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Analysis of extent of diversification and determinants of diversification in cropping pattern

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Abstract

The concept of diversification conveys different meaning to different people at different levels. At the national level, it generally conveys a movement of resources, especially labour, out of agriculture to industry and services, a sort of structural transformation. Within agriculture, however, diversification is considered a shift of resources from one crop (or livestock) to a larger mix of crops and livestock, keeping in view the varying nature of risks and expected returns from each crop/livestock activity, and adjusting it in such a way that it leads to optimum portfolio of income. The present study is cropping pattern of Kolhapur district over 34 years beginning from 1980-81 and nature, extent and determinants of crop diversification at farm level. The average productivity of total cereals, total pulses, total oilseeds and total food grains increased during the period of study. The productivity of sugarcane, soybean and groundnut also Show increased considerably by 60.71%, 300.40% and 45.87% respectively. The magnitudes of diversification indices in Kolhapur were on lower side for cereals, other crops and pulses over base period 1980-81, which indicated that the extent of diversification for these group of crops was less compared to base period. The magnitude of diversification index for fruits, vegetables and total oilseeds increased over base period which indicate higher diversification.

Keywords: cropping pattern, crop diversification, concentration of crops, Average productivity.

Introduction

Cropping pattern connects the crop-mix grown in a particular area in a agricultural year. It determines the output mix in a particular region. A change in cropping pattern implies a change in proportion of area under different crops. It has significant bearing on widening the geographical inequalities in income distribution. Hence, present study was conducted with specific objectives to analyse change in cropping pattern over the years, growth performance of various major crops to measure extent and nature of crop diversification and to examine the factors contributing to changes in cropping pattern in Kolhapur district in western – Maharashtra.

Objectives

This paper aims to evaluate changing land use, agriculture cropping pattern and crop intensity and to examine Diversification and factors responsible for diversification in Kolhapur district during the 1981-2014.

1. To examine the growth rates in area, production and productivity of major crops.
2. To study the extent of diversification in cropping pattern.
3. To know the determinants of diversification in cropping pattern.

Database and methodology

The secondary data have been collected from socio-economic abstract of Kolhapur district for 1980-81 and 2013-14 to analyses the land use and cropping pattern. Simple statistical techniques (Percentage and average) are used to analyses the changing trend in cropping pattern and diversification indices and which factors determine diversification.

For the sake of convenience total period will be divided into three sub period as given below while the third period is considered as an overall period.

- | | |
|-----------------------------|--------------------|
| I) Period: | 1980 -81-1994-95 |
| II) Period: | 1994-95-2013-14 |
| III) Overall period: | 1980-81 to 2013-14 |

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Compound growth rate

The compound growth rates were worked out by fitting exponential function of the

$$Y = ab^t$$

Where, Y = Area in hectares, production in quintals and yield in quintals per hectare

a = Intercept

b = Regression coefficient

t = Time period in year

Finally, the annual compound growth rate in area, production and productivity of the major crops were worked out by using the formula.

$$\text{CGR (\%)} = (\text{Antilog } b - 1) \times 100$$

The significance of the estimated compound growth rates was tested with the help of students' test.

3.4 Extent of diversification

Broadly, two measures have been used in economics literature to estimate diversification viz., 1. Entropy index (DE). 2. Modified entropy index.

1. Entropy Index (E.I.)

Entropy Index will be used to measure the economic diversification.

$$\text{E.I.} = - \sum_{i=1}^N P_i \times \log P_i$$

Or

$$\text{E.I.} = \sum_{i=1}^N P_i \times \log (1/P_i)$$

Where N is total number of crops and P_i represents acreage proportion of the i th crop in total cropped area.

2. Modified Entropy Index (M.E.I.)

Instead of fixed base logarithm, variable base of logarithm is used in Modified Entropy Index (M.E.I.) to overcome the limitation of Entropy Index

$$\text{M. E.I.} = - \sum_{i=1}^N (P_i \times \log N P_i)$$

The M.E.I., however, is equal to $\text{E.I.} / \log N$. It is worth mentioning that the base of logarithm is shifted to 'N' number of crops.

The M.E.I. imparts uniformity and fixity to the scale used as norm to examine the extent of diversification.

Thus, two measures of crop diversification were used to estimate crop diversification level or extent of diversification. These indices were worked out to examine diversification within different crop groups' viz., cereals, pulses, oilseeds, fruits, vegetables and all crops together for Kolhapur district at different periods of time.

Determinants of diversification

To find out the determinants of diversification, the multiple linear regression analysis was carried out by using the

secondary data for different time periods. Entropy indices of crop diversification were regressed on the selected explanatory variables as indicated below. Also, the efforts were made to find out the determinants of diversification by using the time series data of 34 years starting from the year 1980-81 to 2013-14 and by using same independent variables for different regions and the state as a whole. There is some limitation the data available from agricultural census was not continuous.

The regression model used for analysis is as under:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + u$$

Where,

Y = Dependent variable (EI)

A = Intercept

X1 = Consumption of total fertilizers (NPK) per hectare of Gross irrigated area in kilogram.

X2 = Percentage of area of HYV seeds to gross sown area.

X3 = Number of dug wells per thousand hectares of net Sown area

X4 = Average annual rainfall in mm

X5 = Amount of loan (short and medium term) disbursed through State Co-operative Bank per year in lakh of rupees.

X6 = Percentage of gross irrigated area to gross Cropped area.

X7 = Number of milch animals.

u = Error term.

The significance of coefficients of each of the variables from the estimated function were tested with the help of 't' statistics and the above techniques of analysis have been used to obtain numerical estimates to accomplish the objectives of the study.

Study area

Kolhapur district is located between 15 43' and 17 17' North latitude and 73 40' and 74 42' East longitude of southern Maharashtra. The region receives average rainfall 1900 mm. The total numbers of villages are 1196 and towns are 18. The district is consisting of 12 revenue tehsils' namely Shahuwadi, Panahala, Hatkangale, Shirol, Karveer, Gaganbavada, Radhanagri, Kagal, and Bhudhargad.

Results and discussion**Changes in the Productivities of Principal Crops**

It is believed that the process of agricultural development has pronounced effects on productivity of agriculture and as a result higher level of agricultural production is achieved per unit of available resources. Table 1 indicates the changes in the average productivity of major crops in Kolhapur district. It is concluded from the Table that the productivity of all cereals has increased over the base year. Among the cereals, the productivity of rice has increased by 156.23 per cent over the base year. The productivity of gram and green gram increased by 62.69 and 152 per cent over the base year. However, maximum productivity increases of 62.69 per cent in gram during the Period- III and on green gram 152 per cent during the Period-III. The productivity of rice was 1122 kg/ha in the year 1980-81 which increased to 2875 kg/ha during the year 2013-14. In case of bajra, red gram, and total food grains, the average productivity has decreased during the span of last thirty-four years in Kolhapur district. Among these crops, the productivity of red gram decreased by 65.58 per cent over the base year. The productivity of kharif jowar and rabi jowar increased by 16.16 and 221.16 per cent respectively, over the base year. It is noted that, the

Table 1: Changes in the Productivities of Principal crops from (1980-81 to 2013-14) (Kg/ha)

Sr. No.	Particulars	Period-I 1980-81	Period-II 1995-96	Period-III 2013-14	Percent change over base year 1980-81	
					1995-96	2013-14
1	Rice	1122	1145	2875	2.04	156.23
2	Wheat	1584	2074	2660	30.93	67.92
3	Kharif-Jowar	1627	1819	1890	11.80	16.16
4	Rabi-Jowar	411	229	1320	-44.28	221.16
5	Bajra	222	333	1	50	-99.54
	Total cereal	1643	2064	2425	25.62	47.59
6	Gram	516	779	840	50.96	62.69
7	Redgram	959	517	330	-46.08	-65.58
8	Black Gram	500	500	840	0	68
9	Green Gram	250	500	630	100	152
	Total Pulses	579	571	631	-1.38	8.98
	Total Food grains	1210	1435	1688	18.59	39.50
10	sugarcane	56	65	90		
11	soyabean	500	1115	2790		
12	Groundnut	1042	1629	1520		
	Total Oilseeds	1031	1257	1853		

(Figures in parentheses indicate per cent age change over the base year.)

Note: Sugarcane Productivity is in ton/ha

Source: Season and Crop Report, Department of Agriculture, Govt of Maharashtra State, Kolhapur.

Average productivity of groundnut has increased from 1042 kg/ha in 1980-81 to 1520 kg/ha in 2013-2014. Similarly, in the case of wheat, productivity has increased from 1584 kg/ha in 1980-81 to 2660 kg/ha in 2013-14. In the case of total pulses, the average productivity has increased from 579 kg/ha in 1973-74 to 631 kg/ha in 2013-14. However, the average productivity of gram has increased from 516 kg/ha in the year 1980-81 to 840 kg/ha in the year 2013-14.

The productivity of sugarcane was 56 ton /ha in the year 1980-81 which was increased to 90 ton /ha in the year 2013-14. The productivity of soybean increased by 458 per cent in the year 2013-14 over the base year. Thus, the increase in the average productivity of major crops in Kolhapur district is a good sign of agricultural development in the district.

Compound growth rates in area, production and productivity of cereals and pulses

The period wise annual compound growth rates in area, production and productivity of cereal crops for the period 1980-81 to 2013-14 are presented in Table 5.10. The compound growth rates of area, production and productivity of all cereals, pulses, oilseed and sugarcane fluctuated widely during the period under consideration. The production and productivity of cereals like maize, kharif jowar and wheat is positive and highly significant for the entire period of thirty-four years. The production and productivity of total

cereals increased 0.20 and 1.26 per cent per annum, it clearly showed for Kolhapur district the production of total cereals during the span of thirty four years had increased mostly by improving in the productivity of cereals and less by increase in area under cereals. The area, production and productivity of total cereals had increased at higher rates (0.18,1.11 and 1.34 per cent) during period II (1995-96 to 2013-14) as compared to period I (1980-81 to 1994-95) and period III (1980-81 to 2013-14) growth rates of area, production and productivity of total cereals is -0.75,0.31,1.32 per annum respectively. Among different cereals, the annual growth rates in area, production and productivity of wheat, kharif and rabi jowar for period II, III was positive and highly significant except productivity of kharif jowar in period II and period third. The growth rates for bajra were negatively highly significant during II and III study period. In general, the annual growth rates of area, production and productivity of cereals viz., wheat, kharif jowar, rice, rabi jowar showed an increase at higher rates in period II (1995-96 to 2013-14) and period III (1980-81 to 2013-14) as compared to period I (1980-81 to 1994-95). The annual compound growth rates in area, production and productivity of pulses in Kolhapur district have turned out to be positive and highly significant during the entire period (1980-81 to 2013-14) except area in period II and III negative.

Annual compound growth rates in area, production and productivity of cereals and pulses 1980 – 81 to 2013-14

Sr. No	Crops	Period I (1980-81 to 1995-96)			Period II (1995-96 to 2013-14)			Overall period (1980-81 to 2013-14)		
		A	P	Y	A	P	Y	A	P	Y
1	Rice	-0.17	1.10	0.24	-5.09	9.44	20.94	14.35	20.44	11.44
2	Kh. Jowar	4.96***	17.04***	1.44	10.92	11.01	0.82	23.21*	24.52	0.05
3	Rabi jowar	-6.96***	-2.20	2.90	56.87***	32.30	4.65	38.76	38.41	4.41
4	Bajra	4.39	-0.04	5.11*	-11.52***	-17.24***	-18.04***	-14.05***	-23.11***	-20.54***
5	Wheat	-3.82**	-1.70	2.19***	16.65*	28.74***	2.05	3.05*	20.91***	2.0
6	Maize	-3.14***	1.39	1.59	10.47	38.47***	3.68	13.08***	50.47***	1.31**
7	Total cereals	1.05***	1.01*	-2.86	0.18	1.11**	1.32	-0.75	0.31	1.32
8	Red gram	3.62	-1.27	-0.52	5.99	18.51*	-0.21	21.03***	18.02	-1.02
9	Gram	8.04	12.28**	0.56	21.57*	23.24*	1.39**	24.56***	26.74***	-0.11
9	Green gram	21.82***	27.20***	4.59**	31.15**	31.06**	0.35	31.34***	35.14***	2.04***
10	Black gram	12.84***	14.27***	1.23	21.64*	21.35*	0.16	27.83***	29.99***	1.69**
11	Total pulses	1.21	2.71	1.43*	-0.11	1.05	1.20**	-0.67*	0.68	1.34**
12	Total food Grains	-0.72*	1.073*	1.85***	0.004	1.20*	-1.84**	-0.88***	0.21	-0.70**

*, **, *** significant at 10, 5 and 1 per cent level of significance A- Area
P-Production Y- Productivity

The production and productivity of total pulses in Kolhapur district had increased at the rate of 0.68, and 1.34. The growth rates for area seem to be almost negative. Thus growth in production primarily attributed to productivity of HYV. As far as different periods are concerned, all the periods except I showed negative growth rates for area, because area of pulse crops shift for commercial crops. The annual growth rates in area, production and productivity of total pulses have increased at the rate (1.21, 2.71, and 1.43 per cent) during period I as compared to period II (-0.11, 1.05, 1.20) and period III (-0.67, 0.68 and 1.34 per cent). In general, it is indicated that there is great scope to increase the area and production of total pulses in Kolhapur district.

Among pulses studied for the Kolhapur district, total pulses growth rates for overall period were positive and highly significant. Black gram, green gram and red gram have positive and significant higher growth rates over entire period thirty four years of study. Red gram productivity decreasing in period III but its area, and production have positive and significant growth rates over period II and III. The total food grain area, production and productivity fluctuate over study

period. The production and productivity of food grain increasing positively and highly significant during period I (1980-81 to 1994-95) compare to period II (1995-96 to 2013-14) and period III 1980-81 to 2013-14).

Compound growth rate in of total oilseeds and commercial crops

The area, production and productivity of total oilseeds, cotton and sugarcane crop had fluctuated widely during the period under study in Kolhapur district. The growth rates in area, production and productivity of oilseeds for entire period have turned out to be positive and increased at the rate of 2.02, 3.65 and 1.43 per cent respectively. The growth rates for period I (1980-81 to 1994-95) were -0.22, 0.19 and 0.42, which were positive and highly significant showing satisfactory growth rate except for area. However it decreased in period II. In particular growth rates for area, production and productivity for period I, II and III for *kharif* groundnut was positive and highly significant except productivity for period II declined with negative growth rates.

Annual Compound Growth Rates in Area, Production and Productivity of Oil-seeds and Commercial Crops

Sr. No.	Crops	Period I (1980-81 to 1995-96)			Period II (1995-96 to 2013-14)			Over all period (1980-81 to 2013-14)		
		A	P	Y	A	P	Y	A	P	Y
1	Groundnut	3.30***	7.22***	4.05***	15.28*	8.17*	-1.78	22.28***	21.33***	0.81*
2	Safflower	-11.44**	-11.66**	8.55***	-2.50**	-0.22	-2.2***	-3.54**	23.1**	-2.6**
3	Soybean	68.75***	80.35***	106.09***	22.55*	29.40**	1.54	56.80***	61.39***	33.37***
4	Total oilseed	-0.22	0.193	0.42	-0.02	2.33	0.74	2.02***	3.65***	1.43***
5	Cotton	-11.24***	-6.60	3.57**	2.09	26.09***	7.55	17.08***	22.01***	-6.64*
6	Sugarcane	3.25***	25.53***	20.64***	27.80**	23.01*	0.51	25.98***	31.71***	5.07**

*, ** and *** indicates 10, 5 and 1 per cent level of significance, respectively.

Among the different cash crops annual compound growth rate in area, production and productivity of cotton is positive and highly significant in period II, and III, except productivity in period III negatively significant. Sugarcane had a positive and significant growth rates for area, production and productivity as 25.98, 31.71 and 5.07 per cent, during overall period of study. This may be number of sugar factory increased.

The groundnut crop is the important oilseed crop in Kolhapur district. The annual compound growth rate in area production and productivity of groundnut had positively and highly significant during period I, II and III, except productivity of groundnut in period II. The annual compound growth rates of area, production and productivity of soybean is positive and highly significant during period of study. The growth rates in area production and productivity of soybean crop increased at (56.80, 61.39 and 33.37) in entire period of study. From the above analysis, it can be concluded that there exist wide variability's in the performance of individual crops like groundnut, soybean and sugarcane in terms of changes in their performance, total production, productivity in the district over a period under study.

Extent of Diversification

Various diversification measures have been used in economic Literature to indicate the extent of diversification. Among them, commonly used measures are, Entropy index (DE) and Modified Entropy index (MEI). These quantitative measures are mainly used for analyzing the functional relationship

between degree of economic diversification, economic performance and economic stability. They help in understanding structural composition of an aggregate and to compare it over time and space, also used as indicator of safety and risk. In addition to this, they reveal allocation strategy among activities of the different firms.

In the present study, crop diversification is supposed to be agricultural diversification because cropping pattern gives the picture of agriculture of a particular region. In the present study, diversification indices viz., Entropy index (E.I.) and overcoming the limitations of Entropy index, Modified Entropy Index (M.E.I.) were used to estimate extent of agricultural/crop diversification. These indices were worked out for different crop groups viz., All crops (which comprises of 7 cereals, 4 pulses, 4 oilseeds, sugarcane, cotton, fruits, vegetables, other cereals, other pulses, other oilseeds and other remaining crops), Cereals (Paddy, Wheat, Kh. Jowar, Rb. Jowar, Bajra, Maize, Ragi, other Cereals), Pulses (Gram, Mung, Tur, Udid, other Pulses), Oilseeds (Groundnut, Safflower, Sunflower, Soybean, other Oilseeds), Fruits (Grapes, Banana, Mango, Sweet Orange, Orange, Pomegranate, Guava, Sapota, Cashewnut, other fruits), Vegetables (Onion, Tomato, Potato, Brinjal, Cabbage, Cauliflower, other vegetables) were considered for judging the extent of the diversification among the specific group of crops. The period wise results of these indices are presented and discussed in subsequent paragraphs.

Crop diversification indices of all crops (1980-83 to 2013 14)

Sr. No	Crops	Time periods			
		1980-83	1990-93	2000-03	2009-12
A	Entropy Index= $\Pi^* \text{Log } 1/\Pi$				
1	All Crops	0.94	0.96	1.07	1.12
2	Cereals	0.62	0.57	0.67	0.48
3	Pulses	0.48	0.67	0.66	0.58
4	Oilseeds	0.20	0.34	0.37	0.37
5	Fruit crops	0.31	0.42	0.35	0.60
6	Vegetable crops	0.57	0.61	0.62	0.63
7	Other crops	0.50	0.43	0.39	0.34
B	MEI = $\Pi^* \text{Log } N1/\Pi$				
1	All Crops	0.66	0.65	0.68	0.69
2	Cereals	0.69	0.62	0.63	0.53
3	Pulses	0.62	0.86	0.74	0.72
4	Oilseeds	0.34	0.38	0.48	0.47
5	Fruit crops	0.26	0.34	0.52	0.54
6	Vegetable crops	0.75	0.83	0.67	0.73
7	Other crops	0.41	0.33	0.31	0.29

Due to peculiar agro-climatic conditions, cropping pattern of the Kolhapur district has centred on paddy, sugarcane, soybean, groundnut and fodder crops. It is observed from the Table 5.12 that the cropping pattern of Kolhapur district was more diversified during period 1980-83 than 2013-14. Modified Entropy Index (M.E.I.) imparts uniformity and fixity to the scale used as norm to examine the extent of diversification. It measures the deviation from equal distribution among the existing activities, i.e. number of crops only, and does not incorporate the number of activities in it. The values of MEI for all crops, cereals, pulses, fruit crops, vegetables and other crops were 0.66, 0.69, 0.62, 0.26, 0.72 and 0.41 respectively during 1980- 83, which were lower and higher than the values during 2009-12 for the respective crop group (0.69, 0.53, 0.72, 0.47, 0.54 0.73 and 0.29, respectively) indicated that the specialization has taken place during crops groups in Kolhapur district. The farmers have diverted their area to most remunerative crops in particular crop group e.g. more area to paddy than ragi and sugarcane, fodder crops and groundnut rather than Sesamum, Bajara and cotton.(District statistical Abstract)

The modified entropy index of other crops is decreased from 0.41 to 0.29 because sugarcane occupied about 33 % area and

which indicate area under pulses, oilseeds is reduced and which goes under sugarcane due more irrigation facilities and amount of rainfall.

M.E.I of fruits is increased from 0.26 to 0.54 during year (1980 -2014) which indicates more diversification within fruits crops. The value of entropy index for all crops, cereals, pulses, fruit crops, vegetables and other crops were 0.94, 0.62, 0.48, 0.20, 0.31 and 0.57 respectively which were lower and higher during 2009-12 (1.12, 0.48, 0.58, 0.37, 0.60, 0.63 and 0.34).

Determinants of crop diversification

This analysis mostly relied on the sample mean, percentage and proportion of individual items in the total of respective variants. The type of analysis deployed for the purpose, however had certain limitations of its own as it could not measure the relative contribution of individual variables in combination of other variables in influencing crop diversification in Kolhapur district.

The factors influencing crop diversification in Kolhapur district are very important. Therefore, the multiple linear regression equation was fitted to the data to obtain the factors influencing crop diversification in Kolhapur district.

13 Period wise regression results of agricultural diversification

Sr. No	Particulars	Y=Entropy Index		
		1980-94	1994-2014	1980-2014
1	Constant (a)	616.4*** (47.94)	-300.7 (861.9)	572.64*** (123.7)
2	Fertilizer Consumption	3.2* (1.6)	-6.75 (5.55)	-2.14 (2.98)
3	Percentage of HYV seeds	-1.88(3.33)	25.78*(12.77)	6.66*(5.32)
4	No. of dug wells perthousandsq.km	7.19 (9.05)	-96.58* (93.89)	3.33 (1.84)
5	Rainfall in mm (X4)	0.026* (0.016)	-0.0135 (0.0642)	-0.092* (0.3362)
6	Loan disbursed in year (lakhs)	-0.11*** (0.0064)	-0.0001 (0.0989)	-0.0939* (0.047)
7	Percentage of GIA/GCA	2.9 (2.7)	16.66 (18.80)	-1.87 (5.55)
8	Number of milch animals	0.0009*** (0.00023)	0.020*** (0.00078)	0.0007*** (0.0002)

*, ** and *** indicates 10, 5 and 1 per cent level of significance, respectively.

Notes: All the values in the table are multiplied by a constant number (1000) to improve readability.

For temporal analysis data of Kolhapur district regarding selected variables for the years 1980-94, 1995-2014, 1980-2014 and pooled data of these three periods were regressed on transformed value of Entropy indices and results of the same are presented in above table.

It is revealed from the table that the values of R2 were at higher side for the Entropy index as dependent variable. The magnitude of R2 was highest during the year 1980-2014

(0.78) and lowest during the year 1980-94 (0.49) which means the selected explanatory variables has explained 78 per cent variation during 1980-2014 whereas only 49 per cent variation was explained by selected variables during 1980-94. The results of pooled regression indicated that the number of livestock animals, percentage of HYV seeds have positive impact on diversification whereas rainfall had negative, but

significant influence on diversification of agriculture in Kolhapur district except period first.

The numbers of livestock animals, percentage of HYV seeds have positive impact on diversification during all time periods with varying magnitude. The regression coefficient for fertilizer consumption turned negatively significant during 1980-1994 might be less availability of fertilizers to farmer in the Kolhapur district.

Negative sign or non-significance of variable per cent gross irrigated area to gross cropped might be because the farmer tends to go for specialization when they have irrigation facilities. Loan distributed overall period of study (1980-2014) have negative but significant effect on crop diversification. Due to availability of credit to the farmer they shifted crops like minor millets to sugarcane and fruit crops which gave higher income to the farmer. Number of dug wells showed positive but non –significant effect on crop diversification except period second.

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