



## Trend analysis of production and yield of major crops over South Bengal, India during last six years

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### Abstract

*This paper has analyzed the growth rate of production, yield and trend of cultivated area under traditional crops of Aman, Boro, Aus and Mustard seed over the West Bengal. A time series data on these crops were used for six years (2011-2017) along with their selected character. Data sets of consecutive period has been considered and collected from Bureau of Applied Economics and Statistics, Government of West Bengal. Slope coefficient of considered time series has been measured for both instantaneous growth rate and compound growth rate (Semi –log model) for area, production and dry yield. The results show that, the area under traditional paddy cultivation has decreased. While, the production and dry yield of these crops have increased during the considered period. Comparatively, the percentage of instantaneous growth as well as compound growth has increased for this period. It clearly indicates that, the production and yield have increased for paddy crop but the trend in area has decreased due to increase of Ravi crop variety.*

**Keywords:** Growth trend of agro-product, semi-log model, yield management.

### Introduction

Rapid growth of population of India is one of the major structural threats of today. All the economical growth, development policies etc are concentrated on that matter. Many social scientists are trying their best efforts to find out the smooth way to serve the increasing population. Undoubtedly, agricultural production is the backbone of our society. Wide spread fertile land in our country helps us to fulfill the requirements as well as additional food demand through time. Analysis of agricultural production, yield, practice trend etc are introduced by the different scientist by different dimension for the betterment of food security as well as economic strength of the entire society. So it is earnestly necessary to analyze the cropping pattern and production related components in regional scale. Different scientists have suggested some meaningful and scientific way by their regional investigations<sup>1</sup>. These meaningful suggestions can help the policy makers to attending the sustainable development of the entire society<sup>2</sup>. Societal demand has been increased day by day, so these types of investigation or regional study always drag some fruitful indicators regarding sustainable increase of food grain production<sup>3</sup>. Presently, the acquisition of agricultural land has also additional process due to construction of modern rural society and ultimately, the gross and neat production significantly decreases. So, for the sustained agricultural growth factors, gross resource management cannot make balance to the demand and supply. Thus, the imbalance augment is a growing concern in every rural economy in present day. Trading system, commercial agriculture practice, mixed farming etc. are the secondary associated activities in rural economic society<sup>4</sup>.

So the marginal farmers become bounded to reduce the stress of personal economy and forced to produce more products from their own land. By this way, the sectoral contributions of GDP of the entire population make balance in income disparity between the agricultural and non-agricultural sectors<sup>5</sup>. The vogue of developed countries indicates that the alteration of labour efficiency from agricultural sectors to non-agricultural sectors had increased productivity growth in agriculture sectors and hence higher income also<sup>6</sup>. Every agricultural dependent economic sector always needs higher growth of production, because it is the backbone of their society<sup>7</sup>. On the other hand rural sectors become reaching in respect to their annual income. If proper policy should be implemented by the researchers or policy makers, showing the fruitful outcome, then the entire society should be developed gradually<sup>8-11</sup>. The economic base of the West Bengal also depends upon the conventional agriculture practice and production. Most of the districts of West Bengal are made up by fertile alluvial soil. So agriculture is being practiced intensively over these districts and it's considered as primary activity from the beginning stage of the society. Presently, the agriculture contributes a large economic portion by more production and more yield.

Rapid changing nature of surface topography, potential components of soil, food demand etc. are not maintained their balance everywhere, So an analysis or investigation of the nature of agricultural production in the recent past and estimates of its functional growth rates can take steps a basis for future trend line of agricultural output<sup>12</sup>. This paper endeavors to analyze the changes characters, trends and growth in area under cultivation, production and dry yield as also contribution of

different elements to the growth of major cash crops or non cash crops output in West Bengal.

### Methodology

To conduct this work, some continuous agro based data were considered during last six years (2011-2017). These time series data were collected from Bureau of Applied Economics, Government of West Bengal<sup>13</sup>. However, varieties of major crops like paddy (Aman, Boro and Aus) and mustard seeds production, yield and cropped area were considered for this work. Because, these types of crops are more significant for this region as well as their productions are very high in amount. By following the semi-log trend functions were applied to find out the recent trend and estimate the magnitude of growth rate for area, production and dry yield of considered crops of West Bengal by applying following formula:

$$\ln Z = \beta_0 + \beta_1 X + e \tag{1}$$

Where:  $Z$  = dependent variable (for Area, production and dry yield);  $X$  = trend over considered time period;  $\beta_1$  = coefficient of trend,  $\ln$  = natural logarithm, and  $e$  = error.

By this formula the coefficient value of trend ( $\beta_1$ ) measures the constant proportional relation or relative change in  $Z$  for a given absolute change in respect to the value of the regressor  $X$ .

$$\text{Here also } \beta_1 = \frac{\text{Relative change in regressand}}{\text{Absolute change in regressor}} \tag{2}$$

If 100 multiply with the relative change in  $Z$ , it give the change of percentage of the growth rate. So, 100 times  $\beta_1$  value gives the actual or absolute growth rate in  $Z$ .

In this method, 100 times  $\beta_1$  is refers to the semi-elasticity characteristics of  $Z$  in respect of  $X$ . Finally, by the following statistic the instantaneous (at a point in time period) rate of growth and the compound (over the considered period of time) rate of growth were calculated.

$$\beta_1 = \ln(1 + r) \tag{3}$$

Where:  $\beta_1$  = Instantaneous rate of growth in percentage (%), for each three categories,  $\ln$  = natural logarithm and  $r$  = Compound

rate of growth in percentage (%). Moreover, 1 subtracts from antilog of  $\beta_1$  and multiply the difference by 100 gives compound rate of growth in percentage (%).

### Results and discussion

Paddy and mustard are the traditional agricultural practice in West Bengal. Depending upon the changing trend of food demand, the farmers have been practicing different varieties of paddy in most of the districts such as Purba Medinipur, Paschim Medinipur, Haora, Hooghly Burdwan, Murshidabad, Birbhum, North and South Dinajpur, Kochbihar, North and South 24 Pargana etc. Aman, Boro and Aus are the common seasonal paddy in West Bengal. Modern hybridization, physical changes of land characters and climatic change have been leading this practice to some extent. This paper emphasizes on to estimate the trends of changing area, production and dry yield for the traditional agriculture in West Bengal.

So, only paddy (Aman, Boro and Aus) and Mustard are considered for this work. The cultivated area, production and dry yield of Aman paddy since 2011-2017 are given in Table-1. It indicates that the production of Aman paddy is being increased every year.

The initial production amount of Aman paddy exhibits 10259.384 (000, tonnes) in 2011-2012 session, while in 2016-2017 session, the production increased by 2108.175 (000, tonnes). Similarly, the dry yield rate (kg/hect) also increases every year. On the other hand, if we look into the area for this cultivation, it has revealed that, the trends of area fluctuate during the considered period. The database of Boro paddy is given in Table-2. This seasonal paddy production amount is most among other three seasonal productions. Presently, Boro paddy is considered as commercial one in West Bengal. This database also represent the same results like Aman paddy. This seasonal cultivation is much popular because its yield is very high and it takes short period of time than the others. The average increase in production of Boro paddy is near about 300-350 (000, tonnes) each year. Similar types of results are shown for the Aus paddy and Mustard seed, which are given in Table-3 and 4. For these three cases, the trend of area gets decreased while the production and dry yield get increased.

**Table-1:** Area, production and dry yield of Aman paddy in West Bengal (2011-2017)<sup>13</sup>.

Considered Crop	Crop year	Cultivated Area (000' hect)	Production (000, tonnes)	Dry yield rate (kg/hect)
Aman Paddy	2011-12	3999.653	10259.384	2565.07
	2012-13	4010.973	10410.533	2595.51
	2013-14	4016.656	10545.076	2625.34
	2014-15	4008.662	10983.992	2741.06
	2015-16	3561.248	11824.033	2814.12
	2016-17	3410.589	12367.559	2948.56

**Table-2:** Area, production and dry yield of Boro paddy in West Bengal (2011-2017)<sup>13</sup>.

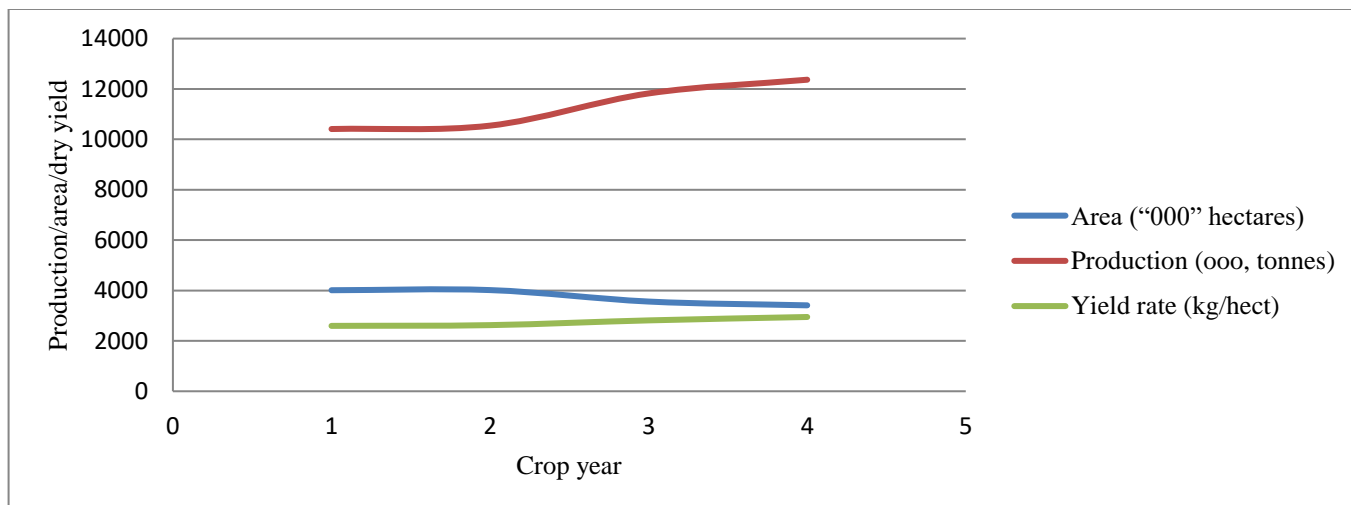
Considered Crop	Crop year	Cultivated Area (000' hect)	Production (000, tonnes)	Dry yield rate (kg/hect)
Boro Paddy	2011-12	1221.076	3875.10	3172.51
	2012-13	1228.263	4065.05	3309.59
	2013-14	1286.995	4338.142	3370.75
	2014-15	1290.020	4351.753	3373.40
	2015-2016	1120.321	4441.254	3465.221
	2016-2017	1024.647	4329.214	3521.014

**Table-3:** Area, production and dry yield of Aus paddy in West Bengal (2011-2017)<sup>13</sup>.

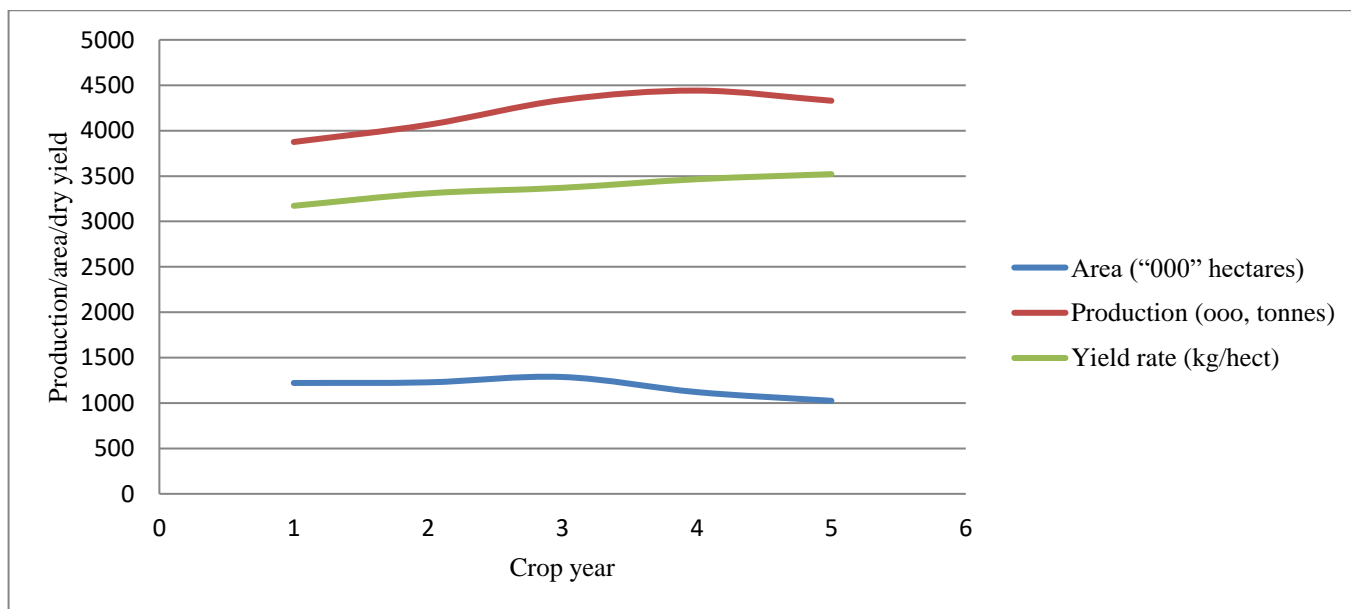
Considered Crop	Crop year	Cultivated Area (000' hect)	Production (000, tonnes)	Dry yield rate (kg/hect)
Aus Paddy	2011-12	212.971	471.28	2212.89
	2012-13	205.082	471.150	2297.38
	2013-14	210.036	493.651	2350.33
	2014-15	227.829	591.451	2596.04
	2015-2016	187.256	624.335	2861.21
	2016-2017	181.258	634.018	2934.08

**Table-4:** Area, production and dry yield of Mustard Seed in West Bengal (2011-2017)<sup>13</sup>.

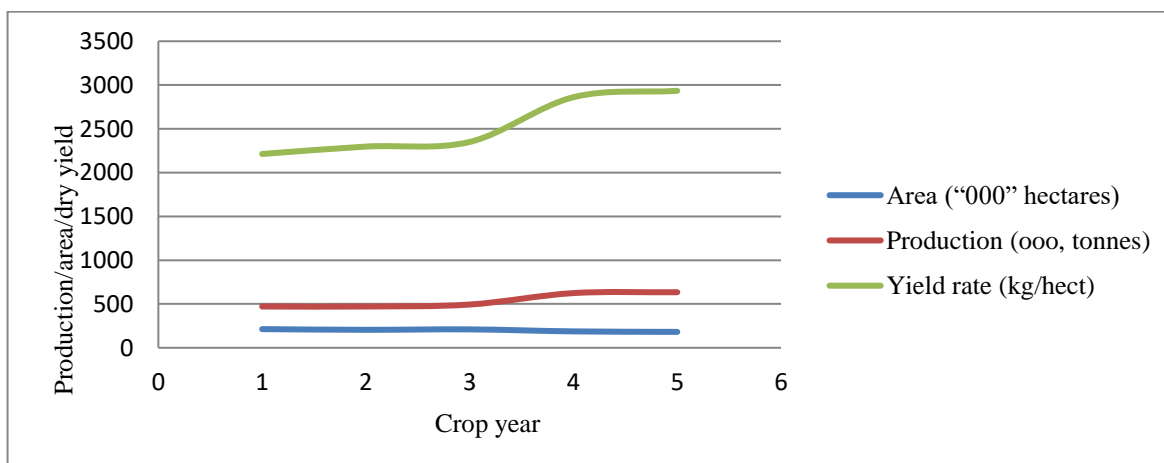
Considered Crop	Crop year	Cultivated Area (000' hect)	Production (000, tonnes)	Dry yield rate (kg/hect)
Mustard Seed	2011-12	419.473	380.914	908.08
	2012-13	446.918	474.832	1062.46
	2013-14	448.591	478.084	1065.75
	2014-15	448.602	479.647	1069.20
	2015-2016	425.251	488.325	1072.28
	2016-2017	411.214	510.487	1098.35



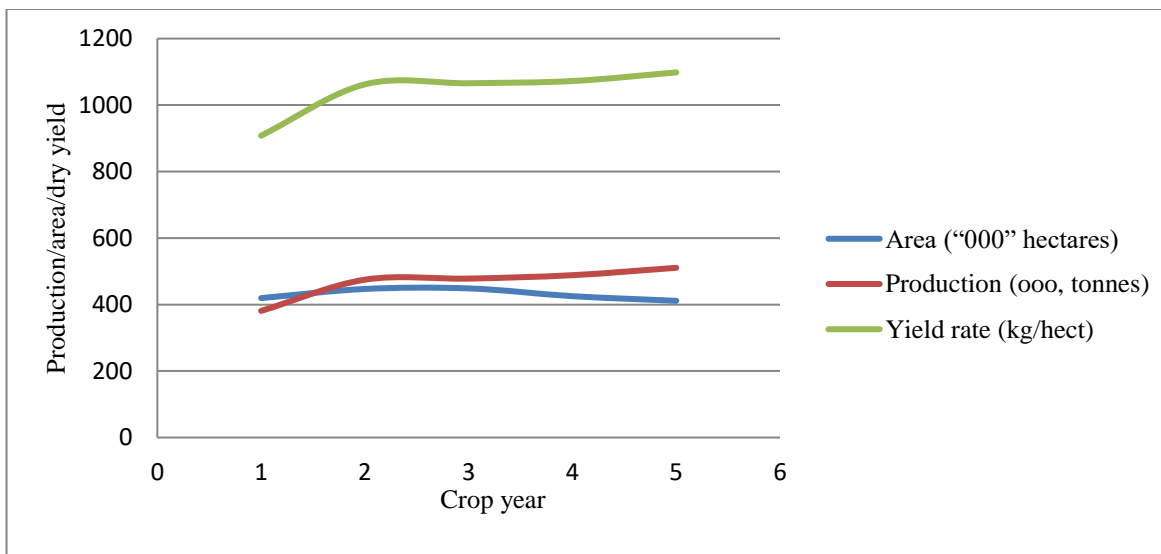
**Figure-1:** Trends of area, production and dry yield of Aman paddy (2011-2017).



**Figure-2:** Trends of area, production and dry yield of Boro paddy (2011-2017).



**Figure-3:** Trends of area, production and dry yield of Aus and Mustard seed (2011-2017).



**Figure-4:** Trends of area, production and dry yield of Mustard seed (2011-2017).

The results of semi-log model for trend of area, production and dry yield of Aman paddy, Boro paddy, Aus paddy and Mustard seed (dry crop) are given in Table-5, Table-6, Table-7 and Table-8 respectively. *F*-statistics also used to identify the significant level of trend of area, production and dry yield of different seasonal paddy crops as well as Mustard seed (dry crop) in West Bengal. The result reveals that, trend coefficient for Aman paddy production and dry yields are positive. For this analysis only trend in growth area indicates negative coefficient for Aman paddy. The *F*-statistic of Aman paddy (Table-5) indicates that, trends of area and dry yield are significant at considered confidence level ( $p \leq 0.01$ ) and the production of Aman paddy indicates significant value at considered confidence level ( $p \leq 0.05$ ). *T*-statistic also indicates that, the trend of area and capacity of dry yield are significant at 1% level of confidence, while production of the considered period also indicates significant at 5% level of confidence. Growth rate is one of the important components of agriculture in West Bengal. That component is also statistically analyzed here. The instantaneous growth rate and compound growth rate indicate remarkable and for instantaneous growth rate of production and dry yield are increased by 0.61 and 0.80 percent respectively. On the other hand compound growth rate of production and dry yield are same to the instantaneous growth rate. The results of semi-log model for Boro paddy is given in Table-6. The results reveal that, trend in area, production and dry yield are significant at chosen confidence level ( $p \leq 0.05$ ) after employed the *F*-statistic.

The trend coefficient for area is negative, while production and dry yield indicate positive trend for this crop. Corresponding *t*-statistic also indicates the same results as indicated by *F*-statistic. Instantaneous growth rate and compound growth rates are decreasing for area, while both these growths for production and dry yield indicate increasing percentage (0.60 & 0.80 percent respectively.). The semi-log model result of Aus paddy

has been given in Table-7. This result is also almost identical to other two types of crops. Trends of area, production and yield are significant at considered confidence level ( $p \leq 0.05$ ). In respect of *t*-statistic, only dry yield is significant at considered confidence level ( $p \leq 0.05$ ). While other two categories like trend of area and production indicate statistically significant values at considered confidence level ( $p \leq 0.01$ ). One another agricultural practice has been considered here Mustard seed: Because, this crop is being popularly cultivated over West Bengal and it is also a traditional one. The result of the crop is present in Table-8. Here, the trend coefficients are positive for all the categories such as area, production and dry yield. For the *F*-statistic, the statistic values are significant at considered confidence level ( $p \leq 0.05$ ) for all the considered categories and *t*-statistic indicate significant at considered confidence level ( $p \leq 0.01$ ) for production. On the other hand, dry yield indicates statistically significant at considered confidence level ( $p \leq 0.05$ ). The percentage of instantaneous growth rate and compound growth rate for both production and dry yields are increased during the considered period.

**Table-5:** Trend and nature of growth in area, production and dry yield of *Aman Paddy* during considered period (2011-2017).

Specifications	Cultivated Area	Production	Dry yield
<i>F</i> - statistic value	7.21**	6.47*	65.5**
Trend Coefficient value	-0.002	0.004	0.006
<i>t</i> - statistic value	-2.94**	3.15*	6.75**
Instantaneous growth rate in %.	-0.31	0.61	0.80
Compound growth rate in %.	-0.31	0.61	0.80

\*\*Significant at  $p \leq 0.01$  / \* significant at  $p \leq 0.05$  level of confidence.

**Table-6:** Trend and nature of growth in area, production and dry yield of *Boro Paddy* during considered period (2011-2017).

Specifications	Cultivated Area	Production	Dry yield
F- statistic value	8.14**	14.45**	47.5**
Trend Coefficient value	-0.002	0.005	0.008
t- statistic value	-4.45**	3.15*	7.54**
Instantaneous growth rate in %.	-0.40	0.60	0.80
Compound growth rate in %.	-0.40	0.60	0.80

\*\*Significant at  $p \leq 0.01$  / \* significant at  $p \leq 0.05$  level of confidence.

**Table-7:** Trend and nature of growth in area, production and dry yield of *Aus Paddy* during considered period (2011-2017).

Specifications	Cultivated Area	Production	Dry yield
F- statistic value	12.45**	3.56**	21.31**
Trend Coefficient value	-0.003	0.008	0.015
t- statistic value	-2.24*	2.01*	3.45**
Instantaneous growth rate in %.	0.20	1.20	1.30
Compound growth rate in %.	0.20	1.21	1.30

\*\*Significant at  $p \leq 0.01$  / \* significant at  $p \leq 0.05$  level of confidence.

**Table-8:** Trend and nature of growth in area, production and dry yield of *Mustard Seed* (Dry crop) during considered period (2011-2017).

Specifications	Cultivated Area	Production	Dry yield
F- statistic value	6.24**	52.32**	68.21**
Trend Coefficient value	0.004	0.018	0.021
t- statistic value	1.68	3.47*	5.24**
Instantaneous growth rate in %.	0.20	1.50	0.70
Compound growth rate in %.	0.21	1.50	0.71

\*\*Significant at  $p \leq 0.01$  / \* significant at  $p \leq 0.05$  level of confidence.

## Conclusion

The plain land of West Bengal is the gift of Ganga and Padma River. Mostly, huge alluvial deposits have made this more fertile. About 9 crore of population settle their habitat over West Bengal. So, the demand of food and agro-economic activities are more in this region. Cropping pattern has been changed through the time. After this research work, it has been established that, the compound growth rate and instantaneous growth rate have increased during the considered period. Most of the farmers are engaged with traditional paddy culture, but they are also habituated with the other vegetables cultivations

during spring and winter seasons. In this circumstance, the trend in area for paddy culture decreases day by day. While the production becomes high due to intensive and mixed agricultural practice. So, the yield per hectars indicates increasing trend.

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