Study of Agricultural Regionalization Status using GIS Platform in Bilaspur District, Chhattisgarh, India

Subir Kumar Moyra1
1Guest Lecturer
1M. N. Mahavidyalaya, C. U.

Abstract— Information on agricultural regionalization status constitutes an important aspect of agricultural geography as it provides a good basis to understand relative position of crops on regional scale. In order to facilitate planning and development of agriculture, a systematic study of agricultural regionalization has a great significance. Such inputs are indeed essential for proper management of agro-climatic constraints and to reach the destiny of sustainable agricultural development. The present study attempts to identify the agricultural regionalization status of Bilaspur district using quantitative technique. Beside it also presents systematical development of agricultural regionalization index. In order to get maximum level of accuracy the whole processing has been done under GIS environment with the help of data obtained from District Statistical Hand Book 2010-11.

Key words: GIS, Regionalization, Quantitative Techniques, Methods, Pattern, Combination

I. INTRODUCTION

Bilaspur district situated in fertile tract of river Mahanadi and its tributary, Arpa, Hasdeo, Soneath etc. The prevailing economy of the study area is dominated by agricultural activity. The district has a total cultivable land of 2733.53 Km.2 (DSHB, 2010-11, Bilaspur district) in which mostly rice are cultivated with semi intensive method. Alongside rice, other crops are also grown in the area with various level of intensity. Due to extreme agro-climatic condition and high demand of cereals in the district, paddy is cultivated here in all possible agricultural holding once in a year with the help of monsoon water. For this very reason the district is often called as Dhan Ka Katora.

Agricultural regionalization is regarded as a device for clustering both visible and non-visible agricultural phenomenon on the earth surface. Such device enables geographers to divide an area into several regions in terms of diversity present in agricultural system. It gives us the relative position of crops on regional scale (Ogale, 2014). The prime advantage of agricultural regionalization lies in the fact that it helps in the formulation of agricultural plans which is indeed useful to reducing the regional disparities. Such analysis would ultimately minimize the change of oversimplified generalization (Ali M, 1978). There are various methods of agricultural regionalization, most of which is done by the help of agricultural statistics. Study of cropping pattern and crop combination is by far the two most familiar and universal methods of agricultural regionalization.

Unlike the previous findings (Kaojarern, 2001, Motebennur, 2014), this study has been directed to upgrade the agricultural regionalization methods. The present research work is trying to generate inputs by processing the data using recent technologies like Geographical information System (GIS) in cooperating with in situ observations and field verification (Panigrahy, 2005). Geographic Information System (GIS) is regarded as a set of tools for collecting, storing, transforming, and displaying spatial data from the real world observation for fulfilling the desired. It is indeed ‘a system for capturing, storing, checking, integration, manipulation, analyzing and displaying data which are spatially referenced to the Earth (Burrough, 1986).”

II. THE STUDY AREA

Bilaspur district lies in western parts of newly formed Chhattisgarh state. Bilaspur is the head-quarter of Bilaspur subdivision.

III. DATA AND SOFTWARE USED

The entire study is based on secondary sources of data. It has been collected for the entire district, accessing it upto tehsils level based on the latest administrative set up. District Statistical Handbook of Bilaspur district has been considered as the main source of raw data. Agriculture related statistics has been also obtained from diverse sources.
like, Land Record Office of Bilaspur and Indira Gandhi Agricultural Research Centre, Bilaspur. As most of the data used is of secondary type, they were verified by ground truth survey.

Erdas Imagine 9.2 has been used for digitization and boundary generation of the selected area under study. Whereas GIS based thematic map was prepared by the help of ARC GIS 10.1. MS-Excel was also successfully used to tabulate and processed such large amount of statistics.

IV. METHODOLOGY
The methodology of the present appraisal was primarily based on Geographical Information System based data analysis approach. A series of activity has been performed in order to identify the present agricultural regionalization status of the study area which is shown by following flow chart.

A. Background of Agricultural Regionalization
The first agricultural regionalization method was come into light in way back sixties of the previous century. It was based on empirical technique (Baker, 1926). Since then many techniques of regionalization has been developed in the arena of agricultural geography i.e. single element, statistical, quantitative cum qualitative and normative etc. Among these statistical techniques are considered as more improved than other as it considers closely associated multiple responsible element. For this often this technique is also called multi-element technique.

B. Selection of Regionalization Technique
In the present study agricultural regionalization status of Bilaspur district was identified with the help of two selected statistical technique, Cropping pattern and Crop combination. Both the techniques has the strong ability to depict the real agricultural phenomena of the respective study area which ultimately helps influence the decision making process of the farmers.

C. Computation with Selected Techniques
The cropping pattern of a particular area exhibits the effort of man to overcome the climatic conditions in that area (Kavitha & Aruchamy, 2013). The cropping pattern (CP) of a region may be determined on the basis of areal strength of individual crops. The first three crops of an areal unit may be called as the dominant crops of that unit. In any cropping pattern each crop is given its position in terms of percentage in relation to the gross cropped area of an areal unit. Minor crops are eliminated and not considered while recognizing with the cropping pattern. Following is the computation:

$$\text{CP} = \left( \frac{C_i}{A} \right) \times 100$$

(Where, $C_i$ = area of individual crop, $A$ = total cultivated area.)

To identify the crop combination regions in Bilaspur district Weavers Statistical technique has been applied. Crops are generally grown in combinations (Weaver, 1954). For the determination of minimum deviation, standard deviation method has been usually used. But Weavers pointed out, the relative (SD), not absolute value being significant, square roots was not extracted so, the actual formula used as follows:

$$\text{SD} = \frac{\sum d^2}{n}$$

(Where, $d$ = difference between actual and observed percentages, $n$ = no. of crops.)

V. SPECIFICATION OF SELECTED TECHNIQUES
Statistical techniques selected for the identification of agricultural regionalization status of Bilaspur district are discussed below.

A. Cropping Pattern:
Cropping patterns are the extent to which the available land under different agricultural activities can be put to use. It is largely depend upon physical, socioeconomic and political influences which determine the possibility of the farmer to choose the input intensity with which he farms. Considering an assumed supply of water and availability of modern inputs specially high yielding varieties of seeds and chemical fertilizer, it becomes possible for the farmer to replace less profitable crops with more profitable ones and also to enhance the intensity of use of the available land by growing two or even three crops in the same field in a year. Differences in altitude towards rural land in the levels of prosperity and technology have produced changes in emphasis, which are only gradually coming to be appreciated, although in the long run their effects in both landscape and land use studies are likely to be far reaching.

B. Crop Combination:
Crops are generally grown in combinations and it is rarely that a particular crop occupies a position of total isolation than other crops in a given areal unit at a given point of time (Husain, 1926). The distribution maps of individual crops are useful for planners but it is more important to view integrated assemble of the various crops grown in an areal unit. For a comprehensive and clear understanding of agricultural mosaic of an agro climatic region, planning and development of its agriculture, a systematic study of crop combination has a great significance. First attempt for delineation of agricultural regions was made by Weaver in
1954 for crop combination study of Middle East countries. Coppock (1964) modified Weaver’s method where he considered the rank in recognizing the leading crops. The technique was subsequently again modified by Doi (1959) where he supplied one sheet of table required only the summing up of actual percentages under different crops instead of finding differences between actual percentage and theoretical distribution. In Indian context, Rafi-ul-lah (1956) provide new technique by considering positive and negative difference from the median value of the theoretical curve value regarding the combination.

VI. RESULTS AND DISCUSSION

A. Findings in cropping pattern
Most of the tehsils cover 70% of paddy crop as compare to gross cropped area and it is also found that other crops are minor in share.

1) Tehsil Level Status:
As per tehsil wise cropping pattern scenario, rice remains the first crop for all the tehsils. Cropping area under rice is highest in Bilha with 82.31% and lowest in Takhatpur with 59.2%.

Tewra is the second crop in Masturi, Takhatpur and Kota, oil seed is the second crop in Pendra and Gourela tehsil while wheat, maize and vegetable holds second position in Bilha, Marwahi and Bilaspur.

Regions third dominant crop is wheat which also holds third rank in Takhatpur, Pendra and Bilaspur tehsil. Maize is also ranked third in some tehsils.

![Cropping Pattern Map](image)

**Fig. 3: Cropping Pattern Map**

B. District Level Status:
The study Bilaspur district have a following cropping patterns. According to table no. 1, first rank crop in the Bilaspur district is rice; this is about 72.43% of the gross cropped area of the district. Tewra is the second rank crop covers 10.1% area of the total cropped land. Wheat is the third rank which covers 4.81%.

From the overall cropping pattern scenario the area is distinctly mono cropped having dominancy in cereals.

<table>
<thead>
<tr>
<th>Tehsils</th>
<th>Rice</th>
<th>Wheat</th>
<th>Maji</th>
<th>Kodo</th>
<th>Other cereals</th>
<th>Chan</th>
<th>Tewra</th>
<th>Urad</th>
<th>Other pulses</th>
<th>Fruit</th>
<th>Vegetables</th>
<th>Oil Seeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masturi</td>
<td>82.3</td>
<td>1.43</td>
<td>0.18</td>
<td>0.05</td>
<td>0</td>
<td>0.07</td>
<td>12.4</td>
<td>0.2</td>
<td>0.78</td>
<td>0.33</td>
<td>1.58</td>
<td>0.63</td>
</tr>
<tr>
<td>Bilha</td>
<td>75.8</td>
<td>2.77</td>
<td>0.17</td>
<td>0.21</td>
<td>0</td>
<td>0.86</td>
<td>15</td>
<td>0.1</td>
<td>1.52</td>
<td>0.09</td>
<td>2.50</td>
<td>0.82</td>
</tr>
<tr>
<td>Takhatpur</td>
<td>59.2</td>
<td>13.7</td>
<td>0.19</td>
<td>1.03</td>
<td>0.06</td>
<td>2.99</td>
<td>15.1</td>
<td>0.1</td>
<td>3</td>
<td>0.54</td>
<td>2.81</td>
<td>1.02</td>
</tr>
<tr>
<td>Kota</td>
<td>78.0</td>
<td>2.01</td>
<td>1.63</td>
<td>1.26</td>
<td>0.13</td>
<td>1.07</td>
<td>8.61</td>
<td>0.3</td>
<td>1.71</td>
<td>0.14</td>
<td>1.71</td>
<td>3.28</td>
</tr>
<tr>
<td>Pendra</td>
<td>74.7</td>
<td>4.19</td>
<td>3.73</td>
<td>1.44</td>
<td>1.79</td>
<td>0.91</td>
<td>0.47</td>
<td>1.9</td>
<td>3.2</td>
<td>0.26</td>
<td>1.31</td>
<td>5.95</td>
</tr>
<tr>
<td>Gourela</td>
<td>70.9</td>
<td>4.03</td>
<td>4.44</td>
<td>1.90</td>
<td>2.27</td>
<td>1.01</td>
<td>0.79</td>
<td>1.7</td>
<td>3.91</td>
<td>0.37</td>
<td>1.43</td>
<td>7.18</td>
</tr>
<tr>
<td>Marwahi</td>
<td>66.1</td>
<td>0.99</td>
<td>10.0</td>
<td>3.36</td>
<td>3.92</td>
<td>0.61</td>
<td>0.26</td>
<td>1.9</td>
<td>2.44</td>
<td>0.36</td>
<td>1.14</td>
<td>8.77</td>
</tr>
<tr>
<td>Bilaspur</td>
<td>75.6</td>
<td>3.28</td>
<td>0.19</td>
<td>0.005</td>
<td>0.00</td>
<td>0.3</td>
<td>14</td>
<td>0.2</td>
<td>1</td>
<td>0.471</td>
<td>2</td>
<td>4.01</td>
</tr>
<tr>
<td>Dist Total</td>
<td>72.4</td>
<td>4.81</td>
<td>1.91</td>
<td>0.99</td>
<td>0.71</td>
<td>1.11</td>
<td>10.1</td>
<td>0.6</td>
<td>2.04</td>
<td>0.346</td>
<td>3</td>
<td>2.17</td>
</tr>
</tbody>
</table>

Table 1: Cropping Pattern of Bilaspur

Source: DSHB, 2011, Bilaspur District (C G)

C. Findings in Crop Combination:
While delineating crop combination, medial value for monoculture was considered at 50 percent, for two crop-combinations it is 25 percent, three crop-combinations the value is 16.7 percent, for four it is 12.5 percent and for five crops it is 10 percent. In present study area, 5 crops were used for computation of crop combination region. The
obtained results of crop combination are shown in table no. 2.

1) Tehsil Level Status:
Illustration of Weavers technique in Bilha tehsil was done as a sample calculation. The tehsil has five major crop percentages like as stated, rice (75.89%), tewra (15.0%), wheat (2.77%), vegetable (2.50%) and chana (0.86%).

1) Monoculture = (100-75.89)/1 = 947.64
2) Two crops = (50-75.89) + (50-15) / 2 = 1027.08
3) Three crops = (33.33-75.89)2 + (33.33-15)2 + (33.33-2.77)2 / 3 = 1027.08
4) Four crops = (25-75.89)2 + (25-15)2 + (25-2.77)2 + (25-2.5)2 / 4 = 922.55
5) Five crops = (20-75.89)2 + (20-15)2 + (20-2.77)2 + (20-2.5)2 + (20.86)2 / 5 = 906.36

The deviation of the actual percentages is seen to be the lowest for mono culture in Bilha tehsil. Hence it can be firmly said that the respective tehsil has shown mono culture, i.e. in terms of crop combination practice.

Most of the tehsils of the study area has under mono crop combination having an individual SD value ranging from 312.91 to 1144.2.

The acquired value for rest of the tehsils has almost shown same trend as Bilha except Marwahi and Takhatpur tehsil which has lowest SD value in two crop culture. These tehsils has the fortune to enjoy maximum no. of crop combination in the district. Takhatpur and Marwahi have rice wheat and rice oil seed combination. However, deviation value shows that two crops combination is second lowest in rest of the tehsils also.

Rice is leading crop in study region showing highest coverage in all eight tehsils of study region. However its intensity is more towards southern part. This happened due to existence of fertile and deep soil in the respective tehsils of the southern part of study area.

High dominancy of rice crop is slightly neutralized towards northern parts as wheat and maize are replaced by rice. Oil seed and pulses are also grown in large amount towards these rice shortage tehsils. Interestingly vegetables are placed in a significant position in urbanized tehsil of Bilha and Masturi.

VII. CONCLUSION

The physical conditions of an area effect the extent of agricultural operations. However, the role of human activity is equally important. Many a time, man is able to make satisfy his needs. Extensions of irrigation and use of drought resistant high yielding varieties are some of the agricultural purposes.

To get rid of this situation measures should be taken in the direction of enhancing crop diversification. Study of agricultural regionalization is one of the preliminary steps in this regard.

REFERENCES


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