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Modelingand Forecasting Castor Price Dynamics in Andhra Pradesh

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Abstract

The present study was conducted during January, 2011 to August, 2025 at Agricultural College, Bapatla, aimed to forecast castor (*Ricinus communis* L.) prices in the Adoni, Kurnool and Yemmiganur markets of Andhra Pradesh using secondary time series data spanning 176 months. India, the fourth largest producer of oilseeds in the world, accounting for 20.8% of total global cultivated area and 10% of global production. Oilseeds were cultivated over 29.16 mha in 2021–22, producing 37.70 mt with an average yield of 1,292 kg ha^{-1} in the country. Andhra Pradesh, one of the largest producers of oilseeds in India during 2021–22, the area under oilseeds in Andhra Pradesh was 0.91 mha, with a production of 0.548 mt and average yield of 603 kg ha^{-1}. In this study, various linear-nonlinear regression models (Linear, Quadratic, Cubic, Exponential and Power) and time series models (ARIMA, GARCH), along with hybrid time series models were employed. Based on diagnostic criteria such as R^2, RMSE and MAPE, GARCH and hybrid time series models were found to outperform the other selected models for Adoni and for both Kurnool, Yemmiganur markets, respectively. Consequently, the prices of castor in Adoni, Kurnool and Yemmiganur were forecasted by using AR(1)-GARCH (1,1), ARIMA (1,1,1)-GARCH (1,1) and ARIMA (2,1,1)-GARCH (1,1) models, respectively. The forecasted prices for February 2026 were projected at ₹ 5498.54, ₹ 5186.02 and ₹ 5854.62 q^{-1} for the Adoni, Kurnool and Yemmiganur markets, respectively.

Keywords: Prices, Andhra Pradesh, castor, hybrid and garch

1. Introduction

Oilseed crops are the second most important component of the agricultural economy, ranking next only to cereals among field crops. India is the fourthlargest producer of oilseeds in the world, accounting for 20.8% of the total global cultivated area and 10% of global production. At the national level, oilseeds were cultivated over 29.16 mha in 2021–22, producing 37.70 mt with an average yield of 1,292 kgha^{-1}. The country produces a variety of oilseeds, including groundnut, soybean, sunflower, sesame, niger seed, mustard and safflower. According to official estimates, total oilseed production in 2021–22 reached a record 37.70mt, which is 1.75 mthigher than the 35.95 mt produced in 2020–21. Over the five-year period from 2015–16 to 2020–21, oilseed production in India grew at a compound annual growth rate (CAGR) of 7.7%. The major oilseed-producing states include Andhra Pradesh, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal. India is also one of the largest exporters of oilseed products (Anonymous, 2022).Andhra Pradesh is one of the leading states in India in terms of area and production of major edible oilseed crops. Groundnut, sesame and sunflower are the predominant edible oilseeds grown in the state, while castor is the principal non-edible oilseed crop. In 2021–22, the area under oilseeds in Andhra Pradesh was 0.91 m ha, with a production of 0.548 mt and an average yield of 603 kg ha^{-1} (Anonymous, 2023a). Castor (*Ricinus communis* L.) is an important non-edible oilseed crop in India, predominantly cultivated in arid and semi-arid regions. It belongs to the family Euphorbiaceae and is believed to have originated in Ethiopia. Castor seeds contain high oil content ranging from 45 to 50% and the crop holds considerable industrial importance due to the presence of ricinoleic acid, a unique fatty acid. Castor oil is widely used in the manufacture of various industrial products such as soaps, printing inks, lubricants, cosmetics, pharmaceuticals and bio-based materials. (Patel et al., 2025). Furthermore, Castor, as a commercial oilseed crop, holds a significant place in the agricultural landscape of Andhra

Pradesh. It ranks second after groundnut in terms of acreage and economic importance within the state. India leads global castor production and dominates the international castor oil trade, accounting for 92% of the world's total castor oil output. In 2021, castor was cultivated across 7.547 lakh hain India, producing 15.08 lakht. In Andhra Pradesh, castor cultivation covered 0.351 lakh ha during 2021–22 (Anonymous, 2023b). Time-series analysis plays a vital role in forecasting agricultural prices by identifying patterns and trends in historical data. GARCH and EGARCH models are widely used for modeling price volatility, as they account for timevarying conditional variance and volatility clustering, which are common features of agricultural price series. While GARCH modelsproposed by Bollerslev (1986) effectively capture volatility clustering, their symmetric structure limits their ability to reflect asymmetric responses to positive and negative price shocks (Raju and Kumar, 2025).These forecasting methods have been extensively applied in agricultural research. Hazarika and Phukon (2025) demonstrated the usefulness of ARIMA models in forecasting sugarcane production in Assam. Hybrid modeling approaches further enhance forecasting accuracy by integrating mean and volatility dynamics. Dritsaki (2018) showed that hybrid ARIMA–GARCH models improve oil price forecasting performance, while Ghani and Rahim (2019) successfully applied an ARMA–GARCH framework to capture volatility dynamics in Malaysia's natural rubber prices. Trendbased analyses have also been conducted by Maheshnath et al. (2024), as to examine changes in area, production, productivity and market prices of maize in Telangana, highlighting the importance of long-term trend analysis for effective agricultural planning.

2. Materials and Methods

The present study was held during January, 2011 to April, 2025 at Agricultural College, Bapatla, through use of secondary time series data on market prices of Adoni, Kurnool and yemmiganur markets of Andhra Pradesh, fromthe sources such as Agmarknet (www.agmarknet.gov.in). In this, various statistical tools such as ARIMA, GARCH and ARIMA-GARCH models were also been employed to model and forecast the prices, in addition to focus on its descriptive statistics and outlier detection techniques.

2.1. Linear and non-linear regression models

Statistical modelling mainly consistedin constructing a model, represented by a set of equations to describe the relationship of input-output variables of interest. From a realistic point of view, such relationship among variables in the fields of agriculture and biological sciences was generally 'non-linear' in nature. In such type of models, a unit change in the value of independent variable might not cause in an equivalent unit change in the dependent variable. Mathematically, a linear model was one in which all the parameters appeared linearly; in contrast to this, in nonlinear model at least one of the parameters appearednonlinearly (Draper and Smith, 1998).

In the present investigation, a set of selected linear and nonlinear regression models as listed in Table 1, such as Linear, Quadratic, Cubic, Logarithmic, Power and Exponential were fitted to the data as due to its wide applicability in the forecasting studies, as reported by Maheshnath et al., 2024.

Table 1: List of linear-nonlinear models

Sl. No.	Name of the model	Model form
1.	Linear model	Y_t=a+bt+e_t
2.	Quadratic model	Y_t=a+bt+ct^2+e_t
3.	Cubic model	Y_t=a+bt+ct^2+dt3+e_t
4.	Logarithmic model	Y_t=a+b ln (t)+e_t
5.	Power model	Y_t=a tb+et
6.	Exponential	Y_t=a*Exp (bt)+e_t

2.2. ARIMA model

ARIMA (p,d,q) model which wasa combination of Auto Regressive (AR) and Moving Average (MA) with an order of integration or differencing (d), where p and q werethe order of auto correlation and moving average respectively (Box and Jenkins, 1976) was selected.

The Auto-regressive model of order p denoted by AR (p) wasas follows:

$Y_t=c+Ø_1 Y_{t-1}+Ø_2 Y_{t-2}+\ldots +Ø_p Y_{t-p}+e_t$

The Moving Average (MA) model of order q or MA (q) can be written as:

$Y_t=c–θ_1 e_{t-1}–θ_2 e_{t-2}– \ldots\ldots–θ_q e_{t-q}+e_t$

Where c was constant term, $Ø_p$ was the pth auto regressive parameter, $θ_q$was the qth moving average parameter and $e_t$wasthe error term at time 't'.

ARIMA in general form wasas follows:

$ΔdY_t=c+(Ø_1Δd Y_{t-1}+ \ldots +Ø_pΔdY_{t-p})–(θ_1 e_{t-1}+ \ldots +θ_q e_{t-q})+e_t$

where Δ denotes difference operator like

$Δ Y_t=Y_t-Y_{t-1}$ (data form of first order differentiation)

$Δ2 Y_{t-1}=ΔY_t-ΔY_{t-1}$ (data form of second order differentiation)

Here, Y_{t-1}, …, Y_{t-p} were values of past series with lag 1, …, p respectively.

2.3. GARCH model

GARCH wasa mechanism that includedpast variances in the elucidation of future variances. More specifically, GARCH wasa time series technique that allowed users to model and forecast the data series by considering conditional variance of the errors. If an ARMA model was assumed for the error variance, the model was called GARCH (Bollerslev, 1986).

The basic GARCH model has two equations; one equation wasto describe the behaviour of the mean and another to describe the behaviour of the variance. Here, mean equation (Y_t) was a stationary time series which mightbe either from a linear regression function that containeda constant or possibly some explanatory variables or it mightbe from AR model (Raju and Kumar, 2025).

The mean equation of model was $Y_t = c + \varnothing_1 Y_{t-1} + e_t$

Here e_t denoted the error of model, $e_t = v_t \sqrt{h_t}$

where, V_t was white noise with variance (σ_v^2) and h_t was the variance equation, and was given by, $h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1}$

Where, α_0 - Constant term

ε_{t-1}^2 - ARCH term this was the news about volatility from the earlier period, measured as the lag of the squared residuals from the mean equation model

h_{t-1} - GARCH term, it was the last periods forecast variance.

2.4. Hybrid model (ARIMA-GARCH)

Zhang (2001) proposed a hybrid approach that decomposed a time-series process into its linear and nonlinear component. The hybrid model considered the time-series Y_t as a combination of both linear and nonlinear components i.e., $Y_t = L_t + N_t$; where L_t and N_t represented the linear and nonlinear components present in the given data, respectively, which wereto be estimated from the data.

In the present study, ARIMA-GARCH hybrid model has been developed, by confirming the ARCH effect through ARCH-LM test.

This hybrid method of combining forecasting hadfollowing steps:

• First, a selected linear time-series model (ARIMA) was to be fitted to the data.

• At the next step, residuals of the fitted linear model, has to be verified for nonlinear component (ARCH effect). Let e_t denotedthe residual at the time t from the linear model, then $e_t = Y_t - L_t$

• Once the residuals of linear model confirmed the ARCH effect, then the residuals weremodelled using a selected nonlinear model (GARCH). And also obtain the forecast values, $\hat{N}_t$ for the residual series.

• Finally, the forecasted linear and nonlinear components werecombined to obtain the aggregated forecast values as $\hat{Y}_t = \hat{L}_t + \hat{N}_t$

Considering the selected diagnostic criterion like R^2, RMSE andMAPE, finally the best fitted model would be identified among various nonlinear models (linear, Cubic, Quadratic, Exponential and power models), time series models (ARIMA and GARCH) and Hybrid Times series models was selected. The hybrid approach was graphically represented in figure 1

3. Results and Discussion

From Table 2, it was confirmed that no outliers were detected by the Grubb's test during the study period. The prices of castor during this period fluctuated from 2800.00 to 6751.20 (₹ q-1), 2754.81 to 6252.67 (₹ q-1), and 2797.40 to 6350.35 (₹ q-1) for the Adoni, Kurnool, and Yemmiganur markets, respectively. Based on the recorded standard deviation values, it was inferred that the prices exhibited considerable scattering across the months.

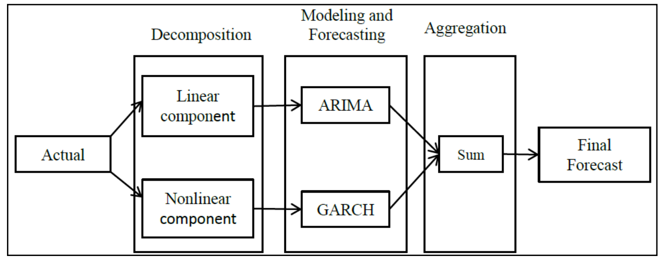

Figure 1: Flow chart of hybrid (ARIMA-GARCH) methodology

Table 2: Descriptive statistics for the prices of castor in selected markets

Castor prices (₹ q^{-1})	Adoni	Kurnool	Yemmiganur
Mean	4066.56	3931.96	3947.45
Minimum	2800.00	2754.81	2797.40
Maximum	6751.20	6252.67	6350.35
Standard deviation	1018.55	945.95	938.94
Outliers detected (Grubbs test)	No	No	No

Later, various selected linear and nonlinear regression models were applied to the castor prices of the selected markets during the study period. All the estimated parameters and goodness of fit measures by those models were depicted in Table 3. It was revealed from the results that among the fitted models, the maximum R^2 value of 42% was observed in case of cubic model with minimum values of RMSE (486.37) and MAPE (13.25) in comparison to those of the other models for Adoni market.

Likewise, the model parameters were also found to be significant at 5% level of significance. Hence it was concluded that cubic model was found as one of the suitable models to fit the Castor prices of Adoni market. Similar kind of report was obtained by Reddy et al. (2021) to fit the Prices and Arrivals of Turmeric in Duggirala Market. Similarly, the same kind of model was found to be suitable for other two markets also.

To apply the selected linear time series model (ARIMA), the stationarity of data series was first assessed using the Augmented Dickey-Fuller (ADF) test. As shown in Table 4, all market price series were non-stationary in their original form but attained stationarity after first differencing, with the null hypothesis rejected at the p=0.05 level of significance (p-value=0.01<0.05).

From Table 5, using the diagnostic criteria of highest R^2 (0.884), lowest AIC (2071.63), RMSE (314.54) and MAPE (5.72) values, along with the statistical significance of all estimated parameters at the p=0.05 level of significance, the ARIMA (2,1,2) model was identified as the most suitable

Table 3: Fitting of linear and nonlinear regression models for prices of castor in selected markets

Market	Model	Parameters estimates				R^2	RMSE	MAPE
		Constant	b_1	b_2	b_3			
Adoni	Linear	2819.21	16.73			0.497	720.26	18.24
	Logarithmic	2228.9	457.09*			0.185	919.45	15.59
	Quadratic	4026.99	-31.56*	0.32**		0.598	488.49	12.34
	Cubic	3901.8	-21.65*	0.15**	<0.01**	0.651	486.37	13.25
	Power	2635.94	0.1*			0.174	911.93	20.77
	Exponential	2990.6	<0.01			0.496	693.81	17.53
Kurnool	Linear	2791.32	15.31			0.481	678.9	16.84
	Logarithmic	2309.65	403.53*			0.162	862.87	13.48
	Quadratic	3880.41	-28.25*	0.29**		0.608	482.81	12.1
	Cubic	3861.6	-26.76*	0.26**	0.001**	0.628	482.76	10.36
	Power	2627.64	0.098			0.157	855.7	11.47
	Exponential	2929.9	0.01			0.478	656.57	12.13
Yemmiganur	Linear	2785.66	14.59			0.507	657.1	18.13
	Logarithmic	2248.15	422.67*			0.181	847.21	23.18
	Quadratic	3822.24	-25.86*	0.28**		0.617	479.78	15.42
	Cubic	3830.1	-26.49*	0.29**	0.01**	0.643	474.77	10.16
	Power	2588.7	0.09*			0.179	838.03	27.16
	Exponential	2928.02	<0.001			0.511	633.17	20.12

**: Significant at p=0.01 level, *: Significant at p=0.05 level

Table 4: Result of ADF test for the prices of castor in selected markets

Castor	Data type	ADF statistic	Critical value (p value)	Decision
Adoni	ADF at level	-2.47	0.37	Data non-stationary
	ADF at 1st difference	-4.98	0.01	Data became stationary
Kurnool	ADF at level	-2.50	0.36	Data non-stationary
	ADF at 1st difference	-6.21	0.01	Data became stationary
Yemmiganur	ADF at level	-2.59	0.32	Data non-stationary
	ADF at 1st difference	-4.54	0.01	Data became stationary

for forecasting castor prices in the Adoni market. Applying the same criteria, ARIMA (1,1,1) and ARIMA (2,1,1) were found appropriate for modelingcastor prices in the Kurnool and Yemmiganur markets, respectively. Similar models have been stated in previous studies, such as ARIMA (2,1,1) for forecasting sugarcane production in Assam (Hazarika and Phukon, 2025) and ARIMA (1,1,1) for forecasting coconut production in India (Naveena et al., 2014).

Later, the basic GARCH model was also developed for the Adoni market Prices by using mean equation (Y_t), as a stationary time series of Autoregressive (AR) model. Before employing the GARCH model, the residuals of AR (1) model were verified for existence of ARCH effect. From ARCH-LM test, it was found that the residuals of mean equation model had heteroskedastic nature, as due to significant prob. value (0.007) at 5% LOS. Hence GARCH (1,1) model was developed by using AR (1) model and their model fit statistics were depicted in Table 6.

Now, residuals of the selected ARIMA model i.e., ARIMA (2,1,2) was also further verified for ARCH effect through ARCH-LM test. By this test, it was also concluded that residuals of ARIMA (2,1,2) model had heteroskedastic nature, as due to the significant prob. value (0.048) at p=0.05 LOS.

Similarly, for the Kurnool and Yemmiganur markets, the ARCH-LM test results were significant, with probability values of 0.0024 and 0.047. Consequently, the ARIMA (1,1,1)-GARCH

Table 5: ARIMA model fit statistics for selected market prices of castor

Castor	ARIMA model	Parameter estimates					Goodness of fit				
		Con-stant	Autoregressive Coefficient		Moving average coefficient		R^2	RMSE	MAPE	AIC	BIC
			AR_1	AR_2	MA_1	MA_2					
Adoni	(0,1,1)	16.76			-0.31**		0.872	317	5.78	2074.32	2086.23
	(1,1,1)	16.72	0.02*		-0.32*		0.877	316.99	5.74	2076.31	2088.18
	(1,1,2)	16.68	-0.40*		0.10*	-0.15*	0.880	317.78	5.81	2078.12	2090.97
	(2,1,1)	16.82	-0.28*	-0.14*	-0.02*		0.878	315.83	5.77	2077.27	2086.21
	(2,1,2)	17.62	0.67**	-0.51**	-0.98**	0.69**	0.884	314.54	5.72	2071.63	2081.45
Kurnool	(1,1,1)	14.2	-0.78**		0.66**		0.878	294.18	5.5	2058.47	2070.29
	(1,1,2)	14.36	-0.72*		0.64**	0.05	0.871	296.1	5.58	2060.58	2075.43
	(2,1,2)	14.3	0.14*	0.74	-0.31*	-0.69	0.87	298.42	5.63	2062.87	2074.75
	(2,1,1)	14.32	-0.68*	0.04	0.59**		0.868	298.4	5.66	2061.68	2075.53
Yemmiganur	(1,1,1)	12.92*	0.26*		-0.46*		0.904	274.09	4.72	2044.38	2058.26
	(1,1,2)	13.02*	-0.37*		0.20*	-0.21	0.905	272.64	4.7	2034.88	2049.73
	(2,1,1)	12.90*	-0.02*	-0.16*	-0.15*		0.911	263.89	4.62	2028.7	2036.51
	(2,1,2)	12.94*	0.90**	-0.88**	-1.07*	0.93	0.905	272.21	4.71	2032.34	2043.29

Table 6: Model fit statistics for GARCH & ARIMA-GARCH for selected market prices of castor

Castor markets	Model	Model form	RMSE	MAPE	R2
Adoni	GARCH	AR (1) - GARCH (1,1)	309.04	5.59	0.917
	ARIMA-GARCH	ARIMA (2,1,2) - GARCH (1,1)	312.80	5.68	0.890
	ARIMA	ARIMA (2,1,2)	314.54	5.72	0.884
Kurnool	GARCH	AR (1) - GARCH (1,1)	288.69	5.38	0.890
	ARIMA-GARCH	ARIMA (1,1,1) - GARCH (1,1)	285.90	5.32	0.904
	ARIMA	ARIMA (1,1,1)	294.18	5.50	0.878
Yemmiganur	GARCH	AR (1) - GARCH (1,1)	255.48	4.53	0.916
	ARIMA-GARCH	ARIMA (2,1,1) - GARCH (1,1)	249.02	4.45	0.929
	ARIMA	ARIMA (2,1,1)	263.89	4.62	0.911

(1,1) model was selected for Kurnool, and the ARIMA (2,1,1)-GARCH (1,1) model for Yemmiganur. Similar findings were reported by Ghani and Rahim (2019) for forecasting rubber prices in Malaysia.

From Table 6, it was observed that among the selected models, the hybrid models AR(1)–GARCH(1,1), ARIMA(1,1,1)–GARCH(1,1), and ARIMA(2,1,1)–GARCH(1,1) were found to be the most appropriate for the Adoni, Kurnool, and Yemmiganur markets, respectively, based on superior diagnostic criteria. The estimated parameters corresponding to these best-fitting models were presented in Table 7. Subsequently, residual analysis was conducted to assess the adequacy of the selected models. The residual ACF and PACF plots (Figure 2) revealed that none of the residual lags were significant, indicating that the residuals were independently distributed, thereby confirming the good fit of the selected models. A similar finding was reported by Dritsaki (2018), who concluded that the ARIMA–GARCH model outperformed other models in estimating oil prices.

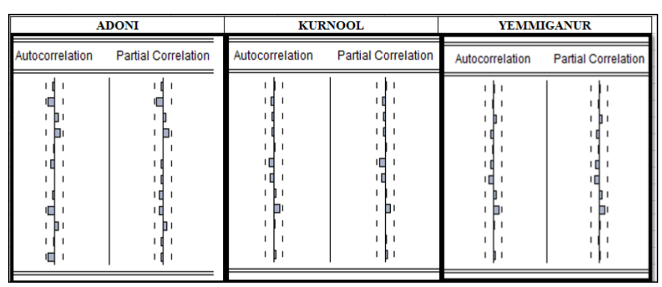

Figure 2: Residual ACF and PACF plot for GARCH and Hybrid models

Table 7: Estimated parameters for GARCH for selected market prices of castor

Type of model	Model form	Mean equation				Variance equation		
		Constant	AR_1	AR_2	MA_1	Constant	ARCH effect (α_1)	GARCH effect
GARCH model	AR (1) - GARCH (1,1)	13.38	-0.26*			5932.55*	0.13*	0.71*
Hybrid model	ARIMA (1,1,1) - GARCH (1,1)	21.01	-0.88*		0.77*	16046	0.12*	0.67*
Hybrid model	ARIMA (2,1,1) - GARCH (1,1)	22.49	0.08*	-0.19*	-0.2*	2654.27	0.54*	0.29*

**: Significant at p=0.01 level, *: Significant at p=0.05 level

Using the best-fitted models, forecasting was carried out up to February 2026. As shown in Table 8, the actual and forecasted values were closely aligned, further confirming the suitability of the selected models for the Adoni, Kurnooland Yemmiganur markets, respectively. The forecasted price for the Adoni market in April 2024 was estimated at ₹ 5498.54 q^{-1} l.

Finally, the actual and fitted graphs of Castor prices for Adoni, Kurnool and Yemmiganur markets were made by using AR (1) - GARCH (1,1), ARIMA (1,1,1) - GARCH (1,1) and ARIMA (2,1,1)-GARCH (1,1) models as depicted in Figure 3, which indicated as there would be slight increasing in the trend of Prices in future.

Table 8: Sample of predicted values using ARIMA-GARCH model

Period	Adoni			Kurnool			Yemmiganur		
	Actual	Forecasted	Forecast Error (%)	Actual	Forecasted	Forecast Error (%)	Actual	Forecasted	Forecast Error (%)
Jun-25	5562.54	5550.35	0.22	5433.89	5504.94	1.31	5648.21	5777.09	2.28
Jul-25	5578.33	5543.50	0.62	5800.67	5460.02	5.87	5839.50	5787.21	0.90
Aug-25	5677.14	5536.90	2.47	5701.53	5416.64	5.00	5839.34	5797.18	0.72
Sep-25		5530.35			5374.76			5807.04	
Oct-25		5523.86			5334.32			5816.78	
Nov-25		5517.43			5295.28			5826.41	
Dec-25		5511.07			5257.58			5835.92	
Jan-26		5504.77			5221.17			5845.33	
Feb-26		5498.54			5186.02			5854.62	

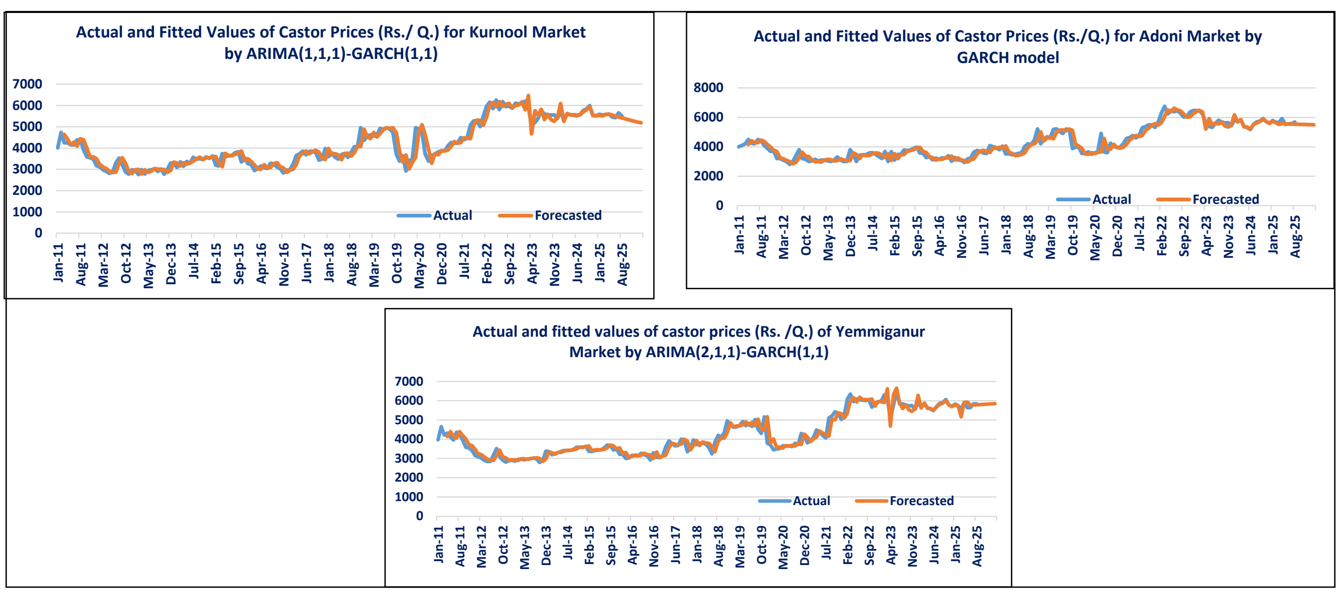

Figure 3: Actual and fitted values of castor prices in selected markets

4. Conclusion

Castor prices in Adoni, Kurnool and Yemmiganur markets showed high variability during 2011–2023. Hybrid ARIMA–GARCH models performed better than individual models. AR(1)–GARCH(1,1) was most suitable for Adoni, ARIMA(1,1,1)–GARCH(1,1) for Kurnool and ARIMA(2,1,1)–GARCH (1,1) for Yemmiganur, as evidenced by lower RMSE, MAPE, higher R^2 and insignificant residual autocorrelations. Finally, the forecasted values (₹ q^{-1}) of Feb-2026 were recorded as ₹ 5530.35 q^{-1}, ₹ 5374.76 q^{-1} and ₹ 5807.04 $q^{-1}$for Adoni, Kurnool and Yemmiganur markets respectively.

5. References

Anonymous, 2020. Agmarknet. Agricultural Marketing Information Network. Available from: https://agmarknet.gov.in/home. Accessed on: 7th October, 2025.

Anonymous, 2022. MoAFW: Ministry of Agriculture & Farmers Welfare. Available from:https://www.pib.gov.in/PressReleasePage.aspx?PRID=1852470&utm&reg=3&lang=2. Accessed on: 7th October, 2025.

Anonymous 2023a. Indiastat. Available from: https://www.indiastat.com/data/agriculture/rice/data-year/2022. Accessed on: 7th October, 2025.

Anonymous, 2023b. AMIC, PJTSAU. Agricultural Market Intelligence Centre, PJTSAU.Available from: https://www.pjtau.edu.in/files/AgriMkt/2023/February/castor-February-2023.pdf.Accessed on:7thOctober, 2025.

Bollerslev, T., 1986. Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics 31(3), 307–327. DOI: https://doi.org/10.1016/0304-4076(86)90063-1.

Box, G.E., Jenkins, G.M., 1976. Time series analysis: forecasting and control.In: A Very British Affair. Revised Edition, John Wiley & Sons, 161–215. ISBN 9781137291264. ISBN 1137291265. Available from: https://link.springer.com/chapter/10.1057/9781137291264_6.

Draper, N.R., Smith, H., 1998. Applied regression analysis. John Wiley & Sons. Vol. (326). DOI: 10.1002/9781118625590.

Dritsaki, C., 2018. The performance of hybrid ARIMA-GARCH modeling and forecasting oil price. International Journal of Energy Economics and Policy 8(3), 14–21. Available from: https://www.econjournals.com/index.php/ijeep/article/view/6437.

Ghani, I.M., Rahim, H.A., 2019. Modeling and forecasting of volatility using ARMA-GARCH: case study on Malaysia natural rubber prices. In: IOP Conference Series, Materials Science and Engineering 548(1), 012023. DOI: 10.1088/1757-899X/548/1/012023.

Hazarika, M., Phukon, K.K., 2025. Development of ARIMA model for forecasting sugarcane production in Assam. Indian Journal of Agricultural Research 59(6), 968–973. Doi: 10.18805/IJARe.A-6169.

Maheshnath, M., Kumari, R.V., Suhasini, K., Reddy, D.S., Meena, A., 2024. Trends in area, production, productivity and market prices of maize in Telangana state. International Journal of Research in Agronomy 7(9), 256–260. DOI: https://doi.org/10.33545/2618060X.2024.v7.i9Sd.1484.

Naveena, K., Santosha, R., Garima, S., Yogish, K.J., 2014. Forecasting of coconut production in India: a suitable time series model. International Journal of Agricultural Engineering 7(1), 190–193. Available from: https://researchjournal.co.in/Online/IJAE/IJAE%207(1)/7_190-193_A.pdf.

Patel, M., Devani, D., Agrawal, K., Malek, F., 2025. Evaluation of castor (*Ricinus communis* L.) based intercropping systems in South Gujarat: impact on growth, yield, resource utilization and economic viability. Plant Archives 25(1), 1051–1054. DOI: https://doi.org/10.51470/PLANTARCHIVES.2025.v25.no.1.157.

Raju, D.D., Kumar, M., 2025. Forecasting of onion price through GARCH and EGARCH time series models in Nasik District of Maharashtra. International Journal of Bio-resource and Stress Management 16(10), 1–6. DOI: 10.23910/1.2025.6124.

Zhang, G.P., 2001. Time series forecasting using a hybrid ARIMA and neural network model. Neurocomputing 50, 159–175. DOI: https://doi.org/10.1016/S0925-2312(01)00702-0.