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Forecasting of Arrivals and Prices of Major Pulses in Chhattisgarh Using ARIMA Models

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ABSTRACT

The study was undertaken to forecast the arrivals and prices of three major pulse crops in Chhattisgarh using the monthly time series data of total arrivals and average prices of three major pulse crops in the markets (*mandis*) of Chhattisgarh during April 2009 to December 2017(105 months). Since the data was seasonal, seasonal ARIMA models were fitted and the appropriate models were selected based on highest R^2, lowest RMSE, MAE, MAPE. The selected appropriate models were used for future forecasts of next two years. The results shows that the arrivals of all three pulse crops will follow the same pattern of seasonality for next two years while the prices do not show much variation but the month fetching highest prices are revealed.

Key words: *seasonal ARIMA, R^2, RMSE, MAE, MAPE, Forecast*

Pulses play a vital role in our lives. Pulses are the cheapest source of dietary proteins. The highest content of protein in pulses makes the diet more nutritive. India is one of the largest pulses producing country in the world. India is the largest producer, 25% of world's production, and consumes 27% of total pulses of the world. In India's total food grains Area, Production and Productivity Pulses contribute 18.92%, 6.791%, and 35.91% respectively (*Pulses in India: Retrospect and Prospects*). In Chhattisgarh, Rice is the foremost crop. Next to Rice, Pulses are grown in most parts of Chhattisgarh. Chhattisgarh contributes 3.57% of Area and 3.26% of Production of Pulses in India(*Pulses in India: Retrospect and Prospects*). Among Pulses, Pigeonpea, Chickpea, Moong/Urd, Lentil, Lathyrus and Pea are grown in different parts of Chhattisgarh. In this study three major pulse crops of Chhattisgarh *viz.* Chickpea, Pigeonpea and Lathyrus are taken.

Fluctuation or instability in prices is the greatest source of risk next only to weather in agricultural production system.The fluctuating characteristics of agricultural prices enter directly in the decision frame of farmers, both in production and marketing (Naidu *et al.,*). Forecasting is the process of making predictions of future, based on past data. Forecasting provides an important and useful input for proper, foresighted and informed planning in agricultural sector, which is full of uncertainties. Now a day's agriculture has become highly input and cost intensive. With the help of forecasted arrivals and prices, farmers can find the forecast for the specific month fetching high and remunerative price of their produce.

Plenty of work has been done on forecasting of arrivals and prices using ARIMA models. Barathi et al., (2011) worked on foresting of cocoon arrivals and prices in Ramanagram and Siddlaghatta markets, Darekar *et al*.,(2016) used ARIMA models for onion price forecasting in Kolhapur market, Naidu G M *et al.,*(2016) used the similar models for study of arrival and prices of maize in Andhra Pradesh, Dhakre and Bhattacharya (2014) worked on price behaviour of potato and their forecasting in Agra market using the ARIMA models.

MATERIAL AND METHODS

Collection of Data

Time series data on the monthly arrivals and prices of three major pulses required for the study is collected from the records of the corresponding Agricultural Market Committees and the website of Chhattisgarh State Agricultural Marketing(*Mandi*) Board, http://cg.nic.in/agrimandi/ . The data on monthly arrivals and model prices in individual markets are collected for the study period, i.e. 2009-10 to 2017-18 (105 months). The monthly arrivals of each market in particular month is added to get the monthly total arrivals in Chhattisgarh while for prices, geometric mean is taken of monthly prices of market where that particular pulse crop's arrival took place in that particular month.

ARIMA Model

The ARIMA(p,d,q) model can be represented by the following general forecasting equation:

$$Y_t = \mu + \sum_{i=1}^{p} \Phi_i Y_{t-i} + \sum_{j=1}^{q} \theta_j \mathcal{E}_{t-j} + \mathcal{E}_t$$

whereμ is the mean of series, the$\Phi_1, \ldots . \Phi_p$ are the parameters of the AR model, the $\theta_1 \ldots \theta_q$ are the parameters of the MA model and the $\mathcal{E}_t, \mathcal{E}_{t-1}, \ldots, \mathcal{E}_{t-q}$ are the noise error terms. The value

Table1. Fitted models for Arrivals of three major pulse crops in Chhattisgarh

Crop	Model	R^2	RMSE	MAE	MAPE
Chickpea	ARIMA(1,0,0)(1,1,1)[12]	0.73	28327.62	16687.62	36.4
Pigeon pea	ARIMA(1,1,1)(1,1,1)[12]	0.62	2404.21	1281.53	43.15
Lathyrus	ARIMA(2,0,1)(0,1,1)[12]	0.81	6864.72	4149.36	31.14

Similarly, Table.2 represents the appropriate model fitted for prices of major Pulse crop in Chhattisgarh.

Table 2. Fitted models for Prices of three major pulse crops in Chhattisgarh

Crop	Model	R^2	RMSE	MAE	MAPE
Chickpea	ARIMA(2,1,0)(2,1,1)[12]	0.94	237.97	156.04	4.57
Pigeon pea	ARIMA(1,1,1)(1,0,0)[12]	0.86	414.64	322.47	9.10
Lathyrus	ARIMA(0,1,1)(1,1,1)[12]	0.86	154.03	100.63	5.39

The appropriate ARIMA models which are represented in above tables were used to forecast the future arrivals and prices of the considered three major pulse crops in Chhattisgarh. The forecasted values of monthly arrivals and prices for next 2 years are given in the following table.3

Table 3. Forecasted Arrivals and prices of Major pulse crops in Chhattisgarh

Crop		Chickpea		Lathyrus		Pigeonpea	
Year	*Month*	*Arrivals*	*Prices*	*Arrivals*	*Prices*	*Arrivals*	*Prices*
2018	Jan	21921.99	4313.74	3879.02	1673.58	7125.22	4004.66
2018	Feb	29726.06	4188.29	12094.88	1517.27	14608.77	3933.95
2018	Mar	123104.98	4204.41	46951.41	1501.25	18508.18	3907.34
2018	Apr	134170.56	4273.00	34007.56	1579.64	11193.65	4150.17
2018	May	80659.01	4336.41	20416.43	1530.70	9025.12	4212.84
2018	Jun	85610.67	4313.64	16838.50	1572.27	9869.92	4085.87
2018	July	55779.84	4334.64	13428.14	1555.43	7212.21	4134.95
2018	Aug	38060.29	4402.21	14651.78	1569.64	6677.68	3924.87
2018	Sep	25923.81	4535.72	7969.13	1550.21	5575.68	4185.85
2018	Oct	25728.75	4489.08	10681.55	1637.05	4644.63	4049.52
2018	Nov	26499.44	4376.06	12683.29	1562.45	5097.18	3944.99
2018	Dec	32758.10	4298.56	7289.24	1539.50	5155.89	3710.07
2019	Jan	20599.31	4613.38	4062.53	1623.40	7401.88	3965.90
2019	Feb	28282.41	4427.75	11770.02	1480.56	16398.15	3897.50
2019	Mar	122498.31	4395.11	46893.95	1461.18	21729.03	3871.42
2019	Apr	134397.73	4543.79	33939.34	1538.48	13251.91	4113.07
2019	May	80367.28	4613.87	20388.77	1496.34	10886.00	4174.48
2019	Jun	85103.57	4885.70	16819.98	1544.74	12443.04	4042.48
2019	July	54977.44	4951.32	13418.67	1530.41	9180.51	4093.02
2019	Aug	37365.97	4935.84	14646.23	1541.28	8868.12	3893.71
2019	Sep	25791.08	5045.44	7966.10	1528.00	7098.39	4151.76
2019	Oct	25711.79	5197.31	10679.83	1615.54	5883.99	4012.80
2019	Nov	26032.29	5292.65	12682.34	1544.66	6954.37	3912.97
2019	Dec	32648.51	5365.35	7288.70	1519.27	7101.19	3678.94

of p is called the order of AR model while the value of q is called the order of the MA model.
Since seasonal data is taken for this study so ARIMA model will be extended readily to handle seasonal aspects and the general shorthand notation is

(p,d,q) P,D,Q) [s]

(Non seasonal part of model)(seasonal part of model) , s = number of periods per season

Criterion of Model Selection

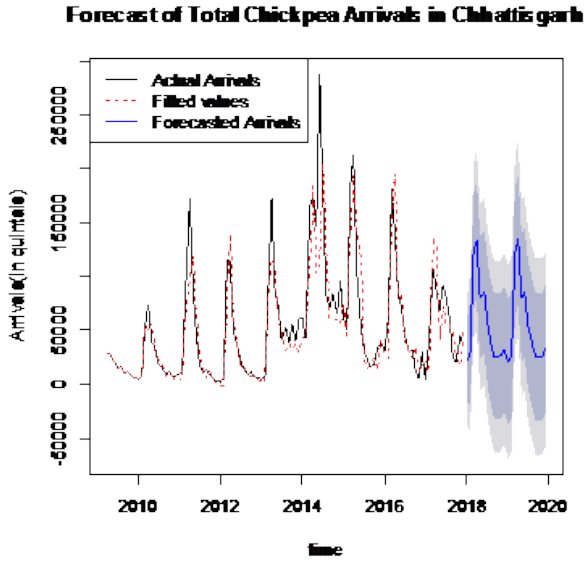
The best model for Arrivals and Prices of pulses in different markets is identified based on highest R^2, lowest Mean Absolute Percentage Error (MAPE), lowest Mean Absolute Error (MAE), and lowest Root Mean Square Error (RMSE) criterion. After analysis best model was identified; based on which the forecasting is done to forecast the Arrivals and Prices of major pulses in the markets of Chhattisgarh.

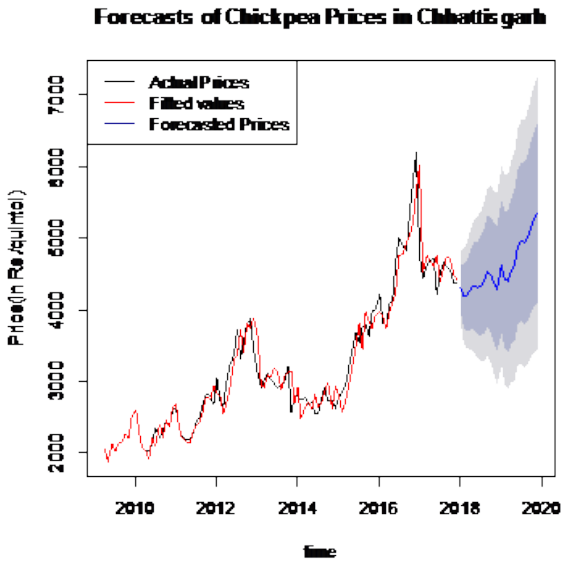
RESULTS AND DISCUSSION

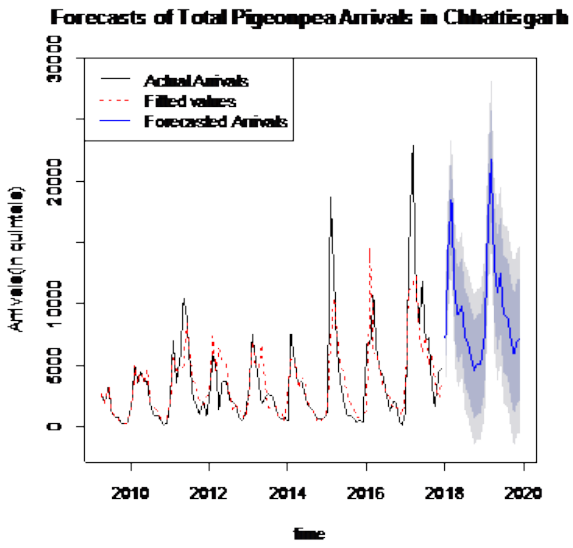
The monthly time series data of arrivals and prices of different pulse crops in Chhattisgarh is collected and it is observed that there is seasonality and non stationarity in the data which can be handled by using the ARIMA models. Different ARIMA models with different orders were tried and the appropriate ARIMA model was selected based on the highest R^2, lowest MAPE,MAE, RMSE. The following Table.1 represents the appropriate fitted model for arrivals of major Pulse crop in Chhattisgarh

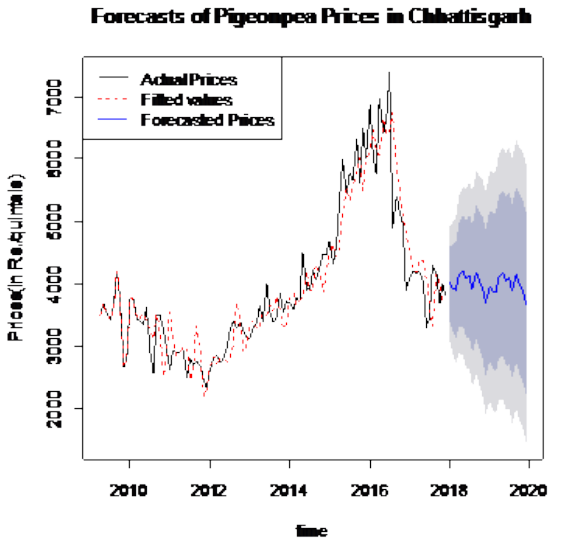
Forecasts projections

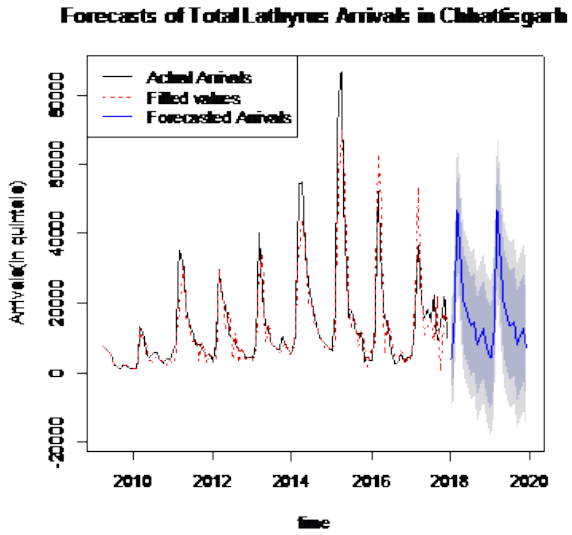
The forecasts projections of Arrivals and Prices of chickpea, pigeon pea and lathyrus are given below

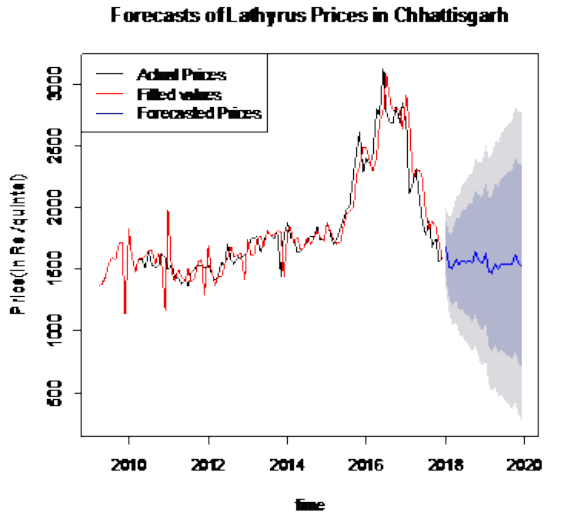












From Table.3, it is revealed that the maximum arrival of chickpea expected in the month of April of both the years 2018 and 2019 while the forecasted price of chickpea is showing the increasing behaviour over the next two years and highest price will be in the month of September 2018 and in the month of December in 2019. For lathyrus the maximum arrivals are expected in the month of March of both the years 2018 and 2019 and highest prices are expected in the month of January of both the year 2018 and 2019. Similarly for pigeon pea the maximum arrivals are expected in the month of month of both the years and highest prices are expected in the month of May in 2018 as well as in 2019.

From the graphs it is revealed that the chickepea arrivals and prices are also an increasing trend. Where as the pegionpea arrivals are an increasing trend but the prices are in discreasing trend. As the Lathyrus arrivals are an increasing trend but the prices are in discreasing trend for the coming two years.

CONCLUSION

The study concluded that the ARIMA models gave good fitting for the data with seasonality. The forecasted arrivals of all three pulse crops are following the same pattern of seasonality as of their actual arrivals and the maximum arrivals are expected in the similar months which were in study period. The forecasted price of chickpea is showing increasing trend over the next two years while the forecasted price of two other pulses not showing much variation but month fetching highest prices are spotted and stated above.

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