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Economic Effect of Certified Organic Fertilizer Usage: A Case Study in Menderes District, Izmir Province

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ABSTRACT: *In this study, an answer has been sought to the question of whether a partial or a full transition into using certified organic fertilizer usage is economical for the farmers or not. In this context, the findings of a field work which were collected by face-to-face interviews with 140 farmers in Menderes district of Izmir province in Türkiye were analysed. Of the 140 farmers interviewed; 50 of them were certified organic fertilizer users and 90 of them were non-users. In order to compare the partial economic impact of producing foods using certified organic fertilizers to relying solely on inorganic fertilizers, partial budget analysis method has been utilized. In the analysis which was made about mandarin in open-area and cucumber in greenhouse, if the farmers who use only inorganic fertilizers in production adopt a certified organic fertilizer + farmyard manure + inorganic fertilizer combination, the economic effect of this change would be positive. According to the partial budget analysis, in the case of such change; mandarin producers can gain a significant profit (+) US$6690.71 ha^{-1}, and cucumber producers can gain a significant profit (+) US$11822.96 ha^{-1}. These results prove that the most profitable option for the farmers is the combined fertilizer application including certified organic fertilizer.*

Keywords: *Organic fertilizer, certified organic fertilizer, farmers, economic effect, economic analysis.*

Sertifikalı Organik Gübre Kullanımının Ekonomik Etkisi: İzmir İli Menderes İlçesi Örneği

ÖZ: *Bu çalışmada esas olarak sertifikalı organik gübre kullanımının çiftçiler açısından ekonomik olup olmadığı sorusuna yanıt aranmıştır. Bu sorunun yanıtı açık alanda ve örtü altında gerçekleştirilen tarımsal üretim koşullarında verilmiştir. Bu kapsamda Türkiye'de İzmir'in Menderes ilçesinde 140 çiftçi ile yüz yüze gerçekleştirilen bir saha çalışmasının bulguları analiz edilmiştir. Görüşme yapılan 140 çiftçinin 50'sini sertifikalı organik gübre kullananlar, 90'ını ise kullanmayanlar oluşturmaktadır. Sertifikalı organik gübre kullanımının işletmeler üzerindeki ekonomik etkisi analiz edilirken kısmi bütçeleme analizi kullanılmıştır. Açık alanda mandalina, örtü altında ise hıyar üzerinde yapılan incelemede, üretimde sadece inorganik gübre kullanan çiftçiler sertifikalı organik gübre+çiftlik gübresi+inorganik gübre interaksiyonunu uygulamaya başlamaları durumunda bu değişikliğin ekonomik etkisi pozitif çıkmaktadır. Kısmi bütçeleme analizine göre, mandalina üretimi yapan çiftçiler böyle bir değişikliğe gitmeleri durumunda birim alan başına (+)US$669,07 da^{-1}, hıyar üretimi yapan çiftçiler ise birim alan başına (+)US$1.182,29 da^{-1} gibi önemli sayılabilecek düzeyde kar elde etmektedir. Bu sonuçlar, gübre uygulamaları açısından çiftçiler için en karlı seçeneğin sertifikalı ticari organik gübrenin de içinde olduğu karma gübre uygulaması olduğunu ortaya koymaktadır.*

Anahtar Kelimeler: *Organik gübre, sertifikalı organik gübre, çiftçiler, ekonomik etki, ekonomik analiz.*

INTRODUCTION

The global demand for nitrogen, phosphorus and potassium for fertilizer use was estimated to be 191.98 million tonnes in 2019. It is expected to reach 200.92 million tonnes by the end of 2022 (FAO, 2019). The global market for chemical fertilizers reached a value of nearly $104.9 billion in 2018 and it is expected to grow at a compound annual growth rate (CAGR) of +3.7% to nearly $121.3 billion by 2022 (Anonymous, 2021a). In the report entitled “Chemical Fertilizers Global Market Opportunities and Strategies to 2022” it was revealed that growth of global chemical fertilizer demand stemmed from growth in emerging markets, government support, a low interest environment, government subsidies and intensive farming techniques. In the same report, some factors that negatively affect the demand for chemical fertilizers were also mentioned. These factors were interpreted as safety regulations, erratic rainfall, overcapacity in food production, and rising prices for natural gas.

The harmful effects on the soil and the environment are the leading factors that negatively affect the demand for chemical fertilizers. There are several studies that draw attention to this point. Chen (2006) and Han (2016) emphasised that the use of excess fertilizer could result in a number of problems, such as nutrient loss, surface water and groundwater contamination, soil acidification or basification, reductions in useful microbial communities, and increased sensitivity to harmful insects. According to Rahman and Zhang (2018), farmers used chemical fertilizers more often to increase their yields due to subsidized prices. According to these authors, excessive use of chemical fertilizers caused significant environmental degradation. Buckler (2018) pointed out that because the damage caused by chemical fertilizers is often long-term and cumulative, it may be wiser to consider alternative and sustainable methods for fertilizing the soil. Bilge and Artukoğlu (2019) emphasized that unconscious use of fertilizers by farmers causes an increase in the amount of chemical fertilizers used. According to the authors, unconscious use of fertilizers leads to a decrease in plant nutrients in the soil.

Considering the points pointed out by the authors, it is important to review alternative and sustainable methods in fertilizing the soil. At this point, organic fertilizers can be seen as a good option. FAO (2021) reported that over time, soils treated only with synthetic chemical fertilizers lost organic matter and the living organisms that help to build a quality soil. For this reason, FAO drew attention to the importance of using organic fertilizers. According to the FAO, using organic fertilizers has a positive impact on water pollution, soil erosion and fertility. According to the OECD's definition, organic fertilizers are fertilizers derived from animal products and plant residues containing sufficient nitrogen (OECD, 2022). FAO reports that organic fertilizers include (green) manure, slurry, worm castings, peat, seaweed, humic acid, guano, sewage sludge, compost, blood meal, bone meal (FAO, 2021).

The European Consortium of the Organic-Based Fertilizer Industry (ECOFI) remarks that organic-based fertilizers include three specific product categories: organic fertilizers, organo-mineral fertilizers and organic soil improvers. ECOFI has defined organic fertilizers as a fertilizer whose main function is to provide nutrients under organic forms from organic materials of plant and/or animal origin. According to ECOFI, organo-mineral fertilizers are complex fertilizers obtained by industrial co-formulation of one or more inorganic fertilizers with one or more organic fertilizers and/or organic soil improvers into solid forms (with the exception of dry mixes) or liquids. Organic soil improver is defined as a soil improver containing carbonaceous materials of plant and/or animal origin, whose main function is to maintain or increase the soil organic matter content (ECOFI, 2021).

According to a recent market report published by Future Market Insights (FMI), the global market for organic fertilizers has witnessed a steady growth in the recent past owing to government support and favourable perception among farmers and end-users. FMI has put forward that owing to the eco-friendly nature of organic fertilizers, governments in many countries have subsidised the prices; making it easier for farmers to use it. According to FMI, the other factors fuelling the growth of organic fertilizer market are revolutionizing farming practices, heavy investments in R&D and rising demand for food security (FMI, 2020). The organic fertilizers market was estimated to be valued at USD 6.30 billion in 2017 and was projected to reach USD 11.16 billion by 2022, at a CAGR of 12.08% during the forecast period (Anonymous, 2021b).

Despite the growth in global organic fertilizer market, high costs and constant reliance on the inorganic fertilizers for cultivation has been restraining the growth of organic fertilizer market (FMI, 2020). Especially, it is predicted that the high cost perception of farmers negatively affects organic fertilizer demand. Most farmers using chemical fertilizers focus on the price of organic fertilizers. Many farmers do not prefer organic fertilizer use in agricultural production due to the higher price tag of certified commercial organic fertilizers. This price perception of the farmers has a limiting effect on the adoption of organic fertilizers. It is known that certified commercial organic fertilizers are sold at higher prices compared to chemical fertilizers. However, the price factor on its own is not enough warrant a decision on the integration organic fertilizers.

In order to extend the usage of organic fertilizers -including certified organic fertilizers- and to ensure the usage of these fertilizers by more farmers, the economic effect of organic fertilizers should be better explained. There are some studies examining the economic impact of the use of organic fertilizers in agricultural production. However, it was found that a significant part of these studies focused on other organic fertilizers (farmyard manure, compost, etc.), excluding certified commercial organic fertilizers. Accordingly, it is thought that this study will fill the gap in literature. In previous studies, the positive economic effects of the use of organic fertilizers in agricultural production were mentioned (Alimi et al., 2006; Soomro et al., 2013; Gebremedhin and Tesfay, 2015; Henderson et al., 2016; Sekumade, 2017; Martey, 2018; Jjagwe et al., 2020). Alimi et al. (2006) determined that the change from no fertilizer technology to commercial organic fertilizer technology in vegetable production was profitable. Soomro et al. (2013) stated that partial economic analysis showed higher revenue and net returns through integration of organic and inorganic nutrient sources. Gebremedhin and Tesfay (2015) pointed out that integrated use of farmyard manure (FYM) and chemical fertilizers on rice production was the best alternative. Henderson et al. (2016) showed that using a mix of organic and inorganic fertilizers in vegetable production was the most profitable approach. Sekumade (2017) revealed that small-holders maize farmers who use organic fertilizers were more profitable than those who use inorganic fertilizers. Martey (2018) found that despite higher variable cost for adopters, the net returns per hectare were comparatively higher by 90% for organic fertilizer adoption. Jjagwe et al. (2020) indicated that vermicomposting was the most economically viable manure treatment method due to low operating costs and higher returns on investment.

In this study, an answer has been sought to the question of whether certified organic fertilizer usage is economical for the farmers or not. In order to find an answer to this question, Turkish fertilizer market example, which is one of the markets where the demand for certified organic fertilizers increased gradually, was examined. In this context the findings of a fieldwork done face to face with 140 farmers in Menderes district of Izmir province in Turkey has been analysed. As mentioned above, the organic fertilizer market has expanded in Turkey over the recent years. It is possible to infer this development from the statistics. When Turkey’s 5-year period organic fertilizer consumption between the years 2014-2018 is observed, it is seen that the consumption has increased approximately 148%. While organic fertilizer consumption was 190879 tons in 2014, it has increased to 474088 tons in 2018. Following the certified organic fertilizers in sales volume in Turkey, is organomineral fertilizers, which include both organic and inorganic substances. While organomineral fertilizer consumption was 126741 tons in 2014, it has increased to 187758 tons in 2018. When Turkey's 5-year period organomineral fertilizer consumption between 2014-2018 is analysed, it is seen that the consumption has increased approximately 48% (MAF, 2020).

Another reason that makes this study important is that the answer to the research question is presented for two different cultivation systems. For this reason, mandarin cultivation in the open field and cucumber in greenhouse production systems have both been analysed as examples.

MATERIALS AND METHODS

Data collection

The main data source for this study is based on primary data. The primary data was collected from the original qualified data which was obtained from farmers by conducting face-to-face interviews. Due to intense level of agricultural activity and the high rate of fertilizer usage, Izmir was chosen as the city in which to conduct the research. Izmir is located on the Aegean Coast in the west of Turkey and is the third largest city of Turkey. When deciding the location that the study will carry out, districts with the highest rate of fertilizer usage in Izmir have been considered. In this context, Menderes district is found suitable as the location that the study will carry out. In addition to vineyards and open field vegetable production areas, Menderes also houses the majority of citrus and greenhouse farming in Izmir. The variety of agricultural production practices along with the relative scale of these practices were deciding factors behind this district to be chosen as the study location.

As there is an absence of readily-accessible official data base related to certified organic fertilizer use in agricultural farms, the number of farmers interviewed were determined by the judgement (purposive) sampling. In light of this, considering the possibility of certified organic fertilizer user agricultural farms were low in number, 50 farmer interviews were planned. Snowball sampling, one of the purposive sampling methods (non-probability sampling), were used to detect certified organic fertilizer user farmers.

Also, in this study, it has been aimed to measure the certified organic fertilizer usage tendencies of farmers who do not use certified organic fertilizers. With this purpose, traditional (conventional) farmers who did not use certified organic fertilizer were also interviewed. While interviewing non-user farmers, it was ensured that they were in the same area, sharing similarities with those who use certified organic fertilizer. Again, the number of farmers interviewed were determined by the judgement (purposive) sampling. Considering the fact that agricultural farms that do not use certified organic fertilizers are more than those that use them, 100 farmers were planned to be interviewed. In the field study, a survey was conducted with 100 farmers and 10 of the surveys were not evaluated because of insufficient data. The survey study was carried out between December 2016 and December 2017. When valid surveys were taken into account for the analysis of the survey data, 140 farmers were interviewed in 19 villages in the Menderes district of Izmir province. The survey participants were invited to take part in a research study about economic effects of certified organic fertilizer usage. They were first fully informed as to the intent and purpose of the study. They were asked for their consent to participate in this study. The consent procedure been carried out face-to-face.

Statistical analysis

In general, average and percentage calculations have been used in the evaluation of data. Some statistical analysis has been made in order to test whether there is a difference between certified organic fertilizer user and non-user farms in terms of analysed variables. Based on the normal distribution test made with Kolmogorov-Smirnov test in continuous variables, t-test (independent two samples t-test) for variables that show normal distribution, Mann-Whitney U test for the ones that does not show has been used. To determine whether the groups using or not using certified organic fertilizers differ according to the classification criteria obtained by counting, Chi Square independence test was used.

Determining economic effects of certified organic fertilizer usage

While the economic effect of certified organic fertilizer usage was being analysed, partial budget analysis has been used. Partial budget analysis has been employed in order to determine the bottom-line impact that emerges when farmers choose different alternatives instead of using inorganic (chemical) fertilizers. Those alternatives are; those who use certified organic fertilizers together with inorganic fertilizers, and those who use certified organic fertilizers, farmyard manure and inorganic fertilizers together. Partial budget analysis could not be carried out for the farmers who exclusively use certified organic fertilizers. The reason for this is because 94% of farm owners who use certified commercial organic fertilizers use certified commercial organic fertilizers combined with inorganic (chemical) fertilizers. In addition, the fact that the number of farms that solely use certified organic fertilizers as opposed to other fertilizers in the agricultural production is 1, does not allow such analysis due to the insufficient data.

Tigner (2018) states that a partial budget helps farm owners evaluate the financial effect of incremental changes. In partial budgeting, only the income and costs required by the proposed partial change are taken into calculation. Incomes and costs or enterprises that are not affected by the partial changes are left out of the calculation, for comparison purposes. In other words, the income and costs outside the scope of the proposed partial change are disregarded. The marginal change that is expected in the farm owner's business income is limited to gains and costs attached to employing the new fertilization regimen. In partial budget analysis, on one side of the calculation; additional income and the reduction in costs due to operational changes is calculated, on other side; the expected increases in costs, due to these modifications are determined. The difference between these two values give the net benefit (Aras, 1988). According to Tigner (2018), the positive net benefit indicates that farm income will increase due to the proposed changes, while a negative net indicates the change will reduce farm income. Soha (2014) emphasizes that if the proposed change has a positive net effect, the change would be considered superior to the current method and would be considered for adoption.

The related costs used in the partial budget analysis are variable costs resulting from alternative applications. Variable costs in fertilizer applications include fertilizer costs, fertilization labour costs (transportation of fertilizer and application of the fertilizer) and machinery costs (the fuel used between the transportation of fertilizer and application of the fertilizer). The income used in the partial budget analysis, however, has been calculated by the multiplication of the yield amount obtained per unit area (hectare) with the unit price of the related product.

RESULTS AND DISCUSSION

Socio-economic characteristics of respondents

In this section, socio-economic characteristics of the farmers who use and do not use certified organic fertilizers have been presented. When the gender of the farmers who use and do not use certified organic fertilizers analysed, it is seen that in both groups 96% of farmers are male. When the level of education of the interviewed farmers have been analysed, level of education of the farmers who use certified organic fertilizers are observed to be higher. In fact, while 62% of the farmers who do not use certified organic fertilizers are primary school graduates, this rate has been detected as

32% in farmers who use certified organic fertilizers. The ratio of the high school and university graduate farmers are 32% for farmers who use certified organic fertilizers while it is approximately 24% for farmers who do not use certified organic fertilizers.

It has also been detected that farmers who use certified organic fertilizers are younger than non-user farmers. When an analysis made based on age groups, the ratio of the farmers who are older than 54 years old is 32% for farmers who use certified organic fertilizers, while it is 63% for non-users. While the average age of certified organic fertilizer user farmers is 48, it is approximately 57 for non-users. It has been detected that farmers who do not use certified organic fertilizers have more farming experience than those who do. While the average experience duration of certified organic fertilizer user farmers is approximately 29 years, it is 38 years for non-users.

The average household size of the interviewed farmers in general is 3.97 person; while this size is 3.80 person for farmers who use certified organic fertilizers, and 4.07 person for those who do not use. Based on the analysis in terms of annual household income, it is seen that farmers who use certified organic fertilizers earn higher income than those who do not use. The ratio of farmers who earn more than TRY50000 (US$13774.10) annually is 40% for certified organic fertilizer users while it is 20% for non-users.

Farm characteristics of respondents

In this section, information about the agricultural characteristics of the farms who use and do not use certified organic fertilizers has been gathered. In this context, farmland sizes, farmland tenure form, types of agricultural activities, applied farming systems and cultivation systems of the farms have been analysed. Agricultural characteristics related to the analysed farms has been shown in Table 1.

Table 1. Farm characteristics of users and non-users of certified organic fertilizers.
Çizelge 1. Sertifikalı organik gübre kullanan ve kullanmayanların tarımsal işletme özellikleri.

Variables	Users (%)	Non-Users (%)	All (%)	Chi-square value	P-value
Farm size (hectares)					
≤2	32.00	35.56	34.29	.185	.912
2.1-5	38.00	35.56	36.43		
>5	30.00	28.88	29.28		
Average farm size (ha)	6.53	5.43	5.82		
Land tenure					
Full owner	50.00	70.00	62.86	5.761	.056***
Part owner	34.00	22.22	26.43		
Full tenant	16.00	7.78	10.71		
Types of agricultural activities					
Crop farming	82.00	71.11	75.00	2.034	.362
Livestock farming	2.00	3.33	2.86		
Mixed crop and livestock farming	16.00	25.56	22.14		
Farming systems					
Conventional farming	68.00	82.22	77.14	9.754	.021**
Organic farming	4.00	-	1.43		
Good agricultural practices (gap)	20.00	6.67	11.43		
Conventional and good agricultural practices	8.00	11.11	10.00		
Cultivation systems					
Open-field	54.00	82.22	72.14	15.294	.000*
Greenhouse	26.00	5.56	12.86		
Open-field and greenhouse	20.00	12.22	15.00		

*, ** and *** denote significance at the 1%, 5% and 10% levels respectively.

Upon evaluating farms in terms of their farmland sizes, it is seen that farms using certified organic fertilizers have large farmlands than non-users. While approximate farmland size is 6.5 hectares in certified organic fertilizer user farms, it is 5.4 hectares for non-users. When farms have been analysed in terms of farmland size groups, a statistically significant difference between certified organic fertilizer user and non-users was not found.

When farmland tenure types of certified organic fertilizer user and non-user farmers have been analysed, it is seen that farmers usually do farming in their own land. The ratio of full owner farmers using certified organic fertilizer is 50% while it is 70% for non-users. When farms have been analysed based on land tenure types, a statistically significant difference was determined between certified organic fertilizer users and non-users. In fact, it is seen that in certified organic fertilizer user farms, full tenant lands are more common.

When farms have been analysed in terms of types of agricultural activities, mainly crop farming is seen. The ratio of certified organic fertilizer user farmers who do only crop farming (82%) is more than non-users (71%). On the other hand, the ratio of farmers who do crop and livestock farming together was higher in those who did not use certified organic fertilizers (25.56%) than those who used it (16%). In addition, in terms of types of agricultural activities, a statistically significant difference between certified organic fertilizer user and non-users was not found.

When farms have been analysed based on farming systems, conventional farming systems are seen to be more common. In addition, in terms of applied farming systems, a statistically significant difference was determined between certified organic fertilizer users and non-users. The ratio of certified organic fertilizer user farmers who apply only conventional farming systems is 68% while it is 82.22% in non-users. It is seen that in certified organic fertilizer user farms, sustainable farming systems such as organic farming and good agricultural practices are applied more. While the ratio of certified organic fertilizer user farmers who do their agricultural production only with good agricultural practices is 20%, it is 6.67% for non-users. Organic agricultural practices are carried-out by certified organic fertilizer user farmers. However, the number of farms which do organic farming is very low.

When farms have been analysed in terms of cultivation systems, it is seen that open-field cultivation is common. However, in terms of cultivation systems, a statistically significant difference between certified organic fertilizer user and non-users was found. The ratio of farm owners who only perform open-field cultivation is 54% in certified organic fertilizer users, whereas it is 82.22% in non-users. Also, the ratio of farmers who do greenhouse cultivation is higher in certified organic fertilizer user farms. While 26% of the certified organic fertilizer user farmers do only greenhouse cultivation, in non-users this rate is at a very low level of %5.56. In addition to this, there are also farmers who do both open-field and greenhouse farming. While 20% of the certified organic fertilizer user farmers do both open-field and greenhouse farming, this ratio is 12.22% in non-users.

It is seen that in the conventional open-field cultivation systems, majority of the certified organic fertilizer user farmers do mandarin production. Most commonly produced products after mandarin are; olive, corn and wheat. It has been detected that mandarin cultivation is common amongst the farmer owners who also employ good agricultural practices along with certified organic fertilizers use. Products of farmers doing conventional open-field cultivation are mainly; grape, olive, mandarin, corn and wheat. Major crops that these farmers cultivate while adopting good agricultural practices are grapes and mandarin.

In conventional greenhouse farming, it is seen that both certified organic fertilizer users and non-user farmers do vegetable and flower production. It has been determined that mainly vegetable farming is carried-out in farms where certified organic fertilizers are used in conventional greenhouse settings. In vegetable production, especially, cucumber production was common. In addition, there are also farms observed in this study which cultivate other vegetables such as: lettuce, pepper, eggplant, tomato, and mixed vegetables. Agricultural products produced under good agricultural practises in greenhouses are seen exclusively to be vegetables, as cucumber and mixed vegetable production is common here.

When greenhouse production patterns of farms in which certified organic fertilizers are not used has been analysed, vegetable-based production emerges again. Especially, cucumber, lettuce, and pepper crops are commonly seen to be cultivated. In addition to this, the number of farmers who do greenhouse production with good agricultural practices are very low. It has been detected that these crops cultivated with good agricultural practices are cucumber and lettuce.

Fertilizer use in certified commercial organic fertilizer using farms

It was detected that farmers who use certified commercial organic fertilizers have been using certified organic fertilizers in their agricultural production approximately for 84 months, in other words, for 7 years. The ratio of lands where certified organic fertilizers was used within the total farmland varies between 8.16% and 100%, and on average it is around 75%.

47 (94%) of the 50 farmers who use certified commercial organic fertilizers use certified organic fertilizers with chemical fertilizers. While there are 2 farmers who use certified organic fertilizers with other organic fertilizers, there is only 1 farmer who uses only certified organic fertilizers in production. The most frequent used organic fertilizers that farmers use after certified organic fertilizers are sheep and goat, and cattle originated farmyard manures. Compost and green manure application as an organic fertilizer of these farmers are quite few. As mentioned above, a very large portion, 94% of the interviewed farmers, use certified commercial organic fertilizers in combination with chemical (inorganic) fertilizers. The three most used chemical fertilizers according to the frequency of use by the aforesaid farmers are in the order of; urea (46%), potassium sulphate (50%) and ammonium sulphate (21%).

When certified commercial organic fertilizers have been analysed in terms of frequency of use, it is seen that the most frequently used certified commercial organic fertilizer by the farmers is humic acid. This is followed by in the order of; moss/algae-based fertilizer, plant originated liquid fertilizer and solid farmyard manure. From these fertilizers; moss/algae-based fertilizers are used occasionally, plant originated liquid fertilizers and solid farmyard manures are, however, used in a level between occasionally and rarely. On the other hand, microbial fertilizers are used rarely. It is seen that worm castings, which has become quite popular in the recent years, however, is not preferred by farmers on a large scale (Table 2).

Table 2. Application frequencies of various certified organic fertilizers in the farms using certified organic fertilizers.
Çizelge 2. Sertifikalı organik gübre kullanan işletmelerde çeşitli sertifikalı organik gübrelerin uygulama sıklıkları.

Certified commercial organic fertilizers.	$\bar{x}$	SD.
Humic acid	4.02	1.5683
Moss/algae-based fertilizers	2.92	1.7825
Plant originated liquid fertilizer	2.40	1.7143
Solid farmyard manure	2.22	1.7413
Microbial fertilizers	1.90	1.2689
Liquid worm castings	1.38	1.0280
Plant originated solid fertilizer	1.36	1.1205
Bat guano	1.24	0.8787
Fish waste fertilizer	1.18	0.5654
Solid worm castings	1.16	0.4677
Liquid farmyard manure	1.13	0.6400
Bone meal	1.04	0.2857
Blood meal	1.00	0.0000

$\bar{x}$: mean score of likert scale by usage frequency (1: never-5: always); SD: standard deviation

Primary agricultural crops where certified organic fertilizers were used in agricultural production are mandarin and cucumber. Correspondingly, 44% of the farmers who use certified organic fertilizers produce mandarin while 24% of them use them in cucumber production. Rest of the farmers generally apply certified organic fertilizer to the crops in vegetable category. Also, there are farmers who use certified organic fertilizers in specific or mixed flower production.

Economic Effect of Certified Organic Fertilizer Use on Farms

In this section, the economic effect of certified organic fertilizer usage on the analysed farms have been presented. While the economic effect of certified organic fertilizer usage on farms was being analysed, partial budget analysis was used. Preceding the partial budget analysis, net benefit analysis was made in different use interactions of control, inorganic and certified organic fertilizer use for both mandarin and cucumber production. As part of the net benefit analysis, gross production value (gross benefit) and variable costs of fertilization per unit area (hectare) were calculated (Table 3 and 4).

Tablo 3. Net benefit analysis of mandarin production under different fertilizer treatments.
Çizelge 3. Farklı gübre uygulamalarında mandalina üretiminin net fayda analizi.

Income and cost items	Treatments*			
	C	IF	COF + IF	COF + FYM + IF
Gross Benefit				
1.Average yield (kg ha^{-1})	31941.00	66992.90	49981.00	106303.00
2.Average farmgate price (TRY kg^{-1})	0.59	0.59	0.73	0.66
3.Gross production value (TRY ha^{-1})	18845.19	39525.81	36486.13	70159.98
Variable costs of fertilizer treatments				
4. Fertilizer costs (TRY ha^{-1})	-	3699.20	19749.70	8794.60
5. Labour costs for fertilizer application (TRY ha^{-1})	-	566.30	932.20	1556.10
6. Machinery costs (TRY ha^{-1})	-	471.00	738.60	732.70
7) Total variable costs (TRY ha^{-1}) (4+5+6)	-	4736.50	21420.50	11083.40
Net Benefit				
8) Net Return (TRY haa^{-1}) (3-7)	18845.19	34789.31	15065.63	59076.58

*Treatments: C: control (no fertilizer); IF: inorganic (chemical) fertilizer; COF: certified organic fertilizer; FYM: farmyard manure
Note: The monthly average exchange rate of U.S. dollar to Turkish lira from December 2016 to December 2017 was US$1 = TRY3.63 (CBRT, 2019); ha^{-1} : per hectare

Table 4. Net benefit analysis of cucumber production under different fertilizer treatments.
Çizelge 4. Farklı gübre uygulamaları altında hıyar üretiminin net fayda analizi.

Income and cost items	Treatments*		
	C	IF	COF + FYM + IF
Gross Benefit			
1.Average yield (kg ha^{-1})	55937.50	170833.30	202272,70
2.Average farmgate price (TRY kg^{-1})	0.41	0.41	0.41
3.Gross production value (TRY ha^{-1})	22934.38	70041.65	82931.81
Variable costs of fertilizer treatments			
4. Fertilizer costs (TRY ha^{-1})	-	43792.50	12762.50
5. Labour costs for fertilizer application (TRY ha^{-1})	-	1584.90	2236.10
6. Machinery costs (TRY ha^{-1})	-	1013.50	1365.10
7) Total variable costs (TRY ha^{-1}) (4+5+6)	-	46390.90	16363.70
Net Benefit			
8) Net Return (TRY ha^{-1}) (3-7)	22934.38	23650.75	66568.11

*Treatments: C: control (no fertilizer); IF: inorganic (chemical) fertilizer; COF: certified organic fertilizer; FYM: farmyard manure
Note: The monthly average exchange rate of U.S. dollar to Turkish lira from December 2016 to December 2017 was US$1 = TRY3.63 (CBRT, 2019); ha^{-1} : per hectare

While gross production value was being calculated, the yield amount of per unit area was taken into consideration. When amounts of yield in mandarin have been analysed according to different fertilizer applications, it was seen that the highest amount of yield was obtained from certified organic fertilizer + farmyard manure + inorganic fertilizer combination. In this interaction, yield was determined as 106303 kg ha^{-1} (per hectare). Yield was about 66993 kg ha^{-1} under conditions where only inorganic fertilizers were used while it was 49981 kg ha^{-1} in certified organic fertilizer + inorganic fertilizer regimen. In cucumber cultivation, however, there are also farmers who do combined fertilizer application as certified organic fertilizer + farmyard manure + inorganic fertilizer in addition to farmers who solely rely on inorganic fertilizers. When yield amounts of farmers in cucumber production was analysed, according to different fertilizer applications, it was seen that the highest amount of yield was obtained again from certified organic fertilizer + farmyard manure + inorganic fertilizer interaction. Feeding this mix of fertilizers, the yield was determined favourable as 202272.70 kg ha^{-1}. On the other hand, yield was about 170833.30 kg ha^{-1} under conditions where only inorganic fertilizers were used. These finding shows that certified organic fertilizers will give better results in terms of yield when used in combination with farmyard manure. The fact that the yield obtained from certified organic fertilizer + farmyard manure + inorganic fertilizer interaction is higher than the yield obtained under inorganic fertilizer conditions is highly encouraging for farmers in terms of transitioning to organic fertilizer applications.

There are some studies that demonstrate the positive effect of integrated usage of organic and inorganic fertilizers on yield. Gebremedhin and Tesfay (2015), on the study pertaining to rice cultivation, they have evaluated the integration of farmyard manure with inorganic fertilizers as the best alternative option. These authors claim that this integration improves the yield and helps save part of the costs incurred due to chemical fertilizer usage. Soomro et al. (2013), on the study about sugarcane production, detected that farmers obtained higher yield by the integration of organic and inorganic fertilizers. According to the writers, both organic and inorganic fertilizers, when applied individually, as opposed to an integrated use system, productivity was affected negatively. Demirtaş et al. (2012) in their study, analysed the effects of some plant-based liquid organic fertilizers, chemical fertilizers and different combinations of these to fruit yield and quality in greenhouse tomato cultivation. In the study, it is stated that chemical + organic fertilizer applications give the most encouraging results in terms of tomato’s fruit weight and yield.

When crop prices were analysed in relation to fertilizing applications, a price difference was detected only in mandarin. Farmers achieved the highest price in mandarin with certified organic + inorganic fertilizer interaction and the average price was TRY0.73 kg^{-1} (per kilogram) (US$0.20 kg^{-1}). Farmers achieved the second highest price in mandarin with certified organic fertilizer + farmyard manure + inorganic fertilizer combination. Farmers achieved TRY0.66 kg^{-1} (US$0.18 kg^{-1}) for the mandarin they produced in certified organic fertilizer + farmyard manure + inorganic fertilizer combination. On the other hand, farmers were seen to market the mandarin they produced under inorganic fertilizer condition with the price of TRY0.59 kg^{-1} (US$0.16 kg^{-1}). The fact that farmers who apply certified organic fertilizer interactions in mandarin get high prices than those who apply inorganic fertilizers is a result of the fact that these farmers employ good agricultural practices. As a matter of fact, it is observed that products produced are sold at higher prices when good agricultural practices are exercised. It is seen that the price is not affected with regards to the different fertilizer applications in cucumber. The reason for this is that a vast majority of the farmers who produce cucumber do conventional farming. Therefore, no price difference occurred in terms of fertilizer applications. Farmers who produce cucumber achieved TRY0.41 kg^{-1} (US$0.11 kg^{-1})

from both inorganic and certified organic fertilizer + farmyard manure + inorganic fertilizer interactions.

After evaluating various fertilizer application combinations, the highest gross production value per unit area in mandarin and cucumber was found to be attained by the integration of certified organic fertilizer + farmyard manure + inorganic fertilizers. Gross production value per unit area was TRY70159.98 ha-1 (US$19327.82 ha^{-1}) in mandarin and TRY82931.81 ha^{-1} (US$22846.23 ha^{-1}) for cucumber. On the other hand, under inorganic fertilizer conditions lower gross production value per unit area emerges. These values are TRY39525.81 ha^{-1} (US$10888.65 ha^{-1}) in mandarin, TRY70041.65 ha^{-1} (US$19295.22 ha^{-1}) in cucumber.

Net benefit gained by fertilizer applications also depends on variable costs of fertilizer applications, along with yield. The highest cost factor among the variable costs is the fertilizer cost, followed by labour and machinery costs for fertilizer applications. While the amount of variable costs per unit area in mandarin is TRY4736.50 ha^{-1} (US$1304.82 ha^{-1}) in inorganic fertilizer application, it is TRY11083.40 ha^{-1} (US$3053.28 ha^{-1}) in certified organic fertilizer + farmyard manure + inorganic fertilizer interaction. As it would be understood from these figures, the amount of variable costs for fertilisation in the unit area is slightly higher in organic fertilizer + farmyard manure + inorganic fertilizer interaction compared to the inorganic fertilizer conditions. However, it is seen that certified organic fertilizer + farmyard manure + inorganic fertilizer interaction is very advantageous compared to inorganic fertilizer in terms of gross production value obtained from the unit area. On the other hand, it has been revealed that certified organic fertilizer + inorganic fertilizer interaction is disadvantageous compared to other fertilizer applications in terms of both variable costs per unit area and gross production value.

While the amount of variable costs per unit area in cucumber is TRY46390.90 ha^{-1}(US$12779.86 ha^{-1}) in inorganic fertilizer application, it is TRY16363.70 ha^{-1} (US$4507.91 ha^{-1}) in certified organic fertilizer + farmyard manure + inorganic fertilizer interaction. As it would be understood from the figures, the amount of variable costs for fertilisation in the unit area is much lower in certified organic fertilizer + farmyard manure + inorganic fertilizer combination than in inorganic fertilizer conditions. In other words, a farmer who applies certified organic fertilizer + farmyard manure + inorganic fertilizer interaction achieves TRY30027.20 (US$8271.96) saving per hectare in variable cost. In terms of variable costs in fertilizer applications, a different situation was encountered in cucumber than in mandarin. In the cucumber, which is generally produced in greenhouse, it is seen that the fertilizer costs are quite high in the case of only inorganic fertilizer application, and on the other hand, farmers have gained an important advantage in terms of costs in the case of balanced certified organic fertilizer + farmyard manure + inorganic fertilizer interaction usage. These analyses also show us that variable costs vary considerably for products of different feature cultivated in open-field and greenhouse. As a matter of fact, it has been determined that in the production of cucumber in greenhouse, more fertilization costs are made than the mandarin production in the open-field.

Fertilizer application where farmers get the most net benefit in both mandarin and cucumber is certified organic fertilizer + farmyard manure + inorganic fertilizer interaction. In this interaction, farmers are seen to gain TRY59076.58 ha^{-1} (US$16274.54 ha^{-1}) net profit for mandarin and TRY66568.11 ha^{-1} (US$18338.32 ha^{-1}) for cucumber. On the other hand, farmers who apply only inorganic fertilizers earn a net income of TRY34789.31 ha^{-1} (US$9583.83 ha^{-1}) per unit area for mandarin, for cucumber it is TRY23650.75 ha^{-1} (US$6515.36 ha^{-1}) per unit area. As it would be understood from these figures, farmers who apply certified organic fertilizer + farmyard manure + inorganic fertilizer interaction gain so much more net benefit than the inorganic fertilizer application.

In the partial budget analysis made for mandarin, for the farmers who only use inorganic fertilizers in production, commencing a certified organic fertilizer + inorganic fertilizer regime, would turn out a negative economic impact. In a sense, if farmers go to such change, they lose (-) TRY19723.68 ha^{-1} (US$5433.52 ha^{-1}) per unit area (Table 5).

On the other hand when farmers who use only inorganic fertilizers in their production of mandarin, commencing a certified organic fertilizer + farmyard manure + inorganic fertilizer regime would result in a positive economic effect. If farm owners decide such change, they would reap additional profits (+) TRY24287.27 ha^{-1} (US$6690.71 ha^{-1}) per unit area (Table 6).

This plus value, which is about TRY25000 (US$6887.05 ha^{-1}) per unit area, is high enough to encourage many mandarin farmers to use organic fertilizers. This plus value corresponds to an income of TRY82500 (US$22727.27) given that the average mandarin orchard size per farm is 3.3 hectares.

Partial budget analysis in cucumber production was utilized for certified organic fertilizer + farmyard manure + inorganic fertilizer combination, since farmers using certified organic fertilizer + inorganic fertilizer interaction are low in number. In the analysis, the change in profitability was observed in the case farmers who only use inorganic fertilizers in production. A change in course towards certified organic fertilizer + farmyard manure + inorganic fertilizer interaction yielded preferable results for inorganic fertilizer users. If farmers decide such change, they would enjoy significantly higher profits; to the amount of (+) TRY42917.36 ha^{-1} (US$11822.96 ha^{-1}) per unit area (Table 7). This plus value means an additional income of approximately TRY 25750.42 (US$7093.78) for farmers, given the average size of cucumber field per farm is 0.6 hectares.

Table 5. Partial budget analysis of converting to a combined use of inorganic fertilizers and certified organic fertilizers from an exclusive use of inorganic fertilizers in mandarin production.
Çizelge 5. Mandalina üretiminde inorganik gübrelerin özel kullanımından inorganik gübreler ve sertifikalı organik gübrelerin kombine kullanımına geçişin kısmi bütçe analizi.

Negative effects	Value (TRY ha^{-1})	Positive effects	Value (TRY ha^{-1})
Reduced income (income obtained from inorganic fertilizers application alone)	39525.81	Additional income (income obtained from combined use of inorganic fertilizers with certified organic fertilizers)	36486.13
Additional costs (total variable costs in combined use of inorganic fertilizers with certified organic fertilizers)	21420.50	Reduced costs (total variable costs in inorganic fertilizers application alone)	4736.50
A-Total reduced income and additional costs	60946.31	B-Total additional income and reduced costs	41222.63
		Change in net income (B-A)	(-) 19723.68

Note: The monthly average exchange rate of U.S. dollar to Turkish lira from December 2016 to December 2017 was US$1 = TRY3.63 (CBRT, 2019); ha^{-1} : per hectare

Table 6. Partial budget analysis of changing fertilizer application from inorganic fertilizers to combined use of inorganic fertilizers with certified organic fertilizers and farmyard manure in mandarin production.
Çizelge 6. Mandalina üretiminde sertifikalı organik gübre, çiftlik gübresi ve inorganik gübre interaksiyonunun sadece inorganik gübre kullamının olduğu koşullara göre kısmi bütçe analizi.

Negative effects	Value (TRY ha^{-1})	Positive effects	Value (TRY ha^{-1})
Reduced income (income obtained from inorganic fertilizers application alone)	39525.81	Additional income (income obtained from combined use of inorganic fertilizers with certified organic fertilizers and farmyard manure)	70159.98
Additional costs (total variable costs in combined use of inorganic fertilizers with certified organic fertilizers and farmyard manure)	11083.40	Reduced costs (total variable costs in inorganic fertilizers application alone)	4736.50
A-Total reduced income and additional costs	50609.21	B-Total additional income and reduced costs	74896.48
		Change in net income (B-A)	(+) 24287.27

Note: The monthly average exchange rate of U.S. dollar to Turkish lira from December 2016 to December 2017 was US$1 = TRY3.63 (CBRT, 2019); ha^{-1}: per hectare

Table 7. Partial budget analysis of converting to a combined use of inorganic fertilizers, certified organic fertilizers and farmyard manure, from an exclusive use of inorganic fertilizers in cucumber production.
Çizelge 7. Hıyar üretiminde yalnızca inorganik gübre kullanımından inorganik gübreler, sertifikalı organik gübreler ve çiftlik gübresi kombine kullanımına geçişin kısmi bütçe analizi.

Negative effects	Value (TRY ha^{-1})	Positive effects	Value (TRY ha^{-1})
Reduced income (income obtained from inorganic fertilizers application alone)	70041.65	Additional income (income obtained from combined use of inorganic fertilizers with certified organic fertilizers and farmyard manure)	82931.81
Additional costs (total variable costs in combined use of inorganic fertilizers with certified organic fertilizers and farmyard manure)	16363.70	Reduced costs (total variable costs in inorganic fertilizers application alone)	46390.90
A-Total reduced income and additional costs	86405.35	B-Total additional income and reduced costs	129322.71
		Change in net income (B-A)	(+) 42917.36

Note: The monthly average exchange rate of U.S. dollar to Turkish lira from December 2016 to December 2017 was US$1 = TRY3.63 (CBRT, 2019); ha^{-1} : per hectare

Partial budget analysis in both mandarin and cucumber revealed that profitability is higher in combined fertilizer application systems, that also include a certified commercial organic fertilizer in the mix. Findings from previous studies also support these results. Henderson et al. (2016) has come to the conclusion that the farmers who adopt a combined fertilizer application approach enjoy significant increases in profitability. Gebremedhin and Tesfay (2015) revealed that the integrated use of organic and inorganic fertilizers provides much higher net returns than control treatment. Soomro et al. (2013) determined that farmers obtain much higher income and net yield by the integration of organic and inorganic fertilizers. Soomro et al. (2013) emphasised that integration of organic and inorganic nutrients should be applied in their studies.

CONCLUSIONS

The results of this study reveal that in terms of fertilizer applications, the most profitable option is the combined fertilizer application regimen that includes a certified commercial organic fertilizer in the mix. The positive economic effect of combined fertilizer application encourages many farmers to include certified organic fertilizers in their applications. This ultimate result actually overshadows productivity and cost discussions, and is a central data point for farmers, suppliers of organic fertilizers in the industry and government officials as decision makers. In fact, the economic effect of organic fertilizers needs to be better explained in order to expand the use of organic fertilizers, including certified organic fertilizers, and to ensure the use of these fertilizers by farmers. Many farmers who use chemical fertilizers are not inclined to use certified organic fertilizers without seeing its positive economic effects. If this economic effect is well described, farmers' tendency to use certified organic fertilizers will also increase. In this context, economic outcomes of those using certified organic fertilizers should be conveyed to farmers who use chemical fertilizers. In order to achieve this goal, it is recommended to both train the farmers on organic fertilizer applications, and provide technical support to farmers who are interested in organic fertilizer applications. It is thought that especially technical support will have an encouraging effect on farmers' transition to organic fertilizer applications.

The results of this study revealed that the price is the most important factor that limiting the demand for certified organic fertilizers by farmers accustomed to using chemical fertilizers. Although the positive economic effects brought by certified organic fertilizer integration are explained, it is seen to be important to take some measures that will alter the price perceptions of the farmers towards a more positive direction. In this context, financial incentives given by the government bear importance. To this point, the organic fertilizer subsidies provided by the Ministry of Agricultural and Forestry of Turkey is deemed critical. The organic fertilizer subsidy provided by the government is allowed for solid organic and organomineral fertilizers, and the amount of support is TRY100 (US$27.55) per unit area ($ha^{-1}$). Chemical based fertilizer subsidies provided in Turkey are land-based payments. Fertilizer subsidy per unit area varies according to the products, and it is between TRY40-80 ha^{-1} (US$11.02-22.04 ha^{-1}) (MAF, 2021). The amount of subsidy given for organic fertilizers is quite low compared to chemical fertilizers. The amount of the subsidy does not appear to be strong of an incentive to encourage farmers to use organic fertilizers. Even though the organic fertilizer usage is widely promoted in Turkey, an increase in the amount of the subsidy is deemed necessary.

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