1 Forecasting models for prices of sorghum in selected markets of Karnataka

For forecasting the sorghum prices in the selected markets, the monthly price data of sorghum for a period of 15 years (January 2009 to December 2024) was used. The last year's (July 2023 to June 2024) actual price values were also used for comparing with the forecasted values. The Box-Jenkins procedure was used to fit different Autoregressive models and to forecast the data. For building the model using the Box-Jenkins method, the data must be stationary. So stationarity of the data was tested using the Augmented Dickey-Fuller (ADF) test. Hence, the series were differenced once to obtain stationarity and it was found that the first differenced series were stationary as the ADF statistic was found significant. The detailed results of the test are given in Table 4.7

Table 1: Stationary test for monthly prices of sorghum in the selected markets

Augmented Dickey -Fuller Test			
Belagavi Market		Statistics	p-value
	Level	-2.8463	0.22
	Differenced	-5.4785	0.01

4.2.1 Forecasting the prices of Belagavi market

Based on the ACF and PACF plots given in Fig 4.7, the tentatively selected SARIMA model were SARIMA(2,1,2)$(1,0,1)_{12}$, SARIMA(1,1,0)$(1,0,0)_{12}$, SARIMA(0,1,1)$(0,0,1)_{12}$, SARIMA(0,1,0)$(1,0,0)_{12}$, SARIMA(0,1,0)$(1,0,1)_{12}$, SARIMA(4,1,0)$(0,0,1)_{12}$, SARIMA (4,1,0) $(1,0,1)_{12}$, SARIMA (1,1,1) $(1,0,0)_{12}$. The estimates of the parameters of the tentatively identified models were estimated by using least square principle. MAPE and BIC values were used to select the best model. The model statistics and Ljung-Box Q statistic of the tentatively identified models are given in Table 4.8

Table 2: MAPE, BIC and Ljung-Box Q statistic of tentatively selected SARIMA models for prices of sorghum in Belagavi market

Sl.No.	Models	Model Statistics		Ljung-Box Q	
		MAPE	BIC	Statistic	p-value
1	SARIMA (2,1,2) $(1,0,1)_{12}$	5.79899	1918.42	0.02659	0.8705
2	SARIMA (1,1,0) $(1,0,0)_{12}$	5.87747	1906.27	0.00062	0.9802
3	SARIMA (0,1,1) $(0,0,1)_{12}$	5.85351	1905.85	0.15044	0.6981
4	SARIMA (0,1,0) $(1,0,0)_{12}$	5.89928	1901.91	0.42935	0.5123

5	**SARIMA (0,1,0) $(1,0,1)_{12}$**	**5.79723**	**1901.18**	**0.20775**	**0.9285**
6	SARIMA (4,1,0) $(0,0,1)_{12}$	5.80146	1914.32	0.0202	0.8873
7	SARIMA (1,1,1) $(1,0,0)_{12}$	5.81341	1906.35	0.55287	0.4571

SARIMA (0,1,0) $(1,0,1)_{12}$ model was found to be the best model among the tentatively selected models as it had the lowest MAPE and BIC values. The estimates of the model parameters along with their standard errors of the SARIMA (0,1,0) $(1,0,1)_{12}$ are given in Table 4.9

Table 3: Estimates of parameters of SARIMA (0,1,0) (1,0,1)12 model for prices of sorghum in Belagavi market

Parameters	**Estimate**	**Standard error**	**t-value**	**p-value**
sam1	-0.7442	0.35433	-2.1003	0.03570*
sma1	0.82725	0.32513	2.5443	0.01095*

*Indicates Significant at 5% level

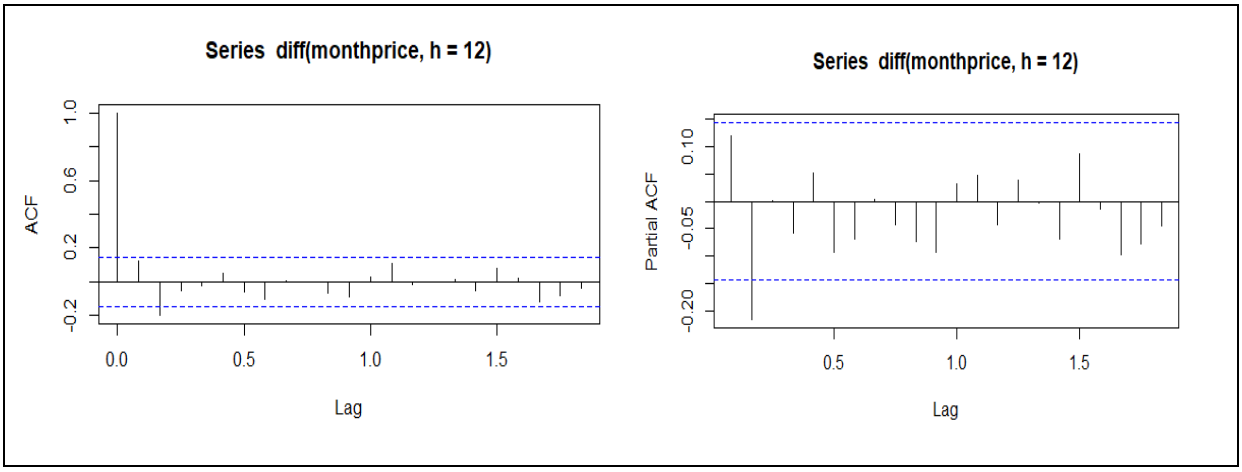

Fig. 1: Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots for prices of tomato in Belagavi market after differencing series by D =1

Residual ACF and PACF plots and Ljung-Box Q statistics were considered for diagnostic checking of the selected model. Fig. 4.8 indicated that the autocorrelations of the residuals were not significant in almost all the lags. In addition to that Ljung Box Q test statistic (Table 4.8) was not significant indicating that the residuals are uncorrelated. The diagnostic checking revealed that the SARIMA (0,1,0) $(1,0,1)_{12}$ model is adequately fitting to the prices series of the Belagavi market and hence the model is used for forecasting the sorghum prices of Belagavi market. The forecasted values of Belagavi prices by the SARIMA model are given in Table 4.15

Table 4: Forecasted values by SARIMA model for prices of sorghum in Belagavi Market

Sl. No.	Month and Year	Price Forecast by SARIMA $(0,1,0)\ (1,0,1)_{12}$			
		Actual (Rs)	Forecast (Rs)	Lower confidence limit (Rs)	Upper confidence limit (Rs)
1	Jal-23	4500	4198	3154	5241
2	Aug-23	5180	5212	3136	5287
3	Sep-23	5350	4202	3095	5308
4	Oct-23	5000	4193	3056	5331
5	Nov-23	6200	4219	3052	5386
6	Dec-23	7000	4210	3012	5407
7	Jan-24	7000	4215	3986	5445
8	Feb-24	5900	4207	3945	5445
9	Mar-24	5000	4206	3913	5468
10	Apr-24	5000	4216	3893	5498
11	May-24	5000	4218	3864	5539
12	Jun-24	4666	4211	3830	5578
13	Jul-24	NA	4214	3800	5627
14	Aug-24	NA	4203	3760	5646
15	Sep-24	NA	4211	3716	5683
16	Oct-24	NA	4217	3669	5717
17	Nov-24	NA	4198	3648	5727
18	Dec-24	NA	4205	3618	5727
19	Jan-25	NA	4200	3598	5762
20	Feb-25	NA	4207	3574	5783
21	Mar-25	NA	4208	3574	5816
22	Apr-25	NA	4200	3541	5842
23	May-25	NA	4199	3514	5859
24	Jun-25	NA	4201	3492	5883
25	Jul-25	NA	4202	3468	5935
26	Aug-25	NA	4209	3452	5967
27	Sep-25	NA	4204	3422	5986
28	Oct-25	NA	4119	3393	5005
29	Nov-25	NA	4214	3384	5043
30	Dec-25	NA	4208	3355	5062
31	Jan-26	NA	4211	3334	5089
32	Feb-26	NA	4207	3305	5109
33	Mar-26	NA	4206	3280	5132
34	Apr-26	NA	4212	3262	5162
35	May-26	NA	4213	3240	5086
36	Jun-26	NA	4211	3214	5208