Forecasting Prices and Production of Pulses in Faisalabad Market, Pakistan

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Abstract
Forecasted values of prices and production are important for value chain actors because they can plan their activities while considering these values in mind for improving profitability. The present study is designed to determine forecasted values of production and prices of mung bean, lentil and chickpeas using arrival quantity of pulses in the big market of pulses in Punjab, i.e. Faisalabad. Similarly price data is used to forecast of future prices. Faisalabad market is among the big market of pulses in the province. ARIMA model is employed to determine forecasted arrival quantities and prices of pulses. Results show that there no smooth price increases in mung beans during different months of a year. This provides useful insights for the producers and wholesalers. They need to plan arrival quantities accordingly. Smooth increase in prices of chickpeas and lentil is useful for planning production activities by the producers while forecasted values of arrival quantities fluctuate in all three pulses. However, a declining value of lentil and chickpeas is an alarming indications for all the concerned value chain actors. Estimated values based on ARIMA models for price and arrival quantities of pulses have important implications for the producers and wholesalers dealing in pulses particularly chickpeas, mung beans and lentil. A declining forecasted value of lentil and chickpeas leaves a serious thought on the sustainability of value chain of these pulses in the province. Supply of lentil leaves a big question mark for value chain actors involved in this pulse value chain especially sustainability. A declining supply in the market with an increased in price in the coming years will affect stakeholders of this supply chain.

Keywords: Forecasted values, Production, Prices, Pulses

1. Introduction
Although the demand for pulses in Pakistan has increased significantly since 1960, pulses demand has significantly increased due to change in dietary habits, rapid population growth and awareness of their nutritional benefits for human health in the last few decades (Wu and Findlay 1997). Moreover, due to a change in dietary habits, consumers are consuming more pulses than ever before. The nutritional strength and other health benefits of pulses has increased not only the demand, but also prices of pulses have increased (Raza et al. 2022). On an average yearly pulses consumption is 6-7 kg/per person in Pakistan whereas per capita consumption of chickpeas is 3-4 kg and lentils consumption per person is 0.5-1 kg (Special One Grain, 2018). In 2018, Pakistan produced 0.7 Mt of pulses and consumed 1.5 Mt, implying that the country is not self-sufficient in pulses production and has to import a significant volume of 0.72 Mt (Ullah et al. 2020).

Dramatic increase in pulses consumption and stagnated pulses production has significantly increased the pulses import concern in Pakistan. That is why the government of Pakistan has banned pulses export in 2007 by imposing 35 percent export tax with less profitability. Little profitability leads to lowering the interest of farmers in increasing land area under production of pulses as a result of increasing profitability and competitiveness of production of pulses with other crops. Presently there exists a weak supply chain of pulses in Pakistan and is mainly controlled by private sector and farmers commonly sell their produce to the local dealers or collectors without cleaning or grading (Raza et al. 2022). Big wholesale markets are located at a far distance from pulses growing districts. Those big wholesale markets in Punjab include Faisalabad, Sargodha, Lahore, Multan and Rawalpindi. Since small farmers dominate in Pakistan’s agriculture economy, they are not able to sell their produce at these big wholesale markets. However, these big wholesale markets are integrated through price signaling where bidirectional relationships exist between them. Transmission channels of prices follow from the Sargodha market and followed by other markets in the region (Mushtaq et al. 2020).

However, farmers gain very little benefits of integration of big wholesale markets because of very little access to market information, lack of transport facilities, financial constraints, etc.

Raza et al. (2022) argue that farmers growing pulses gain less profitability. Little profitability leads to little interest in pulses production and allocation of few acres of land to pulses. Further, they emphasized that average yield of pulses in Pakistan is stagnant over the years mainly due to lack of availability of good quality seed, absences of improved value chain, poor marketing channel and lack of government policy support for pulses. Self-sufficiency in pulses can be attained if farmers have access to high quality seed with climate and pest resilience, in addition to developing a competitive value chain of pulses in Pakistan (Raza et al. 2022). Price fluctuation of pulses is another important determinant of supply in domestic market. Own price fluctuation of pulses and cross price flexibility have significant impact on supply of pulses in the country. Rani et al. (2012) find a positive growth rate in pulses whereas lentils and mung have relatively more price flexibility as compared to grams. So prices are important in making decision relating to production of pulses in the country. Fluctuation in prices and production uncertainty can lead to lowering the interests of the producers. Real domestic prices of pulses showed only marginal price increases until 2005, but since then prices increased almost

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four-folds (Ullah et al. 2020). Further, a decreasing tendency in cultivation area and production of pulses mainly mung bean and lentil over the last five decades is found, leading to increases in imported pulses to meet domestic demand (Ullah et al. 2020).

The province of Punjab is a major consumer and producer of pulses in Pakistan, while Faisalabad is one of the big wholesale markets in Punjab and Pakistan (Mushtaq et al. 2020). Increasing consumption of pulses over the time highlights the importance of a suitable policy framework regarding production and prices of pulses, so farmers and other stakeholders in value chain of pulses can attain benefits. Forecasting of production and prices of pulses is thus important for designing policies framework and pulses planning at national level to resolve the increasing concerns of demand supply gap (Amir et al. 2022). Thus it is imperative to study major pulse markets in Punjab to investigate supply-price relationship. Government and the stakeholders of pulses value chains can take informed decision based on the forecasted values of price and supply information. The present study intends to understand supply and price variation of major pulses in the wholesale market of Faisalabad.

2. Methodology

Faisalabad market is famous for wholesale market of pulses in Pakistan as the produce of pulses arrives in this market from different districts and regions of Pakistan. Commonly known districts of Punjab include Bhakkar, Layyah, Minawali, Khushab, etc. in addition to adjoining districts of KP province. Faisalabad is also famous for processing industry of pulses. Therefore, this district is considered to be very significant marketing place of pulses.

Data on arrival of three pulses (lentil, mung bean and chickpeas) and prices were obtained from Faisalabad Market. Data contained information on prices and arrival of pulses in the market on daily basis. Data on prices and arrival of pulses in the market don’t have any information relating to quality parameters. Agriculture Marketing Information System, Directorate of Agriculture (Economics and Marketing) Punjab, maintains daily record of prices and arrival of commodities in different markets of Punjab province through website (http://www.amis.pk/ViewPrices.aspx?searchType=1&commodityId=2). Minimum and maximum prices along with frequently quoted prices and quantity of agriculture commodities including pulses are reported. There is a little variation in the information on daily prices and quantity, monthly data is considered for the present report. Data on prices and quantity of chickpeas, lentil and mung beans considered in the manuscript ranges from January, 2018 to June, 2023. Data on price of pulses is measured in Rs/100kg and arrival quantity of pulses is given as 100 kg per month.

Prices and arrival quantities of pulses have trends, patterns and seasonality. Producers and wholesalers have to consider these information during making business plans. Effective forecasted values of future price and arrival quantities of pulses are important for producers and wholesalers. There are different methods to forecast values of prices and supply of agriculture commodities. Autoregressive integrated moving average (ARIMA) model is commonly used for time series data. This model provides unique results when the unit series of data have patterns, trend and seasonality (Gibson, et al., 2019). Prices and supply of mung beans, chickpeas and lentil are characterized with seasonality, trends and patterns, so ARIMA is employed in analyzing and forecasting future values of the above mentioned pulses.

There are three components of ARIMA model namely auto-regression (AR), differencing and moving average (MA). AR considers relationship between current observation and certain lag value of that observation. Differencing involves making data series stationary. MA considers dependency between current observation and a residual error from a moving average applied to the lagged observations.

ARIMA method is a powerful tool for short-term and medium forecasting and it has been widely applied to forecast values of agricultural commodities (Adil, et al. 2012, Iqbal et al. 2005, Chattha et al. 2013).

3. Results and Discussion

ARIMA model is used to forecast prices and supplies of three pulses (lentil, chickpeas and mung beans) in Faisalabad wholesale market. First selection of the best model is decided. Then forecast is estimated separately in this section.

3.1. Selection of the best model for prices of pulses

Akaike information criteria (AIC) is used to select the best model for forecasting price of chickpeas, mung beans and lentil in Faisalabad wholesale market. The lower value of AIC indicates the best model among the possible fit models for ARIMA. On the basis of AIC, ARIMA (8,1,11) is the best fit for forecasting price of mung bean in Faisalabad wholesale market. For chickpeas, ARIMA (0,1,2) is selected for the purpose. ARIMA (0,1,1) is the best model selected for forecasting price of lentil in Faisalabad wholesale market.

3.2. ARIMA analysis for wholesale prices in Faisalabad market

Table 1 provides information on the analysis of wholesale price ARIMA models for lentil, chickpeas and mung beans. In ARIMA (0,1,1) for lentil, intercept is non-significant while MA(1) coefficient is statistically different from zero. For chickpeas ARIMA model, intercept is significant, whereas coefficients of MA(1) and MA(2) are significant thus ARIMA (0,1,2) is considered. For mung bean, ARIMA (8,1,11) is used. Results of moving average with lag 2 are reported only because of the space, otherwise it is MA(11). Other statistics such as Durban Watson statistics show no autocorrelation in the data of prices of all three pulses.

3.3. Forecasting of wholesale prices of pulses in Faisalabad

Based on the estimates of ARIMA models, prices of pulses are forecasted for Faisalabad wholesale market for a period ranging from July, 2023 to June, 2025. In Fig 1 (a, b and c), actual and forecast values of wholesale prices of pulses are shown. One can see that price increases in lentil and chickpeas is smooth in the forecast time period. However, forecasted values of price of mung bean is not smooth over the forecasted time period (Fig 1, c). These results are consistent with existing literature where, pulses price growth remained consistent over the last five decades and mung prices showed flexible behaviors as compared to other pulses in Pakistan (Rani et al. 2012).
3.4. Selection of the best model for production of pulses
A total of 20 different ARIMA models are estimated and based on the AIC, the model with the lower value is taken for each arrival quantities of pulses in wholesale market of Faisalabad. Fig 2 shows AIC information for the top 20 best models. On the basis of lowest value of AIC, ARIMA (12,1,2) is the best model for forecasting arrival quantity of lentil in Faisalabad wholesale market and for chickpeas and mung beans, ARIMA (4,0,3) and ARIMA (3,0,2) are selected respectively.

3.5. ARIMA analysis for arrival quantities of pulses in Faisalabad market
Supply of pulses in the wholesale market of Faisalabad is estimated using ARIMA models. Different models are analyzed separately for each pulse supply. Table 2 shows results of ARIMA models for all three pulses considered in the report. For ARIMA model (lentil), AR values upto 12 are taken and the first values of AR are significant. Intercept and MA(1 and 2) are not significant. For chickpeas ARIMA model, intercept is found statistically significant, AR (1 and 3) coefficients are also significant whereas MA are non-significant. Considering ARIMA model for mung beans, intercept here is significant, coefficients of AR are statistically different from zero as well while those of MA are not significant.

3.6. Forecasting of arrival quantities in Faisalabad wholesale market
Fig 3 indicates arrival quantities of mung bean, lentil and chickpeas in the wholesale market of Faisalabad. Forecasted value of lentil records high ups and downs over the period of July, 2023 to June, 2025. The values also imply that supply of lentil will decline in the forecasted time period. It may be due a decline in area and or productivity of lentil in the province.

For mung bean and chickpeas, forecasted values of both pulses are not smooth but a declining indication is not found as it happens in the case of lentil. Since forecasted values are on monthly basis, arrival quantities during and after harvest season of mung bean(July-August) increases compared to other months, so overall supply is almost smooth. However, values of chickpeas over the
forecasted time period also alert both producers and wholesalers that a decline in arrival quantities of chickpeas in the market would happen.

**Table 2: Results of ARIMA for pulses production in wholesale market of Faisalabad**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Lentil</th>
<th>Chickpeas</th>
<th>Mung beans</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-0.02 (0.02)</td>
<td>11.05(0.14)***</td>
<td>11.12(0.12)***</td>
</tr>
<tr>
<td>AR (1)</td>
<td>.</td>
<td>-1.14(0.24)***</td>
<td>-0.25(0.04)***</td>
</tr>
<tr>
<td>AR (2)</td>
<td>1.29 (0.16)***</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>MA(1)</td>
<td>-1.06 (0.18)***</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>MA(2)</td>
<td>.</td>
<td>0.70(0.16)***</td>
<td>0.82(0.01)***</td>
</tr>
<tr>
<td>MA(3)</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>SIGMASQ</td>
<td>0.03(19.71)</td>
<td>0.04(2.59)</td>
<td>0.04(6.12)</td>
</tr>
<tr>
<td>Model</td>
<td>ARIMA (12,1,2)</td>
<td>ARIMA (4,0,3)</td>
<td>ARIMA (3,0,2)</td>
</tr>
<tr>
<td>Log likelihood</td>
<td>9.15</td>
<td>5.18</td>
<td>10.45</td>
</tr>
<tr>
<td>Durban-Watson test</td>
<td>1.91</td>
<td>2.00</td>
<td>2.10</td>
</tr>
<tr>
<td>Observations</td>
<td>59</td>
<td>60</td>
<td>60</td>
</tr>
</tbody>
</table>

**Fig 3: Forecasted and actual values of arrival of pulses** (a=lentil, b=chickpeas, c=mung bean)

4. Discussion

4.1. Price variation over the forecasted time period

Forecasted values based on ARIM models for the selected pulses provide an important insight on the variation in prices of these pulses in wholesale market in Faisalabad. Although forecasted values of lentils and chickpeas are smooth over the forecasted time period, price of mung beans is not found smooth. This may be due to the fact that Pakistan imports lentils and chickpeas when shortage of these pulses in the market happens. Moreover, Mung bean shortage can happen as it is substitute with other major crops (sugarcane, Maize, vegetables etc.) where it is relatively more sensitive toward weather (rain, heatwaves) and climatic factors (temperature). Chickpeas is highly concentrated in the barani areas of Bhakkar district and this district is vulnerable to climate change. Same is the case with mung beans. Climatic variations induce spread of pests and diseases in mung beans and chickpeas (Rani et al. 2012). Lentil supply is declining with the passage of time as cash crops are consuming areal allocated to lentil mainly due to the difference in profitability between lentil and cash crops (Vanzetti et al. 2017).

4.2. Arrival quantities of pulses in Faisalabad wholesale market

Arrival quantities of lentil is forecasted to decline substantially, although a small decline in the forecasted value for chickpeas is also found based on the estimation of ARIMA models. Mung bean supply during the forecasted time period doesn’t show an alarming situation. Supply fluctuations is expected to happen due to the fact that climate change has devastated effect on pulses in general and chickpeas and mung beans in particular. Chickpeas supply predominantly depends on the weather conditions (rainfall and temperature). Chickpeas is highly concentrated in the barani areas of Bhakkar district and this district is vulnerable to climate change. Same is the case with mung beans. Climatic variations induce spread of pests and diseases in mung beans and chickpeas (Rani et al. 2012). Lentil supply is declining with the passage of time as cash crops are consuming areal allocated to lentil manly due to the difference in profitability between lentil and cash crops (Vanzetti et al. 2017).

5. Conclusion and implications

Prices of pulses are forecasted to increase in the time period considered. No smooth price increases in mung beans during different months of a year provides useful insights for the producers and wholesalers. They need to plan arrival quantities accordingly. Smooth
increase in prices of chickpeas and lentil is useful for planning production activities by the producers while forecasted values of
arrival quantities fluctuate in all three pulses. However, a declining value of lentil and chickpeas is an alarming indications for all
the concerned stakeholders.
Estimated values based on ARIMA models for price and arrival quantities of pulses have important implications for the producers
and wholesalers dealing in pulses particularly chickpeas, mung beans and lentil. A declining forecasted value of lentil and chickpeas
leaves a serious thought on the sustainability of value chain of these pulses in the province. Further, the producers and wholesalers
can make their business plans in order to sustain livelihood.
Supply of lentil leaves a big question mark for the stakeholders involved in this pulse value chain especially sustainability. A
decreasing supply in the market with an increased in price in the coming years will affect stakeholders of this supply chain.

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