Pattern diversities in cropping systems in tribal regions: a case study of Jhabua tribal district in Madhya Pradesh, India

Singh, Vivek Kumar and Singh, RD
International Maize and Wheat Improvement Centre (CIMMYT), Barkatullah University, Bhopal

10. January 2011

Pattern diversities in cropping systems in tribal regions: a case study of Jhabua tribal district in Madhya Pradesh, India*

Vivek Kumar Singh ** R.D. Singh ***

Abstract

Agricultural development has been analysed by studying the cropping pattern and cropping diversification and crop specialization in any agro-ecosystem in regional and temporal framework. Tribal regions are experiencing agricultural intensification through diversification of cropping systems and crop specialization as a result of ecological economic changes as well as impact of public policy of technology transfer and resource use intensification. The market forces also are influencing the crop intensification as a result of exogenous market demand.

In this paper, an attempt is made to analyze the pattern of cropping system in inter regional framework and identify how these patterns have changed over a period of time in Jhabua tribal district of Madhya Pradesh. Such an analysis will help in taking policy decisions for diversification and specialization of crop production in the changing cropping systems in regional framework with the objectives of achieving higher level of regional food production, maximisation of production and income to the farmers through promotion of cash crops etc. The analysis of the pattern diversity in regional framework would indicate to the eco-regional and exogenous impacts of market and public policies following the law of entropy.

1. Introduction

1.1 In economic literature, diversification and specialization of economic and production systems are used as the method for analysis of structure of economic system and the system change as a dynamic analysis. Agriculture, being an organic production system, has a specific agro-ecological relation with the regional environment and resources. These conditions are the regional ecological factors for agricultural system of different regions and are deterministic or **ecological factors**. The other factors are anthropogenic in nature influenced by human factors, which may be categorized as **exogenous factors.** These factors constantly interact in space and time to bring about changes in the cropping system in regional framework. Agriculture, as a bio-productive system or as an economic system, requires the study of the regional pattern of cropping diversity and diversification as a process over a period of time. This will help in framing regional agricultural policy for development.

---

* The research article is the outcome of ICAR Ad-hoc Research Scheme entitled "Eco-regional Modelling of Agricultural Development in Tribal Regions : A case study of Jhabua district." (F.No. 6-10/2003-ESM)

** Vivek Kumar Singh is Senior Research Scientist in International Maize and Wheat Improvement Centre (CIMMYT), New Delhi and corresponding author (v.singh@cgiar.org).

*** R. D. Singh is Professor in The Department of Regional Planning and Economic Growth, Barkatullah University, Bhopal (M.P.).-462026

Another process of agricultural growth or development is analysed in terms of localization and specialization of particular crop influenced by the geo-environmental (local) conditions and the demand by the population and the market (anthropogenic or external factors). In economic literature, crop specialization has been analysed by taking labour and capital as factors of production, which has ignored the ecological or environmental factors. The Agricultural geographers, on the other hand, have taken land as an important factor influencing regional specialization of crops and their productivities. The regional scientists have used localization coefficient of crops for studying regional specialization of cropping pattern in specific geo-environmental regions and the intra-regional variations in the level of specialization. This approach may help to take policy decision for micro level and regional planning for maximisation of production by studying the local conditions and their regional variations in cropping pattern.

1.2 The diversification of crops has been studied by agricultural geographers, agricultural economists and agricultural scientists in their own areas of emphasis and specialization. The agricultural geographers have attempted to identify the geographical variation of cropping systems as well as crop combination and crop rotation in different regions. The agriculture economists have used the study of diversification of agriculture primarily for selecting crops for maximisation of production and income. The agricultural ecologists are trying to evolve sustainable agro-ecosystem for ensuring food security and environmental balance. Both subjective and objective criteria are being used in the study of cropping diversity

Panda (2001) used subjective criteria for measuring crop diversification by using diversification of crop combination, changes in food grains and non-food grains and their production in India in six regions. Neena (1998) used Ginni coefficient and entropy index for measuring inter- regional variation in cropping pattern in India. Singh, et. al. (1997) used mixed integer programming model as farm management for maximisation of economic returns by input minimization, diversification of crops in Meerut district of Uttar Pradesh for marginal farms. Verma, et. al. (1997) studied the small farms in North Bihar and identified the tendencies of farmers towards the objectives of increasing food security or income generation activities. It is identified that the marginal farmers have a tendency to income maximisation by shifting to cash crops rather than increasing food security in the process of cropping diversification. Pandey, et. al. (1996) studied the tendencies of crop diversification as a method of ensuring food self-sufficiency by farmers.

Singh, et. al. (1991) studied the cropping diversity as a method for regionalization used by geographers for cropping system using single element technique or multiple element technique. Regions of highly localized agricultural production which exhibits higher degree of concentration of crops or livestock enterprises is identified by using single element technique. On the other hand, by using multiple element technique we can diversify the cropping pattern as system of rural production and their diversities determined by regional ecological factors of a combination of crops, livestock and agriculture enterprise diversification. Rao et. al. (1994) have studied the agriculture in the new perspective and policy implication. Palaniappan (1985) has studied the principles and basic concepts of cropping pattern in the tropic regions.

On the basis of above reviews, it becomes clear that subjective and objective criteria have been used for studying cropping diversities to identify the tendencies of food crops diversities for increasing food availability or income maximisation in different regions. In this paper, an attempt is made to study the diversities in cropping pattern in regional and

temporal framework to check the diversity and specialization of crops as a pattern and process.

2. Objective, Method and techniques used in the study

The objective of the research article is to identify the pattern and process of crop diversification in regional frame work which will be helpful for crop planning at local and regional levels.

2.1 The tribal regions have high degree of geo-physical diversities and , therefore, cropping patterns are influenced by deterministic eco-regional factors and the exogenous factors like market and public policies. Tahsils have been taken as sub-regions in the district. A system of regionalization on the basis of administrative boundary helps in analyzing the cropping pattern diversities under given geo-physical condition.

2.2 Diversification Index has been calculated by taking proportional share of different crops in different regional units during 1990-91 and 2007-08 using Ginni coefficient for comparison of diversity index for inter-regional and inta-regional analysis in the study area. The Entropy index has been used to identify the level of constraints in the diversification of the cropping pattern in different regions.

The Ginni coefficient have been calculated by using the following formula

$$\text{Ginni Coefficient} = \sqrt{\sum_{i=1}^{N} p_i^2} \qquad \text{----------} \quad (1)$$

p_i = proportion of area under ith crop

2.3 The Entropy Index has been calculated to identify the environmental constraints put to the different crop systems influencing cropping diversities in different sub-regions of the tribal district using the following formula -

$$\text{Entropy Index} = \sum_{i=1}^{N} p_i \log(1/p_i) \qquad \text{---------} \quad (2)$$

2.4 The localization coefficient of different crops in different regions have been calculated as a measure of regional specialization of crops using the following formula –

$$\text{L.Q.} = \frac{c_i}{c} \Big/ \frac{C_i}{C} \qquad \text{----------} \quad (3)$$

where, c_i = area under crop ‘ i ‘ in particular tahsil,
c = area under all crops in particular tahsil,
C_i = area under crop ‘ i ‘ in the district,
C = area under all crops in the district.

For calculation of Ginni coefficients and Entropy Index, the crops having minimum of 5 % or more area under the gross cropped area in the district have been taken. The crops having less than 5% of the gross cropped area in the district have been ignored considering them as insignificant.

3. Analysis

3.1. Crop Combination and rotation

For analysis, principal crops in kharif and rabi seasons have been taken for analysis. The principal kharif crops in the Jhabua district are maize, rice, jowar, urad, soyabean and cotton as per the data of 2007-08. It is found that the area under commercial crops like soyabean, cotton and urad are increasing during the kharif season, whereas the cereals like jowar and rice are declining and area under maize is increasing. It reveals that agriculture is stabilizing during the study period between 1990-91 and 2007-08. The commercial crops are increasing as an impact of market and tendencies of maximisation of income by farmers substituting the crops which are water intensive like rice and the inferior crops like jowar, kodo-kutki and bajra. This indicates environmental, technological and market response in the diversification of cropping pattern in the district during the kharif season.

In the rabi season, the principal crops are wheat and gram along with other negligible areas in oilseeds like Til, Alsi, Groundnut and Rye and Mustard. The area under groundnut is increasing indicating to the market impact on cropping pattern. The area under wheat is increasing faster, whereas of the gram is declining during the study period.

3.2 Regional pattern of crop diversity in Jhabua district

The principal cereal crop of Jhabua district is maize which covers almost 27.76 percent of the gross cropped area, which increased from 22.76 percent of 1990-91. Urad is the second crop which dominants after maize in Jhabua district. However, there is high degree of regional diversity in the cropping pattern between tahsils. There is general tendency of regional specialization of cropping system as indicated by increasing areas of commercial crops and adoption of superior crops in place of inferior ones. Petlabad, Thandla and Meghnagar are fast specializing in commercial crops of cotton and soyabean. Though maize and rice are grown in kharif season as dominant food crop, wheat is now increasing during rabi season.

Generally there is mixed cropping system in most of the tahsils with crop combinations of cereals, pulses, oilseeds, vegetables and spicies indicating to crop diversification in the region. Over the period of time, rice, jowar, gram is declining, whereas maize, wheat, soyabean, urad and cotton are increasing. However, in Thandla and Meghnagar tahsils, area under maize has decreased. Urad has sharply decreased in Petlabad tahsil.

Ginni Coefficient has been used for calculating regional pattern of crop diversity. Bhabhra and Meghnagar tahsils show higher level of crop diversity followed by Jobat, Thandla, Jhabua, Ranapur, Alirajpur and Petlabad. The lower value of Ginni Coefficient of Petlabad may be explained by the relatively higher level of specialization in the cropping system.

3.3 Temporal analysis of cropping diversity

The cropping diversities have been calculated for the periods of 1990-91 and 2007-08 to indicate the diversity in the cropping pattern over a period of time in different tahsils and the district. It is found that there is visible change in the cropping pattern during these two periods. On the one hand, the commercial crops like soyabean, cotton etc. having higher market value are increasing in the region, substituting the low market value crops in almost all regions. There is also a tendency to introduce superior food crops like wheat, maize etc. having higher productivity than the inferior food crops like jowar, bajra, kodo-kutki etc. The region is also diversifying the cropping pattern by increasing tendencies of production of vegetables and spices.

The Entropy Index has been used for measuring cropping diversity in different tahsils in the district. It is found that Bhabhra and Meghnagar tahsils have higher level of cropping diversity during 1990-91, which has increased during 2007-08. In general, the cropping diversity has increased in all the tahsils of the district during the study period. The temporal variation in cropping diversity is very high in Petlabad tahsil followed by Ranapur, Thandla and Jhabua tahsils. The lower temporal variation in cropping is found in Alirajpur, Bhabhra and Jobat tahsils.

3.4. Localization and specialization in cropping system

Localization is a process of relative spatial concentration of particular cropping system. The maize crop in the district is having higher level of localization in Meghnagar, Jhabua, Thandla, Ranapur and Bhabhra tahsils. However, the localization coefficient has decreased in most of these tahsils during 1990-91 and 2007-08. Urad is highly localized in Bhabhra, Jobat and Alirajpur tahsils. Wheat is being grown in almost all tahsils. However, it has higher level of localization in Thandla, Jhabua and Petlabad tahsils. The commercial crops like cotton and soyabean have localized more in Petlabad, Thandla and Jhabua tahsils. The inferior crop like jowar has higher level of localization in Jobat and Alirajpur tahsils. The rice crop is having higher level of localization in Thandla, Jhabua, Bhabhra and Ranapur tahsils. Jobat and Alirajpur have low level of localization of rice.

In general, due to geographical diversity in the land forms, the upland regions Alirajpur and Jobat have generally localization of inferior crops and have low level of localization coefficient for superior food crops and commercial crops. The superior food crops and commercial crops like wheat, soyabean and cotton are localized in Petlabad, Thandla and Jhabua tahsils. The general decline of localization coefficient indicates to increasing cropping diversity in most of the tahsils. The environmental factors may also tend to decrease the localization of the superior crops due to risks and uncertainties of environment and market.

4. Summary and Conclusion

4.1 There is a general tendency of diversification of crops in the tribal areas. However, due to the lack of infrastructural facilities like irrigation, the cropping pattern is unstable and is susceptible to the environmental uncertainties. It is necessary to conserve water resources in the study area, so that the cropping systems become stable and able to adopt technology for higher levels of crop productivity.

4.2 There is a general tendency of crop specialization and market linkages of the commercial crops like soyabean and cotton in relatively developed tahsils like Petlabad, Thandla and Jhabua. Among the food crops, maize and wheat are localizing faster, whereas water-intensive crop like rice has declined due to the environmental problems. This calls for agricultural policy mix for stabilization of food crops by ensuring an integrated and decentralised efficient resource use for maximisation of food productivity and promotion of income generating commercial crops which have increasing market linkages with trade and industries.

4.3 In tribal areas, agriculture is diversifying due to vertical socio-economic linkages from forest economic-ecologic dependence to agriculture. The geographical constraints limits the expansion of cultivable land, hence it is required to intensify the agricultural production by crop diversification and increasing crop productivity. This will not only help to achieve higher rate of agricultural growth in tribal areas, but also ensure conservation of forest rather than extensive agriculture to create environmental balance and sustainable growth.

References

1. Panda, R. K., (2001), "**Diversification in agriculture-Issues & future action**", Productivity, Vol. 42, No.1, pp 147-150.
2. Neena, D.,(1998), "**Inter state variation in cropping pattern in India**", Indian Journal of Regional Science, Vol. XXX, No. 2, pp 57-63.
3. Singh, N.K., Rajbir Singh & R.P. Singh, (July, 1997), "**Impact of diversification on income, Employment and credit needs on Marginal farms**", Agricultural Situation in India, pp 191-197.
4. Verma, Binoy N. & R.R. Mishra, (July, 1997), "**Crop diversification and related issues on small farmers in North Bihar**", Agricultural Situation in India, pp 181-188.
5. Pandey, V.K. & Sharma K.C. (1996), "**Crop Diversification and self sufficiency in food grains**", Indian Journal of Agricultural Economics, Vol.51 (4).
6. Rao, C.H. Hanumanta & A. Gulati (1994), "**Indian Agriculture: emerging perspective and policy issue**", Economic and Political Weekly, Vol. 29(53).
7. Singh, Jasbir & S.S. Dillon, (1991), "**Agricultural Geography**", Tata Mc Graw Hill Company Limited.
8. Palaniappan, S. P. (1985), "**Principles and basic concepts in: Cropping system in the tropics, principles and management**", Wiley Eastern Limited, New Delhi, pp 5-38.

Annexure

Table 1(a). Cropping Diversity in Jhabua district represented by Ginni Coefficient (1990-91)

Region	GCA	C_1	C_1^2	C_2	C_2^2	C_3	C_3^2	C_4	C_4^2
Bhabra	25465	27.93	780.08	35.48	1258.83	3.81	14.52	3.34	11.16
Alirajpur	105976	11.16	124.55	26.41	697.49	12.45	155.00	1.43	2.04
Jhabua	67876	32.77	1073.87	5.58	31.14	6.02	36.24	6.97	48.58
Jobat	59511	15.64	244.61	32.9	1082.41	13.52	182.79	3.95	15.60
Pethlabad	59392	21.06	443.52	3.64	13.25	1.86	3.46	7.08	50.13
Thandla	34637	30.61	936.97	7.18	51.55	5.48	30.03	7.40	54.76
Meghnagar	28078	41.55	1726.40	2.53	6.40	2.8	7.84	6.42	41.22
Ranapur	34575	26.9	723.61	7.08	50.13	4.43	19.62	5.30	28.09
Dist.Jhabua	415510	22.76	518.02	16.38	268.30	7.61	57.91	4.78	22.85

Conti…

Region	C_5	C_5^2	C_6	C_6^2	C_7	C_7^2	$\sum C$	$\sum C^2$	Ginni Co.
Bhabra	0.01	0.0001	8.42	70.90	10.25	105.06	89.24	2240.55	47.33
Alirajpur	0.87	0.76	3.26	10.63	3.85	14.82	59.43	1005.29	31.71
Jhabua	6.38	40.70	9.18	84.27	9.51	90.44	76.41	1405.25	37.49
Jobat	0.63	0.40	2.95	8.70	7.45	55.50	77.04	1590.01	39.87
Pethlabad	18.41	338.93	7.38	54.46	6.73	45.29	66.16	949.04	30.81
Thandla	15.43	238.08	10.03	100.60	7.21	51.98	83.34	1463.98	38.26
Meghnagar	10.07	101.40	9.47	89.68	12.3	151.29	85.14	2124.24	46.09
Ranapur	0.51	0.26	10.18	103.63	11.71	137.12	66.11	1062.47	32.60
Dist.Jhabua	5.99	35.88	6.65	44.22	7.6	57.76	71.77	1004.95	31.70

Source: Calculation based on data available in District Statistical Handbook for Jhabua, Govt. of Madhya Pradesh

GCA=Gross Cropped Area

C1=Proportion of area under maize,C2=Proportion of area under urad, C3 = Proportion of area under Jour,
C4 = Proportion of area under wheat, C5 = Proportion of area under cotton, C6= Proportion of area under rice,
C7 = Proportion of area under gram

Table 1(b). Cropping Diversity in Jhabua district represented by Ginni Coefficient (2007-08)

Region	GCA	C_1	C_1^2	C_2	C_2^2	C_3	C_3^2	C_4	C_4^2
Bhabra	25465	33.39	1114.89	35.48	1258.83	0.78	0.61	6.13	37.58
Alirajpur	111407	16.15	260.82	26.41	697.49	8.13	66.10	3.32	11.02
Jhabua	69951	33.86	1146.50	5.58	31.14	2.6	6.76	11.21	125.66
Jobat	59474	18.84	354.95	32.9	1082.41	9.87	97.42	8.46	71.57
Pethlabad	59839	28.53	813.96	3.64	13.25	0.37	0.14	11.80	139.24
Thandla	35093	29.82	889.23	7.18	51.55	5.48	30.03	11.35	128.82
Meghnagar	30564	40.45	1636.20	2.53	6.40	0.45	0.20	9.20	84.64
Ranapur	34799	33.08	1094.29	7.08	50.13	2.97	8.82	9.17	84.09
Dist.Jhabua	426592	27.76	770.62	16.38	268.30	5.05	25.50	8.80	77.44

Conti…

Region	C_5	C_5^2	C_6	C_6^2	C_7	C_7^2	C_8	C_8^2	$\sum C^2$	Ginni Co.
Bhabra	1.78	3.16	6.94	48.16	6.65	44.22	1.76	3.10	2510.56	50.11
Alirajpur	1.56	2.43	4.1	16.81	3.27	10.69	0.38	0.14	1065.51	32.64
Jhabua	9.48	89.87	6.29	39.56	6.11	37.33	10.64	113.21	1590.04	39.88
Jobat	5.61	31.47	1.87	3.49	4.73	22.37	4.88	23.81	1687.50	41.08
Pethlabad	23.34	544.76	3.00	9.00	2.22	4.93	15.35	235.62	1760.89	41.96
Thandla	15.39	236.85	8.51	72.42	8.26	68.23	10.28	105.68	1582.82	39.78
Meghnagar	13.76	189.34	9.27	85.93	12.15	147.62	3.57	12.74	2163.08	46.51
Ranapur	2.66	7.08	9.34	87.23	8.26	68.23	8.44	71.23	1471.10	38.35
Dist.Jhabua	8.60	73.96	5.55	30.80	5.46	29.81	6.57	43.16	1319.60	36.33

Note: Minimum 5% of crop area has been included for calculating Ginni Coefficient and Entropy Index

Table 2(a). Cropping diversity in Jhabua district represented by Entropy Index (1990-91)

Region	$C_1 \log(1/C_1)$	$C_2 \log(1/C_2)$	$C_3 \log(1/C_3)$	$C_4 \log(1/C_4)$	$C_5 \log(1/C_5)$	$C_6 \log(1/C_6)$	$C_7 \log(1/C_7)$	EI
Bhabra	-40.39	-54.99	-2.21	-1.75	0.02	-7.79	-10.36	-117.47
Alirajpur	-11.69	-37.55	-13.64	-0.22	0.05	-1.67	-2.25	-66.97
Jhabua	-49.66	-4.17	-4.69	-5.89	-5.13	-8.34	-9.3	-87.18
Jobat	-18.68	-49.92	-15.29	-2.36	0.13	-1.38	-6.49	-93.99
Pethlabad	-27.87	-2.04	-0.5	-6.02	-23.29	-6.41	-5.57	-71.70
Thandla	-45.48	-6.15	-4.05	-6.43	-18.34	-10.04	-6.18	-96.67
Meghnagar	-67.25	-1.02	-1.25	-5.18	-10.1	-9.25	-13.41	-107.46
Ranapur	-38.46	-6.02	-2.86	-3.84	0.15	-10.26	-12.51	-73.80
Dist.Jhabua	-30.89	-19.89	-6.71	-3.25	-4.66	-5.47	-6.69	-77.56

Table 2(b). Cropping diversity in Jhabua district represented by Entropy Index (2007-08)

Region	$C_1 \log(1/C_1)$	$C_2 \log(1/C_2)$	$C_3 \log(1/C_3)$	$C_4 \log(1/C_4)$	$C_5 \log(1/C_5)$	$C_6 \log(1/C_6)$	$C_7 \log(1/C_7)$	$C_8 \log(1/C_8)$	EI
Bhabra	-50.87	-54.99	0.08	-4.83	-0.45	-5.84	-5.47	-0.43	-122.80
Alirajpur	-19.51	-37.55	-7.40	-1.73	-0.30	-2.51	-1.68	0.16	-70.53
Jhabua	-51.80	-4.17	-1.08	-11.77	-9.26	-5.02	-4.80	-10.93	-98.82
Jobat	-24.02	-49.92	-9.81	-7.85	-4.20	-0.51	-3.19	-3.36	-102.86
Pethlabad	-41.52	-2.04	0.16	-12.65	-31.93	-1.43	-0.77	-18.21	-108.39
Thandla	-43.97	-6.15	-4.05	-11.97	-18.27	-7.91	-7.57	-10.40	-110.30
Meghnagar	-65.00	-1.02	0.16	-8.87	-15.67	-8.96	-13.18	-1.97	-114.51
Ranapur	-50.27	-6.02	-1.40	-8.82	-1.13	-9.06	-7.57	-7.82	-92.10
Dist.Jhabua	-40.07	-19.89	-3.55	-8.31	-8.04	-4.13	-4.03	-5.37	-93.39

EI- Entropy Index

Table 3. Crop Specialisation in Jhabua district represented by localisation coefficient for 1990-91 and 2007-08

Tahsil/	Maize		Urad		Jowar		Wheat		Cotton	
District	90-91	07-08	90-91	07-08	90-91	07-08	90-91	07-08	90-91	07-08
Bhabra	1.24	1.17	2.14	2.12	0.51	0.15	0.71	0.68	0.001	0.2
Alirajpur	0.46	0.54	1.03	1.52	1.52	1.52	0.28	0.36	0.13	0.17
Jhabua	1.50	1.27	0.43	0.35	0.82	0.53	1.52	1.33	1.11	1.15
Jobat	0.69	0.67	1.88	1.99	1.77	1.94	0.83	0.95	0.10	0.65
Pethlabad	0.93	1.01	0.96	0.22	0.25	0.07	1.50	1.32	3.10	2.68
Thandla	1.37	1.14	0.58	0.46	0.73	0.13	1.57	1.37	2.16	1.90
Meghnagar	1.96	1.58	0.25	0.17	0.39	0.09	1.44	1.14	1.8	1.74
Ranapur	1.24	1.24	0.67	0.45	0.61	0.61	1.17	1.08	0.09	0.32

Conti…

Tahsil/	Rice		Gram		Soya bean		RCLC	
District	90-91	07-08	90-91	07-08	90-91	07-08	90-91	07-08
Bhabra	1.28	1.22	1.35	1.19	0.08	0.26	0.91	0.87
Alirajpur	0.46	0.69	0.47	0.56	0.002	0.055	0.54	0.68
Jhabua	1.44	1.17	1.29	1.16	1.07	1.68	1.15	1.08
Jobat	0.44	0.33	0.97	0.86	0.077	0.74	0.84	1.02
Pethlabad	1.12	0.53	0.89	0.4	4.80	2.3	1.69	1.07
Thandla	1.53	1.63	0.96	1.61	1.56	1.66	1.31	1.24
Meghnagar	1.53	1.81	1.73	2.42	0.62	0.59	1.22	1.19
Ranapur	1.61	1.74	1.61	1.57	0.92	1.33	0.99	1.04

RCLC-Regional Crop Localisation Coefficient