Trend in Area, Production and Productivity of all Rice and boro Rice in Bihar State

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Abstract

Rice occupies a pivotal place in Indian agriculture and provides 43% calorie requirement for more than 70% of its people. It accounts for about 42% of total food grain production and 55% of cereal production in the country. The CGAR (from 1997-98 to 2017-18) of area, production and productivity under all rice was found as 1.09 per cent, 0.68 per cent and 0.62 per cent, respectively, while that of boro rice it was found as 1.73 per cent, 1.58 per cent and 0.91 per cent, respectively. The annual growth rate for the same period of all rice in zone II of Bihar was 1.18 percent for area, 0.84 per cent for production and 0.72 per cent for productivity while that of boro rice of was 1.60 for area, 1.44 per cent for production and 0.90 per cent for productivity. Thereby showing that area, production and productivity of all rice and boro rice has increased from 1997-98 to 2017-18 in the state. In Bihar state rice is grown in 3.30 million hectares, covering 60 percent of Net Cropped Area, producing 8.09 million tonnes with the productivity of 2447 kg/ha (DES, 2017-18). The productivity of the crop in the state is far below the national average (2578 Kg/ ha). In the state, rice is grown in versatile adaptation from precarious moisture as rainfed upland to deep water area having 3-4 meter water as deep water crop with many intermediate situations in between. The diverse ecological situation, varying climate and pedagogical conditions along with socio-economic diversities make rice cultivation a highly risky venture, resulting in overall poor productivity of the crop in the state. In Bihar around 33 percent of the total rice area in the state is under assured irrigation while remaining 67 percent is under rainfed situation. A large tract of land of Bihar state becomes unsuitable for traditional kharif crops due to flood and water logging from rivers and its tributaries from July to October months. The cultivation of rice during rabi crop season (November to May) was unknown probably till the new rice cultivars were introduced in eastern part of India through Bangladesh refugees. The cultivation of rice during winter months is termed as

Keywords
Trend, CAGR, Garrett Score, boro rice, Zone II Bihar

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Introduction

India is the second largest producer, consumer and exporter of rice after China. Rice is the most dominant cereal crop accounting 45 per cent of the total food grain production of the country. India produced 112.91 million tonnes of rice from an area of 43.79 million ha during 2017-18. However, the country ranked 9th in terms of productivity (2578 kg ha⁻¹) in the world which is far below the world average of 3173 kg/ha (DES, 2017-18). It occupies a pivotal place in Indian agriculture and provides 43% calorie requirement for more than 70% of its people. It accounts for about 42% of total food grain production and 55% of cereal production in the country. It is cultivated in three seasons i.e. Aus (April to June), Aman (June to November) and Boro (November to April) rice in India.

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A large tract of land of Bihar state becomes unsuitable for traditional kharif crops due to flood and water logging from rivers and its tributaries from July to October months. The cultivation of rice during rabi crop season (November to May) was unknown probably till the new rice cultivars were introduced in eastern part of India through Bangladesh refugees. The cultivation of rice during winter months is termed as boro rice. Boro is a Bengali word derived from Sanskrit word ‘Borob’ that refers to special rice cultivation in low land pockets during November to May months. The farmers innovated this rice cultivation with short duration photoperiod insensitive varieties to supplement poor kharif harvest. The boro rice area in eastern states of Assam, Odisha and West Bengal are mainly distributed in swampy low lands. In Bihar, it is spread in low lying belts of North-Eastern districts namely Purnea, Saharsa, Madhepura, Kisanganj, Supaul, Darbhanga, Katihar and North-Western districts viz. East Champaran and West Champaran, where rain water is accumulated and remains stagnated beyond October month. Recently with the introduction of cold tolerant rice varieties boro rice has become boon to the farmers of this region.

Materials and Methods

The study was based the time-series data on area, production and productivity of all rice as well as of boro rice in Bihar state and its zone II (from 1997-98 to 2017-18) were collected from various published sources. The data were summarized, tabulated and analyzed using statistical measures like trend analysis.

Trend analysis

The trend in area, production and productivity were analyzed on the basis of Compound Annual Growth Rate (CAGR). The formula used for estimation of CAGR was as;

\[ CAGR = \left(\frac{y_n}{y_1}\right)^{\frac{1}{n}} - 1 \]

Where,
\( y_1 = \) Data (1st year);
y_n = Data (n^{th} year) and n=No. of years.

Results and Discussion

Trend in area, production and productivity of total rice and boro rice in Bihar & Zone II from 1997-98 to 2017-18

The Compound Annual Growth Rate (CAGR) of total rice in Bihar is presented table 1, which reveals that CAGR for area, production and productivity 1.09, 0.68 per cent and 0.62 per cent, respectively and of boro rice in the state was estimated as 1.73, 1.58 and 0.91 per cent, respectively. It shows that area, production and productivity of total rice as well as of boro rice has increased in Bihar. It is also indicated from the table that area, production and productivity under boro rice increased more as compared to all rice in the state during the period from 1997-98 to 2017-18.

The trend in area, production and productivity of total rice in Zone II (District-wise)of Biharis presented in table 2. The table reveals that CAGR of area of total rice for the districts of Araria, Katihar, Khagaria, Kisanganj, Madhepura, Purnea, Saharsa and Supaul of zone II was estimated as 0.77, 2.30, 1.23, 1.23, 1.16, 1.16, 1.32 and 1.10 per cent, respectively. The CAGR for production was found to be 0.58, 1.56, 0.58, 0.84, 1.06, 0.76, 0.79 and 0.81 per cent, respectively for the above districts. It is revealed that highest increase in area (2.30 per cent) and production (1.56) was recorded in Katihar district, while highest increase in productivity was (0.92) in Madhepura district.

The trend in area, production and productivity of boro rice in Zone II (district-wise) is also presented in table 2. It is revealed from the table that highest CAGR of area (6.61 per cent) and production (5.18 per cent) of boro rice was found in Saharsa district while that of highest productivity (1.03 per cent) was estimated for Kishanganj district of zone II. The CGAR of area, production and productivity in all districts of zone II was positive thereby indicated increase of these in all districts during the reference period (1997-98 to 2017-18) (Fig. 1 and 3; Table 3).

Table 1 Trend in area, production and productivity of total rice and boro rice in Bihar &Zone II (per cent) from 1997-98 to 2017-18

| Particulars         | Area  | Production | Productivity |
|---------------------|-------|------------|--------------|
| Total Rice (Bihar)  | 1.09  | 0.68       | 0.62         |
| Total Rice (Zone II)| 1.18  | 0.84       | 0.72         |
| Total boro rice (Bihar) | 1.73  | 1.58       | 0.91         |
| Total boro rice (Zone II) | 1.60  | 1.44       | 0.90         |

The data for study period is appended in Appendix and presented graphically.
**Table 2** Trend in area, production and productivity of total rice and boro rice in Zone II of Bihar (Per cent)

| District   | Total rice (Zone II) |          | Total boro rice (Zone II) |          |
|------------|----------------------|----------|---------------------------|----------|
|            | Area | Production | Productivity | Area | Production | Productivity |
| Araria     | 0.77 | 0.58       | 0.75         | 1.02 | 1.03       | 1.01         |
| Katihar    | 2.30 | 1.56       | 0.68         | 1.42 | 1.17       | 0.82         |
| Khagaria   | 1.23 | 0.58       | 0.47         | 0.85 | 0.66       | 0.78         |
| Kisanganj  | 1.23 | 0.84       | 0.69         | 0.70 | 0.72       | **1.03**     |
| Madhepura  | 1.16 | 1.06       | **0.92**     | 4.46 | 4.57       | 1.02         |
| Purnea     | 1.16 | 0.76       | 0.66         | 3.18 | 3.08       | 0.97         |
| Saharsa    | 1.32 | 0.79       | 0.60         | **6.61** | **5.18** | 0.78         |
| Supaul     | 1.10 | 0.81       | 0.74         | 3.00 | 2.50       | 0.83         |

**Table 3** Area, production and productivity of rice in Bihar

| Year        | Area ('000 ha) | Production ('000 tonnes) | Productivity (Kg/ha) |
|-------------|----------------|--------------------------|----------------------|
| 1997-98     | 3621.33        | 5395.08                  | 1489.81              |
| 1998-99     | 3110.89        | 4670.65                  | 1501.39              |
| 1999-00     | 665.47         | 945.25                   | 1420.44              |
| 2000-01     | 3656.84        | 5444.37                  | 1488.82              |
| 2001-02     | 3564.54        | 5301.22                  | 1487.21              |
| 2002-03     | 3584.70        | 5085.57                  | 1418.69              |
| 2003-04     | 3667.66        | 5568.09                  | 1518.16              |
| 2004-05     | 3140.12        | 2472.16                  | 787.28               |
| 2005-06     | 3251.24        | 3709.29                  | 1140.88              |
| 2006-07     | 3364.01        | 5027.95                  | 1494.63              |
| 2007-08     | 3477.37        | 4458.98                  | 1599.30              |
| 2008-09     | 3495.27        | 5589.98                  | 1599.30              |
| 2009-10     | 3124.03        | 3640.21                  | 1165.23              |
| 2010-11     | 2845.37        | 3112.62                  | 1093.92              |
| 2011-12     | 3350.94        | 8237.97                  | 2458.41              |
| 2012-13     | 3298.89        | 8322.01                  | 2522.67              |
| 2013-14     | 3150.81        | 6649.59                  | 2110.44              |
| 2014-15     | 3263.37        | 8241.62                  | 2525.49              |
| 2015-16     | 3232.31        | 6802.22                  | 2104.44              |
| 2016-17     | 3339.78        | 8238.77                  | 2466.86              |
| 2017-18     | 3306.98        | 8093.16                  | 2447.29              |
| CAGR (%)    | **1.09**       | **0.68**                 | **0.62**             |

Source: https://aps.dac.gov.in/
| Year    | Area ('000 ha) | Production ('000 tonnes) | Productivity (Kg/ha) |
|---------|----------------|--------------------------|----------------------|
| 1997-98 | 120.94         | 231.89                   | 1917.40              |
| 1998-99 | 128.80         | 264.46                   | 2053.30              |
| 1999-00 | 124.87         | 246.81                   | 1976.45              |
| 2000-01 | 126.13         | 214.18                   | 1698.12              |
| 2001-02 | 182.25         | 195.59                   | 1073.21              |
| 2002-03 | 120.32         | 197.56                   | 1073.21              |
| 2003-04 | 116.89         | 169.90                   | 1450.58              |
| 2004-05 | 116.22         | 166.20                   | 1430.03              |
| 2005-06 | 113.25         | 182.83                   | 1614.35              |
| 2006-07 | 109.44         | 163.99                   | 1498.49              |
| 2007-08 | 110.44         | 172.29                   | 1560.04              |
| 2008-09 | 105.53         | 178.24                   | 1689.06              |
| 2009-10 | 95.67          | 176.64                   | 1846.42              |
| 2010-11 | 84.46          | 163.01                   | 1930.08              |
| 2011-12 | 96.16          | 182.65                   | 1899.39              |
| 2012-13 | 105.10         | 285.79                   | 2719.23              |
| 2013-14 | 92.21          | 215.95                   | 2342.03              |
| 2014-15 | 82.27          | 181.56                   | 2206.95              |
| 2015-16 | 81.07          | 200.42                   | 2472.29              |
| 2016-17 | 84.32          | 224.33                   | 2660.35              |
| 2017-18 | 67.87          | 143.83                   | 2119.38              |
| CAGR (%)| 1.73           | 1.58                     | 0.91                 |

Source: https://apsdac.gov.in/
Table 3 Area, production and productivity of rice in Zone II of Bihar

| Year   | Area (‘000 ha) | Production (‘000 tonnes) | Productivity (Kg/ha) |
|--------|----------------|--------------------------|----------------------|
| 1997-98| 784.817        | 1006.271                 | 1282.17              |
| 1998-99| 657.846        | 753.811                  | 1145.88              |
| 1999-00| 232.370        | 335.949                  | 1445.75              |
| 2000-01| 816.142        | 1016.100                 | 1245.00              |
| 2001-02| 786.944        | 885.950                  | 1125.81              |
| 2002-03| 791.625        | 903.155                  | 1140.89              |
| 2003-04| 877.709        | 1190.465                 | 1356.33              |
| 2004-05| 741.595        | 623.144                  | 840.28               |
| 2005-06| 751.058        | 810.448                  | 1079.08              |
| 2006-07| 742.048        | 791.260                  | 1066.32              |
| 2007-08| 732.334        | 676.272                  | 923.45               |
| 2008-09| 684.893        | 766.827                  | 1119.63              |
| 2009-10| 722.054        | 870.152                  | 1205.11              |
| 2010-11| 680.157        | 785.162                  | 1154.38              |
| 2011-12| 707.524        | 1306.333                 | 1846.34              |
| 2012-13| 705.698        | 1517.307                 | 2150.76              |
| 2013-14| 706.496        | 1476.594                 | 2090.02              |
| 2014-15| 687.362        | 1557.307                 | 2265.63              |
| 2015-16| 669.644        | 1322.969                 | 1975.63              |
| 2016-17| 714.761        | 1513.372                 | 2117.31              |
| 2017-18| 660.056        | 1202.453                 | 1821.75              |
| CAGR (%)| 1.18          | 0.84                     | 0.72                 |

Source: https://aps.dac.gov.in/
### Table 4: Area, Production and Productivity of *boro* rice in zone II of Bihar

| Year    | Area (‘000 ha) | Production (‘000 tonnes) | Productivity (Kg/ha) |
|---------|----------------|--------------------------|----------------------|
| 1997-98 | 95.23          | 188.729                  | 1981.82              |
| 1998-99 | 102.608        | 230.31                   | 2244.56              |
| 1999-00 | 101.71         | 214.124                  | 2105.24              |
| 2000-01 | 103.654        | 176.325                  | 1701.09              |
| 2001-02 | 138.931        | 138.629                  | 997.83               |
| 2002-03 | 98.571         | 158.559                  | 1608.58              |
| 2003-04 | 96.209         | 144.268                  | 1499.53              |
| 2004-05 | 95.037         | 135.59                   | 1426.71              |
| 2005-06 | 93.872         | 163.815                  | 1745.09              |
| 2006-07 | 90.691         | 136.16                   | 1501.36              |
| 2007-08 | 90.791         | 141.833                  | 1562.19              |
| 2008-09 | 88.713         | 150.172                  | 1692.78              |
| 2009-10 | 83.294         | 160.256                  | 1923.98              |
| 2010-11 | 74.264         | 145.704                  | 1961.97              |
| 2011-12 | 90.353         | 172.561                  | 1909.85              |
| 2012-13 | 91.791         | 256.453                  | 2793.88              |
| 2013-14 | 75.904         | 181.939                  | 2396.96              |
| 2014-15 | 68.119         | 156.834                  | 2302.35              |
| 2015-16 | 68.513         | 170.119                  | 2483.02              |
| 2016-17 | 73.08          | 200.879                  | 2748.75              |
| 2017-18 | 58.19          | 129.046                  | 2217.67              |
| CAGR (%)| **1.60**       | **1.44**                 | **0.90**             |

Source: [https://aps.dac.gov.in/](https://aps.dac.gov.in/)
Figure 1 Area, production and productivity of rice in Bihar
Figure 2 Area, production and productivity of *boro* rice in Bihar
Figure 3 Area, production and productivity of rice in Zone II of Bihar

1976
Figure 4 Area, production and productivity of *boro* rice in zone II of Bihar
It may be concluded from the study that area, production and productivity of boro rice has increase more as compared to total rice in Bihar. The probable reason for this may be because of that boro rice system takes advantage of residual moisture after the harvest of kharifrice. Such area with high moisture retention capacity are low-lying ditches where water is stored or gets accumulated, areas adjoining canals and roads, Chaur-lands/Tal lands, etc are suitable for boro rice cultivation. Boro rice is a winter season, photo insensitive, transplanted rice cultivated with supplemental irrigation. It gives the farmers a chance to grow a rainy season crop, which normally they could not grow.

In the state boro rice is normally grown under irrigated condition. The average rainfall in in Bihar as well as in zone II is high but it does not distribute uniformly, so at the time of rice cultivation, it cannot meet the actual water requirement of the crop in respect to time and space. Therefore, a long area of cultivable land remains fallow during winter season due to insufficient soil moisture. With the increase in irrigation facilities, boro rice crop is now being taken in areas outside its traditional boundaries and a new cropping system is emerging (Singh, 2003). Irrigation can therefore bring more areas under boro rice cultivation. Another factor that affects the boro rice cultivation is fall of water table below ground surface. Lack of appropriate variety and water management practice is a limiting factor for successful boro rice cultivation under shrinking water condition. Therefore, appropriate agronomic management is a prerequisite to exploit full potential of the available resources. To realize the maximum possible benefits from boro rice, it is essential to develop appropriate package of practices for successful cultivation and yield maximization. Among the various cultural practices appropriate varieties and water management practice may play important for yield maximization.

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