RESEARCH ARTICLE

Growth and Forecast Performance of Turmeric in India: An Empirical Analysis

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ABSTRACT

India is the world's main supply of turmeric, accounting for more than 90 per cent of the global turmeric trade. Considering the economic importance of this crop, an attempt has been made to assess the performance of turmeric in terms of area and production, as well as the cost of cultivation in India. Aside from that, the study used the Auto-Regressive Integrated Moving Average (ARIMA) model to project the price of turmeric in the future. The results of growth analysis of turmeric area and production in India using secondary data from 1950-51 to 2020-21 through compound growth rate revealed a positive growth pattern of the area, production, and productivity at rates of 2.60, 4.02, and 1.40 per cent per year, respectively. A total of Rs. 3,08,511 was required for one hectare of turmeric output. According to the results of forecasting methods, the price of turmeric would be Rs. 7179, Rs. 7172, Rs. 7170, Rs. 7170, and Rs. 7170 per quintal in May, June, July, August, and September, respectively, assuming the current growth rate remains the same. Due to increased turmeric arrivals, the expected values of turmeric price exhibited a falling trend in the next five months. Hence, the government should increase and maintain funding for turmeric development programmes, given the importance of turmeric in terms of export revenues and domestic requirements. If these challenges are solved, there is a lot of space to increase turmeric production in the future.

Keywords: *Growth analysis; Economies of cultivation; Forecasted price; Turmeric; Utilization pattern*

INTRODUCTION

India is known as the "Spice Bowl of the World" because of its high-quality spice output. Growing spices for various uses has been practiced since antiquity (Angles *et al.*, 2011). As early as 6000 BC, the Vedas contain data concerning several spices and their properties. India has been known for trading since the time of sea route exploration, owing to its wide range of spices and exceptional quality drew outsiders to the country. This is the primary motive for the European countries' invasion and imperialization of India. India is known for its spices to such an extent (Bhosale *et al*, 2020; Gowri and Shivakumar, 2020).

Turmeric is an Asian and Indian spice with a long history. Turmeric's tuberous rhizomes or underground stems have been used as condiments, a color, and an aromatic stimulant in a variety of remedies since antiquity (Govindasamy *et al*, 2021). It is a common spice in South Asian and Middle Eastern cuisines. It is known as "Indian saffron" and is a major commercial spice crop grown in India. India is the world's leading producer, consumer, and exporter of turmeric (Kiruthika, 2013). Because of its high curcumin concentration, Indian turmeric is regarded as the greatest grade and is increasingly used in medicinal and aesthetic applications. Bangladesh, Pakistan, Sri Lanka, Taiwan, and China are all major producers of turmeric. India, Thailand, Taiwan, and several other Southeast Asian, Central, and Latin American countries are major turmeric exporters.

India is the world's largest producer, consumer, and exporter of curcumin, accounting for more than 80% of global output (Dash *et al*, 2017). Turmeric ranks third among India's total spice exports. Curcumin exports have been steadily increasing over the years, reaching 1.36 lakh tonnes worth Rs. 1216.40 crores in 2019-20. On the other hand, turmeric imports were 0.17 lakh tonnes worth Rs. 184.33 crores in 2017-18 (Sahoo *et al*, 2022). The current study has the following objectives, which are based on the relevance of Indian turmeric on a global scale.

i) To examine the economies of cultivation of turmeric in India

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ii) To analyze the trend and utilization pattern of turmeric in India and

iii) To forecast the turmeric price in India and suggest suitable policy measures for strengthening turmeric production.

MATERIAL AND METHODS

The present analysis was regulated by applying data on time series of turmeric prices for January 1997 to April 2022 period. The data pertained from the different issues of the Season and Crop Report of Tamil Nadu, Directorate of Economics and Statistics published by the Government of India. Data were explored by using SPSS software. The present study implemented linear, quadratic, and exponential tend models. Based on the measures of accuracy, the best model was selected. The accuracies were MAPE (mean absolute percentage error), PACF (partial autocorrelation function), and ACF (autocorrelation function). Minimum standards of all these actions are a sign of a fine built-in model with the least forecasting errors (Beniston, 2004); it was also used by Karim *et al,* 2010. For this paper, the best model for predicting the future area and production of small millets was a quadratic model for 2022 to 2026.

To measure the associations, observations contained in the series wereanalyzed by the Auto-Regressive Integrated Moving Average model (Box–Jenkins). This model communicated as ARIMA (p, d, q), and it was pretentious (Box and Jenkins, 1976). Past values of the differenced sequence occurring in the forecasting equation are termed as Auto Regressive and history values of the error term in forecasting are calledMoving Average. For stationary data, time series data that need to be differenced are called integrated time series. This model combines three kinds of processes, namely, P (autoregressive), D (differencing for making data stationary), and Q (moving average). It is related to fixed data/stationary and for the non stationary data differencing of data is a must.

$Dt = Y_t - Y_{t-1}$.

The Dt series is said to be the first difference of Yt and

$Vt=D_t - D_{t-1}$ is called the second difference.

The ARIMA incorporates the following steps.

Recognition of the model is alarmed with pronounced proper values of three orders viz.,

P, D, Q

P is the autoregressive (non seasonality)

D is the differencing (non seasonality)

Q is the moving average (non seasonality)

Before recognizing the model, choose the distinctiveness of time series data for stationary and seasonality in the case of vegetables and fruits as supposed above, and a similar must be detached. After differencing the data for stationarity, the subsequent step in furnishing the ARIMA model is to predict and correct the autocorrelation that leftovers the time series data if any. Certainly, software in the vein of stat graphics could attempt to a diverse amalgamation of terms and find what the best is. However, the organized method involves observing the diagram of the ACF and PACF of the differenced data. The autocorrelation function plot is purely a bar chart of the correlation coefficients among the time series and their lags. The partial autocorrelation function plot is the bar chart of the partial correlation coefficients among the time series and their lagged values.

After selecting the best model, the next walk is to have the squares of minimum. Evaluating the coefficients of this model is a relatively convoluted nonlinear assessment issue. Commercial statistical software was used to overcome these problems, viz., SPSS, ANN, SAS, Minitab, etc. for the parameter estimation. After parameter estimation, it is essential to check that the selected model is satisfactory. After fulfilling the adequacy, it can be applied to forecast time series data.

RESULTS AND DISCUSSION

1) Economies of Cultivation of Turmeric

The results of the study indicated that the operational cost occupied in turmeric cultivation was more than 50 per cent of the total cost of cultivation, in which labour cost constituted nearly 28 per cent followed by manure (9.65%) and input (8.03%) cost. As a result, the agricultural extension system should adopt suitable measures to promote scientific turmeric growing practises in order to lower the variable cost of production, and the state government's agriculture department and development organizations must organise training programmes to educate farmers about the proper use of inputs (Table 1)

2) Trend analysis of turmeric in India (1950-2021)

The total area under Turmeric in India rose gradually from 0.55 lakh hectares in 1950-2021 to 2.6 lakh hectares in 2021 (Table 2). At the same time, the production has also risen from 2.91 lakh tonnes in 1950 to 10.64 lakh tonnes in 2021. The yield increased from 2,877 kg/ha to 4,500 kg/ha for the same period. From the growth analysis of turmeric it could be inferred that from 1950 to 2021 a positive growth rate of 2.60, 4.02 and 1.40 per cent in area, production, and productivity has been observed per annum (Gowri and Prabhu, 2017)

3) Utilization pattern of turmeric in India

Turmeric has been used in India for countless decades, with references to it dating back to the Vedic era. Turmeric is associated with all things auspicious, making it an essential part of all celebrations and festivals. India utilises between 90% and 92% of its total annual output. Households account for the majority of demand for a spice and food colouring agent. It has also been employed in the pharmaceutical and dyeing industries, in addition to food.

4) Seasonal Index

Seasonal price variations in agricultural commodities have been observed in the past and are linked to the annual nature of the crop cycle. Due to supply pressure, crop prices in the cash and futures markets are normally the lowest near harvest. On the other hand, they are normally at their greatest near the conclusion of the marketing year, when supplies are few.

Seasonal price changes, on the other hand, will vary based on supply and demand fundamentals. Actual supply variances from predicted supplies, in particular, can significantly impact seasonal price trends. The index of variability determines the price index's reliability. It denotes the range inside which the index is most likely to fall with a 95% probability 1. The lower limit determines the range's low end, while the upper limit defines the range's high end with 95 percent certainty 1.

5) Forecasting model for turmeric price in India

The present study used a time series model for the trend analysis of turmeric in India on evidence of small values of accuracy actions (Karim *et al,* 2010). From Table 4, it was observed that accurately measure values for the turmeric in India was minor for ARIMA (1, 1, 0) (0, 0, 0). Hence, the ARIMA (1, 1, 0) (0, 0, 0) model is the best fit to predict the values for the future price of turmeric in India for the next five months.

Identification of model

The ARIMA method is predictable only after modifying the variables under prediction into a series of stationary viz., constant variance and constant mean. It was examined through plots. The recently assembled variable Yt was constant mean (stationary), the further is to recognize the autoregressive and moving average values. For this PACF and ACF were assessed (Figure 2). The time series model recognized above was anticipated through the SPSS package. Different forms of ARIMA models were calculated viz., ARIMA (1, 0, 1); ARIMA (0, 1, 0);ARIMA (0, 1, 1); ARIMA (1, 1,1); ARIMA (2, 1, 0) and ARIMA (2, 1, 2) and found that the best fitted model ARIMA (0, 1, 0) was selected on the basis Maximum Absolute Percentage Error (MAPE) values (Table 4), it was examined that MAPE for turmeric price (7.066) was the smallest value for ARIMA (1, 1, 0) (0,0,0) model. Hence, ARIMA (1, 1, 0) (0, 0, 0) was the most indicative model for the price of turmeric in India.

Checking of diagnostic error

The model confirmation is alarmed with the residuals checking; if residuals enclosed regular pattern, it might be eliminated. This could be completed by observing the residuals of autocorrelations. For this reason, different autocorrelations up to 23 lags were calculated, and similar results were examined (Figure 3). The results revealed that none of the abovementioned autocorrelations was significantly dissimilar from zero at any rational level. This demonstrated that the chosen ARIMA model was a suitable model for forecasting the turmeric price in India.

Forecasted price of turmeric in India

The rate of area under turmeric growth has a positive trend in India. The plot of the trend analysis for turmeric in India is shown in Figure 4. The red color indicates the actual values, and blue color indicates the forecasted values of the turmeric price. The outcome from Table 4 shows that if the existing growth rate remains similar, the price of turmeric would be Rs. 7179, Rs. 7172, Rs. 7170, Rs. 7170 and Rs. 7170 per quintal for May, June, July, August, and September months, respectively. The predicted values of turmeric price showed a decreasing trend in the upcoming five months due to high arrivals of turmeric.

For the present study, the ARIMA model (Box-Jenkins) was used in the analysis to forecast turmeric prices. It is world widely considered as the most efficient forecasting technique and is used extensively for time series forecasting in India. The use of ARIMA for forecasting turmerics is important with uncertainty as it does not assume knowledge of any underlying model or relationships as in some other methods. In this study, ARIMA relies on previous values and error terms of turmerics and produced the best forecasting results.

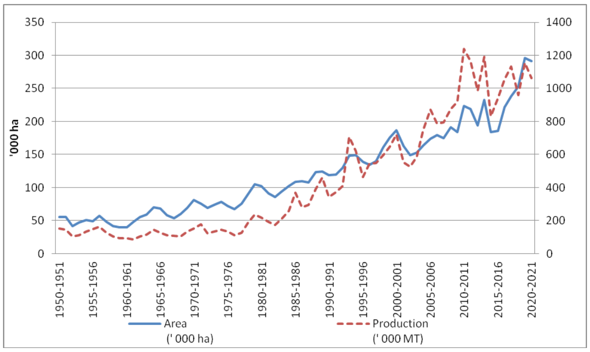

Figure 1. Trend analysis of turmeric in India

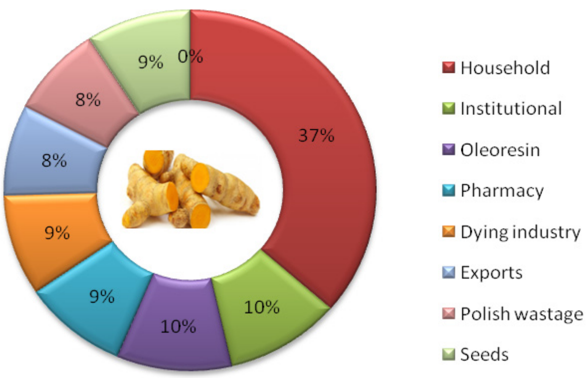

Figure 2. Utilization Pattern of Turmeric

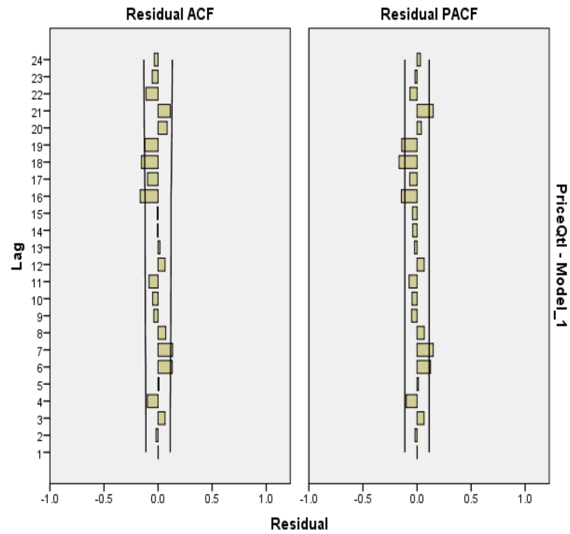

Figure 3. ACF and PACF functions of prices of turmeric

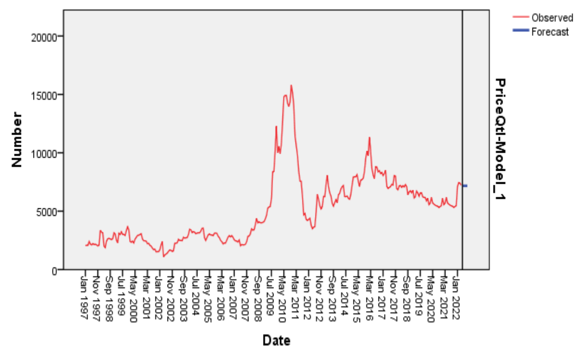

Figure 4. Forecasted values of turmeric price

Table 1. Economies of cultivation of turmeric in India

S. No.	Particulars	Rs./ha	Per cent
I	Operational cost	191510	62.08
	Labour	84955	27.54
	Cost of rhizomes	24785	8.03
	Transportation charge	7214	2.34
	Organic Manure	29785	9.65
	Fertilizers and Plant protection chemicals	20214	6.55
	Herbicide	5321	1.72
	Interest on working capital	19236	6.24
II	Total fixed cost	88955	28.83
	Subtotal (I+II)	280465	90.91
	Managerial cost @ 10%	28046	9.09
	Total cost	308511	100
	Yield (Q)	60	
	Cost of Production (Rs. /Q)	5142	

Table 2. Compound Growth Rate of turmeric in India

S. No.	Particulars	CAGR
1	Area	2.60
2	Production	4.02
3	Yield	1.40

Table 3. Seasonal Index of Turmeric Markets

Months	Erode	Duggirala	Sangli
Jan	1.015	1.021	1.067
Feb	1.000	1.003	1.123
Mar	1.013	0.976	1.127
Apr	1.033	0.98	1.077
May	1.018	0.959	1.032
Jun	0.946	0.927	0.98
Jul	1.012	0.966	0.966
Aug	1.000	1.036	0.946
Sep	0.978	1.034	0.912
Oct	0.990	1.029	0.899
Nov	0.994	1.049	0.904
Dec	1.001	1.021	0.964

Table 4. Forecasted values of turmeric price in India

Months	Best fit (ARIMA (1,1,0) (0,0,0))	(1,0,0) (0,0,0)	(1,0,1) (0,0,0)	(1,1,1) (1,0,0)	(1,1,1,) (1,1,0)	(1,1,1,) (1,1,0)	(1,0,1,) (1,0,1)
May 2022	7179	7175	7133	7154	6549	7051	7096
June 2022	7172	7135	7079	7157	6390	6916	7032
July 2022	7170	7096	7026	7167	6279	7065	6972
August 2022	7170	7057	6974	7179	6208	7101	6915
September 2022	7170	7019	6923	7193	6183	6950	6861
MAPE	7.066	7.445	7.500	7.128	9.628	7.943	7.553

CONCLUSION

From this study of trend analysis of turmeric area and production in India, it was obvious that the swing from 1950 to 2021 for both area and production was constructed to be significantly positive and the results were proven by Sahu *et al*., 2021 and Shukla *et al*., 2014. In order to meet the domestic and international demand, the production of turmeric has to be upgraded through swelling in productivity. This is necessary to meet the increasing domestic demand on the one hand and maintain the monopoly supply position in the international market. In this study, ARIMA model was applied to forecast the prices of turmeric in India, and price trends over the next five months were examined. It was created that ARIMA (1, 1, 0) (0, 0, 0) model was best fitted and it exhibited a decreasing trend in upcoming months. The error term from the best fitted ARIMA method was explored to observe autocorrelation among the values and indicated that the errors have constant variance and zero, which designates the appropriate condition of the model for forecasting the area and production of turmerics. The predicted values of turmeric price showed a decreasing trend in the upcoming five months. The price drop comes as the new crop begins to arrive in mandies, indicating that output prospects in Andhra Pradesh, Telangana, and Maharashtra are improving. As a result, increased turmeric productivity can be accomplished through enhanced technologies and turmeric-related research and development. Given the importance of turmeric in terms of export revenues and domestic needs, the government should boost and maintain its funding for turmeric development programs. If these issues are addressed, there is a lot of room to enhance turmeric production in the future.

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Ethics statement

This study was based on secondary data, which were collected from open sources. Hence, no special permits were required for the stated study.

Originality and plagiarism

The authors acknowledged that this research is original and have not been submitted/consideration in any other journal

Consent for publication

The content was agreed to be published by all of the contributors

Competing interests

The publication of this article does not involve any conflicts of interest.

Data availability

The price data of turmeric used in this study is included in the MS. If any further details required, it can be communicated through drmumagowri@gmail.com.

Author contributions

Idea conceptualization-MU, Experiments-MU, PR, BT, Guidance-VS, Writing original draft–MU and PR Writing-reviewing & editing-MU, PR, VS and BT

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