RESEARCH ARTICLE

SPATIO-TEMPORAL ANALYSIS OF CROPPING INTENSITY AND LEVEL OF FARM MECHANIZATION IN RAMPUR DISTRICT

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ARTICLE INFO	ABSTRACT
	The present study aims to analyse the spatial and temporal variations in the levels of cropping intensity and farm mechanization among the six blocks of the Rampur district and examine the causal relationship between cropping intensity and farm mechanization in the district. The study is based on secondary sources of data collected from the district statistical handbook for the periods of fifteen years (1995-2010). The boundary of block has been considered as the smallest unit of study. The study reveals that the intensity of cropping has been decreased in the blocks of Saidnagar, Bilaspur and Milak and increased among the blocks of Suar, Chamrauwa and Shahabad. Moreover, the blocks of Shahabad, Bilaspur, Suar and Chamrauwa rendering the decreasing trend in the level of farm mechanization. However, the level of farm mechanization has been increased in the blocks of Milak and Saidnagar during the span of fifteen years.

INTRODUCTION

There are only three alternatives to feed the millions of population, firstly, to increase the area under cultivation, which is not possible due to continuous growing demands for non-agricultural land uses, and for maintaining the ecological balance further clearance of forests may also not be allowed because one-fourth of the total area should be under forest, secondly, to replace the low value crops by high value crops, which has been already done in most parts of the country, and thirdly, to increase the cropping intensity (Khan *et al*., 2011). Therefore, it is the need of hour that existing agricultural land resource can be augmented only through by enhancing the cropping intensity (Dahiya, 1991). The term cropping intensity refers to the percentage of the gross cropped area to the net sown area. In other words, it is a ratio between net cropped area (NCA) and total cropped area (TCA) (Husain, 2009). The cropping intensity is a good measure of the degree of multiple cropping being followed by a region (Mehta and Kumari, 1990) and total production increased on a unit of land. However, in the context of commercialization of agriculture system and phenomenal increase of population, mechanization of farms plays an important role in teeming and feeding of millions of population of the world. The use of modern inputs of agriculture like chemical fertilizers, different methods of irrigation, modern machineries like combined harvesters and threshers, tractors etc. have contributed a lot in increasing the agricultural output due to their timeliness and efficiency of operations. Without mechanization it will not be possible to maintain multiple cropping patterns, which need quick land preparation, planting, weeding, harvesting, processing etc. (MoA, 2009). Thus, to increase production and cropping intensity, the most important gain will be the faster development of agricultural mechanization as well as variety development. Replacing the traditional inefficient agricultural tools, efficient mechanized cultivation must be introduced and extended. (Islam, 2009) Mechanization of farm is determined by a set of inter-related factors

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such as farm size, irrigation, access to institutional credit, governmental extension services, experience of the farmers (Ghosh, 2010), use of modern agricultural inputs like, HYV seeds, fertilizers and modern implements in farming practices which may have enhanced the overall productivity and production of a unit of land with the lowest cost of production. According to Tewari, *et al.* (2012) farm mechanization is a package of technology to ensure timely field operations, increased productivity, reduced crop losses and improved quality of grain or product. The contributions of agricultural mechanization in various stage of crop production could be viewed as saving in seeds (15-20%), saving in fertilizers (15-20%), saving in time (20-30%), reduction in labour (20-30%), increasing in cropping intensity (5-20%) and higher productivity (10-15%). Reliable and comprehensive information on spatial patterns of cropping intensity is a pre-requisite in Rampur district where more than 65 per cent working population is engaged in agriculture and agro-allied activities, and the district covers only 0.98 per cent of the total geographical area of the state of Uttar Pradesh. Hence, in the present paper an attempt has been made to analyse the regional variation of cropping intensity and its causal relationship with the levels of farm mechanization among the blocks of Rampur district.

Objective of the study

The present study has the following specific objectives:

- To analyse the spatial and temporal variations in the levels of cropping intensity and farm mechanization among the six blocks of the Rampur district.
- To examine the causal relationship between cropping intensity and farm mechanization in the district.
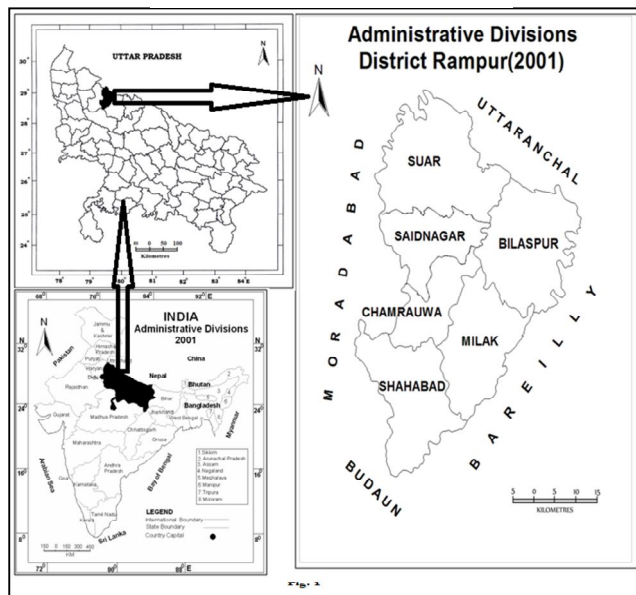
Study Area

Rampur is the smallest district of Moradabad division. It lies between 28^0 $25'$ and 29^0 $0'$ North latitudes and 78^0 $5'$ to 79^0 $28'$ East Longitudes. The area of Rampur district is 2367 sq.km which is 0.98 per cent of Uttar Pradesh. It is almost heart shaped and bounded by Nainital on the north, Badaun on the south, Bareilly on the east and

Moradabad on the west. The climate of the district is pleasant. The temperature ranges from 2° C in winter to 44° C in summer. The average rainfall is 1150 mm. Ramganga and its tributaries Kosi, Peela, Khar, Senjani & Gangan are the main rivers flowing in the district. Bullai, Domath and Matiyar are commonly found soils in the district. For administrative convenience, the district of Rampur has been divided into five tehsils namely, Rampur, Bilaspur, Suar, Milak and Shahabad. These tehsils are further divided into 6 blocks namely Suar, Bilaspur, Saidnagar, Chamaraua, Shahabad and Milak. According to the Census 2011 the district has population 2,335,398 comprised of 1226175 male and 1109223 female population. Sex ratio (female per one thousand of male) is found to be 879 in the district as against the 898 of the state of Uttar Pradesh. Density of population is found to be higher in the district (898) as against Uttar Pradesh (690). The higher density of population may be viewed as an outcome of higher population in the district. As per census 2001, 38.70 per cent population was literate and the corresponding figures for male and female literacy were 48.20 per cent and 27.90 per cent.

Rampur District: Location Map

Database and Methodology

The present study is entirely based on secondary sources of data collected from District Statistical Handbook available at the website www.upgov.nic.in for the years 1995 and 2010, and boundary of a block has been considered as smallest unit of study. A set of sixteen indicators of various sectors have been taken into account to determine the levels of farm mechanization in the six blocks of the Rampur district which are broadly classified into four categories like sources of irrigation, various types of agriculture implements, chemical fertilizers and main facilities related to agriculture. In order to work out the cropping intensity of the year 1995 and 2010, following method has been used:

$$\text{Cropping Intensity} = \frac{\text{T.C.A.}}{\text{N.C.A}} \times 100$$

Here, T.C.A. stands for Total Cropped Area (Net Cropped area + Double/Multiple Cropped Area); and N.C.A. for Net Cropped Area (Total Cropped Area – Double/Multiple Cropped Area).

To find out the spatial and temporal variations in the levels of cropping intensity and farm mechanization, fifteen years of gap have been taken into account. In the first step, the raw data for each variable has been computed into standard score. It is generally known as Z value or Z-score. The score quantify the departure of individual observations, expressed in a comparable form. This means it becomes

a linear transformation of the original data (Smith, 1973). It may be expressed as:

$$Z_{ij} = \frac{X_{ij} - \overline{X_i}}{\sigma_i}$$

Where,

Z_{ij} indicates Standardized value of the variable i in block j;
X_{ij} for Actual value of variable i in block j;
$\overline{X_i}$ for Mean value of variable i in all blocks; and
σ_i for Standard deviation of variable i in all blocks.

In the second step, the Z-scores of all variables have been added block wise and the average has taken out for these variables which may be called as composite score (CS) for each block and may be algebraically expressed as:

$$CS = \frac{\sum Z_{ij}}{N}$$

Where, CS is composite score,
N refers to the number of variables;
$\sum Z_{ij}$ indicates z-scores of all variables i in block j.

The positive values relating to the block's z-score explain high level of cropping intensity/ farm mechanization and negative values the low level of cropping intensity/ farm mechanization in the study area. These values also used to determine the relationship between cropping intensity and the level of farm mechanization in the different blocks of the Rampur district. Besides, advanced cartographic and statistical techniques, GIS-Arc view programmes (Version 3.2a) have been applied to show the regional variations in the pattern of cropping intensity and levels of farm mechanization among the blocks of the district through maps.

Table 1 presents the block-wise z-scores of cropping intensity and farm mechanization of two point of time. An analysis of data given in Table 1 reveals that in the span of fifteen years, there is a large scale variation may be noticed in the spatial patterns of cropping intensity among the blocks of the district. The level of cropping intensity has been decreased in the blocks of Bilaspur, Saidnagar and Milak, among them, Milak block has recorded the highest decrease in the level of cropping intensity i.e. – 1.545 score, while, the level of cropping intensity has increased in blocks of Shahabad (1.810 score), Chamrauwa (1.359 score) and Suar (0.036) in the span of fifteen years. The further examination of data given in Table 1 envisages that the blocks of Bilaspur Milak and Saidnagar rendering the increasing trend in the level of farm mechanization, among them, Saidnagar block has recorded the highest increase i.e. 0.702 score in the district. However, level of farm mechanization has been decreased in the blocks of Shahabad, Bilaspur, Chamrauwa and Suar during the phase of fifteen years and the highest decrease was witnessed by Shahabad block i.e. – 0.488 score.

Regional Patterns of Cropping Intensity in Rampur

Table 2 visualizes the block-wise z-score of cropping intensity in Rampur district for the years 1995 and 2010 respectively. The whole range of spatial variations of cropping intensity may be arranged into three categories such as, high (above 0.500 scores), medium (0.500 to - 0.500 score) and low (below - 0.500 score) for both years (see Figure 2 and 3). In the year 1995, the two blocks (Suar and Saidnagar) come under the category of high level of cropping intensity (above 0.500 score) and constituted a region situated in the northern and north-western part of the district. Medium level of cropping intensity has been experienced by three blocks, namely,

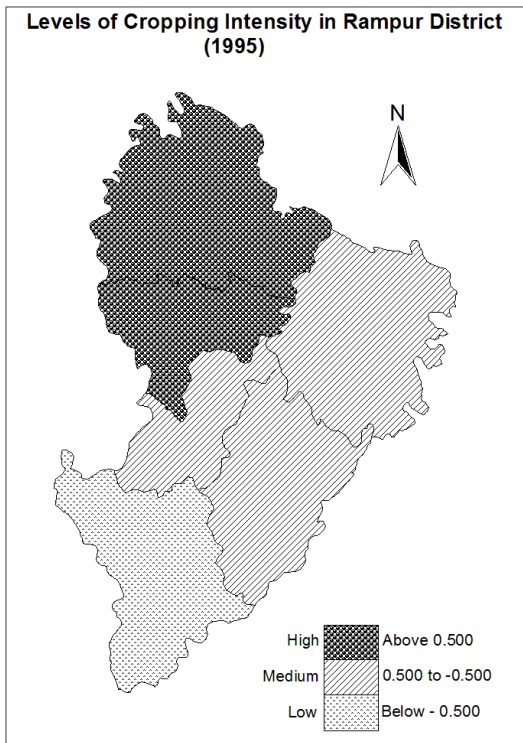**Table 1. Block Wise Z-score Values of Cropping Intensity and Farm Mechanization in Rampur District, 1995-2010**

S.No.	Name of Blocks	Score of Farm Mechanization		Difference (1995 to 2010)	Score of Cropping Intensity		Difference (1995 to 2010)
		(1995)	(2010)		(1995)	(2010)	
1.	Suar	0.556	0.474	-0.081	0.630	0.665	0.036
2.	Bilaspur	0.449	0.083	-0.365	0.154	-0.768	-0.923
3.	Saidnagar	-0.499	0.202	0.702	1.087	0.348	-0.739
4.	Chamrauwa	-0.210	-0.328	-0.118	-0.084	1.275	1.359
5.	Shahabad	-0.214	-0.702	-0.488	-1.841	-0.031	1.810
6.	Milak	-0.081	0.269	0.350	0.055	-1.490	-1.545

Source: District Statistical Handbook, 1995 and 2010.

Table 2. Status of Cropping Intensity in Rampur District

Year		(1995)	(2010)
Category	Z-Score	Name of the Blocks	
High	Above 0.500	Suar and Saidnagar	Suar and Chamrauwa
Medium	0.500 to - 0.500	Milak, Bilaspur and Chamrauwa	Shahabad and Saidnagar
Low	Below -0.500	Shahabad	Milak and Bilaspur

Source: Based on Table 1.

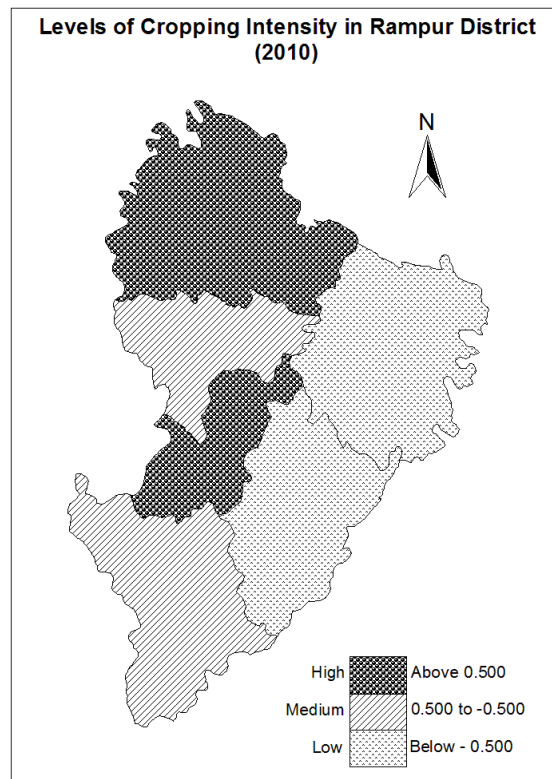**Levels of Cropping Intensity in Rampur District (1995)**

Source: Based on Table 2.   Fig: 2

Bliaspur, Chamrauwa and Milak lies in the eastern and central parts of the district, while only one block (Shahabad) lies in the southern part which has witnessed the low level of cropping intensity in the study area (Fig. 2). The further examination of data given in Table 2 depicts that two blocks, namely, Chamrauwa (1.275 score) and Suar (0.665 score) have high level of cropping intensity in the year 2010, which are located in the north and western pockets of the district. The medium grade (0.500 to - 0.500 score) of cropping intensity has been recorded by two blocks viz., Saidnagar and Shahabad situated in the western and southern parts of the district. At last, two block (Bilaspur and Milak) placed in the eastern and south-eastern pockets of Rampur district have the low level (below -0.500 score) of cropping intensity in 2010.
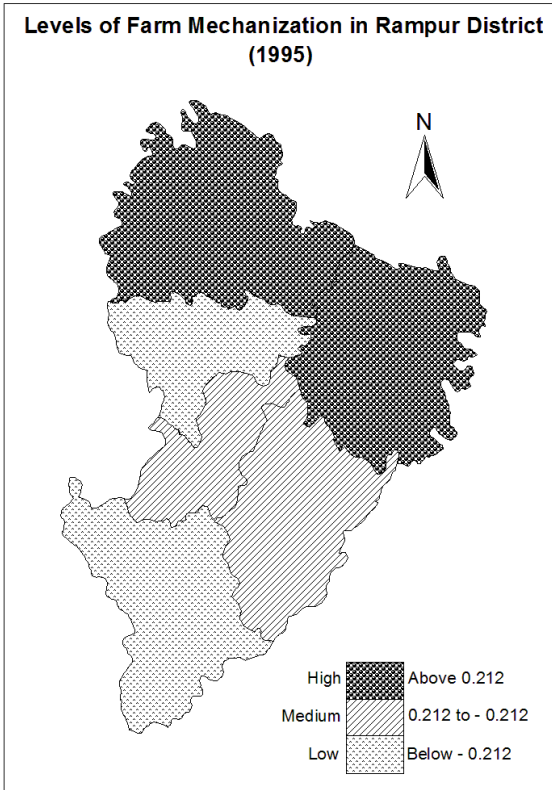
Level of Farm Mechanization

Table 3 shows the block-wise composite mean z-scores of farm mechanization in the district for two years 1995 and 2010 respectively. The entire array of variations in the levels of farm mechanization may be arranged into three grades i.e. high (above 0.212 score), medium (0.212 to - 0.212 score) and low (below - 0.212 score). Figure 3 depicts that the two blocks of the districts which

experienced the high level (above 0.212 score) of farm mechanization in the year 1995, viz., Suar (0.556 score) and Bilaspur (0.449 score) which make out a contiguous region in the northern and eastern parts of the district. The medium level of farm mechanization has been witnessed by Chamrauwa and Milak located in the western and south-eastern pockets of the study area. The remaining two blocks, namely Saidnagar and Shahabad form two separate regions in the western and southern parts of the study area come under the category of low level (below -0.212 score) of farm mechanisation. On the other hand, Table 3 also portrays variations in the levels of farm mechanization in the blocks of Rampur district in the year 2010. Figure 5 exhibits that two blocks fall under the high levels of farm mechanization (above 0.212 score) in the district, they are Suar and Milak and form two isolated regions in the northern and south-eastern pockets of the district. Moreover, Bilaspur and Saidnagar blocks witnessed the medium level(0.212 to - 0.212 score) of levels of farm mechanization and make a contiguous latitudinal region in the central part of the district. However, the lowest score (below -0.212 score) of farm mechanization has been recorded by Chamrauwa and Shahabad block loacted in the south-western and southern parts of Rampur district (see Figure 5).
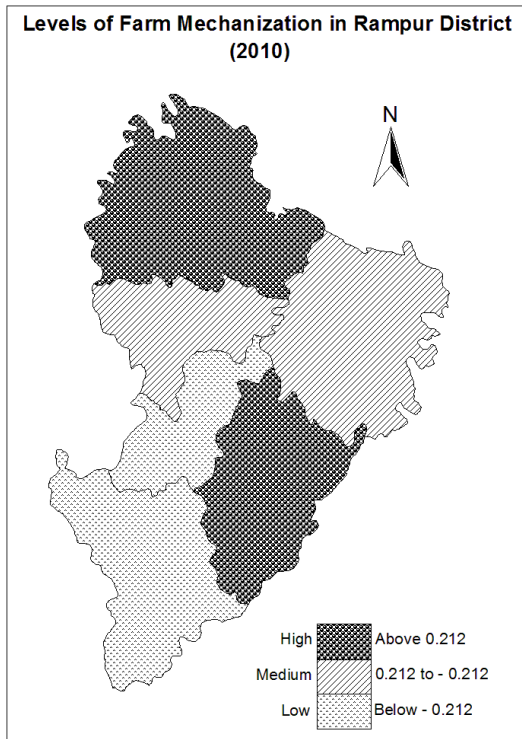

Levels of Cropping Intensity in Rampur District (2010)

Source: Based on Table 2.   Fig: 3

Levels of Farm Mechanization in Rampur District (1995)

High	Above 0.212
Medium	0.212 to - 0.212
Low	Below - 0.212

Source: Based on Table 3.   Fig: 4

Levels of Farm Mechanization in Rampur District (2010)

High	Above 0.212
Medium	0.212 to - 0.212
Low	Below - 0.212

Source: Based on Table 3.   Fig: 5

Table 3. Status of Farm Mechanization in Rampur District

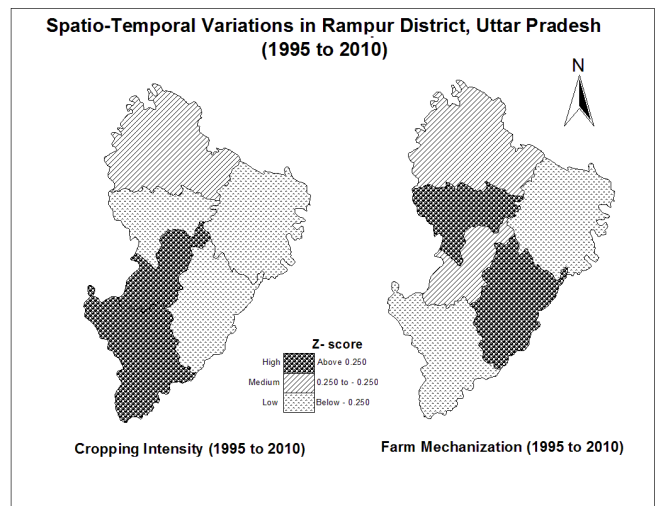| Year		(1995)	(2010)
Category	Z-Score	Name of the Blocks	
High	Above 0.212	Suar and Bilaspur	Suar and Milak
Medium	0.212 to -0.212	Milak and Chamrauwa	Bilaspur and Saidnagar
Low	Below -0.212	Shahabad and Saidnagar	Chamrauwa and Shahabad

Source: Based on Table 1.

Spatio-Temporal Changes in the Patterns of Cropping Intensity and Levels of Farm Mechanization

Table 4 and Figure 6 depicts the spatio-temporal variation in the patterns of cropping intensity and farm mechanization from 1995 to 2010 in Rampur district. The blocks with reference to the differences of z-scores values (from 1995 to 2010) of cropping intensity and farm mechanization may be arranged into three category such as high (above 0.250) medium (0.250 to -0.250) and low (below -0.250) as given in the index. It is clear from the Figure 6 that two blocks namely Shahabad and Chamrauwa in the southern pocket of the district fall under the high category of cropping intensity (above 0.250). As far as the medium category is concerned, Suar is the only block in the study area which comes under the medium category ranging from 0.250 to - 0.250, and situated in the northern part of the district. Moreover, the cropping intensity has been recorded lowest in three blocks, namely, Saidnagar, Bilaspur and Milak and they combinely formed a extensive contiguous region in the central and the south-eastern parts of the district. On the contrary, the difference in composite z-scores of two years 1995 and 2010 of farm mechanization in the district does not show any identifiable region over the study area. The map clearly depicts that two blocks viz, Saidnagar and Milak come under the high level of farm mechanization (above 0.250) which are situated in the western and south-eastern portion of the district respectively.

Table 4. Spatio-Temporal Variation in the Levels of Cropping Intensity and Farm Mechanization in Rampur District (1995 to 2010)

Category	Z-Score	Name of the Blocks	
		Cropping Intensity	Farm Mechaization
High	Above 0.250	Shahabad and Chamrauwa	Saidnagar and Milak
Medium	0.250 to - 0.250	Suar	Suar and Chamrauwa
Low	Below - 0. 250	Milak, Bilaspur and Saidnagar	Shahabad and Bilaspur

Source: Based on Table 1.

Spatio-Temporal Variations in Rampur District, Uttar Pradesh (1995 to 2010)

	Z- score	
High		Above 0.250
Medium		0.250 to - 0.250
Low		Below - 0.250

Cropping Intensity (1995 to 2010)   Farm Mechanization (1995 to 2010)

The blocks of Suar and Chamrauwa fall under the medium category of farm mechanization, among them, Suar, is northern most block and Chamrauwa is south-eastern block of the district. The low level of farm mechanization (below -0.250) witnessed in two blocks of the district, namely, Bilaspur, and Shahabad lying in the north-eastern and south-western parts of the district. The comparative analysis of both maps of cropping intensity and farm mechanization in Figure 6 exhibit the fact that out of the six blocks, only two blocks, namely, Suar (medium to medium) and Bilaspur (low to low) situated in the northern and eastern parts of the district have witnessed the positive correlation between cropping intensity and farm mechanization, while, remaining four blocks, viz., Saidnagar, Chamrauwa, Milak and

Shahabad located in the western and south-western pockets of the district have experienced the inverse relationship i.e., high level of farm mechanization but low level of cropping intensity and vice versa, excluding the only one block of Chamrauwa lies in the western pocket experienced the high level of cropping intensity but medium level of farm mechanization.

Conclusion

The overall analysis of the study reveals that the level of cropping intensity has been decreased in the blocks of Bilaspur, Saidnagar and Milak, while, it has been increased in the blocks of Shahabad, Chamrauwa and Suar. Moreover, the blocks of Milak and Saidnagar rendering the increasing trend of farm mechanization in the district. On the contrary, level of farm mechanization has decreased in the blocks of Shahabad, Bilaspur, Chamrauwa and Suar during the span of fifteen years. It may also be concluded that out of the six blocks, four blocks, viz., Saidnagar, Chamrauwa, Milak and Shahabad located in the western and south-western pockets of the district have experienced the inverse relationship i.e., high level of farm mechanization but low level of cropping intensity and vice versa, excluding the only one block of Chamrauwa lies in the western pocket experienced the high level of cropping intensity but medium level of farm mechanization. Therefore, it may be summarized from the above analysis that it is not necessary that cropping intensity will increase with the increase in the level of farm mechanization and there might be some other factors, besides, mechanization of farms which have been affected the intensity of cropping in the study area.

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