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Comparative financial analysis of open-field and greenhouse crop rotation and green manure applications in organic strawberry production

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ABSTRACT

This study investigated the profitability of open field crop rotation and greenhouse green fertilization along with farmland manure applications implemented to ensure sustainability of soil fertility in strawberry cultivation performed in line with the organic farming principles. In the open field experiment (1) Cowpea (*Vigna sinensis* L.), (2) Bean (*Phaseolus vulgaris* L.), (3) Cucumber (*Cucumis sativus* L.) were used as the crop rotation plants. In the greenhouse experiment 1) Cowpea (*Vigna sinensis* L.), (2) Bean (*Phaseolus vulgaris* L.),) were used as green fertilizations. Also this study investigated the impact of certified organic farmland manure as [(1) farmland manured and (2) farmland manure-free] on the parcels. The study compared the profitability in organic strawberry cultivation between crop rotation application in open field and green manure incorporation under soil by conducting a financial analysis. To conclude, result of the financial analysis indicated that both in greenhouse and open field, the application which combined Cowpea and farmland manure was found to be more economical.

Contribution/ Originality
This article "As opposed the general belief in society the study proves that organic farming costs are lower than conventional farming costs and so there will be no reduction in the income of the manufacturer, consumers will be able to reach healthy products at low cost." contributes to the field of organic agriculture.

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1. INTRODUCTION

All human activities are driven by the desire to satisfy human needs that arise within the boundaries of their assets. According to the science of economics the essential problem that human beings face is that human needs considered limitless are met through limited resources available. At the heart of these needs lies nutrition need. In this sense, agriculture, as the production source of the nutrients required to fulfil the nutrition need is indispensable.

Throughout centuries, agriculture has undergone changes with human beings and this change has gained pace with technological and industrial advances. Establishment of European Community in the late 60s and the policies it implemented to support agriculture and manufacture of pesticides and chemical fertilizers in 1970s contributed to this development. The initiative named 'Green Revolution' in agriculture was introduced in 1960s and 70s with the aim of offering a solution to the nutrition problem that arose out the rapid population growth particularly and this initiative only aimed at an increase in efficiency and use of synthetic chemical agricultural drugs and mineral fertilizers increased. However, because of these implementations that disregarded the fundamental principle of economics (that the resources to meet the needs are limited) great damages were made to our nature, in the other words our living environments, which is a vitally important agricultural source.

The adverse effects that green revolution caused in agriculture were primarily seen in developed countries where green revolution was intensely followed. Green revolution, which initially set out to offer a solution to the hunger problem in the World, not only failed to achieve this goal but also made enormous damages to the nature and human health. Scarce agricultural resources available (nature) began to lose their sustainable production ability in an irreversible manner. People began to seek alternative solutions to solve the problems that resulted from agricultural green revolution applications and to protect sustainable production ability of agricultural resources, in other words to protect the nature and human existence.

One of this alternative methods is ecological farming which is expressed with concepts such as alternative agriculture, biological agriculture, biodynamic agriculture, natural agriculture, low input agriculture, integrated agriculture system, good agricultural practices and organic agriculture. The ecological farming system aims to protect the natural balance disturbed as a result of bad practices by maximizing the efficient use of the resources. In this farming system, use of syntactic chemical fertilizers, drugs, and hormones is prohibited. Soil fertility, selection of the appropriate method for protection against diseases and pests, crop rotation, recycling plant wastes, green fertilization, use of organic wastes, animal manure and biological control and similar methods are among the methods applied within the scope of ecological farming. Organic agriculture is a system which aims to achieve high productivity in agriculture. The essential objective of it is to ensure production optimization safely in life chain among soil-plant-animal and human.

Ecological farming which started as a family business initially has gained a commercial dimension after it lost family business status. When ecological products began to be traded, there occurred the requirement for legal arrangements regarding control and certification. The rules to be conformed to during the production, processing, labelling, storing and marketing of the ecological products were specified by the legislations in a detailed way (Anonymous, 2005). All national and international standards about organic agriculture necessitate the control and certification of all steps followed about the product from soil to shelf. Through certificates an assurance is provided to the customers who aim to pursue healthy lives and to protect the environment by consuming organic products. Moreover, certification allows organic agricultural manufacturers to prove their that production takes place in accordance with the standards by documenting it and market their products at prices they are worth of.

Organic agriculture which started in Turkey in 1980s with conventional products such as dried grapes and dried figs in line with exportation demands, has showed significant developments in years. Organic agriculture activity started with eight products and has exceeded 200 products in recent years. As of 2016, in a total of 523.778 ha field, 489.671ha of which is production field and 34.106 ha of which is natural collection field, about 2.473.600 tons of production is made by 68.000 manufacturers (Table 1). A similar development is seen in the number of the firms that specialize in production, processing and marketing the products (Anonymous, 2017).

As a vast majority of the organic products (more than 85%) (Sayin *et al.*, 2005) manufactured in Turkey are exported, the number and variety of organic food manufacturing is shaped in line with the demands from foreign countries. Production organization institutions employ farmers on contract to undertake organic food production because of its nature. Contracted production ensures price and sale assurance to manufacturers. The contract made specifies production conditions, price and rate of premium, if any, and secures the partners legally by reserving the right to take a legal action (Demiryürek, 2000; 2004; 2011).

However, in recent years, as a result of some disputes between organic product manufacturers and the companies that they have a contract with some manufacturers have begun to start their own unions. These manufacturers obtain their certificates from Control and Certification Institutions that they make a deal through their own organizations and try to market their organic products in and outside of Turkey on their own (Günay, 2007; Demiryürek and Ceyhan, 2008).

Table 1: Organic agriculture plant production (transition period included)

Years	Number of Products	Number of Farmers	Farming Field (ha)	Natural Collection Field (ha)	Total Production Alanı(ha)	Production Amount (ton)
2002	150	12.428	57.365	32.462	89.827	310.125
2003	179	14.798	73.368	40.253	113.621	323.981
2004	174	12.751	108.598	100.975	209.573	377.616
2005	205	14.401	93.134	110.677	203.811	421.934
2006	203	14.256	100.275	92.514	192.789	458.095
2007	201	16.276	124.263	50.020	174.283	568.128
2008	247	14.926	109.387	57.496	166.883	530.224
2009	212	35.565	325.831	175.810	501.641	983.715
2010	216	42.097	383.782	126.251	510.033	1.343.737
2011	225	42.460	442.581	172.037	614.618	1.659.543
2012	204	54.635	523.627	179.282	702.909	1.750.126
2013	213	60.797	461.395	307.619	769.014	1.620.466
2014	208	71.472	491.977	350.239	842.216	1.642.235
2015	197	69.967	486.069	29.199	515.268	1.829.291
2016	225	67.878	489.671	34.106	523.778	2.473.600

Within this scope, taking into consideration that income inequalities in our country have a deeper effect on the people who live in rural areas and who do not have an opportunity to be engaged in other economic activities other than agricultural one, implementations are needed to enable especially people who live in mountain and forest villages to get better living conditions. It is foreseen that organic farming, as an alternative production system for the local people, could provide a production model which would increase the income and which fits the regional characteristics (Usal, 2006).

Usal (2006) investigated the profitability of organic agriculture in their study carried out to compare the activity results of the institutions that are engaged in conventional agricultural production with the institutions that are engaged in organic agriculture in the villages located in the

highlands of Adana Toros Mountain and to reveal the possibility of organic agriculture manufacturing. Findings of the study indicated that the major reason why manufacturers want to be engaged in organic agriculture is that organic agriculture is an environmentally protective and healthy production model as well as the expectation of yield high income.

The reasons why strawberry is the most common and widely produced one among the berry fruits is that its farming dates back to old times and its multidimensional consumption (Türemis and Agaoglu 2013). Turkey is the third strawberry producer country worldwide and 3.857,05 tons' of this production was organic (FAO, 2015). According to TÜİK (TSI) reports (2016) 1575 tones strawberries were produced in Adana. Strawberry, which is cultivated and produced in high quality worldwide, has also gained importance in our country, recently (Macit *et al.*, 2006). Cultivar selection is a feature in strawberry production (Nacar, 2012).

2. MATERIAL AND METHOD

2.1. Material

The study was conducted within 1000 m^2 open field and 1000 m^2 glass greenhouse in Çukurova University Yumurtalık Research Station test field and fresh and frigo strawberry seedlings of Sweet Charlie species cultivated under organic seedling cultivation conditions were used as the plant material. The experiment was carried out in four cases of recurrence according to split parcel test pattern. In main parcels, crop rotation and green manure applications and in lower parcels Ekoflora organic farmland manure applications were examined.

The factors and their levels handled in the test are as follows:
Main parcel: Crop Alternation (CA) Application (Open Field):

- Cowpea (C),
- Bean (B),
- Cucumber (C),
- Fallow (F)

Lower parcel: Ekoflora Organic Farmland Manure (FM) Application

- With Ekoflora Organic Farmland Manure FM (+)
- Without Ekoflora Organic Farmland Manure FM (-)

Main parcel: Green Manure (GM) Application (Greenhouse):

- Cowpea (C),
- Bean (B),
- Fallow (F)

Lower parcel: Ekoflora Organic Farmland Manure (FM) Application

- With Ekoflora Organic Farmland Manure FM (+)
- Without Ekoflora Organic Farmland Manure FM (-)

In open-field agriculture system, each September seedlings were planted according to split test parcels test pattern divided in a way which will include 30-35 plants in each recurrence.

For the greenhouse, each October, which is the seedling planting time, seedlings were planted in a way which will include 30-35 seedlings in each recurrence.

In open fields and in greenhouse fields where strawberry seedlings would be planted the parcels where soil preparations were made and crop rotation was applied and Green manure parcels (main parcels) were divided into two. The compost used in the study was made juicy in line with the method specified by Brinton *et al.* (2004). It was determined at the end of the analysis that the

juice contained 0.001% N; 0.02% P; 0.18% K. Applications were made in a way in which the juice obtained from 30 kg compost was provided to the irrigation system.

Juice preparation: After measuring 3% organic farmland manure and resting it in the necessary amount of water for 2 days, it was given to the plants. Fertilization was performed this way, however, no application was done on the other one. Farmland manure was applied on the parcel left fallow in crop rotation and on half of the Fallow parcel on which green fertilization was not performed. However, no fertilization was performed on the other half. At the end of the study, gross margin analysis was conducted in order to compare the profitability of the strawberry on which green manure was applied and the strawberry which was cultivated after open field crop rotation applications (Aras, 1988).

3. FINDINGS AND DISCUSSION

The applications which performed in the greenhouse and open fields for organic strawberry cultivation is of importance in order to explore the best strawberry cultivation method. Additionally, financial data of these applications are significant in terms of the continuity of these applications and implementing them. Even though it is desired to apply organic agriculture methods that aim to achieve production for a sustainable agriculture without damaging the environment, it does not sound realistic to expect the manufacturers to undertake these applications without a financial support.

Macit *et al.* (2011) carried out a study in order to investigate the applicability of organic strawberry cultivation in Black Sea Agricultural Research Institute test field between 2004-2005. Financial analysis findings obtained from their study indicated that organic strawberry cultivation and conventional strawberry cultivation methods were examined with regard to profitability and both were found to be so. However, since they could not obtain accurate information about organic strawberry price, they could not make a financial comparison in terms of profitability between the cultivation methods. In our experiment, the most marketable product in organic strawberry cultivation carried out in open field was obtained from the parcel where cowpea was used as the previous crop and farmland manure was applied during crop rotation. From among the organic strawberry products that we put on the market with an average of 3 TL sale price, the highest profit was obtained from the parcel where Cowpea + farmland manure was applied with 7.921 TL. Whereas, the lowest profit was obtained from the fallow parcel, where no application was carried out with 1.920 TL. As presented in Table 2-3 since raw material input costs are quite similar, use of Cowpea+farmland manure application method in greenhouses and open fields would be financially more rational.

Table 2: Open-field organic strawberry production budget-I values

Budget	Applications			
	Fallow	Bean	Cowpea	Cucumber
1. Annual Income				
I. Yield per Crop (g/plant)	178	263	288	239
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare*Yield per Crop	1.068	1.578	1.728	1.434
III. Total Income (TL/da) =Total Yield* Kg Price(3 TL)	3.204	4.734	5.184	4.302
2. Annual Income				
I. Yield per Crop(g/plant)	146	262	281	234
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per	876	1.572	1.686	1.404

Decare*Yield per Crop				
III. Total Income(TL/da) =Total Yield* Kg Price(3 TL)	2.628	4.716	5.058	4.212
TOTAL INCOME 1ST YEAR+2ND YEAR	5.832	9.450	10.242	8.514
2-YEAR PRODUCTION EXPENSES	Fallow	Bean	Cowpea	Cucumber
I. Equipment Machinery Leasing(TL/da)	25	115	115	115
II. Labour Costs(TL/da)	2.050	2.050	2.050	2.050
III. Material Costs(TL/da)	2.881	3.016	3.061	2.941
IV. Fixed Costs(TL/da)	684	684	684	684
TOTAL COSTS(TL/da)	5.640	5.865	5.910	5.790
NET PROFIT (TL/da)	1.920	3.585	4.332	2.724

Table 3: Open-field organic strawberry production budget-II values

Budget	**Applications**			
	Fallow+ FM	**Bean+FM**	**Cowpea+F M**	**Cucumber+ FM**
1. Annual Income				
I. Yield per Crop	308	386	400	313
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare* Yield per Crop	1.848	2.316	2.400	1.878
III. Total Income =Total Yield* Kg Price(3 TL)	5.544	6.948	7.200	5.634
2. Annual Income				
I. Yield per Crop	274	343	385	289
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare*Yield per Crop	1.644	2.058	2.310	1.734
III. Total Income =Total Yield* Kg Price (3 TL)	4.932	6.174	6.930	5.202
TOTAL INCOME 1^{ST} YEAR+2^{ND} YEAR	10.476	13.122	14.130	10.836
2-YEAR PRODUCTION EXPENSES	Fallow +FM	Bean +FM	Cowpea +FM	Cucumber +FM
I. Equipment Machinery Leasing(TL/da)	25	115	115	115
II. Labour Costs(TL/da)	2.125	2.125	2.125	2.125
III. Material Costs(TL/da)	3.105	3.240	3.285	3.165
IV. Fixed Costs(TL/da)	684	684	684	684
TOTAL COSTS(TL/da)	5.939	6.164	6.209	6.089
NET PROFIT (TL/da)	4.537	6.958	7.921	4.747

The most marketable product in organic strawberry production carried out in the greenhouse was obtained from the parcel where cowpea was used as the previous crop in green fertilization and farmland manure was applied. From among the organic strawberry products that we put on the market with an average of 3 TL sale price, the highest profit was obtained from the parcel where Cowpea + farmland manure was applied with 5.275 TL. Whereas, the lowest profit was obtained from the fallow parcel with 1.236 TL, where no application was carried out (Table 4-5).

Table 4: Greenhouse organic strawberry production budget–I

Budget	Applications		
	Fallow	Bean	Cowpea
1. Annual Income			
I. Yield per Crop	133	149	174
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare*Yield per Crop	798	894	1.044
III. Total Income (TL/da) =Total Yield* Kg Price(3 TL)	2.394	2.682	3.132
2. Annual Income	Fallow	Bean	Cowpea
I. Yield per Crop	249	304	317
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare*Yield per Crop	1.494	1.824	1.902
III. Total Income (TL/da) =Total Yield* Kg Price(3 TL)	4.482	5.472	5.706
TOTAL INCOME 1ST YEAR+2ND YEAR	6.876	8.154	8.838
2-YEAR PRODUCTION EXPENSES	Fallow	Bean	Cowpea
I. Equipment Machinery Leasing(TL/da)	25	115	115
II. Labour Costs(TL/da)	2.050	2.050	2.050
III. Material Costs(TL/da)	2.881	3.016	3.061
IV. Fixed Costs(TL/da)	684	684	684
TOTAL COSTS(TL/da)	5.640	5.865	5.910
NET PROFIT(TL/da)	1.236	2.289	2.928

Table 5: Greenhouse organic strawberry production budget–II

Budget	Applications		
	Fallow+FM	Bean+FM	Cowpea+FM
1. Annual Income			
I. Yield per Crop	162	192	241
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare*Yield per Crop	972	1.152	1.446
III. Total Income =Total Yield* Kg Price(3 TL)	2.916	3.456	4.338
2. Annual Income	Fallow +FM	Bean+FM	Cowpea +FM
I. Yield per Crop	355	376	397
II. Total Production kg (Crop Yield *6.000 Items/da)/1000 =600 Seedlings per Decare*Yield per Crop	2.130	2.256	2.382
III. Total Income =Total Yield* Kg Price(3 TL)	6.390	6.768	7.146
TOTAL INCOME 1ST YEAR+2ND YEAR	9.306	10.224	11.484
2-YEAR PRODUCTION EXPENSES	Fallow +FM	Bean+FM	Cowpea+FM
I. Equipment Machinery Leasing(TL/da)	25	115	115
II. Labour Costs(TL/da)	2.125	2.125	2.125
III. Material Costs(TL/da)	3.105	3.240	3.285
IV. Fixed Costs(TL/da)	684	684	684
TOTAL COSTS(TL/da)	5.939	6.164	6.209
NET PROFIT(TL/da)	3.367	4.060	5.275

When open field and greenhouse models in organic strawberry production and were examined within the scope of Yumurtalık region climate conditions, it was found that open field organic strawberry production was more profitable than the greenhouse organic strawberry production from a financial perspective. Taking into account the climate expectations of strawberries, it was observed that Yumurtalık region climate provided natural greenhouse conditions for strawberries. Besides, it was seen that organic strawberry production took place in the greenhouse was adversely affected in the region where heat increases swiftly in spring months. Considering production input costs, it was found that it was possible to derive the highest profit in organic strawberry production from the open field in Yumurtalık region.

Atasay (2007) conducted a financial analysis in the study carried out on Directorate of Eğirdir Fruit Research Institute Camarosa strawberry species between 2004-2006. This study compared the profitability obtained from conventional production and organic production applications. At the end of 2-year production applications, the highest profit was obtained from organic production application. Besides, amount of the production achieved was found to be highly similar between conventional production (4.206 kg/da) and organic production (4.072 kg/da).

No difficulties were encountered in marketing the products produced in the study with the desired price (3.00 TL in average). A high demand was observed in this field. However, some problems were encountered in preserving the products, supply of suitable packing materials, difficulty in transportation to the demanding markets. For a crop like fruit, which must be put into the market immediately after its harvest, facing such problems causes a loss in the marketable products. It would be possible to enhance profit by preserving the strawberries harvested under suitable conditions and by providing the necessary packing materials.

The findings obtained from the financial analysis of the abovementioned studies demonstrate that organic agriculture activities and organic strawberry production are still profitable despite some structural problems. The financial cost of the profit derived from protecting the natural resources for a sustainable agricultural production is excluded from this calculation.

4. RESULT

In the organic strawberry production carried out in open field where crop rotation was performed the highest profit (7.921 TL/da) was obtained from the parcel where Cowpea + farmland manure was applied, whereas, the lowest profit (1.920 TL/da) was obtained from the fallow parcel. In organic strawberry production carried out in the greenhouse where green fertilization applications were performed the highest profit (4.060 TL/da) was obtained from the parcel where Cowpea + farmland manure was applied, whereas, the lowest profit (1.236 TL/da) was obtained from the fallow parcel where farmland manure application was not performed. When open-field and greenhouse applications were compared, it was seen that the highest profit was derived from Cowpea + farmland manure application. In the financial analysis evaluations of the previously conducted studies, no problems regarding the low amount of production achieved or marketing were encountered during organic production transition process. In the present study problems encountered include preserving the product, supply of suitable packing materials, and difficulty in transportation to the demanding markets. Also in this study, other problems arose out of warm weather that adversely affected the organic strawberry production in the greenhouse. Similarly, the results obtained from financial analysis of the previous studies concluded that organic agricultural activities and organic strawberry production were profitable. Open-field organic strawberry production is recommended since open field organic strawberry production was found to be financially more profitable at the end of 2-year production activities.

To conclude, open-field organic strawberry production was found to be more economical for Yumurtalık (Adana) region because climate conditions of this region provide a natural greenhouse environment for strawberries.

One of the points that must be taken into account in order achieve sufficient yield and quality in organic strawberry production is the use of farmland manures obtained from organic farms or farmland manures certified for organic agricultural use. Additionally, use of farmland manure along with green fertilization materials is both economical and also enhances yield and quality to a great extent.

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