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Potato Price Dynamics in the Eastern Himalayan Region: A Case Study of Meghalaya

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Abstract

The present study was undertaken with a view to find out how the price of potatoes changes in Meghalaya, a small state in the eastern Himalayas and is predominantly an economic activity in terms of potato farming. To analyze monthly price fluctuations during the period 2002-2023, simple yet powerful time series forecasting models, such as GARCH and ARIMA, are used instead. The forecasted values for the price of potato from October, 2023 to February, 2024 had an upward trend, implying that the farmers and policymakers would benefit in making better decisions with regard to reducing the risk and for better profit. The primary goal of this is to help policymakers create practical market supply chain solutions that will gradually stabilize the potato market. According to this study, farmers in the region deal with two significant issues: climate variability and a lack of storage facilities.

Keywords: Forecasting, Potato, Time series, Trend

Introduction

Price fluctuations are a major concern among farmers' community and the policymakers which directly affects the livelihood of farmers. The precise forecasting of prices is essential for making better strategies for the benefit of farmers. In Meghalaya, Potato plays a vital role in ensuring food security from a long period which is the most important cash crop in Meghalaya. Also, Meghalaya is the second leading producer of potato in the Northeastern region after Assam leading with cultivable area of about 18,000 to 20,000 hectares. Rainfed conditions in Meghalaya favor the potato cultivation, mainly in the hilly areas of the East Khasi hills, which constitutes one-third of the total area under the tuber crops. Recently various potato varieties have been introduced in Meghalaya; David Scott in 1930 introduced early varieties to combat late blight disease in potato in Khasi hills. Recently introduced varieties include Up-to-date, Great Scot and Arran Consul from England, which are susceptible to late blight. Central Potato Research Institute (CPRI) in the 1970s at upper shilling recommended Kufri Jyoti which shows high yield and resistance to late blight of potato compared to other potato varieties but the quality of Kufri Jyoti is inferior when compared to Up-to-date which leads to degradation in its genetic viability. To combat this problem CPRI has introduced Kufri Giriraj, a better variety for Meghalaya having resistance to late blight of potato. Also, different varieties have been introduced from time to time like Royal Kidney, Kufri Megha and Kufri Khasi-Garo, but these varieties were not so prominent in terms of late blight resistance, so they gradually got replaced by varieties that are highly resistant to late blight and perform better yield. Forecasting models are now very influential for predicting future price as well as witnessing and examining the pattern of price in coming years to aid farmers and policymakers in dealing with pricing-related issues and marketing. After all, the forecasted values will give a broad outlook to policymakers to make useful strategies and decisions regarding when to harvest, sell, cultivate and other post-harvest processes to improve market stabilization.

Forecasting Methods

Different time series models were used including Autoregressive Integrated Moving Average (ARIMA) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models to predict the future market price of Potatoes for Meghalaya. The ARIMA model is effective in dealing with non-stationary data that have predicted monthly prices and identified the future fluctuations; however,

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GARCH models are good in determining and assessing the price Volatility. For predicting future agricultural prices and determining the seasonal patterns in potatoes, ARIMA is much more effective compared to other time series models (Chandran and Pandey, 2007). Also for a valid and reliable forecast for agricultural commodities, the forecast models should be validated using a variety of accuracy measures (Sahinli, 2020).

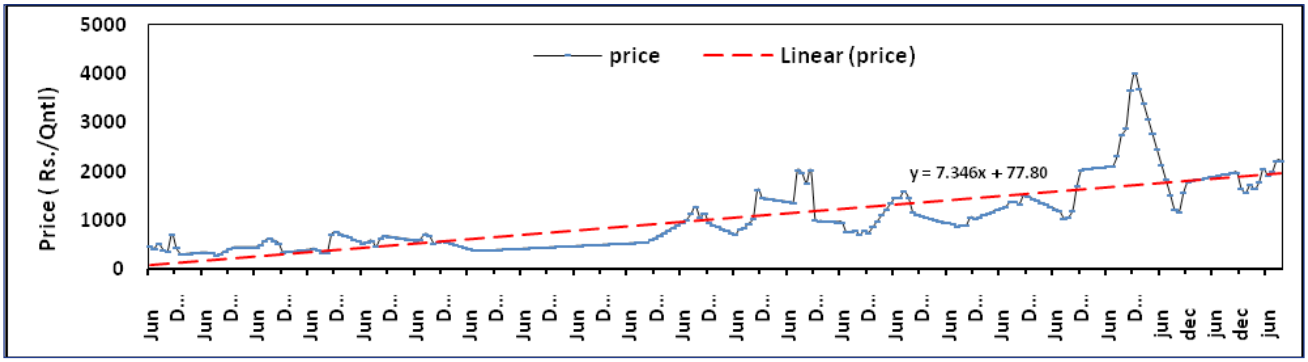

Figure 1: Potato Market Price Trend

In this study, the monthly market price of potatoes in Meghalaya over 22 years from June, 2002 to September, 2023 was analyzed to see the price dynamics and changing patterns in prices. Figure 1 shows seasonal fluctuations with spikes and troughs, which indicate seasonal fluctuation in the market price of potato in Meghalaya. The equation, y = 7.3464x + 77.805 shows an increasing trend for potato prices from June, 2002 to September, 2023. The positive slope of the equation in the graph signifies that the price of potatoes follows an upward trend for which the possible contributing factors include changes in market dynamics, uneven hikes in prices due to inflation and increases in the cost of production and inputs, *etc*. The periodic trough has seen in the graph solely accounts for the high market arrival during the post-harvest months, which leads to the downfall in the market price of potatoes (Figure 1). So, this fluctuation in market price seeks a better and valid forecasting model to predict future prices to deal with this price volatility and uneven change in prices. This will aid farmers and policymakers in dealing with the market dynamics to mitigate the risk related to economics and to stabilize the market price of potatoes. The linear trend indicates that although prices are on an upward trajectory, short-term volatility remains a critical issue requiring targeted interventions such as better storage facilities and improved market access to buffer farmers against unpredictable price crashes.

Following an examination of price trends across the period under study, we employed a variety of forecasting techniques, such as ARIMA, AR and GARCH modeling. To forecast the future market price, five different models including; ARIMA (1,1,1), ARIMA (1,1,1) (0,1,0), iGARCH (1,1), sGARCH (1,1) and AR (1) were identified. After proper identification of the model following suitable procedures, the models were assessed for their validity by using different forecast accuracy measures which includes Root Mean Square Error (RMSE), Akaike Information Criterion (AIC) and Mean Absolute Percentage Error (MAPE) and based on their least values, ARIMA (1,1,1) was identified as the best model for forecasting the future market price of potato. Accordingly the parameter estimate of the best model; ARIMA (1,1,1) is presented in table 1, where the first autoregressive term was found to be significant at 5% level of significance. The forecasted price from October, 2023 to February, 2024 is given in table 2. The plot of the actual price and predicted price of the model is given in figure 2.

Table 1: Parameter estimates given by the model ARIMA (1,1,1) for price of potato

Parameter	Estimate	Std. Error	z-value	p-value
AR1	0.492	0.162	3.022	0.002*
MA1	-0.295	0.173	-1.703	0.088

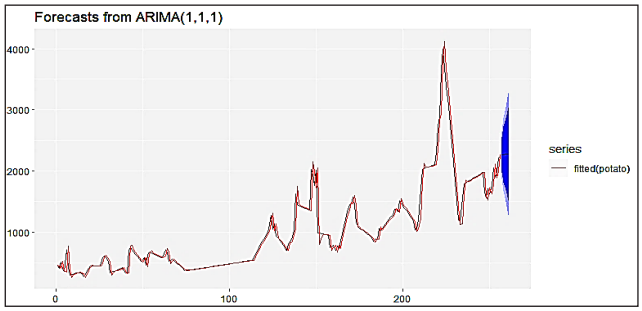

Figure 2: Actual price versus predicted market price of potato given by the model ARIMA (1,1,1)

Novelty of the Study

The study's exclusivity is in its fair and accurate execution of forecasting models and its appropriate evaluation of their accuracy measures, such as AIC, BIC, RMSE and MAPE, in order to identify and forecast which model is optimal amongst them. Policymakers may find these findings useful in developing market conditions solutions to address future price volatility. After ARIMA forecasting, an increasing trend in potato prices was observed for the next five months, from October, 2023 to February, 2024 (Table 2). Agra's seasonality and cycles revealed a similar upward tendency, which supports our findings (Dhakre and Bhattacharya, 2014). In contrast to our results, the HWA and HWM methods for Turkey's consumer potato prices indicated a downward trend in the anticipated prices between September and December of 2019 (Sahinli, 2020).

Table 2: ARIMA (1,1,1) forecasted values

Period	Point Forecast	Low 95%	High 95%	Low 99%	High 99%
Oct, 2023	2263.158	1973.744	2552.572	1882.803	2643.512
Nov, 2023	2272.688	1821.207	2724.168	1679.342	2866.033
Dec, 2023	2277.382	1690.703	2864.060	1506.355	3048.408
Jan, 2024	2279.694	1576.045	2983.343	1354.942	3204.445
Feb, 2024	2280.833	1473.739	3087.927	1220.131	3341.534

Benefits of Forecasting for Farmers and Policymakers

Forecasting assists farmers, policymakers and market participants by providing potential future pricing based on historical data. In order to cope with abrupt and uneven price variations and market collapses, farmers can make early decisions about when to produce, harvest and sell with the use of accurate and precise price predictions. It does, however, directly assist policymakers in formulating strategies based on market conditions and pricing dynamics. Following the establishment of appropriate harvest and sale plans, storage facilities, *etc*., these policymakers are essential in helping farmers manage market swings for increased revenue and decreased losses. This enables support programs during price volatility. Accurate forecasts also enhance market efficiency by reducing uncertainty, benefiting both producers and consumers. However, farmers can use forecasts to align sowing and harvesting with favorable market conditions (Sahinli, 2020). Policymakers can stabilize prices and invest in storage infrastructure. Timely information plays a significant and important role in supporting supply chain management and export plans, constructing a resilient agricultural economy and assisting farmers in making well-informed decisions (Singh *et al.*, 2016).

Challenges in Forecasting and Farmer Difficulties in Meghalaya

Meghalaya faced significant challenges in forecasting the future price of potatoes which included a lack of price data, influence of volatility, seasonality, selection of the best model and validation of the model. A major challenge is the lack of consistent data on production and market arrivals, affecting model development. Another major potato marketing obstacle is steep terrain, 70% of the land in the northeastern regions is hilly and rocky and hence increasing the cost of transportation (Sah *et al*., 2011). The fluctuations in the market exert pressure on selecting the accurate model, mainly due to the uneven hike and trough in prices, the model cannot predict precisely or it's a bit difficult to formulate the forecasting process for the dynamic data of market price of potato. In addition to this, climate-related constraints including climate variability like uneven and excessive rainfall hamper the yield and quality of potatoes. Moreover, the increasing cost of inputs such as soil amendments, fertilizers, disease-resistant seeds and tolerant varieties further hampers the farmers for a further package of practices. Additionally, marketing and storage were noted as significant shortcomings in India's potato production (Sah *et al*., 2011).

Conclusion

The study highlights the significance of proper and effective forecasting of the market price of potatoes in Meghalaya. By using advanced and better time series forecasting models, it gives a shape of the patterns observed in the market price as well as the fluctuations in the market and its possible rationales. However, addressing the challenges in forecasting and improving market infrastructure and storage facilities are crucial for maximizing the benefits of such studies. Improving farmers' access to the market and increasing their knowledge on better cultivation and storage can also further strengthen the potato sector in Meghalaya and help in improving food security and economic stability. The predicted price further furnishes valuable insights into future price trends which help the policymakers to aspire for a sustainable solution for the volatility in the market. To accomplish this, governmental organizations, academic institutions and farmers ought to collaborate and work together to find the best and most sustainable solution to deal with this sudden market fluctuation and volatility.

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