Comparison of organic and conventional wheat in terms of efficiency and cost in Turkey: a case study of Erzurum Province

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Abstract

This study aimed to compare organic and conventional wheat production in Erzurum province in terms of efficiency and cost to reveal which branch of production is more advantageous. The research data consists of 150 surveys from Aşkale, Hinis, Aziziye, Palandoken, and Yakutiye districts of Erzurum province. According to the data obtained, the wheat production amount of the management and land size as input, change costs, and nitrogen, phosphorus, and potassium ratios in fertilizer were evaluated by Data Envelopment Analysis (DEA). According to fixed and variable return, DEA and Bootstrap efficiency values were determined. As a result of the study, according to fixed return, while efficiency was 83,4% in DEA and 80,4% in Bootstrap, respectively. According to the variable return, efficiency was 85,8% in DEA and 81,5% in Bootstrap, respectively. In the first stage of the bootstrap has been determined that the use of seed and fertilizer will be reduced in both organic and conventional management. In the second stage of the bootstrap has been observed that the socio-demographic factors of the agricultural enterprises and business manager may be cause great variability on efficiency. It was determined that organic wheat-producing enterprises had higher yields and variable costs than conventional wheat-producing enterprises. The enterprises producing organic wheat have the potential to be effective and efficient in production by reducing their variable costs.

Keywords: Efficiency. Organic Wheat. Bootstrap. Data Envelopment Analysis

1. Introduction

As in many countries, individuals in Turkey, too, feed mainly on vegetal products, and more than half of the diet of Turkish people consists of grain and grain products (Elgin and Ertugay, 1995). While wheat makes up about 25% of the world grain production, this rate is 58% in Turkey (FAOSTAT, 2020). Also, considering the worldwide consumption, wheat provides 20% of the calories that people get, but this rate reaches over 50% in Turkey (Unakıtan and Aydın, 2018). Grain production is important worldwide, and there are significant natural losses (Deng et al. 2014). Demand in Turkey, which is self-sufficient in terms of wheat production, has not been met due to quality and production problems stemming from adverse climatic conditions in some years, and therefore it has been imported (ZMO, 2019). These losses have led to a high amount of product imports to meet the nutritional needs of the growing population, thereby paving the way for the development of different technological methods, as well. In addition to these methods, the ever-growing use of artificial fertilizers and pesticides has greatly escalated environmental pollution. As a result, the balance of the ecosystem has disrupted, the taste, aroma, and colors of the foods have changed, and the use of chemicals has led to various diseases on living things. Ultimately, conventional agriculture has begun to pose problems for countries (Karakoçan 2004).

Organic farming is a sustainable farming system; conventional farming, on the other hand, is a farming system, where the living environment of soil organisms is disrupted, there is no crop rotation, and weeds are killed, organic matter and humus is lost. Nowadays, farmers and consumers are turning to producing and consuming agricultural products that do not harm human health by trying to get rid of the harmful effects of traditional agriculture. The new form of production is called organic agriculture, biological or ecological agriculture (Kodaş and Er 2012).

The share of wheat organically produced in Turkey in the total wheat production amount and areas is relatively small. One of the problems preventing the transition from conventional production to organic production is the low yield of organically produced wheat. However, as the yield of conventionally grown wheat is decreasing, the difference between organically produced wheat and conventionally produced wheat is decreasing, as well. Most of the businesses that produce wheat in Turkey are small family businesses. As their lands are small and the amount of inputs they use is low, the yield they get from traditional production is also very low. In light of this information, it can be said that in businesses where the wheat yield is below the Turkey average, organic wheat farming can be an alternative if domestic varieties are preferred and the soil quality is promoted (Akkaya, 2018).

While the share of Erzurum province in Turkey wheat production was 1.75% in 2015, it increased to 1.85% in 2019. However, the wheat yield in the city was 167 kg/da in 2015, whereas it decreased to 161 kg/da in 2019. The average wheat yield in Turkey was 281 kg/da in 2015; however, it decreased to 276 kg/da in 2019. There has been no yield increase in Erzurum city for the past four years, and the yield has been observed to be below the average wheat yield of Turkey (TURKSTAT, 2020).

The low yield of organic wheat is generally the weakest side of organic wheat against traditional wheat. It is feared that if organic wheat becomes widespread, the production and consumption balance will be disrupted, and the requirements of the increasing population will not be met due to its low yield. A 21-year long study conducted in Europe has determined that grain yield will decrease by 20% if organic wheat is produced (Mader *et al.*, 2002).

To increase the profitability, productivity, and competition power of agricultural sustainability in rural areas, inputs such as the use of pesticides and fertilizers can be reduced, efficient input use can be achieved, and outputs such as crop yield can be improved, and thus the needs of the growing population can be met (Unakıtan and Aydın, 2018).

In general, increasing the yield in wheat production is an important factor in meeting food needs quickly. This helps policymakers and development practitioners to improve wheat productivity. To evaluate the efficiency and factors affecting the efficiency in wheat production, Stochastic Frontier Analysis, and translog functional form with a one-step approach are employed. Here, the effects of the household head's gender, age and education level, livestock breeding, having a cooperative membership, farm size, land fragmentation, farming experience, and using inorganic fertilizers in production on efficiency are investigated (Tiruneh and Geta 2016).

Only experimental results are widely used in field studies, but research approaches are hardly ever employed. Given this background, this detailed survey study is expected to close this gap and put forward practical management strategies that provide technical and economic stability in organic and conventional wheat production, which will both help producers to carry out a profitable production activity and ensure the protection of society, producers, and the environment. For this reason, this study aimed to determine the efficiency rates of the businesses in wheat production in Erzurum province by identifying the cost of wheat in organic and conventional businesses.

2. Literature Review

There are numerous studies in the literature across the world and in Turkey on the efficiency, effectiveness, production cost, and economic analysis of organic or conventional wheat. Some of these studies can be listed as follows:

Birinci and Küçük (2004) calculated the amounts of inputs used by wheat-producing businesses during the production phase and unit costs of wheat. As a result of their research, by comparing the expenses during the production phase to the wheat sale price, they determined that the wheat-producing businesses in Erzurum city made a 25% loss. They concluded that the most important reason for this loss was the high production costs and the low yield per unit area.

Diaz *et al.* (2004) studied the effectiveness of irrigation methods. They carried out their research in 5 districts affiliated to the Andalusia region in Spain. They tried to explain which products increased or decreased in the region and which irrigation methods could provide more efficient water use. In their research, they determined that the use of the labor and water consumption was high, but that water use had a positive effect on productivity.

Bhushan (2005) tried to explain the Total Factor Productivity (TFP) of wheat produced in India using the data envelopment analysis (DEA) and the Malmquist approach. In the study, Bhushan used data from 1981-1982 and 1999-2000 production seasons in certain regions of India. In conclusion, technological progress was found to contribute to the increase in total productivity in wheat production, but it was not equal in the regions studied.

Alemdar and Ören (2006) aimed to determine the technical efficiency of wheat producers in the Southeast Anatolia region in Turkey. The research data were obtained through a questionnaire administered to 193 wheat producers at the end of the 2000-2001 production season. The data consisted of information about the income and production costs of these producers, and it was analyzed using the DEA method. The authors found that the yield was low and that the main reason for this was the fragmented agricultural areas and the high machine working hours.

In their study, Malana and Malano (2006) sought to explain the productivity of wheat produced in selected regions of Pakistan and India using the DEA method. In the study, they aimed to investigate the use of irrigation, seed, and fertilization inputs and reveal their effectiveness. According to the results of the analysis, they determined that there was a decrease in wheat yield. They found that the main reasons for the decrease were excessive use of irrigation and fertilizer inputs.

Javed *et al.* (2008) aimed to determine the technical and economic efficiency of wheat and rice grown in the Punjab region of Pakistan. They concluded that the technical and economic efficiency of the producers was very low. According to the results of the study, they emphasized the necessity of providing training and extension services to the region by the related institutions due to the inadequate training of the producers, increasing the use of technology in production, reducing the prices of inputs such as seeds, fertilizers, fuel used in the production phase, decreasing the prices of the inputs used in the production phase, and eliminating the hardship in producers' access to the market and thus ensuring they make a profit.

Konyalı and Gaytancıoğlu (2008) aimed to measure and analyze the efficiency of the inputs used by the wheat-producing businesses in the Thrace region. By employing the DEA method, They tried to determine the rate of input used by each county in the study region and whether they used these inputs effectively. As a result of their research, they determined that some wheat producers in the region were using excess input. They concluded that the amount of input used affected the yield, the prices of these inputs were higher than the price of wheat, and that the producers did not have enough knowledge of when and how much of a given input to use.

According to Berber *et al.* (2012), organic farming is considered a strategic chance and a success factor for economic development, especially in many countries producing wheat. Here, businesses aim to reduce costs, manage their resources rationally and efficiently, and generate higher profits. In their study, by measuring the economic efficiency indicators and doing a comparative analysis of profit estimation in organic and conventional production, Berber *et al*. determined that businesses could obtain higher profits compared to conventional production. They also investigated government regulations that provided better conditions for organic agricultural production as well as higher business success.

Watto and Mugera (2019) tried to reveal the technical efficiency and water use efficiency of wheat producers in Pakistan. In the study, they analyzed the data they obtained by surveying 200 wheat producers using the bootstrapped meta-frontier DEA method. As a result of the study, they found that wheat producers had low technical and water use efficiency, most of them did not have access to technology and that some did not use existing technology efficiently. They stated that quality seed should be used to increase irrigation efficiency and that authorities should help producers to access and use appropriate technology efficiently.

Wagan *et al.* (2020) aimed to compare the input and production efficiency of wheat in China and Pakistan in their study. They analyzed the data obtained through random interviews with a total of 120 wheat farmers in both countries using the Stochastic Frontier Analysis (SFA) model. To analyze wheat production efficiency, they investigated the effect of wheat production land, wheat seed, fertilizers, farm manure, pesticides, labor, and machine power variables on wheat yield. They used variables such as wheat farmer's age, education, and agricultural experience to estimate the technical inefficiency of a household. According to the results, the agricultural experience of wheat farmers in both countries was the most important activity component of wheat production. Also, wheat seed and the use of more machinery in wheat farms were positive factors for wheat production in both countries. They concluded that China had more agricultural businesses with higher wheat production efficiency compared to Pakistan thanks to the adoption of modern seed technology, the high use of modern machinery, and the appropriate use of input sources.

Wana and Sori (2020) applied a stochastic production frontier model to the data they obtained by surveying 124 individuals to determine the wheat production efficiency of Ethiopia. By determining the average technical efficiency, as 63.9% in wheat production, they found that soil, seed, and the use of DAP and chemicals increased the production efficiency of wheat positively. According to the results of the factor model, they determined that family size, wheat production experience, and obtaining information from the extension services positively affected the technical efficiency and that the increase in the total cultivated area had a significant negative effect on technical efficiency.

3. Materials and Methods

3.1. Materials

The study data were obtained from the businesses producing organic and conventional wheat in Erzurum using a questionnaire. In addition to these data, data obtained from Erzurum Agricultural Provincial and Forestry Directorate and Eastern Anatolia Agricultural Producers and Stockbreeders Union were also used. Besides, studies carried out on the subject in Turkey and other countries were investigated and used as a reference in the present study.

3.2. Methods

3.2.1. The method used in determining the number of businesses

The number of questionnaires was determined by considering the records of Agriculture and Forestry Provincial Directorates for the year 2018. The total number of questionnaires to be used in the study was determined with the Proportional Sampling Method. The method was based on a 95% confidence interval and a 5% margin of error.

The equation used to determine this sample size is given below (Newbold, 1995).

$$n = \frac{N*p*(1-p)}{(N-1)*\left(Q_p\right)^2+p*(1-p)} \qquad (1)$$

where n=sample size, N_1=total number of conventional wheat producers (33 262), $Q_p{}^2$= variance, r= deviation from the mean (%5), $Z\alpha/2$= z-score (1.96), and p=the proportion of individuals with more than 20 years of experience (95%).

$$Q_p{}^2 = \left(\frac{r}{Z\alpha/2}\right)^2 = \left(\frac{0{,}05}{1{,}96}\right)^2 = (0{,}0255)^2 = 0{,}000651 \qquad (2)$$

$$n = \frac{33\ 262 * 0{,}95 * 0{,}05}{(33\ 261 * (0{,}0255)^2 + (0{,}95 * 0{,}05)} = 72{,}8$$

Using the equations above, the sample size found only by assigning a value to N and using a 95% confidence interval and a 5% margin of error is given below.

N_2 = Total number of organic wheat producers (1,822),

$$n = \frac{1\ 822 * 0{,}95 * 0{,}05}{(1\ 821 * (0{,}0255)^2 + (0{,}95 * 0{,}05)} = 70.21$$

In Erzurum province, 75 conventional and 75 organic wheat producers were asked about their wheat experiences, and 95% of them were found to have more than 20 years of experience. The number of questionnaires determined in the formula was increased to 150 by adding three more questionnaires for conventional production and four more questionnaires for organic production.

3.2.2. The data envelopment analysis method (DEA)

The first study to determine the technical efficiency of the production units was carried out by Farrell (1957). In those days, two techniques, one parametric and the other nonparametric, were used to measure efficiency. While econometric estimation methods are used for parametric functions, mathematical programming is employed for non-parametric functions (Tutilmez, 2012). The parametric approach, the first of these methods, was used by Aigner and Chu (1968) in a decisive parametric frontier study (Gülcü and Eşlı 2018), and Aigner *et al.* (1977) and Meeusen and Broeck (1977) developed the Stochastic Frontier Analysis (SFA). The main feature of this analysis is that it allows the hypothesis testing based on the inclusion of the stochastic error in the model.

The second approach to measuring effectiveness is non-parametric analyses. The nonparametric approach consists of the DEA method. This analysis was first put forward by Charnes *et al*. (1978). This method shows the effectiveness of the economic unit according to the best example based on the proportion of its weighted output sum to the sum of weighted inputs (Ersen, 1999; Altan, 2010). In this model, by comparing each unit to the best example, the units with low efficiency are determined, and eventually, things that should be done to increase the efficiency of these units are investigated (Demirci, 2001).

The DEA method has an input or output orientation perspective, investigates the extent to which inputs in businesses wasting resources can be reduced to reach a constant output in input-oriented models, and determines the extent to which outputs in businesses with inefficient production using a constant input can be increased in output-oriented models (Yolalan, 1993). In the stochastic frontier analysis, the DEA method is not needed for the distribution of the desired production function and the error term. For this reason, DEA, which is more advantageous compared to stochastic frontier analysis, is used in many studies (Candemir and Kızılaslan, 2019).

In recent years, semi-parametric two-stage approaches, which take the measurement of efficiency determined by the DEA as a dependent variable and combine it with regression analysis in the second stage, have become popular. The DEA done in the second stage is a censored (Tobit-like) regression that considers the limited nature of efficacy scores or simply the least-squares method (LSM) (Simar and Wilson, 2007). Despite their popularity and intuitive appeal, such two-stage estimators have been criticized by Simar and Wilson (2007) because they lack a clear theory of the basic data generation process that would justify their two-stage approach, the effectiveness scores of the DEA are calculated over a common data sample, and businesses that have autocorrelation problems cannot be included in the sample. It is not appropriate to treat them as independent observations, and there are problems with invalid inferences due to multiple correlations. Simar and Wilson (2007) developed a two-stage bootstrapping procedure that considers the issues mentioned above (Badunenko and Tauchmann, 2018).

While bootstrapping identifies efficiency estimates of the DEA, it provides a consistent inference in models and generates standard errors and confidence intervals for estimations. This approach improves the statistical properties of the model and derives implications for concrete policies (Owusu and Hailu, 2014).

Input-oriented technical efficiency measure of Farrell (1957):

In the first part of the two-stage approach, technical efficiency scores were obtained using the DEA procedure. The DEA approach assumes the access of all businesses in the sample to the same technology for converting them into M outputs determined as y for the transformation of the N input vector denoted by x (Owusu and Hailu 2014). This technology can be defined as in Formula 2.

$$T \subseteq \epsilon R_{+}^{N} * R_{+}^{M} \text{ that is}, \varphi = \{(\text{x},\text{y}) \epsilon R_{+}^{N} * R_{+}^{M} : \text{x} \epsilon R_{+}^{N} \text{ can be generated } \text{y} \epsilon R_{+}^{N}\} \quad (3)$$

where $\text{x}\epsilon R_{+}^{N}, \text{y}\epsilon R_{+}^{N}$ is a vector of N inputs that is used to obtain the output vector M.
The upper limit of technology is appealing for efficiency measurement. Inefficient businesses range from points within T to the distance representing the ineffectiveness limit at each point in T. Therefore, observations at the limit are considered effective (Nedelea and Fannin, 2013).

$$\hat{\theta}(\text{x},\text{y}) = \min\{\theta > 0 | \text{y} \leq \sum_{i=1}^{n} \lambda_i y_i ; \theta\text{x} \geq \sum_{i=1}^{n} \lambda_i x_i ; \sum_{i=1}^{n} \lambda_i = 1, \ \lambda_i \geq 0, \text{i} = 1 \ldots \text{n}\} \quad (4)$$

In formula 3, the input with a value of θ,0≤θ≤1 is the technical efficiency measure. If θ = 1, the farmer is at the limit. y_i is an output vector and x_i is an input vector. Vector λ is an Nx1 weight vector that describes the linear combination of the peers of the i^{th} business. $\lambda_i x_i$ and $\lambda_i y_i$ are efficient projections at the limit. By solving the linear programming problem N times, a value was provided for each business in the sample (Owusu and Hailu, 2014).
The most common procedure used in the second phase of the analysis is the determination of DEA efficiency estimations against peripheral variables using the Least Squares method (LSM) or Tobit regression (Stanton, 2002). However, this procedure may cause serial

correlation and bias problems in the estimations of efficiency, as well as a correlation between the error term and explanatory variables in the second stage model. For this reason, Simar and Wilson (2007) proposed a pair of bootstrapping processes where biased corrected scores are used in a parametric bootstrapping on the nonlinear maximum likelihood estimation Here, confidence intervals are created for regression parameters as well as efficiency scores. The second stage regression model is defined as follows:

$$0 < \hat{\theta}_i = z_i\beta + \mathrm{i} \leq 1 \qquad \mathrm{i} = 1,2,\ldots,\mathrm{n} \qquad (5)$$

where $\hat{\theta}_i$ is the technical efficiency of *the first* business; ε_i is the statistical noise assumed to be distributed to the left at $-z_i\beta$ and the right at $1 - z_i\beta$; and z_i is the vector of factors affecting the efficiency of the businesses.

In the present study, based on the assumption that businesses did not work at an optimum scale, an input-oriented, variable-scale return (VRS) approach was used. With the input-oriented two-stage bootstrapped DEA method, we investigated the extent to which businesses wasting resources can reduce their inputs to achieve a stable output.

4. Findings and Discussion

4.1. Variables used in the bootstrapping and the DEA and their explanations

In two-stage bootstrapping, the variables used as input in the first phase were taken into account. In the second stage, the change in efficiency was investigated by considering the variables related to the business, the owner, and the family.

Descriptive statistics and explanations of variables are given in Table 1.

Table 1: Descriptive Statistics and Variable Explanations

DEA Variables	Explanations of Variables	$\bar{X}$	Sd
	Output and Input Variables		
Y	Wheat production (1000 kg)	28.28	30.57
X_1	Land amount (da)	123.4	136.9
X_2	Fixed costs (1000 TRY)	9.01	8.80
X_3	Variable costs (1000 TRY)	25.69	29.57
X_4	Fertilizer NPK (kg)	1.28	1.63
	Other Variables	**$\bar{X}$**	**Sd**

Sland	Small land (5-39 da =1, others =0)	0.19	0.40
Mland	Middle land (40-80 da =1, others =0)	0.57	0.50
Lland	Large land (≥ 81da =1, others =0)	0.24	0.43
Cland	Categorical land (Sland =1, Mland =2, Lland =3)	2.05	0.66
Irrigation	Irrigation type (irrigated, =1, non-irrigated =2)	0.11	0.31
Production	Production method (organic =1, conventional =0)	0.50	0.50
Age	Age of the farmer (year)	50.99	9.08
Sage	Small age (29-47 years =1, others =0)	0.13	0.33
Mage	Middle age (48-55 years=1, others =0)	0.74	0.44
Bage	Big age (56 years ≥=1, others =0)	0.13	0.34
Cage	Categorical age (Sage=1, Mage=2, Bage =3)	2.01	0.51
Education	Educational status of the farmer (year)	1.93	0.78
Leducation	Low education (0-5 years=1, others =0)	0.33	0.47
Seducation	Secondary education (6-8 years=1, others =0)	0.41	0.49
Heducation	Higher education (9≥ years=1, others =0)	0.25	0.44
Ceducation	Categorical education (Leducation=1, Seducation=2, Heducation=3)	1.92	0.76
Individual	Number of individuals in the family (people)	5.49	2.07
Cindividual	Categorical individual (2-4=1, 5 =2, 6≥=3)	2.09	0.58
Experience	Wheat experience of the farmer (years)	33.10	10.21
Lexperience	Low experience (5-25 years=1, others =0)	0.13	0.34
Mexperience	Medium experience (26-39 years=1, others =0)	0.71	0.45
Hexperience	High experience (40≥ years=1, others =0)	0.15	0.36
Cexperience	Categorical experience (5-20=1, 21-40=2, 41≥3)	2.02	0.54
Nonagri	Non-agricultural work (yes=1, no=0)	0.19	0.39
Fworker	Foreign worker employment (employee=1, non-employee =0)	0.15	0.36
Rent	Land property status (rent=1, property =0)	0.09	0.29
Credit	Use of credit (use=1, don't use =0)	0.53	0.50
Debt	Debt status (yes=1, no=0)	0.07	0.25
Receivable	Receivable status (creditor=1, no creditor =0)	0.11	0.32
Price	Sales price of wheat (TRY)	0.87	0.05
katfiyat	Categorical price (0.75-0.84 TRY=1, 0.85-0.89 TRY=2, 0.9-1.1 TRY=3)	1.96	0.75
Grosspvalue	Gross production value (TRY)	311.1	2202.3
Aşkale	Askale district (Askale=1, others=0)	0.12	0.33
Hınıs	Hınıs district (Hınıs=1, others=0)	0.20	0.40
Central	Central districts (Center=1, others=0)	0.68	0.47
Cdistrict	Categorical districts (Aşkale=1, Hınıs=2, Center=3)	2.56	0.70
bceff.vrs	Boot activity analysis value according to variable return	0.82	0.09

The mean wheat production amount of the businesses was 28,288.03 kg, and the standard deviation was 30,569.94 kg. The mean land width was 123.4 da, and the standard deviation was 136.93 da. The reason for the big standard deviation here was due to the very large and very small businesses. The mean of the fixed costs was TRY9,011.64, and the standard deviation was TRY8,808.37. The mean of the variable costs was TRY25,692.32, and the standard deviation was TRY29,571.73. The reason for the big standard deviation of the variable costs was due to the high amount of farm manure use per da by businesses making organic production and the use of a low amount of chemical fertilizer per da by businesses making conventional production. Spraying costs were among the variable costs. However, since no businesses were found to use spray for wheat, it was not included in the variables. Irrigation costs did not make up an excessive cost in the businesses. Because wheat is a product that does not require irrigation, most businesses do not do irrigation. While the rate of businesses that did irrigation in wheat was 12.7%, the rate of those which did not do it was 87.3%. The average NPK of the fertilizer contents used was 1,279.472 kg, and the standard deviation was 1,631.813 kg. All the businesses, except one of the conventional businesses, were found to use chemical fertilizers (Urea and Dap). Organic businesses were determined to use farm manure. Among the variables, nitrogen, phosphorus, and potassium values of all three fertilizers were calculated and analyzed over the NPK total. Regarding the other factors, we presented the mean and standard deviation values for the business-related criteria and the variables related to the business owner and the family, and the districts where the business was located.

4.2. The results of the bootstrapping and the DEA

Table 2 shows DEA and bootstrapping efficiency values according to fixed and variable returns.

Table 2: DEA and Bootstrap Efficiency Values According to Fixed and Variable Returns

	$\bar{x}$	Sd	Min	Max	Fully Effective Employee
DEA Fixed Return	0.834	0.110	0.526	1.000	12
Difference Fixed Return	0.031	0.019	0.008	0.112	
Bootstrap Fixed Return	0.804	0.100	0.505	0.963	
DEA Variable Return	0.858	0.108	0.526	1.000	22
Difference Variable Return	0.043	0.026	0.010	0.129	
Bootstrap Variable Return	0.815	0.093	0.504	0.962	

In this study, while efficiency was 83.4% in the DEA according to fixed income, it was 80.4% in the bootstrapping. The lowest efficiency in the DEA ranged between 0.52 and 1, and it was found to vary between 0.50 and 0.96 in the bootstrapping. When the fully efficient working status was considered, 12 businesses were found to operate fully efficiently in the DEA, but there were no fully efficient businesses in the bootstrapping. The smaller the standard deviation is, the better the significance of the parameters is. The deviation between DEA and bootstrapping was 3.1%.

Table 3 presents the technical efficiency estimations in the DEA.

Table 3: Technical Efficiency Estimations in the DEA.

	TE (Variable Return)	Adjusted	Minimum	Maximum
Average	0.858	0.043	0.774	0.854
Standard deviation	0.108	0.026	0.087	0.107
Minimum	0.526	0.010	0.488	0.523
Maximum	1.000	0.129	0.928	0.997
	TE (Fixed Return)	**Düzeltilmiş**	**Minimum**	**Maksimum**
Average	0.834	0.031	0.774	0.830
Standard deviation	0.110	0.019	0.094	0.109
Minimum	0.526	0.008	0.491	0.522
Maximum	1.000	0.112	0.932	0.996

According to the variable return, the effectiveness of the DEA was 85.8%, but it was 81.1% in bootstrapping. The lowest efficiency in the DEA ranged between 0.52 and 1, and between 0.50 and 0.96 in bootstrapping. Also, 22 companies were found to operate fully efficiently in the DEA, but there were no actively operating businesses in the bootstrapping. The deviation between them was 4.3%.

Table 4 presents the significance of the data in the second phase of the bootstrapping analysis.

Table 4: The Significance of the Data in the Second Stage of the Bootstrap Analysis

Variables	Variable Explanations	Estimates	$\bar{x}$	Sd
Constant		-1,51		
Mland	Middle land (40-80 da =1, others =0)	0.67***	0.57	0.50
Lland	Large land (≥ 81da =1, others =0)	-0.02	0.24	0.43
Irrigation	Irrigation type (irrigated, =1, non-irrigated =2)	-0.10	0.11	0.31
Production	Production method (organic =1, conventional =0)	0.10***	0.50	0.50
Age	Age of the farmer (year)	0.01***	50.99	9.08
Individual	Number of individuals in the family (people)	0.03***	5.49	2.07
Seducation	Secondary education (6-8 years=1, others =0)	0.30***	0.41	0.49
Heducation	Higher education (9≥ years=1, others =0)	0.28***	0.25	0.44
Mexperience	Medium experience (26-39 years=1, others =0)	0.17***	0.71	0.45
Hexperience	High experience (40≥ years=1, others =0)	0.30***	0.15	0.36
Nonagri	Non-agricultural work (yes=1, no=0)	-0.01	0.19	0.39
Fworker	Foreign worker employment (employee=1, non-employee =0)	-0.10***	0.15	0.36
Rent	Land property status (rent=1, property =0)	-0.04	0.09	0.29
Credit	Use of credit (use=1, don't use =0)	0.02	1.03	1.10
Debt	Debt status (yes=1, no=0)	-0.01	0.07	0.25
Receivable	Receivable status (creditor=1, no creditor =0)	0.51***	0.11	0.32
Aşkale	Askale district (Askale=1, others=0)	0.12	0.12	0.33

Central	Central districts (Center=1, others=0)	0.57***	0.68	0.47

The businesses that had medium size lands were determined to be more efficient compared to the businesses with small and large lands according to the significance of the data. When the land of business is either too small or too large, the costs of input use increase compared to the land. Therefore, businesses with medium-size land were more effective than small businesses in production-related operations. Small businesses could not be effective in production because they did not use fixed capital elements efficiently. According to the results of the analyses, large businesses appeared to be ineffective as they used the inputs wastefully.

The businesses with organic production style were observed to be more effective than the businesses with conventional production style. Businesses making conventional production applied the inputs they used during the production phase to obtain more products from the unit area. However, they were found to use chemical fertilizers regardless of the structure of the soil and the need for suitable fertilizers. As a result, a significant decrease was observed in the yield. It was concluded that businesses making organic production were more efficient than businesses making conventional production since the formerly made production only by using farm manure and using no chemical fertilizers at all. Karadaş *et al.* (2011) stated that farm manure had a positive effect on yield and was not harmful to the natural environment.

Business owners gain more knowledge and experience in farming as they get older. These producers, taking lessons from the mistakes they have made in the previous production periods, make more efficient production.

As the educational status of the business owners increases, their efficiency in production also increases. Business owners with a higher education level are more likely to learn, perceive, and use agricultural information compared to business owners with a low education level. As the middle and high-educated farmers are open to innovations, change, and development, their efficiency increases at the same rate. Javed *et al.* (2008) stated that insufficient and low training levels of business owners also reduced the efficiency of technical and economic efficiency in wheat production.

The business owners with medium and high experience were more efficient compared to those who had a low experience. This is because as experience increases in a branch of production, the margin of error, and the possibility of making mistakes decrease. Business owners continue production by producing the same products every year, thereby comparing the mistakes they have made in the past years and not making these mistakes in the future.

The businesses that employed foreign workers were found to be more inefficient than businesses that did not. Coelli *et al.* (2002) stated that one of the main reasons for low efficiency was due to the status of the labor use and high labor costs. Aslan (2013) determined that temporary labor costs were high in businesses producing organic and conventional apricot. Diaz *et al*. (2004) found that the use of the labor force in the region was high and that this reduced efficiency in production. Labor wages are an important expense item for agricultural businesses. Businesses that can use the workforce well can manage to be effective in production. Also, individuals work with more self-devotion in their businesses. In this study, the businesses that did not employ foreign workers were determined to be more effective compared to the businesses that employed them.

The business owners who were beneficiaries were observed to work more efficiently compared to business owners who were not. Businesses that are beneficiaries operate by following the cost of production and calculating when and how much to spend. Thus, they can use their resources more efficiently.

The businesses located in the central districts were found to be more efficient than the businesses in Aşkale and Hınıs districts. Although the central districts had the opportunity to access the inputs they used in production and obtained cheap inputs because they were close to the province, they also used fewer inputs because they knew the consumer preferences. Also, central districts did not have any problem in marketing their products because they were close to the city center. Therefore, they were determined to be more efficient in using inputs than Aşkale and Hınıs districts.

4.1.3. The comparison of the before and after the status of the Data Envelopment Analysis and Bootstrap Analysis

Table 5 shows the comparison of before and after the status of the DEA and the bootstrap analysis.

Table 5: Size of land for conventional x organic business

Variables (Average)	General		DEA		Bootstrap	
	Conv.	Organic	Conv.	Organic	Conv.	Organic
Number of Businesses	75	75	10	25	13	22
Land size (da)	144.40	102.40	225	69.88	136.30	82.04

Seed (kg/da)	21.19	19	21.76	19.07	20.08	18.93
Farm Fertilizer (kg/da)	11.33	1 059	-	1 042	-	1 032
DAP Fertilizer (kg/da)	2.11	-	1.2	-	1.88	-
Urea Fertilizer (kg/da)	11.66	-	12.50	-	12.15	-

Note: Conv.: Conventional production method

As seen in the table, the size of the land in conventional businesses was 144.40 before the analysis. After the analysis, more efficient wheat production was observed in 225 da land according to the DEA and in 136.30 da land according to the bootstrapping. Before the analysis, the land size was determined to be 102.40 da in organic businesses. As a result of the analysis, more efficient wheat production was observed in 69.88 da land according to the DEA and in 82.04 da land according to the bootstrapping.

The amount of seed used was 21.19 kg/da in conventional businesses before the analysis. After the analysis, it was found to be 21.76 kg/da according to the DEA and 20.08 kg/da according to bootstrapping. This suggested that the businesses needed to reduce the amount of seed they used. The amount of seed used in organic businesses was 19 kg/da before the analysis. After the analysis, it was determined to be 19.07 kg/da according to the DEA and 18.93 kg/da according to the bootstrapping. This also suggested that the businesses needed to reduce the amount of seed they used. Bayramoğlu and Oğuz (2005) determined that the amount of seed used in wheat production was high.

The use of farm manure in organic businesses was 1,059 kg/da before the analysis. After the analysis, it was found to be 1,042 kg/da according to the DEA and 1,032 kg/da according to the bootstrapping. This revealed that the businesses needed to reduce the amount of farm manure they used. Coelli *et al*. (2002) found that the main reason for low productivity was due to the excessive use of fertilizers.

In conventional businesses using Dap fertilizer, the amount of fertilizer used was 2.11 kg/da before the analysis. After the analysis, it was determined to be 1.2 kg/da according to the DEA and 1.88 kg/da according to the bootstrapping, which suggested that the businesses needed to reduce the use of Dap fertilizer. Malana and Malano (2006) concluded that fertilizer was overused, but that efficiency would increase by reducing fertilizer use.

Conventional businesses were found to use 11.66 kg/da urea fertilizers before the analysis. After the analysis, the amount was found as 12.50 kg/da according to the DEA and 12.15 kg/da according to the bootstrapping, which revealed that the businesses needed to increase the use of urea fertilizer.

5. Conclusions and Recommendations

An average of 20 million tons of wheat a year is produced in Turkey. Research into the production of organic wheat has been growing in recent years. Turkey ranks eleventh in world wheat production. Also, Erzurum province ranks third in organic wheat production in Turkey. In this study, a survey was conducted with 150 farmers producing organic and conventional wheat in Erzurum province. Businesses producing organic and conventional wheat were compared in terms of efficiency and cost. The DEA and bootstrapping methods were employed to determine the efficiency of the businesses. In the study, the efficiency of the seed, fertilizers, lands, the capital, labor force, and draught-power used by the businesses was determined by the amount and size of use. In conclusion, while the overall efficiency was 81.5% for the 150 businesses according to the variable return, it was 80.7% in conventional production and 82.5% in organic production. In other words, the businesses making organic production were found to achieve the same production by using less input. The businesses making both conventional and organic production were observed to achieve the same production by reducing land size, the amount of seed used, labor force, draught-power, and capital by a certain percentage. In other words, when businesses reduce the amount of seed and fertilizers by doing soil analysis, they will obtain a positive change in terms of both cost and efficiency. Thus, producers, consumers, natural resources, and the environment will be affected less.

6. **References**

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