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Organic Barley and Wheat Production Forecast: The Case of Ağrı Province

Ayça Nur ŞAHİN DEMİREL[1*]

[1]*Igdir University, Faculty of Agriculture, Department of Agricultural Economics, Igdir-Turkey (ORCID: 0000-0003-2988-8448)*

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Abstract

This study explains the trend analysis for organic wheat and barley production in Turkey-Ağrı province between 2021 and 2024. For organic product production, the organic agricultural farm area trend and the organic agricultural worker trend have been analyzed. Until 2015, it has been determined that there was an increase in the number of organic agricultural areas and workers, but between 2015 and 2020 the trend of stagnation and then the downtrend had been occurred. While a similar trend has occurred in organic wheat production, it has been determined that organic barley production has been increasing overall since 2008. For the estimations of 2021-2024 years in the organic farming area, number of workers, wheat and barley production in Ağrı province, the Exponential Growth Method was applied separately to the 2007-2020 data with the Quadratic Trend Analysis method and ideal estimation data were tried to be obtained. Within the scope of the forecast results obtained, organic barley production is expected to be on an upward trend in the coming years, while organic wheat production is expected to be the opposite. In the light of these analysis results, it is of great importance for agricultural producers to raise awareness of producers and turn the downward trends back into an upward trend.

1. Introduction

Nowadays technology is known to further reduce people's physical mobility in daily life via fast foods, internet orders, etc. [1,2]. This situation causes extreme weight gain and obesity risk by bringing in particular malnutritional habit. People who are in such a situation are looking for the remedy in dietary foods in order to return to their healthy lives. Barley which is the most remarkable product in healthy living and dietary products, stands out as one of the best dietary foods [3]. Barley contains almost all the nutrients necessary for a person in the right proportions. Barley also has many medical restorative properties with its water [4]. Especially, it can be used as an appetite regulator in addition to reducing body weight or controlling weight. Barley which is used in the production of various health tonics and malt beverages in industrial uses, proves to be an important product worldwide [5].

Wheat, another important nutrient as well as barley, is consumed worldwide and is considered one of the most important food products for humans [6,7]. Wheat is known to rank first among cultural plants in the world in terms of cultivation and production [8]. The first domesticated wheat production in history was grown in a limited area between the Tigris and Euphrates rivers of Turkey, which was called the "Fertile Crescent" at the time [6,7]. This situation shows how important Turkey plays in world wheat cultivation. While a grain of wheat contains a suitable feeding value for a person, it is the main food of approximately 50 countries due to the conveniences of storage and processing. Wheat provides the world's population with approximately 20% of the total calories from plant-derived foods [6,9]. In general, wheat is used in many foods and industrial sectors, especially bakery products.

*Corresponding author: aycanur.sahin@igdir.edu.tr
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Although Wheat and Barley are used in many fields in the industry, more production is provided in shorter periods with various modifications in order to meet the increasing demands in present conditions. In particular, this allows the introduction of genetically modified products to the market, which leads to the introduction of nutrients that are beneficial to human health, such as wheat and barley, into unhealthy forms. However, the awareness of organic food consumption that has emerged in recent years is gradually changing this situation. Organic products are generally defined as products that are natural, do not contain contamination in seeds and products, do not pose an additional risk of food poisoning, may contain more vitamins and minerals and secondary nutrients, i.e. vegetable foods, than traditional foods [6,9]. It is inevitable that conscious consumers will direct all producers to organic product production again in the long term, especially by directing them to organic products.

Given the general situation for Barley and Wheat, the past status of these products and the estimate of possible future productions may play a vital role in establishing a policy framework to find a sustainable solution to future food insecurity problems [10-14]. Specially, these estimates not only affect the price policy of the product produced, except that the fertilizer used in the production of the products, diesel fuel, certified seed, etc. it will also affect the pricing policy of expenses. In this study, production estimates have been made between 2021 and 2024 for Turkey's Ağrı province, which has become popular in Turkey in recent years and started organic wheat production in 2007 and organic barley production in 2008. As of 2020, the number of organic product varieties in Ağrı has reached to 23 different species [14]. In addition to organic barley and wheat, this province, where other products such as pears, sunflowers, sainfoin and clover are produced, is of great importance in terms of organic product production. While organic wheat production in Ağrı is 10.03% of the general organic product production throughout Turkey, it has a share of 12.62 % in organic barley production [14, 21]. These percentages were obtained in proportion to the total production of hundreds of organic products. In other words, these percentages will be obtained much higher when only wheat and barley are evaluated. This situation makes Ağrı province an organic barley and wheat production center. On the other hand, considering organic barley production, organic wheat production, number of workers and total production areas for Ağrı province, very striking results have been emerged. It has been determined that the downtrend after 2015, especially in wheat production, also affects the province of Ağrı, and this downtrend is expected to occur in the coming years. On the other hand, this trend for organic barley production has been determined to be the opposite. With this study, it is expected that organic barley and wheat production forecasts for Ağrı province will be a guide for both agricultural producers and auxiliary units in production (diesel suppliers, fertilizer producers, seed producers, etc.).

2. Material and Method

In this study, statistical data of the Ministry of Agriculture and Forestry of Turkey has been used for the annual number of agricultural workers in Ağrı, total area of production of organic products, total amounts of organic wheat and barley. Minitab software-Quadratic Trend Analysis (QTA) and Exponential Growth Model (EGM) methods have been used to do trend analysis in general for 2021-2024. QTA and EGM trend forecast methods have been used in all analysis methods to make the most ideal trend analyses. In QTA analysis, quadratic trend tests are performed to determine the coefficients of orthogonal polynomials and the possible future figure. Thus, the continuity course is determined according to the trend of the data. QTA has been used as a linear regression equation and this equation is;

$$Y_t = b_0 + b_1 t + b_2 t^2 \quad (1)$$

here, b_0 is for intercept; b_1 and b_2 are for the 1st and 2nd time variables, respectively; and t is for time [15-17].

Another method most commonly used in time-series analysis is Exponential Growth Method. In general, this method can give accurate forecast results when there is a tendency to continuously increase or decrease continuously in a series. The EGM formula is [15-17];

$$Y_t = b_0 + e^{b1t} \quad (2)$$

here b_0 is for intercept, b_1 is for time variable and t is for time. In order for the forecasts made as a result of trend analysis to be closer to reality, it is desirable that the historical data be in longer series. But in conditions where this is not possible, short-

term data can be made more regular by the Double Exponential Smoothing (DES) method in order to equalize the data fluctuation and obtain results closer to reality [16,17]. The DES was applied to some data in this study by making use of the double exponential smooth feature of the Minitab program. The data used for the years 2007-2020 have been generally accepted as short-term data and the DES method was applied in order to deal with some fluctuations in the data such as the number of workers and wheat production, and then estimate analyses have been carried out with QTA or EGM. The main purpose of choosing 3-year periods in both estimation analysis methods is that the data obtained in the past periods are defined as short-term intervals. In other words, data from 2007 or earlier periods must be found in order to carry out a longer-term forecasting study.

The numerical data obtained from the analysis were evaluated to compare the accuracy of the periodic forecasting analyses. These data are respectively Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD) and Mean Squared Deviation (MSD). The MAPE, MAD and MSD data are important for metric evaluations in the forecasts, and the analysis method with the smaller of these three values is preferred for a more consistent estimation [18-20].

3. Results and Discussion

After examining the statistical data made by the Ministry of Agriculture and Forestry since 2000, it has been determined that Ağrı had started producing organic wheat in 2007 and organic barley in 2008. When evaluated in general, for the province of Ağrı, which is still a baby producer, investigations of organic product production areas were made first.

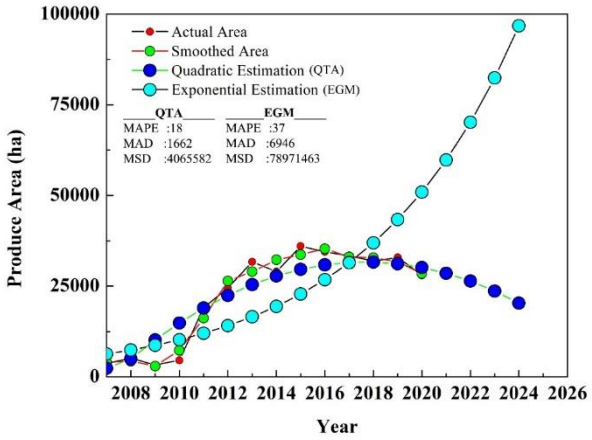

Figure 1. Total agricultural area used in the production of organic products for Ağrı.

Figure 1 shows the total amount of agricultural land used for all organic products produced in Ağrı. The level of agricultural land used for organic product production, which started in 2007, was at standard levels until 2010 and increased from 2010 to 2015. This situation indicates that the interest in organic product production had increased between 2010 and 2015 in Ağrı. In general, the organic product production trend, which reached saturation in 2015, has been seen to enter a downtrend between 2015 and 2020. In order to carry out organic product farmland trend analysis, DES method was applied first and data was prepared for QTA and EGM analysis. As a result of the trend analyzes in Figure 1, MAPE, MAD and MSD values for QTA and EGM were compared. For a more accurate future estimation, it was determined that the QTA method, where these 3 values are the smallest, is more suitable for 2021-2024 agricultural land forecasts. Accordingly, between 2021 and 2024, the amounts of agricultural land to be used has been given in Table 1.

According to the QTA results, 27990.3 hectares of agricultural land were used in 2020, compared to 30171.29 hectares according to the QTA estimate. The difference of 2180.99 hectares generally indicates that the QTA estimate is calculated accurately at the rate of 82%, according to MAPE value. Given that the accuracy estimate, which remains above 70%, is generally acceptable, it can be considered that QTA estimates are more accurate with 82%.

Table 1. Organic agricultural area trend analysis data of Ağrı.

Years	Actual Area (ha)*	Smoothed Area (ha)	QTA (ha)	EGM (ha)
2007	3727.96	4012.781	2372.52	6322.26
2008	5176.37	4337.712	4975.66	7422.775
2009	3301.87	2992.543	10206.59	8714.856
2010	4565.89	7334.928	14868.2	10231.85
2011	19038.68	16203.92	18960.48	12012.91
2012	24485.05	26427.38	22483.43	14103.99
2013	31742	29029.63	25437.05	16559.07
2014	28986.03	32261.58	27821.35	19441.51
2015	36038	33693.64	29636.33	22825.69
2016	34504	35326.11	30881.97	26798.95
2017	33341	33055.65	31558.29	31463.84
2018	31914.72	32862.84	31665.29	36940.75
2019	32920	31694.16	31202.95	43371.02
2020	27990.3	28499.01	30171.29	50920.61
2021			28570.31	59784.36
2022			26400	70191.01
2023			23660.36	82409.16
2024			20351.39	96754.11

*It was obtained from the organic agriculture statistics of the Republic of Turkey, the Ministry of Agriculture and Forestry.

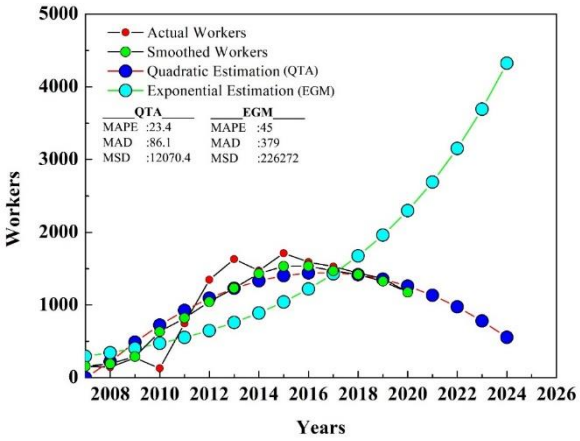

Figure 2. Trend analysis data on the number of workers working in organic agricultural areas in Ağrı

Figure 2 shows the total number of workers working in organic product production in Ağrı, as result of the trend analyses of QTA and EGM analyses. As with farming area data, a similar trend has emerged in worker analysis. While it was stagnant between 2007 and 2010, the number of organic agricultural workers increased between 2010 and 2015. Similarly, between 2015 and 2020, a stagnant and declining trend emerged. Due to fluctuations in the data between 2007 and 2020, the DES method has been applied to the data first and then QTA and EGM analyses have been performed. As a result of the trend analyzes in Figure 2, MAPE, MAD and MSD values were compared. It has been determined that the QTA method, where these 3 values are the smallest, is more ideal for the estimates of the number of workers for the years 2021-2024.

According to the Ministry of Agriculture and forestry data, there were 1175 employees of organic products in 2020, while according to the QTA analysis, this value has been estimated at 1261. After the QTA analysis, a difference of 86 people has been formed. The difference of 86 people has shown that the consistency of the forecast is 76.6%, according to MAPE value. This indicates that the QTA analysis will greatly confirm the expectations of the labor trend by 2024, that is, organic agricultural workers will decrease between 2021 and 2024. Especially the decrease in the organic agricultural area and the number of workers is an expected result being correctly proportional. However, the reasons of this decrease since 2015 need to be carefully examined. Therefore, it will be able to create auxiliary methods to investigate the production of organic wheat and barley in Ağrı, which is the basis of the study, and to understand the reasons for the downward trend.

Table 2. Organic agricultural worker trend analysis data in Ağrı.

Years	Actual Worker*	Smoothed Worker	QTA	EGM
2007	158	158	122	294

2008	147	192	221	344
2009	272	290	488	403
2010	130	633	723	473
2011	746	821	924	554
2012	1348	1044	1093	648
2013	1631	1233	1229	759
2014	1473	1432	1333	889
2015	1713	1531	1403	1042
2016	1590	1534	1441	1220
2017	1529	1469	1445	1430
2018	1439	1419	1417	1674
2019	1366	1326	1355	1961
2020	1175	1175	1261	2297
2021			1134	2691
2022			974	3152
2023			781	3692
2024			555	4324

*It was obtained from the organic agriculture statistics of the Republic of Turkey, the Ministry of Agriculture and Forestry.

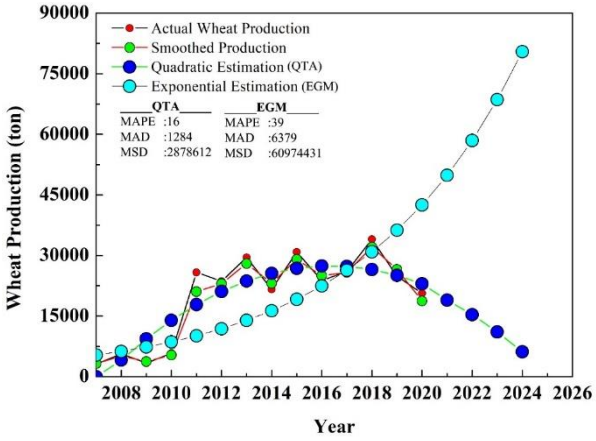

Figure 3. Trend analyses data for wheat production of Ağrı

In Figure 3, the analysis data of organic wheat production of Ağrı are seen between 2007-2020. Similar trends of increase and decrease are observed when examined together with Figure 1, Figure 2 and Figure 3. When the data of the Ministry of Agriculture and Forestry have been examined, it has shown that organic agriculture started with organic wheat production in Ağrı and then the product diversity has increased over the years. Again, according to these data, the fact that the highest amount of organic wheat production is made in Ağrı ensures that both the amount of organic agricultural land and the number of organic agricultural workers vary. In other words, the change in agricultural land area and the number of workers also affected wheat production in direct proportion.

Table 3 shows organic wheat production amounts between 2007-2020 and trend analysis results between 2007 and 2024. While 20636.41 tons of organic wheat has been produced for 2020, this value has been calculated as 22997.67 by QTA analysis. According to 2020 data, this difference of 2361.26 tons have revealed an accuracy rate of 84% overall. This suggests that forecasts made by QTA method can be reliable by 2024. It has been concluded that the QTA method, in which MAPE, MAD and MSD values are the smallest, is more reliable for estimating wheat production amounts for the years 2021-2024.

Although a downtrend is observed in organic wheat production compared to the number of agricultural land and workers formed after 2015, it has been determined as a result of the literature study that this situation is not only for the province of Ağrı [21]. Especially since 2015, wheat production has been on a downtrend throughout Turkey, and Ağrı has adapted to this trend [21]. The main reasons for this situation occurring throughout Turkey are that Turkey produces enough wheat only for itself, that production becomes more expensive than imports due to increasing exchange rates, COVID-19 that emerged in 2019 and with it the decrease in agricultural worker mobility and some political reasons can be cited.

Table 3. Trend analysis data of organic wheat production in Ağrı.

Years	Actual Wheat Production (ton)*	Smoothed Wheat Production (ton)	QTA (ton)	EGM (ton)
2007	3112.55	3245.36196	0	5354.97589
2008	5715.25	5138.76737	4108.31357	6280.24046
2009	3355.78	3771.93702	9361.45409	7365.37774
2010	5838.36	5356.04787	13945.68053	8638.01149
2011	25821.3	21044.621	17860.99288	10130.53847
2012	23626.37	23023.77854	21107.39113	11880.95312
2013	29535.13	28015.3522	23684.8753	13933.81483
2014	21633.93	23123.38174	25593.44538	16341.38219
2015	30883	29071.8713	26833.10136	19164.94335
2016	23786.1	25019.82205	27403.84326	22476.37618
2017	26058.21	25815.84573	27305.67107	26359.97807
2018	34017.1	32102.89153	26538.58479	30914.61178
2019	24867.41	26556.20291	25102.58441	36256.22218
2020	20636.41	18743.98546	22997.66995	42520.78778
2021			18962.47069	49867.78226
2022			15360.68811	58484.23412
2023			11097.06223	68589.48775
2024			6171.59306	80440.78718

*It was obtained from the organic agriculture statistics of the Republic of Turkey, the Ministry of Agriculture and Forestry.

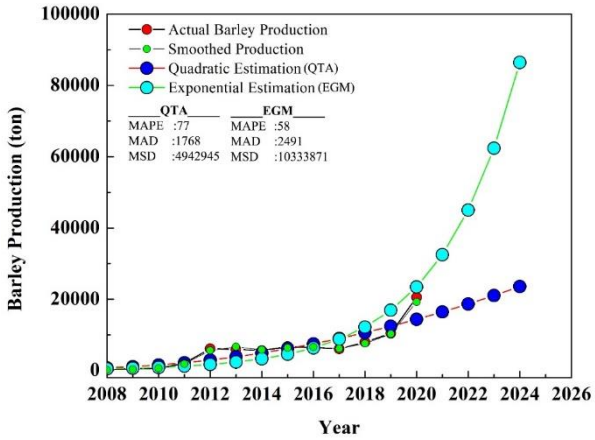

Figure 4. Trend analysis data of organic barley production of Ağrı

Figure 4, organic barley, which began production as of 2008, has consistently shown an increasing trend in the process until 2020. This situation differs more than organic wheat production. Table 4 provides actual production data for organic barley and QTA and EGM analysis results between 2008 and 2020. When the data for 2020 were examined, organic barley production, which is 20589.44 tons, has been estimated as 14375.93112 tons by QTA method, while EGM analysis has estimated this value as 23460.82883. In particular, the increase in actual production values until 2020 suggests that the EGM method may yield more probable results. MAPE, MAD and MSD values, which show the correctness of this idea, were compared in the two analyses methods (QTA and EGM). According to these values, it has been confirmed by numerical analysis that the EGM method is more reliable for barley production forecasts for the years 2021-2024.

When the organic product production of Ağrı is generally examined, the adventure that started with organic wheat production in 2007 had developed in an increase trend with the number of agricultural and agricultural workers until 2015. However, after 2015, this situation first entered into stagnation and then into the downtrend. Within the scope of the trend analyzes carried out until 2021, it was decided as a result of the examination of similar studies in the literature whether the analyzes between the years 2022-2024 will give correct results. In the Ruekkasaem and Sasananan [22] study, they compared the rice prices by traditional forecasting and time series analysis. After, examining has been made on forecasts results 12 different models depending on time series with different analysis methods [22]. The obtained results showed that as a result of the evaluation of MAPE, MAD, MSD values, the time series analyzes will give more accurate results for future forecasts. In another study, Sabır and Batuk performed time series analyzes on textile dyes, in 2013 [23]. Although the compared this study differs with organic products, it shows that time series trend analyzes can give accurate forecast results in different products and different applications. With their work, Sabır and Batuk [23] showed that time series trend analyzes gave successful results in the field of textiles as well.

Table 4. Trend analysis data for organic wheat production in Ağrı.

Years	Actual Barley Production (ton)*	Smoothed Barley Production (ton)	QTA (ton)	EGM (ton)
2007	-	-	-	-
2008	137.81	161.72728	758.27879	469.25576
2009	556.69	341.91654	1091.26072	650.11086
2010	603.18	654.5398	1570.02855	900.66903
2011	2129.27	1886.86956	2194.58227	1247.79443
2012	6144.97	5648.9289	2964.92189	1728.70487
2013	5956.81	6679.47872	3881.04741	2394.96222
2014	5607.52	5840.03459	4942.95882	3318.00075
2015	6749	6386.96289	6150.65613	4596.78606
2016	6448.6	6609.29693	7504.13933	6368.42595
2017	6083.57	6185.81226	9003.40843	8822.87071
2018	8020.3	7592.82912	10648.46343	12223.27907
2019	10459.89	10283.37334	12439.30433	16934.23331
2020	20589.44	19253.21129	14375.93112	23460.82883
2021			16458.34381	32502.82899
2022			18686.54239	45029.69183
2023			21060.52687	62384.51265
2024			23580.29725	86428.02694

*It was obtained from the organic agriculture statistics of the Republic of Turkey, the Ministry of Agriculture and Forestry.

According to Global Wheat Market reports, there has been a decrease in wheat production worldwide since 2017 [24]. The downward trend experienced in the period from 2017 to 2021 has similarly affected Turkey. It has been observed that the most important factor causing this downward trend is the stagnation of the demand for organic wheat consumption worldwide [24, 25]. Commenting that the stagnation in consumption demand may continue in the next few years has been seen to support the downtrend forecasts, especially for the years 2021-2024 [24, 25]. On the other hand, it has been determined that the production forecasts made between 2019-2026 and 2020-2028 in organic barley production show an increasing trend around the world [26, 27]. Considering that the production increase and decrease trends in the world directly affect Turkey, it is possible that an increase trend in organic barley production between the years 2021-2024 in Ağrı province will occur. According to the results of the forecast and literature researches, it is forecasted that the downtrend in organic wheat production will continue for some time, while on the contrary organic barley production will increase in the coming years. Evaluation of this situation may also help the organic product producers to enter an upward trend in a short time by raising awareness for wheat production.

4. Conclusion and Suggestions

The production area, annual number of workers, wheat and barley productions for Ağrı province, which is one of the organic product production centers of Turkey, have been successfully analyzed according to the data between 2007 and 2020. As a result of the analyses, two different (QTA and EGM) methods have applied to make trend predictions between 2021 and 2024. Based on historical production data, the QTA method has been found to give more likely results in production area, number of workers and organic wheat production estimates. In organic barley production, it has been determined that the EGM analysis results gave more ideal results for future production. Within the scope of the results obtained, it is predicted that the downtrend in organic product agriculture, number of workers and organic wheat productions in Ağrı will continue between 2021 and 2024, while production in organic barley production will be on an increasing trend. It has been considered that the

reason for the downtrend is the lack of export production throughout the country, the high costs to the producer because of rising inflation and the COVID-19 pandemic restricting worker mobility and working times. As a result, organic barley which is the rising trend in organic product production in Ağrı will provide a great advantage for producers in the coming years. Also, as a recommendation for policy makers, it is thought that for the period until 2024, focusing on the production of different types of organic products instead of organic wheat production would be beneficial for both the producer and the domestic organic market. For the future of organic barley production, increasing the support that should be given to the producer will be beneficial both for the domestic market and for exports.

Statement of Research and Publication Ethics

The study is complied with research and publication ethics

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