Organic and Conventional Farming: a Comparison Analysis through the Italian FADN

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Abstract. *This paper shows some results arisen from a wider research on economic and environmental sustainability of organic farming. It focuses on organic and conventional farming comparison through an investigation of Italian FADN data. In order to identify some of the main differences between organic and conventional farms a "distance analysis" has been carried out. The study aims to highlight some of the main characteristics of those two groups of farms to better address differences (if any) in production technology, costs and revenues. Furthermore it shows the findings of a non-parametric efficiency analysis on the Italian olive-growing farms. The purpose is to estimate difference in efficiency and productivity between organic and conventional olive producers. Results reveal that looking at the average values on Invested Areas, conventional farms' Gross Production is significantly higher than the organic ones, as the Net Margin, as the Net Product and Costs. The average values on Total Labour Force instead, shown that, even if conventional farms still have higher values than organic ones, the "distance" become shorter. That means that the two groups are quite similar and that, even if organic farms still produce a lower "economic value", they better compensate productive factors, especially in terms of Labour Force. Regards to efficiency analysis, we found that organic olive-growing farms are more able in using their disposable resources (with reference to their own frontier), and the higher efficiency permits them to compensate the lower productivity with respect to the conventional farms.*

Keywords: FADN Sampling, Organic Farming, Distance, Efficiency Analysis.

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1. Introduction

Organic agriculture is a production method that allow to apply low environmental impact techniques, since it does not employ chemical products that could affect both the final product and the environment. In spite of the great increase of organic production in Italy in the last decade, it has to be notice that this practice has not been developed following an homogenous way both in terms of territory (geo-distribution) and cultivations. In fact, crops prevails on all the other production's typologies and some Regions (South and Islands) lead on the other in terms of cultivated areas. Moreover, the organic production is mainly located to the South Italy, while processing activities are mainly located to the North. Finally, the consumption of organic products is higher in the North. Except for few farms that start from the very beginning to produce organic, the main ones switch trough the organic method from the conventional practice (Scardera, Zanoli, 2002).

The aim of this paper is to analyse two groups of farms respectively constituted by organic and conventional farms. It is an evidence that productivity in the organic process are generally lower than in the conventional farming (Offermann and Nieberg, 2000). It is clear that presence of inadequate efficiency and productivity levels could be a disincentive for farmers to shift towards organic farming[1]. As a consequence - living aside the environmental and health externalities generated by this practice - development of organic farming could be invalidated if individual farms do not reach adequate efficiency levels. This would imply that organic farms must tend to be efficient both on the productive and on the economic sides. In the light of this consideration, an important research issue is the comparison of productive and economic performances between organic and conventional farms. A crucial point is evaluating the "distance" between the two

[1] Several studies have found that financial subsidies and not profitability represent the main incentive to farmers to switch towards organic farming (Pietola and Oude Lansink, 2001).

practices by the structural and efficiency sides as to obtain useful information about convenience or otherwise of adopting an organic technique. Our study is a part of a wider research aimed to compare Italian organic and conventional farms and their sustainability in a long run. Specifically, the present work focuses on the following two objectives: the first part of this paper presents a brief literature overview of the most recent statistical methodologies applied to address the selection of similar farms to be compared. The results of the procedure applied to the Italian FADN sample is then presented. The study try to provide evidence of heterogeneity or homogeneity among farms (organic and conventional) through the analysis of some key economic variables. The second purpose aims to evaluate differences in efficiency between organic and conventional farming by a technical point of view. More specifically, this paper shows some findings of a case study that takes into specific consideration the Italian olive-growing sector. Trough a non-parametric approach (Data Envelopment Analysis), analysis evaluates which technique is more able in using their disposable productive inputs.

2. Comparing Organic and Conventional Farms: Methodologies and Selection Criteria

The comparative analysis introduces some problems related to methodological issues. Some researchers argue about the effective reasonableness of the comparison itself, because it is carried out on two systems characterized by: a) high differences as far as the productive techniques are concerned; b) different technical-productive paradigm, admitted that it is possible to define a peculiar one for each group; c) heterogeneity inside, mostly because conventional farming is a mix of agronomic techniques, some of those quite similar to the organic ones. With respect to this last aspect, conventional farming could be considered as the most widespread production system in a territory or, as well, all the other kind of productive techniques which can be considered as alternatives to the organic ones (Offermann and Nieberg, 2000). Even if the choice is dictated by the analysis' object, it is known that there is the risk to argue about not homogenous systems, neither from the technological point of view, neither from the management one. It is then necessary to emphasize that – as well as for any comparative analysis - the results coming from the comparison between organic and conventional farms are strictly linked to the modalities with which the comparison is carried out. Holding the limits of those kind of analysis, in this section will be examined the most applied procedure useful to compare the two systems. Then an application to FADN data base is carried out (Section 3).

An approach used for the comparison, between the two productive systems, through FADN data, defines conventional farms as an approximation, that means *how an organic farm should be if it were conventional*. The similarity between the two kind of enterprises, which should operate in the same context, is founded on the same levels of potential production, and on the same level of available resources. So the hypothesis is that there is technological homogeneity between the two productive systems. This approach, however, introduces many problems (Offermann, Lampkin 2005) and the more important are: - a) the selected variables' submission to the system/context: how much variables depend by the organic or conventional farming? - b) the business management: often the more innovative farms show greater conversion inclination – c) the *auto-selection* problem: if all the farms had the same information to maximise profits, then the comparison would not have reason to exist, because every farms would adopt the more rewarding productive technique.

As far as the organic and conventional FADN sub-samples is concerned, the best solution would be to consider a constant sample[2] of farms, that is a *panel* to be analysed during a specified temporal lag. Following this approach it would be possible to evaluate the conversion period looking at some of the most important impacts on farms' economic performance and market behaviour. A temporal analysis, in fact, is considered as the preferable one (where possible) because it allows to carry out both a *within* and *between* farms' analysis (Santucci, 2002). This is one of our purpose for further analysis. Other recent studies developed using FADN data have, instead, favoured the application of a *spatial approach*, analysing farms' structural and economic characteristics. This would not take

2 FADN sample has a variable quota of farms: every year some farms are dropped out from the survey and some new others are included – at least since 2003.

into account the possible effects coming from a change in business management, as well as those necessary to evaluate the effective convenience to convert (evaluation of cost-oppurtunity).

Some studies match groups of farms ensuring only that group averages are similar, while some others select a group of comparable farms for each organic farm. Furthermore, some studies use an aggregated measure of similarity which allow to rank conventional farms and then select a number of most similar farms (Offermann, 2004). These differences make comparison across countries difficult (Lee, Fowler, 2002) so a proposal of guidelines for harmonisation have been developed (EU-CEEOFP). The comparison analysis that could have been adopted can be summarize as follows: a) comparison between groups of similar farms: averages inside groups are similar; b) comparison between two farms considered as the most representative of their farm type; c) comparison between organic and conventional farms classified as similar thanks to a weighting system of selection; d) comparison between farms based on "minum similar criterion", where the conventional farms selected have specific minimum requirements; e) comparison between two groups of farms with similar characteristics as far as productive system, dimension and localization is concerned. The debate on farms' selection process *for* comparison is still open, however, it has been followed some of the main guidelines shown in recent studies (Nieberg et al., 2005) and seminars (IFOAM, 2005). According to these researchers, organic and conventional farms to be compared have to achieve the following requirements:

- similar environmental conditions (land fertility, climate…);
- same localization (Region);
- same equipment of productive factors;
- same business typology (farm type)

The selection of the comparison groups of farms have been done by selecting those that fall within a set of criteria (indicators) that submit the requirement to be independent from the system of production, following the main guidelines for harmonization (Offerman, Nieberg, 2000). As a result, a group of conventional farms of 799 farms have been selected. The two FADN sub-sample have though the same number of farms, as for each organic farm have been selected the most similar one with respect to some selection criteria (Section 3).

3. The *distance* between organic and conventional farms: an application to FADN data base

The *reference population* (universe) is the Italian FADN data base (2003)[3], the *statistical unit* (basic unit) coincides with the *research unit*, that is the farm. The FADN sample counts 14,811 units, the organic farms sub-sample consists of 799 units. It is necessary to point out the peculiarity of the organic sample, which is affected by the so called "auto-selection" biased. This has to be taken into great account while reading the analysis' results, because it has an influence on the variability of the whole system and affected the carried out analysis.

FADN (Farm Accountancy Data Network) is an important informative source[4] of micro-economic data for the agricultural sector. It gathers structural and economic data for a large sample of farms (an average of about 17,000 Italian farms/year represent the 31% of the total European sample)[5]. The European Union universe of farms is a set of farms of at least 1 hectare, while the Italian one establish a limit in terms of ESU (> 2 ESU since 1985 until 2001; > 4 ESU since 2002). The value of one ESU is defined as a fixed number of EUR/ECU of Farm Gross Margin. Both the *economic dimension unit* and the *technical and economic orientation* are based on the *standard gross margin* of the production activities. The concept of Standard Gross Margin (SGM)[6] is used to determine the economic size of farms, which is expressed in terms of European Size Units (ESU). This concept is also used in the Farm Structure Survey organised by Eurostat. The selection of farms have been

[3] FADN is the only harmonised source, at European level, that includes technical, financial and economic data on farming. It is not the official statistical source of information on financial/economic aspects of the organic agriculture, nevertheless it has been widely used in several national and international studies.

[4] Farm Accountancy Data Network (FADN) was founded by Reg. (EC) n. 79/65 and Reg. CEE 797/85, 2328/91, 950/97. FADN is managed for Italy by the National Institute of Agricultural Economics (INEA).

[5] The field of observation of Italian FADN refers to those farms that are defined "commercial", meaning with this that firm's management is the main entrepreneur's activity. A commercial farm is defined as a farm which is large enough to provide a main activity for the farmer and a level of income sufficient to support his or her family. In order to be classified as commercial, a farm must exceed a minimum economic size.

[6] SGMs are expressed in European Currency (EUR/ECU).

based on a stratified sampling method based on firm's *geographical location*, *technical and economic orientation* and *economic dimension unit*. The variables used for stratification are in fact:

- TEO[7]: The classification used for selection is based on 67 principal farm type categories.
- ESU[8]: The classification used for selection is based on 7 farm size categories.
- Region[9]: The classification for selection is based on 21 Italian Regions and on 3 district areas (North, Centre, South and Islands).

Every cell containing a specific number of organic farms have been filled up with those conventional farms that shown the best requirements. The choice of variables for the selection of comparable conventional farms have been restricted to *non-system dependent* factors. Some indicators have been considered to select those conventional farms that could be defined similar to the organic ones in terms of production potential, resources endowment, land area, farm type. In particular, the *selecting procedure* have been carried out following three steps: 1) evaluation of the selection variables using FADN data (data availability in the Italian FADN data base); 2) set-up of the selection indicators for the submission of conventional farms; 3) data processing for the effective conventional farms' selection. Data processing on FADN Data base have considered the following indicators: a) Indicator for similar natural and production condition: Altitude zone; b) Indicator for similar localization: Region; c) Indicators for similar endowment with production factors: CA/TA (Cultivated Area/Total Area), FLF/TLF (Familiar Labour Force Units/Total Labour Force Units), Machinery and Equipment; d) Indicators for similar farm type: SGM (Standard Gross Margin). Those indicators have been compared simultaneously and lead to select the most similar conventional farm for each organic one observed.

Living the issues related to the environmental impact of organic farming versus conventional of the productive process[10], the comparison has been developed through the analyses of some of the most

[7] TEO stands for T*echnical and Economic Orientation*.
[8] ESU stands for *European Size Unit*.
[9] FADN Regions (NUTS).
[10] The SABIO project carried out the analysis about the environmental impact through a set of indicators based on land productivity, technical practices employed and energy.

important structural and economic characteristics of farms. Organic FADN sub-sample (2003) represents the 5.4% of the total sample and it is distributed as shown in Table 3.1. Organic farms are mainly concentrated in the South of Italy with 400 farms where the 48.8% are Specialized in Permanent Crops.

Table 3.1. Organic farms by type of farming (Technical Economic Orientation) and District - %

	N. FARMS / DISTRICT							
TYPE OF FARMING	**North**	%	**Centre**	%	**South and Isl.**	%	**Total**	%
Specialist field crops	18	2,3	59	7,4	47	5,9	124	15,5
Specialist horticulture	3	0,4	2	0,3	4	0,5	9	1,1
Specialist permanent Crops	47	5,9	58	7,3	195	24,4	300	37,5
Specialist grazing livestock	63	7,9	43	5,4	80	10,0	186	23,3
Specialist granivore	2	0,3	4	0,5	3	0,4	9	1,1
Mixed cropping	17	2,1	26	3,3	34	4,3	77	9,6
Mixed livestock	1	0,1	8	1,0	5	0,6	14	1,8
Mixed crops-livestock	11	1,4	37	4,6	32	4,0	80	10,0
Total	**162**	**20,3**	**237**	**29,7**	**400**	**50,1**	**799**	**100,0**

Source: Own data processing on FADN data (2003).

Some of the main structural characteristics of the two groups of farms taken into account are shown in Tables 3.2. and 3.3. The results give evidence of the fact that, on average, organic farms are wider than conventional ones in terms of cultivated areas for all the type of farming processed. This is confirmed both with respect to the total sample and to the *non-comparison* sample as well. Organic farms field crops' specialized and horticulture specialized invest greater areas than conventional ones. As far as the dimension of breedings is concerned, some differences are found for the specialist grain-growing, but, on average, the dimension of the two groups of farms compared is equivalent (37.11 and 36.40) with values attested both under the total sample and the *non-comparison* sample ones. The Standard Gross Margin turns out on average with same level for organic farms and conventional farms, being the same for comparison and non comparison sample. Furthermore, these values achieve the total sample one.

A low intensity of employment is registered for conventional farms, both in terms of Total Labour Force and of Family Labour Force as shown in Table 3.3.

Table 3.2. Organic and Conventional sub-samples: Cultivated Areas (CA), Grown Cattle Unit (GCU) and Economic Dimension (SGM) by type of farming (Technical Economic Orientation) – Averages.

CA - Cultivated Area

	organic	conventional	non comp	Total
Specialist field crops	72.48	63.50	49.00	50.30
Specialist horticulture	89.39	33.18	4.22	5.29
Specialist permanent Crops	25.02	21.95	14.49	15.68
Specialist grazing livestock	65.65	61.66	49.25	51.16
Specialist granivore	148.57	20.99	21.91	25.49
Mixed cropping	53.76	51.94	29.27	31.83
Mixed livestock	76.84	46.66	48.62	50.21
Mixed crops-livestock	61.05	55.26	43.19	45.75
total	51.24	44.42	32.71	34.34

GCU - Grown Cattle Unit

	organic	conventional	non comp	Total
Specialist field crops	6.36	2.20	3.66	3.71
Specialist horticulture	0.06	-	0.14	0.14
Specialist permanent Crops	1.30	0.46	0.60	0.64
Specialist grazing livestock	62.75	63.33	82.32	79.77
Specialist granivore	649.14	2,605.57	612.64	670.44
Mixed cropping	15.20	18.53	5.11	6.39
Mixed livestock	70.64	74.75	322.84	292.52
Mixed crops-livestock	37.11	36.40	74.47	68.01

SGM – Standard Gross Margin

	organic	conventional	non comp	Total
Specialist field crops	56.28	57.89	52.13	52.47
Specialist horticulture	326.26	314.80	98.78	102.91
Specialist permanent Crops	52.83	53.17	41.66	43.16
Specialist grazing livestock	52.48	51.17	70.11	67.69
Specialist granivore	228.86	261.86	115.45	122.85
Mixed cropping	62.35	52.70	39.39	41.36
Mixed livestock	53.07	44.88	101.91	95.49
Mixed crops-livestock	34.38	39.07	50.80	48.39
total	57.42	57.13	56.56	56.64

Source: Own data processing on FADN data (2003).

Table 3.4. introduces some economic variables as average values. It would be useful to process data by type of farming in order to highlight differences between the main technical economic orientation (and this is our purpose for the next future). In any case, it is possible to notice that looking at the average values on Cultivated Areas, conventional farms' Gross Production is significantly higher than the organic ones, as the Net Margin, as the Net Product and Costs. The average values on Total Labour Force instead, shown that, even if conventional farms still have higher values than organic ones, the "distance" become shorter. That means that the two groups are

quite similar and that, even if organic farms still produce a lower "economic value", they better compensate productive factors, especially in terms of Labour Force.

Table 3.3. Organic and Conventional sub-samples: Total Labour Force (TLF) by type of farming (Technical Economic Orientation) – Averages.

	TLF - Total Labour Force			
	organic	conventional	non comp	Total
Specialist field crops	1.84	1.56	1.61	1.62
Specialist horticulture	8.73	4.19	3.09	3.16
Specialist permanent Crops	2.20	2.10	1.95	1.97
Specialist grazing livestock	2.07	1.91	2.05	2.04
Specialist granivore	6.41	8.49	2.83	3.10
Mixed cropping	3.18	2.36	1.92	2.01
Mixed livestock	2.14	1.91	2.94	2.83
Mixed crops-livestock	1.79	1.89	1.86	1.85
total	2.29	2.07	1.99	2.01
	FLF - Family Labour Force			
	organic	conventional	non comp	Total
Specialist field crops	1.07	1.01	1.03	1.03
Specialist horticulture	1.68	2.29	1.41	1.42
Specialist permanent Crops	0.97	0.99	1.01	1.01
Specialist grazing livestock	1.50	1.56	1.55	1.55
Specialist granivore	1.30	1.24	1.48	1.47
Mixed cropping	1.17	1.08	1.09	1.09
Mixed livestock	1.38	1.61	1.54	1.53
Mixed crops-livestock	1.49	1.45	1.34	1.36
total	1.20	1.21	1.19	1.19

Source: Own data processing on FADN data (2003).

Table 3.4a. Most important balance sheet elements: comparison between organic and conventional farms – Average values on Cultivated Area (CA) and on Total Labour Force (TLF) (*continue to the next page*).

	On CA - Cultivated Area			
	organic	conventional	non comp	Total
Land Capital	20,472.37	23,182.59	62,551.88	58,158.01
Exercise Capital	4,432.38	8,601.35	31,372.70	28,690.94
Machinery and Equipment power	8.55	9.89	20.79	19.54
Chartering	29.83	39.82	204.78	186.44
New Investments	416.23	866.52	13,414.65	12,036.50
Gross Production (PLV)	3,920.41	9,121.73	30,204.33	27,649.08
Variable Costs	1,647.43	4,912.72	15,526.90	14,205.56
Gross Margin (Valore Aggiunto)	2,339.59	4,294.83	13,075.27	12,022.45
Fixed Costs	1,058.57	1,959.80	5,596.38	5,155.40
Net Margin (Reddito Netto)	1,359.19	2,416.27	9,286.20	8,487.96
Net Product (Prodotto Netto)	2,175.75	3,735.36	12,894.64	11,822.29

Table 3.4b. Most important balance sheet elements: comparison between organic and conventional farms – Average values on Cultivated Area (CA) and on Total Labour Force (TLF).

On TLF – Total Labour Force

	organic	conventional	non comp	Total
Land Capital	376,629.08	340,459.52	346,628.19	347,913.85
Exercise Capital	57,497.09	49,648.91	52,398.05	52,524.82
Gross Production (PLV)	53,200.17	56,027.65	47,571.60	48,331.41
Gross Margin (Valore Aggiunto)	32,491.30	40,021.54	28,947.84	29,736.38
Net Margin (Reddito Netto)	20,756.03	29,015.86	19,339.40	19,937.83
Net Product (Prodotto Netto)	29,925.09	35,880.01	24,938.28	25,797.57

Source: Own data processing on FADN data (2003).

4. Efficiency analysis and data

Technical efficiency (TE) is defined as the measure of the ability of a firm to obtain the best production from a given set of inputs (*output-increasing oriented)*, or as a measure of the ability to use the minimum feasible amount of inputs given a level of output (*input-saving oriented*) (Greene, 1980; Atkinson and Cornwell, 1994)[11]. In case of input-oriented approach, TE represents a cost efficiency measures that reflects the degree of reduction of input use in order to obtain the same output level.

4.1 - The analytical framework

Several procedures have been proposed in literature to estimate efficiency[12]. Data Envelopment Analysis (DEA) is a *non-parametric* approach to estimate efficiency originally proposed by Charnes *et al.* (1978) and based on the Farrell's model (1957). DEA consents the estimation of efficiency in multi-output situations and without assuming *a priori* functional form for frontier production (Roland and Vassdal, 2000). Solving a linear programming problem, DEA calculates efficiency by comparing each production unit against all other units. The best practice frontier is represented by a piecewise linear envelopment surface. Therefore, TE scores arisen from DEA are invariant to technology, because obtained trough comparisons among an observation and each others and not with respect to an estimated frontier.

11 When firm operates in a constant return of scale area the two measures coincide (Fare and Lovell, 1978).

12 See Førsund et al. (1980), Bauer (1990) and Pascoe (2001) for more detailed information about the parametric techniques and their applications. A survey of applications in agriculture is shown in Battese (1992).

Several DEA methods were proposed in literature[13]. The discussion about DEA presented here is brief and it concerns the input-oriented *Constant Return of Scale* (CRS) DEA and *Variable Return of Scale* (VRS) DEA.

The CRS DEA corresponds to the original method proposed by Charnes *et al.* (1978). It is an input-oriented methodology that measures TE under constant return of scale assumption. TE is derived solving the following linear programming model (Sharma *et al*., 1999):-

$$(1) \qquad \begin{aligned} \min_{\theta,\lambda} \quad & \theta_i \\ \text{subject to} \quad & Y_i \le Y\lambda, \\ & \theta_i x_i \ge X\lambda, \\ & \lambda \ge 0 \end{aligned}$$

where θ_i is a scalar associated with the TE measure of the i^{th} DMU (Decision Making Unit that in this work is assimilable to a farm), λ is a $N\times1$ vector of weights relative to efficient DMUs, Y is the matrix of the M×N outputs and X represent the K×N input matrix.

Banker *et al.* (1984) suggested to adapting the model in order to account for a variable return of scale situation. Adding the convexity constraint $N1'\lambda = 1$, the model can be modified into VRS DEA.

A measure of scale efficiency (SE) – that reflects the role of return of scale in technical efficiency - can be arisen by comparing TE^{CRS} and TE^{VRS} scores. A possible difference in the two TE scores indicates there is scale inefficiency and it can be calculated as TE^{CRS}/TE^{VRS} ratio (Coelli, 1996). However, a shortcoming of the SE score is that it does not indicate if a farm is operating under increasing or decreasing return of scale. This is resolvable by simply imposing a *non-increasing return of scale* (NIRS) condition in the DEA model, *i.e.* changing the convexity constraint $N1'\lambda = 1$ of the DEA VRS model in to $N1'\lambda \le 1$. If TE^{NIRS} and TE^{VRS} are unequal, then farms operate under increasing return of scale (IRS); if they are equal there exists a decreasing return of scale (DRS)[14].

13 See Seiford and Thrall (1990), Charnes et al. (1994), Seiford (1996), Coelli (1996) and Herrero (2000) for a detailed illustration of DEA models.

14 Obviously, in the special case in which SE is equal to zero, a farm operates in a constant return of scale area.

4.2 - The data

Olive is a typical Mediterranean plant. In this contest only some data are illustrated as to put on evidence the importance of this cultivation and of olive oil production in the Mediterranean basin and in Italy. In the 2004/2005 more than 98% of world oil production came from Mediterranean countries (IOO, 2006). Especially, olive oil production into the European Union amounted to about 2.5Mt that corresponded to 78.2% of world production. Italy follows the Spain as the main producer in the world (29% and 32% the quote of world production for Italy and Spain respectively). In 2004 Italian land area cultivated with olive amounted to 1.2Mha (third country in the Mediterranean area after Spain and Tunisia) and the olive production was equal to 4.5Mt. In our analysis, DEA was applied on a sample of 115 organic and 114 conventional Italian olive-growing farms. The two sub-samples were selected according to the criteria described in the paragraph 2. The choice of utilizing a sample composed by an equal number of farms in the two groups was driven in order to have a substantial homogeneity between organic and traditional farms as regards structural, environmental and management aspects. This approach is a well-know procedure in these sort of studies that consists to compare "*average for groups of organic farms (…) with averages for conventional farms differentiated by region, type, size and other characteristics*" (Lampkin, 1994, p. 33). According to Offermann and Nieberg (2000) this methodology presents the advantage of minimizing risk of including external aspects ("non-system determined") that can affect results because comparability is guaranteed by the fact that organic and conventional farms show a similar "potential" endowment. Concerning the variables used in DEA, they were defined as follows: *Output* (Y) represents the value of production (in euro) by each farm; *Land* (x_1) is the total amount of UAA (in Ha) on which olive is grown; *Labour* (x_2) represents the total amount of used labour (in man-hours) used; *Machineries* (x_3) is the annual utilisation of machineries (in euro); *Capital* (x_4) is the total amount of fixed capital and it represents the value (in euro) of investment in building; *Technical inputs* (x_5) is the expenditure (in euro) on fertilizers, pesticides and other technical inputs; *Other expenditures* (x_6) is the value (in euro) of the other expenditures by each farm.

5. Empirical results

Efficiency measures carried out using the Deap 2.1 program created by Coelli (1996).

In a first step, analysis was conduct refereeing TE to a unique production frontier for organic and conventional farms, *i.e.* under the hypothesis of technological homogeneity between the two agronomic methods. In this case, efficiency measures can be directly comparable as to evaluate which technique reveals a better overall capacity in using their disposable inputs. Results indicate that, under CRS assumption, the average technical efficiency score is 0.422 for organic olive-growing farms and 0.467 for conventional farms (Table 5.1). Assuming a VRS technology the average TE amounts to 0.543 and 0.568 for organic and conventional farms respectively[15]. This difference would indicate that conventional olive-growing farmers use their inputs more efficiently than conventional ones. However, the difference between the TE^{VRS} means are not significant, implying that the two type of farmers show a similar ability in using farm resources[16]. On the contrary, scale efficiency is significantly different in conventional olive-growing's favour (0.837 vs. 0.796). This evidence suggests that the influence of farm size issue on technical inefficiency is more relevant in organic farms than in conventional ones. Adjusting the scale of the operation, organic farms could improve their efficiency by about 20%, while the margin would be 16,3%% for conventional farms. In other terms, the search for an optimal scale would become a priority particularly for organic farmers. Imposing the NIRS condition to (1), it carries out that the most of the farms exhibit an increasing return of scale in both sub-samples (93% of the organic and 90% of the conventional farms). Therefore, cost inefficiency of olive-growing farms could be reduced by exploiting economies of size in a scale increase direction. Experience suggests that a probable cause of this lack in adjusting scale could be identified in the difficulty in implementation of new technique such as organic farming, tendentially based on high-labour intensity and on low-capital

15 Under a VRS assumption, a good 17 conventional farms lie on frontier production (14,9% of the sample), while only 9 organic show a full efficiency (7,9% of the sample).

16 In a case study on Sardinian olive-growing farms, Idda *et al.* (2004) found that organic farms (TE^{VRS} = 0.676) were significantly more efficient than conventional ones (TE^{VRS} = 0.623)

intensity. As in all such innovations, the introduction of a new technique could require time in the learning of how to employ it (Nelson and Winter, 1982). As time passes, organic farms may gradually optimize their size and improve scale efficiency.

Table 5.1. Overall technical efficiency and scale efficiency from DEA

Efficiency	**TE^{CRS}**	**TE^{VRS}**	**SE**
	ORGANIC FARMS		
Mean*	0,422	0,543	0,796
s.d.	*(0,203)*	*(0,241)*	*(0,188)*
Frequency distribution (%)			
< 0.200	*9,6*	*5,2*	*0,9*
0.200 - 0.399	*45,2*	*30,4*	*3,5*
0.400 – 0.599	*28,7*	*28,9*	*7,0*
0.600 – 0.799	*11,3*	*15,6*	*33,0*
0.800 – 0.999	*1,7*	*12,1*	*52,2*
1.000	*3,5*	*7,8*	*3,5*
	CONVENTIONAL FARMS		
Mean*	0,467	0,568	0,837
s.d.	*(0,238)*	*(0,263v*	*(0,170)*
Frequency distribution (%)			
< 0.200	*5,3*	*0,9*	-
0.200 – 0.399	*45,6*	*34,2*	*2,6*
0.400 – 0.599	*26,3*	*31,6*	*9,6*
0.600 – 0.799	*11,4*	*7,9*	*21,9*
0.800 – 0.999	*2,6*	*10,5*	*57,0*
1.000	*8,8*	*14,9*	*8,8*

(*) p-values for *t*-test on difference between means: TE^{CRS} = 0.062; TE^{VRS} = 0.228; SE = 0.044)

A further critical point is to verify if organic and conventional farms operate on a substantial technological homogeneity[17]. Using a non parametric approach, refereeing efficiency analysis both to a unique reference frontier and to separate (organic and conventional) frontiers could drive to more realistic interpretation of TE. It consents to evaluate if the higher TE of conventional farms is originated by a best input use or by a higher productivity. Due to this methodological opportunity, in a second step we estimated separately organic and conventional TE using specific observations at the reference group. In this way we can obtain a productivity measure both for the two groups as the ratio of TE relative to the own reference group frontier and the aggregate (overall) TE measure (Oude Lansink *et al.*, 2002):-

17 See Oude Lansink et al. (2002) and Madau (2006) for more information about this point.

(2) $\varphi = TE_o / TE_g$

where φ is the productivity factor indicating the difference between the organic and conventional frontiers, TE_g is the technical efficiency for each farm refereed to the specific sub-group frontier (organic or conventional) and TE_o is the efficiency for each farm refereed to the overall group. If the difference between the specific φ measures is sensitive, it means that the two techniques operate on a different technological ground (no technological homogeneity). Results of (2) are reported in Table 5.2.

Table 5.2. Specific (group) technical and scale efficiency and productivity from DEA

Efficiency	**TE^{CRS}**	**TE^{VRS}**	**SE**
	ORGANIC FARMS		
Mean*	0,589	0,709	0,829
s.d.	*(0,244)*	*(0,228)*	*(0,193)*
Productivity (φ)	0,716	0,766	
	CONVENTIONAL FARMS		
Mean*	0,473	0,581	0,833
s.d.	*(0,238)*	*(0,270)*	*(0,178)*
Productivity (φ)	0,988	0,977	

(*) p-values for *t*-test on difference between means: TE^{CRS} = 1.56E-04; TE^{VRS} = 7.63E-05; SE = 0.422)

Empirical findings show that organic farms are using a less productivity technology than conventional farms (0.766 vs. 0.977 with the DEA VRS model for organic and conventional farms respectively). On the contrary, the estimated specific TE indicate that organic olive-growers are sensitively more efficient (0.709) than conventional ones (0.581), relative to their own frontier technology.

Since, overall TE is not significantly different between the two olive-growing techniques, it implies that the organic farmers are able to compensate for their technical disadvantage – *i.e.* less productivity - with higher (specific) efficiency in input use. In other terms, the organic farmers substantially achieve a similar overall TE with respect to the conventional ones due to a more rationale use of their own inputs rather than from a more productivity.

These results would seem surprising, were it not for the fact that this pattern stands out in other study on organic farming efficiency (Tzouvelekas *et al.*, 2001a; 2002a and 2002b; Oude Lansink *et al.*, 2002)[18]. According to Tzouvelekas *et al.*, 2001a, the rationale underlining for olive-growing farms is that producer's belief that productivity in organic farming is not elevated could force them to pay more attention in input use, such as to over-make up them for the productivity deficit. Furthermore, the higher specific efficiency seen in organic olive-growing could be a logical consequence of the fact that farmers under consideration were producers who had knowingly and actively chosen the organic method. They, therefore, have the right technical and professional skill for using efficiently the technical inputs. On the other hand, although the organic farms observed show more efficiency than the conventional ones, their overall efficiency is effectively not completely satisfactory. This would suggest that there exist ample margin for the increasing of managerial and technical skills as to improve performance in organic olive-growing in order to compensate adequately the gap (with respect to conventional practice) in terms of productivity.

6. Conclusions

Recent developments in agriculture have stirred up interest in the concept of "sustainable" farming systems. Still it is difficult to determine the extent to which certain agricultural practices can be considered sustainable or not. Aiming at identifying the necessary attributes with respect to sustainability, this paper focused on estimating "distance" between organic and conventional farming in Italy. Firstly, through the analysis of some key economic variables, a sample of organic and conventional farms, collected from the Italian FADN data base, have been analysed in order to highlight some of the main structural and economic differences. Secondly, it has been applied an efficiency analysis on a sample of olive-growing farms in order to estimate which technique reveals greater efficiency and productivity levels. What emerges from this study is that organic farms are

18 Other studies – *e.g.* the analyses of Tzouvelekas *et al.* 2001b on cotton farms and Madau (2006) on Italian cereal farms – found that organic farming does not reach to compensate the less productivity with a more efficiency in their inputs using.

mostly concentrated in the south of Italy and that they are wider than conventional ones in terms of cultivated areas, on average, at national level (regional results may lead to different results because of their peculiar characteristics). The economic variables analysed show that the average values on Cultivated Areas, conventional farms' Gross Production is significantly higher than the organic ones, as the Net Margin, as the Net Product and Costs. The average values on Total Labour Force instead, show that, even if conventional farms still have higher values than organic ones, the "distance" become shorter. That means that the two groups are quite similar and that, even if organic farms still produce a lower "economic value", they better compensate productive factors, especially in terms of Labour Force.

With regards to efficiency analysis on olive-growing farms, we found that: 1) organic farmers reveal a specific a greater technical efficiency than conventional ones; 2) it is substantially sufficient to compensate the less productivity of organic farms with respect to the conventional farms; 3) the role of scale inefficiency is more relevant in organic olive-growing farms than in the conventional ones.

This study represents only a partial contribution and that the results cannot lead to generalization. More empirical research needs to be done to provide further information on the "distance" between organic and conventional farming with respect the whole agricultural system. Prior research with FADN Italian data have shown that an established group of organic farms can be as profitable as a conventional farms under certain circumstances (Scardera, Trione, 2003). However, organic farming systems require a transition period before they are fully established after a changeover from conventional farming (conversion period). This aspect have not been yet analysed, but it is on our purpose to develop further analysis in order to better understand some of the main mechanisms that characterized organic farms acting in the global market.

REFERENCES

Atkinson, S.E., Cornwell, C. (1994). Estimation of Output and Input Technical Efficiency Using a Flexible Functional Form and Panel Data, *International Economic Review* 35: 245-255.

Banker R.D., Charnes A., Cooper, W.W. (1984). Some Models for Estimating Technical and Scale Inefficiency in Data Envelopment Analysis, *Management Science* 30: 1078-1092.

Battese G. (1992). Frontier Production Functions and Technical Efficiency: A Survey of Empirical Applications, *Agricultural Economics* 7: 185-208

Bauer, P.W. (1990). Recent Developments in Econometric Estimation of Frontiers, *Journal of Econometrics* 46: 39-56.

Carillo F., Doria P., Marino D., Scardera A. (2005). *Struttura e risultati economici delle aziende biologiche: un'analisi tipologica attraverso l'utilizzo della banca dati RICA*, INEA, Roma.

Charnes A., Cooper W.W., Rhodes E. (1978). Measuring the Efficiency of Decision Making Units, *European Journal of Operational Research,* Vol. 2: 429-444

Charnes A., Cooper W.W., Seiford L.M. (1994), *Data Envelopment Analysis: Theory, Methodology and Application*, Dordrecht, Boston e Londra, Kluwer Academics.

Cichitelli G., Herzel A., Montanari G. E. (1992). *Il campionamento statistico*, Il Mulino, Bologna.

Cisilino F. (2003). *L'analisi della rappresentatività del campione RICA nel periodo 1990-2000* in INEA. *Analisi comparativa delle fonti statistiche e ricognizione delle procedure di rilevazione delle statistiche agricole*, Rapporto RICA, INEA, Regione Veneto.

Cisilino F. (2005) *La rappresentatività dei dati campionari: criteri e metodi di* in INEA. *La rete contabile agricola nazionale RICA: da rete di assistenza tecnica a fonte statistica*, Quaderni "I metodi Rica" WP INEA, Roma.

Cisilino F. (2005). *Il campione RICA probabilistico: che cosa è cambiato nel 2003* in INEA. *La rete contabile agricola nazionale RICA: da rete di assistenza tecnica a fonte statistica*, Quaderni "I metodi Rica" WP INEA, Roma.

Coelli T. (1996). *A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer) Program*, CEPA Working Paper 96/8, Armidale, University of New England.

Doria P., Scardera A. (2005). *The FADN and the Analysis of Organic Farming: the Italian Perspective*, in *Towards a European Framework for Organic Market Information*. Proceedings of the Second EISfOM European Seminar, Brussels, November 10 & 11, 2005. Research Institute of Organic Agriculture FiBL, Frick, Switzerland. http://orgprints.org

Färe, R., Lovell, C.A.K. (1978). Measuring the Technical Efficiency of Production. *Journal of Economic Theory* 19: 150-162.

Farrell M.J. (1957). The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society*, A 120 part 3: 253-290.

Førsund F.R., Lovell C.A.K., Schmidt P. (1980). A Survey of Frontier Production Functions and of their Relationship to Efficiency Measurement, *Journal of Econometrics* 13: 5-25.

Greene W.H. (1980). On the Estimation of a Flexible Frontier Production Model, *Journal of Econometrics*, 13: 101-115.

Hamm U., Zanoli R. (2006) *The need for a long-term strategy for data collection on organic markets.* Paper presented at Joint Organic Congress, Odense, Denmark, May 30-31, 2006.

Herrero I. (2000). DEA: A Review of Some of the Main Papers. In Pascoe S., Fousakis P., Herrero I., Juliussen V., Mardle S., Roland B.E., Vassdal T. (eds.). Technical Efficiency in EU Fisheries: Methodological Report. TEMEC Working Paper I, University of Portsmouth.

Idda L., Furesi R., Madau F.A., Rubino C. (2004). *L'olivicoltura in Sardegna. Aspetti economici e prospettive alla luce di un'analisi aziendale*. Quaderni di Economia e Politica Agraria n. 2 della Sezione di Economia e Politica Agraria (Università di Sassari), Sassari, Tipografia Editrice Giovanni Gallizzi.

IOO (2006): http://www.internationaloliveoil.org/economics2.asp (December 21, 2006)

Lampkin N. (2005). *EISFOM recommendations concerning farm financial data* in *Towards a European Framework for Organic Market Information*. Proceedings of the Second EISfOM European Seminar, Brussels, November 10 & 11, 2005. Research Institute of Organic Agriculture FiBL, Frick, Switzerland.

Lampkin N.H. (1994). *Researching Organic Farming Systems.*, in Lampkin N.H., Padel S. (a cura di). *The Economics of Organic Farming. An International Perspective*. Wallingford: CAB International.

Lee H., Fowler S. (2002). *A critique of methodologies for the comparison of organic and conventional farming systems* in Powell et al. (eds), UK Organic Research 2002: Proceedings of the COR Conference, 26-28 March 2002, Aberystwyth, pp. 281-284.

Madau F.A. (2006). Technical Efficiency in Organic Farming: Evidence from Italian Cereal Farms, Agricultural Economics Review 7 (forthcoming)

Marino D., Scardera A. (1998). *Struttura e risultati economici delle aziende biologiche della RICA*, in Santucci F.M. (editor). *L'agricoltura biologica tra PAC e mercato*, Quaderni dell'Istituto di Economia Politica Agraria di Perugina, n. 25, Perugina.

Meier B. (2005). *Organic Sampling and Weighting in Farm Accountancy Data Networks – a discussion note on Standard Gross Margins and calibration* in *Towards a European Framework for Organic Market Information*. Proceedings of the Second EISfOM European Seminar, Brussels, November 10 & 11, 2005. Research Institute of Organic Agriculture FiBL, Frick, Switzerland.

MIPAF (2006). http://www.politicheagricole.it/ProdottiQualita/ProdottiBiologici/default.htm

Nelson R.R., Winter S.G. (1982). The Schumpterian Trade-off Revisited. *American Economic Review* 72: 114-132.

Nieberg H., Offermann F. (2003) *Economic aspects of Organic Farming – The Profitability of Organic Farming in Europe* in OECD (eds.) *Organic Agrculture: Sustainability, Markets and Policies*: 141-151,

Offermann F. (2004). *Comparing organic and conventional farm incomes in FADN – Issues in international harmonisation and quality assurance*, Proceedings 1st EISFOM Seminar 26-27 April 2004, Berlin.

Offermann F., Lampkin N. (2005) *Organic Farming in FADNs – Comparison Issues and Analysis,* in *Towards a European Framework for Organic Market Information*. Proceedings of the Second EISfOM European Seminar, Brussels, November 10 & 11, 2005. Research Institute of Organic Agriculture FiBL, Frick, Switzerland.

Offermann F., Nieberg H. (a cura di) (2000). *Economic Performance of Organic Farms in Europe*. Organic Farming in Europe. Economics and Policy, Volume 5. Hohenheim, Universität Hohenheim.

Oude Lansink A., Pietola K., Backman S. (2002). Efficiency and Productivity of Conventional and Organic Farms in Finland 1994-1997, *European Review of Agricultural Economics* 29: 51-65.

Pascoe, S., Fousakis, P., Herrero, I., Juliussen, V., Mardle, S., Roland, B.E., Vassdal, T. (eds.). *Technical Efficiency in EU Fisheries: Methodological Report*, TEMEC Working Paper I, University of Portsmouth.

Pietola K.S., Oude Lansink A. (2001). Farmer Response to Policies Promoting Organic Farming Technologies in Finland. European Review of Agricultural Economics 28: 1-15.

Recke G.; Willer H.; Lampkin N., Vaughan A. (2004). *Development of a European Information System for Organic Markets - Improving the Scope and Quality of Statistical Data.* Proceedings of the 1st EISfOM European Seminar, held in Berlin, Germany, 26-27 April, 2004. FiBL-Report. Research Institute of Organic Agriculture (FiBL), CH-Frick. http://orgprints.org

Richter T. (2006). *The need for a European harmonised data collection on private organic consumption – methodological and economic issues*. Paper presented at Joint Organic Congress, Odense, Denmark, May 30-31, 2006. http://orgprints.org

Rippin M.; Vitulano S., Zanoli R., Lampkin N. (2006). *Synthesis and final recommendations on the development of a European Information System for Organic Markets*, Deliverable D6 of the European Project EISfOM QLK5-2002-02400. Report, Institute of Rural Sciences, University of Wales. http://orgprints.org

Rippin M.; Willer H.; Lampkin N., Vaughan A. (2006). *Towards a European Framework for Organic Market Information.* Proceedings of the Second EISfOM European Seminar, Brussels, November 10 & 11, 2005. Research Institute of Organic Agriculture FiBL, Frick, Switzerland Eds. http://orgprints.org

Roland B.E., Vassdal T. (2000): *Estimation of Technical Efficiency using DEA*, in Pascoe S., Fousakis P., Herrero I., Juliussen V., Mardle S., Roland B.E., Vassdal T. (a cura di): *Technical Efficiency in EU Fisheries: Methodological Report*, TEMEC Working Paper I, University of Portsmouth.

Scardera A., Trione S. (2003). *Struttura e risultati economici delle aziende biologiche con allevamento – analisi della banca dati 2000*, WP n.1, Research Project *La zootecnia biologica in Italia: situazioni attuali e prospettive. Tipologie d'imprese, trasformaizioni necessarie e possibili, incentivi pubblici e di mercato, domanda di ricerca*, Ministero delle Politiche Agricole e Forestali, Roma.

Scardera A., Zanoli R. (eds.) (2002). *L'agricoltura biologica in Italia, Metodologie di analisi e risultati dell'utilizzo dei dati RICA*", INEA, Quaderni "I metodi RICA", Roma.

Seiford L.M (1996). Data Envelopment Analysis: The Evolution of the State of the Art (1978-1995). *Journal of Productivity Analysis* 7: 99-138.

Seiford L.M., Thrall R.M. (1990). Recent Developments in DEA. *Journal of Econometrics* 46: 7-38.

Sharma K.R. - Leung P. - Zaleski H. (1999). Technical, Allocative and Economic Efficiency in Swine Production in Hawaii: a Comparison of Parametric and Non Parametric Approaches. *Agricultural Economics*, 20: 23-35.

Tzouvelekas V., Pantzios C.J., Fotopoulos C. (2001a). Technical Efficiency of Alternative Farming Systems: the Case of Greek Organic and Conventional Olive-growing Farms, *Food Policy* 26: 549-569.

Tzouvelekas V., Pantzios C.J., Fotopoulos C. (2001b). Economic Efficiency in Organic Farming: Evidence From Cotton Farms in Viotia, Greece, *Journal of Agricultural & Applied Economics* 33: 35-48.

Tzouvelekas V., Pantzios C.J., Fotopoulos C. (2002a). Measuring Multiple and Single Factor Technical Efficiency in Organic Farming*, British Food Journal* 104: 591-609.

Tzouvelekas V., Pantzios C.J., Fotopoulos C. (2002b). Empirical Evidence of Technical Efficiency Levels in Greek Organic and Conventional Farms, *Agricultural Economics Review* 3: 49-60.

Vrolijk H. C. J. (2005). *Sampling of organic farms in the Dutch FADN: Lessons learned* in *Towards a European Framework for Organic Market Information*. Proceedings of the Second EISfOM European Seminar, Brussels, November 10 & 11, 2005. Research Institute of Organic Agriculture FiBL, Frick, Switzerland.