

An Analysis of Spatio-Temporal Changes in the Pattern of Crop Diversification in Undivided Sivasagar District, Assam (India)

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Abstract: *The study aims at analyzing the spatial variation and temporal perspective of the changing pattern of crop diversification in Sivasagar district between 1985-86 and 2015-16. Crop diversification means cultivation of various crops in a given area in an agricultural year which is essentially important in relieving risk of crops grown on the one hand and accelerating maximum return of produce on the other hand. The study is carried out with the help of secondary data collected from the Directorate of Economics and Statistics, Govt. of Assam. Gibb's and Martin's method of crop diversification is applied to investigate the pattern of crop diversification in the district and the results drawn reveal that district is marked with its spatio-temporal variation both in the district level and the revenue circle level.*

Key Words: *Crop diversification, Spatio-temporal Changes, Sivasagar District, Gibb's and Martin's method*

1. Introduction:

Agriculture is the backbone of Indian Economy. According to Agricultural Census of India 2011, 61.5% people are engaged in agriculture. As per the Economic Survey 2017-2018 also, agriculture sector employs more than 50% of the total workforce in India and contributes around 18% to the GDP (Gross Domestic Product) of the country. Hence the study of agricultural pattern of the country has been very relevant recent time. Crop diversification is one of the crucial parameters – the others being crop combination, crop concentration, cropping intensity etc that help in studying the actual scenario of agricultural pattern of a given region and thereby in contriving agricultural land use planning for better return in future. Crop diversification is therefore a fundamental element incorporated in agricultural geography. Crop diversification means cultivation of various crops in a given area in an agricultural year. It refers to the alteration from single crop farming to multiple crops farming or practice of a certain number of crops with their varieties or from subsistence farming to commercial farming. The magnitude of crop diversification is largely determined by many factors such as geo-climatic condition of a region, socio-economic and cultural conditions of the cultivators, availability of mechanical tools and implements, requirement of more returns from limited cropped area etc. The introduction of crop diversification during the period of Green Revolution drastically brought about a conspicuous change in Indian agriculture. It replaced the traditional pattern of mono cropping system on the one hand and accelerated the productivity of the soil on the other hand.

Keeping in view the importance of crop diversification, many geographers and academicians from different spheres i.e. geography, economics and allied disciplines have evolved different techniques for measurement of crop diversification. Among them, Gibb and Martin (1962), Bhatia (1965), Ayyar (1969), and Singh (1976), are most prominent. In 1962, Gibb & Martin formulated a method for calculating the index of diversification which was:

$$\text{Index of Crop Diversification} = 1 - \frac{\sum x^2}{(\sum x)^2}$$

Here, X is the percentage of gross cropped area or total cropped area absorbed by an individual crop. According to this formula, the index value is directly related to magnitude of crop diversification. It means higher the index value higher the magnitude of crop diversification and vice versa.

Bhatia¹ (1965) analyzed the cropping pattern of India on a regional basis with a view to bringing out the areal concentration and diversification of crops. In his study of cropping pattern in India, he analyses the regional character of crop concentration and its variation with the help of the following formula:

$$\text{Index of Crop Diversification} = \frac{\text{Percentage of sown area under 'X' crops in a region}}{\text{Number of 'X' Crops included in a region}}$$

Here, X crops are those crops which separately grasp 10% or more than 10% of the gross cropped area or total cropped area in a region. He summed up the total area under these crops and divided the sum by the number of crops. According to his method, higher the index, lower is the magnitude of crop diversification and vice-versa.

In 1969, Ayyar² evolved a new technique for measuring crop diversification regions in Madhya Pradesh. He modified the Bhatia's method by counting all the crops which possessed 1% or more than 1% of the total harvested area; and divided the sum of crops by the number of crops which absorbed 1% or more than 1% of the total cropped area.

In 1976, Jasbir Singh³ further modified the methods of Bhatia and Ayyar by counting those crops that individually occupied 5% or more of the total cropped area.

2. Study Area:

Sivasagar district is situated in the North-Eastern part of Assam between 94°25 and 95°25 longitude and 26°45 to 27°15 latitude east of Guwahati. Earlier Sivasagar was the capital of the mighty Ahoms, who had ruled Assam for more than six hundred years before the advent of the British. Sivasagar district, which included present Jorhat district as a sub-division of the greater Sivasagar district, had remained undivided till 1st July, 1983. In 1983, as Jorhat was carved out of the greater Sivasagar district, its geographical area was restricted only to 2668 sq km. The district is located at Upper Brahmaputra Valley of agro-climatic zone⁴ of the state. The northern and the western parts of the district are bounded by Dibrugarh and Jorhat district of Assam respectively and the eastern and southern part is bounded by Arunachal Pradesh and Nagaland. Sivasagar district consists of 3 civil sub-divisions – Sivasagar, Nazira and Charaideo⁵; 7 Revenue Circles; 9 Community Development Blocks, 5 Municipal Boards, 118 Gaon-Panchayats, 9 Anchalik Panchayats, 24 Mouza, and 878 census villages (866 inhabited villages and 12 uninhabited villages). The district occupies 2668 sq km. Out of it, Sivasagar sub-division, Nazira sub-division and Charaideo sub-division cover 999.55, 441.65 and 1226.8 sq km respectively.⁶ It is also worthwhile to mention here that Sivasagar district had consisted of only five revenue circles namely Dimow, Sivasagar, Amguri, Nazira and Sonari till 1991. In 1991, Mahmora Revenue Circle was split carving out one part (Khaloighugura Mouza) from Dimow Revenue Circle and the other part (Mahmora Mouza) from Sonari Revenue Circle. In 2013, Sapekhati Revenue Circle was formed out of Sonari Revenue Circle. Hence, at present, the undivided Sivasagar district comprises seven Revenue Circles namely Dimow, Mahmora, Sivasagar, Amguri, Nazira, Sonari and Sapekhati.

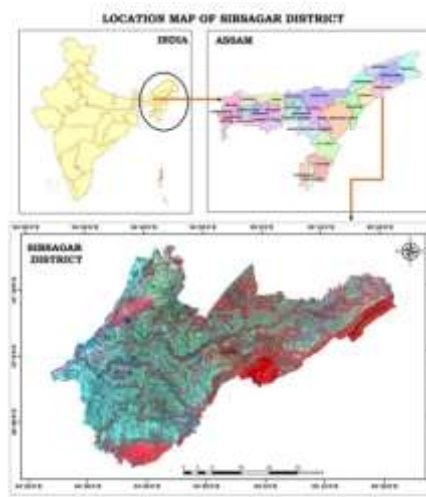


Fig. 1: Map showing the location of Sivasagar District in Assam (India)

3. Objectives:

The following two objectives are formulated to investigate the research problem:

- i) To analyze the spatio-temporal pattern of crop diversification in Sivasagar district.
- ii) To highlight the factors responsible for spatio-temporal changes in crop diversification in the district.

4. Methodology:

The study is carried out with the help of secondary data collected from Directorate of Agriculture, Government of Assam. To analyze the crop diversification in Sivasagar district, a period of thirty years is assumed based on the data of agricultural land use pattern of the district from 1985-86 to 2015-16 at an interval of five years i. e. 1985-86, 1990-91, 1995-96, 2000-01, 2005-06, 2010-11 and 2015-16. The entire spatio-temporal changing pattern of crop diversification index of the district is shown with the help of both tables and maps.

Gibb's and Martin's method of crop diversification is applied to investigate the characteristic features of cropping pattern in Sivasagar district. To highlight the magnitude of crop diversification in the studied area, the index value below 0.40 is shown as 'Low', between 0.40 to 50 as 'Moderate' and above 50 as 'High'.

5. Analysis & Findings:

The index value of crop diversification is found fluctuating between the range of 28 and 59 from 1985-86 to 2015-16. Table 1 to Table 7 represent the indices of crop diversification pattern in the district level as well as the revenue circles level of Sivasagar district from 1985-86 to 2015-16. From the concerned tables, it has been transparent that in the district level, Sivasagar ranged between 'moderate' and 'high' degree of crop-diversification from 1985-86 to 2015-16. Having remained in 'moderate' degree of crop-diversification from 1985-86 to 1995-96, the district attained in 'high' degree of crop-diversification from 2000-01 to 2005-06 and again fluctuated to 'moderate' degree of crop-diversification in 2010-11 and 2015-16.

So far as the revenue circle level is concerned, it has been discernible from the indices that there is no spatio-temporal uniformity of crop diversification among the revenue circles of the district in all the seven intervals. In 1985-86, Nazira fell into 'high' degree of crop-diversification followed by 'moderate' crop-diversification in Dimow and Sonari; and 'low' crop-diversification in Sivasagar and Amguri revenue circles.

As Table 2 shows, both Sonari and Nazira revenue circles were struck with 'high' degree of crop-diversification in 1990-91. It is seen that Sonari shifted from 'moderate' to 'high' degree of crop-diversification in 1990-91. Further, Dimow and Amguri revenue circles remained as 'moderate' and Sivasagar as 'low' degree of crop-diversification region in 1990-91.

In 1995-96, Nazira and Sonari revenue circles again stood together with an index of 'high' crop-diversification. Likewise, Dimow, Amguri and Mahmora revenue circles glowed with 'moderate' degree of crop-diversification. On the other hand, Sivasagar revenue circle still remained as 'low' degree of crop-diversification in 1995-96.

It is observed from Table 4 that in 2000-01, four revenue circles namely Dimow, Mahmora, Nazira and Sonari fell into the index of 'high' degree of crop-diversification. On the contrary, the index of crop-diversification still remained 'low' and 'moderate' in Sivasagar and Amguri revenue circles respectively.

In 2005-06 and 2010-11, all the revenue circles were characterized with the same index of crop-diversification level as shown in Table 4. However, in 2015-16, both Dimow and Mahmora revenue circles receded to 'moderate' and Amguri receded to 'low' degree of crop-diversification.

In respect of Nazira it is seen that it was the only revenue circle which remained in 'high' degree of crop-diversification in all the intervals from 1985-86 to 2015-16. In 1985-86, though Sonari remained as 'moderate' crop-diversification region, it emerged as 'high' degree of crop-diversification region in 1990-91 and continued the same till 2015-16. On the contrary, Sivasagar revenue circle remained in the same 'low' level of crop-diversification in all the seven intervals of five years from 1985-86 to 2015-16.

Table 1: Index of Crop Diversification in Sivasagar District, 1985-86

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.44	Moderate
2	Sivasagar	0.37	Low
3	Amguri	0.39	Low
4	Nazira	0.53	High
5	Sonari	0.48	Moderate
6	Sivasagar District	0.45	Moderate

Source: Computed by the Researcher

Table 2: Index of Crop Diversification in Sivasagar District, 1990-91

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.44	Moderate
2	Sivasagar	0.36	Low
3	Amguri	0.45	Moderate
4	Nazira	0.59	High
5	Sonari	0.51	High
6	Sivasagar District	0.48	Moderate

Source: Computed by the Researcher

Table 3: Index of Crop Diversification in Sivasagar District, 1995-96

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.47	Moderate
2	Mahmora	0.45	Moderate
3	Sivasagar	0.35	Low
4	Amguri	0.41	Moderate
5	Nazira	0.58	High
6	Sonari	0.52	High
7	Sivasagar District	0.48	Moderate

Source: Computed by the Researcher

Table 4: Index of Crop Diversification in Sivasagar District, 2000-01

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.57	High
2	Mahmora	0.52	High
3	Sivasagar	0.39	Low
4	Amguri	0.45	Moderate
5	Nazira	0.58	High
6	Sonari	0.54	High
7	Sivasagar District	0.52	High

Source: Computed by the Researcher

Table 5: Index of Crop Diversification in Sivasagar District, 2005-06

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.52	High
2	Mahmora	0.52	High
3	Sivasagar	0.23	Low
4	Amguri	0.41	Moderate
5	Nazira	0.55	High
6	Sonari	0.55	High
7	Sivasagar District	0.50	High

Source: Computed by the Researcher

Table 6: Index of Crop Diversification in Sivasagar District, 2010-11

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.51	High
2	Mahmora	0.51	High
3	Sivasagar	0.22	Low
4	Amguri	0.43	Moderate
5	Nazira	0.56	High
6	Sonari	0.52	High
7	Sivasagar District	0.49	Moderate

Source: Computed by the Researcher

Table 7: Index of Crop Diversification in Sivasagar District, 2015-16

SL No	Revenue Circles	Index of Diversification	Degree of Diversification
1	Dimow	0.49	Moderate
2	Mahmora	0.48	Moderate
3	Sivasagar	0.28	Low
4	Amguri	0.34	Low
5	Nazira	0.54	High
6	Sonari	0.55	High
7	Sapekhati	0.53	High
8	Sivasagar District	0.49	Moderate

Source: Computed by the Researcher

The spatio-temporal changes of crop diversification pattern in Sivasagar district is further shown with the help of maps drawn in Fig. 2 to Fig. 8 based on the concerned tables.

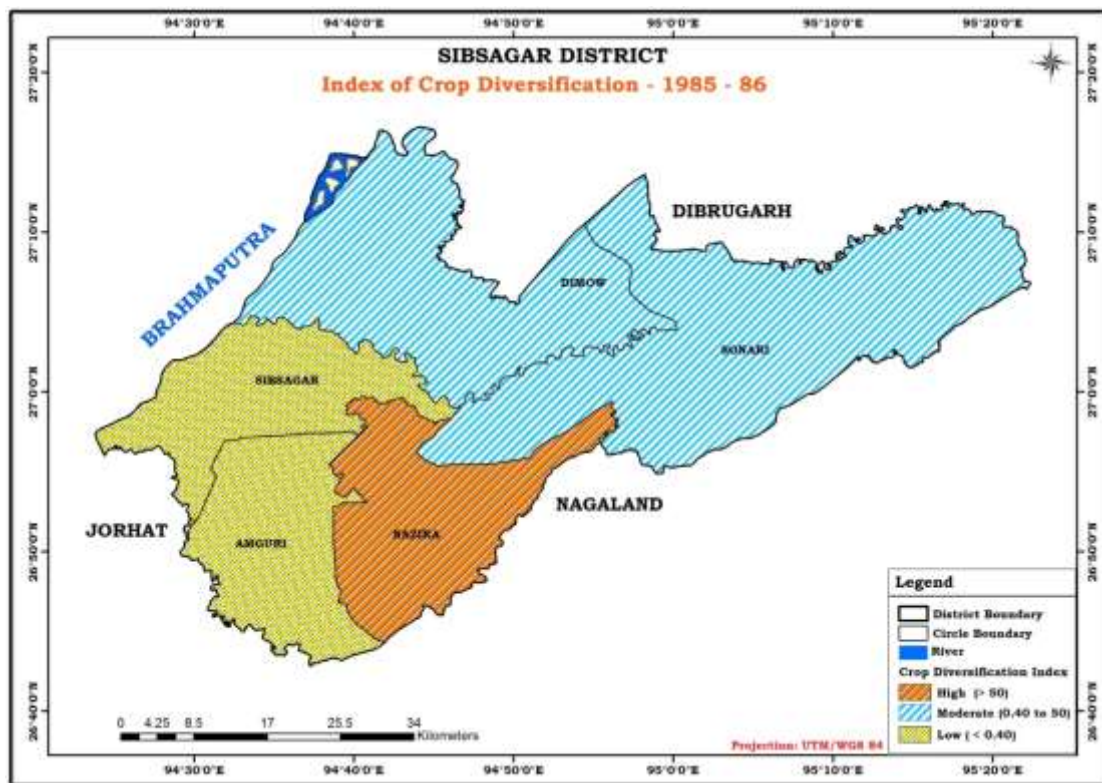


Fig. 2: Map showing crop-diversification scenario among the five revenue circles of Sivasagar district in 1985-86.

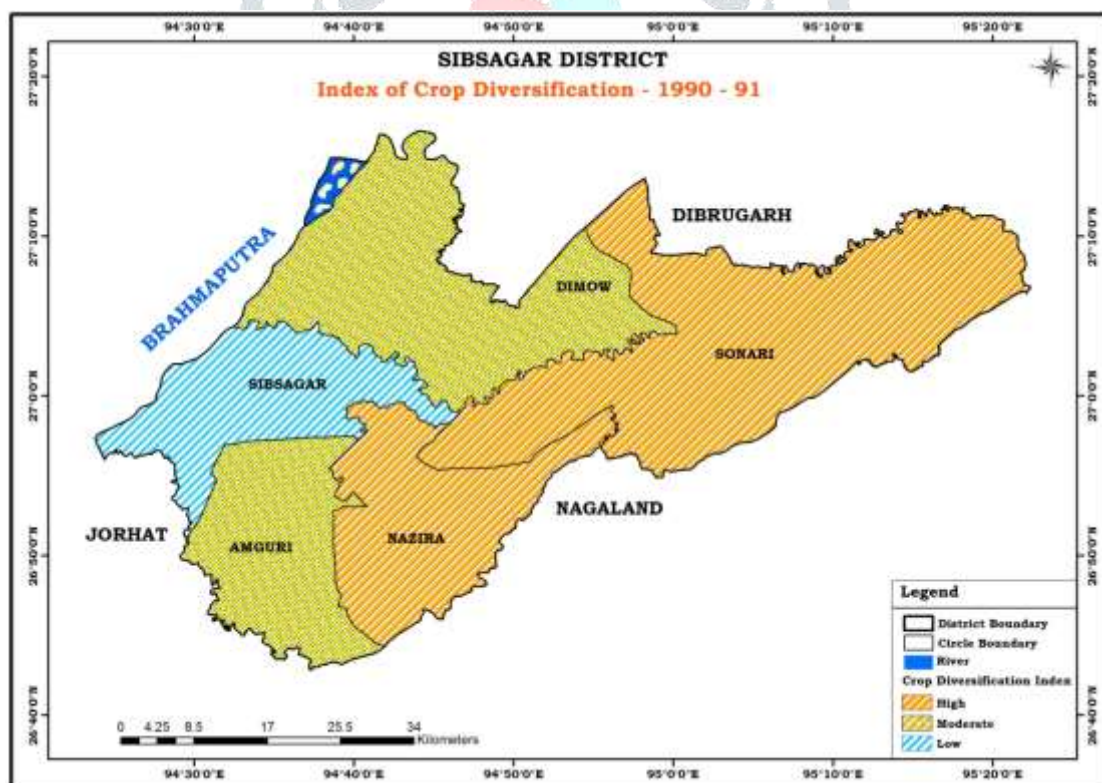


Fig. 3: Map showing crop-diversification scenario among the five revenue circles of Sivasagar district in 1990-91.

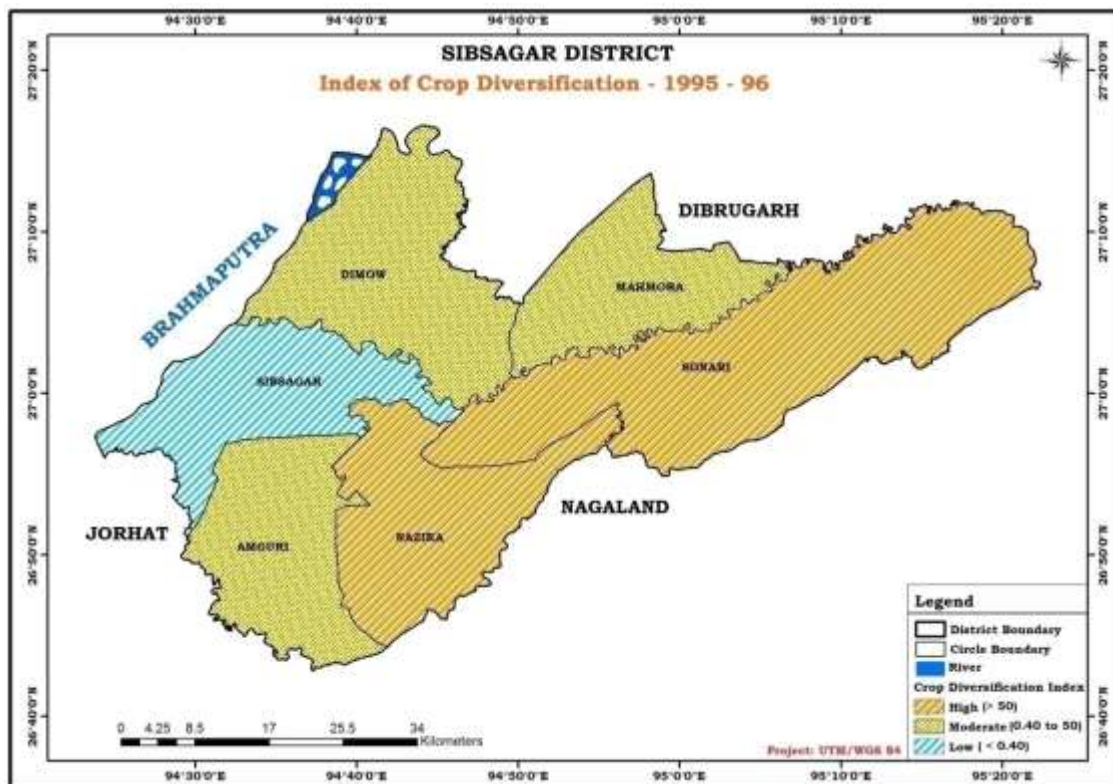


Fig. 4: Map showing crop-diversification scenario among the six revenue circles of Sivasagar district in 1995-96.

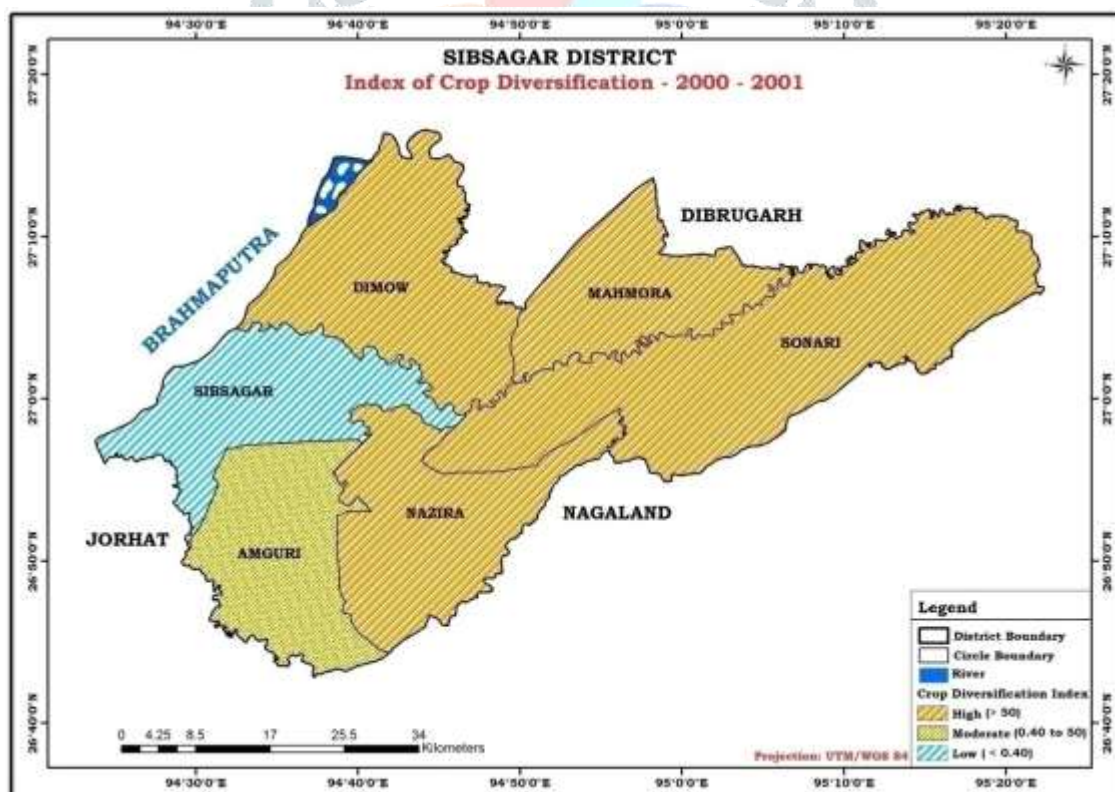


Fig. 5: Map showing crop-diversification scenario among the six revenue circles of Sivasagar district in 2000-01.

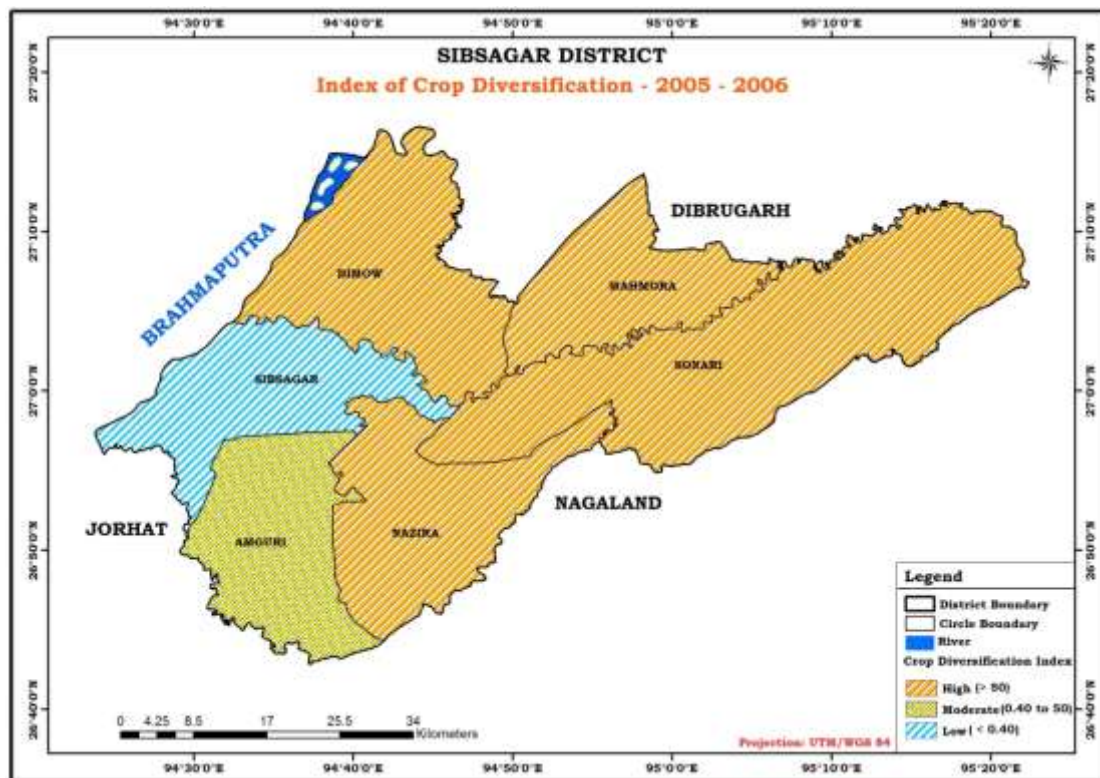


Fig. 6: Map showing crop-diversification scenario among the six revenue circles of Sivasagar district in 2005-06.

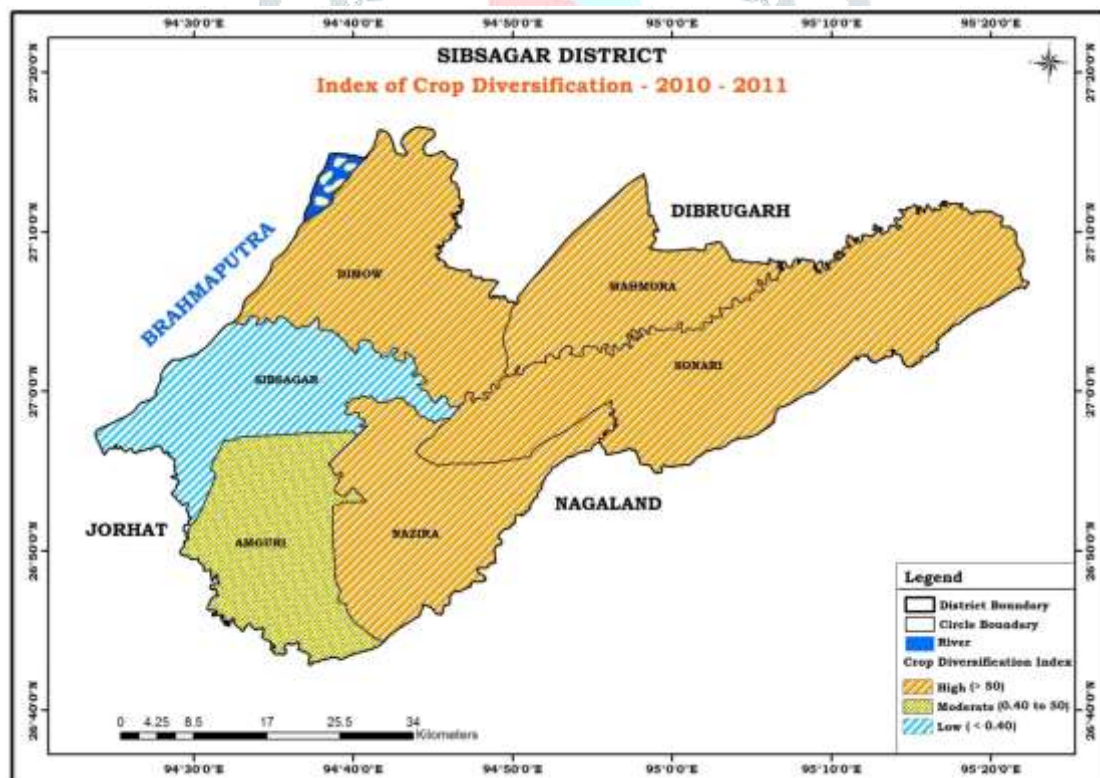


Fig. 7: Map showing crop-diversification scenario among the six revenue circles of Sivasagar district in 2010-11.

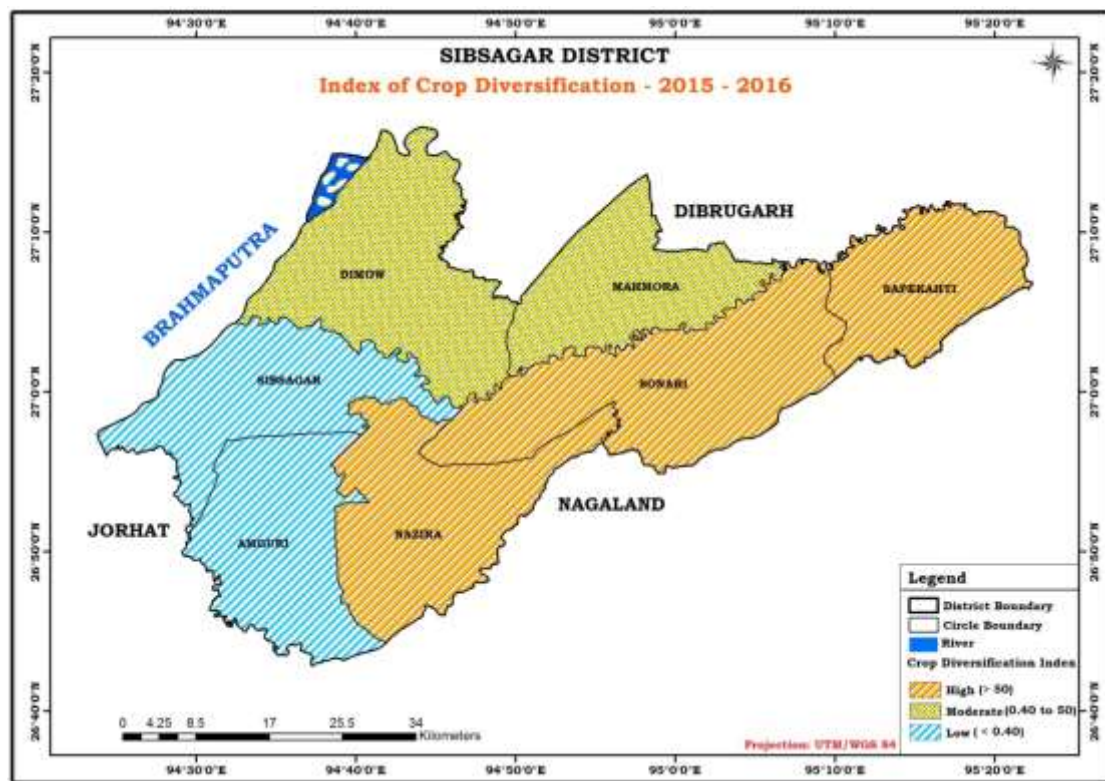


Fig. 8: Map showing crop-diversification scenario among the seven revenue circles of Sivasagar district in 2015-16.

6. Conclusion:

Thus, from the study it is observed that the district is marked with its spatio-temporal variation in crop diversification. It is also worthwhile to state that the variation is determined or influenced by some crucial factors such as lack of adequate irrigation system, small land holding size, inadequacy of proper planning in agricultural activities, expansion of tea garden in agricultural area etc. Facility of irrigation still remains far behind. The agricultural activities in the district primarily hinge on weather conditions. The fate of the farmers is determined by the average rain fall in the district. Hence, it is seen that winter paddy is the dominant crop of the district. Very scanty portion of agricultural area is facilitated with irrigation in the district. On the other hand, it is also very important to note that, like the other districts of upper Assam (India) such as Golaghat, Jorhat, Dibrugarh and Tinsukia, Sivasagar is also gifted with a very conducive geo-climatic condition for tea cultivation. The cultivators have contrived to expand tea garden area as much as possible in the district with the hope of getting maximum return from tea plantations. The return of tea plantations is much higher than that of the most dominant crop – paddy. It is therefore seen that the district is marked by an increasing trend of tea plantation area against the decreasing trend of area absorbed in paddy and other crops in the district. So, expansion of tea plantations in agricultural area can be accounted to be another significant factor which affects in the crop diversification in the district.

To wind up the study, the following three suggestions are put forward:

1. Lack of irrigation facility is the main factor in the spatio-temporal variation of crop diversification in the district. It is very regretful to state that the irrigation system is still in a very deplorable condition in the district. What has been done regarding it is not sufficient. A holistic and strategic cum scientific step is urgently required in the practical ground to mitigate it. Priority should be given to sincere survey and classification of the cropped land; and the feasibility of irrigation scope must be extracted thereof. Minor irrigation projects like lift irrigation and deep tube well irrigation must be extensively initiated in the grass root level. Creation of small ponds in the midst of the fields, covering the marshes and the depressed areas with the twin aims of irrigation and pisciculture can be an appropriate approach towards increasing the irrigation-potential in the area. Project of rain-harvesting can be implemented as an alternative means of it. Besides, the two main tributaries namely the Dikhow and the Dichang, and the other small flows can also be harnessed positively as the source of supplying water to the cropped areas.
2. Adoption of improved technology can never be possible if the farm size is not raised to an economically feasible unit. Therefore, fragmentation of land holdings should be prohibited by legislation. Non-cultivators should not be allowed to possess cultivable land. The name of the genuine cultivators should be officially registered; and cooperative farm societies should be established in order to inspire and make them responsible to accelerate agricultural economy.
3. Government can also take a holistic but far-reaching step in the magnitude of crop diversification through legislative and administrative measures. Steps may be taken by the government to ease or subsidize the supplies of farm inputs and knowledge. The intensity of crop diversification depends on availability of agriculture related facilities such as

high yielding of seeds, fertilizers and manures; adoption of crop rotation, mixed cropping, relay cropping etc; improved facilities for plant protection, water-storage, marketing, transport etc. Hence, adequate and immediate measures should be taken on the part of government regarding it targeting the benefit of the cultivators.

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3. Singh, J. (1976), *An Agricultural Geography of Haryana*, Vishal Publication, Kurukshetra, pp. 253-264.
4. The agro-climatic zone is nothing but a climatically classified location suitable to agriculture. The National Commission on Agriculture classified India into 127 agro-climatic zones in 1971.
5. The Charaideo Sub-division was declared a district in 2015. However, it is included in the study area (hence undivided Sivasagar district) since the spatio-temporal changes of cropping intensity is shown from 1985-86 to 2015-16.
6. Sivasagar District at a Glance 2009.

