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Custos e @gronegócio *on line*, **ISSN 1808-2882, Recife, volume 20, número 2, p. 1-327, Abril/Junho. 2024.**

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Analysis of ınput utilization efficiency in wheat production: the case of Turkey

Recebimento dos originais: 08/112023
Aceitação para publicação: 25/01/2025

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Abstract

Wheat production is an essential agricultural activity in the world and Turkey. In 2021, the world wheat production was realized as 771 million tons on 221 million hectares of land. Turkey had a share of 3.00% in the world's wheat production area, and 2.29% in the production amount. The most important condition for the competitiveness of enterprises in agricultural production is low production costs and efficient use of inputs. Unused input not only increases production costs but also reduces the competitiveness of the businesses. In this study, input use efficiency in wheat production was analyzed by means of the data obtained from 104 enterprises determined by the Simple Random Sampling Method. The average cultivation area of wheat production was 159.03 da, and the yield per unit area was determined as 555.00 kg/da. In the function of wheat production; the production elasticity coefficient of the fertilizer variable was found significant at a 1% probability level, and the agricultural pesticide at a 5% probability level. The sum of the coefficients of production elasticity ($\sum\beta_i$: 1.013) for the forecast function indicates increasing returns to scale. The highest marginal efficiency coefficient (2.34) in the equation was found as the seed variable. The research results revealed that none of the variables in wheat production were used at the economic optimum level.

Keywords: Wheat. Efficiency. Marginal yield. Marginal income. Marginal efficiency. Turkey.

1. Introduction

The agricultural sector has a vital role in order to meet the nutritional needs of the people. From this perspective, each country aims to provide self-sufficiency to meet the domestic supply in products that are crucial in community nutrition (Eraktan, 2001; Kızılaslan, 2004).

Due to wheat being the raw material of many bakery products such as bread, a major staple food product; and due to it having a large number of producers, wheat is an extremely important product that is being produced vastly around the world (Kızılaslan, 2004).

According to the 2020 data of the United Nations Food and Agriculture Organization (FAO), wheat is the third most produced product in the world after sugar cane and corn. According to the data of the same year, wheat production meets 8.17% of the total crop production in the world, and 25.40% of the total grain production (FAO, 2022).

In 2021, a total of 220 million 760 thousand hectares of wheat was harvested in the world. The yield was 3,492 kg per hectare, and the total production amount was determined as 770 million 877 thousand tons. Turkey's share in the global wheat production area was 3.00%, and 2.29% in the production amount (FAO, 2023).

In terms of the wheat production area size in 2021, India was first with 14.38%, followed by Russia with 12.65%, and China with 10.68%. Turkey's wheat production area size was 6 million 623 thousand hectares, and was ranked 10th in the world with a share of 3.00%. In terms of the production amount in the same year, China was first with 17.76%, followed by India with 14.22%, and Russia with 9.87%. Turkey's production amount was 17 million 650 thousand tons in 2021, which was 11th in the world with a share of 2.29%. According to the data of 2021, Turkey's wheat yield was 2,665 kg ha^{-1} which was below the world average of 3,492 kg ha^{-1} (FAO, 2023).

Worldwide, 198 million 139 thousand tons of wheat was exported in 2021 with a total value of 54 billion 941 million USD. In the same year, 264 thousand 520 tons of wheat was exported from Turkey for 97 million 554 thousand USD. In the same year; 201 million 10 thousand tons of wheat was imported in the world with a total value of 63 billion 291 million USD. Turkey imported 8 million 877 thousand tons of wheat for 2 billion 692 million 632 thousand USD, which constitutes 4.42% of the total wheat import amount in the world and 4.25% of the import value.

The largest wheat exporter countries in 2021 respectively were; Russia with 13,29%, USA with 13,26%, and Australia with 12.93%. In terms of wheat import, Indonesia was first with 5.61%, China was second with 4.80%, and Turkey was third with 4.25% (FAO, 2023).

After losses in production were deducted, Turkey's usable wheat production in 2021 was 16 million 679 thousand tons. In the same time period 9 million 525 thousand tons of wheat was imported and the total supply of the country was found as 26 million 204 thousand tons. While 7 million 898 thousand tons of the total supply were exported, 808 thousand tons of stock change was realized. According to these data, the amount of wheat used in Turkey was 19 million 115 thousand tons in 2021. The distribution of domestic uses were; 79.44% in human consumption, 11.22% in animal feed, 6.35% as seed use, and 2.99% in losses. Wheat consumption per person was 179,30 kg, and this value has remained close to this amount over the years. In 2021, the self-sufficiency rate of Turkey's wheat production was 87.26%. Considering that this rate was 111.71% in 2017, there was a significant decrease in 2021 (TSI, 2023a,b).

Turkey is one of the leading countries in the world in wheat flour and pasta exports. According to the data of 2022, the global wheat flour export was 5 billion 704 million USD, and Turkey was the country that exported the most wheat flour in the world with 26.26%. Turkey was followed by Germany with 8.67% and Uzbekistan with 4.71%. In 2022, a total of 13 billion 766 million USD of pasta exports were realized in the world. Italy was in first place with 30.34%, China was second with 8.68%, South Korea was third with 7.11%, and Turkey was the fourth largest pasta exporter with 7,01% (ITC, 2023).

In 2022, a 75 TL diesel fuel subsidy, 46 TL fertilizer subsidy, and 0.10 TL difference payment subsidy, were provided per unit area for wheat production. In the same way, a 40 TL da^{-1} organic farming subsidy was provided for the producers who applied individually, and 20 TL da^{-1} was provided for producer groups. Other subsidy values were as follows; solid organic-organomineral fertilizers use was 20 TL da^{-1}, certified seed use was 50 TL da^{-1}; certified seed production was 0,10 TL da^{-1}, soil analyses were 50 TL per analysis, and small family business support was 200 TL da^{-1} (Official Gazette, 2022).

Since wheat is a crucial production activity, there are previous studies examining input usage, cost, profitability and production factors, and econometric analysis (Gündoğmuş, 1998; Sureshkumar ve ark., 2014; Aydın ve ark., 2021). Effective use of resources and productivity in agricultural production have great importance for the country's economy and producer welfare. Likewise, the optimal use of production factors can significantly reduce production costs (Semerci, 2022a,b).

Wheat production has a high economic importance in the province of Hatay, located on the Syrian border of Turkey. In this study, the relationship between the input and output in wheat production in the province was analyzed functionally. In order to determine the marginal efficiency levels of the inputs used in wheat production; the elasticity coefficient, marginal efficiency, marginal efficiency value, and marginal efficiency coefficient values for the inputs were calculated. The findings of the research were analyzed comparatively with the findings of previous studies on the subject.

2. Literature Review

Studies on wheat production generally focus on cost analysis, policy implementations, technical and economic efficiency, and energy use efficiency. The summaries of some studies based on the analysis of the factors affecting wheat production are given below.

In a study conducted by Semerci (1998), data were obtained from 74 wheat production enterprises in 10 settlements determined by the Stratified Sampling Method in the Kırklareli province of Turkey. Within the study, the relationship between the inputs used in wheat production and the amount of wheat production was analyzed by means of the production function.

Hassan et al. (2010) carried out a research in order to find the factors affecting wheat production in the Punjab province of India. The data were gathered from 200 randomly selected wheat producers.

In an analysis held in Turkey by Semerci et al. (2012), input use efficiency was examined in wheat production. The data were collected from 781 agricultural enterprises located in the Adana, Ankara, Diyarbakır, Edirne, and Konya provinces by using the Multi-Stage Stratified Random Sampling Method. According to the research results, the estimating equation (R^2) was found as 0.825, and there was an increasing return to scale ($\Sigma\beta i$=1.089) in wheat production.

In a research by Buriro et al. (2013), the technical efficiency of wheat production was examined by the Cobb-Douglas production function in Pakistan, and the data were gathered from 384 wheat production enterprises.

Semerci (2013) examined the input use efficiency in wheat production in the Edirne province of Turkey. Within the study, data were gathered from 90 wheat enterprises which were determined by using the Multi Stratified Random Sampling Method.

An investigation in India by Sureshkumar et al. (2013) aimed to; determine the use of inputs in wheat production, analyze the profitability status, and determine the efficiency of resource use. The data of the study were obtained from 240 agricultural enterprises determined by the Multistage Stratified Random Sampling Method. In this study, the factors affecting the wheat production amount were analyzed with the production function.

Ahmad et al. (2015) conducted a study in Pakistan where data were obtained from 160 agricultural enterprises using the Simple Random Sampling Method. Within the study, the relationship between the inputs used in wheat production and the amount of production was analyzed by means of the production function.

Wheat production in India was examined economically by Agam et al. (2017), and the resource use efficiency of the factors affecting production was analyzed. The data were obtained from 90 agricultural enterprises by means of a questionnaire.

In an analysis by Iqbal et al. (2017), the Cobb Douglas function was used to examine relationships between wheat production and some factors such as; fertilizer, manure, land preparation, pesticides, irrigation, etc. The data were obtained from 234 agricultural enterprises in 3 settlements of Pakistan.

Amoozad-Khalili et al. (2020) carried out a research in Northern Iran, where the relationships between wheat production amount and labor use, machinery use, diesel fuel, chemical fertilizers, and chemical pesticides were analyzed.

In an investigation by Verma et al. (2021), the factors affecting cereal production in Rajasthan, India were examined by means of secondary data from 2000 to 2016. The Cobb-Douglas production function was used to estimate elasticities of selected variables such as; seed, fertilizer, manure, human labor, irrigation, animal use, etc. According to the research results, seed, fertilizer, and irrigation water were found significant.

Mala and Akbay (2022) analyzed the limiting factors for wheat production in Northern Iraq. The data of the research were obtained from 182 agricultural enterprises by means of a questionnaire.

An examination by Verma et al. (2023) was conducted in Uttar Pradesh, India to analyze wheat production economically. Within the study, the input use efficiencies of wheat production were investigated and the data were collected from 100 wheat enterprises.

3. Materials and Methods

3.1. Materials

The main material of the study consists of primary data which were obtained from 104 wheat producers in the Kırıkhan, Antakya, Reyhanlı, Altınözü, Yayladağı, Kumlu, and Hassa districts of the Hatay province. Also, previous studies on wheat, and publications and commission reports of various national and international institutions and organizations, were used as secondary data.

3.2.Methods

3.2.1. Sampling Method

The data base of the Hatay Provincial Directorate of Agriculture and Forestry Farmer Registration System was used to determine the sample size. The Simple Random Sampling Method was used to determine the sample size of the research. The formula of the method is given below (Çiçek ve Erkan, 1996);

$$n = \frac{NS^2\,t^2}{(N-1)d^2 + S^2\,t^2}$$

In the formula;

n= Sample size

N= Total number of units in the sampling frame

S= Standard deviation

t= Confidence interval

d= Acceptable error

3.2.2. The Method Used in the Econometric Analysis of Wheat Production

Within the study, the Cobb-Douglas production function was used for functional analysis. Various researchers also stated that the Cobb-Douglas type production function equations are suitable for the functional analysis of agricultural activities (Özçelik, 1989). In addition, the Cobb-Douglas production function is preferred in many ways such as; providing easy calculation, performing statistical tests of production flexibility, and providing sufficient degrees of freedom even with insufficient data. The equation of the function is given below.

$$Y = aX1^{b1}X2^{b2}X3^{b3}\dots Xn^{bn} \quad (1)$$

Taking the logarithm of both sides of the equation is given as:

$$\log Y = \log \alpha + \beta 1 log x1 + \beta 2 log x2 + \dots + \beta k log xk + e^{u} \quad (2)$$

The symbol of βi in the equation represents the production elasticities (β_i=1,2,....n).

Test of βi coefficients;

$$t\,\beta i = \beta i / se(\beta i) \quad (3)$$

The $t\beta i$ value is compared with the value in the "t-table" (n-k-1) at the intersection of the row showing the degree of freedom, and the column of the desired significance level.

In the regression equation; the multiple regression (R) and coefficient of determination (R^2), elasticity coefficients of independent variables (β_i), standard errors (se βi) and significance levels ($t\beta_i$), geometric mean of variables (X_iG, YG), simple correlation coefficients (ri_j), standard deviation (S), and significance level (F) of the equation were obtained as a result of regression analyses by means of an appropriate statistical software program. In addition to this, the following calculations and correlation studies were made regarding the estimation equation; Coefficient of Determination (R^2), Significance Test of Partial Correlation Coefficients (b_i), Intrinsic Correlation (autocorrelation), and Multiple Correlation presence (multicollinearity).

The formula used in calculating the Marginal Income (MI) of the production factors used in wheat production is shown below (Karagölge, 1973):

$$MjGxj = \beta j \frac{YG\ (mean)}{XjG\ (mean)} Fy \quad (4)$$

The formula used in calculating the Marginal Efficiency Coefficient (MEC) of factors related to wheat production is given below:

$$MEC = \frac{Marginal\ Income\ of\ Factors}{Marginal\ Cost\ of\ Factors\ (Factor\ Price)} \quad (5)$$

The marginal efficiency of the variables (X_i) used in production was calculated by using the geometric mean from the Cobb-Douglas production function, which constitutes the estimation equation by using the equation given below:

$$MVXi = \beta i * YG/XiG \quad (6)$$

Since at the economic optimum; the marginal revenue should equal marginal cost, the efficiency coefficients (MEC X_i) are calculated by dividing the marginal revenues by the factor prices.

The Marginal Rate of Technical Substitution (MRTS) is the ratio that shows how much of the other input must be given up to maintain the same output level when the use of one of the inputs is increased by 1 unit on the isoquant curve. The MRTS is an economic theory that indicates the rate at which one factor should decrease so that the same level of productivity can be maintained when another factor is increased

In this study, MRTS was among the factors used in wheat production. In other words; in order to obtain a production amount at the Y level, the amount of factor X_2 should be used against the amount of factor X_1, and is calculated using the formulas below. In the formula, X_i G is the geometric mean of the data for the variables (Gündoğmuş, 1998; Karkacıer, 2001).

$$\text{MRTS } x2/x1 = \frac{\text{X1G Marginal Yield}}{\text{X2G Marginal Yield}} \quad (7)$$

or;

$$\text{MRTS } x2/x1 = b1.X2G/b2.X1G \quad (8)$$

Factor prices should also be taken into consideration in order to understand which factors need to be decreased or increased in order to make the optimum combinations. At the economic optimum, the MRTS of the factor Xi with respect to the factor Xj is equal to the ratio between the factor Xj price and the factor Xi price.

4. Results and Discussion

Within the research, the information about wheat production businesses in the determined districts of the Hatay province is given below.

The total population of the surveyed enterprises was 488, the household population per enterprise was 4.69, the average age was 51.63 years, wheat production experience was 27.58 years, and the average education of the business owners was calculated as 8.29 years.

The total plant production size of the research space was 44,967 da. In this area, cotton was the most cultivated crop with 45.69% (20,543 da), wheat was in 2nd place with 36.78% (16,539 da), and corn was in 3rd place with 12.48% (5,612 da). In the examined enterprises, 9,021 tons of wheat were produced in an area of 16,539 da for the production period of 2021/22. The average yield of the enterprises was 555.00 kg/da. Out of the producers, 47.12% (49 enterprises) stated that they used agricultural loans, and 66.35% of the enterprises (69 enterprises) had agricultural insurance for wheat production areas.

Within this study, using the data collected from 104 agricultural enterprises in the Hatay province, the relationship between the wheat yield and the input amounts of; seeds, fertilizer, pesticides, machinery power, diesel fuel, the land rental value, as well as the age, education level and experience of the business managers in wheat production were analyzed by using the Cobb-Douglas production function (Neill, 2002). The variables in the wheat production function are shown below:

Dependent variable:

Y = Wheat production amount (kg da^{-1})

Independent variables:

X_1 = Seed amount (kg da^{-1})

X_2 = Fertilizer amount (kg da^{-1}),

X_3 = Pesticide amount (cc da^{-1})

X_4 = Machinery power (minute da^{-1}),

X_5 = Land rental value (TL da^{-1}),

X_6 = Diesel fuel amount (Lt da^{-1}),

X_7 = Producer age (years),

X_8 = Producer education level (years),

X_9 = Producer experience level (years).

As part of the econometric analysis, the functional correlation between the variables used in wheat production is shown below:

$$Y = 1.640 * X_1^{0.098*} X_2^{0.254} * X_3^{0.236} * X_4^{0.031} * X_5^{0.017} * X_6^{-0.078} * X_7^{-0.229} * X_8^{0.286} * X_9^{0.320}$$

($S=0.0975$; $R= 0.565$; $R^2 = 0.319$; $F=4.895$)

Multiple correlation and determination coefficients for the equation ($F_{calc} > F_{table}$) were found significant at a 1% probability level (Table 1). Auto-correlation in the equation was tested by using the "Durbin Watson (DW) Test", and the DW_C (calculation) of the equation

was calculated as 1.981. As a result of the test (0.01; n=104; k'=9), it was concluded that there was no internal correlation problem between the variables (DW_C 1.981> $DW_{U\ (0.05)}$ 1.741). The correlation coefficients and significance levels between the inputs used in wheat production in the research are given in Table 1.

Table 1: Pearson correlation matrix between variables

Variables	Yield	Seed	Fertilizer	Pesticide	Machinery power	Land rental	Diesel fuel	Age	Education
Seed	0.096								
Fertilizer	0.365*	-0.064							
Pesticide	0.336*	0.241*	0.232						
Machinery p.	-0.063	0.057	0.008	-0.046					
Land rental	-0.063	0.066	-0.214**	-0.112	0.054				
Diesel fuel	-0.015	0.172	0.075	0.002	0.369*	-0.078			
Age	-0.084	0.165**	0.020	0.087	0.194**	-0.106	0.035		
Education	0.316*	-0.053	0.079	0.114	-0.205**	0.104	-0.016	-0.476*	
Experience	0.092	0.065	0.168**	0.027	0.128***	-0.211**	0.090	0.746*	-0.368*

(*): Significant at a 1% probability level.
(**):Significant at a 5% probability level.
(***):Significant at a 10% probability level.

It was determined that there was not a structure that disrupted the production relationship among the factors involved in wheat production, or that it did not occur.

The basic statistical values of the inputs used in wheat production in the examined enterprises are given in Table 2. The average wheat yield value in the research area was 555 kg da^{-1}. In order to reach this yield value per unit area; 28.97 kg of seeds, 72.53 kg of chemical fertilizers, 347.95 cc of agricultural pesticides, 80.52 minutes of machinery power, and 16.14 lt of diesel fuel were needed.

Table 2: Descriptive statistics on the inputs used in wheat production

Yield and Production Factors	Arithmetic mean	Geometric mean	Standard Deviation	Minimum	Maximum
Yield (kg da^{-1})	555.00	538.05	130.82	200.00	837.00
Seed amount (kg da^{-1})	28.97	28.78	3.30	20.00	38.00
Fertilizer amount (kg da^{-1})	72.53	69.33	19.83	20.00	125.00
Pesticide amount (kg da^{-1})	347.95	328.87	120.62	144.00	740.00
Machinery power (min da^{-1})	80.52	73.98	33.60	30.60	174.60
Land rental value (TL da^{-1})	901.92	834.09	387.23	400.00	2500.00
Diesel fuel amount (lt da^{-1})	16.14	14.91	6.18	4.16	34.50
Producer age (years)	51.63	50.11	11.96	20.00	89.00
Producer education level (years)	8.29	7.56	3.64	5.00	15.00
Producer experience level (years)	27.58	23.45	12.75	2.00	56.00

One of the important factors affecting the wheat yield value obtained per unit area is the rental value of the land. The average rental value of the land in the research area was calculated as 901.92 TL. Within the study, the socio-economic structures of the producers in wheat production were also examined. In this context, the average age of wheat producers was 51.63 years, the average education level was 8.29 years, and the avarage experience in farming was 27.58 years.

The basic statistics of the variables in wheat production in the research area are given in Table 3, and the variance analysis results are given in Table 4.

Table 3: Basic statistics of wheat production estimation equation

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	0.565[a]	0.319	0.254	0.0975	0.319	4.895	9	94	0.000	1.981

a. Predictors: (Constant),seed amount, fertilizer amount, pesticide amount, machinery power, diesel fuel amount, age, education level, experience level.

b. Dependent Variable: yield

Table 4: Variance analysis of wheat production function

	Degree of Freedom	Sum of Squares	Mean Squares	F value	P value
Regression	9	0.419	0.047	4.895	0.000
Remainder	94	0.894	0.010	-	-
Total	103	1.313	-	-	-

When the production elasticities of the independent variables in the estimation equation were examined: the elasticity coefficients of the seed amount, fertilizer amount, agricultural pesticide amount, machinery power, land rental value, education level, and wheat production experience factors were positive; while the diesel fuel usage amount and producer age were negative (Table 5).

Table 5: Production elasticities of wheat production factors

	X_1 (seed amt.)	X_2 (fert. amt.)	X_3 (pest. amt.)	X_4 (mach pwr.)	X_5 (land rent)	X_6 (diesel amt.)	X_7 (age)	X_8 (edu. level)	X_9 (exp. level)	$(\Sigma\beta_i)$
Elasticities (βi)	0.098	0.254	0.236	0.031	0.017	-0.078	-0.229	0.286	0.320	1.013
Std.Dev.	0.204	0.074	0.072	0.060	0.061	0.059	0.145	0.061	0.053	-

(seβi)										
tβi	1.068	2.752*	2.534**	0.321	0.190	-0.822	-1.621***	2.862*	2.374**	-

(*): Significant at a 1% probability level.
(**):Significant at a 5% probability level.
(***):Significant at a 10% probability level.

The sum of the production elasticities of the factors in the function ($\sum\beta_i$) was determined as 1.013 which represents the increasing return to scale in wheat production. In other words, when the variables are increased by 10%, it is expected that there will be an increase of 10.13% in the wheat production amount (Table 5).

In the equation, in terms of the coefficients of elasticity of the factors; the variables of fertilizer amount (X_2) and the education level of the producer (X_8) were found significant at a probability level of 1%, agricultural pesticides (X_3) and producer experience (X_9) were significant at a probability level of 5%, and producer age (X_7) was found significant at a probability level of 10%.

When the subject is approached from a theoretical point of view, it can be stated that a 10% increase in the amount of chemical fertilizer used in wheat production can increase the production amount by 2.54%, and a 10% increase in agricultural pesticides can increase the production by 2.36%. However, it would be more appropriate to make that comment only if fertilization and agricultural pest control are applied on time.

An increase of 10% in education level and producer experience increases the wheat production by 2.86% and 3.20%, respectively. However, an increase of 10% in producer age reduces the wheat production amount by -2.29%.

Within the research, the marginal product values and marginal efficiency coefficients of the factors affecting the amount of wheat production are presented in Table 6. In determining the marginal product values, the current unit prices of the inputs in the market at the time were taken into account. As is shown in Table 6, among the inputs used in wheat production, only the diesel fuel use variable has a negative sign.

Table 6: Marginal values and efficiency coefficients of the wheat production model

	X_1 (seed)	**X_2 (fertilizer)**	**X_3 (pesticide)**	**X_4 (machinery power)**	**X_5 (land rent value)**	**X_6 (diesel fuel)**	**Y**
Geometric mean	28.78	69.33	328.87	73.98	834.09	14.91	538.05
Marginal yield (kg)	1.83	1.97	0.39	0.23	0.01	-2.81	
Marginal product value (TL)	2.02	12.93	2.53	-18.46	0.07	0.03	-
Factor prices (TL)	5.13	7.69	25.22	50.00	901.92	21.00	-
Marginal efficiency coefficient	2.34	1.68	0.10	0.03	0.01	-0.88	-

In the function, the fertilizer variable (X_2) has the highest marginal yield value (1.97 kg) and marginal product value (12.93 TL). In the calculations, the highest marginal efficiency coefficient among the production factors was found as the seed variable (X_1) with 2.34. This variable was followed by the fertilizer variable (X_2) with 1.68.

When the marginal yield values in wheat production are examined; it is understood that a one unit increase in fertilizer use (X_2) can cause an increase of 1.97 kg in wheat production, and a one unit increase in the use of seeds (X_1) can cause an increase of 1.83 kg in wheat production. Also, a one-unit increase in other production factors can provide an increase of less than one kilogram in the wheat production amount. Furthermore, a one-unit increase in the diesel fuel input (X_6) in wheat production affects the production amount negatively. In other words, it causes a decrease in the production amount.

According to the marginal efficiency coefficients, the seed factor (X_1) and fertilizer factor (X_2) were used below the economic optimum level in wheat production, while other production factors were used above the economic optimum level. According to these values, the input usage closest to the economic optimum level was found as the fertilizer factor (X_2) with 1.68.

According to the analysis results; it could be recommended to increase the use of qualified and certified seeds as the seed input (X_1) which has a marginal efficiency coefficient above 1, and to increase the use of fertilizer input (X_2) per unit area, taking the developmental periods of the wheat and soil analysis results into consideration. Since, in these variables the marginal revenue is above the marginal cost. This situation indicates that the return for an additional 1 TL marginal expenditure on seed and fertilizer inputs, will increase the marginal income from the wheat production over 1 TL.

In determining the Marginal Rate of Technical Substitution (MRTS); if one of the two inputs has a negative and the other a positive production elasticity, there is no substitution relationship between them (Özçelik, 1989). Hence, the marginal technical substitution rates between the diesel fuel variable and other variables were not calculated. The marginal rate of the technical substitution between two factors in the equation is the ratio of the marginal yields of these factors relative to their geometric mean (Heady and Dillon, 1966).

MRTS>1 requires the factor composition to be changed in favor of the variable in the denominator, and MTIO<1 requires that the factor composition be changed in favor of the variable in the numerator. Accordingly, all the factors included in the production function are used at their geometric mean levels. For example; for one unit addition to the seed (X_1) usage

amount, the amount of fertilizer should be reduced by 1.08 kg under the condition that production amount remains at the same level, and no change should be made in the usage amounts of other factors.

Table 7: Marginal rates of technical substitution between factors in wheat production

Production factors	Fertilizer (X_2)	Pesticide (X_3)	Machine power (X_4)	Land rent (X_5)
Seed (X_1)	1.08	0.21	0.12	0.01
Fertilizer (X_2)	-	0.20	0.11	0.01
Pesticide (X_3)	-	-	0.58	0.03
Machine power (X_4)	-	-	-	0.05

In response to a one-unit increase in fertilizer use, it is possible to produce the same amount of wheat with 0.20 cc less pesticides and 0.11 hours less machine power. Also, it is possible to comment similarly for other variables.

By dividing the marginal rate of technical substitution to the price ratio of the inputs, it can be determined how close the input combinations are from the economic optimum level. In this context, the marginal technical substitution and price ratios between factors in wheat production are given in Table 8.

Table 8: Marginal technical substitution and price ratios between factors in wheat production

Production factors	Marginal technical substitution and price ratios	Fertilizer (X_2)	Pesticide (X_3)	Machine power (X_4)	Land rent value (X_5)
Seed (X_1)	$(dX_1/dX_i)/(FX_i/FX_1)$	0.67	0.20	0.10	0.01
Fertilizer (X_2)	$(dX_2/dX_i)/(FX_i/FX_2)$	-	0.30	0.15	0.01
Pesticide (X_3)	$(dX_3/dX_i)/(FX_i/FX_3)$	-	-	0.50	0.03
Machine power (X_4)	$(dX_4/dX_i)/(FX_i/FX_4)$	-	-	-	0.06

Within the research, it was determined that there was no combination close to the economic optimum level among the input combinations used in wheat production. According to the analysis results (Table 8), the values obtained from the ratio of the marginal technical substitution rates of inputs to the ratio of input prices, remains below 1 in all factor combinations. In other words, input combinations in wheat production were used high above the economic optimum (xj<1), or in short, were used excessively. The analysis results indicate that in the research area, more seeds, fertilizers, pesticides and machine power were used in wheat production than the recommended amount per unit area. In this context, it is necessary

to pay attention to the use of input amounts recommended by universities and research institutes in order to create input combinations at the economic optimum level.

The findings obtained from the previous studies on the subject are summarized below and compared with the results of this study.

In the research led by Semerci (1998) the affects of seed cost, fertilizer cost, pesticide cost, tractor power, number of parcels, and education level of the producer on the wheat production amount were analyzed by means of the Cobb-Douglas production function. In the study, the R^2 value of the estimation equation was 0.965, the DW statistic was 1.76, and the F-statistic was 338.17, which was found to be significant at a level of 1%. The elasticity coefficients of the variables in the equation were; seed cost (0.763) was determined as significant at a level of 1%, fertilizer cost (0.129) was at a level of 5%, pesticide variable (0.032) was at a level of 10%, and the number of parcel variable (0.083) was found statistically significant at the level of 10%. The marginal efficiency coefficient of the inputs used in wheat production was determined as 0.552 in seed input, 0.747 in fertilizer input, and 0.044 in pesticide. The marginal technical substitution rates of factor combinations was; -0.366 for seed/fertilizer, -0.635 for seed/pesticide, and -1.736 for fertilizer/pesticide. The marginal efficiency coefficients of the factor combinations in wheat production were determined as 0.980 for the seed/fertilizer combination, 0.062 for the seed/ pesticide combination, and 0.637 for the fertilizer/pesticide combination. According to these values, only the seed input was used at the optimum level compared to the fertilizer input.

Hassan et al. (2010) carried out an examination where the elasticity coefficients and importance levels of the factors affecting the amount of wheat production were found as follows: the number of parcel -2.932 (not significant), education level 0.030 (not significant), rotavator (soil cultivation) 0.070 (0.01), land preparation 0.009 (not significant), time of sowing -0.083 (0.01), seed 0.418 (0.01), irrigation 0.016 (not significant), nitrogenous fertilizer 0.092 (0.01), phosphatic fertilizer 0.004 (not significant), weedicide cost 0.081 (0.01), and farm size -0.04 (not significant). The R^2 value of the estimation equation was determined as 0.55 and the F-statistic as 58.24.

Within the investigation by Semerci et al. (2012), among the factors affecting the amount of wheat production; the area, seed cost, fertilizer cost, pesticide, and precipitation factor as a dummy variable; in wet or dry conditions, were examined. The R^2 value of the estimation equation was determined as 0.825, the F-statistics as 816.56, and the DW statistics as 1.836. The elasticity coefficients of the variables in the estimation equation were as follows; production area was 0.507, seed cost was -0.172, fertilizer cost was 0.494, pesticide

was 0.031, precipitation factor was 0.228, and as a dummy variable was 0.244. All of these variables, except for agricultural pesticides, were found to be statistically significant at the 1% level. The marginal efficiency coefficient of the variables were as follows: production area was 1.65, fertilizer was 6.66, and pesticide was 1.28. These values show that the specified inputs in wheat production were used below the economic optimum level and they should be increased.

In the research led by Buriro et al. (2013), the elasticity coefficients and significance levels of the factors affecting wheat production were calculated. In this context: the production area was determined as 0.07 (0.10), tractor as 0.09 (0.05), seed as 0.02 (not significant), phosphate fertilizer as 0.04 (not significant), area fertilizer as 0.51 (0.01), and pesticide as 0.15 (0.01). The sum of the elasticity coefficients of the variables in the equation was 0.88, which indicates a decreasing return to scale. The R^2 value of the estimation equation was 0.907, and the F-statistic (925.7) was found significant at a level of 1%.

Semerci (2013) conducted a study on the amounts of; seeds, chemical fertilizers, pesticides, precipitation (mm), and land rental value factors that were affecting the amount of wheat production. The R^2 value of the estimation equation was determined as 0.965, the F-statistics as 468.68, and the DW-statistic as 1.723. The elasticity coefficients of the variables in the equation were as follows; seed was 0.459, chemical fertilizer was 0.354, pesticide was 0.049, precipitation was 0.085, and land rental was 0.172. In the variables of the production function, the amounts of seed, chemical fertilizer, and precipitation variables were found statistically significant at the level of 1%, while the variables of agricultural pesticide and land rent value were significant at a level of 5%. The marginal efficiency coefficients of the variables in the estimation equation were as follows; seed amount was 6.398, chemical fertilizer amount was 2,423, agricultural pesticide was 0.274, and land rental value was 0.003.

In an investigation by Sureshkumar et al. (2014), the R^2 value of the estimation equation for wheat production was 0.66, and the F-statistic was 45.25 (significance: 0.05). The elasticity coefficients and importance levels of the variables in the production function were found as follows; seed amount was 0.551 (0.01), manure was 0.059 (0.01), nitrogenous fertilizer was 0.371 (0.001), phosphorus fertlizer was 0.148 (0.01), hired labor was 0.188 (0.01), the number of agricultural spraying was 0.020 (0.05), the number of weeding was 0.171 (0.05), the number of irrigation was 0.288 (0.01), diesel fuel was -0.10 (not significant), and animal power was 0.029 (0.01). The sum of the elasticity coefficients of the variables in the production function were determined as 1.815, which represents the increasing return to scale.

The study Ahmad et al. (2015) carried out shows that the elasticity coefficients and significance levels of the inputs affecting the wheat production amount were as follows; fertilizer cost was -0.09 (0.01), irrigation cost was 0.01 (not significant), plant protection cost was 0.16 (0.10), land preparation cost was 0.01 (not significant), and loan use as a dummy variable was 0.05 (0.05). The R^2 value of the estimation equation was calculated as 0.45 and the F-statistic as 4.21.

Agam et al. (2017) led an analysis where the efficiency coefficients and significance levels of the factors that affect the amount of wheat production were as follows; labor force was 0.11 (not significant), animal power was 0.008 (not significant), machine power was -0.01 (not significant), seed was 0.08 (0.01), fertilizer was -0.002 (not significant), manure was -0.009 (not significant), plant protection was -0.01 (0.05), and production area was -0.13 (0.05). The coefficient of the estimation equation (R^2) was calculated as 0.53. The marginal efficiency coefficient (marginal value of product to factor cost ratio) values of the variables in wheat production were as follows; labor force was 0.08, animal power was 0.009, machine power was -0.12, seed was 0.002, fertilizers were -0.003, manure was -0.14, plant protection was -0.007, and production area was -5.99. These values indicate that all the factors in wheat production are overused and they should be reduced.

In the research done by Iqbal et al. (2017), the efficiency coefficients and importance levels of the factors affecting the amount of wheat production were calculated as follows; fertilizer was 0.231 (0.01), farm manure was 0.014 (not significant), land preparation was 0.023 (not significant), pesticides/weeding was 0.300 (0.01), irrigation was 0.183 (0.01), seed was 0.095 (not significant), and labor was 0.227 (not significant). The R^2 value of the estimation equation was calculated as 0.65, the F-statistics was 59.84, and the DW-statistic was 1.88.

Within the study conducted by Amoozad-Khalili et al. (2020), wheat production was examined as machinery and semi-machinery. According to the research results, the elasticity coefficients and significance levels of the factors in wheat production with the machinery system were; labor force was 0.177 (0.05), machinery was 0.123 (not significant), diesel fuel was 0.317 (0.01), fertilizer and pesticide was 0.303 (0.01), and seed was 0.164 (not significant). The R^2 value of the equation was calculated as 0.82, the DW-statistics was 2.08, and the sum of the marginal efficiency coefficients was 1.084. The elasticity coefficients and significance levels of the factors in the semi-machinery system were; labor force was 0.030 (not significant), machinery was 0.451 (0.01), diesel fuel was 0.472 (0.01), fertilizer and pesticide was -0.261 (0.05), and seed was 0.363 (not significant). The R^2 value of the equation

was 0.76, the DW-statistics was 1.87, and the sum of the marginal efficiency coefficients was 1.055. In both systems, the sum of the elasticity coefficients of the inputs in wheat production showed increasing returns to scale.

Verma et al. (2021) directed an examination where the elasticity coefficients and significance levels of the factors affecting wheat production were found as follows; labor force was 0.28 (not significant), animal power was -013 (not significant), seed was 0.97(0.05), manure was 0.04 (not significant), fertilizer was 0.29 (0.01), plant protection was -0.06 (0.01), and irrigation was 0.02 (0.01). The R^2 value of the estimation equation was calculated as 0.79. The sum of the elasticity coefficients of the variables in the equation was 1.41, which represents the increasing return to scale.

Mala and Akbay (2022) showed that the elasticity coefficients and significance levels of the factors affecting wheat production in the research were as follows; farm size was 0.035 (0.01), pesticide amount was 0.693 (0.01), seed amount was 0.854 (0.01), fertilizer amount was -0.001 (not significant), labor force was -0.047 (not significant), irrigation was 0.111 (0.01), sowing time was 0.140 (0.01), the kind of seed was 0.031 (not significant), and the education level was -0.020 (not significant). The R^2 value of the estimation equation was found as 0.71, and the F-statistic (48.20) was significant at a 1% level. The sum of the elasticity coefficients of the variables in the production function was calculated as 1.976, and this value represents the increasing return to scale.

In another analysis by Verma et al. (2023), the factors affecting the wheat production value were investigated. The efficiency coefficients and significance levels of the factors of production were as follows. In the marginal businesses; labor was 0.098 (0.01), seed was 0.443 (0.01), manure and fertilizer was 0.197 (0.05), and irrigation was 0.082 (0.01). In the small-scale enterprises, labor was 0.474 (0.01), seed was 0.096 (0.05), manure and fertilizer was 0.021 (0.05), and irrigation was 0.243 (not significant). In the medium-scale enterprises labor was 0.369 (0.05), seed was 0.149 (0.05), manure and fertilizer was 0.189 (not significant), and irrigation was 0.127 (not significant). The sum of the R^2 value and elasticity coefficients of the estimation equations were determined as 0.93 and 0.8202 in the marginal enterprises, 0.94 and 0.8342 in the small-scale enterprises, and 0.94 and 0.8343 in the medium-scale enterprises. In the study, when the total elasticity coefficients are taken into consideration, it is concluded that there is a decreasing return in wheat production for all scale groups.

When the findings of this study are evaluated mutually with the other research findings mentioned above, it is revealed that the variables used in functional analysis are close

to each other, and that the coefficient of determination (R^2) and F-test results related to the function also show similarities (Hassan et al., 2010; Ahmad et al.; 2015; Agam et al., 2017).

The variables in the wheat production estimation function may vary according to the purpose of the research. In different studies on wheat production, it is understood that the significance level of the variables in the function; especially precipitation, or irrigation and fertilizer, are higher than the other variables (Semerci et al., 2012; Semerci, 2013; Sureshkumar et al., 2014; Iqbal et al., 2017; Amoozad-Khalili et al., 2020; Verma et al., 2021; Mala and Akbay, 2022; Verma et al., 2023).

In this analysis, among the production factors in the estimation equation; the variables of fertilizer amount (X_2) and education level (X_8) were found significant at the probability level of 1%, agricultural pesticides (X_3) and producer experience (X_9) were significant at the probability level of 5%, and the age of the producer (X_7) was found significant at the probability level of 10%. The sum of the production elasticities of the factors in the function ($\sum\beta i$) was calculated as 1.013. The calculated value shows the increasing returns to scale in wheat production and is similar to some previous research findings (Sureshkumar et al., 2014; Amoozad-Khalili et al., 2020; Verma et al., 2021; Mala and Akbay, 2022).

Within this research; according to the marginal efficiency coefficients, it was determined that the seed factor (X_1: 2.34) and the fertilizer factor (X_2: 1.68) were below the economic optimum level, and other factors were being used above the economic optimum level.

Semerci (1998) conducted a study where the marginal efficiency coefficient of the inputs were determined as; 0.552 in seed input, 0.747 in fertilizer input, and 0.044 in agricultural pesticide, which were all well above the economic optimum level. In another analysis led by Semerci et al. (2012), the marginal efficiency coefficients of the variables in the wheat production estimation equation were; production area was 1.65, fertilizer was 6.66, and pesticide was 1.28, which were well below the economic optimum point. It was concluded that the amount of use per unit area should be increased. As a different study carried out by Semerci (2013) showed, the marginal efficiency coefficients of the variables in the wheat production estimation equation were calculated as; seed amount was 6.398, chemical fertilizer was 2.423, pesticide was 0.274, and land rental value was 0.003. According to these values, it was determined that the amount of seeds and fertilizers were used below the economic optimum, while the pesticide and the land rental variable factor were used above the economic optimum level. In the research led by Agam et al. (2017), the marginal efficiency coefficient of the variables in wheat production were found as; labor was

0.08, animal power was 0.009, machine power was -0.12, seed was 0.002, fertilizer was -0.003, manure was -0.14, plant protection was -0.007, and the production area was -5.99. These values showed that all factors in wheat production were over used and should be reduced.

5. Conclusion and Recommendations

In this study, some variables used in wheat production which are thought of as being effective on the production amount such as; the amount of seed, fertilizer, pesticides, machine power, rental land value, diesel fuel, also some variables from a sociological point of view; producer age, education level, and wheat production experience, were analyzed by means of the Cobb-Douglas production function.

In the function created for wheat production, the variables of the amount of fertilizer use (X_2) and the education level of the producer (X_8) were found significant at the probability level of 1%. The amount of pesticide use (X_3) and the experience of the producer (X_9) were 5%, and the age of the producer (X_7) was found significant at a 10% significance level. It was understood that the sum of the production elasticity coefficients of the factors affecting the production amount ($\sum\beta i$: 1.013) has an increasing return to scale.

Among the variables in the estimation equation, the highest marginal efficiency coefficients belong to the seed (X_1) variable with 2.34 and the fertilizer variable (X_2) with 1.68. According to the marginal efficiency coefficients of the factors; it is recommended to increase the seed (X_1) and fertilizer (X_2) inputs used in the unit area, especially in terms of quality as well as quantity, since the marginal revenue of these variables is higher than the marginal cost.

The amount of input usage in agricultural production is directly related to the input price. In a case where the input prices vary excessively, as they have in Turkey in recent years, producers are forced to keep up with the changing conditions by actions such as decreasing the input amounts. In other words, excessive increases in input prices force producers to decrease the product cost, especially by decreasing the variables of seeds, fertilizers, diesel fuel, and pesticides. As a consequence of this situation, a desired level of efficiency and yield cannot be obtained in the production. Unfortunately, Turkish farmers experience this unusual situation at a high level, especially during 2021 and 2022.

In order to ensure efficiency in the use of inputs in wheat production it is necessary to; determine the input prices at a reasonable level, make the input costs competitive with the

producers of other countries, and support producer welfare more effectively. In this context, the purchase prices announced for wheat production or the current price and subsidy unit prices in the market, should be calculated and applied in real terms.

6. References

AGAM, P.A.; TALE, S.G.; THAKARE, S.S. Economics of wheat production. *International Research Journal of Agricultural Economics and Statistics*, vol. 8, n. 1, p. 1-7. 2017.

AHMAD, A.; JAN, I.; ULLAH, S.; PERVEZ, S. Impact of agricultural credit on wheat productivity in District Jhang, Pakistan. *Sarhad Journal of Agriculture*, vol. 31, n. 1, p. 65-69. 2015.

AMOOZAD-KHALILI, M.; ROSTAMIAN, R.; ESMAEILPOUR-TROUJENI, M.; KOSARI-MOGHADDAM, A. Economic modeling of mechanized and semi-mechanized rainfed wheat production systems using multiple linear regression model. *Information Processing in Agriculture*, vol. 7, n. 1, p. 30–40. 2020.

AYDIN, B.; ÖZKAN, E.; ÇOBANOĞLU, F.; GÜRBÜZ, M.A.; KURŞUN, İ.; KAYHAN, İ.E. Edirne İlinde Buğday Üretiminde Girdi Kullanımı ve Karşılaştırmalı Maliyet Analizi. *Adnan Menderes Üniversitesi Ziraat Fakültesi Dergisi*, vol. 19, n. 1, p. 111-119, 2022.

BURIRO, R.A.; KHOOHARO, A. A.; TALPUR, G. H.; RAJPUT, M. I. Technical efficiency of wheat farming in Sindh Province of Pakistan. *Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences*, vol. 29, n. 1, p. 77-87. 2013

ERAKTAN, G. Tarım Politikası Temelleri ve Türkiye'de Tarımsal Destekleme Politikası. Uzel Yayınları, ISBN 975-8437-01-1, İstanbul. 2001.

FAO. Food and Agriculture Orgaization of The United Nations – Statistical Yearbook 2022. Rome. https://doi.org/10.4060/cc2211en [Erişim tarihi: 09.06.2023]. 2022.

FAO. Birleşmiş Milletler Gıda ve Tarım Örgütü. FAOSTAT. Erişim: http://www.fao.org/faostat/en/#data [Erişim tarihi: 09.06.2023]. 2023.

GÜNDOĞMUŞ, E. Ankara ili Akyurt ilçesi tarım işletmelerinde ekmeklik buğday (Triticum aestivum L.) üretiminin fonksiyonel analizi ve üretim maliyetinin hesaplanması. *Tr. J. of Agriculture and Forestry*, vol. 22, p. 251-260. 1998.

HASSAN,I.; CHATTHA, M.B.; CHATTHA, T.H. ALI, M.A. Factors affecting wheat yield: A case study of mixed cropping zone of Punjab. *J. Agric. Res., vol.* 48, n. 3, p. 403-408. 2010.

HEADY, O.E.; DILLON, J.L. Agricultural Production Functions. Iowa State University Press, USA, 1966.

IQBAL, M.; KHAN, M.F.; SUHAIL, M.; ZAMAN, Q. Determinants of various factors for wheat production. *J. Agric. Res.,vol.* 55, n. 2, p. 379-385. 2017.

ITC. Uluslararası Ticaret Merkezi. Uluslararası İş Geliştirme İçin Ticaret İstatistikleri (TradeMap). Erişim: https://www.trademap.org/Index.aspx [Erişim tarihi: 09.06.2023]. 2023.

KARAGÖLGE, C. Arazi tasarruf şekillerine göre erzurum ilindeki tarım işletmelerinin ekonometrik analizi. Ankara Üniversitesi Ziraat Fakültesi Yayınları: Ankara. 1973.

KARKACIER, O. Tarım Ekonomisi alanına ilişkin fonksiyonel analizler ve bu analizlerden çıkartılabilecek bazı kantitatif bulgular. Gaziosmanpaşa Üniversitesi, Ziraat Fakültesi Yayınları No:49, Ders Notları Serisi No:26, 73 s., Tokat. 2001.

Kızılaslan H. Dünya'da ve Türkiye'de Buğday Üretimi ve Uygulanan Politikaların Karşılaştırılması. Gaziosmanpaşa Üniversitesi Ziraat Fakültesi Dergisi, vol. 21, n. 2, p. 23-38. 2004.

MALA, S.N.; AKBAY, C.K. Input use, cost structure and economic analysis of wheat production in the northern region of Iraq. Custos e @gronegócio *on line, vol.* 18, n. 1, p. 250-270. 2022.

NEILL, R.J. Production and production functions: some implications of a refinement to process analysis. *Journal of Economic Behaviour & Organization*. Vol. 51, n. 4, p. 507-521. 2002.

ÖZÇELİK, A. Ankara Şeker Fabrikası civarındaki seker pancarı yetiştiren tarım işletmelerinde şeker pancarı ile buğday için fiziki üretim girdileri ve üretimin fonksiyonel Analizi A.Ü. Ziraat Fakültesi Yayın No:1113, Bilimsel Araştırma ve İncelemeler, 53 s., Ankara. 1989.

Resmi Gazete. Bitkisel Üretime Destekleme Ödemesi Yapılmasına Dair Tebliğ (Sayı: 32018, Tebliğ No: 2022-37). 19 Kasım 2022.

SEMERCİ, A. The agricultural structure in Thrace Region and the productivity analysis of the major agricultural products. Trakya University Graduate School of Natural and Applied Sciences. 249 p. Edirne, Turkey. 1998.

SEMERCİ, A.; MAZID, A.; AMEGBETO, K. N.; KESER, M.; MORGOUNOV, A.; PEKER, K.; BAGCI, A.; AKİN, M.; KUCUKCONGAR, M.; KAN, M.; KARABAK, S.; ALTİKAT, A.; YAKTUBAY, S. The production functions of wheat production in Turkey. *Bulg. J. Agric. Sci., vol.* 18, n. 2, p. 240-253. 2012.

SEMERCİ, A. Determining the resource use efficiency in wheat (T*riticum aestivum L.*) production: A case study of Edirne province – Turkey. *Bulg. J. Agric. Sci.*, 19: 314-324. 2013. Semerci, A. Tarımsal Üretimde Kaynak Kullanım Etkinliğinin Belirlenmesi: Yağlık Ayçiçeği (*Helianthus annuus, L.*) *Üretimi Örneği. Türk Tarım ve Doğa Bilimleri Dergisi*, vol. 9, n. 2, p. 263-281. 2022a.

SEMERCİ, A. Yağlık Ayçiçeği (Helianthus annuus, L.) Üretiminde İşletme Büyüklük Gruplarına Göre Girdi Kullanım Etkinliğinin Analizi. *Türk Tarım ve Doğa Bilimleri Dergisi*, vol. 9, n. 2, p. 227-243. 2022b.

SURESHKUMAR, A.P.; PATEL, K.S.; ASODIYA, P.S.; PARMAR, V.K. Input use, costs structure, return and resource use efficincy analysis of wheat crop in South Gujarat, India. *Int. J. Agr. Ext.*, vol. 2, n. 1, p. 05-12. 2014.

TSI. Turkish Statistical Institute, Bitkisel Üretim İstatistikleri. Erişim: https://biruni.tuik.gov.tr/medas/?locale=tr [Erişim tarihi: 10.06.2023]. 2023a.

TSI. Turkish Statistical Institute, Bitkisel Ürün Denge Tabloları. Erişim: https://biruni.tuik.gov.tr/medas/?locale=tr [Erişim tarihi: 10.06.2023]. 2023b.

VERMA, D.K.; SINGH, H.; MEENA, G.L. Factors affecting production of cereal crops in Rajasthan: The Cobb-Douglas analysis. *Economic Affairs*, vol. 66, n. 2, p. 01-06. 2021.

VERMA, S.K.; SINGH, R.; PRATAP, A. YADAV, S.; SHAKYA, A.K.; KUMAR, K. Economics of production and resource use efficiency wheat cultivation in Hardoi District of Uttar Pradesh. *Environment and Ecology*, vol. 41, n. 1A, p. 284-291. 2023.

7. Acknowledgement

This study was supported by the Hatay Mustafa Kemal University, Coordinatorship of Scientific Research Projects (Project number: 22.GAP.037). We would like to thank the Hatay Mustafa Kemal University for their financial contribution and the Antakya District Directorate of Agriculture and Forestry for their technical support.

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