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RESEARCH ARTICLE

ANALYSIS OF ECOLOGICAL NICHE OF TULAIPANJI RICE IN RAIGANJ CD BLOCK, UTTAR DINAJPUR DISTRICT, WEST BENGAL, INDIA

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ABSTRACT

Tulaipanji is one of the oldest indigenous aromatic rice varieties of the state of West Bengal, India mainly cultivated in some scattered restricted pockets of Uttar Dinajpur and Dakshin Dinajpur district of the state. Cultivation of this rice is being done here for more than 100 years back. Thus, this rice variety adapted and evolved itself in its microhabitat or niche. Though its productivity is less than half of the HYVs of rice, but due to its taste and aromatic quality, its market value, sometimes reaches to thrice than any of the HYVs of rice cultivated in this area. So that farmers are even showing interest in its cultivation. Its restricted cultivation area makes it so limited and so unique that already this rice had got Geographical Indication (GI) no. which is 530. The cultivated area of this rice is found maximum in Raiganj CD Block in Uttar Dinajpur district in comparison with other CD Block of both the above mentioned districts. Using GIS techniques and DEM besides intensive field survey, this paper attempts to highlight the salient geographical features of the ecological niche of Tulaipanji in the study area to reveal the causes behind its cultivation in some scattered restricted pockets and to suggest the potential zone for its cultivation by following the way of sustainable agriculture.

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INTRODUCTION

To define habitat and ecological niche, Odum (1913) stated "The habitat of an organism is the place where it lives, or the place where one would go to find it. The ecological niche, however, includes not only the physical space occupied by an organism but also its functional role in the community (for example, its trophic position) and its position in environmental gradients of temperature, moisture, pH, soil, and other conditions of existence." The subdivision of a habitat is called a microhabitat. The specific environmental variable in the microhabitat is called microclimate or microenvironment. Joseph Grinnel (1917) coined the term 'niche' to denote the microhabitats where the organisms live. He laid emphasis on the distribution of organisms and their structural peculiarities in relation to microhabitats. Thus he considered the niche to be a subdivision of the habitat and treated it as a distributional unit (Dash, 1993). Tulaipanji is the only popular traditional rice variety mainly cultivated in Uttar Dinajpur district and also some parts of Dakshin Dinajpur district in West Bengal, India more than 100 years back. Though Tulaipanji is mainly cultivated in 5 blocks, namely, Raiganj, Kaliaganj, Hemtabad, Itahar and Karandighi but most of the Tulaipanji cultivated land of the district comes under the Raiganj block.

The lithological and geomorphological set up of this area act as a niche factor for Tulaipanji. The aromatic quality of this rice decreases if it is cultivated far away from this region. So that, the cultivation zone is restricted in a few small pockets of this region to maintain its quality. The quality of this rice is determined by its taste and also the longevity of its aroma which is generally found stable till a year. This rice variety is significant from various aspects. The cultivation of this rice variety generally does not require any type of chemical input and its market price is nearly more than 2.5 times more than any of the HYVs or rice cultivated in this region. The aroma of this rice, even can find stable after a year. Because of these profitable causes, farmers are always showing their interest to cultivate this rice variety. As chemicals are not used, so cultivation process is also eco-friendly and it is the only traditional rice variety struggling with the HYVs for its existence. Obviously this rice variety is significant both from the economic and ecological perspective. Now days, Use of intense chemical fertilizers reduces the aromatic property of this rice variety which adversely affects the consumer demand and reduces the market value of this product. Due to which, cultivators are showing less interest about it. As a consequence, Tulaipanji fields are replaced by the HYV varieties which hamper the ecological niche of Tulaipanji as well as deteriorate the quality of soil. The proper analysis of

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the ecological niche of this rice will further be helpful to find out its potential zones throughout the district. In-situ conservation of this plant species is too much necessary both from ecological and economic perspective. As all the traditional rice diversity is disappearing from this zone, so, conservation of this rice variety is the only to maintain the rice field ecology in its niche area. To protect the overlapping of HYVs in its cultivation zone, delineation of its niche area is also necessary. As its traditional way of cultivation is eco-friendly, so it supports sustainable agriculture. If we analyze its importance from the economic viewpoint, we can easily understand that identifying of its potential zones means increasing its cultivated area which will also increase the net income of the farmers from this specific crop and it will strengthen the farmers' economy in this region. After reviewing the research articles, government and NGO reports on Tulaipanji as well as intensive field survey and personal interview with the Tulaipanji cultivators, the present study aim to analyze the salient features of the ecological niche of Tulaipanji in the study area to reveal the causes behind its cultivation in a few restricted pockets and to suggest the potential zone for its cultivation for the betterment of the stability of the rice field ecology of this specific rice variety.

Study Area and its Environment

Location and size: Raiganj (Community Development Block) is an administrative division in Raiganj subdivision of Uttar Dinajpur district in the Indian state of West Bengal which is situated in the eastern part of India. Its latitudinal extent is from 25°31'31" N to 25°50'04" N and longitudinal extent from 88°01'20" E to 88°14'09" E. This block holds a great strategic significance of physical and socio-cultural aspect. It comprises 466.26 sq. km. (180.02 sq. mile) area. On the North, this block is bounded by Bangladesh and in the west by Bihar. Part of the west is also bounded by Karandighi block, eastern part by Hemtabad and Kaliaganj block and the whole southern part by Itahar block of Uttar Dinajpur district. Administratively, this block is divided into 14 Gram Panchayets which comprises 210 villages.

Physiography: Raiganj CD Block is situated in the Tal plain area of North Bengal Plain which comes under Tista Flood Plain of the lower Ganga Plain. The average elevation of this area is 33 metre. The soil of the area may be classified as old alluvium, alluvium and new alluvium. The texture of old alluvium varies from stiff clay to clay loam. The soil is deep and in reaction neutral to slightly acidic. The region is flat in general with a very gentle slope from North to South as a result of which the rivers generally have the same direction. Nagar, Kulik is the main rivers of the region.

Climate: This area is situated in the humid tropics. The average temperature ranges between 24°C in summer and 10°C in winter. Average annual rainfall is found 150-200cm.

Agriculture: Because of the fertile alluvial soil, agriculture is the main economic activity in this region. Rice is the main food crop here. Besides this, jute is the main cash crop of the region. Except these crops, maize, mustard, wheat are the major crops in this region cultivated rotationally throughout the year.

Demography: According to the 2011 census, the district is the homeland of 4, 30, 221 persons, out of which urban and rural

population comprises 16,078 (3.74%) and 4, 14, 143 (96.26%) respectively. The population density of this district is 780 persons per sq. km. (2,000/sq. mi.).

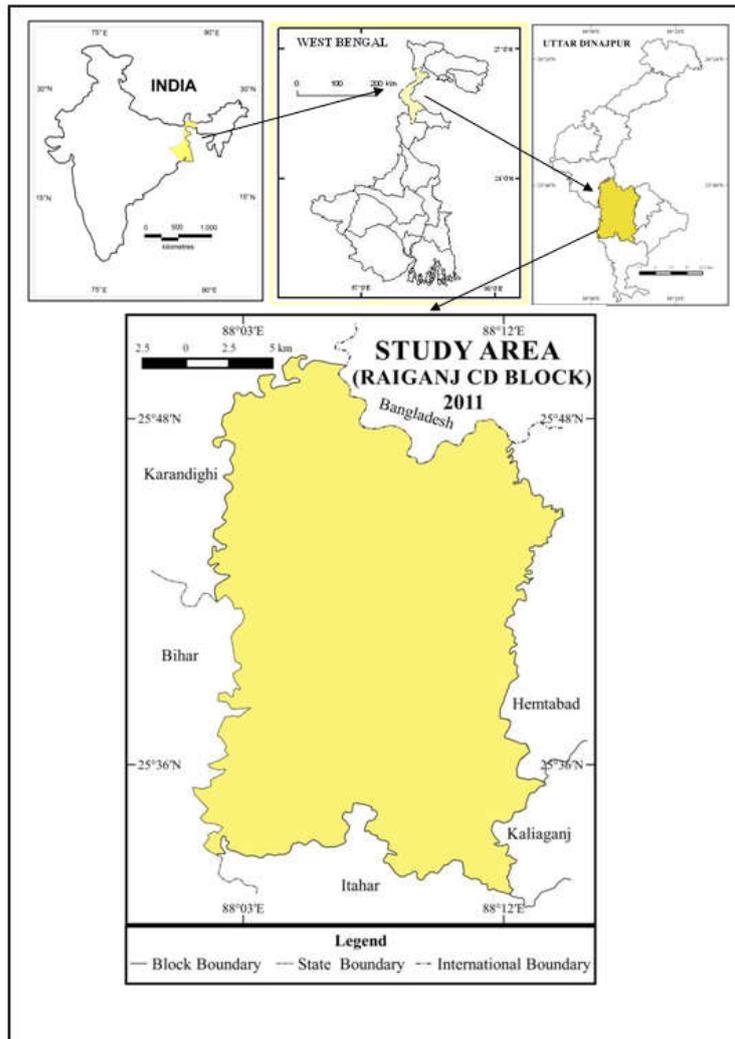
Literature Survey: The analysis of Ecological Niche of Tulaipanji Rice in Raiganj CD Block, Uttar Dinajpur District is a field of study often neglected by the researchers working in this field. Until now, very little attention has been paid to establish the physical set up, especially analysis of the ecological niche of Tulaipanji and its overall impacts on the growth and distribution of this rice variety over the region. Geographical Indications Journal No. 97, Government of India (2017) highlighted the economic significance and way of cultivation of Tulaipanji with mentioning the distribution of its geographic area of cultivation. More emphasis is given to describe the specification of this rice variety as an economic good (pp. 26-37). Singh *et al.* (2000) and Shobharani and Krishnaiah (2001) mentioned the rich genetic diversity of aromatic rice in the state of West Bengal, India. Mondal & Dutta (2013) mentioned the popularity of this medium-grained, fragrant rice cultivar in domestic market for its quality features and potentiality for International trade. Sen *et al.* (2005) shows the economic profit of Tulaipanji cultivation than any other HYVs rice and suggest the conservation of this rice variety. Sen and Kar (2006) focus of the contemporary problem of Tulaipanji cultivation by using chemical fertilizers for higher productivity and its adverse effect on the taste and aroma of rice. Sen and Sarkar (2010) stress upon a new transplanting technique termed as High Intensity transplanting (HIT) for increasing average productivity even after maintaining traditionally followed stress conditions to produce quality aromatic grain of Tulaipanji. They also emphasis on the traditional eco-friendly cultivation method of Tulaipanji.

To find out the most beneficial insecticides for Tulaipanji seedlings, Chakraborty and Deb (2011) studied on the extent of suppression of leaf folder, *Cnaphalorocis Medinalis*, Guen population by some selected insecticides in the field of scented local paddy cultivar Tulaipanji during four consecutive *autumn-crop* seasons of 2007-2010 at Raiganj, Uttar Dinajpur, West Bengal, India. Mondal & Dutta (2013) highlighted on various problems associated with the cultivation of Tulaipanji rice and emphasis on the development of suitable 'marketing channel' and 'branding' the variety. Besides this, they also suggested for further researches for maintaining genetic purity, incorporation of genetic traits. Mondal *et al.* (2014) prepared a detailed report on the status of Tulaipanji rice in North Dinajpur district, specially the crop environment, cultivation practices, grain yield, milling recovery, marketing network, socio-economic impact, etc. Roy and Lachagari (2017) suggest that adding a high density of SNP markers to a mapping or breeding population through GBS has a great value for numerous applications in rice breeding and genetics research. Ghosh *et al.* (2018) emphasis on morpho-genetic characterization of traditional aromatic Tulaipanji rice to develop the phenotypic and genetic database of this rice variety. Actually, no attempt has yet been made to analyze the ecological niche of Tulaipanji and its overall impacts on the growth and distribution of this rice variety over the region and the researcher is the pioneer in this field.

Objectives

The objectives of this paper is to

- Analyze the ecological niche of Tulaipanji Rice.
- Suggest for its potential zone of cultivation.



Source: NRDMS, P.S. Map of Raiganj and Itahar and compiled by the Author

Figure 1. Map showing the study area

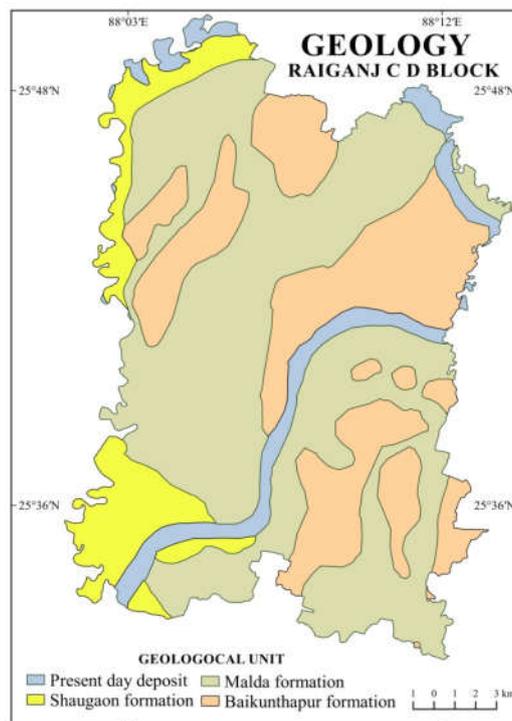


Figure 2. Map showing the Geological Formation

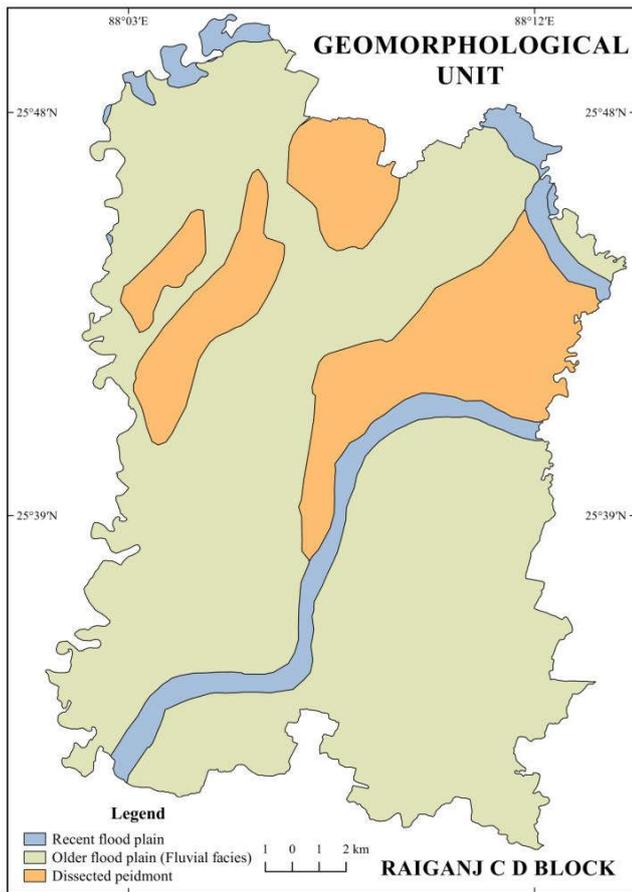


Figure 3. Map showing the Geomorphological Unit

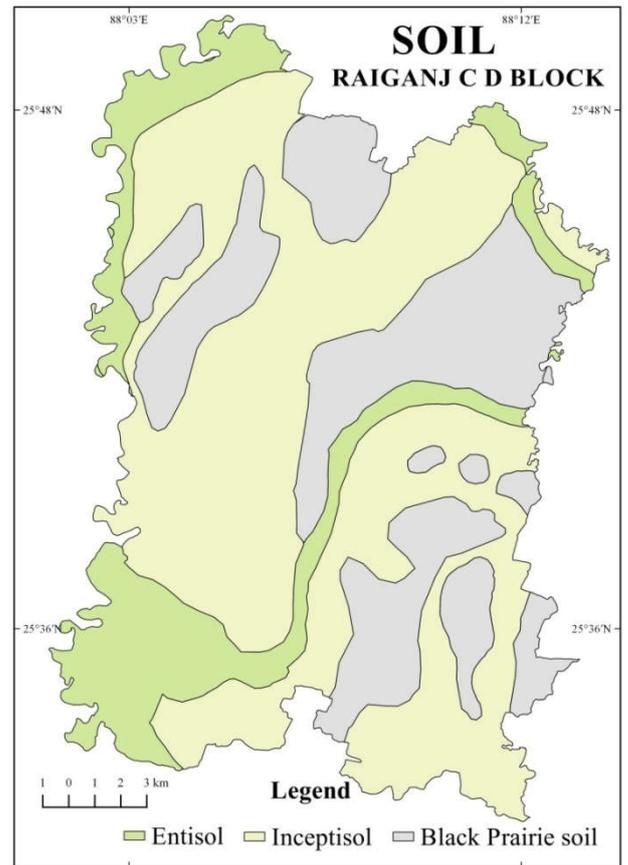


Figure 5. Map showing the Types of Soil

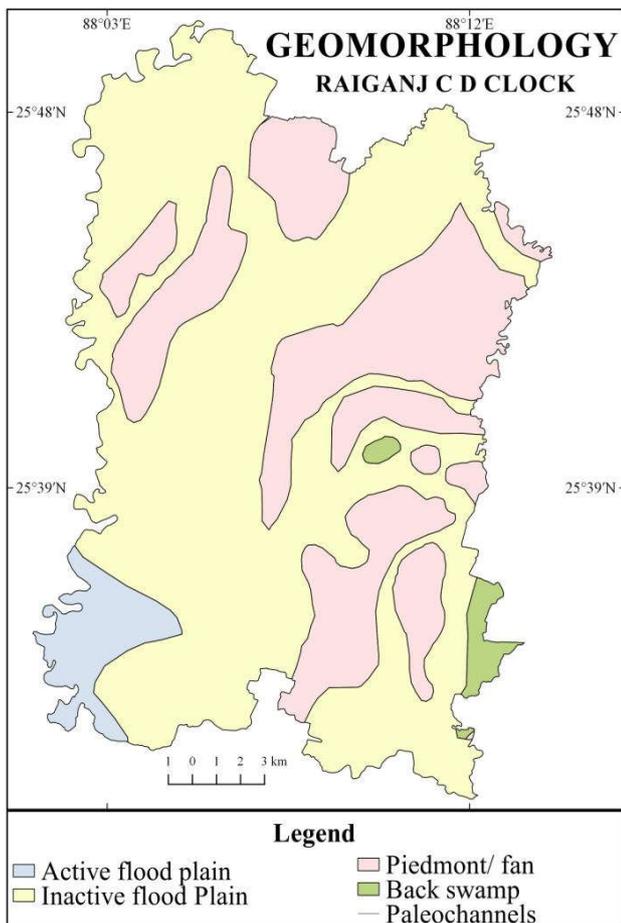


Figure 4. Map showing the Geomorphology

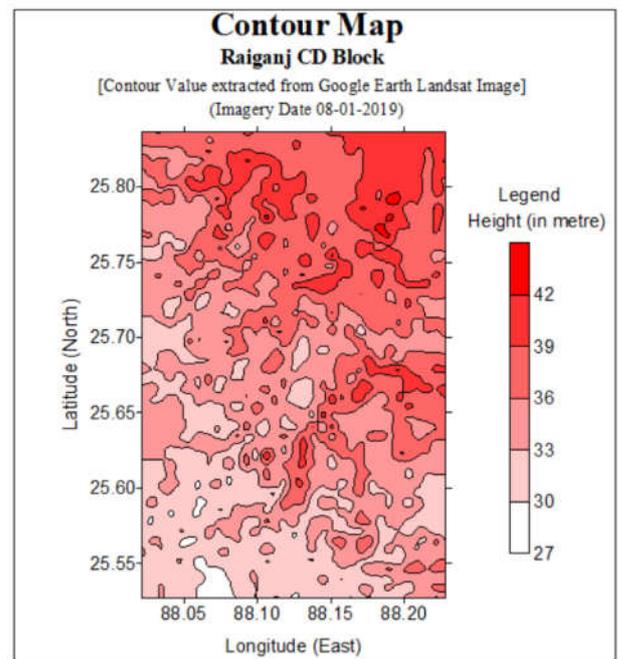


Figure 6. Map showing the Contours

Database and Methodology: The present study is empirical in nature. It is based on both primary observation means field survey and also on secondary data collected from different sources. Both quantitative and qualitative data are taken into consideration. Block has been taken as a unit of study. In the pre-field study, literature review with the concerned topic and collection of secondary data from various sources are done. Base map and physical resource maps of the study area are made using the QGIS software.

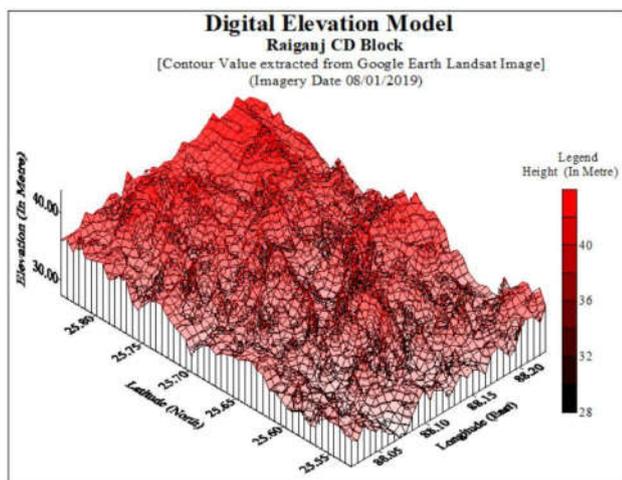


Figure 7. Digital Elevation Model

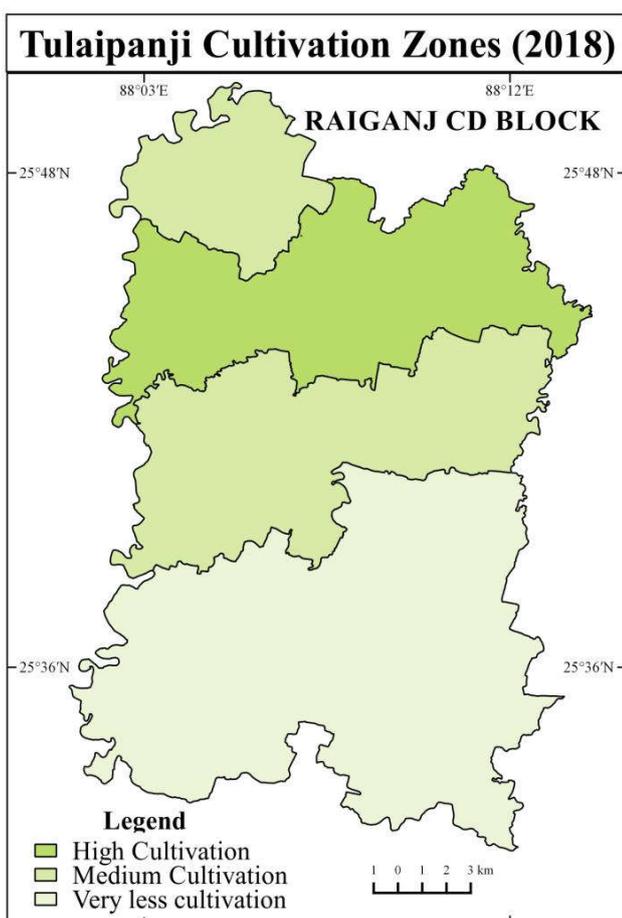


Figure 8. Map showing the Tulaipanji Cultivation Zones

During the field study, interview of the Tulaipanji cultivators as well as intensive field visit is conducted in Tulaipanji cultivated areas and their administrative location as well as geographic location and area also captured through with the help of GPS and Google Maps. Contour map and DEM are created with the help of SURFER software after the extraction of contour values from Google Earth Landsat image in Google Earth Pro software. In the post field study, simple statistical calculations are done using MS-Excel and further mapping are completed using QGIS software. Identified Tulaipanji cultivated zones are plotted on different physical map layers to extract out the characteristics of the ecological niche of Tulaipanji. Based on this, further reports are made for suggestion.

Ecological Niche of Tulaipanji Rice

Analysis of Physical Ecology: Geology, geomorphology, soil and climate are the basic physical factors which determine the growth and quality of any crops in any area. Climate do not vary from blocks to blocks, but the effects of other factors changes significantly. As Tulaipanji rice is cultivated in various small pockets in this region, so, to understand the physical ecology of this rice variety, analysis of the physical set up of the study is area is very necessary. The following discussion will give a proper picture about the physical set up of the study area.

Geology: Geological structure plays a dominant role for determining the geomorphological set up of any area as the intensity of the works of natural agents is totally depends on the nature of the underlying rock structure. The study area consists of four stratigraphic units. In order to older to newer on the basis of their geological age of formation they are Baikunthapur formation, Malda formation, Shaugaon formation and present day deposits respectively. Only Baikunthapur formation is of the late pliestocene to early holocene age and other formations are of holocene age. The major part of the study area is lying on Malda formation which consists of alternating sand, silt and clay. Except the SW part, the evidence of Baikunthapur formation is found all over the study area in a scattered way. It consists of predominantly coarse to fine sand alternating with silty sand. Shaugaon formation is seen only in the NE and SW parts. It also consists of alternating sand, silt and clay. The present day deposit is overlying on all formations. This formation is mainly formed in the riverside areas and it also consists of alternating sand, silt and clay.

Geomorphology: The structure and formation of the geomorphology and geomorphological units of the study area totally follows the geological units of this area. The study area is located in the Tal plain area of North Bengal plain which comes under Tista Flood Plain of the lower Ganga Plain. Micro-level geomorphic features are very common in this area. A major portion of the study area is under inactive flood plain which constitutes higher terrace levels that are usually not inundated by flood waters. Except the SW part, piedmont/fan is common in all other portions in a scattered way. Active flood plain is seen only in SW part. These areas are inundated annually during the floods. Back swamps and Paleochannels are the characteristic features in this area. During the high floods, these areas are only inundated. The study area consists of three geomorphological units, all of which are formed in Holocene age. Recent flood plain is the youngest geomorphological unit which is formed on the formation of present day deposit and dissected piedmont is the oldest geomorphological unit which is formed on the Baikunthapur formation. The remaining broad area which is under older flood plain (Fluvial facies) is formed on Malda and Shaugaon formation.

Soil: The study area is mainly dominated by the recent and older alluvial soils. Based on USDA Soil Taxonomy, soils in this area are classified into three categories. Entisols are formed over present day deposit and shaugaon formation. Soil horizons are not so clear in this soil order and it also contents very less organic carbon as it is the recent alluvium deposits of active flood plain. Major portion of the study area is covered by inceptisol which is formed in older flood plain (fluvial facies over Malda formation in.

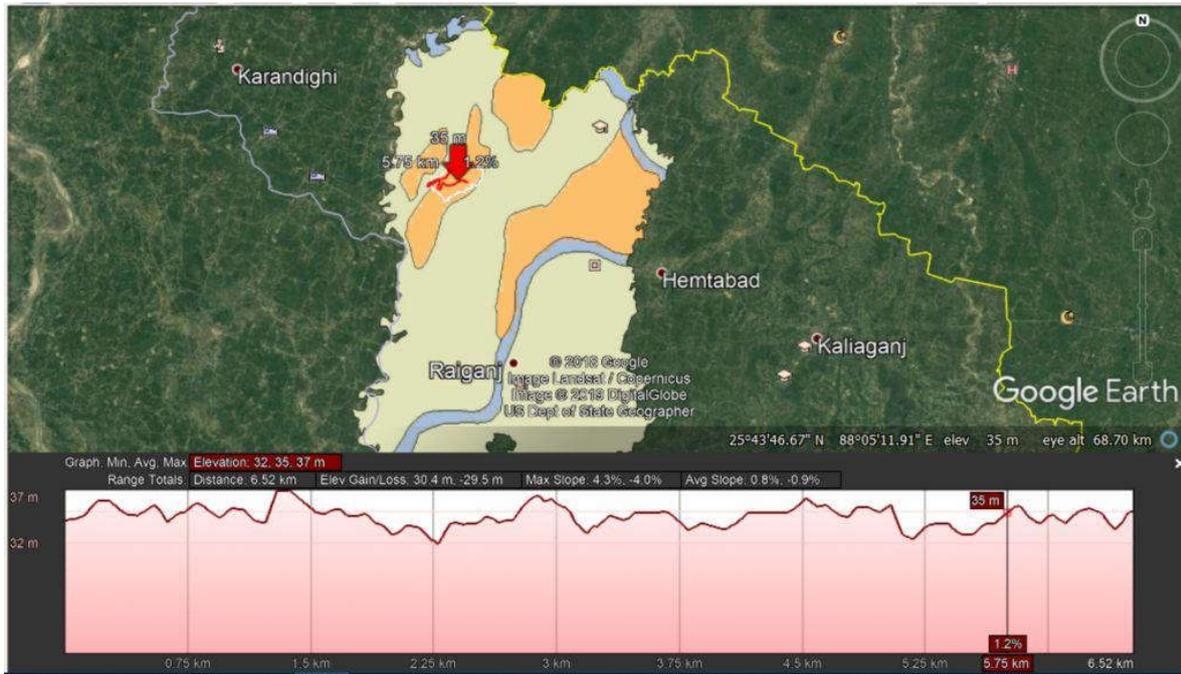


Figure 9. Satellite view and Elevation Profile of Tulaipanji Cultivated Area over Mapped Dissected Piedmont

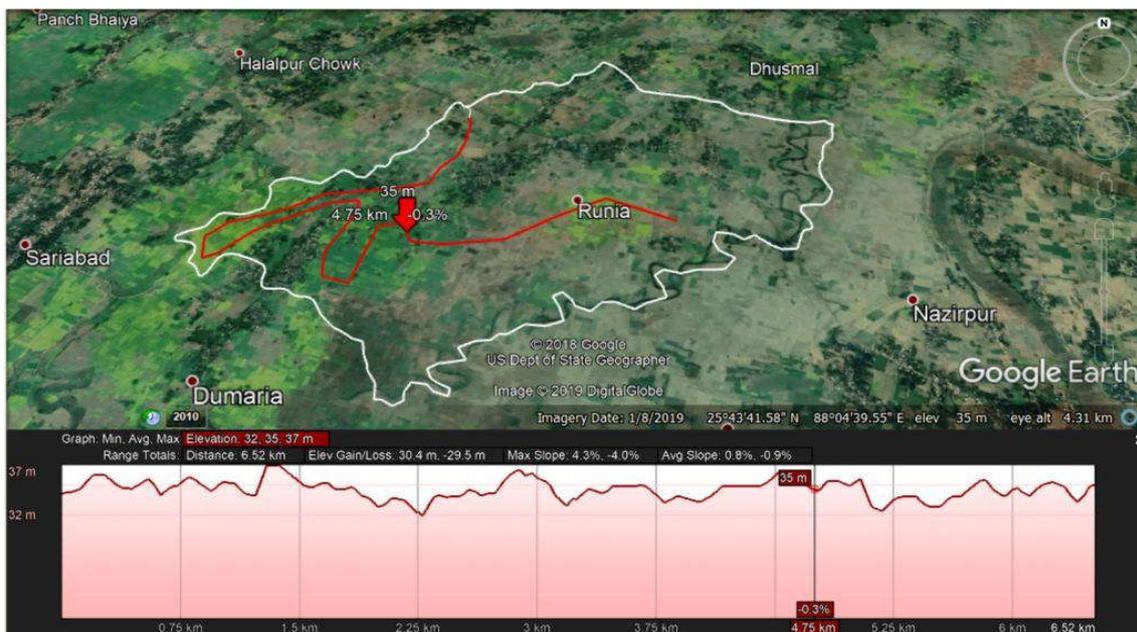


Figure 10. Satellite view and Elevation Profile of a highly cultivated Tulaipanji Village fields

Complete soil horizon is not found in this soil. Yet B horizon is seen elsewhere, but not clearly visible. Black prairie soil or mollisol is formed in the oldest geomorphological unit of dissected piedmont over Baikunthapur formation. This soil is mature in comparison with other soils in the study area. So that soil horizons are clear here and full with organic carbon.

Slope Aspects: General slope direction of the study area is found North East to South West. The rivers flowing in this area also follow this direction. The average slope in the study area is seen 0.8%. Maximum and minimum elevation of the area is 27 and 48 metre respectively. The average elevation of the area is found 33 metre. The contour map of the study area clearly showing the increases of the contour values from south-west to north east. (Fig.- 6) Digital elevation model (Fig.-7) of the study area also supporting this statement.

The covered area of each geological formation, geomorphological unit and soil in the study area are shown in the following table:-

Analysis of Social Ecology: Besides the restriction of the cultivated area of Tulaipanji rice, the cultivars group associated with this rice variety also restricted in its habitat zone. As this rice variety is cultivated here more than a century and its traditional way of cultivation is transferred from one generation to another, because of that the knowledge of its cultivation is limited to the farmers of specific cultivation zones only. After surveying the Tulaipanji cultivated areas, interview also done with the farmers and various social facts were extracted from the interview. Mainly the schedule caste people of more than 40 years are involved with its cultivation out of which Rajbangshi community involves much more with

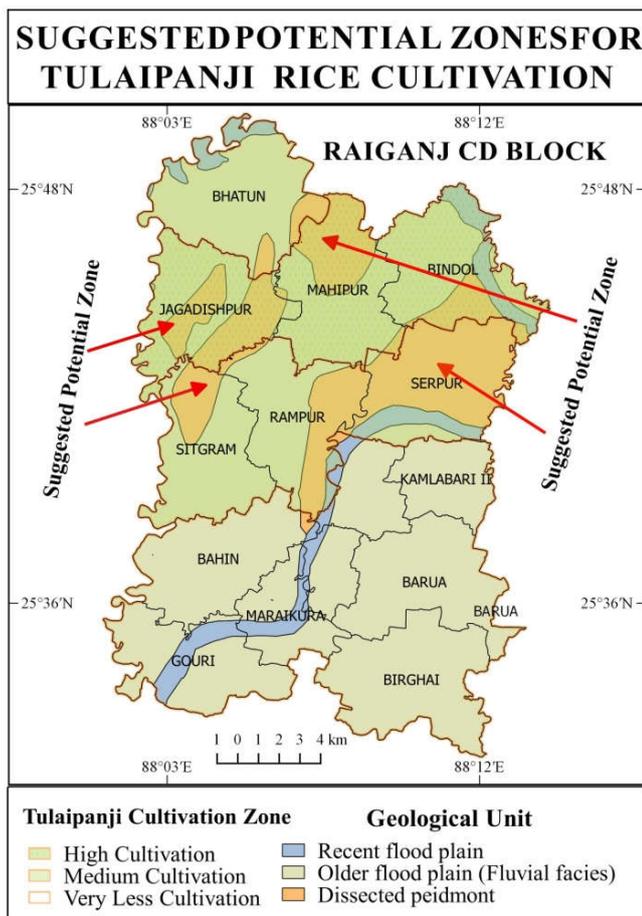


Figure 11. Map showing the suggested potential zones for Tulaipanji cultivation

the cultivation of Tulaipanji. This indigenous aromatic rice also plays an effective role on the socio-economic life of the farmers. As the market value of its paddy is nearly thrice than any of HYVs of rice and it requires no chemical input so its cultivation is economically profitable to the farmers. Besides this, farmers belong to both Hindu and Muslim community used this rice to make special dishes in their special family occasions, festivals and rituals. But in 2017-18, total production area, productivity and production of this rice decreases from the previous year mean 2016-17. Production as well as productivity of Tulaipanji rice found more in jute field. A Tulaipanji farmer generally follows crop rotation system for better production by following the three crop cultivation as Jute-Tulaipanji Rice and Mustard. Thus higher market value of jute and mustard also controls the farmers' psychology to cultivate the jute. Otherwise a farmer shows interest on the cultivation of maize and wheat. On that situation, the cropping system is changed totally and Tulaipanji field are replaced by the HYVs of rice.

Present Distribution of Tulaipanji Cultivation Zones: After surveying the whole block and identifying the Tulaipanji cultivated areas, it is found that the higher productivity and better quality of this rice variety is now cultivated in northern part of the block in the villages of Jagadishpur, Bindol, Mahipur and some parts of Rampur and Sitgram gram panchayets. A huge number of farmers of Runia village in Jagadishpur gram panchayet and Balia village in Jagadishpur gram panchayet is involve in its cultivation and maximum amount of Tulaipanji land is found in these two villages within the study area.

Medium to high land situation are found in this fields. Soil is mainly loamy and after the cultivation of jute, this variety is cultivated in the same jute field. The dead leaves and roots of the jute when mixed with the soil and changes into humus, makes the land more fertile which is suitable for cultivation of Tulaipanji without any fertilizers. Because of its higher market value, farmers out of the natural habitat of this rice variety also trying to cultivate this rice variety outside of its habitat area. In various parts of Sitgram, Serpur and Rampur Gram Panchayet this tendency is also found. If this rice variety is cultivated in non-jute field, that time both of its productivity and aromatic quality decreases.

Findings & Conclusion

From the overall study it is found that all the traditional Tulaipanji cultivated fields are located on dissected piedmont, the oldest geomorphological unit of the study area. This geomorphological unit develops over the Baikunthapur formation. It is predominantly a valley fill deposit of holocene age and its lithology consists of predominantly coarse to fine sand alternating with silty sand. This deposit has only an incipient soil cover. The average elevation found 35 metre in a famous Tulaipanji productive village Runia located on this physiography. If we follow the globally accepted USDA Soil Taxonomy, soil of this area will come in the category of mollisol or black prairie soil. It is mature in nature in comparison with the soil of the other parts of the study area. Soil horizons are clear only in this type of soil. Soils are mainly loamy in nature and full with organic carbon. In this natural habitat, productivity as well as aromatic quality of Tulaipanji reaches to its zenith. Another important fact that comes to knowledge during field survey is that Tulaipanji farmer normally follows the traditional crop rotation system as Jute-Tulaipanji Rice and Mustard throughout the year. Thus stable rice field ecology is already evolved in this natural habitat of Tulaipanji. If the market value of jute and mustard becomes non-profitable to the farmers that time Tulaipanji farmers show interest on the cultivation of wheat or maize in place of jute and mustard and HYVs of rice in place of Tulaipanji which require a huge amount of chemical inputs. Thus the stable rice field ecology of Tulaipanji is interrupted and the ecological balance damaged.

Farmers out of the natural habitat area of Tulaipanji sometimes shows interest on cultivation of Tulaipanji with chemical inputs for more production and more profit. In both cases, the aromatic quality of Tulaipanji rice decreases. Due to which its market value also decreases. Ultimately farmers face loss in its cultivation. The soil health is also damaged due to the use of chemical fertilizers. After a long time use of this chemical fertilizer, the soil fertility becomes so less that even after applied fertilizers no changes occur in productivity. Overall study about this topic suggests that the local agriculture department should have to delineate first the natural habitat of Tulaipanji that's mean the dissected piedmont zone, the oldest geomorphological unit in more accurate way. Out of the natural habitat of Tulaipanji, farmers have to make aware not to cultivate this rice with chemical input. A stable market price of jute and mustard fixed by the local government will also inspire the Tulaipanji farmers to continue the traditional crop rotation system of Jute-Tulaipanji Rice and Mustard. In this way, the use of chemicals should be avoided in Tulaipanji field and the damaged soil health should be regained.

Ultimately the restoration of damaged rice ecology of Tulaipanji in its natural habitat could also be possible by following these ways.

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