Ind. Jn. of Agri. Econ.
Vol.72, No.3, July-Sept. 2017

Agricultural Growth, Disadvantaged Regions and Social Groups: Some Evidences from Madhya Pradesh

Elumalai Kannan*

ABSTRACT

The present study has analysed the implications of exceptionally high growth registered in Madhya Pradesh agriculture in the last one and half decade for regional development and for socially disadvantaged groups. The analysis showed that total factor productivity (TFP) and area growth were responsible for overall crop output growth. TFP growth was impressive at 3.8 per cent during 2000-01 to 2013-14 and has contributed 89.3 per cent of output growth. Area growth augmented by expansion of irrigation has accounted for 60.7 per cent of output growth. However, in the regions where ST population was very high, irrigation development was very low. Consequently, the land productivity was estimated lowest in the ST dominated areas of Jhabua Hills and Northern Hills Zone of Chhattisgarh. Even in the regions with high irrigation development but high concentration of ST population had low level of land productivity. The study results broadly imply that most tribal dominated districts seem to have been left out of the growth process and hence remain underdeveloped.

Keywords: Agricultural growth, Resource composition, Total factor productivity, Madhya Pradesh.

JEL: D24, O18, O47, Q12, Q15

I

BACKGROUND

The agrarian economy of Madhya Pradesh has undergone some significant transformation since the state was reorganised in 2000. Agriculture has contributed over 30 per cent of the gross state domestic product and it helped to propel the overall state economic growth to 7.0 per cent during 2015-16 (Government of Madhya Pradesh, 2016). As compared to most states in India, Madhya Pradesh has very high proportion of workers (70 per cent) who depend on agriculture for their livelihood. The share of cultivator population has declined from 43 per cent to 31 per cent while that of agricultural labours has increased from 29 to 39 per cent between 2001 and 2011 (Government of Madhya Pradesh, 2016). Although there is a natural transfer of workers from agriculture to non-agriculture taking place, still a high dependence of workers on this sector has resulted in lower labour productivity growth between 2001 and 2011. It was 2.5 per cent in agriculture and 4.5 per cent in non-agricultural sector. The agricultural labour productivity was Rs. 41,330 at 2011-12 prices, which was less by five times than that of non-agricultural labour during 2011 (Government of India, various years, a).

*Associate Professor, Centre for the Study of Regional Development (CSRD), Jawaharlal Nehru University (JNU), New Delhi-110 067.

The state of Madhya Pradesh, traditionally known for soybean cultivation, is transforming into a wheat production hub in the country. Evidence also shows diversification of land from cereals to horticultural crops such as onion, potato, coriander, garlic and citrus fruits. The state government has given priority for development of agriculture through favourable policy, which is evident from the initiatives such as setting up of Agriculture Cabinet, separate Agriculture Budget, higher allocation of financial resources particularly for creation of irrigation facilities, distribution of quality inputs and agricultural extension. During 2007-08 to 2011-12, agriculture and its supportive activities such as rural development, irrigation and flood control, energy and transport, received 62 per cent of total budgetary allocation (Government of Madhya Pradesh, 2016). Among these activities, irrigation and flood control accounted for a whopping 40 per cent. All these measures particularly irrigation development seem to have impacted the agricultural sector positively and helped to attain an exceptionally high growth of 7.5 per cent during 2001-02 to 2015-16. This growth rate was much higher than the overall growth of 2.9 per cent at all India level.

However, it is important to analyse the sources of growth and contribution of different sub-sectors to overall agricultural growth in Madhya Pradesh. Agricultural growth led by rise in productivity is sustainable in the long term while too much of input intensification may affect the condition of natural resources such as land and water. In fact, between TE 2003-04 and TE 2013-14, about 0.56 million hectare of additional area has been brought under cultivation. Further, net irrigated area has increased from 5.0 million hectares to 10 million hectares (Government of Madhya Pradesh, 2016). Both surface irrigation augmented by various irrigation schemes and groundwater have contributed to expansion of irrigation facilities. Therefore, it would be useful to analyse whether these developments in agriculture are equitable across regions and social groups.

The state has high concentration of Scheduled Tribe (ST) population, who constitute about 15 per cent of total tribal population in India and about 21 per cent of the state population, as per the 2011 Population Census. Despite endowment of natural resources, efforts of develop agriculture particularly irrigation facilities in different agro-climatic zones of the state and benefits of agricultural growth due to development programmes to different social groups seem to be elusive. So, it is important to analyse whether higher agricultural growth witnessed in the state has benefitted the regions where ST population is high. Unfortunately, these regions also have witnessed high incidence of poverty and malnutrition (Government of Madhya Pradesh, 2007). Therefore, a proper assessment of the regional dimensions of agricultural growth pattern will help to design appropriate policy interventions to bring such underdeveloped regions into the growth process.

The paper is organised in six sections. The second section provides data and methodology. The analysis of structural changes in agricultural economy of Madhya

Pradesh is presented in the third section. The fourth section discusses sources of output growth through a resource decomposition analysis. The regional dimensions of agricultural growth and its implications are discussed in the fifth section. Concluding remarks are made in the last section.

II

DATA AND METHODOLOGY

Data Sources

The study relies on the secondary data compiled from various published sources. Data on value of output for different crops and gross state domestic product were compiled from the Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India. Information pertaining to crop area, production and yield at the state and district level was obtained from the Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare. Similarly, data on cost of cultivation also was compiled from the same source. Particulars related to agro-climatic zones were compiled from the Farmers Welfare and Agriculture Department, Government of Madhya Pradesh. All these data pertained to the period from 2000-01 to 2013-14. Total factor productivity (TFP) was estimated taking into account two outputs and seven inputs. Output index included main product and by-product. The input index comprised seed, fertiliser, manure, human labour, animal labour, machine labour and land.

Analytical Tools

To analyse the sources of crop output growth, a resource decomposition analysis has been carried out for major crops cultivated in Madhya Pradesh. This method involves first, the estimation of total factor productivity (TFP) and then decomposing the contribution of TFP and other inputs to output growth. Growth accounting is commonly used to measure TFP in the agricultural sector (Kumar and Mruthynjaya, 1992; Evenson *et al.*, 1999; Mukherjee and Yoshimi, 2003; Kumar *et al.*, 2004; Kumar *et al.*, 2008; Chand *et al.*, 2011; Kannan, 2011). Under this method, TFP is estimated as the ratio of aggregate output index to aggregate input index. Therefore, TFP growth is the growth of output minus growth of input; this is also called as residual productivity growth. For the present analysis, Tornqvist-Theil index has been used to estimate TFP growth. This index is widely used for its nicety of properties (Diewert 1976, 1978; Capalbo and Antle, 1988; Coelli *et al.*, 2005) and it can be expressed in logarithmic form as given below.

$$ln\left(\frac{TFP_t}{TFP_{t-1}}\right) = \sum_j R_j \, ln\left(\frac{Y_{jt}}{Y_{jt-1}}\right) - \sum_i S_i \, ln\left(\frac{X_{it}}{X_{it-1}}\right)$$

where, R_j is revenue share of j-th output, S_i is cost share of i-th input, Y_{jt} is output and X_{it} is input measured, all in period *t*.

Here, total output growth is estimated by summing growth of each output weighted by its revenue share and input growth is estimated by summing growth of each input weighted by cost share. The difference between growth of total output and growth of total input is called TFP growth.

Output growth can be decomposed into different components. Consider a particular input, for example land, then the output growth can be written as growth in land (area) and growth in yield of this particular resource.

This can be written as follows:

$$\dot{Y} = \dot{X}_1 + \left(\frac{\dot{Y}}{X}\right)$$

The dot above the variable refers to annual growth rate. Following Fuglie (2012, 2015), yield growth can be decomposed into growth due to TFP and other inputs used per unit of land. This can be written as:

$$\dot{Y} = \dot{X}_1 + T\dot{F}P + \sum_{i=2}^{I} S_i \left(\frac{\dot{X}_i}{X_1}\right)$$

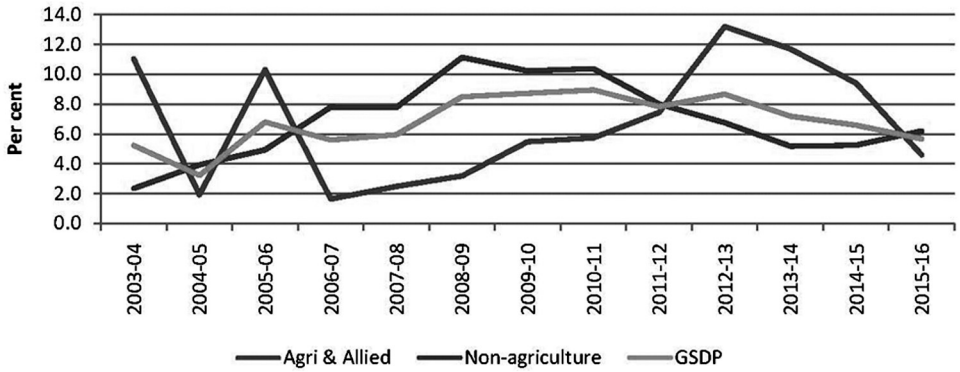
The above equation provides a resource decomposition of output growth as it focuses on quantity changes in physical resource, i.e., land. This equation can be extended to incorporate other natural resources such as irrigation. Expansion of irrigation leads to augmenting total crop area; difference between total crop area and irrigation provides the extent of new area/land brought under cultivation. Hence, contribution of irrigation to total crop area and output growth can be easily estimated.

III

STRUCTURAL CHANGES IN AGRICULTURAL ECONOMY

Agriculture plays a significant role in the overall growth of the state economy and generation of employment to rural workforce. With overall annual growth 0f 7.5 per cent, the agricultural sector has outperformed the non-agricultural sector since 2011-12.However, year-over-year growth shows very high volatility during 2003-04 to 2006-07 and thereafter shown a steady upward trend till 2012-13 (Figure 1). But, the growth rate has shown downward trend during recent years. Nonetheless, it is useful to observe that the actual growth momentum has picked up from 2007-08 and it has continued up to 2012-13 reaching average growth of 13.2 per cent between this period. The upward growth in Madhya Pradesh agriculture during this period is quite astounding in view of severe drought witnessed in many parts of the state in 2008 and 2012. Perhaps, it shows the resilience of the agriculture in the state with high dependence on groundwater irrigation facilities and relative low dependence on

rainfall. Development of adequate surface irrigation facilities in the form of irrigation projects has also improved the adaptive capacity of the farmers to the effects of the climatic variability. Therefore, despite volatility in growth, agricultural sector remains vibrant and supports overall economic development of the state.



Source: Government of India (various issues, a).

Figure 1. Trend in Agriculture, Non-Agriculture and Overall Economic Growth (3-Year Moving Average Series at 2011-12 Prices).

Within agriculture and allied sectors, there is a perceptible change in the structural composition. The crop agriculture accounted for about a little less than three-fourth of total value of output from agriculture and allied activities during 2013-14 and its share has by and large, increased over time (Table 1). Horticulture emerged as the predominant sector contributing over 50 per cent of the total output. this is also the fast growing sector with annual growth of 15.7 per cent during 2001-02 to 2013-14.

TABLE 1. CHANGES IN COMPOSITION OF AGRICULTURE AND ALLIED SECTOR

	Per cent share			Growth rate (per cent)		
Particulars	TE 2002-03	TE 2007-08	TE 2013-14	2001-02 to 2006-07	2007-08 to 2013-14	2001-02 to 2013-14
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agriculture	68.7	67.5	72.8	7.6	10.6	9.2
Field crops	10.8	8.1	19.8	9.5	6.6	7.9
Horticulture	57.9	59.4	52.9	0.5	28.7	15.7
Livestock	25.4	22.6	18.1	4.6	6.1	5.4
Forestry	5.2	9.3	8.6	24.5	10.5	17.0
Fishery	0.7	0.6	0.6	5.1	8.9	7.2
Overall	100.0	100.0	100.0	7.0	9.4	8.3

Source: Government of India (various issues, a).

Surprisingly, the contribution of livestock has declined and it accounted for 18.1 per cent only. However, with increase in per capita income, urbanisation and changes in food consumption basket, livestock sector has potential for achieving higher

growth in future. Madhya Pradesh has very rich forest resources and a significant proportion of tribal population depends on the forests for their livelihood. Output from the forestry has registered a robust growth of 17.0 per cent during 2001-02 to 2013-14. Overall, the analysis implies that the agricultural output growth is largely contributed by crop agriculture and horticulture holds the key for attaining higher growth in this sector.

There is significant change in the cropping pattern. Farmers in Madhya Pradesh utilise the existing land resources to grow mostly cereals and oilseeds. During the recent years, land allocation is shifting towards growing of wheat and horticultural crops. Soil and climatic factors are highly suitable for producing quality wheat. The "MP Wheat" which is popularly known in the northern states of India, is highly preferred by consumers and traders for its quality and better taste (Government of Madhya Pradesh, 2016).

Area under wheat has steadily increased from 18.9 per cent in 2002-03 to 23.1 per cent of the total cropped area in 2014-15 (Table 2). Wheat accounted for about 17 per cent of the total value of agriculture output. The share of area under soybean has marginally increased, while area under gram has remained more or less stable over time. However, rice seems to be losing its importance in the cropping pattern.

TABLE 2. CHANGES IN RELATIVE SHARE OF CROPS AND VALUE OF OUTPUT

	Per cent share of crop area			Per cent share of value output		
Particulars	TE 2002-03	TE 2007-08	TE 2014-15	TE 2002-03	TE 2007-08	TE 2013-14
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Rice	9.39	8.11	8.27	5.10	4.25	5.12
Wheat	18.91	19.00	23.13	16.45	17.33	16.59
Jowar	3.52	2.80	1.05	1.31	1.20	0.61
Maize	4.64	4.33	3.94	3.26	1.87	1.70
Total cereals	40.29	37.12	38.41	26.99	25.45	24.66
Gram	12.73	12.41	12.67	13.24	12.61	9.15
Redgram	1.68	1.61	2.10	1.42	1.16	1.10
Blackgram	2.51	2.24	2.90	1.03	1.12	0.79
Lentil	2.65	2.58	2.38	1.42	1.41	0.99
Total pulses	21.57	20.65	22.49	17.90	16.98	12.81
Total foodgrains	61.86	57.77	60.90	44.89	42.43	37.48
Groundnut	1.16	1.02	0.89	1.30	1.05	0.88
Rapeseed and mustard	2.35	3.46	3.13	1.98	3.93	2.48
Soyabean	23.85	23.34	24.84	16.89	20.79	15.62
Total Oilseeds	29.57	29.95	30.96	21.87	26.90	19.80
Cotton/kapas	2.91	3.14	2.31	1.62	2.58	0.61
Other crops	3.71	6.67	0.33	15.89	16.08	14.84
Total condiments and spices	0.93	1.22	1.93	1.89	2.79	2.55
Total fruits and vegetables	1.02	1.24	3.56	13.81	9.20	23.76
Total horticulture	1.95	2.46	5.49	15.73	12.01	27.28
Total	100.00	100.00	100.00	100.00	100.00	100.00

Source: Government of India (various issues, a, b).

Nevertheless, area under these four crops viz., wheat, soybean, gram and rice taken together constituted nearly 70 per cent of the total cropped area. Maize, blackgram, lentil and, rapeseed and mustard also occupy a significant share of cropped area in the state. Although horticulture accounted for over a quarter of total value of agricultural output, it occupied only 5.5 per cent of the cropped area. Overall, the analysis implies that diversification of cropping pattern is taking place, but at a slower pace.

IV

SOURCES OF OUTPUT GROWTH

Crop output growth is influenced by many factors such as rainfall, soil fertility, use of modern inputs and crop management practices. Identification of sources and estimating their contribution to output growth are important for devising appropriate policy interventions to sustain the growth in the long term. Resources are finite and therefore judicious use by the farmers need to be encouraged based on the current intensity of resources use for achieving higher output.

Growth in crop output and average productivity are provided in Table 3. The land productivity measured as the gross value of output per hectare was much higher for horticultural crops than field crops. Higher return from the cultivation of horticultural crops is highly attractive for the farmers for diversifying crop cultivation from field crops to horticultural crops in the state. Improvement in average productivity for most crops has led to increase in overall crop productivity from Rs.15,550 to Rs.28,684 per hectare between 2002-03 and 2013-14. Except sesamum and cotton, growth in output of other crops was highly positive during 2007-08 to 2014-15. In fact, there was acceleration in output growth for most crops during this period. In terms of contribution to output growth, wheat emerged as the predominant crop contributing about a quarter of total output followed by soybean with 23 per cent. While contribution of gram was 13 per cent, the share of rice in total output was 7.9 per cent. Importance of horticultural crops to output growth is quite prominent during the recent period.

For analysis of sources of output growth, information on input and output details are available for 12 major crops only. The method of resource decomposition of output growth has been carried out to analyse the components of the growth. Before discussing the results of resource decomposition analysis, it is useful to present the trend in weighted indices of output, input and TFP for these 12 crops. The output index has surged quite dramatically from 2003-04 to 2012-13 (Figure 2). With almost a flat trend in input index, TFP has moved closely with the pattern of output index. It is encouraging that rise in TFP has led to increase in output index.

TABLE 3. GROWTH IN CROP OUTPUT AND AVERAGE PRODUCTIVITY (AT 2011-12 PRICES)

	Growth rate (per cent)		Average productivity (Rs./ha)		
Crop	2001-02 to 2006-07	2007-08 to 2014-15	TE 2002-03	TE 2007-08	TE 2013-14
(1)	(2)	(3)	(4)	(5)	(7)
Rice	3.2	16.8	10566	12815	25635
Wheat	8.2	10.0	16985	22260	28901
Jowar	4.9	0.8	7298	10502	24458
Bajra	10.1	9.6	8304	12666	19586
Maize	-5.2	9.6	13737	10592	18171
Barley	1.5	8.4	10716	14440	16033
Gram	6.2	4.1	20415	24893	28426
Arhar/Tur	2.5	6.8	16599	17660	20038
Blackgram	7.1	3.8	8140	12215	12433
Lentil	5.0	3.1	10493	13487	17661
Groundnut	0.8	6.3	21682	25202	37559
Sesamum	10.8	-18.9	31492	18312	5191
Rapeseed and Mustard	24.0	3.0	16182	28069	32907
Linseed	0.2	3.8	8640	10943	14476
Nigerseed	4.3	3.2	4278	4697	10757
Soyabean	9.9	2.2	13847	21856	24810
Cotton	19.4	- 15.8	10828	20098	9664
Chillies	17.4	25.7	35208	55038	173930
Ginger	8.2	9.1	88952	107611	98609
Coriander	12.6	5.2	10265	14959	17092
Garlic	22.9	1.5	157706	169159	65819
Potatoes	10.7	28.2	96845	116547	218045
Bananas	- 5.3	36.4	264534	235838	672679
Onion	17.8	39.0	117231	133417	412667
Sugarcane	6.0	10.1	49124	46189	61593
Overall	8.1	7.5	15550	21127	28684

Sources: Estimated based on Government of India (various issues, a, b).

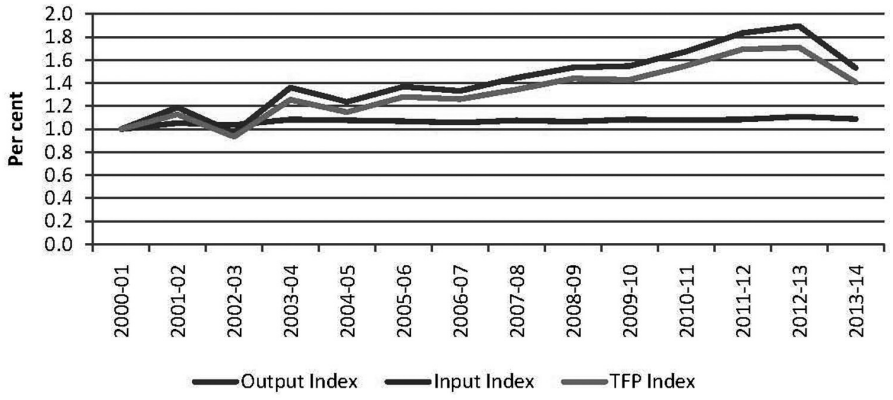


Figure 2. Trend in Output Index, Input Index and TFP Index.

The decomposition of crop output growth into contributions from material inputs including labour, TFP, irrigation and area expansion is given in Table 4. This decomposition analysis allows for estimating the relative contribution of natural resources such as land and water, input intensification and TFP growth to output. For all the crops taken into consideration, output has registered a robust growth of 4.3 per

cent, which was due to a magnificent TFP growth of 3.8 per cent during 2000-01 to 2013-14. The TFP growth has accounted for 89.3 per cent of output growth, while area growth constituted 60.7 per cent. The input intensification (material inputs per hectare weighted by respective cost share) has registered negative growth during the period of analysis. This implies that input intensification has worsened over time. The TFP and area growth are responsible for the overall crop output growth in the state of Madhya Pradesh. Despite a robust TFP growth, reduction in input intensification has resulted in a low yield growth of 1.68 per cent. However, with a negative growth in new land under cultivation, expansion of irrigation (3.9 per cent) has largely contributed to growth in crop area at 2.6 per cent.

TABLE 4. RESOURCE DECOMPOSITION OF OUTPUT GROWTH: 2000-01 TO 2013-14

Crop	Output	Area	Irrigation	New area	Yield	Material inputs	TFP
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Paddy	6.36	0.23	5.87	- 5.64	6.13	- 1.83	7.96
Wheat	4.82	3.11	6.05	- 2.94	1.71	- 2.06	3.77
Sorghum	4.19	- 7.07	1.98	- 9.05	11.26	4.49	6.78
Maize	8.31	- 0.16	5.92	- 6.07	8.47	0.14	8.32
Blackgram	7.73	1.87	5.65	- 3.79	5.87	- 1.58	7.44
Bengalgram	0.72	2.60	4.19	- 1.59	- 1.88	- 1.56	- 0.33
Redgram	2.03	4.38	7.73	- 3.35	- 2.35	- 4.46	2.11
Lentil	-1.46	1.46	5.14	- 3.68	- 2.92	- 0.82	- 2.10
Soybean	2.38	3.07	- 4.39	7.46	- 0.69	- 2.62	1.93
Sesamum	2.63	7.31	0.00	7.31	- 4.67	- 5.75	1.07
Rapeseed and Mustard	3.31	4.81	6.53	- 1.72	- 1.50	- 2.57	1.07
Cotton	11.65	1.12	6.06	- 4.94	10.53	- 1.76	12.29
All crops	4.27	2.59	3.88	- 1.29	1.68	- 2.13	3.81

Source: Estimated by author.

The analysis of relative contribution of different components to output growth at crop level provides interesting results. Except lentil, growth in output of all other crops was very impressive during the study period. Growth in output was largely due to TFP and increase in area, which has been augmented through expansion of irrigation. The highest TFP growth was registered in cotton followed by maize, paddy and black gram. The TFP growth was impressive for most crops, but reduction in input intensification has led to a fall in yield growth. Although TFP has emerged as the source of yield gain, growth in TFP could not compensate the rate of reduction in input intensification on land leading to relatively low yield growth. Overall, the analysis implies that TFP growth and area growth, which is caused by expansion of irrigation were responsible for the crop output growth.

V

REGIONAL DIMENSIONS OF AGRICULTURAL GROWTH

For understanding the regional implications of higher agricultural growth, analysis at the level of agro-climatic zones will be useful. The state has 11 agro-

climatic zones (ACZs) with varying degree of diversity in natural resources, physical infrastructure and socio-economic characteristics. Based on the information available from Government of Madhya Pradesh (2010, 2016), the districts were mapped into different agro-climatic zones. Although some districts overlap with different ACZs, districts whose maximum area falls under a particular agro-climatic zone, is included in that particular zone only as it has been followed in Government of Madhya Pradesh (2010).At the time of reorganisation of the state, Madhya Pradesh had 45 districts and then 6 new districts were formed at different points in time. For the purpose of maintaining consistency in data analysis, only 45 districts were considered and newly formed districts were merged with the older districts.

The characteristics of ACZs combined with certain socio-economic characteristics are provided in Table 5. The average rainfall ranged between 800mm to 1200mm in the state during 2002-03 to 2015-16 (Government of Madhya Pradesh,

TABLE 5. SOME IMPORTANT CHARACTERISTICS OF AGRO-CLIMATIC ZONES IN MADHYA PRADESH

S. No. (1)	Agro-climatic zones (2)	Districts covered (3)	Total population (million) (4)	Per cent rural population (5)	Per cent ST population (6)	Irrigated area (per cent) (7)	CI (per cent) (8)
1.	Chhattisgarh plains	Balaghar	1.7	85.6	22.5	46.6	125
2.	Northern hills zone of Chhattisgarh	Dindori, Mandla, Shahdol, Umaria	4.2	83.5	52.2	8.7	135
3.	Kymore plateau and Satpura hills	Panna, Rewa, Satna, Sidhi, Jabalpur, Katni, Seoni	13.1	75.3	20.7	31.2	142
4.	Vindhyan plateau	Damoh, Sagar, Vidisha, Raisen, Sehore, Bhopal	10.1	62.8	8.7	40.8	161
5.	Central narmada valley	Harda, Hoshangabad, Narsinghpur	2.9	75.4	17.3	53.4	172
6.	Gird zone	Bhind, Gwalior, Morena, Sheopur, Guna, Shivpuri	10.2	70.1	7.4	45.9	143
7.	Bundelkhand zone	Chhatarpur, Tikamgarh, Datia	4.0	79.2	3.9	53.0	144
8.	Satpura plateau	Betul, Chindwara	3.7	77.8	39.2	27.5	137
9.	Malwa plateau	Dewas, Indore, Mandsaur, Neemuch, Ujjain, Dhar, Ratlam, Shajapur, Rajgarh	15.7	64.3	15.1	39.3	172
10.	Nimar valley	Khargone, Barwani, Khandwa	5.3	80.8	44.7	46.8	131
11.	Jhabua hills	Jhabua	1.8	91.5	87.8	20.9	126
	Overall		72.7	72.3	21.08	38.9	151

Source: Compiled based on Government of Madhya Pradesh (2016), Government of Madhya Pradesh (2015) and Government of India (various issues, b).

Note: Data on population pertains to 2011; Irrigation and cropping intensity (CI) refers to triennium ending 2013-14.

2016). Development of irrigation facilities, measured in terms of per cent gross irrigated area, seems to have benefitted only some agro-climatic zones. At the same time, it is appreciable to see the spread of irrigation even in low rainfall zones such as Nimar valley. The share of irrigated area ranged between 8.7 per cent in Northern Hills zone of Chhattisgarh and 53.4 per cent in Central Narmada valley. The cropping intensity was relatively high in Central Narmada valley and Malwa plateau.

The Malwa plateau has the largest population of 15.7 million followed by Kymore plateau and Satpura hills with 13.1 million. The proportion of rural population ranged from 62.8 per cent in Vindhyan plateau to 91.5 per cent in Jhabua hills. The Chhattisgarh plains and Northern Hills zone of Chhattisgarh also have predominantly rural population with 85.6 per cent and 83.5 per cent, respectively. Among social groups, Madhya Pradesh has high concentration of Scheduled Tribe (ST) population in the state. The share of tribal population ranged between 3.9 per cent in Bundelkhand zone and 87.8 per cent in Jhabua hills. Out of 11 ACZs, six regions have tribal population with a proportion of above 20 per cent of total population. Over 50 per cent of the population consisted of tribal in the Northern hills zone of Chhattisgarh, while 45 per cent of population is tribal in Nimar valley. Satpura plateau and Kymore plateau and Satpura hills also have significant proportion of tribal population.

Unexpectedly, the analysis shows that the regions where ST population was very high, irrigation development was considerably low. There are exceptions such as Nimar valley and Chhattisgarh Plains where the irrigated area was much above the state average of 38.9 per cent. But, in the districts such as Dindori, Mandla, Shahdol and Umaria where STs constituted nearly 50 per cent of population, the irrigation development was abysmally low at 8.7 per cent. Similarly, in Betul and Chindwara districts falling under Satpura plateau and Jhabua in Jhabua Hills, the proportion of the irrigated area was only 27.5 per cent and 20.9 per cent, respectively. These results imply that efforts to develop irrigation facilities have not yet reached most part of the tribal dominated regions in the state.

The cropping pattern by agro-climatic zones is provided in Table 6. The cropping pattern is quite varied across the ACZs depending upon the rainfall, soil and other natural conditions. Rice has been predominantly cultivated in Chhattisgarh Plains occupying about 80 per cent of total cropped area in the region. Other regions growing rice included Northern Hills Zone of Chhattisgarh and Kymore plateau and Satpura Hills where it constituted about 43 per cent and 24 per cent, respectively. These regions have also witnessed crop diversification towards pulses. In fact, such diversification is more prominent in Vindhyan plateau with cultivation of multiple crops including soybean and wheat. In fact, soybean and wheat are the predominant crops grown in Vindhyan plateau, Central Narmada valley, Gird zone, Satpura plateau, Malwa plateau and Nimar valley. Wheat occupied about one-fifth of the total cropped area in these regions.

TABLE 6. CROPPING PATTERN BY AGRO-CLIMATIC ZONES: TE 2013-14

ACZ (1)	Cotton (2)	Gram (3)	Maize (4)	Lentil (5)	Rapeseed and mustard (6)	Rice (7)	Sesamum (8)	Soybean (9)	Redgram (10)	Urad (11)	Wheat (12)	Other crops (13)	Total (14)
Chhattisgarh Plains	0.0	2.4	1.3	0.1	1.0	80.6	0.4	0.0	1.3	1.6	5.5	5.8	100
Northern hills zone of Chhattisgarh	0.5	3.4	6.3	8.3	5.0	43.0	1.3	2.6	3.6	2.0	13.3	10.6	100
Kymore plateau and Satpura hills	0.0	13.2	2.2	6.2	0.9	23.6	2.5	8.7	4.9	2.9	26.7	8.3	100
Vindhyan plateau	0.0	20.1	0.7	3.4	0.1	3.2	0.1	35.2	2.2	2.9	29.5	2.6	100
Central Narmada valley	0.0	11.5	0.2	2.5	0.0	3.5	0.1	36.1	3.7	0.8	36.3	5.4	100
Gird zone	0.0	10.7	1.5	1.3	15.9	2.8	2.0	20.1	0.8	3.1	29.1	12.9	100
Bundelkhand zone	2.4	9.8	0.3	1.2	4.3	2.0	10.3	9.5	0.9	12.4	34.8	11.9	100
Satpura plateau	0.0	7.1	16.0	0.6	0.1	5.0	0.1	31.9	4.4	1.1	21.2	12.5	100
Malwa plateau	2.4	14.1	4.7	0.5	1.5	0.1	0.1	47.6	0.3	0.6	22.1	6.0	100
Nimar valley	30.1	2.7	6.3	0.1	0.0	0.7	0.1	21.3	2.2	1.0	19.6	16.0	100
Jhabua hills	5.7	5.9	25.4	0.0	0.0	4.5	0.1	16.4	1.2	14.9	13.2	12.8	100

Source: Estimated based on Government of India (various issues, c).

Malwa plateau accounted for the highest allocation of area under soybean with 47.6 per cent. Among the ACZs, area under cotton was very high at 30 per cent in Nimar Valley and maize at 25 per cent in Jhabua Hills. Similarly, area under rapeseed and mustard was relatively high (16 per cent) in the Gird Zone. However, the cropping pattern is quite diversified in Bundelkhand Zone with a significant proportion of area allocated under cereals, pulses and oilseeds. These results broadly imply that most tribal dominated regions have adopted diverse cropping pattern including cultivation of commercial crops such as cotton and maize as compared to the non-tribal regions.

Distribution of Gains of Agricultural Growth

This section discusses the distributional aspects of agricultural growth for different regions and social groups in the state of Madhya Pradesh. To assess whether all the regions and social groups have equally benefitted from the agricultural growth, land productivity as a measure of development indicator has been used. Improvement in land productivity, which is defined as the value of crop output per hectare, will reflect the extent of sharing of the benefits across the regions and farming people. For estimation of land productivity, information on area, production, price and irrigation were compiled for 25 crops. Farm harvest price for different crops were implicitly derived from the National Accounts Statistics published by the Central Statistics Office. The district level information has been aggregated to agro-climatic zones.

Malwa plateau accounted for one-fourth of total cropped area and almost equal share of total output (Table 7). Vindhyan plateau constituted 17 per cent of area and 15 per cent of output value. Similarly, Kymore plateau and Satpura Hills accounted for 14 per cent of cropped area and 12 per cent of the crop output. The overall land productivity was estimated at Rs. 27,378 per hectare. Five agro-climatic zones

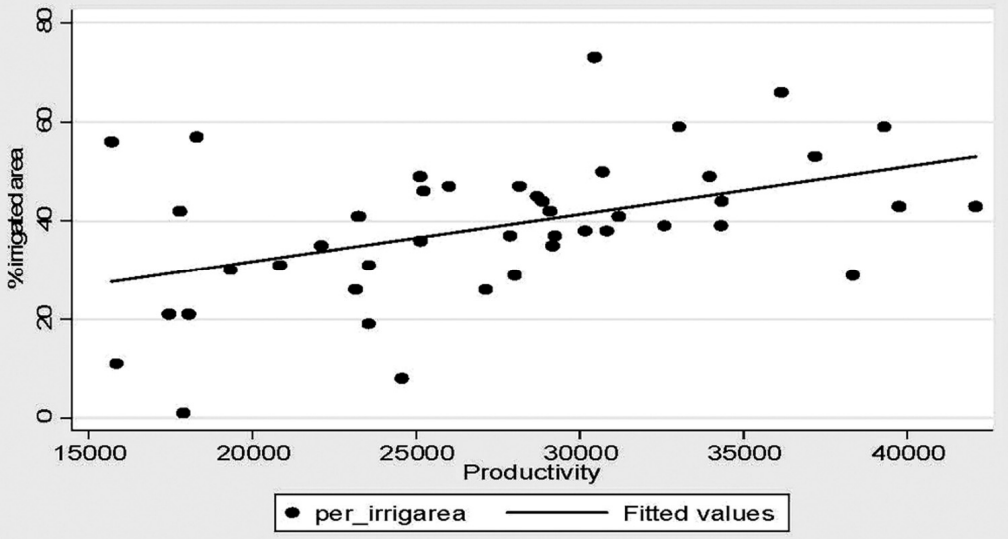
TABLE 7. AREA, OUTPUT AND PRODUCTIVITY ACROSS AGRO-CLIMATIC REGIONS: TE 2013-14

S.No.	Agro-climatic zones	Crop area (000 ha)	Output (Rs. million)	Productivity (Rs./ha)	Per cent share of area	Per cent share of output
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Chhattisgarh plains	320	9020	28147	1.4	1.5
2.	Northern hills zone of Chhattisgarh	1073	21300	19845	4.8	3.5
3.	Kymore plateau and Satpura hills	2986	72900	24414	13.5	12.0
4.	Vindhyan plateau	3732	89700	24037	16.9	14.8
5.	Central Narmada valley	1352	44000	32545	6.1	7.3
6.	Gird zone	2881	91900	31895	13.0	15.2
7.	Bundelkhand zone	1326	27000	20360	6.0	4.5
8.	Satpura plateau	1185	39000	32922	5.3	6.4
9.	Malwa plateau	5540	165000	29782	25.0	27.2
10.	Nimar valley	1330	38900	29255	6.0	6.4
11.	Jhabua hills	420	7580	18053	1.9	1.3
	Overall	22145	606300	27378	100.00	100.00

Source: Computed based on Government of India (various issues, b, c).

registered land productivity lower than the state average. The highest level of land productivity was observed in Satpura plateau followed by Central Narmada Valley and Gird Zone. The land productivity was lowest in Jhabua Hills and Northern Hills Zone of Chhattisgarh where the share of ST population was very high. Even in the regions such as Chhattisgarh Plains and Nimar Valley with high concentration of ST population had higher irrigated area, but relatively low level of land productivity.

However, there exists a positive relationship between land productivity and irrigation (Bhalla and Singh, 2001; Vaidhyanathan, 2000). Therefore, Development of irrigation is very crucial for enhancing land productivity. But, it is disheartening to observe a negative association between regions with high irrigation development-high ST population and low land productivity. Perhaps, various social factors such as tradition, custom and norms tend to influence the adoption of new agricultural practices that have potential for improving farm income. But, government interventions to bring about institutional change and better allocation of resources to improve social and economic efficiency in agricultural production do not provide satisfactory results due to lack of recognition of existing social relations with agricultural production at the level of implementation of programmes (Harriss-White and Janakarajan, 1997). Further, given the fact that certain social groups such as STs have faced discrimination historically, markets also take advantage of their societal position and tend discriminate in input and output markets leading to market failure (Thorat, 2004; Dev, 2012). All these factors cumulatively affect the realisation of better income by these socially disadvantaged groups.



Source: Authors' estimates.

Figure 3. Relationship between Irrigation and Land Productivity: TE 2013-14

The values of land productivity were distributed with variation of about 25 per cent around its mean. Utilising this information, three land productivity classes, viz., low productivity (less than Rs. 25000/ha), medium productivity (Rs. 25000-30000/ha) and high productivity (more than Rs. 30000/ha) were formed. The distribution of districts by land productivity class is provided in Table 8. Out of 45 districts, 16 districts each fell under low land productivity and high productivity groups. Low productivity districts have higher share of crop area and low share of output. The proportion of area irrigated was also lower. These low productivity districts also have relatively high proportion of ST population. These results broadly show the regional inequity in agricultural development and such inequity in development seems to be prominent in tribal dominated regions.

TABLE 8. DISTRIBUTION OF DISTRICTS BY PRODUCTIVITY LEVELS: TE 2013-14

Categories	No. of districts	Per cent district	Area share (per cent)	Output share (per cent)	Per cent area gross area irrigated	Per cent ST population
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Low productivity	16	35.6	34.9	26.5	32.4	25.9
Medium productivity	13	28.9	33.2	33.3	39.8	26.9
High productivity	16	35.6	31.8	40.2	45.1	11.5
Overall	45	100	100.0	100.0	38.9	21.1

Source: Authors' estimates.

Distribution of districts by land productivity and agro-climatic zones is given in Table 9. It can be observed that most tribal dominated districts belonged to low land productivity group. All the districts of Northern Hills Zone of Chhattisgarh and most

TABLE 9. DISTRIBUTION OF DISTRICTS BY LAND PRODUCTIVITY: TE 2013-14

S. No.	Agro-climatic zones	Low productivity	Medium productivity	High productivity
(1)	(2)	(3)	(4)	(5)
1.	Chhattisgarh Plains	-	Balaghar	-
2.	Northern hills zone of Chhattisgarh	Dindori, Mandla, Shahdol, Umaria	-	-
3.	Kymore plateau and Satpura hills	Panna, Rewa, Satna, Sidhi	Jabalpur, Katni, Seoni	-
4.	Vindhyan plateau	Damoh, Sagar, Vidisha	Raisen, Sehore	Bhopal
5.	Central narmada valley	-	-	Harda, Hoshangabad, Narsinghpur
6.	Gird zone	-	Guna, Shivpuri	Bhind, Gwalior, Morena, Sheopur
7.	Bundelkhand zone	Chhatarpur, Tikamgarh	-	Datia
8.	Satpura plateau	-	Betul	Chindwara
9.	Malwa plateau	Rajgarh	Dhar, Ratlam, Shajapur	Dewas, Indore, Mandsaur, Neemuch, Ujjain
10.	Nimar valley	Khargone	Barwani	Khandwa
11.	Jhabua hills	Jhabua	-	-

Source: Authors' estimates.

Note: Low productivity (<Rs. 25,000/ha), Medium productivity (Rs. 25000 to 30,000/ha) and High productivity (>Rs. 30,000/ha).

districts in Kymore plateau and Satpura Hills registered low productivity. However, all the non-tribal districts of Central Narmada Valley and most districts in Gird Zone and Malwa plateau came under high productivity class. In Satpura plateau, Betul was classified as medium productivity district, while Chindwara was grouped under high productivity district. This analysis further shows that most low productivity and low irrigation districts have high concentration of ST population. These results imply that most tribal dominated districts seem to have been left out of the growth process and hence remain underdeveloped.

VI

CONCLUSIONS

Madhya Pradesh agriculture has registered exceptionally high growth rate during the last one and half decades and it has propelled the state economy to register average annual growth rate of over 7.0 per cent. The crop sector has accounted for about three-fourth of total value of agricultural output and was largely responsible for achieving higher growth of the sector. Horticulture has emerged an important activity contributing over quarter of total crop output, yet it occupied only 5.5 per cent of total cropped area. Wheat area has expanded considerably to reach 23.1 per cent during 2014-15. The average land productivity has increased remarkably from Rs. 15,550 per hectare in 2002-03 to Rs. 28,684 per hectare in 2013-14.

The analysis of sources of crop output growth revealed that TFP has contributed 89.3 per cent of output growth, while area growth constituted 60.7 per cent. The input intensification has registered negative growth. The TFP growth was impressive at 3.8 per cent during 2000-01 to 2013-14. Despite a robust TFP growth, reduction in input intensification has resulted in relatively low yield growth of 1.68 per cent. Among crops, except lentil, growth in output of all other crops was very impressive and growth in output was largely due to TFP and increase in area. The increase in crop area has been augmented through expansion of irrigation during the study period.

However, the analysis at agro-climatic zone level showed that the regions where ST population was very high, irrigation development was considerably low. The districts such as Dindori, Mandla, Shahdol and Umaria have nearly 50 per cent of ST population, but the level of irrigation development was abysmally low at 8.7 per cent. Consequently, the land productivity was estimated lowest in the ST dominated areas of Jhabua Hills and Northern Hills Zone of Chhattisgarh. Even in the regions such as Chhattisgarh Plains and Nimar Valley with high concentration of ST population had higher irrigated area, but relatively low level of land productivity. The study results broadly show the regional inequity in agricultural development and such inequity in development seems to be prominent in tribal dominated regions.

REFERENCES

Capalbo, Susan M. and John M. Antle (1988), *Agricultural Productivity Measurement and Explanation*, Edited, Resources for the Future, Washington, D.C., U.S.A.

Chand, P., P. Kumar and S. Kumar (2011), *Total Factor Productivity and Contribution of Research Investment to Agricultural Growth in India*, Policy Paper 25, National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi.

Coelli, Timothy J.; D.S. Prasada Rao, Christopher J. O'Donnell and George E. Battese (2005), *An Introduction to Productivity and Efficiency Analysis*, Second Edition, Springer, U.S.A.

Dev, Mahendra S. (2012), *Small Farmers in India: Challenges and Opportunities*, Working Paper 2012-014, Indira Gandhi Institute of Development Research, Mumbai.

Diewert, W.E (1976), "Exact and Superlative Index Numbers", *Journal of Econometrics*, Vol. 4, pp.115-145.

Diewert, W.E (1978), "Superlative Index Numbers and Consistency in Aggregation", *Econometrica*, Vol. 46, No. 4, pp.883-900.

Evenson, R.E., C.E. Pray and M.W. Rosegrant (1999), *Agricultural Research and Productivity Growth in India*, Research Report 109, International Food Policy Research Institute, Washington, D.C., U.S.A.

Government of Madhya Pradesh (2007), *Madhya Pradesh Human Development Report*, Bhopal.

Government of Madhya Pradesh (2010), *Compendium of Agriculture Statistics 2009-10 Madhya Pradesh*, Department of Farmer Welfare and Agriculture, Bhopal.

Government of India (various years, a), *National Accounts Statistics*, Central Statistics Office, Ministry of Statistics and Programme Implementation, New Delhi.

Government of India (various issues, b), *Land Use Statistics*, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, New Delhi.

Government of India (various issues, c), *Districtwise Crop Production Statistics*, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, New Delhi.

Government of Madhya Pradesh (2015), Agro-Climatic Regions and Crop Zones in M.P., ENVIS Centre of Madhya Pradesh's State of Environment, http://mpenvis.nic.in/index2.aspx?slid=724&sublinkid=478&langid=1&mid=1 (accessed on 9 March 2017) .

Government of Madhya Pradesh (2016), *Madhya Pradesh Agriculture Economic Survey 2016*, Department of Planning, Economics and Statistics, Bhopal.

Harriss-White, B. and S. Janakarajan (1997), "From Green Revolution to Rural Industrial Revolution in South India", *Economic and Political Weekly*, Vol. 32, No. 25, 21 June, pp. 1469-1477.

Kannan, E. (2011), "Total Factor Productivity Growth and its Determinants in Karnataka Agriculture", ISEC Working Paper 265, Institute for Social and Economic Change (ISEC), Bangalore.

Kumar, P., A. Kumar and S. Mittal (2004), "Total Factor Productivity of Crop Sector in the Indo-Gangetic Plain of India: Sustainability Issues Revisited", *Indian Economic Review*, Vol. 34, No. 1, pp. 169-201.

Kumar, P., S. Mittal and M. Hossain (2008), "Agricultural Growth Accounting and Total Factor Productivity in South Asia: A Review and Policy Implications", *Agricultural Economics Research Review*, Vol. 21, pp.145-172.

Kumar, Praduman and Mruthynjaya (1992), "Measurement and Analysis of Total Factor Productivity Growth in Wheat", *Indian Journal of Agricultural Economics*, Vol. 47, No. 3, July-September, pp.451-458.

Mukherjee, A.N. and K. Yoshimi (2003), "Productivity Growth in Indian Agriculture: Is There Evidence of Convergence across States?", *Agricultural Economics*, Vol. 29, No.1, pp.43-53.

Thorat, S. (2004), *Persistence of Poverty: Why is Scheduled Castes and Scheduled Tribes Stay Chronically Poor?*, IIPA for Centre for Studies on Chronic Poverty, London, U.K.