and 12 % or less clay. In this district, the silt clay loam textural classes occupy about 37.8% area. Fig-3 displays the spatial variation in the proportion of silt in the studied district. It is evident that the Diara Region of the southern part comprising the blocks of Kaliachak I, II and III are dominated by higher proportion of silt (> 60%). On the other hand, in the Barind Region of the east, the silt proportion appears to be relatively lesser. Silty soils are generally more fertile than sandy soils, providing good nutrient availability for mango trees. Silt soils can become compacted, reducing root aeration and affecting tree health. In this district's Diara Region, there are wide mango orchards with a higher percentage of silt concentration in soil texture parameters.

4.3.Clayey soils Characteristics in Malda District:

The proportion of the clay in the district and its spatial variation is shown Fig-4. It is clear that the proportion is significantly higher in the southern Diara Region with the blocks of Manikchak, Kaliachak I, II and III displaying greater clay content. These are also the areas which are actively drained by the rivers the Ganga, Mahananda and Kalindri. This explains the clay rich nature of the soils of these areas. In the eastern Barind Region occupied by older alluvial tracts, the proportion of clay decreases. This is the expected outcome since these areas had shown relatively higher concentration of sand. Clay particles hold nutrients well, providing mango trees with a steady supply of essential minerals (like potassium, calcium, magnesium). In this district dense clay soils provide good support for mango tree roots, helping the tree stay upright in windy conditions.

According to the results in the Malda District, soil textural characteristics belong to sandy, coarse-loamy, fine loamy and fine textural groups. Sandy soil comprises loamy sands texture covering 1.5 % area, coarse – loamy soils with sandy loam, loam and silt loam textural class covering 14.5% area, while fine loamy soils, with sandy clay loam, clay loam and silt clay loam textural classes occupy 37.8% area. Sandy clay, Silt clay and

clayey soils are classified as fine soils which constituted 37.1% are in the district. Preferred Soil Texture for Mango Cultivation loamy soils ideal balance of sand, silt, and clay; retains nutrients and moisture while allowing drainage. Sandy loam soils is excellent drainage and root penetration, preferred for commercial mango orchards in Malda.

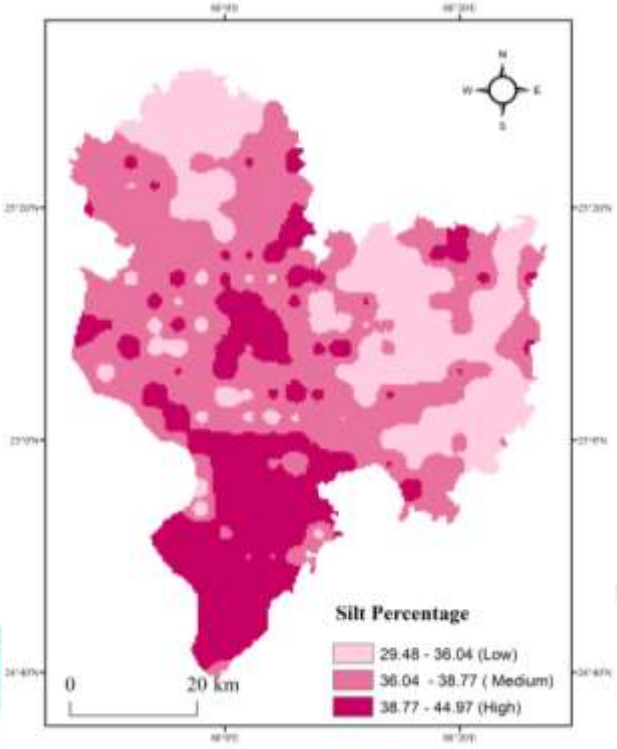


Fig-3 Spatial variation in the proportion of silt in Malda District

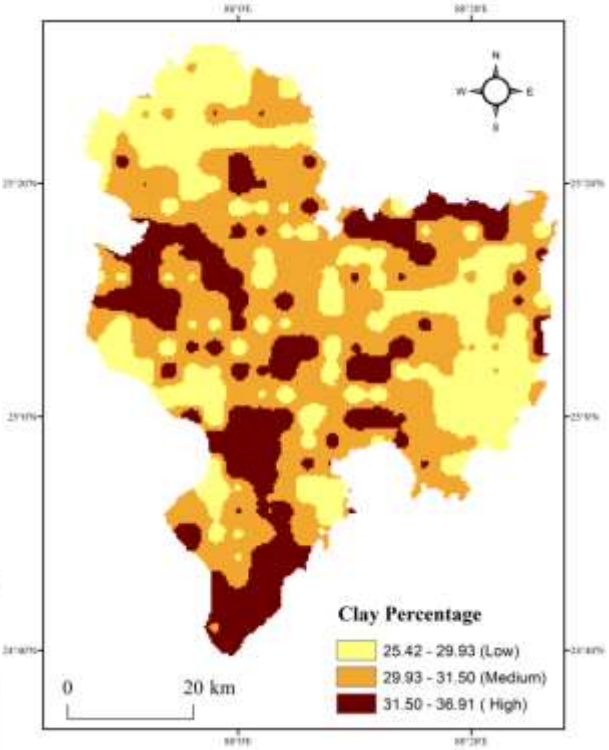


Fig-4: Malda District: Spatial variation in the percentage of clay.

5. Spatial Variation of Mango Productivity in Malda District:

Malda is known as “The Valley of Mango”. The map reveals a significant geographical variation in productivity, despite the fact that mangoes are grown all throughout the region (Fig.5). Three blocks, or 20% of the district, have low productivity. However, 20% of the neighborhood's blocks are extremely productive. The production of the other nine blocks is mediocre. The two blocks with the lowest productivity, Bamongola and Habibpur, are located in the Barind region (Fig.5) whereas Harishchandrapur-I and Ratua-II is found in the Tal region, while Englishbazar and Kaliachak-II, the two blocks with the highest mango productivity, are found in the Diara region. High quality and quantity mango mainly Fazli is grown here. Mango is an important fruit which plays vital role in the economy of Malda. Varieties of mango in Malda district are- Fazli, Langra, Golapbhog, Amrapali Aswina, Brindabani, Saranga, Bensen, Kshirshapati, Laxmanbhog, Kalapahar, Kishanbhog, Dilkush, Madhuchushki, Chatterjee Mulamjam, Mohan Thakur, Mohanbhog and Ranipsand etc (Fig.6).

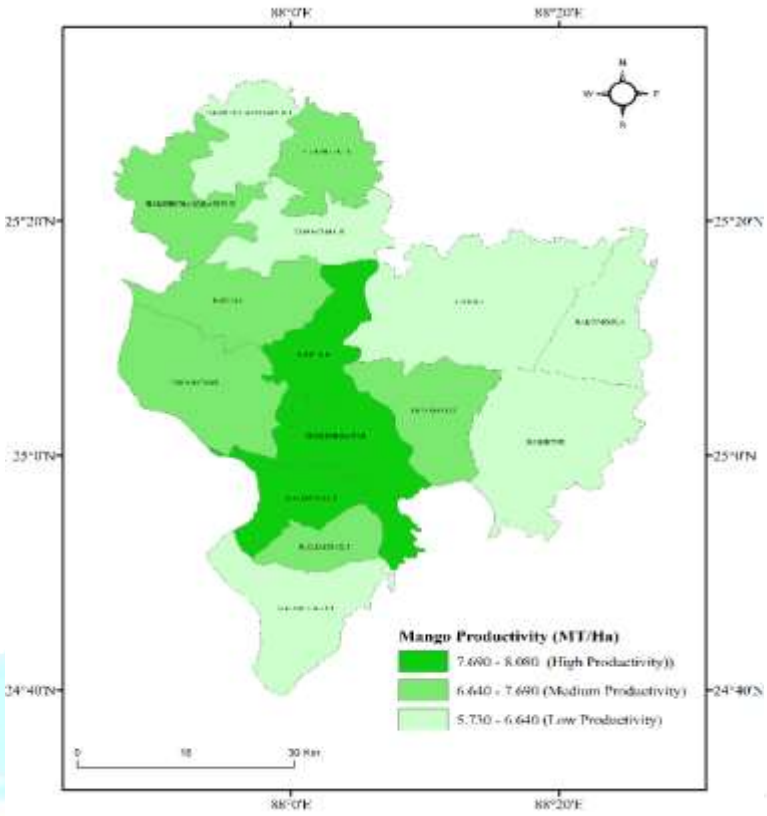


Fig:5: Mango Productivity (2018-2019) in Malda

Fig:6 Some Selected special Mongo sample in Malda

(Sources: ICAR-Central Institute for Subtropical Horticulture, Regional Research Sation, English Bazar, Malda.)

6. Relation between soil textural characteristics and Mango productivity in Malda District:

A correlation coefficient (r) has been calculated between the quantity of soil texture (ha) and block-wise mango productivity (MT/ha). According to the study, there is a very low positive correlation between mango productivity and clay and clay loam soil. In other words, both the amount of clay and clay loam soils had a statistically very low positive impact on the variable mango productivity.

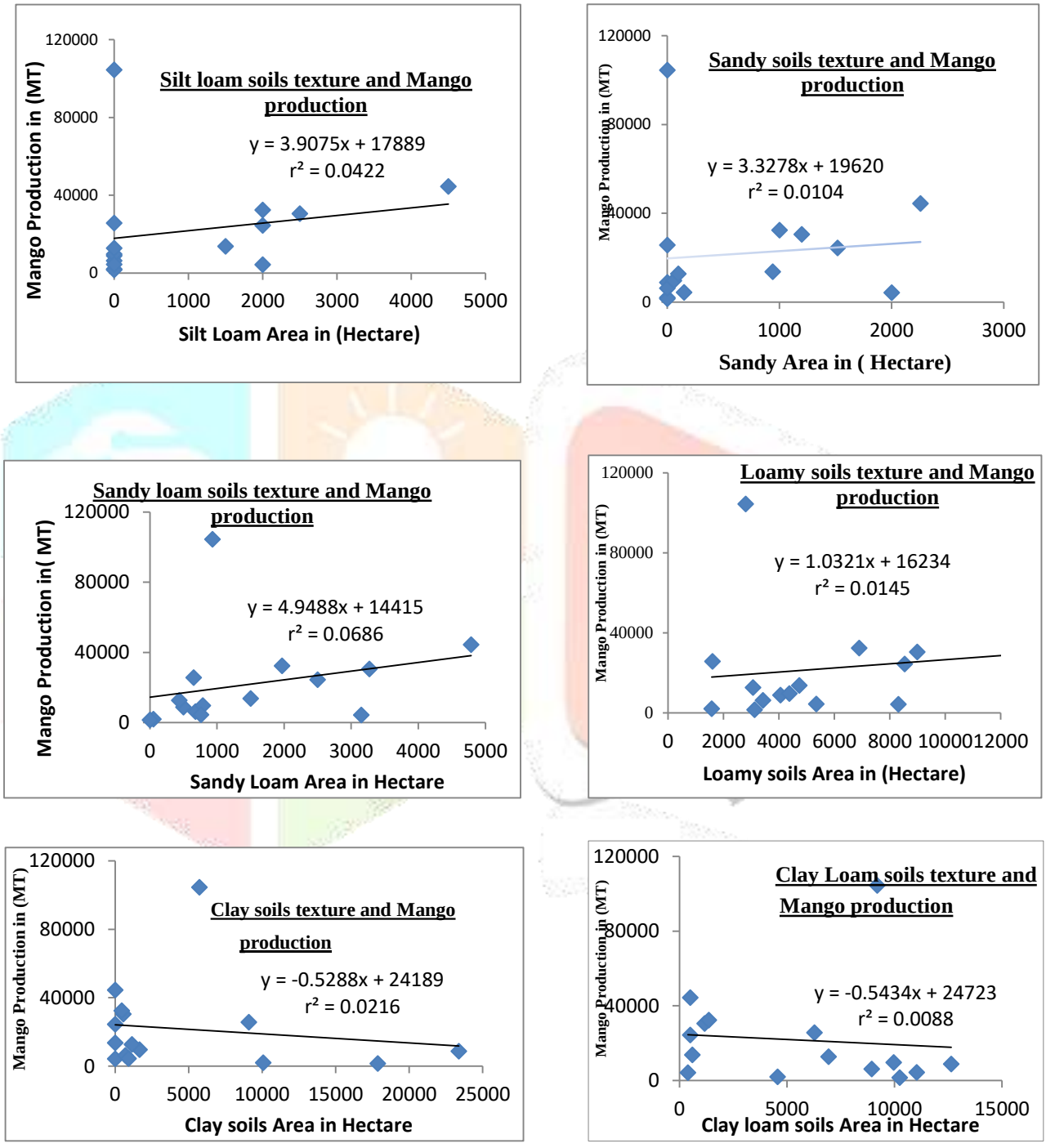


Fig-7, Relation Between Major Soil Textural characteristics and Mango Cultivation of Malda District

This indicates definitely that blocks with greater areal expansion of clay soil and clay loam soil have less mango crop productivity, which is also reflected by a very weak positive correlation between the above-mentioned parameters where the Karl Pearson's Correlation Coefficient (r) is 0.14 and 0.09 (Fig.7). However, the results indicate that there is a relatively good correlation between mango productivity and loamy, silt loam, and sandy loam. In this case, correlation values are 0.12,0.205 and 0.26. Therefore, it is evident that the physical characteristics of soil texture loamy and silt loamy soil is most important soils good productivity of mango cultivation. Put otherwise, there is a statistically significant positive correlation between the quantity of loamy, silty, sandy, and sandy loam and mango productivity. This demonstrates unequivocally that blocks with greater loamy, silt loam, sandy, and sandy loam area expansion have a moderately higher mango crop productivity.

7. Physiographic Region Wise Effects of Soils on Mango Production:

The components and features of soils, among other physical aspects, determine the cropping pattern and productivity level of any given crop. Mango productivity in Malda district is significantly influenced by the soils. According to the detailed report based on the aforementioned findings, the Barind tract has a higher proportion of acidic soil and clay to clay loam soil (Table.2), as well as undulating topography and high surface runoff. It also has a lower proportion of silt loam to loamy soil and sandy loam to sandy soil, which are factors that limit the crop's ability to reach higher productivity of Mango cultivation shows the Table-2.

Table: 2 Physiographic Region wise soils texture classification

S.L. No	Soil Texture (%)	Tal Region (%)	Barind Region (%)	Diara Region (%)
1	Silt Loam (%)	(31.03%),	(Nil)	(55.56%)
2	Sandy (%)	(27.19%),	(Nil)	(72.77%).
3	Sandy Loam (%)	(36.87%),	(3.02%)	(55.69%)
4	Loam (%)	(40.64%),	(13.11%),	(42.64).
5	Clay Loam-(%)	(47.16.%),	(39.98%),	(12.86)
6	Clay (%)	(7.51.%),	(83.88%),	(8.10%).

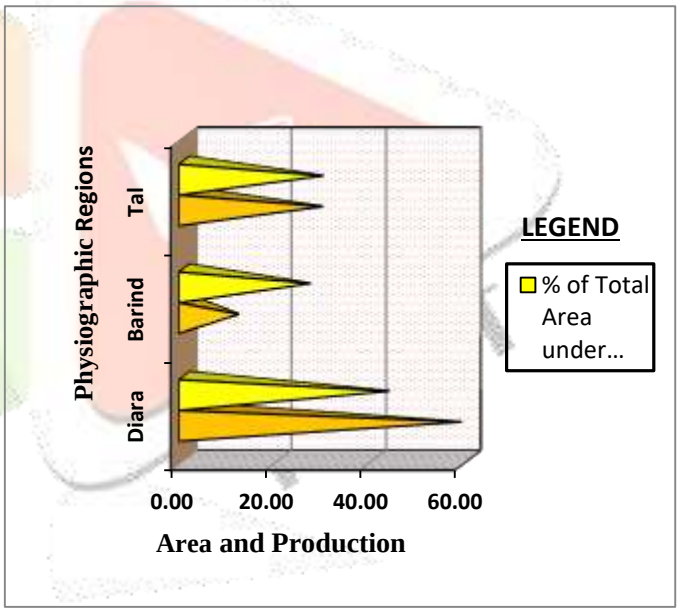


Fig:8 Different Physiographic Regions wise Mango Production

As a result, the entire Barind tract is not very productive, with the exception of the Old Malda block, which has a concentration of orchards along the Mahananda. Productivity in the Tal region ranges from modest to high (Fig-8. The northern portion of this physiographic unit has low productivity, whereas the southern portion has very good output. Higher proportions of clay loam soil are found in the northern blocks of this natural area, namely Harishchandrapur-I, Harishchandrapur-II, Chanchal-I, and Chanchal-II. Alkaline soil results in poorer production.

In addition, the area is extremely vulnerable to flooding due to its low elevation as a basin. Thus, medium to poor production is explained in part by land inundation and soil-related limitations. Due to a larger ratio of light loam to silt loam soil with a neutral soil response, the southern portion, which includes the Ratua-I and Ratua-II blocks, accounts for high production and is best suited for mango plantations. The Diara region, the district's most fertile tract, has all of the high to medium production blocks. The pH range of this area is 6.8 to 7.5, which is ideal for growing mangoes. Mango farming benefits from the increased ratio of loam to silt loam soil. Alluvium, which covers the research region, has a significant impact on mango productivity and production despite being of two different ages and exhibiting distinct physical and physiographic characteristics.

8. Conclusions:

The relationship between soil textural characteristics and mango production is fundamental to achieving optimal yield and fruit quality. Soils of Malda contribute significantly for mango cultivation which mostly depends on soil texture, type of sandy loam to clay loam. Mango trees grow best in well-drained soils with a loamy to sandy-loam texture, which offer a balanced mix of sand, silt, and clay. Such soils provide adequate aeration, moisture retention, and root penetration factors essential for healthy mango tree development. Soils with excessively high clay content tend to retain water and may lead to root rot, while overly sandy soils can drain too quickly, limiting nutrient and water availability. Therefore, understanding and managing soil texture is critical for site selection, irrigation planning, and nutrient management in mango orchards. In conclusion, optimizing soil texture through proper land preparation, organic amendments, and drainage practices can significantly enhance mango productivity in Malda district, fruit size, and overall orchard health. Maintaining the health of the soil for the mango crop requires soil testing to determine the degree of macro and micronutrient quality. Fertilizer administration based on soil tests is a prerequisite for long-term soil health management is key to long-term success in mango cultivation. Orchard owner will attend an awareness and demonstration camp to learn the value of applying green manure, biofertilizer, and macro and micronutrients to improve soil fertility for this delectable fruit crop. Finally, it is suggested that the cultivation of Mango should be done in these soils with clay and clay loam characteristics with integrated crop management practices. Hence, cultivation of mango in these soils with integrated nutrients management vis-à-vis the practice of ‘intercropping’ by planting turmeric, groundnut, various legumes may increase the fertility as well as moisture content.

References:

1. Bhattacharyya, T., Patil, K.D., Kastuire, M. Salvi, B.R., Dusani, A., Patil, V.K. and Haldankar, P.M. (2018). Mango-growing soils and their characteristics. In 'A Review Book on Mango (Eds. B.R. Salvi et al.), pp. 71-98, DBSKKV, Dapoli, Maharashtra.
2. Bagchi, K.G., (1944): The Ganges Delta, Calcutta University Press, India.
3. Census of India (2011): District Census Handbook, Malda, Directorate of Census Operations, West Bengal
4. District Statistical Handbook (2014): Department of Economics and Statistics, Malda District, Government of West Bengal
5. Nabcons. Comprehensive District Agricultural Plan (C-Dap) (2014) for Malda– Final report. Nabard consultancy services pvt ltd., Kolkata, (xi-th plan period) p 1-152
6. National Bureau of Soil Survey and Land Use Planning (NBSS-LUP) Kolkata.
7. Mukherjee (1967) History, Origin and Botany. Ed. C. R. Kurup, The Mango-A Handbook, Indian Council of Agricultural Research, New Delhi, pp 1-13
8. Sys, I. C., Van Ranst, B., Debaveye, J. and Beernaert, F. (1991): Land Evaluation. Part I, Crop Production Calculation, Agricultural Publication No. 7, General Administration for Development Cooperation, Brussels, Belgium
9. Sengupta, J, C., (1969): West Bengal District Gazetteers, Malda. Sree Saraswaty Press Ltd, Kolkata.
10. Singh, K. K. (1967) Climate and Cultivation. Ed. C. R. Kurup, The Mango: A Handbook, ICAR, New Delhi, (1967) pp-70-98
11. Pandey, S. N., & Dinesh, M. (2010) Mango. Directorate of Information and Publications of Agriculture, ICAR. New Delhi