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A Study on Price Forecasting of Paddy in West Tripura, District

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ABSTRACT: Price fluctuations in agricultural commodities have a negative impact on a country's GDP and farmers are harmed both emotionally and financially as a result of their years of toil. Because of this reason prediction of prices may assist the agricultural supply chain in making necessary decisions in minimizing and managing price risk. Present study was conducted in West Tripura District, which was chosen on the basis of price of the paddy crop. Tripura offers all of the suitable circumstances for paddy growing, with a lot of potential. Due to price instabilities, Tripura farmers are currently not interested in growing paddy crops. The market's knowledge, which is essential to the social and economic activities that make up the development process, will be provided via price prediction. In this study, SARIMA models were developed to predict the paddy prices using time series data from January 2000 to February 2022.By comparing Bayesian Information Criteria(BIC), Mean Absolute Percent Error (MAPE) and Ljung-Box test, SARIMA $(0,1,2)(1,0,1)_{12}$ had chosen the top. Based on the fitted model, the paddy price was predicted up to December, 2022 and highest price found to be on September 2022 would be ₹1923.5/qt.

Keywords: Price Forecasting, Paddy crops, ARIMA.

INTRODUCTION

Agriculture and cultivation have long been an aspect of human civilization and it is expanding smart farms. Paddy (*Oryza sativa* L.) is a one of the important crop among all agriculture crop and also known as the "global grain" and as a result it is a major food crop throughout Asia, Africa, South America and to a lesser extent the United States (Janick *et al.,* 1981).

India is the world's second-largest producer of agricultural commodities, with the industry accounting for 17.32 per cent of the country's GDP (Sabu and Kumar 2020). Paddy is a staple food of most of the people in India and is recognized for providing quick energy due to its high carbohydrate content (Darekar and Reddy 2017). Because of all these, the paddy crop's importance in the country cannot be overstated. In India, planted paddy covers 43.39 million hectares, yielding 104.32 million tones with a productivity of 2.4 tons per hectare (Anon., 2016).

Tripura, one of the north-eastern states, is bounded on the north, west, south and southeast by Bangladesh, whereas in the east, it shares a common boundary with Assam and Mizoram. In this state paddy is farmed in both, hills and valleys area. In the hills, jhum or shifting cultivation is practiced, while in the plains, settled farming is practiced. Aush, Amon and Boro are the three seasons in which paddy is farmed. Paddy cultivation in the hills is mostly dependent on rainfall, whereas in the valley areas it is depends on canal irrigation. The state's agricultural inputs, including irrigation infrastructure, are few, and the state's gross irrigated area to total cultivated area is just 35 per cent, which is cause for major caution (Debnath *et al*., 2017). Production, area and productivity during 2020-2021(Boro rice) was respectively 219317 MT, 66500 Ha and 3298 kg.Ha^{-1} (Anon., 2020 to 2021).

West Tripura District headquarter is located in Agartala which is also the capital of the State of Tripura. The district is bounded by Bangladesh in the north and west,

by Khowai district in the east and by Sepahijala District in the south. Rural part of West Tripura District is mainly dependent on agriculture and allied activities.

Farmers are particularly hard hit in years when crops fail, resulting in significant debt. Increased global food demand, pollution, soil degradation, and other factors influence crop quality and quantity, affecting the agriculture supply chain. Various time-series methods can be used to forecast agricultural commodity prices and that can help farmers to take decision.

MATERIAL AND METHODOLOGY

Description of data. This study relied on secondary data and this was the monthly data from January 2000 to February 2022 on price of paddy in West Tripura District. These data were collected from the Statistics division, Department of Agriculture and farmers Welfare, Government of Tripura.

Box-Jenkins Methodology

There are four phases to the Box-Jenkins approach.

1. Identification of the proper p, d, and q values. Examining the test autocorrelations and partial autocorrelations to distinguish proof of the potential models.
2. Estimation is performed to estimate the parameters of autoregressive and moving average terms employed in the equation, after defining the suitable model.
3. Diagnostic checking to see if the chosen model fits the data relatively enough, obtaining the residuals and the function of Autocorrelation (ACF) and Partial Autocorrelation (PACF) of the residuals is a simple diagnostic. Model can be accepted when the residuals obtained from it are white noise.
4. Forecasting to deliver results based on previously collected data. This strategy produces more accurate projections than traditional econometric modeling.

Seasonal Autoregressive Integrated Moving Average (SARIMA) Model. The series can sometimes show a discernible periodic pattern. Normally, the price of agricultural commodities follows a seasonal pattern. The ARIMA notation can thus be easily modified to account for seasonal factors. The Seasonal ARIMA model is denoted by the notation ARIMA (p, d, q) (P, D, Q)s in its most general form

$$\left(1-\varphi_p B\right)\left(1-\Phi_p B^s\right)(1-B)(1-B^s)Y_t = \left(1-\theta_q\right)(1-\Theta_q B^s)\varepsilon_t$$

Where,

'B' is the Backshift operator (i.e. $BY_t = Y_{t-1}$, $B^2Y_t = Y_{t-2}$ and so on),'s' represent Seasonal lag, $'\varepsilon_t'$ and 't' a sequence of independent normal error variables with mean 0 and variance σ^2. $'\Phi'_p$ and $'\varphi_p'$ are the seasonal and non-seasonal autoregressive parameters, respectively.' Θ_q' and 'θ_q' are seasonal and non-seasonal moving average parameters, respectively. Non-seasonal autoregressive and moving average parameters have orders p and q, whereas seasonal auto regression and moving average parameters have orders P and Q, respectively. In addition, the letters'd' and 'D' stand for non-seasonal and seasonal differences, respectively.

ACF and PACF. Models are determined by the patterns of their ACF and PACF plots. Both autocorrelations and partial autocorrelations are calculated for consecutive lags in the series. The autocorrelation of the first lag is between Y_t and Y_{t-1}, the autocorrelation of the second lag is between Y_t and Y_{t-2} and so on. ACFs and PACFs have functions that span all lags. By comparing the acquired patterns of ACF and PACF plots, ARIMA models are recognized with idealized patterns. The best match also shows what parameters (p, d, q) should be included in the model and which size (0, 1, or 1). Nonetheless, the plots may reveal more than one pattern, or the best pattern match may not reduce the residuals to random error. A first best guess is made based on the ACF, PACF pattern, and if the model does not match the data well, another is checked until the diagnostic process is satisfactory.

Forecasting Performance Evaluation. The lowest MAPE model, which can be computed using the following equation, is used to inspect correctness.

$$M = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{A_t - F_t}{A_t}\right|$$

Where A_t is the actual value, F_t is the predicted value, and n represents the number of predicted values. The deviation is calculated using the statistical values that are low or close to 0, suggesting great predicted accuracy.

RESULT AND DISCUSSION

After the data was collected on price of paddy from January 2000 to February 2022, it is displayed on a graph, which is shown in Fig. 1 and revealed there is an increasing pattern in paddy price in West Tripura, District.

The term "stationary data" refers to time series data in which the mean and variance do not change over time. The data should be stationary when using the Box-Jenkins technique to develop a model. Augmented Dickey Fuller test was used to test the stationary of the data. Table 1, indicated that the price data exhibit stationary after first order seasonal difference. In this case, lag1 (d=1) differencing is stationary in terms of mean and variance. As a result, there is no need for further differencing in this time series data, and fitted model was adopted with lag1 (d=1) differencing. This is comparable with the result of Kumar and Baishya (2020). The transformation of data after lag1 (d=1) differencing is shown in Fig. 2. After getting the stationary data, the model was identified using the ACF and PACF plots of the first order seasonal differenced series and presented in Fig. 3 and 4.

Identifying Best-fit model. The tentative models identified for forecasting were SARIMA(0,1,1)(1,0,2)$_{12,}$ SARIMA(0,1,0) (0,0,2)$_{12,}$SARIMA(1,1,1)(0,0,2)$_{12,}$SARIMA(1,1,1)(1,0,0)$_{12,}$SARIMA(1,1,0)(1,0,1)$_{12,}$SARIMA(0,1,2)(1,0,1)$_{12,}$ SARIMA(0,1,2)(2,0,0)$_{12,}$ SARIMA(1,1,0)(1,0,0)$_{12,}$ SARIMA(0,1,1) (0,0,1)$_{12,}$ SARIMA(0,1,1) (0,0,2)$_{12,}$. The best model was selected based on the MAPE and BIC values. The model statistics and Ljung-Box Q statistic of the tentatively identified models are given in Table 2 and that table indicated that SARIMA (0,1,2) (1,0,1)$_{12}$ model has lower MAPE value and lower BIC value. As a consequence, this was the best model among the identified models.

Hence this model was used for forecasting the price of paddy for West Tripura District market. The price was forecasted for January 2020 to December 2022 and compared with actual values. For the accuracy the forecasted value lies within the confidence limit. The forecasted values are shown in Table 3. With the accuracy, paddy price was forecasted for March to December 2022. The result indicates that the price will be high during September, 2022. And graph for the forecasted values is shown in Fig. 5.

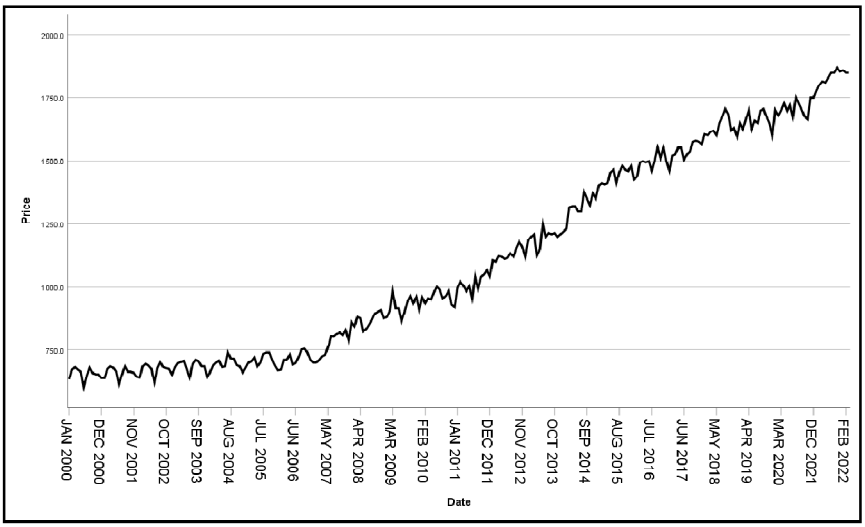

Fig. 1. Monthly Price of paddy from 2000 to 2022.

Table 1: ADF test statistic for prices of Paddy in west Tripura district market.

Sr. No.	Market	Augmented Dicky-Fuller Test		
		Differencing	Statistic	p-value
1.	Mohonpur	Without differencing	-2.2896	0.454
2.	Mohonpur	First order seasonal differencing	-7.6885	0.01

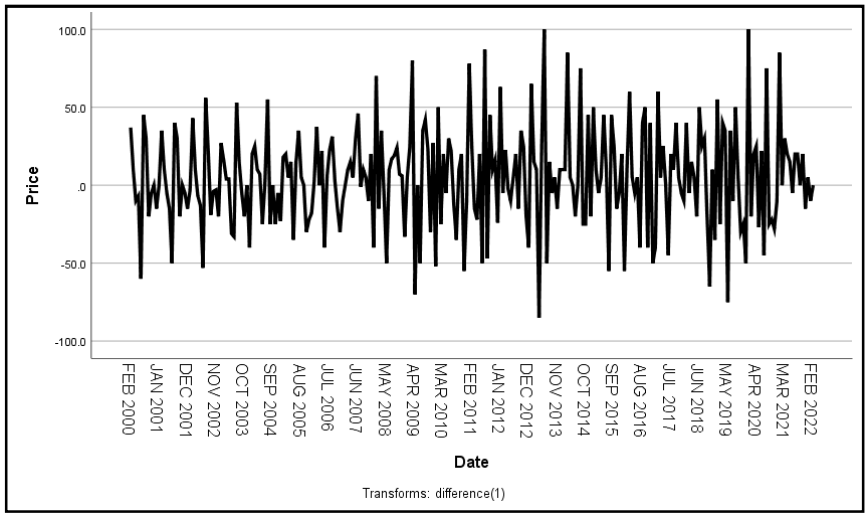

Fig. 2. Transformation of data after first order differencing.

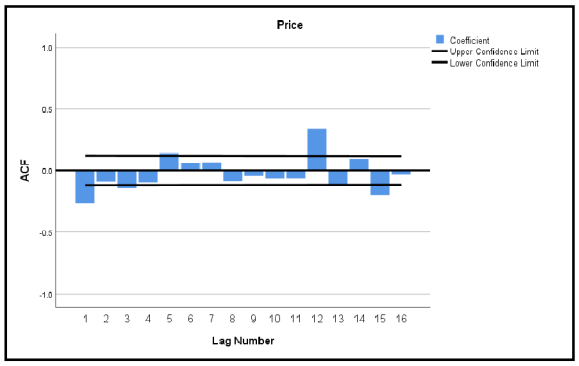

Fig. 3. ACF plot.

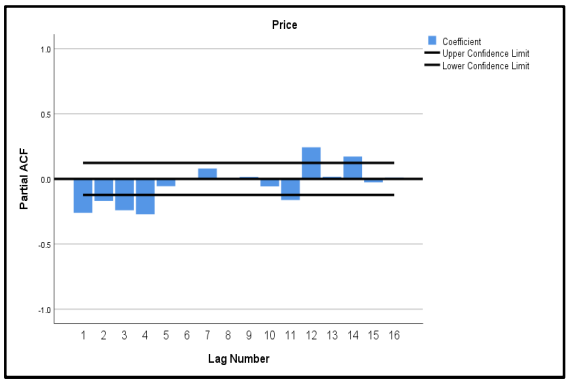

Fig. 4. PACF plot.

Table 2: MAPE, BIC and Ljung-Box Q statistic of SARIMA models for prices of paddy in west Tripura district market.

Sr. No.	Models	Model Statistics		Ljung-Box Q		
		MAPE	BIC	Statistic	DF	P -value
1.	SARIMA(0,1,1)(1,0,2)$_{12}$	2.009	6.731	19.575	14	0.144
2.	SARIMA(0,1,0)(0,0,2)$_{12}$	2.197	6.870	44.838	16	0.000
3.	SARIMA(1,1,1)(0,0,2)$_{12}$	2.064	6.754	20.551	14	0.114
4.	SARIMA(1,1,1)(1,0,0)$_{12}$	2.073	6.735	19.506	15	0.192
5.	SARIMA(1,1,0)(1,0,1)$_{12}$	2.081	6.792	35.492	15	0.002
6.	**SARIMA(0,1,2)(1,0,1)$_{12}$**	**2.000**	**6.713**	**15.014**	**14**	**0.377**
7.	SARIMA(0,1,2)(2,0,0)$_{12}$	2.006	6.726	17.086	14	0.252
8.	SARIMA(1,1,0)(1,0,0)$_{12}$	2.191	6.824	46.004	16	0.000
9.	SARIMA(0,1,1)(0,0,1)$_{12}$	2.232	6.790	44.861	16	0.000
10.	SARIMA(0,1,1)(0,0,2)$_{12}$	2.131	6.774	38.774	15	0.001

Table 3: Forecasted values by SARIMA model for prices of paddy in west Tripura district Market.

Sr. No.	Month and Year	Price forecast by SARIMA (0,1,2) (1,0,1)12			
		Actual	Forecast	Lower confidence limit	Upper confidence limit
1.	Jun-20	1720.0	1711.2	1657.9	1764.6
2.	Jul-20	1675.0	1717.0	1663.7	1770.3
3.	Aug-20	1750.0	1716.6	1663.3	1769.9
4.	Sep-20	1725.0	1749.2	1695.9	1802.5
5.	Oct-20	1703.0	1712.9	1659.6	1766.2
6.	Nov-20	1675.0	1710.8	1657.5	1764.1
7.	Dec-20	1665.0	1673.2	1619.9	1726.5
8.	Jan-21	1750.0	1709.4	1656.1	1762.8
9.	Feb-21	1750.0	1730.4	1677.1	1783.8
10.	Mar-21	1780.0	1752.4	1699.1	1805.7
11.	Apr-21	1800.0	1778.4	1725.1	1831.8
12.	May-21	1815.0	1769.5	1716.2	1822.9
13.	Jun-21	1810.0	1806.0	1752.7	1859.4
14.	Jul-21	1830.0	1791.5	1738.1	1844.8
15.	Aug-21	1850.0	1845.5	1792.2	1898.8
16.	Sep-21	1850.0	1841.3	1788.0	1894.7
17.	Oct-21	1870.0	1829.8	1776.4	1883.1
18.	Nov-21	1855.0	1844.4	1791.1	1897.7
19.	Dec-21	1860.0	1829.9	1776.6	1883.2
20.	Jan-22	1850.0	1887.4	1834.1	1940.7
21.	Feb-22	1850.0	1860.8	1807.5	1914.2
22.	Mar-22	NA	1879.5	1826.1	1932.8
23.	Apr-22	NA	1895.2	1834.3	1956.1
24.	May-22	NA	1888.9	1824.5	1953.4
25.	Jun-22	NA	1897.7	1829.9	1965.5
26.	Jul-22	NA	1896.9	1825.9	1967.9
27.	Aug-22	NA	1923.2	1849.2	1997.2
28.	Sep-22	NA	1923.5	1846.5	2000.4
29.	Oct-22	NA	1918.8	1839.1	1998.6
30.	Nov-22	NA	1912.0	1829.5	1994.5
31.	Dec-22	NA	1904.9	1819.8	1990.1

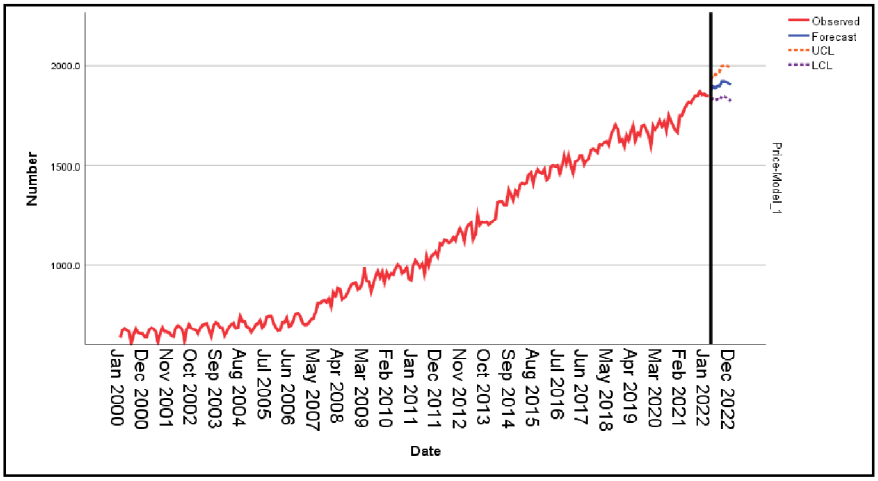

Fig. 5. Forecasted values by SARIMA (0,1,2) (1,0,1) for prices of paddy in west Tripura district Market.

CONCLUSION

In agricultural markets, time series forecasting is essential. Commodity price volatility makes it difficult to make any decision timely based on commonsense. Tripura is having good agro-climatic conditions, deep fertile soils, and subtropical humid climate with abundance of rainfall, which offers tremendous scope for cultivation of paddy and also this, is the major crops grown in the state but farmers in Tripura have been turning away from paddy production in recent years due to price swings. In this study SARIMA $(0,1,2)(1,0,1)_{12}$ was the best fitted model for forecasting the price of paddy in west Tripura district and according to this model, in the September of 2022 price would be high among all these month . So, by the Analysis of this study, decisions can be made by the farmers of West Tripura, District in selecting crop for cultivation that will lead to a better economic outcome.

FUTURE SCOPE

When data for the lead periods become available, it will be possible to confirm the anticipated value by looking at the forecast variable using the constructed model. Researchers can anticipate typical pricing in Tripura using the methodology. However, it needs to be periodically updated with the most recent information.

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Conflict **of Interest.** None.

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