The effect of used wastewater on the cost of agrıcultural productıon

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Abstract

The supply of basic needs of people such as food and clothing is provided from agricultural production. In order to produce agricultural products, it is necessary to make a specific cost. All expenditures made in the process from the preparation of the land for production to the transportation of the produced product to the market are expressed as production costs. For the growth of the product, one of the most important and major factors in these costs is water. It is seen that waste water is used in agricultural production both to reduce production costs and to produce an alternative solution to the water shortage experienced all over the world in recent years. In this study, the effect of wastewater on agricultural production cost was investigated with the help of the data obtained by survey method from 114 producers engaged in agricultural production with wastewater in Konya, which has an important agricultural potential in Turkey. In order to achieve the aim of the study, the producers who produce with wellhole water were also interviewed and the production costs with two different irrigation sources were compared. For the products widely grown in the research area, the costs were calculated according to two different irrigation sources. According to the results of the research, it was been determined that irrigation, fertilization and labor costs in production activities irrigated with wastewater are lower than in production activities irrigated with wellhole water. In addition, it was been determined that the wastewater used has a positive effect on the product yield. It was been concluded that the production activities with wastewater are profitable because it is effective in both income and cost. However, by evaluating the negative effects of wastewater used without treatment on human health, it would be more accurate to use the wastewater to be used in agricultural production after treatment.

Keywords: Agricultural cost. Wastewater. Agricultural production.

1. Introductıon

Agricultural production is needed to meet people's food supply and clothing needs. A specific cost is also required to obtain agricultural products. One of the nutrients required for the quality growth of agricultural products is water, and although it varies according to the product, the water cost covers a significant share of the production cost. Water, which is the basic resource in the life of living things, is also in the first stage of agricultural production. Conscious and planned use of water, which is a scarce resource, is a very sensitive issue in terms of sustainability.

The search for alternative irrigation sources is of great importance in terms of ensuring food security and protecting natural water resources (Jaramillo and Restrepo, 2017). With the use of water that exists in nature for centuries and the climate change that has been felt seriously recently, ensuring the continuity of the existing resources, aside from the protection of water, which is the main resource, the recycling and reusability of the used resources becomes more necessary at this point. In this context, the concept of waste water has emerged.

Waste water is referred to as water that has been used in domestic or all kinds of economic activities and is finally released to the outside. When the water used in all kinds of activities becomes waste water, it can be reused in many ways, such as treating it with different methods with waste water management or returning the waste water directly to the receiving environment according to the density of the content of the waste water, depending on the activity.

2. Review

Agricultural production requires a high amount of water consumption, and it is seen that wastewater is used for agricultural production in many countries (Leverenz and Asano, 2011). Waste water, which is a recyclable alternative to water resources, is a very powerful resource especially in agriculture for irrigation purposes. As a matter of fact, wastewater can be used for agricultural irrigation purposes without treatment, partial treatment, dilution or no treatment (Ak and Top, 2018).

Wastewater was transported to agricultural lands to be used as fertilizer for agricultural products in ancient times (Cooper, 2001). Between 1150 and 1700, direct use of wastewater in agricultural areas became widespread in Germany, Scotland and England (Drechsel et al., 2010; Tzanakakis et al., 2014). After 1800, it was observed that soil irrigation with wastewater was used in cities in Europe and the USA (Tzanakakiset al., 2007). The decrease in the world's water supply due to reasons such as the increase in population and climate change in recent years has made it necessary to develop alternative solutions for water use.

The application of these alternatives is necessary for the sustainability of water use, especially in the agricultural sector, which uses approximately 70% of the total water use.

Wastewater reuse increases agricultural production in water-scarce areas and thus contributes to food security (Corcoran et al., 2010). In addition, the use of wastewater in agricultural activities has been proven to improve crop yield (Oliveira and Sperling, 2008; Mathevarasu et al., 2016) and nitrogen and phosphorus content of waste waters have been effective in reducing the use of fertilizers in agricultural production (Toze, 2006; Kukul et al., 2007; Fatta-Kassinos et al., 2011). For this reason, agricultural production with wastewater is effective in reducing irrigation costs, as well as reducing the cost of fertilizer and the labor cost that will carry out these activities, and has a positive effect. In this study, it is aimed to calculate the cost by examining the effects of wastewater on agricultural production.

3. Material and Method

In order to obtain the data in the research, 5 neighborhoods (Acıdort, Çengilti, Divanlar, Göçü, Karakaya) located in the Karatay district of Konya province, which are the research area, and which carry out agricultural irrigation, were chosen for the purpose; A total of 742 agricultural enterprises were identified as the main population and the number of samples was determined as 125 according to the stratified random sampling method. However, due to the lack of sufficient producers during the field studies, a total of 114 producers were interviewed.

Konya province is the city with the most agricultural area in Turkey, and Karatay district, which is the research area, is the district with the highest agricultural area in Konya. Karatay district has 178,154.7 ha of agricultural land, 50% of which is dry agricultural land. There are suitable soil, climate and ecological conditions for the cultivation of many agricultural products within the neighborhoods of Karatay district within the study area. However, due to the insufficient water supply, wastewater is used as an alternative source in agricultural irrigation.

Production costs in plant production activities are divided into variable and fixed costs. Variable costs are calculated by multiplying their physical quantities with their unit prices. Revolving fund interest (for the examined production period, half of the Central Bank's loan interest rates are taken into account for the agricultural production period) and general administrative expenses (determined by 3% of the total costs) are added to the variable costs calculated for each product, and production costs are found. Revolving fund interest is a variable expense and represents the opportunity cost of capital invested in the production activity. Since the products in the agricultural lands examined, considering the period in which the production costs are spread over the production period and the capital is dependent on production, half of the credit interest rate (9%) valid for the production period examined as the revolving fund interest has been taken. General administrative expenses are calculated as a result of assumptions rather than being real. Because the management in agriculture is usually done by the owner himself. In the study, general administrative expenses were taken as 3% of the total expenses.

4. Research Fındıng and Dıscussıons

4.1. Demographic structure of the ınvestigated enterprises

Age characteristics of the examined enterprises As seen in Graph 1, 8.06% between the ages of 0-6; 9.15% between the ages of 7-14; 48.80% between the ages of 15-49; Age 50 and over is calculated as 33.99%. With this result, it is seen that the ratio of the working population, which is the active population, is the highest. Therefore, it is concluded that the workforce potential of the examined enterprises is good. While the age group of 15-49 constitutes 64% of the family workforce, 35.71% is the group aged 50 and over.

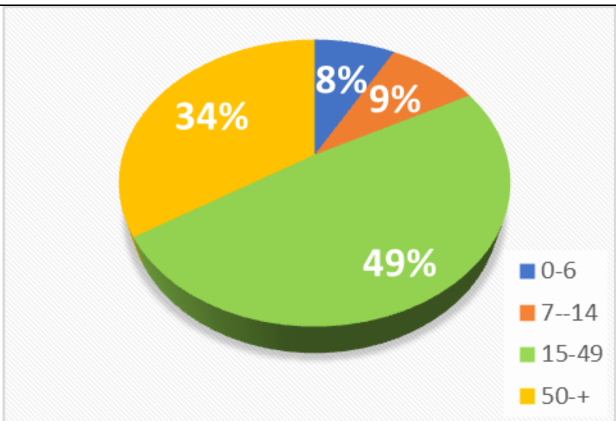

Figure 1: Age Status of the Population in the Surveyed Enterprises

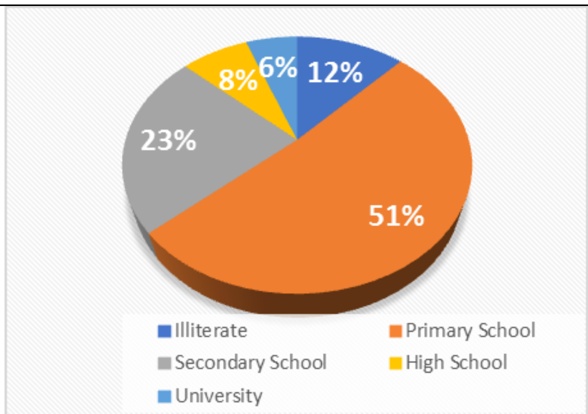

Figure 2: Educational Status of Producers in the Surveyed Enterprises

When the population is analyzed by gender, it is seen that the female population and male population ratios are at equal levels in all age groups. Considering the educational status of the enterprises examined, illiterate people account for 12%; primary school 51%; secondary school 23%; high school constitutes 7.44% and university 5.69%. It has been observed that the education level with the highest number of people is primary school (Figure 2).

It has been determined that 51% of the examined enterprises use wastewater, 23% underground water, and 26% use both irrigation sources in agricultural production. The producers who irrigate with ground water and those who irrigate with wastewater were asked to compare the determined criteria and they observed that there was an increase in efficiency and a decrease in fertilizer use as a result of this comparison. Majority of the producers commented that wastewater meets their base fertilizer needs. In addition, the cost of electricity used in irrigation of lands irrigated with groundwater is quite high, no cost is paid for wastewater; They have seen that since it reduces the cost of fertilizer as well as the irrigation cost, more profit can be achieved with less expenditure in production.

Table 1: Changes Observed as a Result of Wastewater Use in the Research Area

VARIABLES	Increased	Decreased	Unchanged
Quantity of Yield	68	6	12
Quantity of Fertilizer	1	63	22
Quantity of Pesticide	11	7	68
Quantity of Irrigation	7	15	64
Number of Plough	6	8	72
Time of Mellowness of Soil	9	7	70

The producers who irrigate with well water and those who irrigate with wastewater were asked to compare the criteria specified in table 1, and as a result of this comparison, they observed that there was an increase in yield and a decrease in the use of fertilizers. Majority of the producers commented that wastewater meets their base fertilizer needs. In addition, the cost of electricity used in irrigation of lands irrigated with well water is quite high, and no cost is paid for wastewater; They have seen that since it reduces the cost of fertilizer as well as the irrigation cost, more profit can be achieved with less expenditure in production.

4.2. Production Costs in Surveyed Enterprises

The costs of agricultural products, which are widely grown in the research area, were calculated and compared separately according to wastewater and well water irrigations. For cost calculations, firstly, average input prices per unit were determined (Table 2). The price of each input varies according to the product type.

Table 2: Average Input Prices of Products Irrigated with Wastewater ($/decare)*

PRODUCTS	Average Input Prices					
	Seed	Sub-fertilizer	Top-fertilizer	Pestiside	Water	Labor
Wheat	0.35	0.35	0.37	1.20	-	3.65
Barley	0.41	0.46	0.38	1.63	-	3.65
Sugar Beet	11.70	0.35	0.43	6.55	-	3.65
Corn	16.37	0.32	0.39	3.54	-	3.65
Fodder Corn	18.71	0.30	0.37	3.51	-	3.65
Sunflower	13.04	0.07	0.35	2.38	-	3.65
Clover	0.48	0.31	0.33	8.55	-	3.65
Vetch	0.35	0.27	0.37	-	-	3.65

*** 1 $ = 8,55 Turkish Liras at study time (July-2021)**

Considering the average input prices on the basis of products in agricultural activities with wastewater and well water, it is observed that there is not much change in inputs other than water price. Since there is no irrigation cost in agricultural production with wastewater, there is no unit water price, in agricultural production with well water, the price of water per unit area has been determined, although it varies according to the type of product.

Table 3: Average Input Prices of Products Irrigated with Well Water ($/decare)*

PRODUCTS	Average Input Prices					
	Seed	Sub-fertilizer	Top-fertilizer	Pestiside	Water	Labor
Wheat	0.33	0.36	0.37	1.63	17.65	3.65
Barley	0.31	0.37	0.37	1.20	17.26	3.65
Sugar Beet	11.70	0.35	0.36	6.43	57.08	3.65
Corn	16.37	0.36	0.41	3.99	76.34	3.65
Fodder Corn	16.37	0.30	0.36	3.51	58.48	3.65
Sunflower	13.65	0.35	0.35	2.61	47.17	3.65
Clover	0.58	0.35	0.37	7.02	23.39	3.65
Vetch	0.35	0.27	0.37	-	21.05	3.65

*** 1 $ = 8,55 Turkish Liras at study time (July-2021)**

In the research area, the input costs calculated per product per unit area by multiplying the physical input amounts and the input prices according to the product type are given (table 4). In the product costs, while irrigation costs are not found in any product in products irrigated with wastewater, it is noteworthy that some products do not have fertilizer and pesticide costs.

Table 4: Average Operating Input Costs of the Products Irrigated with Wastewater ($/decare)

PRODUCTS	COSTS					
	Seed	Fertilizer	Pestiside	Water	Fuel	Labor
Wheat	5.39	4.88	0.91	-	5.90	7.98
Barley	7.52	7.59	1.65	-	6.16	8.23
Sugar Beet	12.48	10.73	5.03	-	6.80	9.73

Corn	19.52	11.19	3.77	-	5.92	8.81
Fodder Corn	46.78	-	3.51	-	4.79	8.55
Sunflower	11.49	6.08	2.35	-	7.00	7.52
Clover	2.46	4.71	8.55	-	3.09	5.05
Vetch	3.51	-		-	5.93	5.85

*** 1 $ = 8,55 Turkish Liras at study time (July-2021)**

In order to have an optimum production process according to the economic principle, seed, fertilizer, medicine, water, fuel and labor costs, which are the basic expenses in the plant production process, are minimum; productivity should be maximum. At this point, the use of wastewater has a positive effect on production costs. As a matter of fact, the most expense in plant production is irrigation and fertilization costs. Therefore, while there is no cost for water in productions where wastewater is irrigated during the production process, it is seen as a result of the research that the use of fertilizers is reduced thanks to many minerals such as nitrogen, phosphorus and salt in the wastewater.

Table 5: Average Operating Input Costs of the Products Irrigated with Well Water ($/decare)

PRODUCTS	COSTS					
	Seed	Fertilizer	Pestiside	Water	Fuel	Labor
Wheat	8.33	7.57	1.25	2.51	7.93	9.69
Barley	7.83	7.16	1.20	17.26	7.19	9.67
Sugar Beet	11.70	11.74	6.43	57.08	6.69	8.51
Corn	17.56	14.15	4.39	76.34	6.81	10.47
Fodder Corn	32.75	11.61	3.51	58.48	7.03	10.53
Sunflower	14.23	7.33	2.88	48.30	7.02	8.56
Clover	4.68	6.81	7.02	23.39	3.42	6.67
Vetch	4.21	6.43	0.00	21.05	6.46	10.38

*** 1 $ = 8,55 Turkish Liras at study time (July-2021)**

According to the research, the specific input costs of the producers using wastewater and well water were compared, and as seen in Tables 4 and 5, it was concluded that the input costs of the producers who irrigate with well water in general were higher than the producers who irrigate with wastewater. As a matter of fact, there are certain differences in the costs of seeds, fertilizers, pesticides, fuel and labor per product. Although it is known that the need for fertilizer in the use of wastewater in agricultural production is reduced (Toze, 2006), the fact that labor and fuel are not needed for irrigation as much as irrigation with well water has also been effective in lowering these costs.

With the above data, after calculating the variable costs, revolving fund interest and general administrative expenses of each product, the total costs as wastewater and well water were calculated separately and shown in Table 6.

Table 6: Total Costs of the Products Irrigated with Wastewater and Well Water ($/decare)

Product	Wastewater	Well Water
Wheat	28.13	41.87
Barley	34.97	56.49
Sugar Beet	50.26	114.68
Corn	55.26	145.64
Fodder Corn	71.44	139.11
Sunflower	38.66	99.16
Clover	26.78	58.37
Vetch	17.16	54.49

Based on the table 6, when each product is examined separately, it is seen that the total cost of the products irrigated with wastewater is less than the products irrigated with well water. In addition to lower production costs in agricultural production with wastewater, its positive contribution to product yield creates significant differences in the net income of products.

Table 7: Gross Production Value of Products Irrigated with Wastewater and Well Water

PRODUCTS	Wastewater			Well Water		
	Yield (kg/da)	Price ($/kg)	GPV ($/da)	Yield (kg/da)	Price ($/kg)	GPV ($/da)
Wheat	449.57	0.42	188.89	406.26	0.39	157.43
Barley	399.80	0.35	138.48	404.41	0.31	124.56
Sugar Beet	5251.84	0.06	295.20	4688.68	0.06	289.01
Corn	1079.63	0.26	284.09	1067.15	0.33	355.67
Fodder Corn	6600	0.05	308.77	5000	0.05	263.16
Sunflower	303.06	0.59	178.25	247.51	0.65	160.12
Clover	1212.47	0.17	210.88	1056.32	0.15	156.73
Vetch	400	0.18	70.18	800	0.12	93.57

It is known that due to the content of wastewater, it also affects the yield of the product as well as contributing to the reduction of costs (Oliveira and Sperling, 2008). For this reason, the difference between the product yields in the productions made with wastewater and well water is also examined in table 7. When the production amount obtained from the unit area is examined, it is seen that the yield is higher in agricultural production with wastewater in products other than barley and vetch. It is seen that the average product prices differ according to the products as they are not related to irrigation. The high yields of the crops irrigated with wastewater also affected the high GPV obtained from the unit area.

Table 8: Net Income of Products in Surveyed Enterprises ($/da)

PRODUCTS	Wastewater			Well Water		
	GPV	Production Cost	Net Income	GPV	Production Cost	Net Income
Wheat	188.89	28.13	160.76	157.43	41.87	115.56
Barley	138.48	34.97	103.51	124.56	56.49	68.07
Sugar Beet	295.20	50.26	244,94	289.01	114.68	174.33
Corn	284.09	55.26	228.83	355.67	145.64	210.03
Fodder Corn	308.77	71.44	237,33	263.16	139.11	124.05
Sunflower	178.25	38.66	139,59	160.12	99.16	60.96
Clover	210.88	26.78	184,10	156.73	58.37	98.36
Vetch	70.18	17.16	53,02	93.57	54.49	39.08

Considering the net income of the products widely grown in the research area, it is seen that higher net income is obtained in the productions that are irrigated with wastewater. The reason for this is that the costs are lower in production activities with wastewater. Although GPV is higher in production activities with well water in some products, it has resulted in higher net incomes due to low production costs. This situation shows the profitability of production activities made with wastewater.

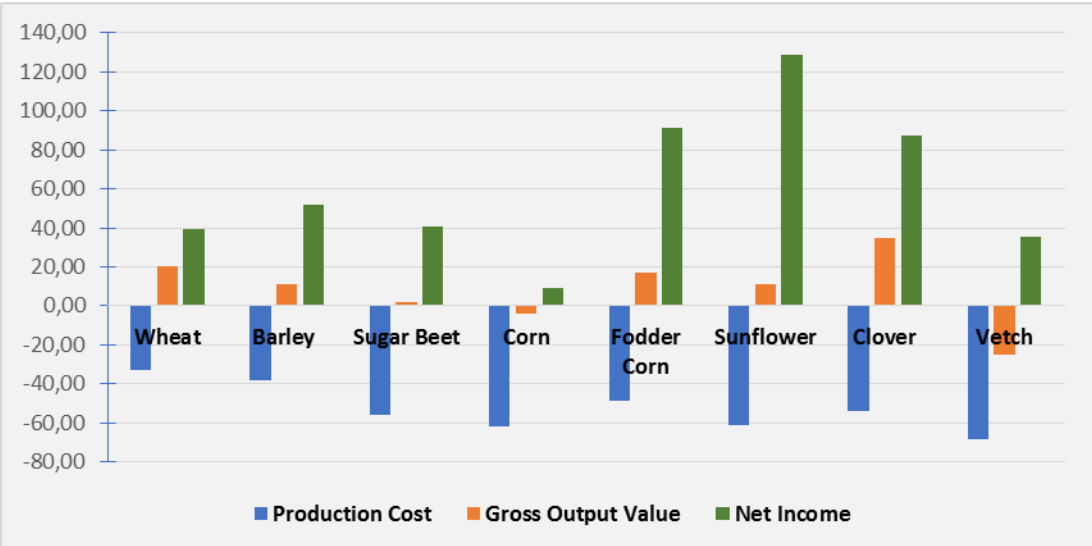

Figure 3: Economic differences ratio between wastewater and well water (%)

Using wastewater instead of well water in agricultural production, the differences in production costs, GPV and net income can be seen proportionally in Figure 3. The biggest difference in production costs by using wastewater instead of well water belongs to vetch (68.51%), grain corn (62.06%) and sunflower (61.01%). The biggest difference for GPV according to the two different irrigations is seen in clover (34.55%), vetch (25.00%) and wheat (19.99%). The biggest difference in net income was in sunflower (129.00%), silage corn (91.32%) and clover (87.17%). At this point, it is seen that the production activity carried out by irrigation with wastewater makes significant contributions to the income of the producer. Wastewater contributes economically, but it cannot ignore the fact that the wastewater used in the research area is not treated and threatens human health.

5. Results And Recommendatıons

In the study area, it has been examined whether the producers who irrigate with wastewater and well water have an effect on the production cost items of two different irrigation sources in their agricultural production activities. It has been determined that the production costs of the enterprises that irrigate with wastewater are lower, their product yields are partially higher and their net incomes are higher. It has been confirmed that the result of irrigation with wastewater has a positive effect on the water cost, the irrigation labor cost and the fertilizer cost. In addition, it has been observed that the wastewater content has an effect on the increase in yield, since it acts as a fertilizer.

According to the information received from the producers during the survey studies, it has been revealed that the irrigation method of the wastewater is generally done in the form of flood irrigation, the mineral substance requirement of the soil is provided more easily and the soil preparation stages are made easier. Producers, who have observed an increase in product yields as a result of production, comment that wastewater is a very useful resource because it both reduces costs and increases soil and product productivity. The fact that water scarcity has become a major problem in recent years, especially due to population growth, climate change, and environmental pollution, and the high use of water in agricultural production makes the wastewater alternative attractive. Contributing to agricultural costs and profitability will increase the use of wastewater. Therefore, it is necessary to make the use of wastewater convenient.

Most of the wastewater used for agricultural irrigation in the study area has not developed any treatment system; It draws water directly from the canal to agricultural lands. In general, wastewater is perceived as a harmful and negative concept; When other studies in the literature and the result of this research are taken into account, it is concluded that with correct and controlled management, it provides benefits for existing resources and reduces environmental pressure. However, the fact that the use of wastewater without treatment can threaten human health should not be ignored. For this reason, it is recommended to establish facilities where treated water can be used in the research area.

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