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# Determining the future trends of safflower plant in Türkiye

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## Abstract

The aim of this study is to reveal the current situation of safflower in Türkiye, to make future forecasts about safflower planting area, production quantity, yield and producer prices. The Double Exponential Smoothing Method was used in time series analysis for future forecasts. The time series used were obtained from FAO and TUIK statistics. Five-year (2022-2026) future projections were made for the planting area, production quantity, and yield using safflower data between 1988-2021. For the producer prices, the data between the years 2004-2021 were used. According to the results of the study, it is forecasted that in the next 5 years, there will be a reduction average of 54 decares of safflower in the planting areas and an average of 515 tons of reduction in the production quantity each year. Producer prices are expected to increase by an average of 20% per year. Although it is predicted that there will be a very small increase in yield for each year, it is predicted that there will be a 2.5% yield increase at the end of 5 years. In order to prevent the decrease in safflower production and to increase production, it is recommended to provide purchase guarantee to producers, to support entrepreneurs, to carry out studies on modern cultivation practices, marketing and promotion.

## Keywords

Safflower, Future Forecast, Double Exponential Smoothing Method, Türkiye

## Introduction

Safflower (Carthamus tinctorius L.) is a plant species considered to have been domesticated in the Middle East. It is assumed that it was formerly cultivated for food coloring and fabric dyeing with the pigments found in its flowers (Knowles, 1980). In addition to its use in medicine, it is also used as bird seed (Dajue and Mündel, 1996; Ekin, 2005; Bergman et al., 2007, Emongor, 2010). New uses include special types of edible oils that improve human nutrition (Velasco and Fernández-Maryinnez, 2004), biofuel (Bergman and Flynn, 2009), easy isolation of oleosine proteins from safflower seed, and the production of transgenic pharmaceuticals (McPherson et al., 2004; Mündel and Bergman, 2009).

Safflower has been adapted to many semi-arid regions of the world (Mündel et al., 1997). Knowles (1989) described three general climatic areas to which safflower is most adapted: 1) areas like south central India, where the crop is autumn-sown in October or November into heavy soils moist from summer rains or irrigated and harvested in the dry spring; 2) areas that have a Mediterranean type climate like Australia, Mexico, Spain, Middle East countries, California in the USA, where typically the winters are moist and the summers are dry; and 3) areas that have a climate similar to the Northern Great Plains of the USA and Canada, where safflower is sown in the spring and harvested in the dry fall months of September and October (Emongor et al, 2017). In Table 1, the planting area (ha), production quantity (tons), and yield (hg/ha) of the countries that have a significant share in the world safflower production in 2020 are given.

While Kazakhstan ranked first among 13 countries in safflower seed production in 2020, this production quantity constitutes 34.72% of the total safflower seed production in the world. The first five countries (Kazakhstan, Russian Federation, India, United States of America, and Mexico) constitute 79.81% of the total production.

There are some publications explaining the reasons for the increasing popularity of safflower in the world. One of these is the potential medical benefit advocated by Gomashe et al. in 2021. According to Gomashe at al. (2021) safflower has pharmaceutical potential for the treatment of male and female infertility, cardiovascular diseases, reduction in the blood glucose level, treatment of cancer and reduction in the plasma cholesterol level, etc.

Safflower silage has shown potential as an alternative forage crop in semi-arid regions (Weinberg et al., 2002) and vegetal safflower can be used as a substitute for grain silages in the diet of high-yielding dairy cows without affecting their milk performance. Safflower pastures are often argued to be more than adequate for ruminants with moderate requirements for rangeland quality (Landau et al., 2005). There are many publications asserting that safflower is a non-polluting alternative fuel produced from renewable resources, whose chemical and physical properties are very similar to petroleum diesel fuel, with its use as biodiesel (Mishra & Goswami, 2017; Demirbas, 2007; Eryilmaz, at al., 2016). In this way, supplying some of the energy consumed worldwide with biodiesel may explain the increasing interest in safflower (Mihaela ve ark, 2013). Although the oilseed plant widely cultivated in Türkiye stands out as sunflower, safflower farming emerges as an alternative oilseed plant for Türkiye (Kolsarici ve ark.,2005, Ilkdogan & Olhan, 2012). It is thought that safflower cultivation was first practiced in Türkiye in the Marmara Region between 1940-1945 by immigrants from Bulgaria. (Babaoglu 2006). When we look at the quantity of safflower production between 2010-2021 and the planting area in parallel, an increasing trend is observed until 2015, while a rapid decline is observed in recent years (Table 2). Ilkdogan & Olhan, (2012) explained this decrease with the preference of transgenic species (soybean, rapeseed and cotton) worldwide. According to 2021 data, the 5 provinces where 65.5% of safflower production is made in Türkiye are Ankara (3974 tons), Aksaray (2232 tons), Kayseri (2201 tons), Konya (1340 tons) and Nevşehir (877 tons), respectively.

Table 1. World safflower planting area, production, and yield quantity in 2020 by country

| Country | Planting Area (ha) | Production Quantity (ton) | Yield (hg/ha) |
|---|---|---|---|
| Kazakhstan | 315.177 | 226.739 | 7.194 |
| Russian Federation | 174.974 | 96.636 | 5.523 |
| India | 85.475 | 44.000 | 5.148 |
| United States of America | 51.270 | 67.040 | 13.076 |
| Mexico | 50.414 | 86.793 | 17.216 |
| Argentina | 27.349 | 22.565 | 8.251 |
| United Republic of Tanzania | 25.170 | 13.721 | 5.451 |
| China, mainland | 22.724 | 33.404 | 14.700 |
| Uzbekistan | 18.324 | 8.885 | 4.849 |
| Türkiye | 15.114 | 21.325 | 14.109 |
| Kyrgyzstan | 9.836 | 9.870 | 10.035 |
| Ethiopia | 7.442 | 9.349 | 12.562 |
| Australia | 6.195 | 3.602 | 5.814 |
| Iran (Islamic Republic of) | 3.568 | 4.701 | 13.175 |
| Tajikistan | 3.438 | 4.293 | 12.487 |

Source: FAO, 2022

Table 2. Safflower planting area, production quantity, and yield in Türkiye

| Year | Planting Area (da) | Production Quantity (ton) | Yield (kg/da) | Producer Prices (TL) |
|---|---|---|---|---|
| 2010 | 135.000 | 26.000 | 193 | 0,54 |
| 2011 | 131.668 | 18.228 | 138 | 0,61 |
| 2012 | 155.918 | 19.500 | 128 | 0,64 |
| 2013 | 292.920 | 45.000 | 154 | 0,76 |
| 2014 | 443.050 | 62.000 | 140 | 0,79 |
| 2015 | 431.071 | 70.000 | 162 | 0,86 |
| 2016 | 395.710 | 58.000 | 147 | 0,95 |
| 2017 | 273.762 | 50.000 | 183 | 0,97 |
| 2018 | 246.932 | 35.000 | 142 | 1,19 |
| 2019 | 158.601 | 21.883 | 138 | 1,72 |
| 2020 | 151.150 | 21.325 | 141 | 2,41 |
| 2021 | 145.882 | 16.200 | 111 | 3,18 |

Source: TUIK,2022

The most basic agricultural policy instrument applied in Türkiye regarding safflower is the deficiency payment per kg, which has been implemented since 2006, in order to increase the production of this product, also known as premium support, diesel-fertilizer and domestic certified seed usage support payments. According to the data obtained by Ilkdogan and Olhan, (2012) from the producers engaged in safflower farming in the Central Anatolia Region, 40% of the producers find the agricultural support given to safflower satisfying, 30% because it is a good animal feed, and 20% because it is easy to grow safflower and 10% stated that they continue to plant safflower because they make good profits from safflower farming.

The aim of this study; to observe the changes in the planting area, production quantity, yield and producer prices for safflower cultivation in Türkiye in the coming years, to make forecasts about the future and to offer recommendations in line with these forecasts.

## Material and Method

### Material

In this study, safflower seed, which has an important place in the oil industry in Türkiye, but whose production is not sufficient, has been examined. The quantity of safflower production, planting area, and yield obtained from FAO (Food and Agriculture Organization of the United Nations) and TUIK (Turkish Statistical Institute) for the years 1988-2021 were examined and 5-year estimates were made for these years. As for the production prices, the data were used between the years 2004-2021. The reason for this situation is that the current data sources provide price data until 2004. In addition, the past and current policies about the safflower plant were evaluated in the study.

### Method

The situation in Türkiye's safflower market has been revealed with complementary statistics and the values that the production quantity, planting area, yield and price variables will reach in the next 5 years have been estimated and interpreted. Throughout the study, 34 years time series data covering the years 1988-2021 were used. In the study, Kolmogorov Smirnov test was used to determine whether each variable provides a normal distribution. According to the Kolmogorov Smirnov test, the non-normally distributed variable data was transformed into a normal distribution state by applying a transformation, and then the stationarity of the variable data was examined.

The "Double Exponential Smoothing" method was used to make future estimations of safflower production quantity, planting area, yield and producer prices. This method is preferred because of the last changes, jumps, monitoring of linear trend and exponential correction in the time series. The equations of this method are as follows.

Average: $A_t = \alpha Y_t + (1-\alpha)(A_{t-1} + T_{t-1})$

Current Trend: $CT_t = A_t - A_{t-1}$

Average Trend: $T_t = \beta CT_t + (1-\beta)T_{t-1}$

Prediction: $\hat{Y}_{t+1} = A_t + T_t$

In the equations, $A_t$ is the exponentially corrected mean of the series in the t period, $CT_t$ is the current trend in the t period, $T_t$ is the exponentially corrected trend in the t period, $\hat{Y}_{t+1}$ is the prediction for the next period, α is the correction factor for the mean ranging from 0 to 1, β shows the correction factor for the trend ranging from 0 to 1. In order to start the application of this method, initial estimates for the mean and trend are needed. In this study, very different combinations of α and β were tried and the combination that gave the best prediction was selected (Anonymous, 2016).

## Findings on the Future of Safflower Plant in Türkiye

### Safflower Planting Area Forecast

Time series data between 1988 and 2021 were used in the forecasts made for the planting area of safflower in Türkiye.

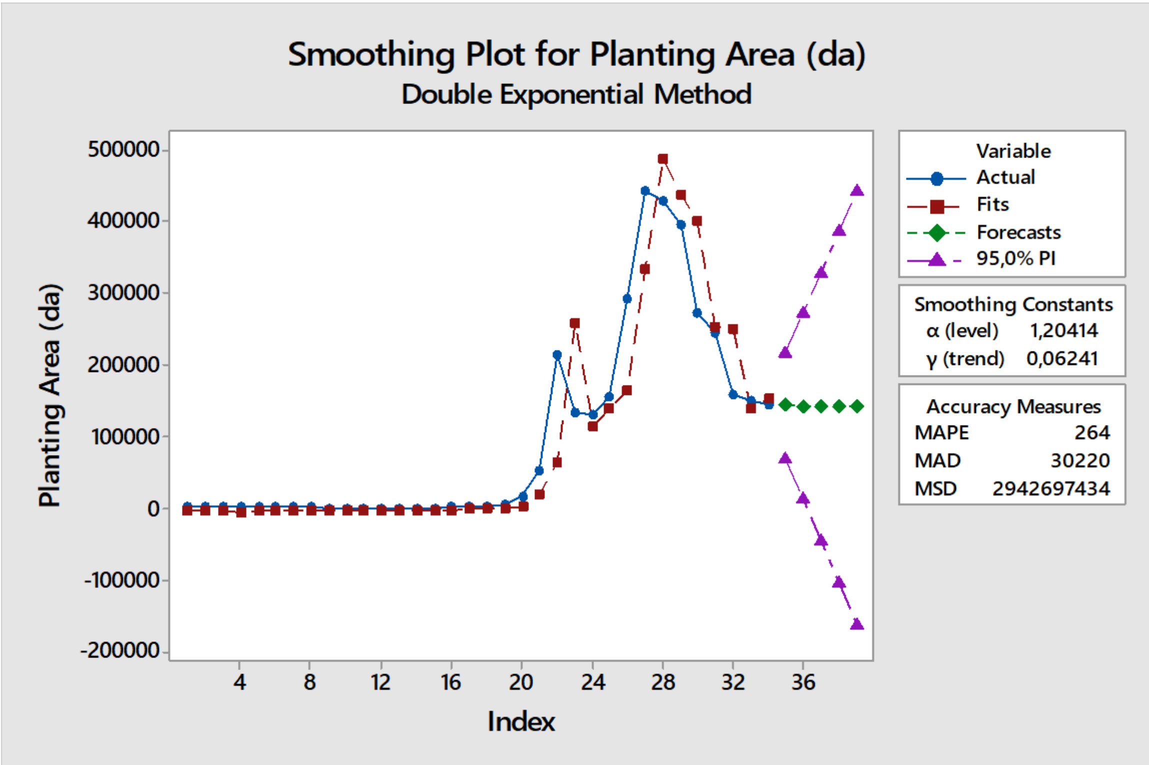


Figure 1. Safflower planting area forecast chart

As can be seen from Figure 1 in the projection made on the safflower planting area of Türkiye, it is seen that the planting areas will decrease gradually, if not very much, in the next 5 years. While there was 143.632 da of safflower planting area in 2022 in Türkiye, it is predicted that it will decrease to 140.950 da in 2026 (Table 3). In the worst case, provided that all conditions remain the same, it is predicted that safflower planting areas will reach the point of extinction (to be replaced by other products) in 2026. The most important reason for the decrease in safflower planting areas and production in Türkiye is the low safflower yield and safflower oil rate, and for these reasons, safflower cannot compete with plants grown under almost the same conditions (Baydar and Kara, 2010).

Table 3. Forecast of safflower planting area in Türkiye for 5 years (da)

| Years | Forecast Value | Maximum | Minimum |
|---|---|---|---|
| 2022 | 143.632 | 217.670 | 69.593 |
| 2023 | 142.961 | 272.781 | 13.142 |
| 2024 | 142.291 | 329.563 | 0 |
| 2025 | 141.621 | 386.845 | 0 |
| 2026 | 140.950 | 444.340 | 0 |

## Safflower Production Quantity Forecast

Time series data between 1988-2021 were used in the forecasts made for the production quantity of safflower plant in Türkiye.

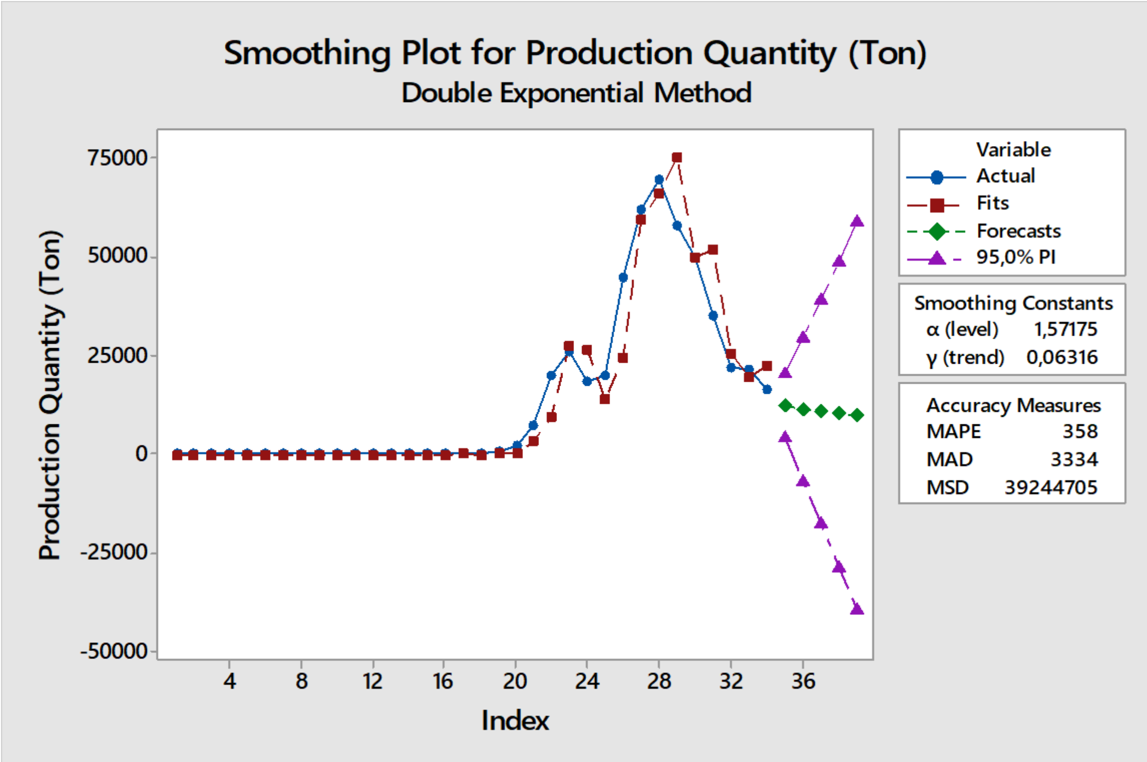


Figure 2. Safflower production quantity forecast chart

In the forecast made on the quantity of safflower production in Türkiye, as can be seen from Figure 2, it is seen that the gradual decrease in the production quantity will continue in connection with the decrease in the planting areas. In Table 4, it is predicted that the quantity of safflower production, which was 12,099 tons in 2022, will decrease to 9,525 tons in 2026. If other conditions remain constant, it is predicted that safflower production may come to a standstill in 2026 in the worst-case scenario. In order to increase safflower production and to provide economic benefits and efficiency, modern cultivation methods should be used, and new varieties with high yield should be developed by using advanced breeding methods (Baydar, Gokmen and Friedt, 2003).

Table 4. Forecast for 5-year safflower production in Türkiye (tons)

| Years | Forecast Value | Maximum | Minimum |
|---|---|---|---|
| 2022 | 12.099 | 20.267 | 3.932 |
| 2023 | 11.456 | 29.845 | 0 |
| 2024 | 10.812 | 39.499 | 0 |
| 2025 | 10.169 | 49.170 | 0 |
| 2026 | 9.525 | 58.846 | 0 |

## Safflower Yield Forecast

Time series data between 1988-2021 were used in the forecasts made for the yield of safflower plant in Türkiye.

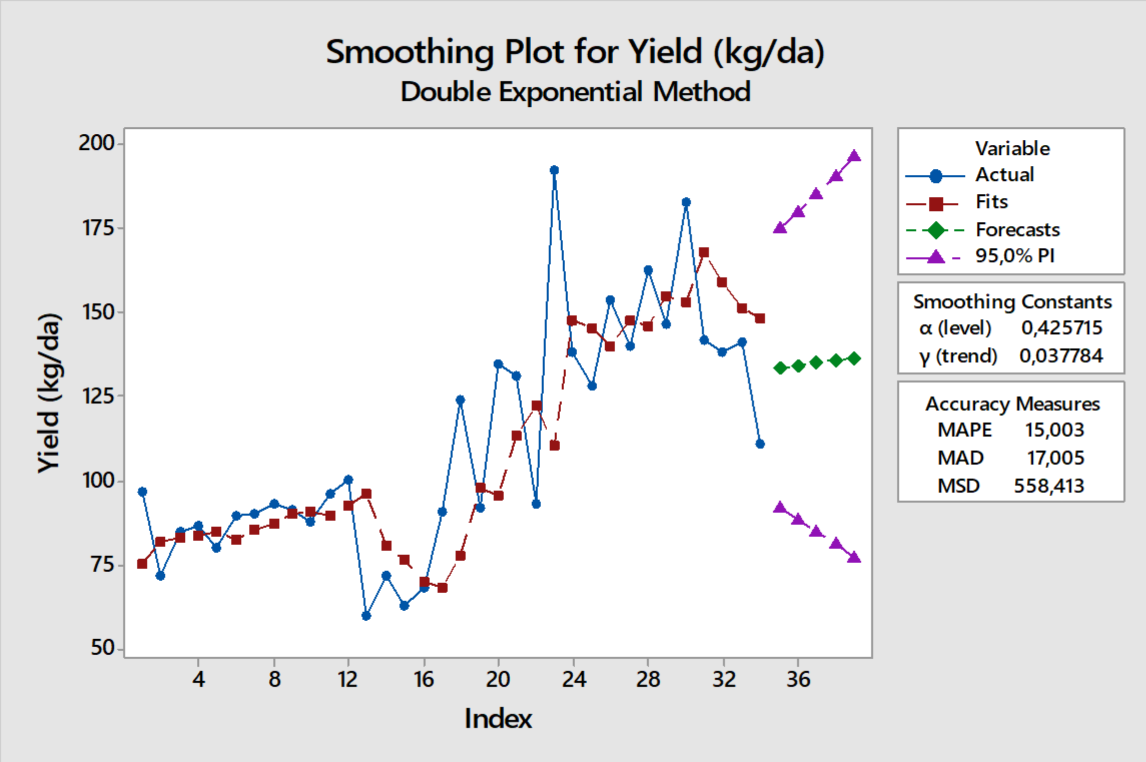


Figure 3. Safflower yield forecast chart

Forecast of safflower yield in Türkiye as seen in Figure 3, it is predicted that yield will increase contrary to the estimations of planting area and production quantity. While safflower yield is 133,4 kg per decare in 2022, it is predicted that it will be 136,7 kg per decare in 2026 (Table 5). When the literature studies on the subject are examined; Baydar et al. (2003), Baydar and Kara (2010), Baydar and Erbas (2016) suggested in their studies that the yield of safflower is not sufficient and that high yielding varieties should be developed. While there are currently 15 registered safflower varieties in Türkiye, 6 of them were registered in 2019 and their yield values are above the world yield averages. (TTSM, 2021). Aslan et al. (2019) also stated in their study on the examination of newly developed safflower varieties that the yield of new varieties of safflower is high. In addition, the yields of 5 countries (Kazakhistan: 72 kg/da, Russia: 55 kg/da, America: 130 kg/da, Mexico: 172 kg/da and India: 51 kg/da) that produced 80% of world safflower production in 2020 when examined, it is seen that Türkiye ranks first in safflower yield (FAO, 2021). For this reason, it is understood that the decrease in safflower planting area is not caused by low yield and the problem of low yield of safflower is resolved. While yield climatic conditions, precipitation regime, technological developments, etc. depending on factors such as, improvements in production techniques, improvement in the economic conditions of the producers, and the use of efficient varieties also have an effect on increasing the yield (Bolat et al. 2017). With the use of productive safflower varieties developed in Türkiye in recent years, the yield per unit area can be increased even more. As seen in Table 5, if all conditions remain the same, it is predicted that the highest safflower yield will be 196,7 kg per decare and the lowest 76,7 kg per decare in 2026.

Table 5. Forecast of safflower yield in Türkiye for 5 years (kg/da)

| Years | Forecast Value | Maximum | Minimum |
|---|---|---|---|
| 2022 | 133,4 | 175,0 | 91,7 |
| 2023 | 134,2 | 179,9 | 88,5 |
| 2024 | 135,1 | 185,2 | 84,9 |
| 2025 | 135,9 | 190,8 | 80,9 |
| 2026 | 136,7 | 196,7 | 76,7 |

## Safflower Price Forecast

In the forecasts made on the producer prices of the safflower plant in Türkiye, nominal price (TL: Turkish Liras) data for the years 2004-2021 were used. Different from the planting area, production quantity and yield, the data between the years 2004-2021 were used in the production prices. The reason for this situation is that the current data sources provide price data until 2004.

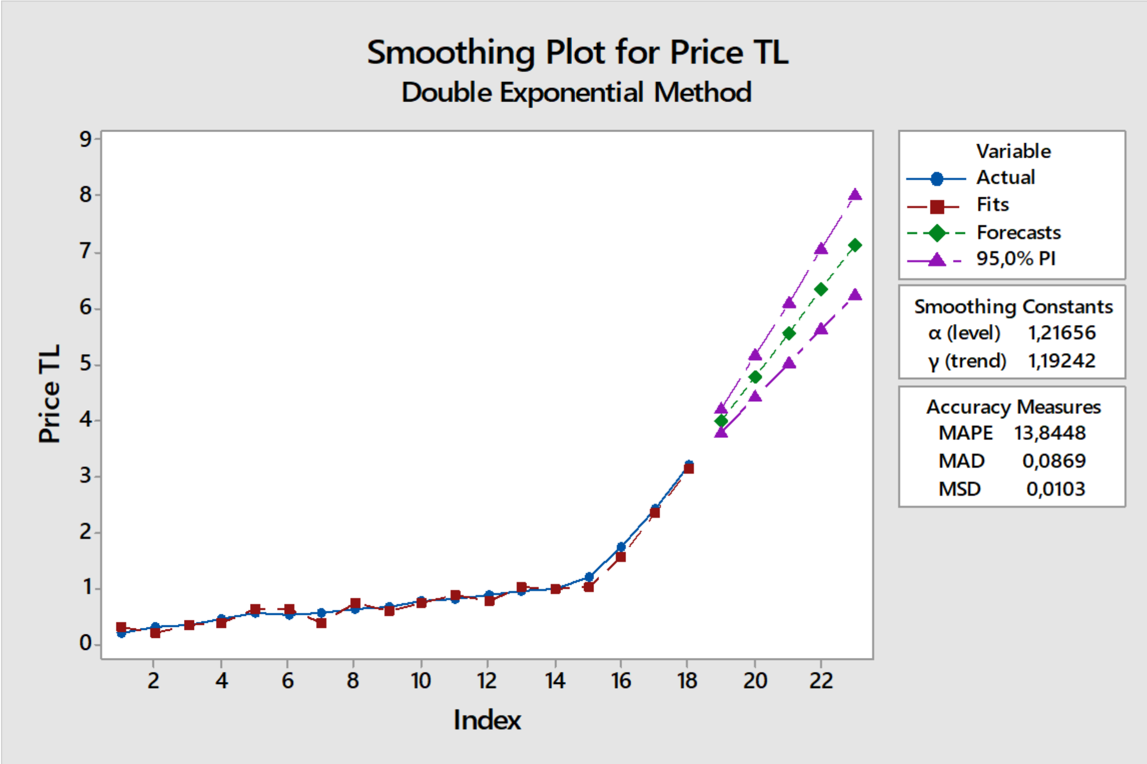


Figure 4. Safflower nominal producer price forecast chart

In the forecast made for safflower producer prices in Türkiye, it is predicted that there will be an increase in prices over the years, as seen in Figure 4. It is predicted that the producer price of safflower will reach 3,97 TL/kg in 2022 and 7,11 TL/kg in 2026 (Table 6). It is thought that safflower production will decrease further in the coming years due to the increase in producer costs. In addition to the decrease in production, the increased production cost has also been effective on the increase in safflower prices (Bolat et al, 2017).

Table 6. Forecast for 5-year nominal safflower producer prices in Türkiye (TL/kg)

| Years | Forecast Value | Maximum | Minimum |
|---|---|---|---|
| 2022 | 3,97 | 4,19 | 3,76 |
| 2023 | 4,76 | 5,14 | 4,38 |
| 2024 | 5,54 | 6,09 | 5,00 |
| 2025 | 6,33 | 7,04 | 5,61 |
| 2026 | 7,11 | 8,00 | 6,23 |

## Result

Safflower is a very important plant in terms of contributing to the biodiesel, dye, oil and feed industry, being easily adapted to the application of rotation, being effective in reducing fallow areas, being able to grow in different types of soil, not needing special equipment in the cultivation process, and contributing to the sustainability of agricultural production and employment.

While safflower has been included in the scope of support by the Ministry of Agriculture and Rural Affairs (former Republic of Türkiye Ministry of Agriculture and Foresty) since 2005 in Türkiye, product support per kilogram has been given, in 2006 deficiency payment support has been started and continues to increase every year. As a result of these supports, gradual increases were observed in production and reached the highest safflower production level in 2014-2015. After the years that reached the highest level, there was a decrease in production due to problems such as yield, oil capacity, marketing, and inability to compete easily with other products.

In recent years, the decrease in safflower production has continued. In the period of 2014-2021, safflower planting area 67% and production quantity 74% decreased. In addition, producer prices increased more than 3 times in the same period. According to the 5-year forecast results made in the study, it is predicted that there will be a decrease in the planting area and production quantity, while it is predicted that the yield and producer price will increase.

Safflower; in the next 5 years, it is predicted that there will be an average of 54 decares (It was calculated by taking the 2022 forecast value difference from the 2026 forecast value and dividing it by the number of forecast years) decrease in planting areas and an average of 515* tons of reduction in production each year. Producer prices are expected to increase by an average of 20% per year. Although it is estimated that there will be a very small increase in yield for each year, in total, there will be a 2.5% yield increase at the end of 5 years.

As a result of the examination of previous studies on the subject and research findings, the things to be done in order to prevent the decrease in safflower production in the future can be listed as follows;

Purchase guarantee should be provided for safflower production

Safflower should be evaluated within the scope of intervention purchases.

Safflower purchase price should be increased

R&D studies should be carried out to increase safflower production.

Entrepreneurs should be given incentives for the establishment of the safflower industry

Technical support should be given to farmers for safflower cultivation and modern cultivation should be ensured.

Facilitation should be provided in the supply of safflower seeds

By emphasizing the importance and benefits of safflower oil, it should be promoted on a consumer basis and demand should be created.

Safflower cultivation has also an important place in the feed industry. Therefore, it should be encouraged by goverment considering that factor.

## Compliance with Ethical Standards

### Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

### Author contribution

The contribution of the authors to the present study is equal.

All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

### Ethical approval

Ethics committee approval is not required.

### Funding

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### Data availability

Not applicable.

### Consent for publication

Not applicable.

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