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STATISTICAL ANALYSIS ON FACTORS INFLUENCING ON SHIFT IN CROPPING PATTERNS IN DIFFERENT AGRO-CLIMATIC ZONES OF KARNATAKA

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ABSTRACT

The study was carried out to assess the factors influencing the shift in cropping pattern in different Agro climatic zones of Karnataka. The study period from 1992 to 2012 was divided into two decades: from 1992-2002 and from 2002-2012. Herfindhal index has been used in this study to measure the extent of Shift in Cropping Pattern. Principal Component Regression (PCR) was used to know the Factors that influence the shift in cropping pattern in both periods. The Result of PCR indicates that PC1 (-0.00027* & 0.000226*) and PC2 (-0.00027* & 0.00054*) were Significant in both the periods ($R^2$was 0.73 & 0.68 for both period of study respectively). The factors such as amount of rainfall (0.490 & 0.574), rural literacy (0.583 & 0.574), Forest area (0.505 & 0.507) were significantly contributing to PC2 in both periods and the number of regulated markets (0.326 &0.365),Small holders (0.353 & 0.371), Net irrigated area (0.325 & 0.344), area under high yielding varieties (0.351 & 0.357) were significantly contributing in PC1 in both periods of study.

INTRODUCTION

Diversification in Agriculture is defined as diversion of a sizable acreage from the existing crop system to some alternative crops or cropping systems or farm enterprises. In India diversification has occurred both across and within the crop or farm enterprises such as livestock, fishery and forestry sectors.

Shift in Cropping Pattern

It is a strategy of shifting from less profitable to more profitable crops or shift from traditionally grown less remunerative crops to more remunerative crops (Maharajan, 2004). Changing of varieties and cropping system, increasing exports and competitiveness in both domestic and international markets, protecting the environment and making conditions favourable for combining different enterprises resultant with shift in cropping pattern (Vyas, 1996).

The crop shift also takes place due to governmental policies and thrust on some crops over a given time. Market infrastructure development and certain other price related supports also induce the crop shift. Often low volume high-value crops like spices also aid in shift in cropping pattern (Joshi *etal,* 2004). Hence the government policies, Market infrastructure, Transportation facility, irrigation area, amount of rainfall, animal husbandry are major determinants of shift in cropping pattern (Tewari, 2004).

Shift in cropping pattern is useful farm mechanism and stabilizes the farm income when there is severe effect of drought on farm resources. The best exampleis sugar cane replacing rice or wheat in a particular area will provide economic yield and growing of large number of crops are practiced in rain fed lands to reduce the risk factor of crop failures due to drought or less rains. Crop substitution and shift are also taking place in the areas with distinct soil problems (Kurosaki, 2003).This study aims to understand the changes in cropping pattern over the years and the factors contributing for these changes.

MATERIALS AND METHODS

To calculate the extent of cropping shift,considered cultivation area of seventeen different agriculture crops such as paddy, finger millet, bajra, wheat, Sorghum, maize, bengal gram, horse gram, green gram, black gram, red gram, sesame, sunflower, groundnut, sugarcane, and cotton from following 10 different agro climatic zones of Karnataka for the period 1992-2012. The entire 20 years of data was completely divided in to two periods. First period from 1992-2002 and the second period from 2002-2012 and the entire analytical frame work was carried out for both the periods separately (Joshi *et al.,* 2004).

The specific reason for choosing this study period was to know the impact of agriculture policy on Karnataka agricultural cropping pattern. To know the factors influencing on the shift in cropping pattern, the following variables considered as the explanatory variables X1=Rain fall(mm), X2=net irrigated area(ha), X3=area under high yielding varieties (ha), X4=rural literacy(%), X5=number of agriculture labourers (numbers), X6=number of regulated markets (numbers), X7=number of financial institution(numbers), X8=rural road length(km's), X9=number of livestock's (numbers), X10=area under small holders (ha), X11=forest cover area (ha), X12=number of IP sets and tractors (numbers) (Mehta, 2009).

Herfindhal index was used for measuring the extent of cropping shift and index values were considered as dependent variable (Chandrasekhar, 1993). There are 10 agro climatic zones in Karnataka and can expect 10 samples for the analysis, but we have 12 explanatory variables (Table 1), so we can't go for regression analysis as the assumption is not holds good (number of sample size is less than the number of independent variables). To reduce the variable size we go for principle component analysis and then the principal components were used as explanatory variables and go for regression analysis by regressing the different components (determinants of cropping shift) on dependent variable (cropping shift-herfindhal index) called principal component regression. The significance of the variable can be identified by the value (>0.3) of the factor loadings in each principal component which were found to be significant in principal component regression (Pal and Pal, 1986).

RESULTS AND DISCUSSION

Table.2 explains the result of Herfindhal index and indicates extent of shift in cropping pattern across different zones of Karnataka. The summary of the table shows Costal zone and hilly zone were wind up with crop specialisation (no shift in cropping pattern), Eastern Zone depicts moderate crop shift and remaining all the zones were indicates high crop shift.

Table 3 depicts the Eigen values corresponding to each component and variability associated with the components. The first Eigen value (7.44) captures maximum variability (62.01%) and the second Eigen value (2.40) indicating second highest variability (20.04%) and so on; finally wind up with 12 components (Guptha and Tewari,2004).the major findings of this table was extent of variation explained by individual principal component.

Fig.1indicates that the first four Eigen values capture maximum variability (96%)and corresponding 4 components were selected for further analysis like principal component regression for1992-2002 (De, 2003). The graphical analysis helps to select the required number of components for further mathematical treatment.

The rotated component factors loadings were presented in Table.4 The factor loadings represents the weights assigned to each of the variable in the linear combination (Xi) corresponding to each Eigen values. First component depicts the weights assigned for the first variable (Rainfall) was -0.166 and for second variable (number of Argil. labour) was 0.321 and so on.

Based on the higher values of factor loadings in each principal components, It can be conclude that the following variables, Rainfall, net irrigated area, area under HYV, number of small holders, Tractors and IP sets, Total livestock numbers, Rural literacy(%), forest covered area and number of regulated markets were significantly influence on Cropping Shift.

Table.5 PCR result explains that the intercepts, first principal component, second principal component were significant. The first principal component was negatively influence on the cropping shift. based on the value of rotated first principal component factor loadings and conclude that the variables, net irrigated area, area under HYV, number of small holders, tractors and IP sets, total livestock numbers, and number of regulated markets were negatively influence on cropping shift.

The second principal component depicts positive influence on shift in cropping pattern. The variables in the second Principal component such as rainfall, rural literacy (%), and forest covered area were positively influencing on shift in cropping pattern (Singh *et al.*, 2006) and the third and fourth principal components were not statistically significant. The computed R^2 value obtained was 0.7379. The result indicates

Table I: Agro climatic zones of Karnataka considered for study

No.	Name	Abbreviation	No. of Taluks
Zone 1	North Eastern Transition Zone	NETZ	7
Zone 2	North Eastern Dry Zone	NEDZ	11
Zone 3	Northern Dry Zone	NDZ	35
Zone 4	Central Dry Zone	CDZ	17
Zone 5	Eastern Dry Zone	EDZ	24
Zone 6	Southern Dry Zone	SDZ	19
Zone 7	Southern Transition Zone	STZ	13
Zone 8	Northern Transition Zone	NTZ	14
Zone 9	Hilly Zone	HZ	22
Zone 10	Coastal Zone	CZ	13

Table 2: Herfindhal Index for measuring shift in cropping patterns

Agro-Climatic Zones	Herfindhal Index 1992-2002	2002-2012
NETZ	0.1275**	0.1198**
NEDZ	0.1588**	0.1446**
NDZ	0.1541**	0.1247**
CDZ	0.1666**	0.1593**
EDZ	0.3785*	0.3608*
SDZ	0.1784**	0.1707**
STZ	0.1745**	0.1694**
NTZ	0.1524**	0.1245**
HZ	0.6133	0.6737
CZ	0.7554	0.7756

** Higher extent of shift in Cropping pattern (0<=H<=0.3), * Moderate Shift in Cropping Pattern (0.3<=H<=0.6).No shift in cropping pattern (0.6<=H<=1)

Table 3: Eigen values and percentage of variation for the Data Set 1992-2002

	F1	F2	F3	F4
Eigen value	07.44	02.40	01.04	00.64
Variability (%)	62.01	20.04	08.66	05.36
Cumulative (%)	62.01	82.06	90.72	96.09

Table 4: Principal Component factor loadings for Data set 1992-2002

Notation	Variables	F1	F 2	F 3	F 4
X1	Rainfall (mm)	-0.166	0.490 *	0.063	0.515
X2	Agril. labour numbers	0.321	0.070	-0.422	-0.006
X3	Net irrigated area (ha)	0.325 *	-0.032	0.315	0.391
X4	Area HYVs (ha)	0.351 *	-0.105	0.090	0.020
X5	Area under small holders (ha)	0.353 *	-0.114	0.101	-0.001
X6	IP sets & Tractors numbers	0.332 *	0.112	-0.233	-0.312
X7	Total Livestock numbers	0.364 *	-0.015	0.009	0.018
X8	Forest covered area (ha)	-0.018	0.505 *	0.552	-0.280
X9	Road length (Km)	0.302	0.246	0.163	-0.464
X10	Rural Literacy (%)	-0.039	0.583 *	-0.305	-0.046
X11	Regulated markets numbers	0.326 *	0.018	0.300	0.311
X12	Financial institutions numbers	0.270	0.248	-0.364	0.303

Table 5: Principal Component Regression (PCR) statistics for data 1992-2002

	Intercept	PC1	PC2	PC3	PC4
Coefficients	0.2771*	-0.00027*	+0.000226*	-0.000481	-0.000155
t- statistic value	2.577	2.621	2.691	1.866	1.835
F- value			5.402 *		
R^2 value			0.737		
Mean error sum of square			0.017		

* Indicates the significance at 5% level

Table 6: Eigen values and percent variation for data set 2002-2012

	F1	F2	F3	F4
Eigen value	06.48	02.74	01.18	01.17
Variability (%)	54.06	22.85	09.85	09.32
Cumulative %	54.06	76.91	86.76	96.09

Table 7: Principal Component factor loadings for data 2002-2012

Notation	Variables	F1	F2	F3	F4
X1	Rainfall (mm)	-0.139	.507 *	-0.312	-0.181
X2	Agril. labour numbers	0.357 *	0.094	0.277	-0.211
X3	Net irrigated area (ha)	0.344 *	-0.083	-0.413	0.081
X4	Area HYVs (ha)	0.357 *	-0.104	-0.319	0.023
X5	Area under small holders (ha)	0.371 *	-0.152	-0.127	0.077
X6	IP sets & Tractors numbers	0.319	0.084	0.491	-0.003
X7	Total Livestock numbers	0.207	0.354	-0.274	-0.441
X8	Forest covered area (ha)	-0.037	0.429 *	-0.158	0.610
X9	Road length (Km)	0.283	0.157	0.251	0.499
X10	Rural Literacy (%)	-0.047	0.574 *	0.174	-0.023
X11	Regulated markets Numbers	0.365 *	0.022	-0.227	0.132
X12	Financial institutions numbers	0.330 *	0.150	0.227	-0.274

*The loadings of the variables which were contributing maximum to the principal components

that around 73.79% of the variations in dependent variable were explained by these four principal components. The F-calculated value was 5.4026 significant at 5% level of significance.

Table 6 depicts the Eigen values corresponding to each component and variability associated with the components, the first Eigen value (6.48) captures maximum variability (54.06%) and hence as the first principal component. The second Eigen value (2.74) was with second highest variability (22.85%) and third one (1.18) captures third highest variability (9.85%) and fourth one (1.17) captures highest variability (9.32) and so on. The first four Eigen values explain a total of 96.09% variability.

Fig.2 indicates that the first four Eigen values capture maximum variability (96%) and corresponding 4 components were selected for further analysis such as principal component regression for 2002-2012 (De, 2003).

The rotated component factors loadings were presented in Table7 The factor loadings represents the weights assigned to each of the variable in the linear combination (Xi) corresponding to each Eigen values. first component indicates that the weights assigned for the first variable (Rainfall) was -0.139 and for second variable (number of Argil. labour) was 0.357and so on.

Table 8: Principal Component Regression statistics for data 2002-2012

	constant	PC1	PC2	PC3	PC4
Coefficients	0.3264*	-0.00027*	0.00054*	-0.00049	0.00018
t- statistic value	2.0613	2.571	2.71	0.432	0.623
F- value			9.455 *		
R^2 value			0.680		
Mean error sum of square			0.010		

Table 9: Summary of the principal component regression for both the periods

Period of study	Influencing factors
Cropping shift (1992-2002)	Rainfall, number of regulated markets, number of livestock's, number of Ip sets and tractors, forest cover area, area under small holders (ha), net irrigated area, area under high yielding Varieties, rural literacy.
Cropping shift (2002-2012)	Rainfall, number of regulated markets, number agriculture labourers, number of financial institutions, forest cover area, area under small holders (ha), net irrigated area, area under high yielding varieties, rural literacy.
Shifted Factors in the Period 1992-2002	Number of livestock's, number of IP sets and tractors.
Included Factors in the Period 2002-2012	Number agriculture labourers, number of Financial institutions.

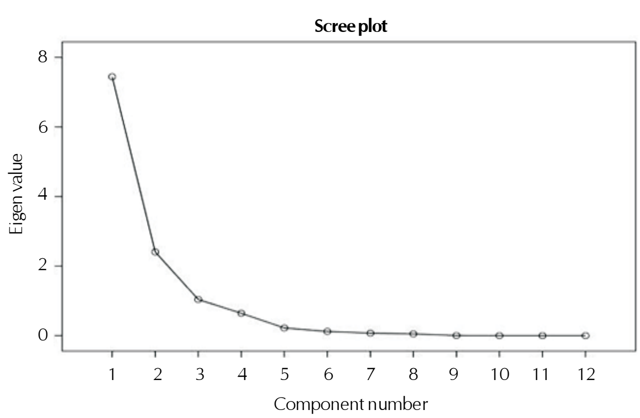

Figure 1: Scree plot for components v/s Eigen values (1992-2002)

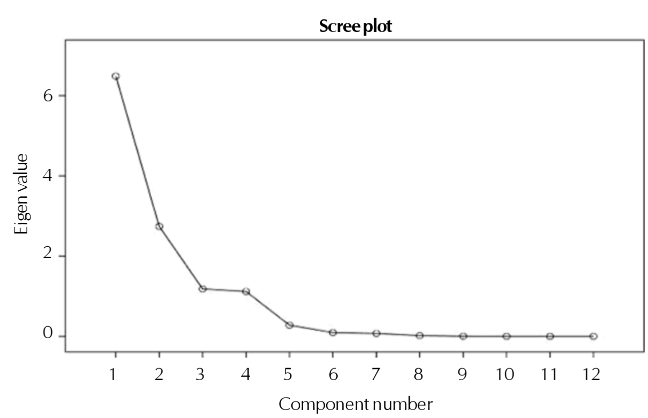

Figure 2: Scree plot for Components v/s Eigen values (2002-2012)

The linear combination of these factor loadings with the Corresponding variables gives the findings on corresponding principal components. The selected four components were taken as independent variables and cropping shift (Calculated value of Herfindhal index) was taken as dependent variable for Analysing PCR.

Table.8depicts the intercept, first principal component and second principal components werestatisticallysignificant. The first principal component was negatively influence on the cropping shift. Based on the value of rotated first principal component factor loadings, it conclude that the variables like net irrigated area, area under HYV, number of small holders, number of agriculture labourers, number of financial institutions and number of regulated markets were negatively influence on cropping shift.

The second Principal component was positive influence on shift in cropping pattern. The variables in the second principal components such as Rainfall, Rural literacy (%), and forest covered area were positively influence on shift in cropping pattern and the third and fourth principal components were not statistically significant. $R^2 = 0.680$, It indicates that about 68.01% of the variations in dependent variable was explained by four principal components. The F statistics was significant at 5%.

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