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SEASONAL VARIATIONS AND FORECASTING IN WHOLESALE PRICES OF RICE (PADDY) IN GUNTUR DISTRICT OF ANDHRA PRADESH

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ABSTRACT

The analysis of trends, seasonal variations and in market prices of rice in Guntur district and Andhra Pradesh and forecast the same for the period 1990-91 to 2009-10 collected from various published statistical bulletins. The seasonal variations in market prices and 12 months moving average method was used to construct the seasonal indices and Box-Jenkins model was used to forecast the future prices. The annual average wholesale price trends of rice from 1990-91 to 2009-10 has shown a significant increase over the years in both Andhra Pradesh and Guntur market. The annual increase in wholesale prices of rice in Andhra Pradesh was Rs. 44.53 per quintal where as in Guntur market it was Rs. 49.38 per quintal. The month wise seasonal index was lowest on the month of April, May and highest in the month of September, October in Andhra Pradesh and Guntur district respectively. Thus, the farmers could receive the better price by postponing the sale of produce during the month of January to June to later months of the year. The models selected for forecasting for whole sale price of rice was ARIMA (2, 2, 0) and ARIMA (0, 1, 1) in Andhra Pradesh and Guntur district respectively based on the Shwartz Bayes Criterion (SBC) and Akaike Information Criterion (AIC). The forecasts of rice wholesale prices were found to be fairly accurate and showed increased trends in both Andhra Pradesh and Guntur district.

INTRODUCTION

Rice is the one of the principle crops which forms a stable diet of the majority of the population in the country. The analysis of prices and market arrivals over time is important for formulating a sound agricultural price policy. Fluctuations in market arrivals largely contribute to the price instability of rice in the state. In order to device the appropriate ways and means for reducing the price fluctuations of agricultural commodities, there is a need to have through understanding of the price behaviour over time. In general major portion of the produce reaches the market during peak season, the prices generally rule low which depress the farmer's income to a great extent. Proper planning of disposing the produce by farmers alone can considerably increase their income without incurring much additional costs. On the demand side the instability in the prices of agricultural commodities is influenced by the number of factors such as annual variation in production, low price elasticity of demand and seasonality of agricultural production. The quantification of these aspects in the rice is immediate need to formulating effective policies to make prices stable there by safe guard the interest of the farmers as well as consumer. Such an analysis is also useful to the farmers in order to decide the optimum time for disposing the produce. Keeping in view the significance discussion and realizing the facts above the study is carried out with the following specific objectives.

- To estimate the trends in the market prices of rice.
- To examine the seasonal variations / fluctuations in the prices of rice.
- To forecast the future market prices of rice.

MATERIALS AND METHODS

Market: The agricultural markets selected for the study were Guntur market and Andhra Pradesh state level. The selection of the market was based on the availability of required time

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series data consistently for a long period and maximum quantity of average annual arrivals of rice crop.

Crop and time period: Rice crop was selected for the study on the basics of area production and importance of the food crop in state. The analysis performed on the basis of monthly and annual time series data on wholesale price over a period of twenty years from 1990-91 to 2009-10.

Data: The study was relied upon the secondary time series data on monthly market prices of rice were collected from the monthly administrative reports of Guntur Agricultural Market Committee and various statistics bulletins of published by the Directorate of Economics and Statistics, Hyderabad.

Analytical Frame Work

With a view to examine the various objectives stated above the following statistics tools were used. To analyze the trend and seasonal variations in rice market prices, multiplicative model of the following form was used.

$$Y = T \times C \times S \times I$$

Trends in Market Prices of Rice

To ascertain the general direction of movement of prices, the method of least square trend line was fitted for each selected markets.

The following equation was used

$$Y = a + bt$$

Where,

Y=Trend values for annual average price in rupees per quintal of rice.
a = intercept;
b=Regression coefficient.
t=Period from 1991-2012

Seasonal Variations

To analyze the seasonality in prices, there are many methods namely moving average method, link relative method, percentage to trend method were tried but moving average method gave stable, clear and definite seasonal variations and therefore this method was used. The relative seasonal fluctuations were calculated after eliminating the trends, cycle and irregular fluctuations with the help of following equation.

$$Y = \frac{T \times C \times S \times I}{T \times C \times I}$$

Where, Y = original data on monthly rice market prices
T = trend component
S = Seasonal variations
C = Cyclical component
I = Irregular variations

In this method firstly the effect of trend and cyclical variations (T×C) were removed from time series to get adjusted specific seasonal indices.

Thus,

$$\frac{T \times C \times S \times I}{T \times C} \times 100 = \text{Adjusted specific seasonal index}$$

Then the monthly averages of these adjusted specific indices were worked out to remove the irregular fluctuations and showing general pattern of seasonal variations alone. The monthly averages of all these months divided by average of monthly averages to estimate the seasonal indices.

$$\text{Seasonal indices} = \frac{\text{Monthly average each month}}{\text{Average of monthly averages}} \times 100$$

In this way seasonal indices were adjusted by the correction factor to make the total of all seasonal indices equal to 1200.

$$\text{Correction factor (K)} = \frac{1200}{\text{Sum of average indices for 12 months}}$$

Price forecasting model (ARIMA)

The Box-Jenkins' model is concerned with fitting of mixed Auto Regressive Integrated Moving Average (ARIMA) to a given set of time series data. For the present investigation ARIMA was used for predicting the future prices of rice in Andhra Pradesh and Guntur market. ARIMA models are quite flexible and can represent a wide range of characteristics of time series that occur in practice. Because of popularity, the ARIMA model has been used as benchmark to evaluate some new modeling approaches (Hwarng and Ang 2001). However, ARIMA is a general univariate model and it is developed based on the assumption that the time series being forecasted are linear and stationary. Box-Jenkins' methodology refers to set of procedures, namely identification, estimation, testing and application of ARIMA models with time series data. ARIMA model is used to produce the forecasts based on the autocorrelation patterns. The pattern of sample autocorrelation calculated from the time series is matched with the known autocorrelation pattern associated with the particular ARIMA model. The process of formulating of the fitted model is repeated until stationary model is found.

Step-I: Model identification (Selecting an initial model)

Determine whether the series is stationary or not by considering the graph of ACF. If a graph of ACF dies down extremely slowly, then the data should be considered non-stationary. If the series is not stationary, it can often be converted to a stationary series by differencing until the data shows scattered horizontally around a constant mean, or equivalently, the graph of ACF either cuts off fairly quickly or dies down fairly quickly. Once a stationary series has been obtained, then identify the form of model by using autocorrelation function (ACF) and partial autocorrelation function (PACF).

Step-II: Model Estimation and testing

Estimate the parameters for a tentative model has been selected. It is necessary to do diagnostic checking to verify the model is adequate. This is done through examining the ACF and PACF of the residuals of various orders.

The general model is ARIMA (p,d,q):
AR: p= order of regression part
I :d = degree of difference
MA: q= order of the moving average part
ARIMA (p,d,q) is defined by

$$\phi_p (B)\Delta^d Y_t = \theta_q (B)\varepsilon_t$$

Where,

$$\phi_p (B) = 1- \phi_1 B - \phi_2 B^2 \ldots\ldots\ldots\ldots - \phi_p B^p$$
$$\theta_q (B) = 1- \theta_1 B - \theta_2 B^2 \ldots\ldots\ldots\ldots - \theta_q B^q$$

B is the back shift operator;
Δ = is the difference operator;
d = differences
ε_t is residual which follows normal distribution with mean zero and variance σ^2
ϕ_p and θ_q are respectively autoregressive and moving average parameters

The best fit was judged based on the criteria such as significance of all lags or returns used in the model, least AIC and SBC. The common penalized likelihood procedure is the Akaike information criterion (AIC) was obtained by

$$AIC = n [1+ \log (2\pi)] + n \log \sigma^2 + 2m$$

Schwartz Bayesian criteria (SBC or BIC) is defined by

$$SBC = \log \sigma^2 + (m \log n)/n$$

Step-III: Forecasting with the Model

After satisfying about the adequacy of the model, it can be used for the forecasting. Forecasts for one period or several periods into the future with the parameters for a tentative model has been selected (Sivaramane and Mathur 2010).

RESULTS AND DISCUSSION

Trends and Seasonal Fluctuations in Prices of Rice

Long term trends in the wholesale prices of rice

The analysis of trend component in the annual average wholesale price series of the rice was carried out by ascertaining the direction of the movement of prices over a period in Andhra Pradesh and Guntur market. The results revealed that there was an annual increase in wholesale prices of rice in Andhra Pradesh was Rs. 44.52 per quintal where as in Guntur market it was Rs. 49.38 per quintal higher than the state average price. The values of R^2 for Andhra Pradesh and Guntur market were 0.73 and 0.80 indicating that in both these markets, the contribution of time to change in prices was to the extent of 73 per cent and 80 per cent respectively (Table 1).

Table 1. Linear trend equation for annual average wholesale prices of rice

Market	Intercept (a)	Slope of coefficient (b)	't' cal value	R^2
Andhra Pradesh	258.08	44.52**	7.06	0.73
Guntur	270.42	49.38**	8.51	0.80

**Significant at 1 per cent level of probability

Seasonal variations in wholesale market prices of rice

The pattern of variation in price within a year is revealed by seasonal indices, computed for each month from 1990-91 to 2009-10. In order to examine the extent of the seasonal variations in prices, the indices of seasonal variations for prices were worked out. To identify the long run seasonal variations, time series data relating to monthly price of rice were subjected to the percentage centred 12 months moving average method.

Andhra Pradesh

The seasonal indices of monthly prices of rice in Andhra Pradesh was presented in Table 2 and shown in Fig 1.The highest seasonal index was found in September, followed by October and August as the indices stood at 104.35, 103.82 and 102.66 respectively of every year in rice crop. The seasonal index was noticed lowest in the month of April with 96.05 closely followed by March with 96.06. The seasonal price indices were above average from June to December while below average from January to May in Andhra Pradesh, where the market arrivals are more.

Guntur market

The final estimate stabilized monthly seasonal indices were shown in Table 2 and illustrated in Fig2. Results revealed that the highest seasonal index was found in October with 105.76, followed by November (105.56) and September (104.33). It showed that the seasonal index was very low during the month of May with 93.33, followed by April with 94.61. The seasonal price indices were above hundred from the month of July to December, while the rest of the months they were below the hundred.

Table 2. Month wise seasonal indices in wholesale prices of rice in Andhra Pradesh and Guntur District (19990-91 to 2009-10)

Month	Seasonal price index	
	Andhra Pradesh	Guntur
January	97.84	96.7
February	96.13	98.87
March	96.06	97.33
April	96.05	94.61
May	96.81	93.33
June	100.07	98.95
July	101.93	100.27
August	102.66	103.13
September	104.35	104.33
October	103.82	105.76
November	102.33	105.56
December	101.89	101.16

Seasonal pattern of rice in Andhra Pradesh and Guntur market showed that the price declined from December to April and reached a lowest point in the month of April. After that they

rose continuously and reached peak in September in Andhra Pradesh and October in Guntur market (Mahendran2012).

Forecasting of monthly wholesale prices of rice

The tentative models were first identified based on the autocorrelation function (ACF) and partial autocorrelation function (PACF) for the given set of time series data. The forecasts were tested with AIC and SBC values to assess the accuracy of the model. Finally the Box-Jenkins methodology used to estimate the ARIMA showed that the model (2, 2, 0) was found as the best model in Andhra Pradesh and (0, 1, 1) model was used to forecast the prices in Guntur market (Table 3).

Table 3. Residual analysis of monthly prices of rice in Andhra Pradesh and Guntur district

Market	Model	AIC	SBC	R^2
Andhra Pradesh	(2, 2, 0)	1783.2	1793.7	0.98
Guntur market	(0, 1, 1)	1918.5	1925.5	0.96

The price forecasted when compared with real prices indicated that the per cent of deviation was found to vary from 0.2 to 9.6 per cent. The forecasted rice prices per quintal in Guntur market were found to be ranging from Rs 1468 to Rs 1583 for the months from January 2011 to December 2012. The price forecasted when compared with real prices indicated that the per cent of deviation was found to vary from 0.4 to 3.4 per cent (Table 4). These results showed that the actual and forecasted prices of rice in Andhra Pradesh were more or less closer so that ARIMA model presented fairly good forecast of rice in both Andhra Pradesh and Guntur market. The price forecasts estimated for the period from January 2011 to December 2012 were found to be fairly accurate when the same were valid (Devi *et al.* 2011).

Conclusions

The study conducted for a twenty years period (1990-91 to 2009-10) has revealed that the annual increase in prices of rice in Andhra Pradesh was Rs 44.52 per quintal where as in Guntur market it was Rs 49.38 per quintal.

Table 4. Forecasted prices and their validation in rice for Andhra Pradesh and Guntur district

Month	Andhra Pradesh			Guntur market		
	Forecasted prices	Real time prices	Per cent deviation	Forecasted prices	Real time prices	Per cent deviation
2010 Jan	1696	1548	9.6	1267	1262	0.4
Feb	1473	1462	0.8	1269	1280	0.9
Mar	1373	1411	2.7	1280	1325	3.4
Apr	1331	1430	6.9	1308	1330	1.7
May	1406	1455	3.4	1324	1350	1.9
Jun	1461	1468	0.5	1342	1380	2.8
Jul	1485	1477	0.5	1366	1390	1.7
Aug	1490	1487	0.2	1383	1400	1.2
Sep	1497	1525	1.8	1397	1425	2.0
Oct	1549	1535	0.9	1416	1445	2.0
Nov	1552	1540	0.8	1436	1465	2.0
Dec	1554	1558	0.3	1456	1470	1.0
2011 Jan	1571	-		1468	-	
Feb	1583	-		1473	-	
Mar	1597	-		1478	-	
Apr	1610	-		1483	-	
May	1623	-		1488	-	
Jun	1636	-		1493	-	
Jul	1649	-		1498	-	
Aug	1662	-		1503	-	
Sep	1675	-		1508	-	
Oct	1688	-		1513	-	
Nov	1701	-		1518	-	
Dec	1714	-		1523	-	
2012 Jan	1727	-		1528	-	
Feb	1740	-		1533	-	
Mar	1753	-		1538	-	
Apr	1766	-		1543	-	
May	1779	-		1548	-	
Jun	1792	-		1553	-	
Jul	1805	-		1558	-	
Aug	1818	-		1563	-	
Sep	1830	-		1568	-	
Oct	1843	-		1573	-	
Nov	1856	-		1578	-	
Dec	1869	-		1583	-	

Both ex-ante and ex-post forecasting were done and it was compared with actual observations. The forecasts from the various models were checked for their efficacy by comparing them with the actual values. The prices were forecasted up to December 2012. The forecasted rice prices per quintal in Andhra Pradesh were found to be ranging from Rs 1571 to Rs 1869 for the months from January 2011 to December 2012.

It was observed there was a significant increase in the prices over the years in both Andhra Pradesh and Guntur district. Month wise seasonal indices of rice in Andhra Pradesh and Guntur market showed that the price declined from December to April and reached a lowest point in the month of April and prices were highest from July to November. So, the farmers are better to sell their produce in these months to get more

prices. The price forecasts of rice price for the period from January 2011 to December 2012 were found to be fairly accurate and showed increased trends in both Andhra Pradesh and Guntur district.

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