Agricultural Development and Crop output in Bihar: A Decomposition Analysis

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Abstract

The present investigation has been carried out to analyze the agricultural output growth and contribution of different components to the output growth in the state of Bihar in the recent past decades. Results of the analysis depicted mixed trend in growth rates of area under different crops in the state. The production growth has been found positive for most of the crops due to enhancement of productivity of the crops. Adoption of modern technology like; use of fertilizers, irrigation and quality seeds helped augmenting the productivity. Net sown area and net irrigated area observed declining trend which may be major concern for increasing agricultural production in Bihar. Researcher efforts therefore need to intensify further development of high yielding varieties suitable for different agro-climatic zones of the state. Shift of cropping pattern towards potato, sugarcane and other horticultural crops has also attributed to the output growth. It is alarming that the growth rates of productivity have declined for overall period for most of the crops except wheat, arhar, oil seeds and potato as compared to period-II under investigation. This is somewhat matter of great concern, when all efforts are towards increasing yields with the help of implementation of new cultivation technologies. This situation warrants the researchers and policy makers and stakeholders to identify the factors responsible for low productivity as there is negligible possibility to enhance arable area in the state, only the enhancement in yield can contribute to the agricultural growth of the state.

Key words: Agricultural output, Cropping pattern, Decomposition, Trend analysis, area, Production, Productivity.

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Introduction

Agriculture is undoubtedly one of the most important economic activities of rural India. It provides not only food to the ever rising population but also raw materials to a number of industries. Bihar is third most populous state in India. It is a home of about 105 million people and about 36 million of whom are poor. Against the backdrops of a large population resides in rural areas and high level of rural poverty, Agriculture sector is critical for development of the state. About nine-tenth of state's population lives in rural areas, as compared to the national average of 68.8 percent (2011 census). There are about 1.61 crore land holdings in Bihar and average land holdings stands about 0.39 ha, of which 91 per cent are small and marginal. This sector shares about 18% of the GSDP with around 70 per cent of the workforce earns their livelihood from this sector (Anonymous, 2018). The development of change in state output depends upon the agricultural development as it exists as dominant sector. This sector plays an important role in economic development, such as provision for food, enlarging exports, transfer of man power to non-agricultural sectors, contribution to capital formation and securing markets for industrialization (Johnston and Mellor, 1961).

The term agricultural development refers to the growth and overall changes of agriculture resulting in vertical expansion. The development of agriculture should be assessed not only by productivity level but also with respect to input use such as fertilizers, high yielding varieties of seeds and cheaper sources of irrigation. Agricultural development indicates the quality of agricultural system of the state; it is multi-dimensional concept which denotes strength of cropped land, enhancement in farming system, improved farm implements, high yielding varieties of seeds, irrigation system and irrigated area, use of fertilizers and insecticides, cropping intensity and specialization and commercialization of agriculture (Ahmad *et. al.,* 2017). The study of agricultural development is of vital importance in agricultural planning as it provides drawbacks and problems areas, which in turn give an insight to remove these drawbacks and problematic areas and to adopt proper action for their remedial and removing imbalances (Singh *et.al.,* 2015).

Quantitative assessment of the contribution of various factors of agricultural output development is important at state or national level to reorganize the different developmental programme to achieve higher growth. There are so many factors which influence the

development of crop output. Among these, area, productivity and cropping patterns are considered the most important one. Splitting growth components like area, productivity, cropping patterns etc help the policy makers and planners in projection of output with alternative programmes and policies.

Keeping in views the present investigation has been conducted to assess the compound growth rates of area, production productivity and different input used in production processes and contribution of different components to agricultural growth of the state.

Methodology

Bihar has four agro-climatic zones and each zone has different cropping patterns depending upon the climatic conditions of the region. For the present study, secondary data of area, production and productivity of important crops like paddy, wheat, maize, arhar, gram, lentil moong and rapeseed & mustard has been taken from various published sources such as Economic Survey of Bihar, Bihar through Figures, Agriculture statistics at a Glance etc. from 2000-01 to 2017-18 i.e. 18 years. The whole period was divided into two sub-periods i.e. period-I (2000-01 to 2009-10) and Period-II (2008-09 to 2017-18).

Compound growth rate

Extent of agricultural growth of a state can be measured by estimation of growth in area, production and productivity of the crops grown in the state. In the present study compound growth rates of area, production, productivity of the major crops have been calculated. Similarly growth rates of inputs were also worked out. The compound growth rate refers to the percentage change of a specific variable within specific period, given certain context. The growth model is given as under:

$$Yt = AB^t$$

Where, Yt = area/production/ productivity for the year‘t’

A = constant

B = growth coefficient

Log transformation of the above equation

log Yt = Log A + t log (B)

Growth rate (%) = {antilog(b)-1}x100; Where b =log(B).

Decomposition of Agricultural output growth

In recent past, attempts have been made to work out the contribution of different components of agricultural output growth. Different additive and multiplicative approached have been developed. Many researchers have studied the influence of individual components and effect of interaction of different components on output growth. In the present study, the contribution of different components of agricultural output growth have been estimated using seven factor decomposition models developed by Minhas (1966) and further modified by Sarma (1975). The output growth for the study of decomposition analysis has been calculated as change in output of current period (Triennium average of Last three years) over the base period (Triennium average of first three years). The changes in different components have also been computed in the same way. Constant price weights have been taken for different crops by taking triennium average of farm harvest prices (Singh 1981) for the year 2012-13 to 2015-16. The model used in the analysis is described as under:

$$P_0 = A_0 \Sigma_i W_i C_{io} Y_{io} \; - - - - - - - (i)$$

$$P_t = A_t \Sigma_i W_i C_{it} Y_{it} \; - - - - - - - - - (ii)$$

From the identities (i) and (ii) we can write

$$\frac{P_t - P_0}{P_0} = \frac{A_t - A_0}{A_0} + \frac{\Sigma_i W_i C_{io} Y_{io} \frac{Y_{it} - Y_{io}}{Y_{io}}}{\Sigma_i W_i C_{io} Y_{io}} + \frac{\Sigma_i W_i C_{io} Y_{io} \left| \frac{C_{it} - C_{io}}{C_{io}} \right|}{\Sigma_i W_i C_{io} Y_{io}} + \left| \frac{A_t - A_0}{A_0} \right| \frac{\Sigma_i W_i C_{io} Y_{io} \left| \frac{Y_{it} - Y_{io}}{Y_{io}} \right|}{\Sigma_i W_i C_{io} Y_{io}}$$

$$+ \left| \frac{A_t - A_0}{A_0} \right| \frac{\Sigma_i W_i C_{io} Y_{io} \left| \frac{C_{it} - C_{io}}{C_{io}} \right|}{\Sigma_i W_i C_{io} Y_{io}} + \frac{\Sigma_i W_i C_{io} Y_{io} \left| \frac{C_{it} - C_{io}}{C_{io}} \right| \left| \frac{Y_{it} - Y_{io}}{Y_{io}} \right|}{\Sigma_i W_i C_{io} Y_{io}} + \left| \frac{A_t - A_0}{A_0} \right| \frac{\Sigma_i W_i C_{io} Y_{io} \left| \frac{C_{it} - C_{io}}{C_{io}} \right| \left| \frac{Y_{it} - Y_{io}}{Y_{io}} \right|}{\Sigma_i W_i C_{io} Y_{io}}$$

Where,

P_t = value of agricultural output for the current year‘t’

P_o = value of agricultural output for the base year ‘o’

A_t = Gross cropped area of the crops in year‘t’

A_0 = Gross cropped area of the crops in year ‘o’

Y_{it} = Yield of i^{th} crop in year‘t’

Y_{io} = Yield of i^{th} crop in year ‘o’

C_{it}= Proportion of area under i^{th} crop to the total cropped area in year‘t’

C_{io}= Proportion of area under i^{th} crop to the total cropped area in year ‘o’

W_i= Constant price weight average of three years farm harvest price.

In this additive model of decomposition, the first component on the right hand is the area effect i.e. increase in output of this magnitude could have taken place in the absence of any change in per hectare yield and cropping pattern. The second component is productivity effect on the total production. The third component depicts the influence of cropping pattern changes during the recent period over the past period in absence of any change in productivity. The first order interaction of area and productivity, area and cropping pattern, productivity and cropping pattern reflects the simultaneous change in the respective components. The second order interaction of area, productivity and cropping pattern explains the effect of simultaneous change in area, productivity and cropping pattern (Minhas and Vaidyanathan, 1965; Sarma and Subrahmanyam, 1984).

Results and Discussion

Growth rates of area, production and productivity of principal crops in Bihar

The compound growth rates of area, production and productivity of principal crops grown in Bihar over two periods of time have been presented in Table 1, Table 2 and Table 3.

Table 1: Compound growth rates of area of principal crops of Bihar

Crops	Period-I (2000-01 to 2009-10)	Period-II (2008-09-2017-18)	Overall Period (2000-01 to 2017-18)
Paddy	-0.52***	0.13	-0.27**
Wheat	0.03	-0.07	0.06
Maize	0.42*	0.48**	0.47*
Total Cereals	-0.19	0.05	-0.11
Arhar	-2.19*	-1.64*	-2.17*
Lentil	-0.21	-1.03*	-0.47*
Gram	-1.41*	0.10	-0.69*
Moong	-0.43	0.14	-0.41*
Total Pulses	-1.18*	-1.09*	-1.16*
Total foodgrains	-0.28***	-0.04	-0.20*
Rapeseed & Mustard	-0.40	-0.20	-0.18*
Total oilseeds	-0.20	-1.23	-0.68*
Potato	5.32*	0.15*	2.49*
Sugarcane	0.68	3.32**	3.07*

*,** and *** indicate level of significance at 1%, 5% and 10% level of probability

Findings of the growth trends in respect of area and production of the important crops for all the periods under investigation revealed mixed trend of growth rates for the state of Bihar. For overall period growth rates of area under paddy, arhar, lentil, gram, moong, total cereals, total pulses, food grains and total oilseeds were found to be negative. Decrease in area of paddy may be due to erratic monsoon. Pulses and oilseed are cultivated in marginal land; they are less remunerative and are more diseases prone may be the reason for decline in area.

During the last decade in fact, unfavourable climatic condition had been noticed; resulting in scanty rainfall, incidence of disease-pest attack on the crop may be the another reason for decrease in area under pulse crops. Wheat and maize recorded positive growth in area in the state. Wheat and maize are more remunerative than that of paddy in cereal groups and in north Bihar maize is generally cultivated in rabi and summer seasons as the yield of rabi maize is more than that of the kharif maize. This may be the reasons for increase in area under wheat and maize. Area under potato and sugarcane recorded upward trends over the subsequent periods. A high growth in areas of these crops was evidently being due to higher returns from growing sugarcane and potato.

Period wise analysis revealed that growth rates of area under cereals, pulses and oil seeds for all the period were negative. Area under potato and sugarcane were recorded positive growth for all the periods. The reason in decline in area for food grains and oil seeds may be shift of area towards cultivation of commercial crops or horticultural crops.

Enhancement in agricultural production over the period of time reflects the pace of agricultural development of the state. Results of compound growth rates of production of different crops under study are presented in Table 2. It was evident from the table that crops like paddy, wheat, maize, lentil, rapeseed and mustard, potato and sugarcane registered positive growth trends in production. The positive growth may be due to use of high yielding varieties of crops and adoption of improved cultivation technologies and irrigation facilities. The growth rates of production of arhar, gram, moong even total pulses were computed negative as the pulses are grown in generally marginal land and are destroyed by wild animal like *nilgai*. Even pulse crops are more disease prone. Low yield of pulses crops may be another reason for declining growth in the state. Similar trend was observed in period wise analysis of the growth trends of production in the state.

Despite of decreasing area under most of the crops except potato and sugarcane for all the periods under investigation, production has substantially increased during these periods. The enhancement in production was obviously due to adoption good quality of seeds for food

grain crops and better crop management in the state. Crops like potato and sugarcane recorded positive growth in all the periods under study as these crops are cash crops and farmers were found shifting towards more remunerative crops. Sugar mills were made functional in the state and cultivators are getting the price of their produce directly in the bank accounts in time. Improvement in procurement policy of sugarcane may be one of the reason for growth in area and production in the state of Bihar

Table 2: Compound growth rates of production of principal crops of Bihar

Crops	Period-I (2000-01 to 2009-10)	Period-II (2008-09-2017-18)	Overall Period (2000-01 to 2017-18)
Paddy	-0.97	3.41**	1.68*
Wheat	0.28	0.76	1.12*
Maize	0.95**	3.38*	2.42*
Total Cereals	-0.20	2.34**	1.59
Arhar	-2.07*	-0.98	-1.29*
Lentil	-0.78	-0.23	0.22
Gram	-1.50	0.35	-0.16
Moong	-0.09	0.75	-0.08
Total Pulses	-1.30*	-0.41	-0.51*
Total foodgrains	-0.25	2.25*	1.51*
Rapeseed & Mustard	0.97	0.20	1.16*
Total oilseeds	1.06**	-0.90	0.39
Potato	8.90*	1.18*	5.16*
Sugarcane	0.55	4.89*	4.11*

*,** and *** indicate level of significance at 1%, 5% and 10% level of probability

A perusal of table 3 revealed that the productivity of all the crops under investigation exhibited enhancing trend for overall period and for period-II. Along with new technology, new institutional reforms enabled the cultivators to adopt improved methods of farming. The increased in productivity might be due to use HYVs seeds, input subsidies, government procurement facilities. Irrigation facilities in the state have also improved during these periods as the gross irrigated area has shown positive growth in all the period under investigation.

Table 3: Compound growth rates of productivity of principal crops of Bihar

Crops	Period-I (2000-01 to 2009-10)	Period-II (2008-09-2017-18)	Overall Period (2000-01 to 2017-18)
Paddy	-0.46	3.28**	1.95*
Wheat	0.24	0.83	1.06*
Maize	0.52	2.89*	1.94*
Total Cereals	-0.01	2.29*	1.70
Arhar	0.12	0.73	0.92*
Lentil	-0.58	0.80	0.70*
Gram	-0.08	0.25	0.54**
Moong	0.34	0.62	0.33
Total Pulses	-0.13	0.68	0.65*
Total foodgrains	0.03	2.29*	1.71
Rapeseed & Mustard	1.38*	0.41	1.34*
Total oilseeds	1.26*	0.34	1.08
Potato	3.42***	1.02*	2.62*
Sugarcane	-0.13	1.52*	1.00*

*,** and *** indicate level of significance at 1%, 5% and 10% level of probability

Growth in input use

The agricultural development is determined by the use of resources like inputs (quality seeds, fertilizers and irrigation). Adoptions of technological advancement boost the agricultural outputs and enable the cultivators to use more productivity enhancing inputs. The agricultural production has increased due to new production techniques. Irrigation, fertilizers, use of HYV seeds are important factors of production enhancement.

Compound growths rates for net cropped area, gross cropped area, net and gross irrigated area are presented in Table 4. A closer look of the table revealed that the net cropped area for the subsequent period of time registered declining growth trend. This result is in confirmation with the result of Sinha *et.al.* 2014. Increase in population give rise to demand for land for construction of dwelling house and other infrastructure like roads, industries are the major causes of shrinking area under cultivation.

Gross cropped area is an important indicator to show the agricultural development. The state of Bihar has fertile land, favourable climatic conditions and abundant of human labour still the cropping intensity of the state hovers around 142 percent. Bihar is considered as the focus

point of second green revolution in the country. Irrigation facilities are of prime importance for the development of agriculture. Improved management of irrigation is crucial as the growth trend in area under net irrigation is negative which emphasized for renovation of the canal and other irrigation system of the state. Only then success of second green revolution may be brought from this region. The table further indicates that growth of gross irrigated area was mere 0.45 percent for overall period of investigation. The growth in gross irrigated area was recorded higher as the cultivators were cultivating only those farms in which irrigation facilities were assured. The state government should make policy for expansion and renovation of the irrigation system which is crucial input for the cultivation.

Table 4: Compound growth rates of area cropped and irrigated in Bihar

Crops	Period-I (2000-01 to 2009-10)	Period-II (2008-09-2017-18)	Overall Period (2000-01 to 2017-18)
Net cropped area	-0.20**	-0.14***	-0.24*
Gross Cropped area	-0.12	0.05	-0.07
Net irrigated area	0.10*	-0.54*	-0.31*
Gross irrigated area	0.67*	0.80**	0.45*

*,** and *** indicate level of significance at 1%, 5% and 10% level of probability

Fertilizer is an important constituent of new crop production technology. The results of Table 5 exhibited positive and significant growth in total fertilizer consumption for all the periods under study. The total fertilizer increased at the rate of 2.35 per annum. It was higher is period-I and lowest in period-II. All the constituents of fertilizers i.e. N, P and K also exhibited the same trend except K showed declined trend in period-II. Growth rate of nitrogen consumption was observed lowest i.e. 1.94 percent for overall period and potash was found highest i.e. 3.84 percent per annum in the state. The positive growth in productivity may be due to the use of fertilizers in the state.

Table 5: Compound growth rates of fertilizer consumption in Bihar

Crops	Period-I (2000-01 to 2009-10)	Period-II (2008-09-2017-18)	Overall Period (2000-01 to 2017-18)
N	2.69*	1.12*	1.94*
P	4.76**	1.36	3.84*
K	8.36*	-0.76	3.72*
NPK	2.90*	0.96**	2.35*

*,** and *** indicate level of significance at 1%, 5% and 10% level of probability

Quality seeds are another most important component of production growth. The output of the crop also depends on the quality of seed used in cultivation of a particular crop. Seed replacement rate for different crops grown in the state has been presented in Table 5. Perusal of the table revealed increasing trend in seed replacement rates except for Rapeseed & mustard had decreased. Still the seed replacement rates are found low as compared to another state like Punjab and Haryana. This may be the reason for low productivity of these crops in Bihar.

Table 5: Seed replacement rate in Bihar

(%)

Crops	2003-04	2008-09	2017-18
Paddy	6.8	19.0	40.74
Wheat	8.1	24.0	17.84
Maize (Rabi)	30.0	67.5	85.51
Pulses	6.0	7.67	8.95
Rapeseed & Mustard	20.0	55.0	31.56

Shift in Cropping Pattern in Bihar

As is well known fact, agricultural development and shift in cropping pattern go parallel. The level of crop diversification influences the extent economic progress in the rural areas. Hence, to know the extent of agricultural growth in the state to study the shift in cropping pattern is also an important aspect.

The cropping pattern of Bihar is shown in Table 6. Findings of the table revealed that total share of food grains was 92.20 percent at TE-2003 which decreased to 86.69 percent in TE-2018. The area under potato and sugarcane increased from 1.31 per cent and 1.79 percent in TE-2003 to 3.16 percent and 4.20 percent at TE-2018 indicated shift of cropping pattern towards more remunerative crops in the state. The diversification has taken place towards high value crops like horticultural crops.

Table 6: Shift in Cropping Pattern in Bihar

Crops	TE-2003	TE-2010	TE-2018
Rice	45.11	43.61	43.14
Maize	7.53	8.38	9.18
Wheat	26.60	27.66	27.59
Total Cereals	83.83	79.77	80.35
Gram	0.91	0.78	0.77
Arhar	0.51	0.37	0.28
Lentil	2.18	2.16	1.90
Moong	2.22	2.21	2.22
Total Pulses	8.38	7.38	6.34
Total Food grains	92.20	87.14	86.69
Rapeseed & Mustard	1.18	1.14	1.12
Total oilseeds	1.82	1.77	1.48
Sugarcane	1.31	1.46	3.16
Potato	1.79	4.06	4.20
Other miscellaneous crops	2.87	5.57	4.48
Gross Cropped Area	100.00	100.00	100.00

TE-Triennium Ending and Figures are percentage area of crop to Gross Cropped Area
Source: Various issues of Bihar through Figures, GOB

Decomposition of total Agricultural output growth in Bihar

The crops in the state have exhibited marginal growth in production. The main factor contributing to this is productivity in general. In order to known the clearly contributing various factors like change in cropping pattern, yield and area with their first and second order interaction in changes in crop output in the state, component analysis was applied and the findings of the analysis is presented in Table 7.

Findings of the seven factors additive decomposition analysis revealed that the productivity growth was the major factor which accounted for the output growth in the state for the period under investigation. Out of total growth in crop output 308.96 percent was attributed to the change in productivity. The interaction between area and yield and area, yield and cropping pattern had positive contribution in crop output of the state. The productivity growth was the major factor accounting for higher proportion of the total output growth of the state. The result indicated that use of high yielding varieties of the crops bought revolution in

enhancement of the crop output in the state. Negative effect of area, cropping pattern and interaction between area and cropping pattern brought decline in the output of the state. The interaction between cropping pattern and yield and interaction between area and cropping pattern were assessed negative pointing out that scope for area expansion is limited. For development of output may be brought from enhancing yield and changing cropping pattern in the state of Bihar.

Table 7: Relative contribution of various components to the total Growth of Crop output in Bihar

Components	Contribution (%)
Area effect	-20.50
Yield effect	308.96
Cropping pattern effect	-71.73
Interaction between cropping pattern and yield	-6.30
Interaction between area and yield	1.47
Interaction between area and cropping pattern	-116.41
Interaction between area, yield and cropping pattern	4.52

Conclusion policy implications

From the ongoing discussion, it emerges that growth rates of area of cereals, pulses, food grains and oilseeds were found to be negative. Potato and sugarcane registered positive growth in area indicated shifting of cultivators towards remunerative crops. Production of all the crop groups except pulses showed positive trend. The production was found enhanced due to increase in productivity of the crops as the area under food grains, pulses and oilseeds were found declining.

Net sown area, gross cropped area and net irrigated area depicted negative growth during the overall period of study reminding policy planner to focus their attention to find out alternative ways to enhance the output of the state to ensure food security.

During the study period, the growth rates of fertilizers were found positive and seed replacement rates were also found increasing indicating adoption of technological changes by farmers in the state which was also evident from positive growth of yields of all the crops considered under investigation.

Percentage share of food grains and oil seeds in the cropping pattern in the state has decreased i.e. share of food grains in gross cropped area was 92.20 at TE-2003 which came down to 86.69 at TE-2018 and for oil seeds from 1.82 to 1.48. But the share of area under sugarcane and potato were found increased i.e. for potato share of area increased from 1.79 percent at TE-2003 to 4.20 at TE-2018 and for sugarcane it was enhanced from 1.31 per cent 3.16 percent.

In decomposition analysis of total agricultural growth, yield effect came out as one of the major contributor the output growth of the state. Interaction effect of area and yield and interaction effect of area, yield and cropping pattern also exhibited positive impact on output growth of the state.

Net sown area and net irrigated area in the state are declining which is major concern. Need of the hour is to stabilize the productivity of the crops. Researcher should make efforts to stabilize the yield of the crops as yield had major contribution to the agricultural output growth of the state. Researcher efforts therefore need to intensify further development of high yielding varieties suitable for different agro-climatic zones of the state. Shift of cropping pattern towards potato, sugarcane and other horticultural crops has also attributed to the output growth.

It is noticeable that the growth rates of productivity have declined for overall period for most of the crops except wheat, arhar, oil seeds and potato as compared to second period under investigation. This is somewhat matter of great concern, when all efforts are towards increasing yields with the help of implementation of new cultivation technologies. This situation warrants the researchers and policy makers to identify the factors responsible for decline in productivity as there is negligible possibility to enhance net sown area in the state only the enhancement in yield can contribute to the agricultural growth of the state.

Note: *The study is based on Doctoral Research in Agricultural Economics being carried out by the first author under the supervision of the second author at the Department of Agricultural Economics at Dr Rajendra Prasad Central Agricultural University, Pusa-Samastipur-848125, India*

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