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PAST AND FUTURE TRENDS USING ARIMA MODEL IN AREA, PRODUCTION AND PRODUCTIVITY OF ONION IN MADHYA PRADESH

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ABSTRACTS

Onion (Allium cepa) family alliaceae is one of the most important commercial vegetables. It is grown in western, northern as well as in southern India. Maharashtra, Gujarat, Uttar Pradesh, Orissa, Karnataka, Tamilnadu, Madhya Pradesh, Andhra Pradesh and Bihar are Major onion growing states in India. India stands 2nd position in Onion production after China in the World. In India, Gujarat stands 2nd position in Onion cultivation after Maharashtra state. The productivity of Onion is 12580kg/Ha all over the India while In Gujarat state, the productivity is highest 22120 kg/ha.In present study to meet g the objective data covering the period of 1975-2011 was used. Onion is a cool season crop. However it can be grown under a wide range of climatic conditions. It grows well under mild climate without extreme heat or cold or excessive rainfall. Production behavior of onion, as visualized through area, production and yield follow mostly the cubic trend, thereby indicating more than one point of inflections. From the forecasted values (664.45 '000 MT), it can be said that in production of onion Madhya Pradesh will having decreasing trend. This forecast prevails for current market sentiments and monsoon and could vary with changes in the market situation

KEYWORDS: ARIMA, Forecasting, Instability, Modelling and Production

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Original Article

INTRODUCTION

Onion is one of the most important commercial vegetable crops in India. Maharashtra, Gujarat, Uttar Pradesh, Orissa and Andhra Pradesh are the major onion growing states. In India, however, its significance is defined not only by its essential role in the diets of millions of Indians, rich and poor, but also the resulting political significance. Additionally, there is also a lot of demand of Indian Onion in the world. Onion is mainly exported from India in the form of dehydrated onion, canned onion and onion pickle. Dehydrated onions are considered as a potential product in world trade and India is the second largest producer of dehydrated onions in the world. Madhya Pradesh is producing about 1298.44 thousand ton of onion from an area of 74.11 thousand ha. With productivity of 17.52 ton/ha in the year 2011 (Source: Indian Horticulture Database). Mishra *et al.*, (2013) attempted to forecast the area production and yield of onion in India up to 2020 using time series data of the area production and yield of onion for modeling purpose.

MATERIALS AND METHODS

Data related to area, production and yield of onion in Madhya Pradesh since 1975 to 2011 were collected from GoI 2011.various statistical measures, such as mean, skewness, standard error etc were worked out.; Box-Jenkins ARIMA modelling has been used to predict series under investigation.

Descriptive Statistics

Descriptive statistics are a set of brief descriptive coefficients that summarizes a given data set, which can either be a representation of the entire population or a sample. The measures used to describe the data set are measures of central tendency and measure of variability. Measures of central tendency include the mean, median and mode, while measures of variability include the standard deviation (or variance), the minimum and maximum variables. Descriptive statistics provide a useful summary of security returns when performing empirical and analytical analysis, as they provide a historical account of return behavior.

In this study also, we have tried different parametric models to describe the series under consideration, which are briefly given here under:

Linear Model: The equation of Linear model is given by $Y_t=b_0+(b_1t)$

Quadratic Model: The equation of Quadratic Model is given by $Y_t=b_0+(b_1t)+(b_2t^2)$

The quadratic model can be used to model a series which "takes off" or a series which "dampens".

Compound Model: The equation of compound model is given by $Y_t=b_0(b_1^t)$ Or

$\ln(Y_t)=\ln(b_0)+t\ln(b_1)$

Cubic Model: The equation of cubic model is given by $Y_t=b_0+(b_1t)+(b_2t^2)+(b_2t^3)$

Exponential Model: The equation of exponential model is given by $Y_t=b_0e^{(b1t)}$ Or

$\ln(Y_t) = \ln(b_0)+(b_1t)$

Logarithmic Model: The equation of logarithmic model is given by $Y_t=b_0+ b_1\ln(t)$

Growth Model: The equation of growth model is given by $\ln(Y_t) = b_0+b_1tY_t$

Where Y_t is the value of the series at time t and b_0, b_1, b_2, b_3 are the parameters.

Among the competitive models, best model for each of the series is fixed on the basis of maximum R^2, minimum standard error and the significance of the coefficient.

Box–Jenkins Models

With the formulation of Box-Jenkins methodology of modeling during seventies of last century, time series forecasting got tremendous boosting; which got further impetuous with the development of computer software's. The basic principle behind this methodology is that the present value of the series is any way related with its past values.

Autoregressive model

The notation AR (*p*) refers to the autoregressive model of order *p*. The AR(*p*) model is (Sahu and Mishra,2013)

$$X_t = c + \sum_{i=1}^{P} \rho_i X_t + \varepsilon_t$$

Where $\rho_1, \rho_2.....\rho_p$ are the parameters of the model, *c* is a constant and ε_t is white noise. Sometimes the constant term is avoided.

Moving Average Model

The notation MA (q) refers to the moving average series of order q:

$$X_t = \mu + \varepsilon_t + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i}$$

Where the $\theta_1,\ldots,\theta_q$ are the parameters of the model, μ is the expectation of X_t (often assumed to equal 0), and the $\varepsilon_t, \varepsilon_{t-1}$ …

A time series $\{X_t\}$ is stationary and if for every

t, $X_t - \phi_1 X_{t-1} - \ldots\ldots\ldots - \phi_p X_{t-p} = Z_t + \theta_1 Z_{t-1} + \ldots\ldots. + \theta_q Z_{t-q}$ where, $\{Z_t\} \sim WN(0,\sigma^2)$ and the polynomials $(1 - \phi_1 Z - \ldots\ldots\ldots - \phi_p Z^p)$ and $(1 + \theta_1 Z + \ldots\ldots. + \theta_q Z^q)$ have no common factors.

where p and q are respectively the AR and MA terms.

Model Formulation

The whole period under consideration (1975-2011) has been divided into two parts.

- The model formulation period (1975-2011).
- Model validation period (2010-2011).
- Forecasting period up to 2020.

Checking for Model Adequacy

Among the competitive Box- Jenkins model best model is selected on the basis of maximum R^2, minimum root mean square error (RMSE), minimum mean absolute percentage error (MAPE), minimum of maximum average percentage error (MaxAPE), minimum of maximum absolute error (MaxAE), minimum of Normalized BIC. Any model which has fulfilled most of the above criteria is selected. This section provides definitions of the goodness-of-fit measures used in time series modeling.

RESULTS AND DISCUSSIONS

Since 1975, the area under onion has been increased from 9.70 thousands ha to 74.11 million ha till 2011, registering a growth of almost 16.74% (Table 1).The average area under onion being 24.19thousands hectare. In fact the effect of green revolution is being reflected. The effect of expansion of area is clearly visible in the production scenario of onion.

Table 1: Summary Statistics of Onion Production in Madhya Pradesh During 1975-2011

	Area('000 ha)	Production (in '000 MT)	Yield (Ton/ha)
Mean	24.19	340.71	12.90
SE	2.52	47.06	0.36
Kurtosis	2.59	3.19	-0.26

Table 1: Contd.,			
Skewness	1.71	1.89	0.51
Minimum	9.70	103.90	8.48
Maximum	74.11	1298.44	17.52
SGR (%)	16.74	31.07	1.99

With an area 103.90 million tonnes of production it has reached to 1298.44 million tonnes during the year 2011 and registering growth of almost 31.07%. B2 (kurtosis) value (3.19) of production indicates there leptokurtic in nature. Starting with only 8.48 tonnes of onion per hectare, it has reached to 17.52tonnes / hectare

Trends in Production Behavior of Onion

Knowing the above overall performance, path of movement of the series was traced through parametric trends models (Table 2). A wide range of models could be fitted but among the comparative models the best fitted models were selected based on the maximum R2 values along with significance of coefficients. In most of the cases, the non-linear patterns are revealed (Figure 1). This may be due to the changes in policies and its execution at different point of times. Of course one cannot deny the heavy dependence of agriculture on agro-climatic fluctuation along with the changes in world market. To trace the nature of area, production and yield of onion using different models cubic was found best fitted.

Table 2: Trends in Area, Production and Yield of Onion in Madhya Pradesh

	Equation	R Square	F	Sig.	Constant	b1	b2	b3
Area	Cubic	0.964	296.311	0.000	5.642	2.117	-0.151	0.040
Production	Cubic	0.430	8.284	0.000	223.400	-35.787	2.933	-0.490
Yield	Cubic	0.817	49.107	0.000	10.582	0.120	-0.006	0.000

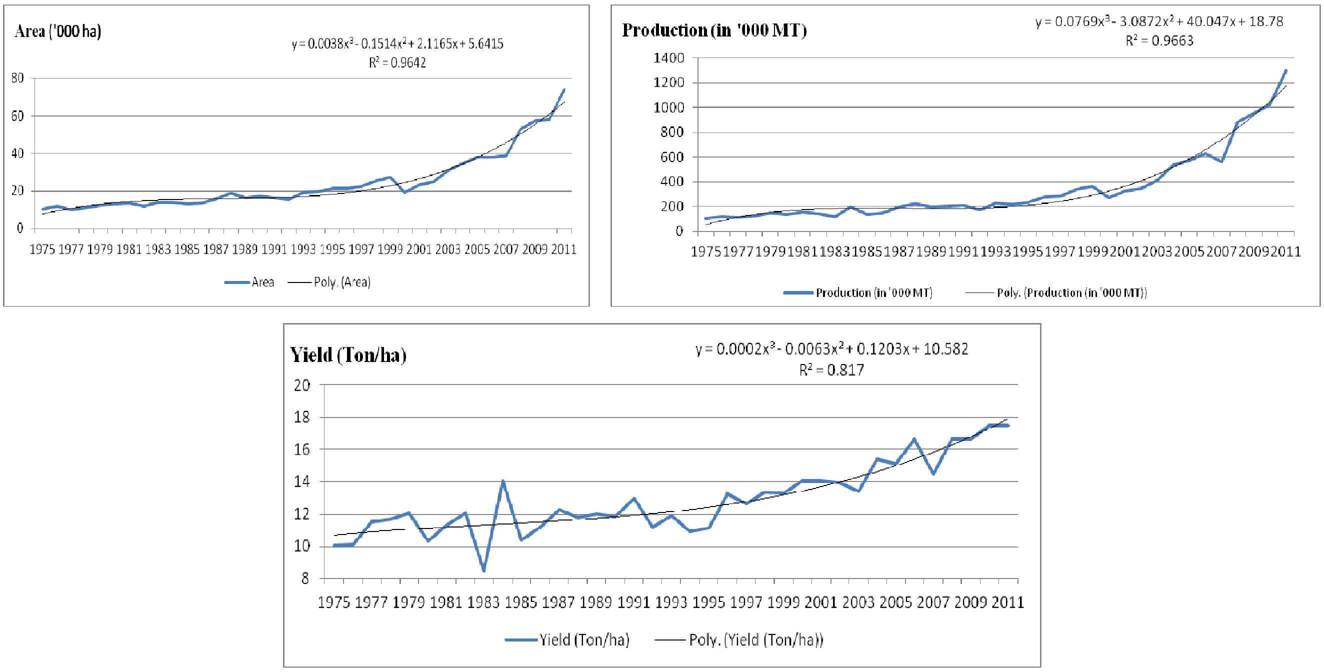

Figure 1: Trends in Area, Production and Yield of Onion in Madhya Pradesh

Box-Jenkins Modelling and Forecasting

After the study the trend of each and every series, our next task is to predict the series for the future. For the purpose of prediction of area, production and yield in onion Box –Jenkins methodology used. For meeting the objective in present investigation data of 1975-2011 was used, while years 2010 and 2011 are taken for prediction validation. For making the series stationary first order differencing required. Best fitted models are used to prediction the series for the future. Though different series has been fitted with different ARIMA models.In case of area of onion in Madhya Pradesh clear that table 3 reveals that ARIMA (1, 1, 1) model is best suited

Table 3: Model Selection Criteria for Area, Production and Yield of Onion in Madhya

ARIMA Model (p, d, q)		R^2	RMSE	MAPE	MAE	Max.APE	Max.AE	Normali Zed BIC
Area	(1,1,1)	0.939	3.964	11.142	2.618	49.490	10.773	3.153
Production	(1,1,5)	0.673	135.418	1319.074	73.020	44026.797	440.268	10.514
Yield	(0,1,5)	0.764	1.152	7.221	0.879	38.885	3.297	0.880

CONCLUSIONS

It is clear from the observed and predicated values, and also from the figures (Figure 2) that by and large the models have adequately been identified. From the forecast values obtained it can be said that forecasted area will increases to some extent in future and it would be 28.96thousands hectare during 2020. In case of production of onion the ARIMA (1, 1, 5). Model is best fitted, it can be said that predicted production would be 664.45 thousands million tones during 2020. Onion yield ARIMA (0, 1, 5) model is best fitted and predicted yield would be 19.44 tons per hectare in 2020 increases to some extent in future i.e. in 2011-12 production of onion was 17.46 tons per hectare. However, consumption and demand of onion is expected to exceed production in future as well, Thus, it calls for an increase in the supply of onion to fulfill the high demand of onion.

Table 4: Model Validation and Forecasting of Area, Production and Yield of Onion in Madhya Pradesh

Year	Area ('000 ha)		Production (in '000 MT)	Yield (Ton/ha)		
	Observed	**Predicated**	**Observed**	**Predicated**	**Observed**	**Predicated**
2010	58.30	64.14	1021.50	1012.00	17.52	17.21
2011	74.11	76.46	1298.44	1212.00	17.52	17.46
2015		101.60		592.20		18.47
2020		128.96		664.45		19.44

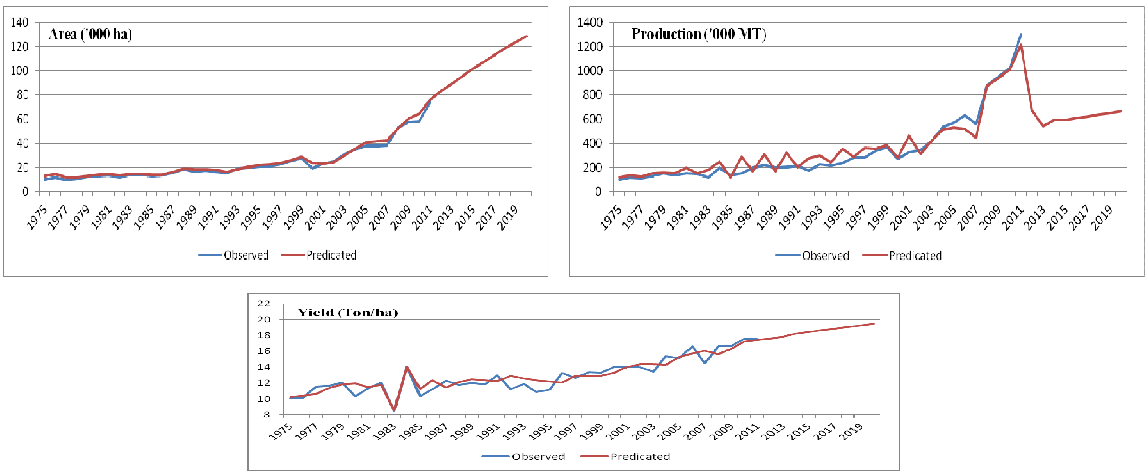

Figure 2: Observed and Forecasted of Area, Production and Yield of Onion of Madhya Pradesh

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