Agricultural density and Population Distribution

Birbhum is primarily an agricultural area. Agriculture is the chief occupation of the people of the district, the majority of the working population being cultivators and agricultural labourers. In Census of 1991, 569,712 persons out of a district total of 2,555,664 persons or 22 percent of the total population were found to depend upon agriculture for their livelihood. Such persons constitute 73.28% of the total workers of the district. The dominance of agricultural pursuits is thus quite obvious. In order to assess the pressure of population upon the agricultural resources of the district, “agricultural density” has been taken as an indicator. “Agricultural density” as proposed by Trewartha, G. T., is computed by \( D_A = N_A/A_c \), where, \( N_A \) = Number of persons engaged in agriculture, \( A_c \) = Cultivable area. It is to be noted that \( D_A \) or agricultural density of the district has been in continual change.

The changes in agricultural density are frequently associated with dynamism or stagnation in the spatial pattern of agricultural production. In Birbhum every extension of agriculture by bringing in hitherto fallow land had attracted immigrants from neighbouring Santal Parganas as agricultural labourers. Growth of export trade and of agriculture-based industry had also attracted immigrant traders and labourers from time to time. Similarly every failure of crop due to natural calamities had led to emigration out of the district and more deaths than births due to starvation and malnutrition. Asok Mitra had rightly commented, “the population in Birbhum has been a weathercock of the district’s agricultural production and natural calamities.” It is interesting to note that the pressure of population in rural areas of the district was subject to only very slight variation till 1951. The sudden rise in the rural density in the decade between 1951 and 1961 is ascribable to the fact that the Mayurakshi Irrigation Project turned a vast quantity of hitherto unarable land into cultivable land able to support a greater number of people than it could previously. The overwhelming proportion of agricultural population with respect to total population still remains a persistent feature in Birbhum.

14.1 Agricultural density

In the light of the above discussion it is assumed that agricultural density may have some bearing upon rural population density in Birbhum. To illustrate the spatial variation in the distribution of agricultural density, a choropleth map has been prepared with the help of population and land use data from 1991 census report of Birbhum district (Fig. 39). Total number of persons making a living out of agriculture i.e. cultivators and agricultural labourers and also cultivable area for each C. D. block have been considered to determine the agricultural density (Trewartha, Glen T. and Ferenczi, I). In agricultural countries where heavy reliance is placed on farming, this density provides one with a means to make a comparison between agricultural population and cultivated area.
including fallow land (Singh J and Dhillon S S 1994). From this map it can be said that the blocks in the eastern part of the district have greater number of persons engaged in agriculture than in the west. From 200 to 225 persons per unit of cultivable area are found in Rampurhat II and Mayureswar II and from 175 to 200 persons per unit area are found in Sainthia, Bolpur-Sriniketan and Nanur in the south and Muraroi II and Nalhati I in the north. In the west in Rajnagar, Mahammadabazar, Khoyrasol and Dubrajpur fewer numbers are engaged in agriculture.

14.2 Relationship between agricultural density and rural population distribution

The two maps of rural population density and agricultural density may be compared visually. It is found that both the phenomena increase from west to east. The lowest rural population density is seen in Rajnagar and Mahammadabazar. The agricultural density is also low in these blocks. Eastward the agricultural density is higher and the same is found to be true of rural density. The C. D. blocks in the east are agriculturally more developed and engage greater numbers in agriculture. Muraroi, Nalhati, Rampurhat and Mayureswar are in this class and also have high rural density. Such visual comparisons do not give any conclusive information. For that the following statistical analysis appears to be a better choice.

As an initial step towards such analytical study, the regression of density of rural population on agricultural density, i.e. agricultural population per sq km of cropland has been employed. Fig. 40 shows a scatter diagram in which the rural population density, i.e. D values have been shown along the Y-axis and agricultural density, i.e. M values have been shown along the X-axis (Appendix 1, Table K). The value of D and M at the areal centre of each block have been taken as paired values whose location in the scatter diagram shows the graphical correlation between the two variables and have been utilised to draw the regression line, i.e. the line of best fit. The regression line obtained by the method of least squares is $D_c = 109.0 + 2.72M$, which shows the linear relationship between agricultural density (M) and rural population density (D). Stated in statistical terms, according to this relationship a block in Birbhum district with 100 persons engaged in agricultural pursuits per sq km of cultivable area, is expected to support a rural population density of 381 persons / sq. km. ($D_c = 109.0 + 2.72 \times 100 = 381$ approx.).

In a similar manner the 'expected' ($D_0$) rural population density for each C. D. block is computed. The values thus obtained may be plotted at the areal centre of respective blocks and isolpets may be drawn through them. If such an attempt were made there would be two population density maps – one showing the actual distribution and the other showing what the density distribution would be if it were entirely dependent on agricultural density as defined by the trend line, i.e. the regression line. In order to find out the strength of relationship or the degree of association between the two variables, the Pearson product moment correlation coefficient has been employed. This shows that the correlation coefficient is 0.61. The value of $r$ is obtained thus:

$$r = \frac{N \Sigma MD - (\Sigma M) (\Sigma D)}{\sqrt{(N \Sigma M^2 - (\Sigma M)^2)} \times \sqrt{(N \Sigma D^2 - (\Sigma D)^2)}}$$
Fig. 40: Scatter diagram (agricultural density and rural population density)
where, \( r \) = Correlation coefficient

\( M = \) Independent variable, i.e. agricultural density

\( D = \) Dependent variable, i.e. rural population density

\( N = \) Number of pairs of observed values.

\( \sum = \) Summation

For a sample size 19 the critical value of the correlation coefficient at 1% level (two-tailed) is 0.575. Therefore this correlation coefficient is significant. In addition to the above, the more conventional Student's 't' test is also applied. The value of 't' works out as follows:

\[
 t = \frac{r \sqrt{(n-2)}}{\sqrt{1-r^2}}
 = \frac{0.61 \sqrt{(19-2)}}{\sqrt{1-(0.61)^2}} = 3.17
\]

The value of 't' at 5% level (two-tailed) with 17 degrees of freedom is found to be 2.11. But here the calculated value of 't' is 3.17. Hence the correlation coefficient is significant. Hence the null hypothesis that the correlation coefficient is zero is rejected. Taking the Pearson correlation coefficient, the percentage of explained variation = \( r^2 \times 100 = 0.61^2 \times 100 = 37 \). Thus only about 37% of the total variation in D i.e. rural population density admits of being explained by the variation in M i.e. agricultural density. Since the correlation coefficient of + 0.61 does not indicate perfect positive relationship between number of agricultural population per sq km with rural population density, the maps showing the 'relief' of these two variables will not match perfectly. The two will differ considerably from each other. Such differences are absolute residuals (\( D - D_e \)). From the absolute residual values standardised residuals have been calculated and plotted at the areal centre of the respective blocks for the preparation of a second isopleth map (Fig. 41). This map depicts the relationship between agricultural density and rural population density in Birbhum in 1991.

The impact of number of agricultural population upon rural population density is reflected in the above mentioned map. The white colour indicates areas where the relationship appears to be very close. The darker the shading the weaker is the impact of agricultural density on population distribution. Such darker shading with plus values is found to occur in the north in Muraroil I and Muraroil II, Nalhati II, Rampurhat I, eastern parts of Nalhati I blocks. This indicates the occurrence of higher population density than what is expected if agricultural density were the only determinant. Western parts of Rampurhat I and some parts of Mahammadazar, Rajnagar and Dubrajpur in the west and Illambazar, Bolpur-Sriniketan, Sainthia and part of Nanur in the south and east show negative values. Negative values indicate that rural population density in these areas is below the level that is 'expected' for the given agricultural density. White areas indicating close correspondence between the two variables are seen in south eastern Nalhati I, Rampurhat I, Mayureswar I, Mahammadazar, Sainthia, Nanur, Dubrajpur and Rajnagar blocks. The isopleth of zero departure in the map brings out the fact that all other factors affecting the distribution of population remaining constant the density of rural population is the same as is to be expected from the number of agricultural population per sq km of cultivable area alone. Areas of high departure values whether plus or minus in the map indicate that agricultural density is not a significant influence upon the distribution of rural population in those parts of the district.
RELATIONSHIP BETWEEN RURAL POPULATION DENSITY & AGRICULTURAL DENSITY
BIRBHUM DISTRICT

Legend
Standardised residuals 
\( \frac{D-D_C}{SE_D} \)

+ 2.0
+ 1.5
+ 1.0
+ 0.5
0
- 0.5
- 1.0

D - D_C = Number of persons / sq km more or less than normal
Normal is D_C = 108.86 ± 2.72M
Population density (D) agricultural density (M)
Standard error of estimate = SE_D

Scale
5 0 5 10 15 km

Fig. 41 : Relationship between rural population density and agricultural density