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Sustainable Farming Systems vs Conventional Agriculture: A Socioeconomic Approach

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1. Introduction

Intensive-type farming, through the application of high-input systems that offer an increased yield, is known as conventional agriculture. This term is broadly used in the international literature to describe intensive farming (Pacini *et al*., 2003). Over the last two decades, attention in industrialised countries has focused on reducing pollution by fertilisers and synthetic pesticides in conventional agriculture. The concern of society for the environmental problems caused by conventional farming, in combination with the increased demand for achieving sustainability in the agricultural sector and for safe, high-quality foodstuffs, has led to the emergence of alternative farming systems in recent years (Parra-Lopez *et al*., 2007). Especially, the increasing consumers' concern about food safety and environmental pollution escalated the value of Sustainable Farming Systems (SFS), such as Organic and Integrated Farming Systems or Integrated Crop Management (ICM).

SFS is a system that can evolve indefinitely toward greater human utility, greater efficiency of resource use and a balance with the environment which is favourable to humans and most other species (Harwood, 1990). The key aspect to sustainability is the ability to adapt to future potential changes (Hendrickson et al., 2008). Sustainable agriculture refers to an agricultural system that is ecologically sound, economically viable, and socially just. The central objective of both organic and integrated farming systems is the attainment of sustainability. These sustainable farming systems are striving to make the environment an integral part of the production process so as to give priority to issues regarding the proper use of natural resources and to offer assurances for the quality of produced foodstuffs (Tovey, 1997). Nevertheless, integrated and organic farming systems have several differences concerning their origin, the practices they implement, their association to the existing system of knowledge and information dissemination and their links with the traditional supply chain (European Commission, 2003).

Organic agriculture is a sustainable way of farming without chemical inputs during cultivation whereas integrated farming system is a sustainable way of farming which falls somewhere in between the conventional and the organic farming system. Organic and integrated agriculture are the sustainable farming systems that have been developing noticeably during the last decade.

A simple, concise and fairly descriptive definition of organic agriculture is the following: "Organic farming is a production method that focuses on the protection of the environment. It avoids the use of chemical inputs, such as fertilisers and pesticides" (Abando and Rohnerthielen, 2007). The concept of organic farming, institutionalised via the E.U. regulation 2092/91, is based on eliminating the use of purchased chemical inputs while maximising the use of on-farm inputs and biological control techniques instead of pesticides (Tzouvelekas et al., 2002).

Integrated crop management is the restrained and proper use of agricultural chemicals and fertilisers which is achieved through a combination of biological and chemical cultivation methods having as a result the reduction in input costs (Morris and Winter, 1999). According to IOBC[1], Integrated Crop Management (ICM) is a farming system which integrates natural resources and regulation mechanisms into farming activities to achieve maximum replacement of off-farm inputs and secures sustainable production of high quality food through ecologically preferred and safe technologies. It also sustains farm income, reduces the sources of environmental pollution currently generated by agriculture and maintains the multiple functions of agriculture (European Commission, 2003).

Organic farmers have been under a subsidy scheme for a period of 5 years and have received acre payments, whereas producers in integrated management have not been directly subsidised. Nevertheless, in the case of certain countries (eg France, Germany, Finland, Portugal, Greece) the ICM-type schemes receive support under specific agri-environmental measures in the context of EU Regulation. In Greece, in the reporting period of the present study, organic peach farmers received 900 €/ha/year, while integrated peach farmers received an average of 77 €/ha/year to cover part of the cost of ICM implementation.

The knowledge requirements differ for the three types of farming, with organic farming making a radical break from conventional farming knowledge networks and effectively requiring the development of a new Research and Development (R&D) and advisory system. ICM needs more targeted R&D within the existing advisory system, whereas conventional farming relies to the traditional R&D and advisory system (Harwood, 1990). Regarding the type of technical assistance which is available for organic and ICM versus conventional farmers in Greece, integrated farming has developed a considerable network of scientific support by the private sector and more targeted R&D within the existing advisory system, in recent years. On the contrary, organic farming has relied to the advice given by private certification bodies and the limited role of the public sector, not having succeeded in developing a considerable R&D and advisory system. In fact, it turns out, from the results of this research, to be the main inhibiting factor in the decision to adopt organic farming.

[1] International Organisation for Biological and Integrated Control of Noxious Animals and Plants.

The certification of organic products in Greece is supervised by a national certification body (AGROCERT) under the Ministry of Rural Development and Food. It sets standards based on EU Regulation 2092/91, which must be met by the private certification bodies that are actually supervising organic farms. With regard to integrated farming, however, there is no common legal framework in the EU which binds each country to meet common standards for the certification of products of integrated farming systems. AGROCERT produced two national standards (AGRO 2-1 & 2-2.) in which all the certification requirements are described in detail.

In the EU-27, the total area of sustainable farming systems has now exceeded 12.1 million hectares, 55% of which is the share of organic and 45% the share of integrated crop management (Willer et al., 2008, ZMP, 2008). In Greece, in 2008, organic farming covered an area of 69,201 hectares and integrated management an area of 29,232 hectares, corresponding to 2.2% and 1% respectively of the total agricultural area of the country. The share of permanent crops is particularly high in relation to total cultivated area and includes fruit trees, olive trees and vines, grown under organic or integrated management system. Peach trees occupy about 30% of the total area under integrated management, followed by the cultivation of olive trees (27%). There are numerous crops that are being organically produced in Greece such as cereals, forage crops, olive and fruit trees. However, the most important crops from an economic and environmental point of view are olives, vines and fruit trees (e.g. peaches).

In Greece, organic farming has already been implemented for 16 years and integrated farming for 9 years. A significant increase of area under Sustainable Farming Systems was observed in the entire implementation period. The intensity of main crops at each region, relative to the use of chemical inputs, is an important adoption factor of the two systems. Thus, organic farming is applied mainly at regions with less intensive crops and integrated farming is applied mainly at regions with more intensive crops, like peach crop that requires many applications of chemical inputs.

In Greece, there is an unequal adoption rate of organic and integrated farming among the regions of Greece at both NUTS-2 and NUTS-3 levels. The distribution of integrated farming among regions is more unequal than the distribution of organic farming at both NUTS-2 and NUTS-3 levels. The type of crops, the policy support for Sustainable Farming Systems and the different extension services between the two systems explain the differences at the development of integrated and organic farming among the regions. The revealed differences point out the need for diversification of policies among the regions of Greece regarding the sustainable farming systems.

On an international level, there is limited research comparing the three farming systems, since most papers study each system separately or make comparisons between two systems only. Nieberg and Offermann (2003) compared the economic performance of conventional and organic farms in Europe and concluded that organic farming has become an economically attractive sustainable farming system in several European countries, despite the fact that its yields are significantly lower compared to conventional farming (by an average of 30-40%). One of the most decisive factors of profitability is the attainment of higher producer prices in organic farming (a difference of over 50% compared to conventional farming). A basic parameter for the economic success of organic farming is the specific subsidies for organic crops, provided within the framework of the Common Agricultural Policy. These subsidies represent a share of 15 to 26% of the profit in Germany, Denmark, Austria and Switzerland. Although on average in the EU, the profit of organic farms is similar to that of conventional farms, very significant variances do appear, both among the organic farms of a country and among EU countries. This variance in the average profitability of organic farms ranges from -20 to +20% of the average profitability of conventional farms.

Swezy *et al.* (2007) compared conventional, organic and integrated tobacco production over a 6-year period in the USA. The yields in integrated and organic farming were lower compared to conventional farming by 19.4 and 34.3%, respectively. The average production costs were higher in integrated and organic farming compared to conventional farming by 28% and 60%, mainly due to the lower yields (and also due to the increased labour cost in organic farming). However, when this comparison is made based on total production cost per unit of land, they are only higher by 3 and 5% in integrated and organic farming compared to conventional farming. The statistical analysis was carried out using analysis of variance, which is a method that was also adopted in the present research.

The higher production cost in sustainable farming is a factor that justifies the demand for higher prices of the products. In fact, the increase in production cost is higher than the increase in producer prices, and consequently a gap is created, which possibly discourages some farm managers from becoming involved in sustainable agriculture. In addition, the environmental cost has not yet been incorporated in the prices of conventional products; while such a development is expected to help bridge the above-mentioned gap (Swezy *et al.*, 2007).

Parra-Lopez and Calatrava-Requena (2006) compared conventional, organic and integrated olive farming in Spain, according to the Multi-Criteria Decision Making Theory (MCDM) and using the Analytic Hierarchy Process (AHP). Based on the results of the overall yield from the three systems, they arrived at the conclusion that integrated and organic farming have a higher value compared to conventional farming of 10% and 19%, respectively. They refer to the total economic value that alternative farming systems offer for the whole of society and include their technical, economic and environmental functions. These values can be used as a guide in order to estimate a fair level of compensation, in relation to society, for producers of sustainable farming systems.

Pacini *et al.* (2003) evaluated the economic aspects of the sustainability of organic, integrated and conventional farm management systems in Italy. It was found that gross profit was higher for organic (subsidies included) rather than conventional farming. This was the only statistically significant difference observed among the three systems.

A recent comparative study on the cherry tree sector in Greece examined whether organic production is capable of offering satisfactory benefits to producers and concluded that conventional production is profitable, in contrast to organic production that is only profitable when subsidised (Tzouramani et al., 2008).

On the other hand, integrated farming in most countries of the European Union, results in lower variable production cost, mainly due to the reduced expenses for agricultural pesticides and fertilisers. As regards the price of products, its increase is the exception rather than the rule in the EU. The price of ICM products, in the majority of systems, does not differ from the price of relevant conventional products. In any case, however, there is an advantage linked to the marketing of these products and this fact, in the long-term, may have a positive impact on gross income (Granatstein, 2000). Gross profit remains almost the same as conventional farming in 44.4% of integrated farming systems, it is increased due to the non-variable gross income and the reduced variable production cost (which is mainly related to the reduced cost for pesticides and fertilisers) in 22.2% of systems and it is reduced in 33.4% of integrated farming systems (European Commission, 2003).

Additionally, it is noticeable that while economic incentives have played a significant role in inducing some managers of farms to adopt sustainable farming systems, there are others who grow organic even in the absence of subsidies. Managers of organic farms can be of at least four types: organic hopefuls, frustrated, pragmatic, and committed, each having a shared viewpoint but giving expression to it in different ways. Managers of conventional farms can be of at least two types: never really considered organic farming or have seriously considered it (Fairweather et al., 1999).

A review of the literature on the decision making process concerning the adoption or not of organic farming does not reveal a clear dominance of economic or environmental motives. Some research results indicate the significance of economic motives in the decision to switch from conventional to organic farming. It has been noted, in Germany for example, that producers turning organic, do so motivated by economic rather than environmental factors (Bruckmeier et al., 1994). It appears that in the UK as well, with prices of organic produce being higher than prices of conventional output by about 50 to 100%, higher income from the sale of organic produce is a significant motivation to adopt organic farming practices (Lampkin. and Measures, 1995). Another research finding supporting this argument indicates that about 1/3 of organic farmers intend to switch to conventional farming, if the financial support given to organic farming be withdrawn (Fairweather and Campell, 1996).

On the contrary, other results underline farmers' environmental consciousness as a major motive for the adoption of organic farming. In several countries, research shows that organic farmers rank environmental protection higher than economic returns (Milder et al. 1991, Storstad and Bjorkhaug, 2003). The protection of natural resources is a parameter that affects farmers' decision to adopt organic farming as they are interested in maintaining soil quality at a high level (Fairweather, 1999). In addition, they appear to show great awareness in matters of environmental pollution, degradation of water resources due to conventional farming and the existence of residues in foodstuffs (Mc Cann et al., 1997).

Meanwhile, an ideological framework for organic farming is emerging and can be seen as a guiding paradigm for the expansion and dynamic development of the agricultural sector (Allen and Kovach, 2000). In studying the ideological motivation of organic farmers, reference must be made to an objective laid down by organic farmers concerning their self sufficiency and autonomy from the agricultural input industry (Verhoog et al., 2002). In a research carried out in Ireland it was found that producers are primarily motivated by ideology when switching to organic farming (Willer and Gillmour, 1992). In the Netherlands, the majority of producers who turned organic were mainly motivated by their beliefs regarding a notion of ecosystems (Duram, 2000). However, in recent years the ideological undercurrent characterising organic farming seems to be fading away (Rigby and Caceres, 2001). The knowledge about the negative effects of conventional farming on the health of producers and consumers constitutes a significant motivation for farmers to adopt organic farming methods. For instance, farmers' apprehension in Norway about the negative implications conventional farming has on the quality of life and social welfare led to the adoption of organic farming (Storstad and Bjorkhaug, 2003).

Research results in England regarding integrated crop management provide a ranking of reasons leading to the adoption of this type of farming as follows: demand for safer and better quality foodstuffs, reduction of input costs and environmental protection. In contrast, an important factor explaining the lack of interest in this system is economic uncertainty during the transitory period (Park et al., 1997). It is for this reason that measures aiming at the reduction of such uncertainty must be part of a strategy to promote integrated crop management. In addition, 87% of conventional farmers believe that integrated crop management protects the environment, hence, recognise its environmental dimension, whereas 50% considers that production costs are significantly lower due to the reduction in input costs (Morris and Winter, 1999). In the Netherlands, 15% of conventional farmers have the option to participate in integrated crop management without having to make any major transformations in the production process (Vereijken and Royle, 1989). Approximately 50% of conventional farmers who do not intend to implement integrated crop management state that it is because they lack the required technical knowledge, whereas 41% because of shortage of data on the input-output relationship. It is worth noting that 61% of English farmers consider the lack of experience in the methods and techniques of integrated crop management as the main inhibiting factor for its adoption (Morris and Winter, 1999).

The comparison between a sustainable farming system and conventional agriculture is essential to understand how farmers choose between farming systems and what their motivations are (Fairweather, 1999). However, existing research focuses on conventional, organic and integrated farming separately, examining the advantages and disadvantages of each one system and not in relation to the other two. So far, very limited research has been done to investigate all three systems simultaneously, for among other things it is rather difficult to obtain secondary data and/or to collect primary data. Yet, the evolution of each system must be seen relatively to the others, because any advance in one is closely linked to the developments in the other two. A comprehensive approach which includes all three systems is likely to give new insights in this matter.

The objective of this chapter is to analyse, in socioeconomic terms, all three farming systems, namely, organic, integrated and conventional agriculture. The chapter analyses certain parameters related to the management of organic, integrated and conventional farms. It examines the economic results of the three farm types and the necessity of a specific subsidy being granted for organic and/or integrated farms. Specific tasks of the research are to examine the characteristics of organic, integrated and conventional farm managers. The differences between the managers of the 3 farm types are examined in relation to age, educational level, reasons for becoming involved in alternative farming systems and their training. In addition, the attitudes of farm managers to economic and environmental aspects of sustainable farming systems are examined. Finally, another task of this research is finding those specific elements which determine organic and integrated farming and also classifying the sustainable farming systems on the basis of farm managers' viewpoints regarding farm economics and environmental protection.

2. Methodology

The primary data were collected using a questionnaire and through face-to-face interviews with the managers of conventional, organic and integrated farms. More specifically, as regards the two sustainable farming systems, it is worth noting that only certified organic and integrated management farms, according to the official data of the Ministry of Rural Development and Food and AGROCERT, participated in the present study. The applied method of data collection for the three different groups of managers was: the population for organic peach farms, stratified random sampling for integrated peach crop management, and simple random sampling for conventional peach farms. The primary research was carried out in 2007. The peach sector was selected, for it is the only sector in which all three agricultural production systems have been implemented since 2001.

During the period under study, the organic farms were 58 and they all took part in the present research. Integrated crop management is almost exclusively practised by cooperatives (or producer groups). Therefore, cooperatives are the research strata under study in this case. A stratified random sampling procedure was used which corresponds to the objectives of this research, for it offers more accurate estimates of the various parameters for the same number of population units, (Hansen et al., 1993). Sampling errors are smaller and this is the result of the homogeneity that this method can preserve in the various population strata (Särndal et al., 2003).

In the simple random sampling procedure, sample size for conventional agriculture, was determined on the basis of the following equation:

$$n = N(zs)^2 / \{Nd^2 + (zs)^2\} \quad (1)$$

Where: n is the sample size, N is the population size, z is reliability, d is the confidence interval and s is the standard deviation calculated for a preliminary sample. Minimum sample size was calculated as n=99. The chosen final sample size was n=100 farms.

The calculation of sample size in the stratified random sampling procedure that was used for integrated crop management was done with the help of the Neyman sampling distribution (Särndal et al., 2003).

$$n = (\Sigma N_h s_h)^2 / \{N^2 D^2 + \Sigma N_h s_h^2\} \quad (2)$$

Where: n is the sample size, N is the population size, D the standard error (D=d/z), z is reliability, d is the required accuracy, s_h is standard deviation in each stratum that was calculated with a preliminary sample. Minimum required sample size n=93. The chosen sample size was n=100 farms which is more than the minimum requirement.

Based on the above, the final sample was set to 258 peach farmers, 100 of which were conventional, 100 were integrated and 58 were organic farmers. The selected sample consisted of conventional, organic and integrated management peach farmers who were located in all peach producing areas of the country. Following the preliminary test, the final questionnaire was used to collect data through direct (face to face) interviews with the selected producers who were also the managers of farms.

The statistical analysis was performed using the SPSS v.15. Parametric and non-parametric statistical analysis methods were used to resolve various research problems, since a different method had to be applied, according to the characteristics of each problem and the nature of the data and variables. The statistical data analysis methods that were used can be summarised as follows:

- One-Way Analysis of Variance.
    - Tukey's HSD Post Hoc Test (Tukey's Honestly Significantly Different Test).
- Independent Samples t-test.
- Kruskal-Wallis H (with a Monte Carlo simulation technique).
- Mann-Whitney U (with a Monte Carlo simulation technique).

The first two methods involve parametric techniques, while the other two are non-parametric statistical techniques.

The one-way analysis of variance is a parametric statistical method which provides the opportunity to examine the hypothesis that the mean values of various populations are equal. It is recommended for use when there are more than two samples, and the aim is to compare the mean values. The accuracy of the diagnosis is considered to be the most important reason for applying this particular method (Katos, 2004).

The application of post hoc analysis is required when the result of the analysis of variance is found to be statistically significant and permits numerous comparisons of mean values. Tukey's HSD (Honestly Significantly Different) criterion was used, which is considered to be one of the safest to test all the comparisons that can be made among the levels-values of the independent variable. Tukey's HSD test was used to carry out the necessary "correction", which takes into account the number of comparisons when estimating the statistical significance. One of the main tasks of this model is to examine whether the relevant *Y* variable presents a different behaviour at the three levels of the categorical variable *X*. Using the *F*-test as a basis, the null hypothesis of the following equation was examined: H_0: $\mu_1=\mu_2=\mu_3$. If this specific hypothesis is rejected, the research question becomes which of the μ differ from the rest. For this purpose, all the comparisons of the mean values are applied in pairs. The multiple tests which occur in the case of alternative farming systems are of the following type: H_0: $\mu_1=\mu_2$, H_0: $\mu_2=\mu_3$, H_0: $\mu_1=\mu_3$.

In the present paper, the t-test was used in cases where the research question only referred to the two types of farming (e.g. integrated and organic farming). In these cases, the test was performed between a categorical variable, with two categories, and the numerical variables under study. The null hypothesis is H_0: $\mu_1=\mu_2$ and the alternative H_1: $\mu_1\neq\mu_2$. The null hypothesis is rejected when, according to the result of *t* test, the observed level of statistical significance *p* is lower than a particular level of significance (a=0.05). In this case, the mean values of the numerical variable under study differ between the two alternative forms of agriculture. In addition, Levene's *F*-test was performed in order to examine the equality of the variances. When the test showed that the variances are equal (p>0.05), then an estimation was made using the model of equal variances; on the other hand, when the variances were unequal (p<0.05), the estimation was made using the model of unequal variances.

The Kruskal-Wallis test is a non-parametric equivalent test of analysis of variance; it was mainly used to examine the statistically significant relation between a categorical variable (with three categories) and ordinal variables. The categories of the variable are the integrated, organic and/or conventional management of agricultural production. Due to the fact that more than two groups are compared, the issue of post-hoc multiple comparisons emerge once again; in this case, they are conducted using the Mann-Whitney U test. The additional post hoc correction is made by dividing the level of statistical significance with the number of comparisons performed.

Finally, the Monte Carlo simulation technique was used for the Kruskal-Wallis and Mann Whitney U methods. A thousand normality tests were carried out and the level of statistical significance *p* was calculated for each one. Then, the mean value of these 1000 *p*-values was estimated, as well as the lower and upper bound of the confidence interval (selected confidence level 95%) for the mean values, based on the 1000 *p*-values. The estimates of the *p*-values, according to the Monte Carlo simulation technique result from the repeated sampling of the data in order to acquire empirical distribution parameters and achieve a greater reliability of the results (Harwell and Serlin, 1994).

3. Results and discussion

According to research results, the managers of conventional and integrated farms present a similar age distribution. On the other hand, organic management is characterised by a lower percentage of older producers (21% are over 55 years), compared to integrated (41%) and conventional farming (43%). Organic farmers, in their vast majority, are middle aged, since 76% are aged 36-55 years, while the relevant percentage in integrated and conventional management is 48% and 47%. On the contrary, the percentage that corresponds to younger producers, appears to be very low in organic management (3.4% are <35 years) compared to conventional and integrated management (10% and 11%, respectively). The structural weakness of the age of farmers in Greece seems reduced in organic farming; however, the latter presents obvious weaknesses in attracting young organic farmers (<35 years). Nevertheless, all the above-mentioned differences were not found to be statistically significant (Table 1).

Age	Conventional		Integrated		Organic	
	No.	%	No.	%	No.	%
< 35	10	10.0	11	11.0	2	3.4
36-45	26	26.0	24	24.0	20	34.5
46-55	21	21.0	24	24.0	24	41.4
> 55	43	43.0	41	41.0	12	20.7
Total	**100**	**100.0**	**100**	**100.0**	**58**	**100.0**
Results of Kruskal-Wallis test: χ^2 = 4.144, d.f.= 2, p = 0.126 Monte Carlo simulation technique: p = 0.124 Confidence Interval (Confidence Level 95%): Lower bound: 0.118 Upper bound: 0.131						

Table 1. Age of managers in alternative farming systems

As regards the educational level of farmers, the Kruskal-Wallis statistical test showed that there are significant differences among the managers of alternative farming systems that are identified, according to the Mann-Whitney U test, between the managers of organic farming and the managers of the other two agricultural production methods (Table 2).

Indeed, as we can see in Table 2, about 1/3 of organic farm managers belong to the two higher educational level categories, while the relevant percentage in integrated and conventional management is only 9% and 6%, respectively. It is remarkable to note that 45% and 43% of managers in integrated and conventional management respectively, have not attended secondary school, while the relevant percentage is only 14% for organic farming.

Education	Conventional		Integrated		Organic	
	No.	**%**	**No.**	**%**	**No.**	**%**
Primary School	43	43.0	45	45.0	8	13.8
Lower Secondary School	25	25.0	25	25.0	18	31.0
Upper Secondary School	26	26.0	21	21.0	12	20.7
Vocational Training	3	3.0	3	3.0	4	6.9
Tertiary Education	3	3.0	6	6.0	16	27.6
Total	**100**	**100.0**	**100**	**100.0**	**58**	**100.0**

Results of Kruskal-Wallis test: χ^2 = 24.983, d.f. = 2, p = 0.000
Monte Carlo simulation technique: p = 0.000 Confidence Interval (95%):
Lower bound: 0.000 Upper bound: 0.000
Results of Mann-Whitney U test:
$z^{INT-CON}$ = - 0.285 (p=0.776) (Monte Carlo: p = 0.772) (C.L[i]: p = 0.764-0.781)
$z^{ORG-CON}$ = - 4.462 (p=0.000) (Monte Carlo: p = 0.000) (C.L.[i]: p = 0.000-0.000)
$z^{ORG-INT}$ = - 4.514 (p=0.000) (Monte Carlo: p = 0.000) (C.L.[i]: p = 0.000-0.000)

[i] Confidence Limits

Table 2. Educational level of managers in alternative framing systems

The overwhelming majority of managers are professional farmers. However, there are significant differences among the managers of alternative farming systems, as regards the percentage of income from non-farming activities. On the average, this percentage amounts to 37.3% for conventional farms, 30.5% for integrated farms and 22.8% for organic farms. The distribution of managers, based on the percentage of off-farm income, presents statistically significant differences among the alternative farming systems, with a statistical significance level a=0.05 (Kruskal-Wallis test). Based on the Mann-Whitney U test, these differences are however only identified between organic and conventional peach farms (Table 3). Indeed, the managers of twice the number of organic peach farms compared to conventional ones (48.3% as opposed to 24%) do not have any off-farm income. Similarly, off-farm income exceeds on-farm income in 41% of conventional and only 24% of organic farms. The percentage for integrated management is somewhere between those two figures, but presents no statistically significant difference with either of the two (Table 3). It is therefore obvious that the organic and integrated management of peach farms is practised on a professional basis, rather than occasionally and that the managers of sustainable farming systems financially depend on their farms to a great extent.

As regards the reasons that urged producers to become involved in farming, about 1/3 of organic managers state they did it for the income, in contrast to conventional and integrated management, where only 1/5 of farmers mentioned income as the cause. The lack of any alternatives was the main reason for becoming involved in farming for approximately 3 out of 10 producers in conventional management, 2 out of 10 producers in integrated management and only 1 out of 10 producers in organic management. A conscious choice of living was the most important reason for the three groups, while family tradition was the primary cause for 24%, 22% and 14% respectively of managers in organic, integrated and conventional farms (Table 4).

Furthermore, another important element is the fact that farm managers have substantial experience in the peach tree sector, since they have been working with this crop for over 20

Percentage of F.I.[i] from sources outside the Farm %	Conventional		Integrated		Organic	
	No.	%	No.	%	No.	%
P[ii] = 0	24	24.0	38	38.0	28	48.3
0< P[ii] <25	17	17.0	14	14.0	6	10.3
25≤ P[ii] <50	18	18.0	12	12.0	10	17.2
50≤ P[ii]<75	28	28.0	24	24.0	10	17.2
75≤ P[ii] <100	13	13.0	12	12.0	4	6.9
Total	**100**	**100.0**	**100**	**100.0**	**58**	**100.0**

Results of Kruskal-Wallis test: χ^2 = 8.113, df= 2, p = 0.017
Monte Carlo simulation technique: p = 0,017. Confidence Interval (95%):
Lower bound: 0.014 Upper bound: 0.020
Results of Mann-Whitney U test:
$z^{INT\text{-}CON}$ = - 1,547 (p=0.122) (Monte Carlo: p=0.124) (C.L[iii]: p=0.118-0.131)
$z^{ORG\text{-}CON}$ = - 2,845 (p=0.004) (Monte Carlo: p=0.004) (C.L.[iii]: p=0.003-0.005)
$z^{ORG\text{-}INT}$ = - 1,443 (p=0.149) (Monte Carlo: p=0.150) (C.L.[iii]: p=0.143-0.157)

[i] Family Income [ii] Percentage [iii] Confidence Limits

Table 3. Distribution of farm managers based on the percentage of off-farm income

Reason	Conventional		Integrated		Organic	
	No.	%	No.	%	No.	%
Family tradition	14	14.0	22	22.0	14	24.1
Way of life	36	36.0	38	38.0	18	31.0
Lack of alternatives	29	29.0	22	22.0	6	10.3
Satisfactory income	3	3.0	4	4.0	12	20.7
Additional income	18	18.0	14	14.0	8	13.8
Total	**100**	**100.0**	**100**	**100.0**	**58**	**100.0**

Table 4. Reasons for which conventional, integrated and organic farm producers became involved in farming

years, on average. It is worth noting that 76%, 87% and 90% of the organic, conventional and integrated farms have been involved in this particular sector of agricultural production for over 15 years. In order to examine whether the farm managers in alternative farming systems differ, as regards the mean duration of their involvement in the sector, the one-way analysis of variance method was used, since, inter alia, Levene's test showed that the homogeneity of variance hypothesis is satisfied (p>0.05) (Table 5).

As we can see in Table 5, the results of the *F* analysis of variance test showed that there is a statistically significant differentiation (*p*<0.05) among the farm managers in alternative systems, as regards the average duration of their involvement in peach tree farming. Statistically significant differences were identified between organic farm managers and the producers of the other two systems of agricultural production (post hoc Tukey's HSD test). Indeed, the farm managers in conventional and integrated agriculture have, on average, an additional experience of 7 years in the peach sector, compared to organic farmers. However, the average number of years shows that there is valuable experience among the farm managers in all three systems of agricultural production.

Duration	Conventional		Integrated		Organic	
	Mean±St.Er.	**St Dev**	**Mean±St.Er**	**St Dev**	**Mean±St.Er**	**St Dev**
Years	29.31[b]±1.231	12.97	29.15[b]±1.16	11.60	22.28[a]±1.297	9.37

Homogeneity of variance test:
Levene Statistic = 2.132, d.f.[i] =2, d.f.[ii] = 255, p=0.121
Results of one-way analysis of variance:
F=7.932, d.f.[i] =2, d.f.[ii] =255, p=0.000
Results of Post hoc Tukey's HSD analysis:
$P_{INT-CON}$ = 0.995, St.Er.: 1.740, M.D.[iii]: -0.160 (95% C.L.[iv]: from -4.35 to 4.03)
$P_{ORG-CON}$ = 0.001, St.Er.: 1.788, M.D.[iii]: -7.034 (95% C.L.[iv]: from -11.35 to -2.72)
$P_{ORG-INT}$ = 0.001 St.Er.: 1.691, M.D.[iii]: -6.874 (95% C.L.[iv]: from -10.96 to -2.79)

[a,b] Means followed by a different letter present a statistically significant difference
[i] Among the groups [ii] Within the groups [iii] Mean difference [iv] Confidence Limits

Table 5. Mean duration of involvement in peach tree farming

At the same time, through the application of the independent sample t-test, it was found that the managers of organic and integrated farms do not present a significant difference, as regards the years of their involvement in this particular sustainable farming system. More specifically, as we can see in Table 6, Levene's test showed that there are unequal variances ($p<0.05$), and therefore this estimation refers to this particular case.

Average Duration	Integrated		Organic	
	Mean ± St.Er.	**St. Dev.**	**Mean ± St.Er**	**St. Dev.**
Years	5.27[a]±0.13	1.25	5.59[a]±0.36	2.73

Results of statistical t-test:
Levene's homogeneity of variance test: F = 27.321, p= 0.000
Estimation of unequal variances:
t= 0.832, d.f.= 70.97, p= 0.408, M.D.[i]: 0.316, St.Er.= 0.380
(95% C.L. [ii].: from -0.441 to 1.074)

[a] Means followed by a different letter present a statistically significant difference
[i] Mean difference [ii] Confidence Limits

Table 6. Duration of farm manager involvement in the integrated/organic peach farming

The average farm, both organic and integrated, has been certified as regards the relevant system for more than 5 years. Therefore, the managers of integrated and organic farms in the sample do not only have long-term experience in peach farming, but also extensive experience in the application of integrated and organic management practices, respectively.

As regards the farm managers' distribution, it is worth noting that the majority of integrated farm managers (68%) have been involved in integrated peach tree farming for 6 years, while the remaining managers of integrated farms in the sample have been certified for a period ranging from 2 to 5 years. The majority of organic farmers have been certified in organic farming for 5 or more years (66%), while the remaining managers of organic farms (34%) have been practising organic farming for a period ranging from 2 to 4 years. In fact, 42% of the organic farms have been certified in organic farming for over 6 years.

Considering training of farm managers, the number of seminars per year presents a significant difference between the average organic and integrated farm (t-test: $p<0.05$). The calculation was made using equal variances, taking into account the result of the Levene test ($p>0.05$). The producers in integrated management attend on average, 5 seminars per year, which are usually organised by the certification consultant. On the contrary, in organic farming, training is not as organised as in the case of integrated farming, and thus managers of organic farms attend on average 1 seminar per year, mainly organised by the certification body (Table 7). It should be mentioned, however, that it is possible that differences also exist in the quality of the provided training.

Frequency of seminars	**Integrated**		**Organic**	
	Mean ± St.Er.	**St. Dev.**	**Mean ± St.Er.**	**St. Dev.**
No of seminars	4.66[b]±0.10	0.98	1.03[a]±0.14	1.08
Results of statistical t-test: Levene's homogeneity of variance test: F = 0.001, p= 0.978 Estimation with equal variances: t= - 21.665, d.f.= 156, p=0.000, M.D.[i] = -3.63, St.Er.= 0.167 (95% C.L.[ii].: from -3.956 to -3.295)				

[a,b] Means followed by a different letter present a statistically significant difference
[i] Mean difference [ii] Confidence Limits

Table 7. Number of seminars per year for managers of integrated and organic farms

According to farm managers, integrated crop management is the appropriate use of fertilisers, pesticides, fungicides and herbicides (34.5%), through programming, management and control of the agricultural production process (34.3%). The quality of products (16%) constitutes a main element which the integrated crop management, followed by the reduction of production costs (6.1%), certification (4%), protection of the environment (3.5%) and protection of producers' and consumers' health (1.6%) (Table 8).

Main elements	**Frequency of elements' appearance in the definitions**	**Percentage %**
Appropriate use of inputs	147	34.5
Programming, management and control of production process	146	34.3
Quality of products	68	16.0
Reduction of production costs	26	6.1
Certification	17	4.0
Protection of environment	15	3.5
Health and quality of life of producers and consumers	7	1.6
Total	**426**	**100.0**

[1] according to the order of appearance in the definitions of farmers of all the three farming systems

Table 8. The basic elements[1] of integrated crop management, according to farm managers

Farm managers consider that the appropriate use of inputs (mainly fertilisers and pesticides) constitutes a basic component of the ICM system. However, they do not refer to the protection of the environment as a main element of the system. Farm managers may offer a hint about environmental protection through their statement for the use of inputs, but there is no clear assertion about the contribution of integrated crop management to environmental protection.

As regards organic agriculture, farm managers consider that it implies the non use of synthetic inorganic inputs (mainly fertilisers and pesticides) (40.8%) and this results to environmental protection (33.4%). In this case, there is a clear statement for the contribution of organic farming in environmental protection. Additionally, according to farmers, organic farming leads to the production of safe agricultural products, which protect consumer health (21.6%) (Table 9).

Main elements	Frequency of elements' appearance in the definitions	Percentage %
Non use of synthetic inorganic inputs	138	40.8
Environmental protection	113	33.4
Safe products which protect the health and improve the quality of life of consumers	73	21.6
Alternative way of pest management	14	4.1
Total	**338**	**100.0**

[1] according to the order of appearance in the definitions of farmers of all the three farming systems

Table 9. The basic elements[1] of organic farming, according to the definition of farmers

The classification of alternative farming systems according to farmer's opinions for the economics (profitability without subsidies) of farms shows that there is a statistically important diversification for integrated farmers, as they consider that integrated outperforms conventional, which outperforms organic farming. The classification of alternative farming systems is the same for organic farmers, but there is a statistically significant difference only between organic and integrated management. For conventional farmers the rank between conventional and integrated farming changes but the difference is not important. The diversification is important for organic management, for conventional farmers consider that organic farming has the lowest profitability in comparison with the other two types of farming (Tables 10-13).

Alternative Farming Systems	Mean Rank of Conventional Farmers	Mean Rank of Integrated Farmers	Mean Rank of Organic Farmers
Conventional farming	2.55	1.88	2.03
Integrated farming	2.32	2.97	2.38
Organic farming	1.13	1.15	1.59
Results of Friedman statistical t-test: $N^{i}=100$, $N^{ii}=100$, $N^{iii}=58$, $(\chi^2)^{i} = 28.533$, $(\chi^2)^{ii} = 167.780$, $(\chi^2)^{iii} = 18.345$, d.f. = 2, p = 0.000 *Monte Carlo simulation technique:* p = 0.000 Confidence Interval (95%): Lower bound: 0.000 Upper bound: 0.000			

[i] Sample of conventional farmers [ii] Sample of ICM farmers [iii] Population of organic farmers

Table 10. Classification of alternative farming systems according to the farmer's attitude for the economic results (without the specific subsidies for organic/integrated farms)

Alternative Farming Systems	Mean Rank of Conventional Farmers	Mean Rank of Integrated Farmers	Mean Rank of Organic Farmers
Conventional farming	1.54	1.03	1.45
Integrated farming	1.46	1.97	1.55
Results of Friedman statistical t-test: $N^i = 100$, $N^{ii} = 100$, $N^{iii} = 58$, $(\chi^2)^i = 0.605$, $(\chi^2)^{ii} = 88.360$, $(\chi^2)^{iii} = 0.621$, df = 1 $p^i = 0,443$, $p^{ii} = 0.000$, $p^{iii} = 0.431$ *Monte Carlo simulation technique:* $p^i = 0.514$, $p^{ii} = 0.000$, Confidence Interval (95%): Lower bound ^{i}: 0.504 Upper bound^i: 0.523 Lower bound ^{ii}:0.000 Upper bound^{ii}: 0.000			

^{i}Sample of conventional farmers ^{ii}Sample of ICM farmers ^{iii}Population of organic farmers

Table 11. Statistical test for the examination of classification between conventional and integrated agriculture according to the farmer's opinion for the economic results (without the specific subsidies for integrated farms)

Alternative Farming Systems	Mean Rank of Conventional Farmers	Mean Rank of Integrated Farmers	Mean Rank of Organic Farmers
Conventional farming	2.00	1.85	1.59
Integrated farming	1.00	1.15	1.41
Results of Friedman statistical t-test: $N^i = 100$, $N^{ii} = 100$, $N^{iii} = 58$, $(\chi^2)^i = 100.000$, $(\chi^2)^{ii} = 49.000$, $(\chi^2)^{iii} = 1.724$, df = 1 $p^i = 0.000$, $p^{ii} = 0.000$, $p^{iii} = 0.189$ *Monte Carlo simulation technique:* $p^i = 0.000$, $p^{ii} = 0.000$, Confidence Interval (95%): Lower bound^i: 0.000 Upper bound^i: 0.000 Lower bound^{ii}:0.000 Upper bound^{ii}: 0.000			

^{i}Sample of conventional farmers ^{ii}Sample of ICM farmers ^{iii}Population of organic farmers

Table 12. Statistical test for the examination of classification between conventional and organic agriculture according to the farmer's opinion for the economic results (without the specific subsidies for organic farms)

Alternative Farming Systems	Mean Rank of Conventional Farmers	Mean Rank of Integrated Farmers	Mean Rank of Organic Farmers
Integrated farming	1.87	2.00	1.83
Organic farming	1.13	1.00	1.17
Results of Friedman statistical t-test: $N^i = 100$, $N^{ii} = 100$, $N^{iii} = 58$, $(\chi^2)^i = 54.760$, $(\chi^2)^{ii} = 100.000$, $(\chi^2)^{iii} = 24.897$, df = 1, p = 0.000 *Monte Carlo simulation technique:* p = 0.000 C. I. (95%): Lower: 0.000 Upper: 0.000			

^{i}Sample of conventional farmers ^{ii}Sample of ICM farmers ^{iii} Population of organic farmers

Table 13. Statistical test for the examination of classification between integrated and organic agriculture according to the farmer's opinion for the economic results (without the specific subsidies for integrated/organic farms)

On the other hand, farm managers of all three farming systems have a more clear attitude regarding environmental protection, for they classify, with an important diversification, organic first, integrated second and conventional farming third (Tables 14 and 15).

Alternative Farming Systems	Mean Rank
Conventional farming	1.00
Integrated farming	2.00
Organic farming	3.00
Results of Friedman statistical t-test: $N^{i} = 100$, $N^{ii} = 100$, $N^{iii} = 58$ $(\chi^2)^{i} = 200.00$, $(\chi^2)^{ii} = 200.00$, $(\chi^2)^{iii} = 116.00$, df = 2, p = 0.000 *Monte Carlo simulation technique:* p = 0.000 Confidence Interval (95%): Lower bound:0.000 Upper bound: 0.000	

[i]Sample of conventional farmers [ii]Sample of ICM farmers [iii]Population of organic peach farmers

Table 14. Classification of alternative farming systems according to the farmer's attitude for the protection of environment

Alternative Farming Systems	Mean Rank
Conventional farming Integrated farming	1.00 2.00
Integrated farming Organic farming	1.00 2.00
Results of Friedman statistical t-test: $N^{i} = 100$, $N^{ii} = 100$, $N^{iii} = 58$ $(\chi^2)^{i} = 100.00$, $(\chi^2)^{ii} = 100.00$, $(\chi^2)^{iii} = 58.00$ df = 1, p = 0.000 *Monte Carlo simulation technique:* p = 0.000 Confidence Interval (95%): Lower bound: 0.000 Upper bound: 0.000	

[i] Sample of conventional farmers [ii] Sample of ICM farmers [iii] Population of organic peach farmers

Table 15. Statistical test for the examination of classification between 1st – 2nd and 2nd -3rd alternative farming system according to the farmer's attitude for environmental protection

In addition, the potential diversification of the attitude of farm managers on environmental aspects of alternative farming systems is examined. As regards the viewpoint on the negative impacts of conventional farming on the environment, organic and integrated farm managers differ on the intensity of its acceptance; with organic farmers showing the highest acceptance.

The majority of integrated farm managers (56%) neither agrees nor disagrees with the viewpoint that integrated farming protects the environment, in contrast with the majority of organic farmers who disagree (76%). Organic farmers (93%) consider that organic farming is the only alternative for environmental protection. On the contrary, about 50% of integrated farm managers disagree with this point of view.

The majority of ICM farm managers (64%) consider that integrated crop management incurs a balanced protection to the environment and to the quality of agricultural products, whereas an equivalent percentage of organic farmers neither agree nor disagree with this viewpoint.

ICM farm managers (86%) consider that integrated differs from conventional farming, whereas the majority of organic farmers consider that it doesn't differ. In addition, the intensity of rejection of the opinion "organic is the same with integrated" differs between the two groups of farm managers; organic are more informed about the differences (93% of organic farm managers disagree very much, against only 35% of integrated farm managers).

Organic farm managers have very high preference on both sustainable farming systems (76% agree very much and 24% agree) against conventional agriculture. This fact is explained by the abhorrence of organic farmers for conventional farming. The intensity of acceptance of both sustainable farming systems by ICM farm managers is much lower (19% strongly agree and 81% agree). Finally, farm managers of both sustainable farming systems disagree with the viewpoint of the adoption of organic and integrated farming for only economic reasons. However, the intensity of rejection is much higher for organic farmers.

The examination of these organic and integrated managers' attitudes regarding the economic and environmental aspects of alternative farming systems was conducted through the statistical test Mann-Whitney U. According to the results, there are statistically significant differences in all cases (Table 16). In most of these cases, this diversification refers to the intensity of acceptance or rejection of each viewpoint.

Viewpoint	**[i] Mann-Whitney U**	
	z	**p**
CON[ii] incurs negative impacts on environment	- 7.169	0.000
INT[iii] protects environment adequately	- 7.619	0.000
ORG[iv] is the only alternative farming system for the environmental protection	- 7.281	0.000
INT[iii] incurs a balanced protection to the environment and to the quality of agricultural products	- 6.737	0.000
INT [iii] differs from CON[ii]	- 6.000	0.000
ORG[iv] is the same with INT [iii]	- 7.067	0.000
I prefer both ORG[iv] and INT [iii] against CON [ii]	- 7.014	0.000
My decision for the adoption of ORG and INT is induced only by economic reasons	- 5.592	0.000

[i] Monte Carlo simulation technique (confidence intervals 95%) confirms in all the case the statistically important results in Mann-Whitney U test.
[ii] Conventional [iii] Integrated [iv] Organic

Table 16. Examination of statistically important diversification of organic and integrated farmers' viewpoints on environmental and economic aspects of alternative farming systems

It is also noticeable that 97% and 98% of organic and integrated peach farmers intend to continue using the selected sustainable farming system. Only 3% of organic farmers will change over to integrated farming and 2% of ICM farmers will change over to organic farming. So there is evidence that there is not a competitive relationship between organic and integrated farming. On the other hand, 43% of conventional peach farmers intend to adopt integrated farming in the next years and only 2% of conventional peach farmers intend to adopt organic farming. So, there is also strong evidence of expansion of integrated crop management in the following years.

The production cost per unit of land, of the average conventional farm is 837 €/str[2]. The production cost of the average integrated farm is lower by 17.4% in comparison with the average conventional farm. On the contrary, the production cost of the average organic farm is higher by 23.9% and 49.9% in comparison with conventional and integrated farms, respectively (Table 17).

The higher production costs in organic farms are mainly due to labour costs, which are 446 €/str, an amount much higher than the respective expenditure in the conventional and integrated crop management (206 €/str). In contrast, land costs do not differ among the average conventional, integrated and organic farm (Table 17).

Production cost	Conventional		Integrated		Organic	
	Mean	St Dev	Mean	St Dev	Mean	St Dev
Land cost	50.86[a]	3.92	50.77 [a]	3.38	50.85[a]	7.26
Labour cost	206.89[a]	79.44	205.89[a]	79.92	445.93[b]	156.35
Variable capital cost	209.60[b]	66.85	150.78[a]	41.46	222.63[b]	100.49
Fixed capital cost	346.42[b]	324.65	250.55[a]	171.86	288.3[a,b]	188.76
Other capital cost	23.07[a]	12.40	33,45[b]	12.11	28.99[b]	12.22
Capital cost	579,09[b]	360.51	434,78[a]	197.56	539.93[a,b]	287.25
Production cost	836,84[b]	402.37	691.45[a]	217.32	1036.72[c]	400.14
Average production cost[1]	0.333[a]	0.275	0.340[a]	0.297	0.709[b]	0.736
Average variable cost[1]	0.129[a]	0.078	0.121[a]	0.108	0.277[b]	0.252
Average fixed cost[1]	0.205[a]	0.208	0.220[a]	0.203	0.432[b]	0.399

[a,b,c] Means followed by a different letter present a statistically significant difference
[1] euro/kg

Table 17. Statistical significance of the differences between the average production cost of alternative farming systems (in €/str)

Capital costs of the average organic and integrated farm are 540 and 435 €/str, which are lower by 6.8% and 24.9% than conventional farms (on average 579 /str). More specifically, fixed capital costs of the average farm under organic and integrated management are 288 and 251 €/str; lower by 16.8% and 27.7% than the respective expenditures of conventional farms (on average 346 €/str). The variable capital costs are 223 €/str on the average organic farm, higher than the average conventional farm by 6.2%. On the other hand, the respective expenditure of the average farm under integrated management is 151 €/str, an amount lower by 28.1% in comparison with the average conventional farm (Table 17). The total expenditure for fertilisers, pesticides, fungicides and herbicides has been reduced in organic and integrated management by 21.5% and 36.8% respectively in comparison with conventional agriculture (105 and 84 €/str on average organic and integrated farm, respectively, against 134 €/str in conventional farms). Regarding integrated crop management, the reduction of these costs in comparison with the conventional management is 39.6% for fertilisers and 35% for pesticides, fungicides and herbicides. This finding is the result of the reduced use of synthetic fertilisers and pesticides in ICM in comparison with

[2] 1 stremma = 0.1 hectare

the conventional agriculture. As in the other European countries, fertilisation and pest management are the main fields of ICM implementation in Greece as well. It has also been observed that in most cases in Europe integrated agriculture is associated with a reduction of production costs due to reduced expenditure for fertilisers and pesticides. As regards organic farms, the reduction in these costs in comparison with conventional farms is important but not very high (18.7% for fertilisers and 23.2% for pesticides) because of both the relative high prices of organic fertilisers and pesticides and the necessity for high quantities of these organic inputs.

The average cost of production is estimated to 0.333 €/kg for the average conventional farm, 0.340 €/kg for the average ICM farm and 0.709 for the average organic farm (Table 17). This cost is only 2.1% higher in integrated in comparison with conventional farming, for the reduction in cost production is compensated by similar reduction in output (yield in kg). Organic farms have, on average, more than twofold average production cost in comparison with conventional and integrated farms, due to both higher production costs and lower yield.

The average fixed cost of production is estimated to 0.205, 0.220 and 0.433 €/kg for the average conventional, integrated and organic farm (Table 17). It is higher by 7.3% in integrated compared with conventional farms and is about twice that of organic farms compared with farms under the other two farming systems.

However, the average variable cost of production is lower in the average integrated farm (0.121 €/kg) compared with conventional farms (0.129 €/kg). This is the result of the higher reduction in expenditures for fertilisers and pesticides than the reduction in yields. On the contrary, the average variable cost of production of organic farms is much higher (0.276 €/kg) compared with conventional farms.

Levene's test that was used to examine the homogeneity of the variances in alternative farming systems, in relation to production costs, showed that this hypothesis is valid in all cases ($p>0.05$). The results of the *F* analysis of variance test showed that there are statistically significant differences concerning all the categories of production costs, except the land costs. The post hoc Tukey's HSD analysis was carried out for the accurate identification of the differences between the three groups. According to the results, statistically significant differences are identified between the average organic farm and the average conventional and integrated farm, as regards the labour cost. Variable capital cost differs between the average integrated farm and the farms of the other two types of farming systems mainly due to less expenditure for fertilisers and pesticides. Fixed capital and total capital cost differ only between the average integrated and conventional farm. Regarding total production costs, statistically significant differences are identified among all the three farming systems. Finally the average fixed, average variable and average total cost of production differ only between organic farms and the farms of the other two types of farming (Table 17).

Concerning the economic results, the focus is on a comparison of the average organic, integrated and conventional farm. When the specific subsidy for organic/integrated farm is not taken into account (Table 18), the average integrated farm makes a profit of 110.7 €/str, which is 8.8% less than the profit of the average conventional farm (121.4 €/str). The specific subsidy for integrated management is relatively low (7.7 €/str), and results in a further reduction (almost elimination) of the difference in profit with an average conventional farm of about 2.5%. The difference in profit between integrated and conventional management is very small, since the lower production costs in integrated management are also coupled with a lower gross income, due to the low price increase and the relatively reduced yield compared to conventional management. On the other hand, the average organic farm makes a loss without the specific subsidy that is equal to 79.9 €/str. In this case, the loss occurs since, despite the higher gross income (which is due to a larger price increase compared to the reduced yield), production costs increase to a greater extent compared to conventional and integrated farms, mainly due to the higher labour costs. The specific subsidy for organic peach tree farming (90 €/str) turn the losses of the average organic farm into a profit of 10.1 €/str, which is still much lower (92%), however, than the profit presented by the average conventional and integrated farm.

The gross margin of the average conventional farm is 635.7 €/str, while it is lower for the average integrated farm by 70.7 and 78.4 €/str, with or without the specific subsidy, a difference that is equal to 11.1% and 12.3%, respectively. The gross margin of the average organic farm, without the specific subsidy for organic farming is lower by 83.5 and 5.1 €/str (13.1% and 0.9%) respectively, in relation to the average conventional and integrated farm. The subsidy for organic farming changes this relation, since the average organic farm now presents a higher gross margin by 1% and 13.7%, compared to the average conventional and integrated farm.

In addition, the farm income of the average conventional farm is 465.1 €/str, while in the case of the average integrated farm it is lower by 6% and 7.7%, with and without the specific subsidy. In contrast, the farm income of the average organic farm, both with and without the specific subsidy for organic farming, is higher by 25.8% and 6.4%, respectively, compared to the average conventional farm. Similarly, it is higher by 33.8% and 15.3%, compared to the average integrated farm.

The farm family income of the average conventional farm is 352.1 €/str; it is lower by 2.6% and 4.8% for the average integrated farm, with and without the specific subsidy. On the other hand, the farm family income of the average organic farm, without the subsidy for organic farming, is lower by 11.1% and 6.7% compared to the average conventional and integrated farm, respectively. The specific subsidy for organic farming changes this relationship, since the average organic farm consequently achieves a higher farm family income by 14.4% and 17.5%, compared to the average conventional and integrated farm.

The land income of the average organic farm without the specific subsidy is negative (-29 €/str.), but becomes positive with the subsidy and amounts to 61 €/str, which means it exceeds the relevant rental costs (approx. 51 €/str.). Labour income is higher in organic compared to conventional and integrated farm management, both with (approximately 40%) and without (11.5% and 15.6%), the subsidy, while it is similar for conventional and integrated management. However, even more important is the labour income per 8 hours, and its comparison with current wages. It is 49.3 €/str in conventional management; in integrated management it is 48.1 €/8hrs and 46.9 €/8hrs with and without the subsidy (2.5% and 5% lower, respectively, than in conventional management). In organic management, it is 35 €/8hrs and 29 €/8hrs with and without the specific subsidy for organic farms, respectively, i.e. lower by 28.2% and 41.2% compared to the average conventional farm. Current wages are approximately 32 euros/8hrs, therefore, they are less than the labour income/8hrs at the average conventional and integrated farm. However, concerning the average organic farm, labour income/8hrs exceeds current wages, only in cases where the specific subsidy for organic farming is included in gross income.

The return on capital was estimated at 9.5% for the average conventional farm, 10.1% and 9.8% with and without the subsidy respectively for the average integrated farm, and only 4.3% and 1.3% for the average organic farm, with and without the organic farming subsidy, respectively.

Levene's test that was used to examine the homogeneity of variances in alternative forms of agriculture, in relation to economic results, showed that this hypothesis is valid in all cases ($p>0.05$). The results of the *F* analysis of variance test showed that there are statistically significant differences (when the specific subsidy is not taken into account) concerning the profit, land income, labour income/8hrs and return on capital ($p^1=0.011$, $p^2=0.011$, and $p^3=0.001$, respectively) (Table 18).

Economic Result	Conventional		Integrated		Organic	
	Mean	St Dev	Mean	St Dev	Mean	St Dev
Net Profit	121.40^b	436.48	110.71^b	377.16	- 79.91^a	510.37
Gross Margin	635.66^a	376.03	557.25^a	351.08	552.20^a	495.78
Farm Income	465.11^a	374.43	429.34^a	363.00	494.89^a	457.80
Farm Family Income	352.11^a	381.15	335.21^a	357.36	312.91^a	437.30
Land Income	172.26^b	436.57	161.48^b	377.12	- 29.05^a	511.33
Labour Income	328.29^a	414.39	316.60^a	381.72	366.02^a	444.46
Labour Income/8hrs	49.34^b	57.63	46.87^{a,b}	67.04	29.01^a	37.36
Return on Capital (%)	9.46^b	10.88	9.82^b	15.82	1.28^a	17.33

[1] without the specific subsidy for organic/integrated management
[a,b,c] Means followed by a different letter present a statistically significant difference

Table 18. Statistical significance of the differences between the average economic results[1] of alternative farming systems (in €/str)

With the addition of the specific subsidy however, the only observed statistically significant difference is the one related to the return on capital. The post hoc Tukey's HSD analysis was carried out for the accurate identification of the differences between the three groups. The statistically significant differences are identified between the average organic farm and the average conventional and integrated farm, as regards profit, land income and return on capital; as regards labour income/8hrs, differences are only observed between organic and conventional farms (Table 18).

4. Conclusions

Taking into consideration research results, it is concluded that organic and integrated crop management are applied by managers on a professional basis. Farm managers present a significant economic dependence on their farms. Managers of organic farms were found to be of a relatively higher educational level, compared to managers of conventional and integrated farms. However, the structural weakness related to age distribution of farm managers, although reduced in the case of organic farming, is nevertheless observed in both sustainable farming systems, since the latter seem to be unable to attract younger farm managers.

It is also concluded, that exists a difference among non-conventional producers in terms of their attitudes towards economic and environmental aspects of organic and integrated farming. Organic farmers appear more sensitive to the environmental impact of conventional agriculture, whereas the attitude of those practicing integrated farm management is influenced more by economic factors compared to organic farm managers.

The definition given by producers in Greece for integrated farm management is similar to that given by producers in England, but differs significantly from the definitions that exist in most EU countries, given that environmental sensitivity is one of the two most frequently occurring arguments in their definitions of integrated farming. Thus, it is for that reason thought necessary to turn to a system of farm managers' education and training with a clearer orientation towards environmental protection.

On the contrary, in the case of organic farming the environmental message is more evident in relation to integrated farm management. Farm managers in all three systems of agricultural production rank organic farming as the most effective production system in environmental protection. Attitudes, however, differ regarding the economic performance of this system, for farm managers of all the three types of farming believe that organic farming has the lowest profitability in relation to the other two systems. Greater emphasis is therefore required to be placed on educating organic farmers in economic issues, such as the efficiency in the use of productive resources and the potential for improving financial results and farm economic performance.

Regarding production expenditures per unit of land, they differ among the three types of farming, for they are reduced in integrated farms compared to conventional farms and augmented in organic farms. In integrated crop management, the reduction in production expenditures is caused by fewer expenses for inorganic inputs, whereas in the organic farms increased expenditures are due to higher labour expenses.

Economic results were not found to differ significantly between conventional and integrated farms. On the contrary, organic farms without the specific subsidy show lower profitability, labour income, land income and capital return compared to conventional and integrated farms. The specific subsidy for integrated crop management is low and does not seem to play a major role; the economic results do not also seem to justify a subsidy for this sustainable system, except if it is only provided for a transitional period. Therefore, the policies for promoting integrated crop management should firstly consider measures to reduce the average age of farm managers and secondly attempt to raise awareness among consumers, so that in the long-term, higher prices are achieved compared to conventional agriculture.

On the other hand, the specific subsidy for organic farming determines the profitability of the average organic farm, has a major and decisive impact on land income, labour income/8hrs and net income; it also increases the return on capital and leads to a reversal of the relation with the other two farming systems, as regards gross margin and farm family income. It is therefore concluded that a potential elimination of the subsidy for organic farming in the peach sector will cause a major deterioration in the economic results of organic farms, compared to conventional and integrated ones. Consequently, if the majority of organic farms continues to operate with the existing economic inefficiency, the provision of a subsidy for this sustainable farming system is considered to be essential.

The policies to promote organic farming should mainly aim at reducing the production cost, increasing the yield and providing training for managers of organic farms. Additionally, the subsidies for organic farming primarily (and for integrated management as well) could also be treated as a measure that would reward farm managers for achieving environmental improvements. Such a decision would depend on the goals set at an agricultural and environmental policy level.

Another conclusion from research results is that the development of the two sustainable agricultural systems does not proceed in a competitive manner and that under present circumstances there is a trend for further expansion of integrated farm management. In the current conditions of economic crisis sustainable agricultural systems can offer an alternative path for the Greek rural economy. An essential requirement, though, is that agricultural policy makers will address the weaknesses that have emerged from the investigation of producer attitudes towards economic and environmental issues, that is to improve the economic performance of organic farms on the one hand and the environmental protection in integrated crop management on the other.

Finally, the appraisal of farms employing different production technologies, in terms of sustainability, gives important information to the decision makers. If the goal of sustainability is to run through the core of agricultural policy, then, policy measures should aim at the promotion of both sustainable farming systems. At the same time, taking advantage of the know-how regarding sustainability that has been building up in the best performance farms, can offer the necessary drive towards sustainable agricultural development.

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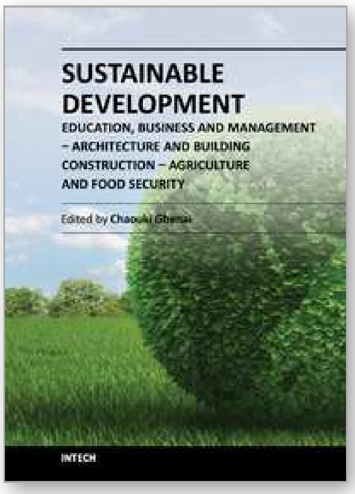

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Securing the future of the human race will require an improved understanding of the environment as well as of technological solutions, mindsets and behaviors in line with modes of development that the ecosphere of our planet can support. Some experts see the only solution in a global deflation of the currently unsustainable exploitation of resources. However, sustainable development offers an approach that would be practical to fuse with the managerial strategies and assessment tools for policy and decision makers at the regional planning level. Environmentalists, architects, engineers, policy makers and economists will have to work together in order to ensure that planning and development can meet our society's present needs without compromising the security of future generations. Better planning methods for urban and rural expansion could prevent environmental destruction and imminent crises. Energy, transport, water, environment and food production systems should aim for self-sufficiency and not the rapid depletion of natural resources. Planning for sustainable development must overcome many complex technical and social issues.

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