International Journal of Agriculture, Environment and Biotechnology
Citation: *IJAEB*: **14**(04): 511-519, December 2021
DOI: 10.30954/0974-1712.04.2021.5

ASSOCIATION FOR AGRICULTURE ENVIRONMENT AND BIOTECHNOLOGY

AGRICULTURAL ECONOMICS

Comparative Economic Analysis of Aggregate Crop Revenue in Jabalpur and Katni Districts of Madhya Pradesh

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Paper No. 939 **Received:** 19-09-2021 **Revised:** 28-11-2021 **Accepted:** 10-12-2021

ABSTRACT

This paper tries to analyze the dynamics of aggregate crop revenue and the changes in the composition of various constituent factors of changes in aggregate revenue of two districts of Kymore Plateau and Satpura hills agro-climatic region of Madhya Pradesh, i.e., Jabalpur and Katni, by using one of the Index decomposition analysis (IDA) methods, i.e., Logarithmic Mean Divisia Index (LMDI), for a period from 2007-08 to 2016-17. The aggregate crop revenue was decomposed into the area, yield, price, and cropping pattern effect. The analysis indicated that a significant portion of the cropped area of the districts was covered by wheat, paddy, and gram. In Katni district, a shift of cropping pattern was more inclined towards oilseeds & pulses, while in Jabalpur, it was more towards food grains. The predominant factor contributing to the overall revenue in Katni districts was the yield effect, while in Jabalpur, it was the price effect. However, the contribution of the cropping pattern effect was relatively negligible compared to other effects in both districts. The highest share in aggregate crop revenue from wheat and paddy crops, predominantly contributed by yield effect and price effect. The study suggests further improving and stabilizing the yield of the crops and implementation of policies focused on improving the cropping pattern in the districts.

HIGHLIGHTS

- Yield effect emerged as the predominant factor in contributing to aggregate crop revenue in Katni while for Jabalpur district price effect was the major factor.

Keywords: Agricultural output, aggregate crop revenue, Decomposition analysis, Area, yield, price, cropping pattern

To revenue-maximizing farmer, gross revenue or value of output matters more than profit. Gross revenue is the single yardstick on which to judge the performance of the agriculture sector. The value of output combines both physical and monetary flow and presents a better picture of performance than either of the flow alone presents. There are several methods that permit decomposition of the change in gross revenue into area effect, yield effect, price effect, and cropping pattern effect (Vani *et al.* 2020). Such an analysis permits overcoming the complexity involved in deciphering the meaning from absolute and relative changes in the gross cropped area, yield, price, and share of various crops in the gross cropped area. However, a lot of emphases had been placed on the study of supply chains to address revenue and value maximization to farmers, but value or supply chains are spread across districts, states, and several geographies. This makes them tough to trace and derive results. At times, value or supply chain studies can only provide static estimates (year specific/ time-specific), but a growing and dynamic agriculture need answers from a dynamic perspective.

How to cite this article: Chaturvedi, P., Awasthi, P.K. and Vani, G.K. 2021. Comparative Economic Analysis of Aggregate Crop Revenue in Jabalpur and Katni Districts of Madhya Pradesh. *Int. J. Ag. Env. Biotech.*, **14**(04): 511-519.

Source of Support: None; **Conflict of Interest:** None

In Indian agriculture, the output value increased from ₹ 3, 73,17,361 lakhs in 2000 to ₹ 43,498,908.2 lakhs in 2010 by 3.11% CAGR. Then next five years, it rose by 0.19%. Major factors behind this change were yield effect, price effect, area effect, and cropping pattern. Between 2000 and 2010, the value of output for Madhya Pradesh agriculture increased two-fold. During the same period, the area rose by 24.67 percent and total production by 69.54 percent. Regardless of changes at the macro level, the micro-level may change in any direction. Among 11 agro-climatic zones of Madhya Pradesh, Kymore Plateau and Satpura hills occupy an important zone covering 18.15 percentage of the total geographical area in the state.

The purpose for attempting to decompose the aggregate revenue of farm families is to know the sources of farm income diversification. This analysis assumes that for the farmer, farm revenue is more important than aggregate production (Vani *et al.* 2020). The decomposition of aggregate revenue into various constituent factors is of paramount importance to the farmers in agriculture since it can help them analyze the relative shares of various factors involved in aggregate revenue. This is useful because, in many commodities, one or more factors have a relatively more significant share than the other. Such knowledge may help the farmer in giving appropriate attention to those factors, which can help in increasing the aggregate revenue and can guide them in taking appropriate measures for the same.

In the past, various studies were conducted to analyze the contribution of various effects through the decomposition effect. A study conducted by Birthal *et al.* (2014) to analyze changes in the sources of growth in agriculture landholders in 20 central Indian states for the period 1980/1981 to 2009/2010 showed that technology and diversification were the most critical factors for the growth of agriculture in India. Bruha and Pisa (ND) conducted a study using LMDI method of decomposition in the agricultural sector to analyze the dynamics of the world agricultural production and consumption showed that all the effects explained the changes reasonably, and the intensity effect was more prominent, whereas structural effects were relatively insignificant. It was also observed that the scale effect was more significant in agricultural consumption compared to agricultural production. Kalamkar (2003) conducted a study to decompose the total change in agricultural production into its constituent forces in Maharashtra State from 1961-62 to 1997-98 & showed that yield effect & expansion of area accounted for the production growth. The growth of crop output in the state was accounted for by the productivity growth and shift in cropping patterns. Similar studies in decomposition of production were attempted by Baghel (2020), Jamal and Zaman(1992), Jamil *et al.* (2019), Kim (2017), Kumar *et al.* (2018), Minhas (1965), Shadmehri (2010), Shrivastava *et al.* (2009) & Singh (2020).

Keeping in view the present investigation deals explicitly with (1) analysis of dynamics of cropping pattern of Kymore plateau and Satpura hills (2) decomposition of changes in aggregate crop revenue into its constituent factors (3) analysis of change in the composition of various constituent factors of change in aggregate crop revenue (4) suggesting policy measures based on findings of the study.

MATERIALS AND METHODS

The present study is confined to two districts of Kymore Plateau and Satpura hill agro-climatic region of Madhya Pradesh i.e., Jabalpur and Katni district, and is entirely based on secondary data for a period from 2007-08 to 2016-17 with 2007-08 as the base year. The data for farm harvest price was collected from the official website of the Directorate of Economics & Statistics, Ministry of Agriculture, and Agmarknet, and the data for area and yield were collected from the official website of Directorate of Land records Madhya Pradesh and official website of M.P Krishi. The crops considered in the study are wheat, paddy, maize, jowar, linseed, gram, *tur*, mustard, and sesamum.

Decomposition analysis

According to Fan and Lie (2017), the decomposition method is mainly divided into two categories, Index decomposition analysis (IDA) and structural decomposition analysis (SDA). In our study, we are mainly concerned with one of the IDA methods. IDA uses annual statistics, which allows the analysis to be conducted in a time-series form, and it requires

few data and facilitates comparative and empirical research and is usually favored by most scholars. Index decomposition analysis (IDA) is a popular tool for analyzing changes in energy consumption over time. The IDA approach has been widely used in the field of energy and environmental economics.

LMDI decomposition technique

The purpose of the decomposing value of output or gross revenue is to quantify the effect of change in underlying factors such as gross cropped area, yield, price, and crop shares over time. Among several schemes available for decomposition, LMDI scheme was used as it possesses several desirable properties like its ease in the application even with a large amount of data, adaptability, academic foundation, and ease in result interpretation. The LMDI refers to Logarithmic Mean Divisia Index, one of Divisia Indexes. The LMDI methodology was developed by Ang in 1998, and it has been widely employed to analyze the driving forces behind changes in CO_2 emissions.

The change in the value of output was decomposed both indifference form (time differences) and in the form of a ratio (ratio of current year to base year). In the case of difference form, an additive scheme of decomposition was used wherein all components of change in the value of output adds up to a difference in the value of output, whereas all ratio forms were decomposed using multiplicative. The additive decomposition measures percentage-point change, and the multiplicative decomposition measures percentage changes (Kaltenegger 2017). Both additive and multiplicative methods can be used for time-series data, but in case of data for selected benchmark years additive method is more convenient. Both methods are applied to the decomposition analysis in the present study.

There are two methods of LMDI decomposition analysis, LMDI-I, and LMDI-II. The difference between them lies in weight formulae (Ang 2015). Although the results obtained from both the methods are similar, but LMDI-I is used commonly partly due to simpler formulae (Kaltenegger 2017). In the present study, also LMDI-I method is used for decomposition.

The LMDI approach has been adopted in different fields of research, including the manufacturing, textile, and power industries, although its use in agriculture is minimal. This study provides the extension of LDMI based decomposition scheme to segregate price, area, and cropping pattern and yield effect from the aggregate value of crops.

Suppose Q is the aggregate value of crop output,

$$Q = A\ \Sigma iw\ ici\ yi \quad \ldots(1)$$

'*T*' subscript is used for the t^{th} year and '0' for the base year. Then absolute change and relative change can be expressed as follows:

Absolute change = $Q_{TOT} = Q_T - Q_O$ & Relative change = $D_{TOT} = Q_T / Q_O$

1. **Area effect:** The effect of change in the area on the production of crops while keeping yield, prices, and cropping pattern constant at base year values.

$$\Delta Q_{AREA} = \Sigma_i \Lambda_i ln\left(A^T / A^O\right) \quad \ldots(2)$$

2. **Yield effect:** The effect of change in yield of crop/crops upon production or aggregate production while keeping the area under crop(s) constant at base year values.

$$\Delta Q_{YIELD} = \Sigma_i \Lambda_i ln\left(Y_i^T / Y_i^O\right) \quad \ldots(3)$$

3. **Cropping pattern effect:** The effect of change in cropping pattern on aggregate production of crops while keeping overall area, yield, and prices (only if production is measured in monetary terms) constant at base year values.

$$\Delta Q_{STR.} = \Sigma_i \Lambda_i ln\left(C_i^T / C_i^O\right) \quad \ldots(4)$$

4. **Price effect:** The change in the production of crop output due to only change in crop output price, while other things remain the same at the base year value.

$$\Delta Q_{PRICE} = \Sigma_i \Lambda_i ln\left(W_i^T / W_i^O\right) \quad \ldots(5)$$

The additive decomposition scheme can be expressed as following:

$$\Delta Q_{TOT} = \Delta Q_{AREA} + \Delta Q_{YIELD} + \Delta Q_{STR.} + \Delta Q_{PRICE} \quad \ldots(6)$$

$$\Lambda_i = L\left(Q_i^T, Q_i^O\right) = \left(Q_i^T - Q_i^O\right) / \left(lnQ_i^T - lnQ_i^O\right) \quad \ldots(7)$$

$L\left(Q^T_i, Q^O_i\right)$ is the logarithmic mean between Q^t_i and

Q^o_i, where,

Q^o_i = Aggregate value of crop output in the base year (2007-08) &

Q^t_i = Aggregate value of crop output in tth year.

RESULTS AND DISCUSSION

From table 1, it can be observed that the average share of major crops was higher in Jabalpur compared to Katni. In Jabalpur district, the average share of wheat in the aggregate area was 5 percentage points more, and for gram, it was nearly 8 percentage points more than it was in Katni district. However, in the case of the paddy crop, Katni had 12 percentage points more share than Jabalpur on an average. Other than Paddy, Katni had a greater average share for linseed and sesamum only. The aggregate area of Jabalpur district was larger than Katni district.

Table 1: Distribution and relative change of aggregate area for selected crops Jabalpur and Katni district

	Average share (%)		Relative change$^{\#}$(%)	
Crop	**Jabalpur**	**Katni**	**Jabalpur**	**Katni**
Wheat	39.94	34.27	43.95	54.08
Paddy	28.61	40.40	43.93	6.40
Maize	1.99	1.85	100.00	72.10
Jowar /Linseed*	0.62	1.28	-66.66	-35.38
Gram	22.78	14.94	-14.92	91.13
Tur	4.18	3.48	85.71	81.64
Mustard	1.40	1.11	0.00	79.18
Sesamum	0.48	2.66	0.00	190.87
Aggregate area	275.53	230.95	26.96	38.51

** Jowar crop for Jabalpur and linseed for Katni; # Relative change was calculated between triennium ending 2009-10 and 2016-17.*

It was observed that the biggest relative change in Jabalpur district was for maize i.e., 100 percent, indicating that its area doubled between triennium ending 2009-10 and 2016-17. In relative change, maize was followed by *tur*, which had a relative change of 85 percent. In the Jabalpur district, the relative change was nearly similar for wheat and paddy. The last shift was observed in *tur*, for which the area declined by 14.92 percent. In the Jabalpur district, oilseeds registered negligible relative change over the period. It can be said that farmers in the Jabalpur district were more inclined towards cereal crops. While in Katni district, a shift in cropping pattern was more inclined towards oilseeds with the biggest relative change by sesamum with 190.87 percent, the lowest shift in the area was observed for paddy with 6.40 percent relative change. The result in table 1 indicates that farmers in Katni were more inclined towards high valued crops as compared to other crops, while in Jabalpur, higher inclination was mainly towards cereals or low-value crops.

Table 2 presents the actual value of output produced per hectare of land in the Jabalpur and Katni districts. It is clear from table 2 that Jabalpur dominated in value of output per hectare compared to Katni. There was a significant difference in the values in both the districts, which narrowed in 2013-14. After the year 2013-14, the difference in the real value of output in Katni and Jabalpur was less compared to all previous years. The most significant difference in values was observed from 2007-08.

Table 2: Real aggregate crop revenue in Jabalpur and Katni district of Madhya Pradesh for the period 2007-08 to 2016-17 (Unit: ₹ ha^{-1})

Year	**Jabalpur**	**Katni**
2007-08	16787	5794
2008-09	14999	7662
2009-10	17393	9388
2010-11	14773	8640
2011-12	21410	16054
2012-13	25351	18849
2013-14	25260	25254
2014-15	22106	18677
2015-16	25039	21087
2016-17	30299	31912
Growth rate (%)	8.33	15.89

Table 3 presents the yield growth rate of various crops in the Jabalpur and Katni districts. From table 3, it can be observed that the rate of growth in yield was higher in all the crops in Katni district compared to Jabalpur except for jowar and linseed. In Jabalpur district, growth in yield over the years in gram was only 2.46 percent, while in Katni, it showed 6.83 percent, similarly for *tur* there was a negative growth rate of -2.18 percent in Jabalpur while in Katni it was 4.55 percent. The largest difference in growth rates was for sesamum in both districts. In the Jabalpur district, the growth rate of sesamum was negative (-1.03), while there had been double-digit growth in yield (13.73 percent)

in Katni. In Jabalpur, considerable growth in yield was observed mainly in maize, paddy, and wheat; however, in Katni, not only the growth in these crops was higher than in Jabalpur but also in gram, mustard and sesamum.

Table 3: Growth rate of yield in Jabalpur and Katni district of Madhya Pradesh between TE 2009-10 and 2016-17 (Unit: %)

	Jabalpur	Katni
Gram	2.46	6.83
Tur	-2.18	4.55
Maize	7.65	11.10
Jowar / Linseed	3.75	3.71
Paddy	9.81	20.64
Wheat	6.20	10.10
Mustard	4.33	6.31
Sesamum	-1.03	13.73

Table 4 provides price growth rates in two districts between triennium ending 2009-10 and 2016-17. From table 4, it can be observed that growth rates in the price of gram, maize, and wheat were approximately the same in both the districts. However, a substantial difference was found for tur, paddy, mustard, and sesamum between price growth rates in two districts. The price growth rate of Paddy in Jabalpur was behind that of Katni in the same manner as the growth rate of yield of Paddy was lagging in Jabalpur compared to Katni.

Table 4: Growth rate of price and revenue share in Jabalpur and Katni district of Madhya Pradesh between TE 2009-10 and 2016-17 (Unit: %)

	Jabalpur	Katni
Gram	7.62 (26.07)	7.38 (18.70)
Tur	2.23 (5.29)	6.83 (3.19)
Maize	5.35 (1.33)	5.68 (1.38)
Jowar / Linseed	13.05 (0.48)	4.78 (1.25)
Paddy	5.16 (18.23)	7.68 (30.36)
Wheat	1.64 (47.07)	1.38 (41.84)
Mustard	5.84 (1.09)	3.09 (0.95)
Sesamum	9.64 (0.43)	3.71 (2.33)
Overall (in Price Index)	5.18	7.56

Table 5 represents the per hectare values by various constituent factors of aggregate crop revenue in

Table 5: Components of absolute change in value of output in Jabalpur and Katni Districts of Madhya Pradesh for period 2008-09 to 2016-17 (Unit: ₹ ha^{-1})

	Jabalpur					Katni				
Year	Area effect	Cropping pattern effect	Yield effect	Price effect	Change in value of output	Area effect	Cropping pattern effect	Yield effect	Price effect	Change in value of output
2008-09	342	39	(1,856)	934	(540)	1,577	302	1,396	239	3,514
2009-10	538	395	338	7,647	8,917	634	1,407	2,850	3,150	8,041
2010-11	1,206	(320)	(2,099)	8,446	7,232	1,522	490	2,464	1,685	6,161
2011-12	1,628	(139)	5,858	10,501	17,847	3,237	1,084	10,264	3,873	18,458
2012-13	3,116	(88)	10,114	9,170	22,312	4,671	1,506	12,807	4,537	23,522
2013-14	5,331	895	9,053	10,398	25,677	7,295	280	23,113	8,181	38,869
2014-15	3,940	1,587	4,717	9,264	19,508	6,240	1,030	15,397	8,839	31,506
2015-16	6,364	8	10,046	13,497	29,915	4,811	2,400	18,799	10,994	37,004
2016-17	9,173	(1,510)	18,913	17,972	44,549	11,240	1,374	33,433	13,885	59,931
Contribution	18.36%	0.38%	32.36%	48.90%	100.00%	18.31%	4.00%	53.54%	24.15%	100.00%

Note: *All changes were calculated with 2007-08 as base year. Figures within bracket indicates negative values.*

the Jabalpur and Katni district. From table 5, it can be observed that there was a higher increase in aggregate crop revenue in Katni compared to Jabalpur during the time period considered except in the year 2010-11, where the more significant increase was observed in Jabalpur (7,232 ₹ ha^{-1}). The cropping pattern effect was also higher in Katni compared to Jabalpur. For each hectare of gross cropped area increase, ₹ 1577 and ₹ 342 were added in Katni and Jabalpur district, respectively, in 2008-09 over a base year (2007-08) [see area effect column]. The area effect too was lagging in Jabalpur compared to Katni district except for 2015-16. For land shifted from low-value crop to high-value crop in Katni during 2008-09 over the base year were added ₹ 302 per hectare to aggregate crop revenue while the same was ₹ 39 in Jabalpur. This figure for cropping pattern effect was 10 times in Katni over Jabalpur in 2008-09. However, Jabalpur district farmers didn't shift area under cultivation towards high-value crops at the same pace as Katni farmers did over the years, except for the year 2014-15. This can be verified from Table 1 where it is evident that for low-value crops like Paddy and Wheat, although Katni had a larger average share of but had a lower growth rate for Paddy (6.4% in Katni Vs. 43.9% in Jabalpur). For high-value crops like Gram, mustard, and sesamum, Katni had a smaller average share of aggregate area but had comparatively higher growth rate than Jabalpur; for sesamum 0% growth rate in Jabalpur vs. 190% in Katni, for mustard 0% in Jabalpur vs. 79.2% in Katni and Gram -14.9% in Jabalpur vs. 91.1% in Katni.

In the year 2013-14 cropping pattern effects contributed 895 ₹ ha^{-1} in Jabalpur while only 280 ₹ ha^{-1} in Katni district at base year area, yield levels, and prices. Following the same pattern in the year 2014-15 also the contribution was higher in Jabalpur, but in the year 2015-16 there was a sharp decline in cropping pattern effect in Jabalpur, from 1,587 ₹ ha^{-1} in 2014-15 it dropped to 8 ₹ ha^{-1} in the year 2015-16 and in the year 2016-17 it dropped drastically to a negative value of 1,016 ₹ ha^{-1}, whereas in Katni it increased from 1,030 ₹ ha^{-1} in 2014-15 to 2400 ₹ ha^{-1} in the year 2015-16. In the year 2016-17 there was a decline in the cropping pattern effect, but it remained positive (1,374 ₹ ha^{-1}).

In Katni district during 2008-09 over base year, increase in yield of crops had contributed ₹ 1,396 per hectare towards aggregate crop revenue, while a decrease in the yield of wheat and rice, two major crops of the Jabalpur, led to a negative yield effect of ₹ 1,856 [see fig. 1]. Over the years, the yield effect followed a mixed pattern in Jabalpur district with the negative contribution in aggregate crop revenue in 2008-09 with marginal improvement with a value of 338 ₹ ha^{-1} in 2009-10. However, for the Jabalpur district, it again showed a sharp decline in the next year, i.e., 2010-11, with a negative value of 2,099 ₹ ha^{-1} with a positive value of ₹ 2,464 per hectare in Katni. Although after 2010-11 yield effect contributed positively to aggregate crop revenue but did not follow a continuously increasing trend.

The reason behind the negative yield effect in Jabalpur district was negative growth rates for any two of the three major crops (rice, wheat, and chickpea) [see fig. 1]. In contrast, in Katni yield effect had a much greater share in aggregate crop revenue throughout the study period. It followed an increasing trend with the highest contribution of 23,113 ₹ ha^{-1} in 2013-14; however, the contribution fell to only 15,397 ₹ ha^{-1} in the next year (2014-15) but it again followed an increasing trend and had shown highest of 33,433 ₹ ha^{-1} in the year 2016-17, which is much greater than the contribution of yield effect in the same year in Jabalpur district i.e. 25,803 ₹ ha^{-1}. A higher growth rate in yield for all the crops in Katni contributed to this greater share of yield effect in aggregate crop revenue in the district than Jabalpur.

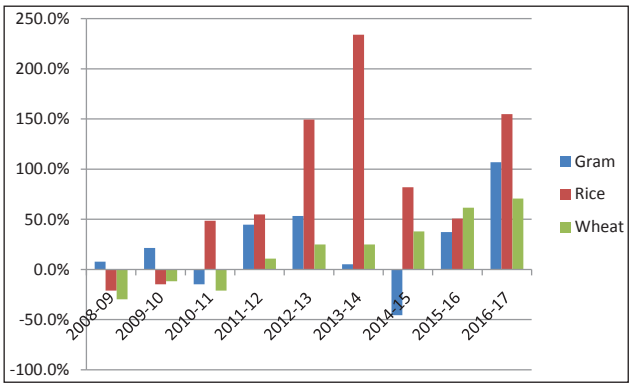

Fig. 1: Compound Annual Growth rates of yield for major three crops of Jabalpur district (base year 2007-08)

For increase in the price of commodities, ₹ 934 per hectare of addition was observed in Jabalpur district towards aggregate crop revenue compared with ₹ 239 per hectare addition observed in Katni

Table 6: Composition of various constituent factors of change in aggregate crop revenue (Unit= in lakh ₹)

	Jabalpur					Katni				
	Areas effect	**Cropping pattern effect**	**Yield effect**	**Price effect**	**Total**	**Area effect**	**Cropping pattern effect**	**Yield Effect**	**Price Effect**	**Total**
Gram	24.91 (23)	40.702 (1)	27.63 (20)	75.772 (8)	169.01 (24)	17.26 (15)	17.55 (83)	34.58 (13)	23.90 (18)	93.28 (17)
Maize	2.10 (2)	0.14 (~0)	2.48 (2)	4.69 (2)	9.41 (1)	2.13 (2)	-0.48 (-2)	2.84 (1)	1.87 (1)	6.36 (1)
Jowar / Linseed	0.51 (~0)	0.01 (~0)	0.07 (~0)	2.31 (1)	2.77 (~0)	1.49 (1)	-2.76 (-13)	1.93 (1)	0.71 (1)	1.37 (~0)
Paddy	31.01 (29)	29.18 (15)	58.72 (42)	78.82 (29)	197.73 (28)	48.25 (41)	-28.09 (-134)	108.66 (41)	62.54 (48)	191.36 (36)
Wheat	43.34 (40)	124.27 (64)	40.76 (29)	86.52 (32)	294.88 (41)	40.17 (34)	30.94 (147)	105.70 (40)	32.40 (25)	209.21 (39)
Tur	4.38 (4)	1.02 (1)	4.20 (3)	17.04 (6)	26.64 (4)	4.04 (3)	2.22 (11)	4.39 (2)	3.62 (3)	14.26 (3)
Mustard	1.52 (1)	0.10 (~0)	4.60 (3)	1.03 (~0)	7.24 (1)	1.25 (1)	-0.88 (-4)	1.96 (1)	0.12 (~0)	2.44 (~0)
Sesamum	0.43 (~0)	0.01 (~0)	1.30 (1)	1.50 (1)	3.24 (~0)	2.96 (3)	2.52 (12)	6.18 (2)	4.46 (3)	16.12 (3)
Total	**108.21 (100)**	**195.42 (100)**	**139.61 (100)**	**267.68 (100)**	**710.92 (100)**	**117.54 (100)**	**21.03 (100)**	**266.22 (100)**	**129.61 (100)**	**534.41 (100)**

Note: *Figures in parentheses represent percentage.*

district at base year area, cropping pattern, and yield levels. Over the years, the price effect was higher in Jabalpur district than in Katni districts for the whole study period. The contribution of price effect towards absolute change in aggregate crop revenue was 48.9% compared to 24.15% for Katni district. Contribution of area effect towards an increase in aggregate crop revenue was 18.36% in Jabalpur, very similar to 18.31% in Katni. At the same time, the contribution of the cropping pattern effect was merely 0.38% in Jabalpur compared to 4% in Katni. Yield effect contributed substantially in Katni (53.54%) towards an increase in aggregate crop revenue compared with 32.36% in Jabalpur. Thus, in Jabalpur, growth in aggregate crop revenue was driven by price effect, while in Katni the same was driven by yield effect. The growth in aggregate crop revenue in Katni was found to be more sustainable than in Jabalpur.

From table 6 it can be observed that in both the districts, more than half of the share in aggregate revenue was contributed by Wheat and Paddy, followed by Gram. Wheat had the maximum share in aggregate revenue in both Jabalpur and Katni districts with 41 percent and 39 percent, respectively, followed by Paddy and Gram. In both districts, coarse cereals and oilseeds had the least contribution in aggregate revenue. In Jabalpur, Sesamum and Jowar had negligible shares, while in Katni, linseed and mustard had the least contribution (~0 percent). The wheat had the highest share in revenue in Jabalpur district mainly due to the cropping pattern effect and expansion in the area, while in Katni, it was due to the cropping pattern effect and increase in yield. As mentioned earlier, increased contribution by yield effect and cropping pattern effect are indicators for sustainable growth in the long run, it can be said that in the case of Katni, growth of the wheat crop is more sustainable compared to Jabalpur as both cropping pattern and yield effect had shown considerable contribution. On the other hand, for paddy, in Katni cropping pattern showed a negative contribution (-134 percent), and its share in aggregate revenue was mainly contributed by price effect (48 percent) with an equal contribution by yield and area effect. In Jabalpur share of paddy was contributed by yield effect (42 percent) and equal contribution by price and area effect (29 percent). Positive contribution by cropping pattern effect was observed only in gram, paddy, wheat, and *tur* and remained zero for the rest of the crops. Wheat and paddy were the major staple crops in India and had notable status since the agricultural boom of the 1960s. The government

had upheld their status with subsidies which encouraged farmers to focus mainly on producing these valuable staples.

To conclude, the two significant findings of this study includes- (a) Yield effect appeared as the primary factor for growth in aggregate crop revenue in Katni district; (b) Price effect was responsible for the growth of aggregate crop revenue in Jabalpur district.

The findings of this study for the Katni district conform with the results of Birthal *et al.* (2014), where yield effect (technology) remained the most important source of agricultural growth, followed by crop diversification. However, the study conducted by Birthal *et al.* was at the macro level covering various regions of India. In contrast, this study is done on the micro-level, covering two districts of Kymore Plateau and Satpura hills region of Madhya Pradesh. The findings of this study for the Jabalpur district were in concordance with the study of Pattnaik & Shah (2015), with the price effect emerging as the dominant factor.

Policy Implications

From the ongoing discussion, it emerged that in both the districts, wheat, and paddy were the most dominating crops covering more than half of the gross cropped area, followed by the gram. The cropping pattern shift was observed towards Jabalpur food grains and towards pulses and oilseeds in Katni. In decomposition analysis of aggregate crop revenue, it was observed that yield effect and price effect emerged as the major contributor in both the districts, with area effect had considerable contribution and cropping pattern had a negligible contribution. Yield and cropping pattern effect led growth is more favorable rather than area and price-led growth. Although price plays an important role in enhancing agricultural growth it can be increased up to a certain extent and is not sustainable in the long run.

Between the two districts, there is substantial variation in the contribution by the various sources of aggregate crop revenue. In Katni, the yield effect has more per hectare contribution in aggregate crop revenue as compared to the price effect, while in Jabalpur price effect appeared as the most important source of growth in revenue. However, in both the districts, per hectare share by area effect was nearly the same and least share as observed by cropping pattern effect. However, it was still comparatively higher in Katni when compared to Jabalpur. The results suggest that greater interest and attention must be devoted towards improving the cropping pattern in both districts since that can lead to more sustainable growth of aggregate revenue. This also reflects a focus on diversification as a source of sustainability.

Declining contribution by cropping pattern effect in aggregate crop revenue shows that farmers are moving away from diversification which can be a concern. Crop diversification needs to be promoted in the districts. It will help in optimum land utilization and enhance the gross revenue from agriculture. In both the districts, farmers are more focused on the cultivation of mainly paddy and wheat since they are the major staple crops, and government policies are also favorable towards the cultivation of these crops through various policies and assured prices. Hence farmers are inclined towards monocropping, which is not sustainable in the long run. This points out the need for increasing the investment in research and extension services for better technologies and better high-yielding, hybrid varieties, which can help in promoting crop diversification. Various government policies and researches focused on encouraging farmers to grow crops other than wheat and rice should be implemented.

Another reason why crop diversification needs to be promoted is that with the ever-increasing population and urbanization, the limited area can be allotted for cultivation. Hence, area expansion-led growth is not sustainable. There is a need for optimization of the available land through crop diversification. In the same way, price-led growth can be beneficial for the farmers in the small run, but it cannot be sustained for a long time, and also it benefits the farmers in the proportion of their marketable surplus so the small scale farmers can gain less than the medium and larger-scale farmers, from such growth in revenue (Birthal *et al.* 2006).

The yield effect had been the most prominent as well as sustainable factor in contributing to aggregate crop revenue. Hence studies and research efforts focused on stabilizing this source of aggregate revenue need to be considered. Developments of

high-yielding varieties of crops suitable for the agro-climatic zone and breakthrough technologies that can enhance the gross revenue are desirable.

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