

# Sources of Growth in Rice Production in India: State Wise Component Analysis

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## ABSTRACT

The present study was taken up to estimate the influence of technology and policy on Rice production in India and its major states with objectives; measuring the magnitude of growth, estimating the instability and assessing the influence of technology and policy factors on Rice production in different states. The time series data of 25 years for the period 1990-91 to 2014-15, on area, production and yield of paddy for different states were collected from the website <http://eands.dacnet.nic.in>. Area and Yield variables were taken as proxy for policy and technology factors respectively. Analytical tools like Compound Growth Rate (CGR), Coefficient of Variation (C.V) and Component Analysis were employed to achieve the objectives. Results reveal that growth and instability in production were more contributed by yield than area. This indicates that growth in production should come from yield attributing factors like development of High Yielding farming system of specific varieties and improvement in input use efficiency. Immediate concern is about the transfer of *technology know-how* to *farmer's do-how*.

## Highlights

- Growth in Rice production was more contributed by yield than area.
- Instability in yield had higher effect on Rice production variability than by instability in area.
- Rice Production differential was more contributed by change in yield than by change in area.

**Keywords:** Rice, Growth, Instability, Technology, Policy and Decomposition

During 2014, India achieved the first rank in area in the world for its paddy cultivation with 43.9 Million hectares (26.93%) and second in production of 157 Million tonnes (21.19%) but ranked at around 50<sup>th</sup> position in yield with 3.72 tonnes per hectare (Statistics at a glance 2016). In India, the leading states in Rice cultivation are Uttar Pradesh, West Bengal, Odisha, Chattisgarh, Bihar *etc.* The low growth in production and yield will adversely affect the prospective production employment and income both at micro and macro levels and will also hamper economic growth of the country. Farm profitability of paddy is influenced by yield and price. Further, yield is influenced by technology efforts and price by policy measures of government.

Studies by Jayadevan (1991) revealed that the growth in crop production during the post-green revolution period has been accompanied with increased instability. The present study was taken up to get a bird's eye view of the extent of influence of technology and policy with the following objectives:

1. To measure the magnitude of growth in area, production and yield of Rice in different states;
2. To estimate the extent of instability in area, production and yield of Rice in different states;



- To assess the influence of technology and policy factors on Rice production in different states.

## MATERIALS AND METHODS

The study pertains to all the states of India. For discussion purpose the states are grouped as 10 major states and North Eastern States and Other states. The time series data for the period 1990-91 to 2014-15, on area, production and yield of paddy for different states were collected from the website of Directorate of Economics and Statistics, ministry of Agriculture, Cooperation and Farmers Welfare (<http://eands.dacnet.nic.in>). Area and Yield variables were taken as proxy for policy and technology factors respectively. For the purpose of analysis, total period (1990-91 to 2014-15) was divided into three periods viz., Period - I (1990-91 to 1999-2000), Period - II (2000-01 to 2009-2010) and Period - III (2010-11 to 2014-2015). The following analytical tools were employed to achieve the objectives.

### Analytical Tools

#### I. Estimation of Growth:

Compound growth rates of area, production and yield for periods mentioned earlier were measured by fitting an exponential function of the following form:

$$Y = Ab^t \quad \text{Log } Y = \text{Log } A + t \cdot \log b$$

Where, Y = Area/  
Production/Yield

b = (1+r)      r = Compound Growth Rate

t = Time variable in years (1, 2, 3...n)

#### II. Estimation of extent of Instability

To estimate the instability, Coefficient of variation (CV) was utilized. Coefficient of variation explains the fluctuations over the period, which is represented by the following formulae:

$$CV = \frac{\left[ \frac{1}{N-1} (\sum_i x_i - \bar{X})^2 \right]^{1/2}}{\bar{X}}$$

Where, N = Number of years

$X_t$  = Area/production/Yield in the year 't'

$\bar{X}$  = Mean of Area/production/yield.

### III. Estimation of Technology and Policy factors affect on production

Minhas and Vaidyanatham (1964) utilized two way component analyses to disaggregate the change in production into area affect, yield affect and interaction affect. In the present study area and yield variables were taken as proxy for policy and technology factors respectively. This is represented by the following form:

$$DP = A_o.DY + Y_o.DA + DA.DY$$

Where, DP = Production difference

Y<sub>o</sub>.DA = Policy affect

A<sub>o</sub>.DY = Technology affect

DA.DY = Interaction affect of Policy and Technology

## RESULTS AND DISCUSSION

### Magnitude of Growth

A perusal of Table 1 reveals that in India, the country as a whole, during the period-1, growth in yield (1.30%) contributed more towards growth in production (1.99%) than by growth in area (0.68%). In majority of the states (Seven out of 10 major states) growth in yield contributed more than growth in area towards growth in production, however, *vice versa* was noticed in Punjab, Maharashtra and Karnataka. Growth rates in area ranged between - 0.50% (Maharashtra) and 2.72% (Punjab), in production it ranged between - 2.54% (Odisha) and 6.39% (Bihar) and in yield it ranged between - 2.56% (Odisha) and 5.95% (Bihar).

During the period-II, for the country as a whole, growth in yield (1.61%) contributed more towards growth in production (1.59%) than by growth in area (- 0.02%). Among the states, except Andhra Pradesh, West Bengal, Bihar and Karnataka, growth in yield had higher affect on the growth in production than by growth in area. Growth rates in area ranged between - 0.8% (Bihar) and 1.47% (Karnataka), in production it ranged between - 0.80% (Tamil Nadu) and 4.7% (Odisha) and in yield it ranged between - 0.30% (Tamil Nadu) and 4.72% (Odisha).

**Table 1:** Compound Growth Rates (%) of area, production and yield of paddy in different states of India

| States               | Period - I<br>(1990-91 to 1999-2000) |            |        | Period - II<br>(2000-01 to 2009-10) |            |        | Period - III<br>(2010-01 to 2014-15) |            |        |
|----------------------|--------------------------------------|------------|--------|-------------------------------------|------------|--------|--------------------------------------|------------|--------|
|                      | Area                                 | Production | Yield  | Area                                | Production | Yield  | Area                                 | Production | Yield  |
| Uttar Pradesh        | 1.15                                 | 3.67       | 2.49   | - 0.44                              | 0.09       | 0.53   | 0.63                                 | 1.95       | 1.31   |
| West Bengal          | 0.62                                 | 1.74       | 1.11   | - 0.02                              | 0.79       | 0.81   | 1.84                                 | 1.05       | 2.91   |
| Madhya Pradesh       | 0.73                                 | 0.37       | - 0.35 | - 0.63                              | 3.88       | 4.55   | 2.90                                 | 6.27       | 3.27   |
| Bihar                | 0.41                                 | 6.39       | 5.95   | -0.80                               | 0.02       | 0.83   | 5.11                                 | 6.95       | 11.26  |
| Odisha               | - 0.02                               | - 2.54     | - 2.52 | - 0.02                              | 4.70       | 4.72   | 0.15                                 | 6.83       | 6.68   |
| Andhra Pradesh       | 0.69                                 | 1.93       | 1.23   | 1.17                                | 2.51       | 1.32   | - 3.73                               | - 4.06     | - 0.34 |
| Punjab               | 2.35                                 | 2.32       | - 0.03 | 0.89                                | 2.67       | 1.76   | 0.56                                 | 1.16       | 0.60   |
| Tamil Nadu           | 0.34                                 | 1.17       | 0.83   | 0.22                                | - 0.08     | - 0.30 | - 2.16                               | - 1.36     | - 3.49 |
| Maharashtra          | - 0.66                               | 1.95       | 2.63   | - 0.03                              | 1.46       | 1.49   | 0.88                                 | 2.75       | 1.85   |
| Karnataka            | 1.28                                 | 2.75       | 1.45   | 1.47                                | 2.67       | 1.18   | - 3.48                               | - 11.02    | - 7.81 |
| North Eastern States | 0.07                                 | 1.29       | 1.22   | - 0.58                              | 0.13       | 0.71   | - 0.55                               | 1.54       | 2.10   |
| Other States         | 1.43                                 | 2.28       | 0.84   | 1.21                                | 3.34       | 2.10   | - 8.20                               | - 6.60     | 1.73   |
| INDIA                | 0.68                                 | 1.99       | 1.30   | - 0.02                              | 1.59       | 1.61   | 0.61                                 | 1.42       | 2.04   |

**Table 2:** Coefficient of variation (%) in area, production and yield of paddy in different states of India

| States               | Period - I<br>(1990-91 to 1999-2000) |            |       | Period - II<br>(2000-01 to 2009-10) |            |       | Period - III<br>(2010-01 to 2014-15) |            |       |
|----------------------|--------------------------------------|------------|-------|-------------------------------------|------------|-------|--------------------------------------|------------|-------|
|                      | Area                                 | Production | Yield | Area                                | Production | Yield | Area                                 | Production | Yield |
| Uttar Pradesh        | 4.02                                 | 11.89      | 8.71  | 8.72                                | 10.87      | 6.73  | 1.90                                 | 6.18       | 4.68  |
| West Bengal          | 2.33                                 | 6.04       | 4.57  | 3.0                                 | 5.38       | 3.49  | 4.27                                 | 6.13       | 2.17  |
| Madhya Pradesh       | 2.42                                 | 11.05      | 11.02 | 2.43                                | 23.27      | 22.95 | 4.57                                 | 9.95       | 5.54  |
| Bihar                | 4.05                                 | 20.74      | 19.35 | 7.12                                | 22.72      | 17.64 | 11.78                                | 30.16      | 22.21 |
| Odisha               | 1.21                                 | 12.54      | 12.90 | 1.57                                | 20.89      | 20.24 | 2.42                                 | 12.97      | 12.03 |
| Andhra Pradesh       | 7.11                                 | 10.83      | 5.71  | 15.06                               | 18.71      | 6.65  | 10.79                                | 8.97       | 3.18  |
| Punjab               | 8.36                                 | 8.71       | 3.78  | 3.41                                | 8.50       | 5.67  | 1.01                                 | 3.06       | 2.66  |
| Tamil Nadu           | 4.70                                 | 12.29      | 9.73  | 12.39                               | 24.25      | 14.95 | 9.63                                 | 21.48      | 13.91 |
| Maharashtra          | 2.40                                 | 7.47       | 9.20  | 1.66                                | 16.07      | 15.15 | 2.25                                 | 5.79       | 3.99  |
| Karnataka            | 4.95                                 | 9.39       | 4.95  | 10.94                               | 25.29      | 18.56 | 7.41                                 | 44.89      | 42.37 |
| North Eastern States | 1.55                                 | 4.75       | 3.94  | 3.68                                | 7.64       | 5.14  | 2.33                                 | 2.72       | 4.09  |
| Other States         | 4.68                                 | 7.56       | 3.42  | 7.03                                | 14.79      | 10.96 | 22.77                                | 20.70      | 3.00  |
| INDIA                | 2.43                                 | 6.71       | 4.61  | 3.35                                | 8.80       | 6.82  | 1.61                                 | 3.52       | 4.21  |

During the period - III, for the country as a whole, growth in yield (2.04 %) contributed more towards growth in production (1.42%) than by growth in area (0.61%). Among the states except Andhra Pradesh, growth in yield had higher affect on the growth in production than by growth in area. Growth rates in area ranged between - 3.73% (Andhra Pradesh) and 5.11% (Bihar), in production it ranged between - 11.02% (Karnataka) and 6.95% (Bihar) and in yield it ranged between - 7.81% (Karnataka) and 11.26% (Bihar).

Rao (2005) stated that during the period 1980-81 to 2001-02 in Andhra Pradesh, India, growth in

production was non-significant. But the silver line on dark cloud is that growth rates in productivity were more than growth rate in area. Similar results were found in the present study on considering the country as a whole.

### Extent of Instability

During the period - I, for the country as a whole, instability in yield (4.61%) had higher affect on production fluctuations (6.71%) than variability in area (2.43%) (Table 2). In majority of the states instability in yield in relation to variability in area had higher affect on production fluctuations.



Instability in area ranged between 1.21% (Odisha) and 8.36% (Punjab), in production it ranged between 6.04% (West Bengal) and 20.74% (Bihar) and in yield it ranged between 3.78% (Punjab) and 11.02% (Madhya Pradesh).

Similar trend was noticed in period – II also where the country as a whole showed that instability in yield (6.82%) had higher affect on production fluctuations (8.80%) than variability in area (3.35%). Among the states, from period - I to period - II production was more de-stabilized. Further, yield variability in many states are higher in period – II than period – I. Instability in area ranged between 1.66% (Maharashtra) and 15.06% (Andhra Pradesh), in production it ranged between 5.38% (West Bengal) and 25.29% (Karnataka) and in yield it ranged between 3.49% (West Bengal) and 22.95% (Madhya Pradesh).

During the period – III, for the country as a whole, instability in yield (4.21%) had higher affect on production fluctuations (3.12%) than variability in area (1.61%). Among the states, from period - I to period - II production was more stabilized. Further, yield variability in many states are higher in period – II than period – III. Instability in area ranged between 1.01% (Punjab) and 11.78% (Bihar), in production it ranged between 3.06% (Punjab) and 30.16% (Bihar) and in yield it ranged between

2.17% (West Bengal) and 5.54% (Madhya Pradesh).

### Extent of Policy and Technology factors affect on Production

During period –I, technology (66.74%) had higher affect on production variability than policy affect (29.32%) and interaction affect (3.93%) in India (Table 3). Similar trend was noticed in major states (eight out of 10 states). Among the states, magnitude of technology affect was highest in Maharashtra (119.32%) and lowest in Punjab (9.14%). Influence of policy factors on production was highest in Punjab (88.03%) and lowest in Maharashtra (- 15.32%). Similar results were also observed in findings by Rao et al. (1981).

During the period – II, for the country as a whole, technology affect (244.24%) had higher affect on production variability than policy affect (- 128.98%) and interaction affect (- 15.26%). In majority of the states (seven out of 10 states) policy measures had dominance over technology efforts on production differential. This phenomenon is in contrast to period – I. Highest technology affect (124.22%) and Lowest policy affect (- 20.82%) were noticed in Maharashtra and Lowest technology affect (- 73.82%) and Highest policy affect (165.05%) were noticed in Uttar Pradesh. Thus, in majority of the states there was a shift from technology dominance

**Table 3:** Policy and Technology Affect (%) on change in Rice production in different states of India

| States               | Period - I<br>(1990-91 to 1999-2000) |                   |                    | Period - II<br>(2000-01 to 2009-10) |                   |                    | Period - III<br>(2010-01 to 2014-15) |                   |                    |
|----------------------|--------------------------------------|-------------------|--------------------|-------------------------------------|-------------------|--------------------|--------------------------------------|-------------------|--------------------|
|                      | Policy Affect                        | Technology Affect | Interaction Affect | Policy Affect                       | Technology Affect | Interaction Affect | Policy Affect                        | Technology Affect | Interaction Affect |
| Uttar Pradesh        | 30.36                                | 62.20             | 7.64               | 165.05                              | - 73.82           | 8.74               | 4.53                                 | 53.78             | 1.69               |
| West Bengal          | 41.92                                | 46.57             | 3.51               | 23.30                               | 74.04             | 2.66               | 69.85                                | 27.72             | 2.42               |
| Madhya Pradesh       | 20.19                                | 76.49             | 3.32               | - 10.93                             | 118.76            | - 7.83             | 48.17                                | 46.12             | 5.70               |
| Bihar                | - 3.64                               | 105.67            | - 2.02             | 65.71                               | 41.86             | - 7.57             | 24.95                                | 55.95             | 19.10              |
| Odisha               | - 5.36                               | 104.13            | 1.23               | - 3.11                              | 104.74            | - 1.63             | - 6.53                               | 108.05            | - 1.52             |
| Andhra Pradesh       | 13.22                                | 85.09             | 1.69               | 122.64                              | - 27.92           | 5.28               | 106.42                               | - 8.04            | 1.59               |
| Punjab               | 88.03                                | 9.54              | 2.44               | 32.16                               | 63.21             | 4.62               | 89.32                                | 10.45             | 0.23               |
| Tamil Nadu           | 15.21                                | 83.0              | 1.79               | 48.82                               | 57.68             | - 650              | 520.95                               | - 446.91          | 25.96              |
| Maharashtra          | - 15.32                              | 119.31            | - 3.99             | - 20.82                             | 124.22            | - 3.40             | 23.44                                | 74.93             | 1.63               |
| Karnataka            | 45.27                                | 47.90             | 6.83               | - 6.00                              | 105.74            | 0.26               | 89.95                                | 11.67             | - 1.62             |
| North Eastern States | 18.51                                | 79.04             | 2.45               | - 40.19                             | 145.09            | - 4.89             | - 19.24                              | 121.09            | - 1.86             |
| Other States         | 62.32                                | 32.91             | 4.76               | 15.84                               | 81.89             | 2.28               | 118.54                               | - 28.19           | 9.65               |
| INDIA                | 29.32                                | 66.74             | 3.93               | - 128.98                            | 244.24            | - 15.26            | 29.41                                | 68.59             | 2.00               |



on production differential in Period – I to policy dominance in Period – II.

During the period – II, for the country as a whole, technology affect (68.59%) had higher affect on production variability than policy affect (29.45%) and interaction affect (2.00%). In majority of the states (seven out of 10 states) policy measures had dominance over technology efforts on production differential. Both Highest technology affect (108.05%) and Lowest policy affect (- 6.53%) and Lowest technology affect (- 446.91%) and Highest policy affect (520.95%) were in noticed Odisha.

Hazell (1984) revealed that the growth in crop production during the post-green revolution period in India has been accompanied with increased instability and yield fluctuation turned out to be the major source of production instability. The present study results are in conformity with reference.

## CONCLUSION

Growth in area and production were higher during period – I and in yield it was noticed during period – III when compared to the other two periods.

Instability was higher in period- II than the other two periods in area, production and yield.

Technology affect on production was higher than by policy affect in all the periods: magnitude was higher during period - III.

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