Importance of Soil Texture in Sustenance of Agriculture: A Study in Burdwan-I C.D. Block

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Importance of Soil Texture in Sustenance of Agriculture: A Study in Burdwan-I C. D. Block, Burdwan, West Bengal

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Abstract

Soil texture is the composition of size of grains constituted of minerals. There are three types of grains i.e. sand (2-0.05 mm), silt (0.05-0.002) and clay (below 0.002) controls the soil texture. Proportions of these soil particles depend on mineralogical composition of parent material and the environment of soil genesis. Soil texture is a controlling factor of soil reaction, nutrient availability, water holding capacity, soil porosity, air-water circulation and soil density. Along with these properties, soil texture is also a determinant for crop selection, irrigation practices, and soil management and fertilizer application. Plant growth is influenced by the size of soil particle through controlling of nutrition availability and root growth. The agricultural practice with appropriate soil texture and proper crop selection produces optimum productivity with minimum water and fertilizer what consequently sustains soil health as well as concerned agricultural systems. But, due to availability of water supply through irrigation and influence of market forces, crops have been cultivated to gain more profit without consideration of the soil texture and suitable crop selection, resulted into degradation of soil's health as well as deteriorating of agricultural productivity.

The issue of unsustainable agricultural practice has been studied in Burdwan-I C.D. Block, Burdwan. The major soil textures of the block are clay, silty clay, clay loam, loam, silt loam, sandyloam. Generally, clay, silty clay and silty clay loam are suitable for rice cultivation whereas loam, silt loam and silt are favorable for wheat, potato, sorghum, barley and sandy loam, loamy sand and sand are also appropriate for maize, potato, groundnut and sesame. But paddy has been cultivated in kharif season with canal irrigation and in rabi season, 90 per cent of the agricultural land has been cultivated for paddy with canal and shallow and or submersible irrigation with intensive use of chemical fertilizer. In contradictory, paddy has been cultivated in sandy loam, loam, silt and silty loam with sufficient supply of water due to urge of profit. As a result, natural soil's health is deteriorating and consequently, production of paddy has been declining remarkably. Presently, the farmers feel reluctant in cultivation what hampers the life and livelihood of the agricultural family and the rural economy.

Key words: *Soil Texture, Canal Irrigation*

Introduction

Soil texture is composition of size of soil particles i.e. sand, silt and clay. Soil texture is defined as the particle size distribution of the fine earth fraction (<2mm fraction) (Geering & So, 2006). There are also subclass in sand and silt. Sand is divided into very coarse sand, coarse sand, medium sand, fine sand and very fine sand (USDA, 1987). Different institutions have classified sand, silt and clay at different diameter of the particle of soil. On the basis of percentage of soil particle, the textural class is determined (Foth, 1990). Quartz is the mineral of sand and silt. Kaolinite, montmerilionite are the mineralogical composition of clay formation. With the parent material, climate is also play an important role in determining soil texture. Physical properties of soil are influenced by soil textural class. Density of soil, porosity, water holding capacity, organic matter content and susceptibility

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Table1: Soil Textural Classes with Suitable Crops (USDA, 1987)

Common Name	*Texture*	*Basic Soil Textural Class*	*Suitable Crops*
Sandy Soils	Coarse	Sand	Maize, Bajra, Groundnut, Potato, Grapes
		Loamy Sand	
		Sandy Loam	
Loamy Soils	Medium	Loam	Wheat, Barley, Maize, Potato, Sugarcane, Jute
		Silt Loam	
		Silt	
	Moderately Fine	Sandy Clay Loam	Rice, Sorghum, Gram, Cotton, Sugar-beet, Banana
		Silty Clay Loam	
		Clay Loam	
Clayey Soils	Fine	Sandy Clay	
		Silty Clay	
		Clay	

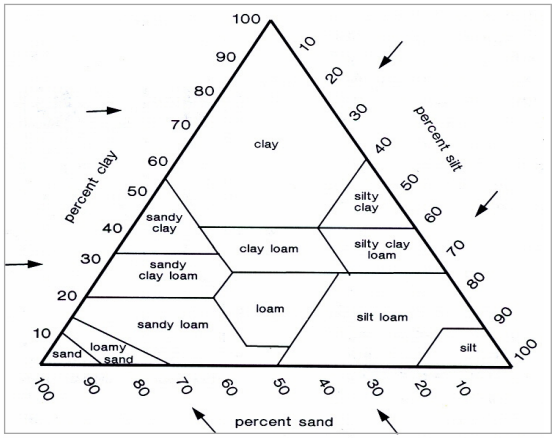


Fig. 1: USDA Soil Textural Triangle (Source: USDA, 1987)

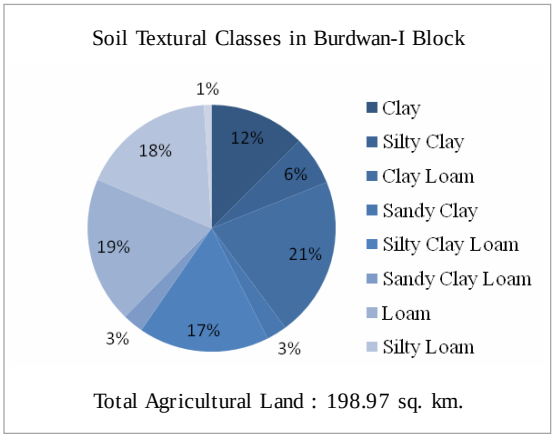


Fig.-2: Soil Textural Classes in Burdwan-I C.D.Block 2014

to erosion are controlled by soil texture (Daji et.al., 1996; Biswas and Mukherjee, 1994). With these factors texture becomes a most important factor for crop selection and crop growth. Sedentary human civilization has grown on crescent alluvial tract of river valley. So, a positive relation has been fitted with human civilization and soil type. Presently, modern man has tried to overcome the natural limitations, overruling of natural soil ecosystem to get more production. Mono crop has been selected to cultivate throughout the year with intensive use of chemical fertilizer and irrigation. Consequently, after weakening of soil buffering capacity, physical and chemical properties are affected considerably with decrease of crop production. Soil is a finite natural resource what can fulfill human need but not human greed.

Study Area

Burdwan District is known as rice bowl of West Bengal for its predominance of paddy cultivation in the old alluvial in middle part of the district and new alluvial soil in eastern part of the district. The study has been completed in Burdwan-I C.D. Block. The latitudinal extension of the block is 23° 12' 4" N to 23° 22' 48" N and longitudinal extension is 87° 47' 8" E to

Table 2: Soil Texture and Cropping Pattern in Burdwan-I C.D. Block, 2014

Basic Soil Textural Class	*Actual Cropping Pattern*						
	Aman Boro	*Aman Potato*	*Aman Potato Til*	*Aman Potato Boro*	*Aman Boro Potato*	*Aman Boro Til Potato*	*Aoush Potato Boro*
Sandy Loam	1 (0.47)*						
Loam	29 (13.81)		8 (3.81)		2 (0.95)		
Silt Loam	27 (12.85)		2 (0.95)				1 (0.47)
Sandy Clay Loam	3 (1.42)	3 (1.42)				1 (0.47)	
Silty Clay Loam	36 (17.14)			2 (0.95)	1 (0.47)		
Clay Loam	44 (20.95)		3 (1.42)		2 (0.95)		
Silty Clay	12 (5.71)		1 (0.47)				
Clay	26 (12.38)		1 (0.47)				

** Figures in bracket represent percentage*

88° 4' 24" E. Total area of the block is 250.4 sq. km. on which 210.9756 sq. km. (84.26 %) is cultivable land with 73.84 per cent of government canal irrigation (Census, 2011).

Objectives

The objectives of the study are as follows.

1. To find out cropping pattern in *kharif* and *rabi* cropping period in Burdwan-I C.D. Block.
2. To determine soil textural categories of the block.
3. To correlate between soil texture and selection of crops of the block.
4. To find out effect of soil's texture and sustenance of the agriculture.

Materials and Methods

The research work has been completed based on primary data. Primarily, the study area has been divided into one sq. km. grid to collect soil samples. Accordingly, 208 soil samples have been collected along with interviewed in detail with land owner to know about cropping pattern, fertilizer application, production and problems as well as their suggestions regarding agriculture.

Literature survey, selection of study area, collection of block map, preparation of questionnaire and selection of location of soil samples in grid methods have been done before going to the field. After completion of field visit, soil texture of collected samples has been tested by hydrometer method. To determine the spatial variations of properties of soil, the tested data are plotted on map by using Map Info 7.0. Final interpretation of findings through maps, diagrams has been done by using MS-Excel 2007, Map Info 7.0.

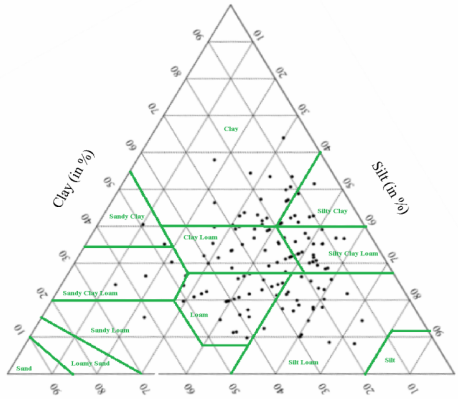
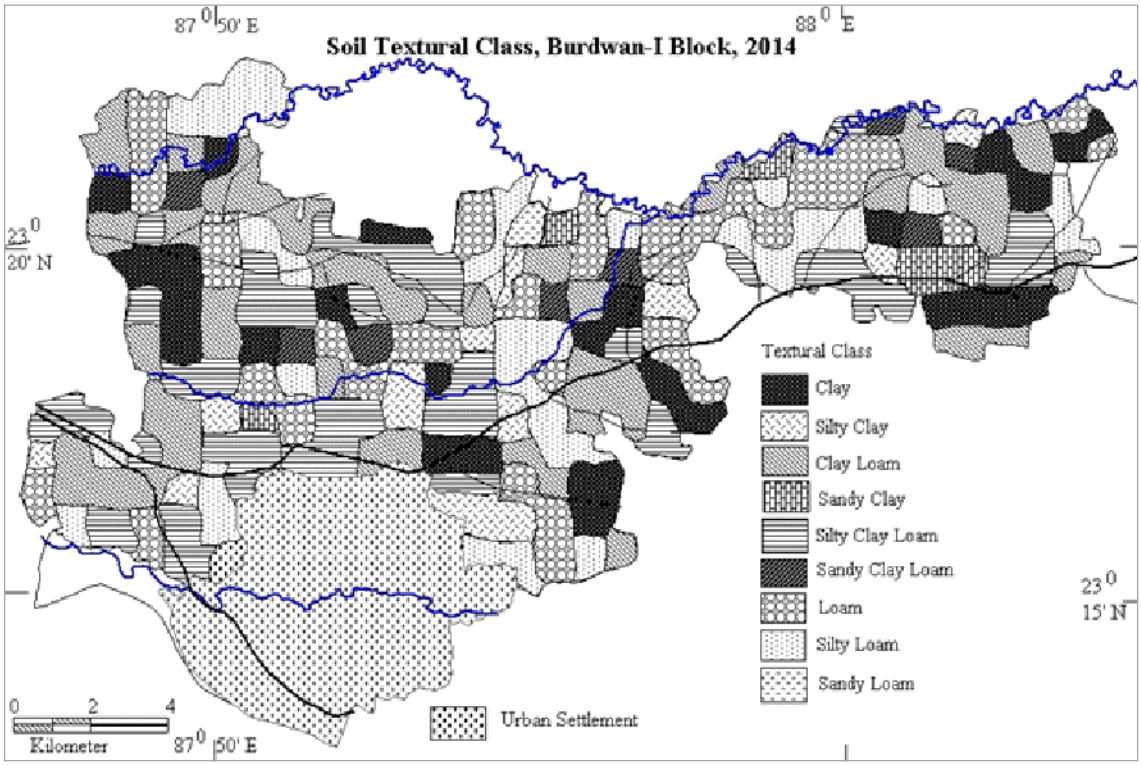


Fig.No.-3: Soil Textural Classes, Burdwan-I C.D Block, 2014

Soil Texture

'Texture refers to the relative amounts of the different particle size fractions or separates in the soil' (Chesworth, 2008). To identify soil texture, particles of soil have been separated according to their size.



Map 1: Soil Textural Classes in Burdwan-I C.D. Block, 2014

The groups are referred as soil separates (Daji et.al., 1996). Soil separates are the individual size-group of mineral particles. There are a number of systems to classify and name of soil separates. There are United States Department of Agriculture (USDA), English System and International Society of Soil Science Society System. In USDA classification, soil separates are sand (2.0mm- 0.05mm diameter), silt (0.05- 0.002 mm) and clay (less than 0.002 mm). Sand is again subdivided into five subgroup as very coarse (2.0-1.0 mm), coarse sand (1.0-0.5 mm), medium sand (0.5 - 0.25 mm), fine sand (0.25 -0.1 mm) and very fine sand (0.1- 0.05 mm). On the basis of soil separates, 12 textural classes have been classified and correlated with the suitable crops combination as stated by Daji et.al., 1996 (Fig No. 1).

Result and Discussion

Soil texture has been tested from collected soil samples and the cropping pattern has been compared of the given grids. As plant growth is influenced considerably by the size of the soil particles, crops are recommended to cultivate according to the size of soil textural groups (Daji et.al., 1996). Soil density, availability of water and retention of water by soil are depended on soil separates (Brady,1990). So, crops should be selected according to the given soil textural class.

Soil Textural Classes of Burdwan-I C.D. Block

Fine Textural Class

(i) Clay Texture

Clay soil contents 40 per cent or more clay, less than 45 per cent silt and less than 40 per cent sand (USDA, 1987). Clayey soils show high water holding capacity and high plasticity (Biswas and Mukherjee, 1994). Clay texture has been found as12.49 per cent agricultural land of the block.

(ii) Silty Clay Texture

Silty clay contains 40 per cent or more clay and 40 per cent or more silt (USDA, 1987). Again 6.45 per cent

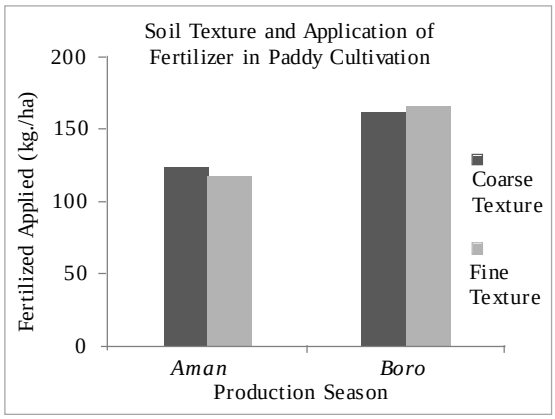


Fig.4: Fertilizer Use on Texture, Burdwan-I, 2014

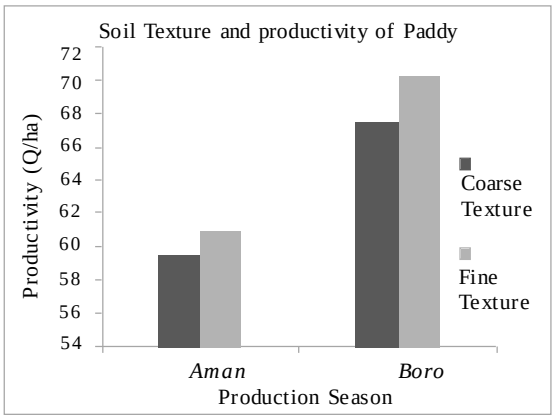


Fig.5: Productivity of Paddy on Soil Texture, Burdwan-I, 2014

area of the block is characterized of silty clay textural class.

(iii) Sandy Clay Texture

Sandy clay contains 35 per cent and more clay and 45 per cent or more sand (USDA, 1987). Only 2.68 per cent area belongs to the textural class.

Moderately Fine Textural Class

(iv) Silty Clay Loam Texture

Silty clay loam contains 27 to 40 per cent or more clay and less than 20 per cent or more sand (USDA, 1987). Silty clay loam has been found on 17.08 per cent of agricultural land.

(v) Clay Loam Texture

Clay loam contains 27 to 40 per cent or more clay and less than 20 to 45 per cent sand (USDA, 1987). 20.9 per cent of the block is characterized of clay loam texture.

(vi) Sandy Clay Loam Texture

Sandy clay loam contains 20 to 35 per cent clay, less than 28 per cent silt and 45 per cent or more sand (USDA, 1987). Sandy clay textured soil has been observed in 2.71 per cent of land.

Medium Textural Class

(vii) Silt Loam Texture

Silt loam contains 50 per cent or more silt and less than 12 per cent clay or 50 to 80 per cent silt and less than 12 per cent clay. Silt loam textural class has been found in 17.58 per cent of agricultural land of the block.

(viii) Loamy Texture

Loam contains 7 to 27 per cent clay, 28 to 50 per cent silt and less than 52 per cent sand. In the block, 19.09 per cent land has fallen in this class (Map No. 1).

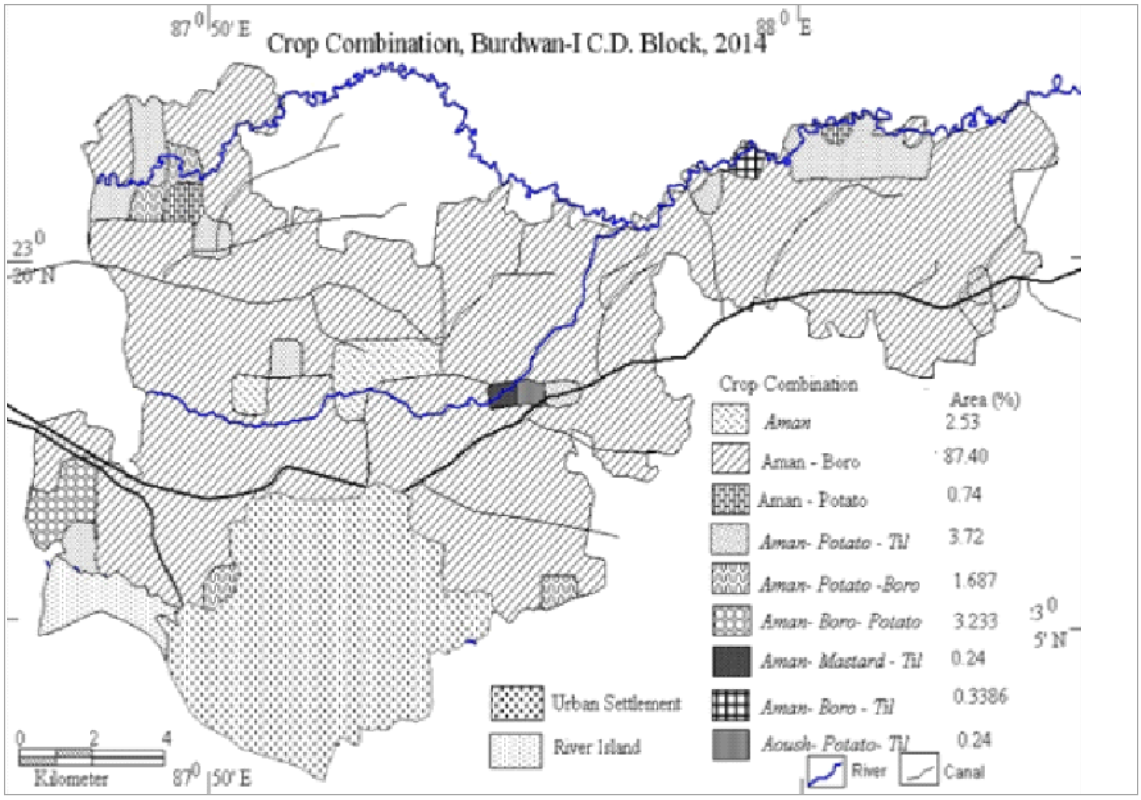
Class of Coarse Texture

(ix) Sandy Loam

Sandy loam contains 20 per cent or less clay, less than 50 per cent silt, and between 43 to 52 per cent sand (USDA, 1987). Only 0.53 per cent of the land is characterized of this textural class.

Generally, fine textured soil classes are most suitable for high water demanding crops like rice, banana, cotton and moderately textured soil is suitable for these types of crops through proper irrigation. Clay textured soil has been found out at four mouzas, Jagdabad, Palitpur, Tentulia and Shampur. These mouzas are enjoying with alluvium deposits through regular flood in certain interval.

Upper 'Ap' layer of the soil (6" to 1ft) is removed from agricultural land several times due to declining of soil fertility and cultivation of paddy have been continued in subsurface layer of soil. So, presently, the surface soil which is studied in this research work is not original surface of soil genesis. As alluvium is



Map 2: Crop Combination, Burdwan-I C.D. Block, 2014

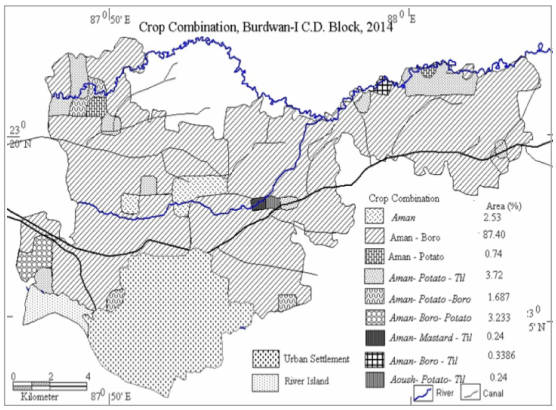
the parent material of soil formation, the physical properties mainly texture differs from one formation to another. This is the main cause of for the textural differences of soil in the block.

Cropping Pattern

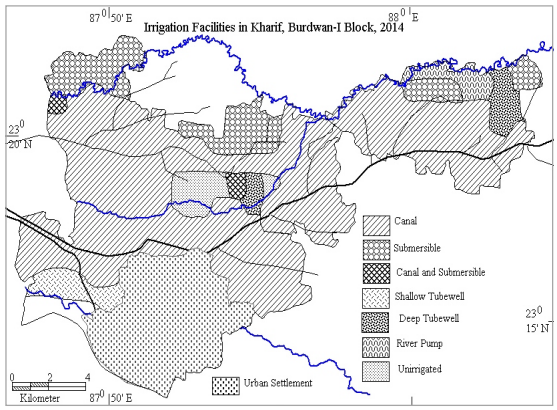
The agricultural land has been cultivated double or three times with the help of intensive irrigation. Crops are being selected on the strength of irrigation types and demand on market. Due to unavailability of required irrigation during post monsoon period, 2.58 per cent of land is cultivated with aman paddy with the help of rain water in single time. Aman and boro paddy are cultivated on 87.40 per cent of the agricultural land of the block. Aman paddy and Potato are cultivated at 0.76 per cent of the land. Aman paddy, Potato and Til (sesame), triple crops, are cultivated in 5.87 per cent of land (Map no. 2). There is no requirement of irrigation in Til cultivation. So, aman-boro paddy, the main cropping pattern of the block, is cultivated with the help of canal and submersible irrigation. Again, 2.53 per cent land is cultivated for only aman paddy with rain water and remains uncultivable in boro season due to unavailability of irrigation facility. It is found out that selection of suitable crop is not done according to the soil texture what intern negatively impacts the productivity of paddy on both aman and boro season.

Cropping pattern on the basis of Soil Textural Class

Soil texture plays an important role on selection of crops for cultivation because porosity of soil, water holding capacity and density depends on soil texture. In the study area, 86.53 per cent of farmer cultivate paddy on kharif and rabi season. Canal irrigation is the main source of water in paddy field. Again, submersible and shallow tube well has established in different parts of the block for cultivation of paddy in



Map 3: Crop Combination, Burdwan-I C.D. Block, 2014



Map 4: Irrigation Facility in Kharif, Burdwan-I, 2014

rabi season. 12.01 per cent agricultural land is cultivated for triple crop and 7 per cent is cultivated for aman-potato and til. 59.13 per cent farmer cultivates on fine and moderately fine textured soil and it is suitable for cultivation of paddy. But the farmers those cultivate on coarse and medium textured soil, are suffering for low water holding in soil. 27 per cent farmer cultivate in coarse textured soil. So, soil texture is not getting much important factor for selection of crop in the block rather guided by availability of water and question of profitability.

Irrigation Facilities

Irrigation is appeared as main controlling factor for selection of crop for cultivation in the block. In monsoon season, aman is cultivated in the entire block. In rainy season, 74.32 per cent of agricultural land is cultivated through canal irrigation and 12.79 per cent is cultivated through submersible. Canal irrigation is not sufficient in some part of the block in kharif and boro season. Alternatively, submersible has become as an irrigation source of 9.54 per cent agricultural land in rainy season and 3.017 per cent agricultural land still remains un-irrigated or rain-fed in kharif season in the area (Map No. 4).

In rabi season, 51.53 per cent land is irrigated through submersible and only 7.27 per cent is irrigated by canal. Again, 30.79 per cent of agricultural land is irrigated by canal at one year interval. This part of the land remains uncultivable due to paucity of irrigation. (Map No. 5). Submersible systems have been set up in different parts of the block to cultivate paddy in boro season.

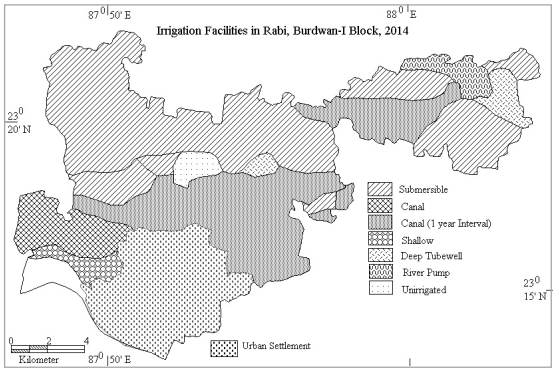
Suitable Crops according to Soil Texture

From the table no. 1, it is found that fine and moderate textured soil are suitable for rice cultivation. In Burdwan-I C.D. Block, 86 per cent of land is cultivated with mono cropped as paddy cultivation without due consideration of soil texture in the study area. Out of 208 farmers, 178 farmers (85.09%) cultivate mono crop, aman- boro paddy. Among them, 57 farmers (25.39 %) cultivate boro on coarse textured soil with submersible irrigation. With the availability of water supply and chances of profitability, doubled cropped paddy is being cultivated with intensive use of chemical fertilizer more than the rate of national standard (121.4 kg/ha) (Savci, 2012).

The farmer who has cultivated paddy in fine textured soil, used to apply 118.84 kg/ha in aman and 166.05 kg/ha in boro. But, the farmer who has cultivated in coarse textured soil, apply 124.67 kg/ha in aman and 163.28 kg/ha in boro (Fig. no. 4). Particle size compatibility is important for selection of fertilizer and uniform spreading of dry, granular fertilizer (Maguire, 2009). So, there is no scientific logic behind the quantity and quality of fertilizer applied in concerned agricultural system.

Productivity of Paddy and Soil Texture

The average productivity of paddy in fine textured soil is 61.029 Q/ha of aman paddy and 70.02927 Q/ha



Map 5: Irrigation Facilities in Rabi, Burdwan-I, 2014

of boro paddy. On the other hand, average production of paddy in coarse textured soil is 59.46 Q/ha in aman and 67.6035 Q/ha in boro (Fig. no. 5). Sandy soils produce less paddy in comparison with the fields with high clay and organic matter' (Chan et.al. 2006). Hence, the farmers are able to produce less in coarse textured soil than fine texture. The loss in present MSP (minimum support price, 1280/Q in 2012) is about 2008/ha in aman and 3442 /ha in boro. So, texture of soil plays an important role in paddy productivity in the block.

Conclusion

From the above discussion, it is clear that aman and boro paddy cultivation are predominance in the block with the canal irrigation in kharif and submersible in rabi season. About 21 per cent and 40.69 per cent of agricultural land is characterized of fine textured and moderately fine textured soil respectively. Paddy is being cultivated in any textural class with high fertilizer application. As a result, productivity of paddy is lower in coarse and medium textured soil than fine and moderately fine textured soil. Recently, with the increase of price of agricultural inputs, profitable return from agriculture has decreased miserably. Due to the unwise crop selection and faulty agricultural methods, the very fertile soil is becoming denser and low productive. Consequently, farmers feel reluctant in agriculture and leased out own agricultural land to land less labourer. At this situation, government should take initiative with academician to test soil at regular interval to scientifically educate the cultivator and to select crops as per texture of soil with proper agricultural methods for sustenance of soil as well as sustainability of agriculture and rural based agricultural society.

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