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THE PRODUCTION FUNCTIONS OF WHEAT PRODUCTION IN TURKEY

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Abstract

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In this research, the efficiency of inputs' level and monetary size of production factors were determined for wheat production in Turkey. In the study Cobb-Douglas, type production function was used and multi-determination coefficient of acquired estimating equation (R^2) was estimated at 0.825. It has been proved that there is increasing return to scale ($\sum\beta_i$=1.089) in wheat production, based on the sum of elasticity coefficient of variables in the function. The coefficients of factors have been considered that when some factors such as land quantity, fertilizer cost and pesticide cost increase the wheat production also increase due to increasing return of scale. In the provinces where this research has been conducted, the average yield of wheat varies between 1.893-4.384 ton ha^{-1}. For the average research provinces, it has been proved that gross production value of the wheat varies between 533.83€ - 1192.45€ ha^{-1} and gross profit varies between 205.43€-826.95€ ha^{-1}. Also agricultural subsidies which were taken by the provinces, according to their yield per unit area, varies between 95.18€ - 145.00€ ha^{-1}. It has been concluded from the research that despite of the support payments to encourage the agricultural production, the competitive power of Turkey is low in wheat and agricultural support unit price is insufficient because of the higher production cost of wheat in proportion to other countries.

Key words: Wheat, Input Use, Production Function, Efficiency, Subsidy, Turkey

Introduction

The wheat (*Triticum aestivum* L. em Thell) , which has the widest adaptation capacity among cereal species, has an important role in human nutrition (Briggle and Curtis, 1987). According to the data on 2009 year, Turkey ranks among the first 11 countries by 3.02 % in the world (FAO, 2011).

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With the respect of cultivated area and production quantity in production pattern, wheat is an important product for Turkey by the socially and economically ways (Ozcelik and Ozer, 2006).

Along with the studies conducted in the research institutes of Ministry of Agriculture and Rural Affair (MARA) and improvement programs of agricultural faculties, the researches on the growing technique of the improved species were also important in the aspect of the increase acquired in wheat production per unit area in Turkey. In this context the studies about wheat varieties and lines, used in wheat production in Turkey, have been conducted in terms of both growing technique and improvement programs (Genctan and Balkan, 2008; Yagmur and Kaydan, 2008; Aydin et al., 2005; Baser et al., 2007; Gecit and Cakir, 2006). The highest performance has been obtained from improved wheat species is closely related with optimum use of the factors in production stage, along with the climatic features of the wheat production area.

The basic objective of the agricultural enterprises at agricultural production is to increase the profit by using land, water, plant, and manpower resources in a productive and compatible way within the enterprises' own conditions and opportunities. The providing of production factors by the most suitable price and using them in optimum level have an effect on increasing the productivity and reducing the costs in the enterprises.

Due to the undercapitalization of the enterprises and lack of technical information, the producers are not able to use agricultural production factors in optimum level and this fact affects the yield and producer income negatively. For that reason the studies that determine the input use level of the producers for agricultural products in a specific model and that show which input must be used at which level, are required (Gundogmus, 1998).

There have been some studies about determining the technical efficiency of input use in wheat production around the world (Battese et al., 1996; Boshrabadi et al., 2008; Hadley, 2006; Coelli et al., 2003; Conradie et al., 2006; Zhu and Lansink, 2010; Hussian et al., 2004). In Turkey where the wheat has been an important role on state economy, some studies have been made on determining the technical efficiency level of the inputs (Ozsabuncuoglu, 1998; Gundogmus, 1998; Bayramoglu and Oguz, 2005).

One of the criteria that has been used for evaluating the agricultural production activities according to the order of priority in producer conditions and for determining the profitability of producers is Gross Profit. In this research, the differences in input use in wheat production have been examined statistically in 5 provinces of Turkey, located at the different geographic regions where approximately 22% of the wheat production has been made and the efficiency coefficients of factors have been calculated with the help of marginal yield and marginal income coefficients. The data obtained, have been compared to former research findings and related conclusions have been made.

Literature Abstracts

In the scope of the research made in Ankara on wheat production, it has been proved that multi-determination coefficient of estimating equation (R^2) is 0.998 and the sum of production elasticity coefficient ($\sum\beta_i$) is 1.033. In the enterprises it has been concluded that pure nitrogenous fertilizer is used excessively and it must be reduced. In the equation created in the extent of the research, it has been observed that production area (0.713) is the most effective factor in wheat production (Gundogmus, 1998).

In the research conducted in South Eastern Anatolian Region, the functions such as multiple linear, quadratic and Cobb-Douglas production function have been used for functional analysis of wheat production. In the estimating equation which has been made, the sum of production elas-

ticity coefficient ($\sum\beta_i$) has been found below 1. The production area, chemical fertilizer and rainfall factors which are effective on wheat production have been examined within the research. As a result of the research, it has been concluded that to provide an increase in the wheat production, input use level must be increased (Ozsabuncuoglu, 1998).

In the research conducted in Konya, the relation between wheat production quantity and production factors has been observed with the help of Cobb-Douglas function type. In the model, it has been determined multi-determining coefficient (R^2) is 0.935 and the most effective factor on production quantity is irrigation. In the research the sum of production elasticity coefficient of variables used in production has been found to be below 1. As a result it has been concluded that irrigation number and land factor must be increased to provide an increase in wheat production (Bayramoglu and Oguz, 2005).

In the research conducted in Tokat, the factors which are effective on wheat production have been examined. The multi-determination coefficient of the created equation has been observed to be (R^2) 0.879 and the sum of elasticity coefficient is ($\sum\beta_i$) 1.635. In the research it has been proved that the most effective factor on wheat production is seed input. For the fact that the sum of the efficiency coefficient of the factors in estimating equation is below 1, it has been concluded that there must be a restriction in input use (Akcay and Uzunoz, 1999).

In the similar research conducted in Kirklareli, the multi-determination coefficient (R^2) of estimating equation in wheat production has been calculated as 0.966 and the sum of elasticity coefficient ($\sum\beta_i$) calculated as 1.079. It has also been observed that the most effective factor on wheat production is seed input (0.763). In the research, efficiency coefficients of the inputs have been evaluated and it has been emphasized that there must be a restriction in seed, pesticide and fertilizer factors (Semerci, 1998).

In the cost research conducted in Thrace Region, it has been calculated that input cost is 337.66€, labor cost is 306.19€, harvest and marketing cost is 91.57€ for 5.050 ton ha^{-1} wheat yield. In the research it has been determined that variable cost is 764.84€, fixed cost is 260.00€ and total crop cost is 938.99€. In the research it has also been determined that the gross production value of the wheat, including the subsidies, is 1358.35€, gross profit is 593.51€ and net profit is 333.51€ (Kumbar and Unakitan, 2011). The literature information about input use level in wheat production has been given in related part as comparatively with research findings.

Material and Method

The material of the research has been obtained from the data acquired in the extent of "Adaption and Impacts of Improved Winter and Spring Wheat Varieties in Turkey" which has been conducted by the cooperation with Ministry of Agricultural and Rural Affairs (MARA) General Directorate of Agricultural Research (GDAR), International Center for Agricultural Research in the Dry Areas (ICARDA) and International Winter Wheat Improvement Program (IWWIP). In the research the cross sectional data of the 2006/2007 production period which has been acquired from 781 wheat enterprises were used. The climatic data used in the research have been acquired from the General Directorate of State Meteorology Affairs and the data of the support payment in wheat productions have been obtained from MARA (TSMS, 2009; MARA, 2011).

Based on the definition of agricultural zones by Turkish Statistical Institute, the general characteristics of the provinces on the research area where the questionnaire has been applied are summarized shortly below (Mazid et al., 2009).

Ankara is within the central north zone with a continental climate and annual rainfall of 375 mm. The production system for cereals, food and forage legumes is predominantly rainfed with extensive rearing of small ruminants, and intensive dairy cattle. Edirne is in the Marmara and Thrace zone with an average rainfall of 700 mm per year. Wheat and other cereals are produced, also sunflower, and vegetables. Adana is part of the Mediterranean agricultural zone in the western coastal area of the country, with average rainfall up to 700 mm per year. Cereals are produced under rainfed conditions or irrigation. Diyarbakir is in the southeast zone with large fertile plains in the southern part. The production system is mainly rainfed, although the South East Anatolia (GAP) project has invested in one of the biggest irrigation scheme in the zone. Konya is part of the central south zone having an average rainfall of 350 mm per year and 80-100 days of frost. Crop production is mainly under rainfed cultivation.

Sampling Method

Central Anatolia, Thrace Region, Southeastern Anatolia and Cukurova Regions are significant wheat production areas even though wheat production spreads through the countrywide in Turkey (Kumbasaroglu and Dagdemir, 2010). The research has been conducted in the regions where wheat productions are intensive and in Adana, Ankara, Diyarbakir, Edirne and Konya which have different agro-ecological conditions. Given provinces consists 21.98% of Turkey's wheat production in 2007 (TURKSTAT, 2011). In the research, Multi-Stage Stratified Random Sampling Method has been used to determine the sampling volume. Distribution of the questionnaires by provinces used in the research has been given in Table 1.

Production quantities, wheat cultivated areas and wheat producer numbers of the provinces in the research area have been taken into consideration in determining the number of the applied questionnaires and their distribution by provinces. Because of this applied method, it has been determined to apply 781 questionnaires in the research.

The Method Used in Functional Analysis

A great deal of functional forms has been defined for production process (Griffin et al., 1987). Cobb-Douglas production function is one of the most widespread function types used particularly in the studies of agricultural-economics for this reason (Debertin, 1986) Cobb-Douglas function type has two sided logarithmic structure. In the model, the coefficient of every X variable measures the (partial) elasticity of the dependant Y variable in proportion to that variable. Additionally, in the Cobb-Douglas production function, sum of the estimated elasticity coefficients has been used as an indicator of returns to scale (Heady and Dillon, 1972). The form related to Cobb-Douglas function type is given below:

$$Y = A \prod_{i=1}^{n} X_i^{\beta i},\ \beta_i > 0 \qquad i = 1,2 \ldots n \qquad (1)$$

where Y is the output, and X a vector of essential inputs used in production, and n is number of inputs used. A is the combined effects on the production function of all inputs (rainfall, disease outbreaks, etc.) that are not under the strict control of the farmer. Empirically, a logarithmic transformation in the following format was made, and dummy variable included to the equation to distinguish the impact of the rainfed or irrigated system on wheat production (Mazid et al., 2009).

In the equality, Y symbolizes wheat production, X_i symbolizes variables such as seed, fertilizer, pesticide, D_j symbolizes the dummy variable re-

$$\ln(Y) = \ln(A) + \sum_{i=1}^{n} \beta_i \ln(X_i) + \sum_{j=1}^{j} \delta_j D_j + \varepsilon, \qquad (2)$$

$$\beta_i > 0 \quad i = 1,2,\ldots.n, \quad j = 1,2,\ldots J$$

lated to the production in watery and dry condition (1: production in watery condition, 0: production in dry condition) and ε symbolizes error term of equation. In the study, Cobb-Douglas function type has been used to define the relations between wheat production quantity (Y) and the inputs used in production (X_i). The variables placing in the model are given below:

Ln Y : wheat production quantity (kg enterprise).
Ln X_1 : production area (ha^{-1} enterprise)
Ln X_2 : seed cost (€ enterprise).
Ln X_3 : chemical fertilizer cost (€ enterprise)
Ln X_4 : pesticide cost (€ enterprise)
Ln X_5 : precipitation in the wheat production period (mm)
Ln X_6 : Dummy variable for production system of the wheat production (1=irrigated, 0 = rain fed)

In the research, elasticity coefficient belonging to the inputs used in wheat production, marginal yield, marginal product value, marginal productivity coefficient have been calculated and the factors have been commented. In the research, the value of marginal yield is obtained as a result of multiplication of elasticity coefficient of related factor (X_i) and the value calculated as a consequence of division of geometrical mean of production quantity (Y) to the geometrical mean of related factor (X_i). Marginal income is obtained because of multiplication of related factor (X_i) and product price. Marginal efficiency coefficient is obtained as a consequence of division of related factor's (X_i) marginal income to the unit price of the same factor (Karkacier, 2001)

The test of Tukey HSD has been used to determine the differences between the input quantities used in wheat production among the provinces that analyzed enterprises are situated (Ural and Kilic, 2006; Altunistik et al., 2007; Green et al., 2000).

Table 1
The distribution of sampling volume by provinces in the research area

Province	District	Communities	Appl. Quest. Numbers	Proportion, %
Adana	7	27	130	16.65
Ankara	6	27	130	16.65
Diyarbakır	7	49	130	16.65
Edirne	8	15	90	11.52
Konya	10	52	301	38.53
Total	38	170	781	100.00

Results and Discussion

As results of data obtained from the enterprises, which have been applied questionnaires in the research area, variable costs of wheat have been calculated and stated in Table 2. When Table 2 is examined, it It has been understood that there are some cost differences within provinces such as 25€ is the difference in pesticide cost, 51€ is the difference in fertilizer cost and the difference in seed cost used per unit area in wheat production is approximately 20€.

When the input costs of investigated enterprises are considered, it has been obviously seen that the highest input cost is in Adana province (280.06€) the lowest input cost is in the enterprises of Ankara province (193.73€). When the input costs are evaluated together with labor costs, it is understood that total variable cost is seen at the highest level in the enterprises of Adana province, at the lowest level in the enterprises of Konya province.

Agricultural production has been subsidies with a variety of policies executed especially since the beginning of 2000's. The utilization level of producers from the supports show differences according to production quantity and production area. Wheat producers also utilize from fertilizer, fuel and soil analysis supports as area based. Additionally, in the scope of encouragement of production, they utilize from bounty (premium) support dependent upon product quantity. Wheat yield, supports

and gross profit values in analyzed enterprises have been stated in Table 3 by provinces.

There have been significant differences in the yield value obtained per unit area in analyzed enterprises. When the yield value within provinces are compared, it has been determined that there are statistically differences at 1% importance level between other provinces while Adana and Edirne don't have any differences statistically. This condition also shows similarities in the point of utilization level from agricultural subsidies.

While wheat yield is above 4 ton ha^{-1} in the enterprises in of Adana and Edirne, it is below 2 ton ha^{-1} in the enterprises of Ankara province. This

Table 2
Unit costs of wheat production in the research area

Cost elements	Provinces				
	Adana	Ankara	Diyarbakir	Edirne	Konya
Input Use					
Seed cost (€ ha-1)	91.41	80.12	83.90	73.54	95.51
Fertilizer cost (€ ha-1)	152.76	104.56	142.60	154.54	122.86
Pesticide cost (€ ha-1)	35.89	9.05	16.72	14.43	5.57
Labor costs					
Ploughing (€ ha-1)	109.63	111.30	129.13	99.81	84.92
Seeding (€ ha-1)	20.86	23.61	23.04	33.02	22.72
Irrigation (€ ha-1)	30.81	29.17	35.46	23.23	26.29
Labor of agri-fight (€ ha-1)	17.64	19.88	27.80	0.00	13.28
Labor of fertilizing (€ ha-1)	15.30	14.80	13.34	14.48	15.40
Harvesting and threshing (€ ha-1)	36.20	31.09	34.16	47.74	32.66
Total variable cost (€ ha-1)	510.50	423.58	506.15	460.79	419.21

Table 3
Gross profit of wheat production in the research area

Indicators	Provinces				
	Adana	Ankara	Diyarbakir	Edirne	Konya
Yield (ton ha)	4 384	1 893	3 702	4 149	2 456
Product price (€ ton)	252.00	262.00	256.00	256.00	291.00
Subsidies					
Bounty (price) support (€ ton)	20.00	20.00	20.00	20.00	20.00
Fertilizer support (€ ha)	12.20	12.20	12.20	12.20	12.20
Fuel support (€ ha)	16.50	16.50	16.50	16.50	16.50
Sertified seed support (€ ha)	28.62	28.62	28.62	28.62	28.62
Total supports (€ ha)	145.00	95.18	131.36	140.30	106.44
Gross production value (€ ha)	1192.45	533.83	1021.75	1145.12	763.82
Total variable cost (€ ha)	510.50	423.58	506.15	460.79	419.21
Gross profit* (€ ha)	681.95	110.25	515.60	684.33	344.61
Gross profit** (€ ha)	826.95	205.43	646.96	824.63	451.05

(*).Total subsidies are excluded.
(**).Total subsidies are included.

condition affects especially the utilization level of enterprises from bounty (premium) support significantly. When total supports are taken into consideration, it has been determined that while wheat gross profit is more than 800€ in the enterprises of Adana and Edirne, it is a little bit more than 200€ in the enterprises of Ankara.

It has been seen that 594.40€ ha^{-1} gross profit calculated in a research conducted for wheat cost in 2007 in Thrace region which is one of the most important wheat production area in Turkey, overlaps with the data of Ankara and Edirne (Kumbar and Unakitan, 2011). Kumbar and Unakitan (2011) have calculated the wheat cost in their research as 184.97€ ton. By the same year, the costs in wheat production in other important countries are as such: 208.15€ ton in USA, 136.50€ ton in Canada, 148.10€ ton in Australia, 151.17€ ton in China, 132.85€ ton in Russian Federation, 115.18€ ton in Ukraine, 176.86€ ton in India (FAO, 2011). When the production costs in the countries, which rank among the leading in wheat production and agriculture, are compared with Turkey's, it has been understood that the wheat cost produced in Turkey is relatively high. This condition shows that Turkey cannot compete with other countries in wheat production and agriculture in the aspect of cost element despite agricultural support payment. According to a research related with this issue, it has been concluded that fuel and fertilizer support are insufficient in the scope of agricultural support (Ozcelik and Ozer, 2006)

The level of input use in wheat production has been examined by provinces in order to determine the differences stem from yield in the analyzed enterprises. The input quantity used per area in wheat production in enterprises within the research is stated in Table 4. When coefficient of variation (CV) belonging to input quantities used per unit area in wheat production by provinces is examined, in the aspect of seed quantity and the use level of pure phosphorous fertilizer, it has been understood that other provinces don't have any significant differences, if the enterprises in Diyarbakir province are excluded.

It has been proved that there are significant differences between the variation coefficient belonging to the pesticide quantities and nitrogenous fertilizer which has a significant role especially on consisting green components in wheat production by province group of enterprises the questionnaire conducted (Table 4). This condition may also affect the productivity in wheat production directly.

Table 4
Quantity of inputs used for wheat production

Indicators	Provinces				
	Adana	Ankara	Diyarbakir	Edirne	Konya
Seed quantity (kg ha-1)	295.74	226.47	213.89	248.56	252.10
Std. dev.	40.59	35.39	24.39	34.26	38.07
C.V.	13.72	15.63	11.40	13.78	15.10
Nitrogen quantity (kg ha-1)	156.21	81.56	159.37	123.36	95.24
Std. dev.	65.18	24.97	27.63	32.03	48.10
C.V.	41.73	30.62	17.34	25.96	50.50
Phosphour quantity (kg ha-1)	58.15	63.75	52.20	66.72	67.35
Std. dev.	28.19	20.96	21.76	27.66	25.09
C.V.	48.48	32.88	41.69	41.46	37.25
Pesticide quantity (cc ha-1)	711.46	1243.26	845.42	564.83	1218.32
Std. dev.	645.00	602.09	851.50	311.00	638.08
C.V.	90.66	48.43	100.72	55.06	52.37

The conducted research has proved that the seed use level may vary between 220 and 260 kg ha^{-1} in wheat production in Turkey's condition (Ozcelik, 1989; Sade et al., 1999; Gundogmus, 1998). It has been understood that when the findings belonging to analyzed enterprises and previous research findings are compared, the seed use quantity per unit is high only in Adana province.

According to a research conducted in USA it has been stated that the necessary pure nitrogenous quantity may vary between 3 to 5 kg for every 100 kg grain (Halvarson et al., 1987) A research conducted in Turkey has proved that wheat need respectively 150 kg ha^{-1} and 160 kg ha^{-1} of pure nitrogenous (Eker and Cagatay, 1999; Ozturk and Gokkus, 2008). It has been observed that pure nitrogenous fertilizer use level in wheat production is at the recommended level when the findings belonging to the analyzed enterprises and other research findings are compared.

Halvarson (1987) has stated that pure phosphorus quantity required for grain yield and vegetative improvement of wheat may vary 2.5 to 4 kg for 100 kg grain. A research conducted in Turkey has recommended that 2 kg P_2O_5 should be given purely for 100 kg grain (Sencar et al., 1991). The pure phosphorus use level per unit area in wheat production is within the recommended level, as in the nitrogenous fertilizer, in the analyzed enterprises,

According to two different studies which input use level has been determined in wheat production, it has been determined, that the pesticide use quantities are respectively 1690 cc ha^{-1} and 2000 cc ha^{-1} (Gundogan, 1998; Ozcelik, 1989). In the research, it has been concluded that pesticide use level in the analyzed enterprises is below other research findings. That the upper limit of pesticide in today's wheat agriculture is on the level of 10 gr ha^{-1} and extensive uses of such kind of pesticide give a certain idea of the average pesticide use quantity, determined as a result of the research, is below the other research findings. The differences and importance level by provinces in the aspect of input use quantity per unit area in wheat production have been stated in Table 5.

It has been determined that there is statistically difference in point of seed use quantity per area amongst the provinces analyzed in this research except the difference between Diyarbakir and Konya provinces. It has also been determined that there is statistically difference in use level of pure nitrogenous fertilizer in wheat production amongst the other provinces except the difference between Adana and Edirne provinces. It has been concluded that there is statistically difference amongst Adana – Diyarbakir – Konya provinces, Ankara – Edirne and Edirne – Diyarbakir and Konya provinces in point of pure phosphorous fertilizer use level. It has been determined that there is statistically difference in the amount of pesticide use amongst the other provinces in the research except the difference amongst Adana – Edirne – Diyarbakir provinces and Ankara – Konya provinces.

Functional Analysis of Wheat Production

Cobb – Douglas production function is one of the most commonly used functions used in determining resource use efficiency in agricultural production. The estimating equation of production function relating to wheat production in this research is given below:

$$\text{Log } Y = 0.235 + 0.507 \text{ Log } X_1 - 0.172 \text{ Log } X_2 + 0.494 \text{ Log } X_3 + 0.031 \text{ Log } X_4 + 0.228 \text{ Log } X_5 + 0.224 \text{ Log } X_6$$

Multiple determination of coefficient (R^2) is 0.825 in the estimating equation and value of the function "$F_{calculation}$" is different from zero at 5% significance level ($F_{calculation: 816.56} > F_{table: 2.09}$). All of the variables in wheat production equation can explain 82.5 % of changes in wheat production. When the multiple determination of coefficients obtained from other conducted researches relating to this topic are analysed, it is seen that multiple

Table 5
Multiple comparisons of the wheat production factors by provinces

Dependent Variables	(I) Provinces	(J) Provinces	Mean Difference (I-J)	Std. Error	Sig.
Seed quantity (kg ha^{-1})	Adana	Ankara	69.269	4.121	0.000
		Edirne	81.842	4.270	0.000
		Diyarbakir	47.172	3.904	0.000
		Konya	43.632	3.376	0.000
	Ankara	Edirne	12.574	4.303	0.029
		Diyarbakir	-22.097	3.939	0.000
		Konya	-25.637	3.417	0.000
	Edirne	Diyarbakir	-34.671	4.095	0.000
		Konya	-38.210	3.596	0.000
	Diyarbakir	Konya	-3.540	3.152	0.794
Nitrogen quantity (kg ha^{-1})	Adana	Ankara	74.653	5.037	0.000
		Edirne	-3.161	5.219	0.974
		Diyarbakir	32.857	4.771	0.000
		Konya	60.973	4.126	0.000
	Ankara	Edirne	-77.814	5.259	0.000
		Diyarbakir	-41.796	4.815	0.000
		Konya	-13.680	4.177	0.010
	Edirne	Diyarbakir	36.018	5.005	0.000
		Konya	64.134	4.395	0.000
	Diyarbakir	Konya	28.116	3.852	0.000
Phosphour quantity (kg ha^{-1})	Adana	Ankara	-5.592	2.878	0.295
		Edirne	5.949	2.983	0.269
		Diyarbakir	-8.569	2.727	0.015
		Konya	-9.198	2.358	0.001
	Ankara	Edirne	11.541	3.005	0.001
		Diyarbakir	-2.977	2.751	0.816
		Konya	-3.606	2.387	0.556
	Edirne	Diyarbakir	-14.517	2.860	0.000
		Konya	-15.147	2.511	0.000
	Diyarbakir	Konya	-0.630	2.201	0.999
Pesticide quantity (cc ha^{-1})	Adana	Ankara	-531.795	71.165	0.000
		Edirne	-133.955	73.742	0.364
		Diyarbakir	146.635	67.411	0.190
		Konya	-506.863	58.302	0.000
	Ankara	Edirne	397.840	74.302	0.000
		Diyarbakir	678.430	68.024	0.000
		Konya	24.933	59.010	0.993
	Edirne	Diyarbakir	280.590	70.715	0.001
		Konya	-372.907	62.092	0.000
	Diyarbakir	Konya	-653.497	54.424	0.000

determination coefficient of estimating equation which is calculated in research is sufficient for cross sectional data (Miran et al., 2002).

In this research, it has been utilized from "DW (d) Test" for examining the autocorrelation in the function. In the equation, "DW (d) Statistic" value is calculated as 1.836 (K=6; n=781). In this study, "DW (d) Statistic" calculation value has been compared with table value and it has been concluded that there is not negative or positive correlation in model at 1% significance level ($d_{\text{table L: 1.613 – U: 1.735}}$). In this research, "Student-t Test" method has been applied in order to determine whether there is correlation or not amongst the variables and partial regression coefficient of the variables have been calculated. Production elasticity coefficients, partial correlation coefficients and significance level of the variables relating to wheat production function have been shown at Table 6.

All of the variables in estimating equation, except the pesticide cost variable, are statistically significant at 1% level. When the values at table 6 are analyzed, it has been concluded that there is not multicollinearity amongst the variables as the determination coefficient is higher, the significance level of the explanatory variables is below 5% and also partial correlation coefficients are lower (Gujarati, 2009). Correlation coefficients showing the relations amongst the factors have been given at Table 7.

When the values relating to correlation coefficients are analyzed, it can be concluded that there are relations especially amongst production area (X_1), seed (X_2) and fertilizer cost (X_3). This leads to being careful while making marginal analysis and economic interpretations (Zoral, 1973). Nevertheless, unless multicolinearity does not has an important effect on coefficient estimation, least squares estimation can lose its integrity to some extent but in such situations, the existence of the multicolinearity can be ignored to some extent (Ozcelik, 1994).

Table 6
Parameters and test values of wheat production function

Variables	Elast. Coeff. (βi)	Std. Err.	Partial Corr.	"t- value"	Sig.
X1 Production area (ha-1)	0.507	0.008	0.234	7.78	0.001
X2 Seed cost (€)	-0.172	0.062	-0.097	-3.13	0.001
X3 Fertilizer cost (€)	0.494	0.046	0.349	12.02	0.001
X4 Pesticide cost (€)	0.031	0.018	0.043	1.39	0.164
X5 Precipitation (mm)	0.228	0.055	0.391	13.7	0.001
X6 Dummy variable	0.244	0.017	0.443	15.95	0.001
R2 : 0.825 F: 816.56 DW: 1.836					

Table 7
Correlation matrix amongst the factors in wheat production

	Prod. Quantity	Prod. Area	Seed Cost	Fertilizer Cost	Pest. Cost
X1 Production area	0.805(*)				
X2 Seed cost	0.775 (*)	0.970(*)			
X3 Fertilizer cost	0.873(*)	0.926(*)	0.903(*)		
X4 Pesticide cost	0.703(*)	0.721(*)	0.702(*)	0.751(*)	
X5 Precipitation	0.204(*)	-0.034	-0.073(*)	0.082(*)	0.316(*)

(*) Significiant at 5% level.

The sum of the production coefficients of the factors in wheat production estimating equation, when the dummy variable is excluded, has been calculated as ($\sum\beta_i$) 1.089. This value can be interpreted, as 10% increase in the inputs will lead to 10.89% increase in wheat production amount on condition that the combination of the independent variables remains stable.

When the production elasticity of the variables in the estimating equation is examined, it is understood that only the coefficient of seed cost factor (X_2) has negative character. The highest marginal production elasticity coefficient belongs to production area (X_1) amongst the variables in estimating equation. Production elasticity coefficients means a percentage increase rate to which a 1% increase in input will lead in wheat production. For instance, 10% increase in fertilizer cost (X_3) which is one of the variables in the production equation will lead to 4.94 % increase in wheat production. Dummy variable factor (X_6) in equation function, given at Table 6, is significant at 1% level and it has been clearly understood that production in irrigated conditions out-tops the production in dry conditions (β_i 0.244). Marginal yield, marginal income, factor prices and marginal efficiency coefficients of the variables in the equation have been given at Table 8. Calculations of the marginal yield, marginal income and marginal efficiency coefficients relating to factors in wheat production have been given at method part. In this research, crop price has been taken as 0.27€ kg^{-1} in calculation of marginal efficiency of coefficient.

The highest marginal yield value amongst the factors in estimating equation belongs to production area (X_1). On condition that use levels of the other inputs remain unchanged, one unit increase in production leads to 140.91 kg increase in production quantity. On condition that production inputs remain stable, one unit increase in precipitation leads to 12.73 kg increase and respectively pesticide 11.81 kg and fertilizer 10.12 kg increase in wheat production quantity.

According to marginal yield values of inputs used in wheat production, one unit increase in production area (X_1) leads to 38.05€ increase in wheat income and respectively 3.44€ increase in precipitation (X_5), 3.19€ increase in pesticide (X_4) and 2.73€ increase in fertilizer factor (X_3).

While elasticity coefficients' marks of the production functions give information about use cases of the relevant factors, it may be said that efficien-

Table 8
Marginal income, marginal yield and marginal efficiency coefficients of the variables in wheat production

Variables	Geo. Mean	Marg.Prod. Elast.	Marg.Yield, kg	Marg. Income (€)	Factor Price (€)	Marg. Effic. Coeff.
Y Production quantity (kg)	20008.75	-	-	-	-	-
X1 Production area (ha-1)	71.99	0.507	140.91	38.05	23.00	1.65
X2 Seed cost (€)	649.53	-0.172	-	-	-	-
X3 Fertilizer cost (€)	976.63	0.494	10.12	2.73	0.41	6.66
X4 Pesticide cost (€)	52.52	0.031	11.81	3.19	2.50	1.28
X5 Precipitation (mm)	358.35	0.228	12.73	3.44	-	-

cy coefficients give more clear and explicit information about the use cases of the factors (Akcay and Uzunoz, 1999). As it is known, using factors at optimum level is very important in terms of increasing productivity and profitability in production. However, use of resources at optimum level in any production process is possible when the inputs are used equally with the price or opportunity cost of the marginal yield value (Henderson and Quandt, 1971).

When the marginal efficiency coefficients of the production factors in the wheat production equation are analyzed, it has been concluded that there must be an increase in these inputs in order to be able to use production area (X_1), pesticide (X_4) and fertilizer cost (X_3) variables at optimum economical level as the marginal efficiency coefficients, reached by division of marginal crop income to factor price, are greater than 1.

Conclusion

Nowadays, efficient use of resources has been one of the most significant terms in any production branch. In recent times, it is observed that there has been an increase in the studies about determining efficiency level of inputs that are used in agricultural activities in terms of agricultural production. In this conducted research relating to wheat production, one of the chief products for human nutrition, the relations between the inputs used in production and production quantity have been analyzed in Turkey.

In this research, Cobb – Douglas production function has been applied while determining the resource use level as it is in many other studies relating to agricultural production economics. Except the pesticide factor, the factors in the estimating equation which is created by means of data obtained from the enterprises analyzed in the scope of research have been considered as significant in terms of statistics. It has been understood that only the seed cost variable in the equation have negatively affected the production quantity. Therefore, it needs to be taken into consideration that the seed quantity that will be used in wheat production must be in the recommended quantity according to regions by various research institutions and agricultural faculties. In wheat production, there is increasing return to scale in respect to sum of elasticity coefficients of the factors in estimating equation.

In this research, it has been concluded that fertilizer and pesticide costs should also be increased besides production area in order to make increase in wheat production according to efficiency coefficients of production factors. In addition to this, at the end of the research, it has been proved that there are significant differences in terms of input use in wheat production amongst the provinces in different regions of Turkey and this situation affects wheat yield. In this study it has been determined that there are statistical differences in terms wheat yield amongst the provinces analyzed in this research. The differences amongst the provinces in terms of wheat yield cause to enterprises benefit from agricultural support payments (both product quantity and area based supports) at different rates. This leads to differences amongst the provinces and regions in terms of wheat cost and producer income.

In this research, it has been concluded that input use should be in the recommended amount, production should be made in irrigated areas, subsidy payments and other subsidies which are given for promoting wheat production should be determined in reel term, and payments should be made on time in order to Turkey able to compete with other countries in wheat production.

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