ISSN: 2278-3369
International Journal of Advances in Management and Economics
Available online at www.managementjournal.info

RESEARCH ARTICLE

Yield of Principal Crops in India: Growth and Trends

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Abstract

India, which is one of the largest agricultural-based economies, has made impressive strides on the agricultural front during the past three decades. However, the yield rates for most of the agricultural products in India are far below comparable rates in a number of other countries. Present study is an effort to find the growth and trends of yield of principal crops in India and to generate the short term forecasts of yields of rice and wheat (principal crops) in India. The analysis shows that there has not been remarkable growth in the yield per hectare of the principal crops except cotton for the period 2001 -2014. The forecasts do not give an optimistic picture about growth of the principal crops in the years to come. An increase in agricultural investments, especially in research and development, is urgently needed to stimulate growth in yield per hectare.

Keywords: *Agricultural yield, Index number, principal crops, Compound Annual Growth Rate, Forecasts.*

JEL Classification C-22, F-21

Introduction

India, which is one of the largest agricultural-based economies, has made impressive strides on the agricultural front during the past three decades. Much of the credit for this success should go to the several million small farming families that form the backbone of Indian agriculture and Indian economy. During the pre-green revolution period, from independence to 1964-1965, the agricultural sector grew at annual average of 2.7 per cent. This period saw a major policy thrust towards land reform and the development of irrigation. With the green revolution period from the mid-1960s to 1991, the agricultural sector grew at 3.2 per cent during 1965-1966 to 1975-1976, and at 3.1 per cent during 1976-1977 to 1991-1992 [1]. As far as the agricultural productivity is concerned the rate of growth of productivity per hectare of all crops taken together increased from 2.07 per cent in the decade ending 1985-1986 to 2.51 per cent per annum during the decade ending 1994-1995. Similar evidence of an increase in yields is seen during the late nineties. Although productivity gains were sustained in the 1990s after the liberalization process began, the yield rates for most of the agricultural products in India are far below comparable rates in a number of other countries [2]. The average yield of rice in India is 2.3 tonne/ha as against the global average of 4.374 tonne/ha. China is the largest producer of rice with an output of 197 million tonne with a per-hectare yield of 6.5 tonne while countries like Australia (10.1 tonne), US (7.5 tonne), Russia (5.2 tonne) lead the tally. India has done better in wheat by achieving an yield closer to the global average. It has recorded an average yield of 2.9 tonne per hectare as against the global benchmark of 3.0 tonne/ha. However, it's still far from countries like France with 7.0 tonne, US with 3.11 tonne and China with 4.8 tonne. In many major crops, India's productivity performance seems to lag behind other countries [3].

Present study is an effort to find the growth and trends of yield of principal crops in India.

Objectives of the Study

The study has been conducted keeping in mind the following objectives:

- To measure the growth of yield of principal crops in India.
- To generate the short term forecasts of production of rice and wheat (principal crops) in India

Data Base and Methodology

The present study is based on secondary data and covers the period 2000-01 to 2014-15. The required data have been extracted from data taken from Directorate of Economics & Statistics (Department of Agriculture & Cooperation) and various issues of Economic Survey of India.

To study the present position of yield of principal crops in India, the compiled data has been arranged in the form of tables so that meaningful inferences can be drawn. To find growth rates following exponential regression model has been fitted [4].

$$Y_i = \beta_1 X_i^{\beta_2} e^{ui} \qquad \ldots\ldots(1)$$

In logarithmic form

$$\text{Log } Y_i = \text{Log } \beta_1 + \beta_2 \log X_i + u_i \qquad \ldots(2)$$

Where Y_i - dependent variable

X_i - independent variable

□ □ $\square_1$ and $\square_2$ are unknown parameters□

□ U - disturbance term.

Using the ordinary least square method, estimated values of □ □ $\square_1$ and □ $_2$ denoted by

$\hat{\beta}_1$ and $\hat{\beta}_2$ have been calculated. Compound annual growth rate (Gr_c) has been computed by taking the antilog of estimated regression coefficient, subtracting 1 from it and multiplying by 100[(4)]. [4]

$$Gr_c = \text{A.L.} (\hat{\beta}_2 - 1) \times 100 \qquad \ldots\ldots(3)$$

Since $\hat{\beta}_2$ is the estimate for $\square_2$

Forecasting Technique

For finding forecasts, univariate ARIMA model has been applied on the series of FDI inflows. With the help of this methodology, probabilistic values of FDI inflows to Asia and India have been calculated on the philosophy of 'let the data speak for themselves' [4]. Differenced first order i.e. ARIMA (1,1,1) has been adopted which followed the following equation for forecasting:

$$\hat{Y}_{(t)} - Y_{(t-1)} = \mu + \alpha (Y_{(t-1)} - Y_{(t-2)}) \qquad \ldots\ldots (4)$$

$$\hat{Y}_{(t)} = \mu + Y_{(t-1)} + \alpha (Y_{(t-1)} - Y_{(t-2)}) \qquad \ldots\ldots (5)$$

Where

$\hat{Y}_{(t)}$ = value to be forecasted

μ = constant

α = autoregressive coefficient

This is a first order autoregressive AR (1) model with one order of non seasonal differencing and a constant term. The adequacy of the model has been checked by auto correlation coefficient and L-Jung Q statistic. The autocorrelation [5] function has been used for the purpose of detecting non-randomness in data. Autocorrelations of residuals were worked out as under:

$$r_k(e) = \frac{\sum_{t=1}^{n-k} e_t \cdot e_{t+k}}{\sum_{t=1}^{n} e_t^2} \; ; k=1,2\ldots\ldots l \qquad \ldots\ldots(6)$$

Computed values of auto correlation coefficient, $r_k(e)$ and the lag k are displayed graphically to depict autocorrelation function (ACF) also known as correlogram. Residual ACF, which lies within the 95% interval taken as insignificant and insignificance of ACF, implies adequacy of the model to generate forecasts.

L Jung-Box Test has been selected to test multiple autocorrelation coefficients. This test is considered to find that the whole set of the values all at a time are significantly different from zero. Ljung-Box Q statistics was computed from the model's residuals by using the following equation:

$$Q = n(n+2)\sum_{k=1}^{L} r_k \frac{(e)^2}{n-i} \qquad \text{For } i = 1 \text{ to } k \quad (7)$$

Where Q is Portmanteau test statistic, n is the sample size, L is the number of lags being tested. Non-significance of Q test is taken to imply that the generated residuals could be considered as white noise, thereby indicating the adequacy of estimated model [6].

Discussion and Results

The study has been divided into two sections. Section I presents the growth rate of yield of principal crops in India and Section II presents short term forecasts of production of rice and wheat (principal crops) in India.

Section I

In the early 1950s, half of India's GDP came from the agricultural sector. By 2000, that contribution was halved again to about 25 per cent. As would be expected of virtually all countries in the process of development, India's agricultural sector's share has declined consistently over time as seen in the Table1.

Table 1: Share of agriculture sector in gross value added at factor Cost in India

Year	Percentage Share
1950	52.5
1960	43.6
1970	43
1980	37
1990	31
2000	25
2010	21

Source: Author's calculations on the basis of data in Economic Survey 2015

Table 2: Index number of yield of principal crops in India

Year	Index
2007-08	104.7
2008-09	103.4
2009-10	100.6
2010-11	110.9
2011-12	113.6
2012-13	113.9
2013-14	114.7

Note: Base Triennium ending 2007-10=100

Source: Economic Survey 2015 [7]

Table 2 highlights the index number of yield per hectare in India. It is evident from the table that the crop yield of principal crops in India has not increased much during the last few years.

Table 3: Growth rate of yield per hectare of principal crops in India

Group/ Commodity	CAGR 2001-2014
Food grains	2.20
Cereals	2.34
Pulses	2.44
Rice	1.97
wheat	1.35
Maize	3.00
Oilseeds	2.94
Groundnut	2.81
Sugarcane	0.66
Cotton	8.56

Source : Author's calculations based on data taken from

Directorate of Economics & Statistics. Dept. of Agriculture & Cooperation.

Table 3 depicts the calculated compound annual growth rate of yield per hectare in case of some principal crops in India. It is quite surprising to note that the growth rate in case of cotton is the highest (8.56) among these selected crops and that in case of sugarcane is the lowest to the tune of 0.66 during the period 2001 to 2014.The compound annual growth rate of food grains is 2.0 but in cases of rice and wheat which are the major constituents of food grains it is 1.97 and 1.35 respectively whereas for maize it is slightly better and is to the order of 3.00. In case of cereals CAGR is 2.34 and for pulses it is 2.44 during the same period. Two other principal crops namely oil seeds and ground nut the growth rates are 2.94 and 2.81. The analysis shows that there has not been remarkable growth in the yield per hectare of any principal crop except cotton.

Water shortage, absence of high-yield varieties of seeds and the lack of research and development are the basic causes behind the low per-hectare yield of crops in India. If production has to go up, yield must improve. For this, working on new areas of research like, stem cell research and nanotechnology is required.

Section II

Forecasting is a necessary input to planning. It can empower the planners because its use implies that they can modify the variable, now, to alter or to be prepared for future.

This enables them to formulate the economic policy which can affect the future value of variable the way, they wish it to be [8].

Adequacy of the Model

The adequacy of ARIMA model is ensured by computing auto correlation functions (ACF) of residuals and by applying Ljung-Box. The value of Q- statistics for rice equal to .577 is found to be insignificant at 5 percent level of significance and the value for wheat is found to be .289 . Both the Q-statistics are found to be non significant. The non-significance of Q- statistics ensures the adequacy of ARIMA model used to generate the forecasts. A careful glance of Fig.1 (for rice) and Fig.2 (for wheat) reveals that the residual ACF showed no pattern.

The coefficients were found to be non-significant as these were all (as a group) with in specified limits. This confirms the adequacy of forecasting model to make prediction regarding future yield per hectare of rice and wheat in India.

The forecasts of yield per hectare of rice and wheat for the period 2015-16 to 2018-2019 are depicted in Table No.4. The generated forecasts do not give an optimistic picture about growth of these principal crops in the years to come. The yield per hectare in case of rice may rise up to 2811.73 kgms in the year 2018-19 and that of wheat to 3688 kgms with expected compound rate of growth of 2.63 and 3.32 percent respectively [9-12].

Table 4: Forecasts of yield of rice and wheat in India

	Rice			Wheat		
Year	**Amount (Kg per hec)**	**UCL***	**LCL****	**Amount (Kg per hec)**	**UCL***	**LCL****
2014-15	2538.25	2763.33	2313.17	3232.98	3438.41	3027.54
2015-16	2585.68	2821.49	2349.86	3346.65	3561.1	3132.19
2016-17	2663.65	2903.32	2423.97	3455.24	3670.83	3239.66
2017-18	2734.02	2973.44	2494.6	3568.26	3783.95	3352.57
2018-19	2811.73	3051.39	2572.08	3688	3903.58	3472.42

Source: Author's calculations on the basis of Economic Survey 2015 data
*UCL Upper confidence limit **LCL Lower confidence limit

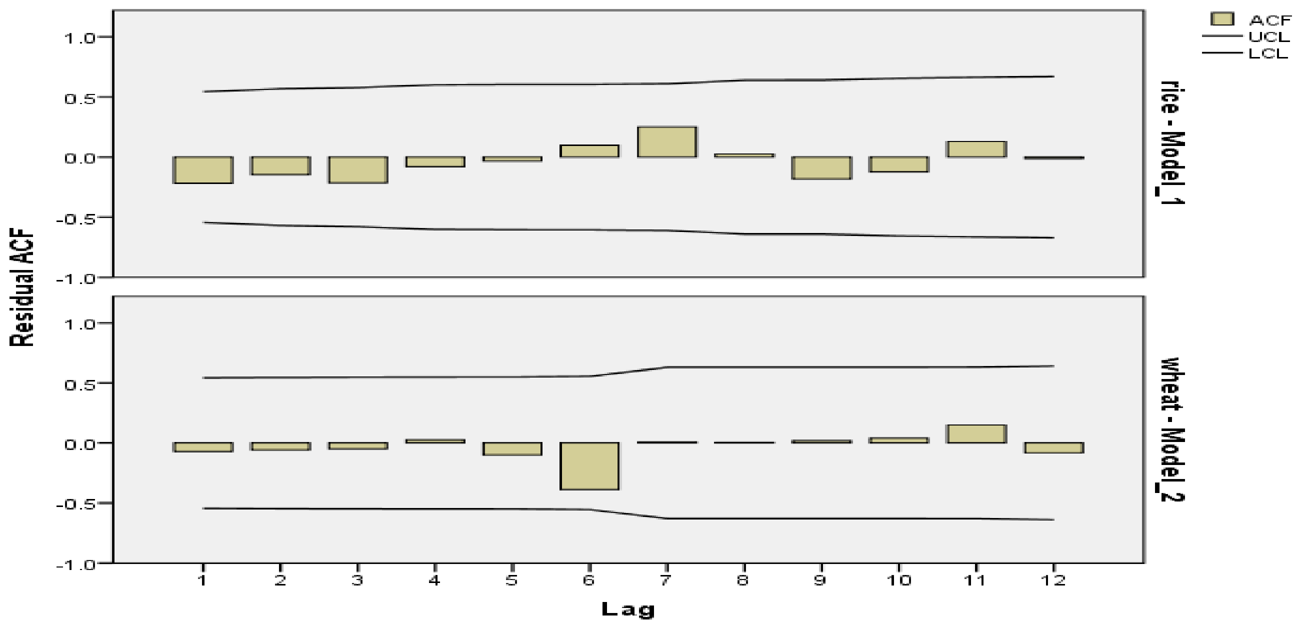

Figure 1, 2: Fig.1 (for rice) and Fig.2 (for wheat) reveals that the residual ACF showed no pattern

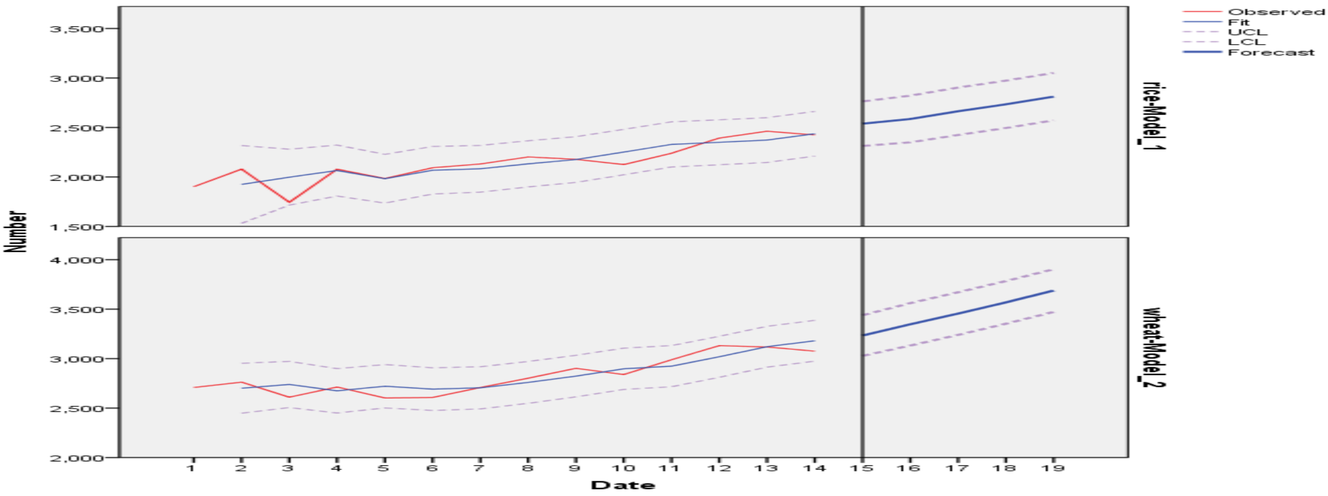

Figure 3, 4: Forecasting of yield per hectare of rice and wheat

Conclusion

The findings of the study have significant policy implications. An increase in agricultural investments, especially in research and development, is urgently needed to stimulate growth in yield per hectare. Recognizing that there are serious yield gaps it is highly pertinent for India to maintain a steady growth rate in yield per hectare. As the yield rate increases, the cost of production would decline and the market prices would stabilize at a lower level. Both the producers and consumers will benefit. The fall in food prices will benefit the urban and rural poor more than the upper income groups, because the former spends a much larger proportion of its income on cereals than that by the latter. Policy support, production strategies, public investment in infrastructure, research and extension for crop and livestock can significantly help in increasing the agricultural productivity, food production and its availability.

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