INTRODUCTION

Agriculture is the main sector in meeting the nutritional needs of people. The sustainability of the sector and fair distribution of production is the strategic goal of every country. For this reason, the concept of food security is gaining importance day by day. This concept is so important that it points to the problems of hunger and malnutrition in many countries in today's world. In this context, the agricultural sector is the production center of the protein that people need with plant and animal production. In some conditions, it becomes difficult to provide animal protein and people turn to plant sources. In plant sources, edible grain legumes come to the fore.

Legumes are grown in almost all parts of the world and 200 species are known to be cultivated (Akçin, 1988). Edible legumes are a source of protein for more than 2 billion people around the world. It is low in fat, high in carbohydrates and nutritious. 22% of plant-based proteins and 7% of carbohydrates in human nutrition in the world; 38% of proteins in animal nutrition and 5% of carbohydrates are obtained from edible legumes (Adak et al., 2010). On the other hand, animal feed is an important group in crop rotation due to its properties such as binding free nitrogen in the air. The role of legumes in the sustainable agriculture system can be listed as low carbon footprint, a healthy soil, fight against diseases and pests, saving water, importance in human nutrition and economics.

The proportional shares of the top 5 countries in terms of production area in the world for edible legumes during 2000-2017 are shown in Figure 1. India ranks first in terms of world edible legume production area. Turkey in the total amount of acreage and production amount is among the top 20 countries. However, it is seen that both the area and the production are in a decreasing trend (2000-2017).

Dry beans are a product included in irrigated farming systems and has a higher profit margin compared to other products. It is an important resource in meeting the protein needs of people with low income. In this study, dry bean projections with the ARIMA model have been made for the provinces of Central Anatolia Region and Turkey in general. The ARIMA model projected that there was an important volatility in the dry bean production areas over the years. As a result of the estimations, although a rising trend in the period up to 2023, especially after the estimate was made in 2021 will again switch to a down trend. In the light of the information obtained, it is recommended to eliminate the factors that will adversely affect the producer's production decisions. It is recommended to further support cost factors to provide price stability and to examine the actors in the supply chain.

Keywords: Fabaceae, Legumes, Dry bean, Vegetable protein, ARIMA model, Turkey.

PROJECTION OF DRY BEANS CULTIVATION AREA FOR TURKEY: CASE OF CENTER ANATOLIAN REGION

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Dry beans are an agricultural product within the legume family. It is a product included in irrigated farming systems and has a higher profit margin compared to other products. It is an important resource in meeting the protein needs of people with low income. In this study, dry bean projections with the ARIMA model have been made for the provinces of Central Anatolia Region and Turkey in general. The ARIMA model projected that there was an important volatility in the dry bean production areas over the years. As a result of the estimations, although a rising trend in the period up to 2023, especially after the estimate was made in 2021 will again switch to a down trend. In the light of the information obtained, it is recommended to eliminate the factors that will adversely affect the producer's production decisions. It is recommended to further support cost factors to provide price stability and to examine the actors in the supply chain.

Keywords: Fabaceae, Legumes, Dry bean, Vegetable protein, ARIMA model, Turkey.
world. Dry bean cultivation areas, which are mostly grown in Asia and America, were at the level of 25 million hectares between 1980-2000; however, it reached 34.5 million hectares in 2018 (FAOSTAT, 2020). Dry beans, as of 2018, it constitutes 36.04% of legume cultivation areas and 32.98% of legume production. India comes first in dry bean production, where these producers for Karaman, Konya, Nevşehir, Yozgat in the study area are given in Table 1.

| Provinces          | Cultivated Area (da) | Yield (kg/da) | Total Product (Tones) |
|-------------------|----------------------|---------------|-----------------------|
| 2009              |                      |               |                       |
| Karaman           | 51920                | 341           | 17712                 |
| Konya             | 162680               | 316           | 51477                 |
| Nevşehir          | 8170                 | 136           | 1109                  |
| Yozgat            | 11645                | 120           | 1395                  |
| 2019              |                      |               |                       |
| Karaman           | 89580                | 288           | 25826                 |
| Konya             | 148331               | 335           | 49664                 |
| Nevşehir          | 73259                | 295           | 21637                 |
| Yozgat            | 4315                 | 131           | 566                   |
| Disparity (%)      |                      |               |                       |
| Karaman           | 72.53                | -15.54        | 45.81                 |
| Konya             | -8.82                | 6.01          | -3.52                 |
| Nevşehir          | 796.68               | 116.91        | 1851.04               |
| Yozgat            | -62.95               | 9.17          | -59.43                |

A decrease is seen in Konya and Yozgat provinces in terms of cultivation area in the last 10 years (Table 1). In terms of production amount, it can be stated that similarly, there is significant decrease in Konya and Yozgat provinces.

Dry bean cultivation area, production amount and yield values in the last 10 years for the provinces of Karaman, Konya, Nevşehir and Yozgat in the study area are given in Table 1.

| Figure 2. Dry bean planting, production and yield distribution by years in Turkey (TURKSTAT, 2020). |

The last 15 years in Turkey beans production areas showed 42.50% decrease and 10% decrease in total production (Fig. 2). Yield increased by 55.82%. Despite the significant increase in yield, the same level of increase was not observed in total production due to the contraction in cultivation areas and other factors. Legumes share in Turkey field crops sowing area in the 1980s was 3%, which especially
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Narrowing of Fallow Field (NAD) in 1990 within the framework increased to 11.2%, while in 2014 decreased to 3.1% (Kün et al., 2005; TURKSTAT, 2019). The decrease in production is less than the cultivation areas, but limited studies, articles and reports on this subject are available for the reasons of the decrease. Many reasons have been shown such as high production costs, low produce prices, requiring intense labor (village population is old due to migration from rural to urban and the problem of finding seasonal workers), use of local varieties, diseases, weeds, and the varieties used are not suitable for mechanization (Adak, 2010; Ton et al., 2014; Ünüvar, 2014; Gülümser, 2016; Bolat et al., 2017; GDARP, 2019). However, the producer’s priority problems, the producer’s solutions to these problems, demands and concrete suggestions to guide policy makers were not presented.

In this study, dry bean planting area estimates were presented with ARIMA model. Konya, Karaman, Nevşehir, Yozgat provinces were determined as research areas. These provinces account for 35% of the total dry bean production area. Also made estimates for overall Turkey.

MATERIALS AND METHOD

In this study, cultivation/production projections has been made for Karaman, Konya, Nevşehir, Yozgat and Turkey. While making these projections, ARIMA (Autoregressive Integrated Moving Average) model was used with the help of the data set created with time series. The research period covers the years 2004-2018. 5-year estimates of cultivation areas are explained with the help of this model. It would be a correct approach to give information about the general structure of the ARIMA model. Autoregressive Moving Average (ARIMA) obtained from Autoregressive and Moving Average models are the most generally stationary Box-Jenkins models. Models that are applied to series that are not I (0) but become stationary as a result of the difference process are called "Autoregressive Integrated Moving Average" model. The purpose of Box-Jenkins models is to determine the model that fits the time series and to make predictions (Çelik, 2013).

Basic notation of ARIMA model;

\[(1 - \varphi_1 B - \varphi_2 B^2 - \cdots - \varphi_p B^p)(1 - B)^d x_t = (1 - \theta_1 B - \theta_2 B^2 - \cdots - \theta_q B^q)\epsilon_t \] 

It was used as ARIMA (p, d, q). Where; p: Degree of autoregressive model, d: The difference of the series, q: The degree of the moving average pattern

Box-Jenkins method consists of four basic steps. At the end of these stages, the model building efforts are terminated and predictions can be made by interpreting the results obtained.

RESULTS AND DISCUSSION

ARIMA model results for the dry bean growing areas in Turkey are given in Table 2.

Table 2. ARIMA Model for dry bean cultivation areas in Turkey.

| Variable | Coefficient | Std. Dev. | t-stat. | Prob. |
|----------|-------------|-----------|---------|-------|
| C        | -0.029138   | 0.0032    | -8.94880| 0.0000|
| AR(1)    | 1.919919    | 0.1248    | 15.38651| 0.0000|
| AR(2)    | -0.996835   | 0.1124    | -8.87111| 0.0000|
| MA(1)    | -1.064195   | 3337.3400 | -0.00032| 0.9997|
| MA(2)    | 0.271858    | 534.5889  | 0.00051 | 0.9996|
| MA(3)    | -1.064248   | 1173.4080 | -0.00091| 0.9993|
| MA(4)    | 0.999940    | 3933.2950 | 0.00025 | 0.9998|
| SMA(1)   | -0.999952   | 7998.8210 | -0.00012| 0.9999|
| SIGMASQ  | 0.001054    | 1.0818    | 0.00097 | 0.9992|
| R²       | 0.680634    | Ad. R²    | 0.5590  |
| F-statistic | 5.594398   | Prob(F-statistic) | 0.0007  |

The selected ARIMA model can be expressed as (2,4) (0,1) as indicated in Table 2. The lowest AIC (Akaike Information Criteria), which is taken into consideration in the model selection, was determined as -2.91827015474. The coefficient of determination obtained is 0.68 and represents the model at the level of 68%. The model is completely statistically significant at the p<0.01 level.

Turkey’s dry bean cultivation area forecast trend graph for 2023 is presented in Figure 3 by using the data of 1988-2018. Turkey has shown considerable volatility during the period taken to examine bean cultivation areas (Fig. 3). Especially in 2013 and 2018, the lowest level of cultivation area was observed. As a result of the estimation made, although there was an increasing trend in the period until 2023, but it was predicted that it would switch to a downward trend again, especially after 2021. Estimation of Turkey dry beans cultivation areas for 2023 year is given in Table 3.

Figure 3. Estimates of cultivated field dry beans for 2023 in Turkey.

![Figure 3. Estimates of cultivated field dry beans for 2023 in Turkey.](image-url)
The projections made according to the ARIMA model for Turkey's 2023 dry bean cultivation areas are presented in Table 3. It showed cultivation area about 892543 da. According to this, Turkey had a lower level of cultivation area by 2019.

Table 3. Estimates of field dry beans cultivation by 2023 in Turkey.

| Year | Cultivation Area (da) |
|------|-----------------------|
| 2023 | 892543.04             |

The results of ARIMA model for the cultivated area of dry beans in Karaman province are given in Table 4. These results stated that the accepted model is (2,1) (0,0). The AIC value was determined as 0.440034903926 based on the criteria for obtaining the lowest AIC value in the model selection criteria. The coefficient of determination of the model was obtained as 0.76, and it explains the model at 76% level. The whole model was found to be statistically significant at the p<0.01 level.

Table 4. Dry bean cultivation area in Karaman province as per ARIMA Model.

| Dependent Variable: Dry Bean Cultivation Area | Prob. Selected Model: (2,1)(0,0) | AIC: 0.440034903926 |
|-----------------------------------------------|----------------------------------|---------------------|
| Variable | Coefficient | Std. Dev. | t-stat. |
| C        | 11.39900    | 0.1378    | 82.704 | 0.0000 |
| AR(1)    | 1.68114     | 0.1105    | 15.209 | 0.0000 |
| AR(2)    | -0.88551    | 0.1178    | -7.514 | 0.0000 |
| MA(1)    | -1.00000    | 30143.9000| -0.000 | 1.0000 |
| SIGMASQ  | 0.03530     | 25.3420   | 0.001  | 0.9989 |
| R²       | 0.76311     | Ad. R²    | 0.6684 |
| F-statistic | 8.05336 | Prob(F-statistic) | 0.0036 |

The trend of dry bean cultivation areas in Karaman province between 2004-2018 and the forecast for 2023 are given in Figure 4. It can be said that the increasing trend continues until 2015. It can be projected that the cultivation area of dry beans, which is in a continuous decline in the following years, will decrease significantly by 2023.

The development course between 2004-2018 and the estimation for 2023 by the ARIMA model created for dry bean cultivation area in Konya is given in Figure 5. The dry bean cultivation area in Konya followed an up and down trend. Its highest level was observed in 2010 during the review period, but the lowest level was realized in 2013. When evaluating the 2023 forecast, it can be stated that it will not reach its level in the past years.

Table 5. Estimates of field dry beans cultivation by 2023 in Karaman province.

| Year | Cultivation Area (da) |
|------|-----------------------|
| 2023 | 70692.83              |

The results of ARIMA model for the cultivation area of dry beans in Konya is given in Table 6. The bean cultivated area for Konya province determined by ARIMA model was (0,2) (0,0). The smallest AIC value considered in determining the model was 23.0139046658. The determination coefficient of the model is 0.47 and it explains the model at the level of 47%. The model is statistically significant at the level of p<0.10.

Table 6. Dry bean planting area in Konya province as per ARIMA Model.

| Dependent Variable: Dry Bean Cultivation Area | Prob. Selected Model: (0,2) (0,0) | AIC: 23.0139046658 |
|-----------------------------------------------|----------------------------------|---------------------|
| Variable | Coefficient | Std. Dev. | t-stat. |
| C        | 1.59e+5     | 11564.24000 | 13.790 | 0.0000 |
| MA(1)    | 0.88819     | 0.27515    | 3.228  | 0.0080 |
| MA(2)    | 0.73461     | 0.33823    | 2.172  | 0.0526 |
| SIGMASQ  | 3.00000     | 1.37000    | 2.191  | 0.0509 |
| R²       | 0.47302     | Ad. R²     | 0.3293 |
| F-statistic | 3.29116 | Prob(F-statistic) | 0.0619 |

The development course between 2004-2018 and the estimation for 2023 by the ARIMA model created for dry bean cultivation area in Konya is given in Figure 5. The dry bean cultivation area in Konya followed an up and down trend. Its highest level was observed in 2010 during the review period, but the lowest level was realized in 2013. When evaluating the 2023 forecast, it can be stated that it will not reach its level in the past years.
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Estimation of dry bean cultivation area in Konya province by 2023 year is given in Table 7, which predicts that the 2023-year estimate for the dry bean cultivation area of Konya is 159469 da.

Table 7. Estimates of field dry beans cultivation by 2023 in Konya province.

| Year | Cultivation Area (da) |
|------|-----------------------|
| 2023 | 159469.25             |

The results of ARIMA model for dry bean cultivation area in Nevşehir province are given in Table 8. When the ARIMA model results were examined, the dry bean cultivation area in Nevşehir province were estimated as (2,1) (0,0). The lowest AIC value, which is the criteria for determining the model, was obtained as 20.7532823324. The coefficient of determination, which reflects the explanatory power of the model, was determined as 0.97, and it explains the model at the level of 97%. The model is generally significant and was found to be statistically significant at the p<0.01 level.

Table 8. Dry bean planting area in Nevsehir province as per ARIMA Model.

| Variable | Coefficient | Std. Dev. | t-stat | Prob. |
|----------|-------------|-----------|--------|-------|
| C        | 34402.19    | 5486.602  | 6.270219 | 0.0001 |
| AR(1)    | 1.893008    | 0.094457  | 20.04105 | 0.0000 |
| AR(2)    | -0.983549   | 0.056188  | -17.50463 | 0.0000 |
| MA(1)    | -0.999983   | 20422.90  | -4.90E-05 | 1.0000 |
| SIGMASQ  | 19267345    | 3.980000  | 0.000484 | 0.9996 |
| R²       | 0.973184    | Adjusted R² | 0.9625 |       |
| F-statistic | 90.72762  | Prob(F-statistic) | 0.0000 |       |

The development trend of dry bean cultivation area in Nevşehir province for 2004-2018 and the forecast for 2023 are given in Figure 6. It can be stated that dry bean cultivation area in Nevşehir has shown a decrease during the study period. According to the ARIMA model results, it is predicted that the cultivated area of dry beans will be in a decreasing trend until 2023.

Estimation of dry bean cultivation area in Nevşehir province is given in the Table 9 for 2023 year. The projection for the province of Nevşehir is as 20687 da for 2023 year.

Table 9. Estimates of field dry beans cultivation by 2023 in Nevsehir province.

| Year | Cultivation Area (da) |
|------|-----------------------|
| 2023 | 20687.16              |

The results of ARIMA model for dry bean cultivation area in Yozgat are given in Table 10. The bean cultivation area for Yozgat was determined by ARIMA model as (2,1) (0,0). The AIC value was 0.92355847735. The R² value, which reflects the explanation power of the model, is 0.89 and it can be stated that it explains 89% of the model. The created model is completely meaningful and statistically significant at p<0.01 level.

Table 10. Dry bean planting area in Yozgat province as per ARIMA Model.

| Dependent Variable: Dry Bean Cultivation Area | Prob. |
|-----------------------------------------------|-------|
| AIC: 0.92355847735                           |       |

| Variable | Coefficient | Std. Dev. | t-stat | Prob(F-statistic) |
|----------|-------------|-----------|--------|-------------------|
| C        | 9.728787    | 0.943168  | 10.31501 | 0.0000 |
| AR(1)    | 1.939875    | 0.142583  | 13.60524 | 0.0000 |
| AR(2)    | -0.973361   | 0.124417  | -7.82338 | 0.0000 |
| MA(1)    | -0.999999   | 29988.83  | -0.00033 | 1.0000 |
| SIGMASQ  | 0.053393    | 48.55202  | 0.00110  | 0.9991 |
| R²       | 0.897098    | Ad. R²    | 0.8559   |       |
| F-statistic | 21.79493 | Prob(F-statistic) | 0.0001 |

The trend of dry bean cultivation area in Yozgat between 2004-2018 and the forecast for 2023 are given in Figure 7. It can be stated that dry bean cultivation area in Yozgat has shown a decrease during the study period. According to the ARIMA model results, it can be said that dry bean cultivation area in Yozgat are in an increasing trend until 2023.

Figure 6. Prediction for field dry beans cultivation by 2023 in Nevsehir province.

Figure 7. Prediction for field dry beans cultivation by 2023 in Yozgat province.
Estimation of dry bean cultivation area in Yozgat province is given in the Table 11 for 2023 year. The cultivation area of dry beans in Yozgat can be predicted as 12818 da for 2023 year.

Table 11. Estimates of field dry beans cultivation by 2023 in Yozgat province.

| Year | Cultivation Area (da) |
|------|-----------------------|
| 2023 | 12818.27              |

**Conclusion:** Edible grain legumes are an important product group in agricultural production. The use of the products produced in this group is as animal feed, taking an active role in the sustainability of agricultural production, taking part in the planning of the agricultural product pattern, and being the main source of protein, especially for low-income people, make edible legumes stand out. Dry beans are also a product included in this group and is produced in irrigated farming systems. Dry beans are an important part of Turkey's agricultural production culture. Dry beans were observed in most growing areas throughout Turkey in 2010; however, the dry bean cultivation projection by 2023 is estimated 892543 da. It can be stated that the 2023 forecast is in a negative course in the provinces of Karaman, Konya and Nevşehir. In Yozgat province, it has been determined that the 2023 forecast is in a constantly increasing trend. In Turkey's agriculture, cost pressure, the presence of actors in the supply chain, extreme price fluctuations on the manufacturer reveals a negative situation. This can possibly be correlated with the cultivation of dry beans. The policy tools put forward by the Ministry of Agriculture and Forestry and other related public institutions were insufficient. It is important that the policy tools that may affect the decisions of the producers, increase in cultivation area of dry beans and maximize profit, include input-side supports. On the other hand, because of the excess and irregularity of the market actors, the price difference between the producer and the consumer also keeps the producer away from production. The efficiency of legal regulations and control mechanisms regarding supply chain and price volatility should be ensured. In addition, changing climate conditions affecting the whole world require new production systems and new methodologies. In this respect, the inclusion of relevant institutions and universities in the decision-making processes of manufacturers can be considered as an achievement.

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