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Analysis of Changes in Crop Combination Regions in Dhule District, Maharashtra, India

Dr. Prakash K. Patil[1], Dr. Manisha S. Pawar[2]

[1]Associate Professor in Geography, Zulal Bhilajirao Patil College, Deopur, Dhule (M.S., India)
[2]Associate Professor in Geography, A.Y.K.K's Arts Mahila College, Deopur, Dhule (M.S., India)

ABSTRACT

The present paper attempts to demarcate the crop combination regions at district, tahsil and circle level and also study the spatio-temporal changes in them. For the present study, area under different crops during the period 1980-83, 1990-93, 2000-03 have been collected from socio-economic reviews of Dhule district. The data at circle level for the period 2002-05 have been collected from tahsil and circle offices. Weaver's and Doi's methods are applied to identify crop combinations.

Study reveals that the district as a whole can be recognized as four crop combination region in recent years. Bajra is the chief crop combining with cotton, jowar and groundnut. At tahsil level, Dhule also reported similar combination. Three crops combination was confined to Shindkheda tahsil by both methods. Here cotton was the predominant crop combining with jowar and bajra. In Shirpur and Sakri tahsils multi-crop combinations were obtained by Weaver's method, while four crops combination resulted by Doi's method. In Shirpur and Sakri tahsils cotton and bajra were leading crops respectively. Circlewise analysis obtained by Doi's method indicates that in five out of thirty two circles there was two crops combination. Eleven circles recorded three crops combination, while in fourteen circles four crops combination was noticed. Five and six crops combination were noticed only in Brahmanwel and Dahiwel circle respectively.

Keywords: Spatio-temporal, Crop combination, Predominant crop.

INTRODUCTION

The study of crop combination of a region is an important aspect of agricultural geography. The concept of crop combination is a scientific device to study the existing spatial relationship of crops in association with each other in agricultural geography and land utilization (Mandal, 1982) [9]. In recent years, the combination analysis in geographical studies has increased greatly. It is helpful by many ways:

i) It provides an adequate understanding of individual crop geography.
ii) It provides a sound and scientific basis for agricultural regionalization.
iii) It is helpful for constructing structure of valid agricultural regions.
iv) It is very useful for future planning and development.

Different statistical methods such as quartile (Johnson 1958) [7], mean positive deviation (Pownall 1953) [12], standard deviation (Nelson 1955) [11], minimum (least) deviation (Weaver, 1954) [16], modified minimum deviation (Doi, 1959 [4] and Coppock, 1964 [3]), least squared deviation (Thomas, 1963) [15], maximum positive deviation (Rafiullah, 1965) [13], maximum distance (Ayyar, 1969) [2] and lower limit method (Athawale, 1966) [1] etc. have been adopted by researchers for establishing crop combinations.

Among them, minimum (least) standard deviation method introduced by Weaver is more famous and widely accepted by many researchers. He used this method for studying the crop combination regions in the Middle West of USA in 1954. He took into consideration the percentages of crop area to total cropped area of a region. Arranged them in decreasing order and compare them with theoretical standard distribution. The theoretical standard is 100 percent of the gross cropped area for monoculture; 50 percent for two crop combination; 33.33 percent for three crop combination; 25 percent for four crop combination and so on. Formula used by Weaver for the determination of minimum deviation for each component is as follows:

$$S.D.= \sqrt{\Sigma d^2 /n}$$

However, Weaver has pointed out that, we are not directly interested in the actual value of standard deviation. Only the relative rank of the amount of deviation among the several possible combinations was desired and hence square root was not extracted in accordance with the standard deviation formula to save work and used the square of standard deviation, i.e. variance. So the actual formula can be expressed as follows.

$$Variance = \Sigma d^2 /n$$

Weaver's method appears to be simple, but in practice it requires a lot of calculations. Occasionally, it also tends to produce highly generalized results in areas of large variants or as admitted by Weaver himself, in areas where the first ranking crop is very large but not large enough to justify monoculture and the remaining crops are comparatively small. In such cases, the results tend to show the lowest deviation for a crop combination that includes every crop occupying as much as 1% of the total cropped area.

To get more realistic results with simplification, Weaver's method has been modified by many researchers. Doi (1959) [4] has putforth a modified form of Weavers' method. This new method solves the problems of Weavers' technique by substituting the variance ($\Sigma d^2/n$) or least standard deviations ($\sqrt{\Sigma d^2/n}$) of Weaver with the sum of squared deviations (Σd^2). The combination having the smallest Σd^2 (the smallest sum of squares/least squares) will be the combination of the primary crops. Doi has made the procedure simpler by providing the critical values in tabular form and there is no need to calculate Σd^2. In this case, only a summation of the percentages of different crops needed. The crop percentages have to be checked with the table of critical values. If the percentage held by a single crop is lower than the critical value, the crop is dropped from the combination and if the percentage is higher than the critical value it is included in the combination.

Several researchers have adopted Doi's method to delineate crop combination regions. In India, Mohammad (1975) [10], Siddique (1975) [14], Majeed (1978) [8], Jasbir Singh (1976) [5] and many others have applied this method and they noted that, the results obtained by this method are more realistic in comparison to other methods. It is equally suitable in areas of high concentration, great diversification or no marked variations in the percentages of different crops. The results are not mere generalizations and in no case adjustments are required. Thus, the modified minimum deviation method putforth by Doi (1959) [4] is a better method for deriving accurate crop combination regions within no time.

Therefore, an attempt has been made in the present study to demarcate the crop combination regions by applying two methods of crop combination i.e. minimum standard deviation method of Weaver (1954) [16] and modified minimum deviation method of Doi (1959) [4] and to highlight the significance of crop combination regions of Dhule district.

STUDY REGION:

For the present study Dhule district has been selected as a study region. It is a peculiar region with distinct physical setting and socio-economic conditions. It is situated in the northern parts of Maharashtra State in the valley of Tapi River. The district comprises of four tahsils namely Dhule, Shirpur, Shindkheda and Sakri. It is extended over an area of 8,063 sq km between latitudes 20^0 38' N to 21^0 39' N and longitudes 73^0 50' E to 75^0 13' E (Figure 1).

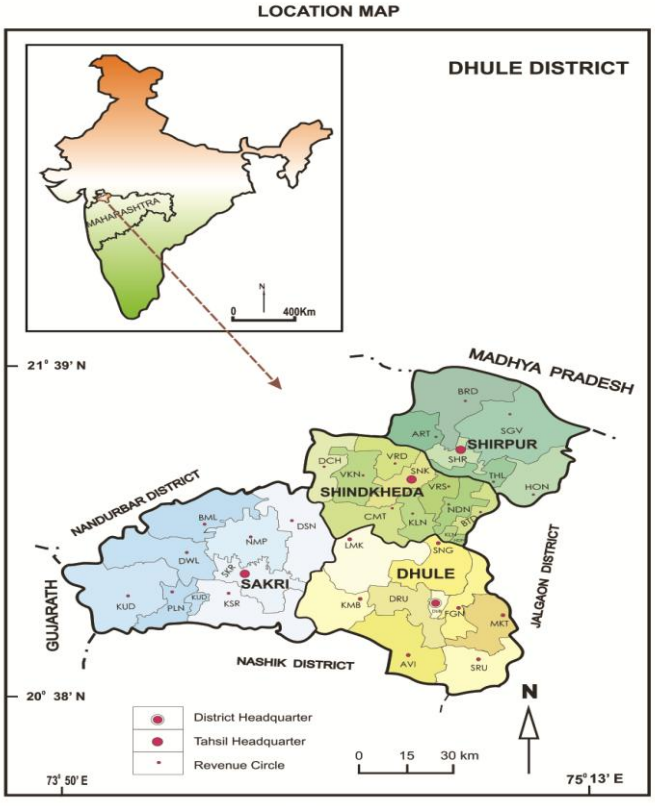

FIG 1

It represents great variation in physiography and most of the part of it experiences semiarid climate. About 58 percent area of the district is identified as 'Drought Prone Area' (Sukhtankar Committee Report). Moreover, socio-economic development of this region is uneven. Northern parts of Shirpur tahsil and south and southwestern parts of Sakri tahsil are dominated by tribal population. They are lagged behind in socio-economic development. Remaining extensive part is economically developing and very limited part is developed one.

DATA USED AND MTHODOLOGY:

For the present study, area under different crops during the period 1980-83, 1990-93, 2000-03 have been collected from socio-economic reviews of Dhule district. The data at circle level for the period 2002-05 have been collected from tahsil and circle offices. To avoid the yearly fluctuations in area under different crops caused due to variations in weather situations and other factors, the three yearly average values are computed and taken in to consideration for the analysis.

Minimum standard deviation method of Weaver (1954) [16] and also modified minimum deviation method of Doi (1959) [4] have been applied to identify and demarcate crop combinations for Dhule district as a whole and at tahsil and circle level. Obtained results are discussed with the help of tables and cartographic techniques.

RESULTS AND DISCUSSION:

a) Crop Combination Regions at District and Tahsil Level:

Crop combination regions are derived from 20 crops namely rice, wheat, jowar, bajra, ragi, maize, other cereals, tur, moong, udid, kulthi, gram (harbara), other pulses, total vegetables and fruits, total condiments and spices, sugarcane, groundnut, til, other oilseeds and cotton that have covered at least 1 percent of the total cropped area.

The results of crop combinations for the period 1980-83 and 2000-03 are listed in table 1. It also indicates the changes in the crop combinations obtained by adopting Weaver and Doi's method.

Table 1: Crop Combination Regions at District and Tahsil Level

Sr. No.	Tahsil/ District	Weaver's Method No. of Crops		Doi's Method No. of Crops	
		1980-83	2000-03	1980-83	2000-03
1	Dhule	5(BJGCK)	4(BJCG)	3(BJG)	4(BJCG)
2	Shirpur	5(JCBMgG)	13*	4(JCBMg)	4(CJBMg)
3	Shindkheda	4(JBGC)	3(CJB)	4(JBGC)	3(CJB)
4	Sakri	6(BGJKROc)	13**	5(BGJKR)	4(BGKJ)
	Dhule District	5(BJGCK)	4(BCJG)	5(BJGCK)	4(BCJG)

Source: Computed by Researcher

Note: * = (CJBMgHSGWVfUMAT); ** = BGKJRgRWVfCOcMUOo

[Abbreviations: R(rice), W(wheat), J(jowar), B(bajra), Rg(ragi), M(maize), Oc(other cereals), A(tur), Mg(moong), U(udid), K(kulthi), H(gram), Op(other pulses), S(sugarcane), C(cotton), Vf(vegetables and fruits), Cs(condiments and spices), G(groundnut), T(til), and Oo(other oilseeds)].

i) Crop Combination Regions (by Weaver's method):

Table 1 indicates that, during 2000-03 four crop combinations observed in the district as a whole. Bajra is the principal crop combining with cotton, jowar and groundnut. Analysis of tahsilwise crop combination during 2000-03 shows grate variation. Three-crop combination was confined to Shindkheda tahsil. Here, cotton was the predominant crop combining with jowar and bajra. A combination of bajra, jowar, cotton and groundnut found in Dhule tahsil. But

in Shirpur and Sakri tahsils, 13 crop combinations are observed. In Shirpur tahsil, cotton was the leading crop. Other crops in combination were jowar, bajra, moong, gram, sugarcane, groundnut, wheat, vegetables and fruits, udid, maize, tur and til. In case of Sakri tahsil bajra was the principal crop. Its' associates were groundnut, kulthi, jowar, ragi, rice, wheat, vegetables and fruits, cotton, other cereals, maize, udid and other oilseeds.

Table 1 also shows the change in the crop combination during the twenty years period. It is observed that, crop combinations have changed in the study area. It changed from five-crop combination in 1980-83 to four crop combination in 2000-03 in Dhule district as a whole and also in Dhule tahsil. It changed from four-crop combination to three-crop combination in Shindkheda tahsil.

Shirpur and Sakri reported significant changes in crop combination. In Shirpur, five-crop combination changed into thirteen-crop combination while in Sakri, six-crop combination in former period converted into thirteen-crop combination in later period.

ii) Crop Combination Regions (by Doi's method):

As mentioned earlier Weaver's method gives generalized picture. It fails to give precise crop combinations of the region. These facts are also noticed in the present study. Therefore, another method introduced by Doi has applied for the study region. The results obtained by Doi's method are more realistic and in precise form. The obtained results are given in the same table i.e. 1 and discussed.

During the period 2000-03, three crop combination noticed in Shindkheda tahsil while in other tahsils and in the district as a whole four crop combinations confined. In Shindkheda tahsil, cotton was the predominant crop combining with jowar and bajra. A combination of bajra-jowar-cotton-groundnut was seen in Dhule tahsil whereas cotton-jowar-bajra-moong combination was confined in Shirpur tahsil. In case of Sakri tahsil, bajra was the leading crop and other crops in the combination were groundnut, kulthi and jowar. Dhule district as a whole also reported four crop combination in which bajra occupied first place. It was associated with cotton, jowar and groundnut.

While looking at the changes in crop combinations from 1980-83 to 2000-03 it is observed that, for the district as a whole crop combinations changed from five crop combination (BJGCK) in 1980-83 to four crop combination (BCJG) in 2000-03. In Sakri tahsil also it has been changed from five crops in combination (BGJKRg) during 1980-83 to four crop combination (BGKJ) in 2000-03. The ragi crop has lost the place in combination.

Shindkheda tahsil reported change in crop combination from four (JBGC) to three crop combination (CJB) during the period under investigation. In this region, the place of groundnut lost by the triennum 2000-03. Another important change observed in the crop combination is that, during 1980-83 jowar was the leading crop in Shindkheda tahsil. It has been replaced by commercial crop, cotton in the triennum 2000-03. It means, in the recent years farmers of Shindkheda tahsil are giving first preference to cotton.

Totally different picture is observed in Dhule tahsil, where three crop combination (BJG) was noticed in 1980-83. It changed to four crop combination (BJCG) in 2000-03. Shirpur tahsil did not show any change in number of crops (four). But it is interesting to note that, during 1980-83 jowar was the leading crop and it was associated with cotton, bajra and moong. By 2000-03 the place of jowar was taken by cotton. That means now a days farmers are giving more preference to grow cotton. This happened mainly due to establishment of cotton ginning and pressing mill in the tahsil and also more profits from this crop.

b) Crop Combination Regions at Circle Level:

Both the Weaver's and Doi's method are applied to identify crop combination in each circle of the study region during the triennum 2002-05. The obtained results of crop combination regions are mentioned in the table 2. However, crop combination regions obtained only by doi's method are shown in figure 2 and discussed.

i) Two Crop Combination:

Five circles in the study region are having two-crop combination viz., Kusumba, Arvi, Chimthane, Sakri and Sangvi (Figure 2). In Kusumba and Arvi circles (Dhule tahsil), bajra is the principal crop combining with jowar. In Chimthane (Shindkheda tahsil) and Sakri circles also, bajra is the leading crop.

However, it is combining with cotton in Chimthane and groundnut in Sakri circle. On the other hand, in Sangvi circle (Shirpur) cotton is the chief crop combining with jowar.

Table 2: Crop Combination Regions at Circle Level (2002-05)

Tahsil/ Circle	Weaver's Method No.of Crops	Doi's Method No. of Crops	Tahsil/ Circle	Weaver'sMethod No.of Crops	Doi's Method No. of Crops
DHULE			**SHINDKHEDA**		
1 Kusumba	10 (*)	2 (BJ)	1 Dondaicha	4 (BCJMg)	4 (BCJMg)
2 Lamkani	6 (BGJKCCs)	4 (BGJK)	2 Vikhran	4 (BCJG)	3 (BCJ)
3 Songir	3 (CBJ)	3 (CBJ)	3 Virdel	4 (CJMgB)	4 (CJMgB)
4 Fagne	3 (JCB)	3 (JCB)	4 Shindkheda	4 (JCBMg)	4 (JCBMg)
5 Mukti	3 (CJB)	3 (CJB)	5 Varshi	4 (CBMgJ)	4 (CBMgJ)
6 Dhule R	3 (BCJ)	3 (BCJ)	6 Nardana	4 (CBJMg)	4 (CBJMg)
7 Dhule U	3 (JBC)	3 (JBC)	7 Betawad	5 (CJBMgT)	4 (CJBMg)
8 Arvi	3 (BJC)	2 (BJ)	8 Khalane	3 (CBJ)	3 (CBJ)
9 Shirud	3 (CBJ)	3(CBJ)	9 Chimthane	2 (BC)	2 (BC)
SHIRPUR			**SAKRI**		
1 Boradi	6 (CJMgBUG)	4 (CJMgB)	1 Brahmanwel	14 (***)	5 (GBKJR)
2 Sangvi	4 (CJBMg)	2 (CJ)	2 Nizampur	3 (BGK)	3 (BGK)
3 Arthe	4 (CMgBJ)	4 (CMgBJ)	3 Dusane	8 (#)	4 (BGKC)
4 Shirpur	11 (**)	4(CMgJB)	4 Sakri	3 (BGK)	2 (BG)
5 Thalner	5 (CMgJBS)	4 (CMgJB)	5 Dahiwel	15 (# #)	6(BMRgRGK)
6 Holnanthe	4 (CBMgJ)	4 (CBMgJ)	6 Kudashi	12 ($)	4 (BOcGR)
			7 Pimpalner	5 (BMWGK)	3 (BMW)
			8 Kasare	4 (BGMK)	3 (BGM)

Source: Computed by Researcher.

Note: * = (BJCGMKCsWHVf); ** (CMgJBSVfWCsTOG); *** = (GBKJRCsMVfWOpRgUAOcH)
= (BGKCCsWJVf); # # = (BMRgRGKJWOcUVfCsOoHS); $ = (BOcGRRgOoKUOpMWCs)
[Abbreviations: R(rice), W(wheat), J(jowar), B(bajra), Rg(ragi), M(maize), Oc(other cereals), A(tur), Mg(moong), U(udid), K(kulthi), H(gram), Op(other pulses), S(sugarcane), C(cotton), Vf(vegetables and fruits), Cs(condiments and spices), G(groundnut), T(til), and Oo(other oilseeds)].

ii) Three Crop Combination:

There are eleven circles where three crop combinations are observed. It consists of six circles of Dhule tahsil, two circles of Shindkheda tahsil and three circles of Sakri tahsil. This crop combination is totally absent among circles of Shirpur tahsil (Figure 2). Combination of cotton, bajra and jowar is observed in Shirud (Dhule) and Khalane circle (Shindkheda). In Mukti circle (Dhule) also, cotton is the leading crop and its associates are jowar and bajra. The combination of jowar-cotton-bajra and jowar-bajra-cotton is found in Fagne and Dhule Urban circle respectively. It is interesting to note that in Nizampur, Pimpalner, Kasare (Sakri), Dhule Rural (Dhule) and Vikhran (Shindkheda) circles, bajra is the dominant crop. It is combining with cotton and jowar in Dhule Rural and Vikhran circle (Shindkheda tahsil); groundnut and Kulthi in Nizampur circle (Sakri tahsil); maize and wheat in Pimpalner circle (Sakri tahsil) and groundnut and maize in Kasare circle (Sakri tahsil).

iii) Four Crop Combination:

Four crop combination is noticed in total fourteen circles of the study region. In most of the circles either bajra or cotton is the dominant crop. However, their associate crops vary from one circle to another. Five out of six circles of Shirpur tahsil recorded four crop combination, i.e. in Boradi, Arthe, Shirpur, Thalner and Holnanthe. In all these circles cotton is the leading crop. It combines with jowar, moong and bajra, however with change in order. Virdel, Betawad and Varshi circles of Shindkheda tahsil also reported similar combination.

A combination of jowar, cotton, bajra and moong is observed only in Shindkheda circle. Lamkani circle of Dhule tahsil has a combination of bajra, groundnut, jowar and kulthi. Dondaicha circle of Shindkheda tahsil as well as Dusane and Kudashi circles of Sakri tahsil reported bajra as a dominant crop. In Dondaicha circle, other crops in combination are cotton, jowar and moong. In Dusane circle, associate crops are groundnut, kulthi and cotton whereas in Kudashi circle other cereal crops, groundnut and rice appear in the combination.

iv) Five Crop Combination:

Only Brahmanwel circle of Sakri tahsil has five crop combination where groundnut is the principal crop. Other crops in the combination are bajra, kulthi, jowar and rice.

v) Six Crop Combination:

This crop combination is confined to only one circle, i.e. in Dahiwel. In this region, bajra is the leading crop and its associates are maize, ragi, rice, groundnut and kulthi (Fig. 2).

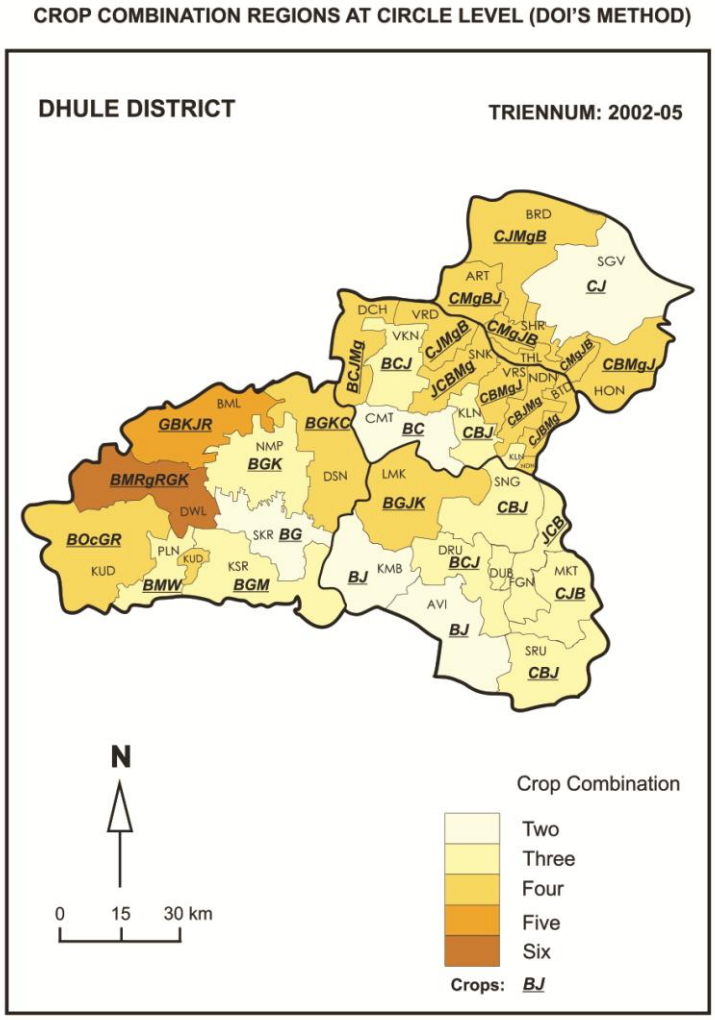

FIG. 2

CONCLUSION

As per results obtained by both methods the Dhule district can be recognized as four-crop combination region in recent years. Bajra is the chief crop combining with cotton, jowar and groundnut. At tahsil level, Dhule also reported similar crop combination. Three-crop combination was confined to Shindkheda tahsil by both methods. Here, cotton was the predominant crop combining with jowar and bajra. In Shirpur and Sakri tahsils, 13 crop combinations are obtained by Weaver's method while four-crop combination resulted by Doi's method. In Shirpur tahsil, cotton was the leading crop while in Sakri tahsil bajra was the predominant crop.

Circlewise analysis of crop combination regions obtained by Doi's method for the period 2002-05 indicates that, in five circles namely Kusumba (BJ), Arvi (BJ), Chimthane (BC), Sakri (BG), and Songir (CJ) there was two-crop combination. Eleven circles recorded three-crop combination while in 14 circles four-crop combination was noticed. Only one circle (Brahmanwel) reported five-crop combination with groundnut as a principal crop. Six-crop combination was also noticed only in one circle (Dahiwel).

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