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Evaluating the Organic Measure of a Mediterranean Region Rural Development Plan

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Abstract. This paper attempts to evaluate the organic measure of the Rural Development Plan (RDP) in Campania, a Mediterranean region in Southern Italy. To do so, several criteria were considered: economic, environmental, and public expenses feasibility. As these criteria are conflicting, given that it is not simultaneously possible to achieve the optimal level of each, a multicriteria approach was adopted so as to reach the best compromise solution among the Pareto efficient ones. The results indicate that the RDP in Campania would be more efficient under two conditions: first, re-allocating financial subsidies more specifically on the basis of real environmental farm performance; and second, operating a horizontal and vertical integration of the organic sector.

Keywords: Rural Development Plan, Organic Farming, Multicriteria Approach, Environmental Impact.

1. Introduction

The European Union (EU) has shown a growing interest over the last decade in reducing negative externalities of agricultural production. EU Regulation 2078/92 was the first step taken by the EU to a more sustainable type of agriculture. With the introduction of Agenda 2000, that pattern has been confirmed. The regions, by means of a Rural Development Regional Plan, are free to sustain economically those farmers who voluntarily choose organic farming procedures over others.

This paper attempts to evaluate the organic measure of the Rural Development Plan in a Mediterranean Region (the Campania region, located in Southern Italy) where organic agriculture represents a growing sector both for production and handling agents/personnel as well as for distribution agents. The evaluation was performed taking into account three different criteria: economic, environmental, and public expenses feasibility. As these criteria are conflicting, in the sense that it is not simultaneously possible to achieve the optimal level of each, a multicriteria approach was adopted to reach the best compromise solution among the Pareto efficient ones.

Data used for the empirical model were directly collected by interviewing a representative sample of farms. An *ad hoc* questionnaire was submitted in order to collect both economic and technical information on conventional and organic farming systems.

The farm sample was selected by ISTAT (Italian Central Institute of Statistics – agricultural census year 2000) and by INEA (National Institute of Agricultural Economics - Farm Accountancy Data Network collection) starting from the data drawn from the last General

Census of Agriculture (2000) [1]. The sample was selected starting from the whole population of the Campania farms without making any *a priori* distinction between those using organic and those using conventional agriculture.

Subsequently, an analysis and evaluation of different scenarios and policy tools related to the organic production sector was made by means of the "Delphi" method. The scenarios were subjected to a multicriteria evaluation, as stated earlier.

This information was then used for selected simulations and for verifying under what technological and economic conditions, and for which type of farm it may be profitable to convert to organic; lastly, the degree to which the regional Rural Development Plan lines up with the stated objectives was evaluated.

2. A brief look at the organic farming worldwide and in Campania

Organic farming can be defined as an approach to agriculture, other than a production method, where the aim is to create integrated, human, environmentally sustainable agricultural production systems. Organic agriculture is strictly regulated by governments and worldwide organizations. This sets out strict requirements which must be met before agricultural products may be marketed as organic.

In order to better understand the results of this research, it is worthwhile to briefly describe the European Union (EU) organic agriculture context in which the Campania farms sample was operating when interviewed.

Organic farming is practiced in approximately 100 countries of the world and the area under organic management is continually growing.

According to the SOEL-Survey (February 2003), almost 23 million hectares are managed organically worldwide. Currently, the major part of this area is located in Australia (10,5 million hectares), Argentina (3,2 million hectares) and Italy (more than 1,2 million hectares) (Figure 1).

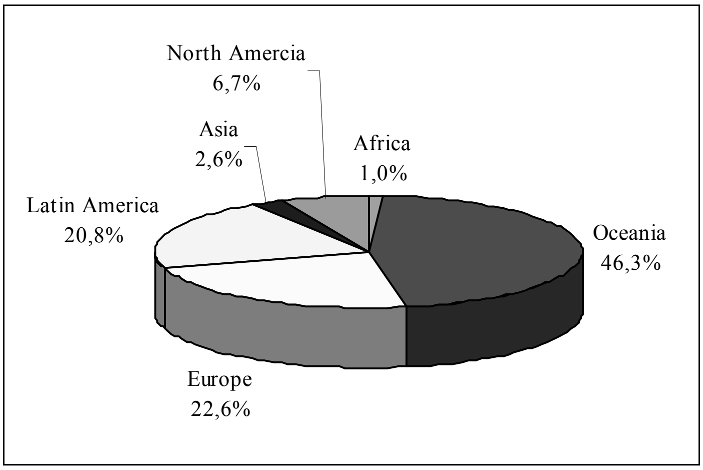

Figure 1. Total area under organic management – Share for each continent (Source[2])

In Australia/Oceania about 10,6 million hectares and 2.400 farms are under organic management: this is the largest area in the world. Australia/Oceania holds 46 percent of the world's organic land, followed by Europe (23 percent) and Latin America (21 percent).

However, most of the organic land area in this region is extensive grazing land. So, it can be stated that the most relevant organic market and production area is the European Union (EU).

According to the Swiss Research Institute of Organic Agriculture (FIBL), by the end of 2001 in the 15 EU countries, 4.442.875 hectares were managed organically by 142.348 farms. This constitutes 3,24 percent of the EU agricultural area and 2,04 percent of EU farms.

If the accession countries (Bulgaria, Estonia, Latvia, Lithuania, Malta, Poland, Romania, Slovenia, Slovakia, Czech Republic, Hungary, Cyprus), the EFTA countries (Iceland, Liechtenstein, Norway, Switzerland), and Turkey, Bosnia-Herzegovina, Croatia and Yugoslavia are included, the number of farms becomes 175,816 and the land under organic management totals 5.152.455 hectares.

As for the European market of organic foods, there has been considerable growth in Europe in recent years. Currently almost half of all organic products worldwide are sold in Europe. There is no sign yet of an end to this increase; however competition between the countries of Europe is growing.

The main drivers of this steady market growth are the commitment of many retail chains as well as favorable policy conditions.

Several EU regulations under Agenda 2000 constitute the reform of the Common Agricultural Policy (CAP) of the European Union for the period 2000 to 2006. With the Rural Development Regulation (No. 1257/99) it is possible to support organic farming with subsidies in various ways: agro-environment programs, investment aid, marketing aid, and regional development and demonstration farms. Payment rates differ substantially from country to country.

The accomplishment of the Regional Planning for organic agriculture in Campania contributed to the determination, in the last years, of a strong increase in the number of farms producing through this method (Figure 2).

Figure 2. European and Italian maps with an indication of the Italian regions

According to the data recorded by the regional statistics office, the organic farms increased from 376 in 1997 to 1.752 in 2001. In Figures 3 and 4, the geographical distribution of number of farms and Utilized Agricultural Area (UAA) in the year 2001 for any of the Campania provinces is reported. Salerno is the province where the organic method is most widespread. In fact, both the organic UAA (about 5.400 hectares) and the number of farms (663) represent 38% of the respective regional totals. In this province, olive is the main crop, followed by fodder and cereals. Vegetables present an unexpressed potential, in spite of the national market evolution which has had a massive increase in the demand of fresh organic vegetable and fruit [3].

In the province of Avellino there are 590 organic farms. The main crop is chestnuts. On a regional scale, they represent 34%, with an organic UAA of about 4.800 hectares. With regard to olives, vines, fresh fruit and horticulture, the use of organic methods is less frequent [4].

In the province of Benevento there are 181 organic farms with a UAA of about 1.600 hectares. In this province the most widespread cultivation are cereals and forages while olives and vines are still far from being cultivated as organic [5].

Finally, there are the provinces of Naples and Caserta. In the first the organic farms are 77, distributed on a UAA of about 300 hectares. It is interesting to point out the wide diffusion of organic production methods for olives and citrus fruits in the Penisola Sorrentina. In the second, instead, there are 241 organic producers, with a UAA of about 2.500 hectares. Particularly widespread here is the chestnut, encouraged by some incentives provided by previous agro-environmental measures (Reg. EEC 2078/92). In both provinces, the surface intended for vegetables and fruits is remarkable [6].

Particularly interesting is the comparison between the distribution of arable land among the various kinds of cultivation in 2001 and 2003. The most important thing to consider is that there are two kinds of cultivation that take the biggest share: dried fruit and olives. At a certain distance, but with considerable land, there are fodder and cereals and at the end, with a marginal role, there are all the other kinds of cultivation. Compared to the previous two years, the oil chain apparently loses its centrality and is substituted, in terms of surface, by dried fruit that includes chestnuts, hazelnuts and walnuts.

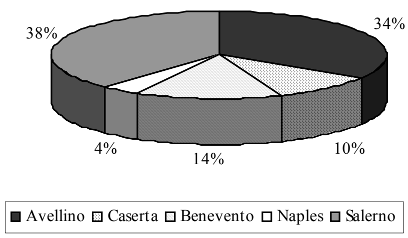

Figure 3. Distribution of organic farms per province

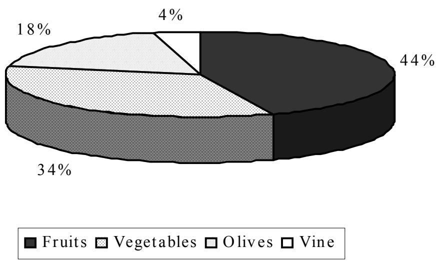

Figure 4. Distribution of organic UAA in Campania per crops

3. Actual tools of Common Agricultural Policy

Public support plays a particularly significant role for many farms. For this reason, we believe it is important to outline the objectives of regional policies regarding the agricultural sector as well as some details on the amount of payment for each crop.

As for traditional agriculture, payments provided by the policies supporting agricultural markets established by AGENDA 2000 were considered.

As for organic agriculture the contribution outlined in "Measure F", Action A2 "Organic Agriculture", in the Campania Rural Development Plan was taken into account.

Among the policies supporting agriculture, we are going to analyse the Common Market Organization (CMO) concerning those cultivations included in our sample: CMO- for seeding, CMO- olive oil, CMO- transformed fruits and vegetables, CMO- tobacco (Table 1).

Table 1. CMO subsidies per crop

Crop	Oats	Durum Wheat	Maize	Olive	Tomato	Tobacco
Subsidy	63 €/t	63 €/t + 344.5 €/ha	63 €/t	132,25 €/q oil	3,41 €/q	326 €/q dry product

The government of common support for corn is based on direct payments per hectare, which are annual and differentiated on a regional scale. This management provides a starting amount (63 €/t) to be multiplied for the average return of corn (expressed in t/ha) within the production area where the farm applying for subsidy is located [7].

In the 1998/1999 seeding campaign (1999/2000 commercialization campaign) the reform regarding the support management for durum wheat came into effect (Reg. EEC no. 2309/97). This amendment provides for the granting of an extra aid (344,50 €/ha), reserved to those farms located in old production areas, and it is to be added to the aid per hectare received in the context of the more general CMO aid for corn [7].

The CMO olive oil is under transitory administration since the 1998/1999 campaign. Recently, thanks to Reg. EEC 1513/2001, the European Commission extended this system till the end of the 2003/2004 campaign. The aid to this kind of production (132.25 €/q.le of oil) contributes to forming a fair income for producers, allotted in accordance with the quantity of oil actually produced.

The system in support of modified fruit and vegetable based products provides an aid to tomato production paid to producer organizations, whose final beneficiaries are the agricultural producers. This aid is defined in accordance with the weight of the raw materials, aside from the final product which will be obtained (3.41 €/q.le).

As for the CMO tobacco, it helps producers that are subordinated to a cultivation contract between the farmer and the transforming firm. The assistance consists of a fixed part, a changeable one – between 35% and 45% of the total aid calculated in accordance with the variety of the product – and a specific one. With regard to our sample of farms, this aid amounts to 326 €/q.le of dried product, considering the variety and the yield within the area in which the farm is located.

When considering the introduction of the organic production system, we have taken into consideration the integration provided for by the 2000/2006 Campania RDP. The latter pursues two main priorities: local development and natural resources. "Measure F", Agri-environmental Measures, is included only in the latter and it is oriented to reducing chemical inputs in agriculture. "Measure F" provides for the payment of a premium to those farmers who voluntarily convert to production methods compatible with environmental guardianship. Such a premium is given annually for the whole committment period.

Agri-environmental measures group actions in support of the production methods compatible with environment guardianship and the preservation of natural resources. The implementation of these actions implies the adoption of specific techniques: Action 1 "Integrated Farming", and Action 2 "Organic Farming". As for organic and integrated farming, the Campania region has allocated, for the year 2003, the amount of € 20,480,000.

At present, it is not possible to distinguish the amounts destined for the two actions (organic and integrated agriculture) as it will be done successively, that is when payments are delivered. In order to reach the application of the agro-environmental measure, the regional territory was divided into three systems. In the enclosure to the DRP, there is a list of the towns belonging to every single system. As we consider the conversion to the organic technique, we are going to focus here on Action 2. The latter pursues the objective of stimulating the use of cultivation methods which eliminate the usage of synthetic chemical substances through the introduction or the keeping of organic production systems as defined in Reg. EEC 2092/91 and successive modifications and integrations. An additional objective is the increase in the number of organic farms in order to satisfy the growing demand of organic products from the market. In Table 2, contributions provided for by the Campania DPR for the cultivations present in our sample are reported.

Table 2. Subsidies of the Rural Development Plan for Campania per crop (values in €/ha)

Crop	Oats	Durum Wheat	Maize	Olives	Cauliflower	Lettuce	Peach	Vines	Strawberry	Hazelnut	Apricot
Subsidy	182	182	182	525** 582***	542	542	900* 813***	834	600	813	900

* System 1; ** System 2; *** System 3.

4. Sampling technique and structural features of farms

The performance evaluation of organic agricultural producers in Campania was done by analysing the characteristics and the economic results obtained by some representative farms, under the assumption that in the same farm either the traditional or organic process can be performed. One of the aims of this work is to value the current EU organic policy in terms of intervention efficiency. For this reason, we selected a sample of farms within the whole population of farms in Campania, without making any *a priori* distinction between traditional and organic agriculture.

The basic idea is to verify under which technological and economic condition and for which type of farm it can be profitable to convert to organic, and to what extent the Campania RDP lines up with the stated objectives. It seemed evident that the only indictable choice was to start from conventional farms, so as to suppose a firm decisional scenerios, in consideration of the organic supporting policies in force, under the present and more likely technical expectations resulting from the conversion, and under the current market conditions.

The procedure followed led to the creation of farm models through the definition, on the one hand, of the set of equipment (such as land and working capital, family and extra-family work) and, on the other hand, the production technologies used in any scenerio. We supposed that, when converting to organic agriculture, land capital and availability of family work should remain stationary while the equipment, such as machinery and agricultural tools as well as extra-family work, should vary in accordance to the technical needs resulting the conversion.

First of all, we individualize farm categories that most widely represent the regional production pattern. In order to individuate the representative agricultural systems, we referred to the theoretical sample, elaborated by ISTAT during the selection of the sample for collecting farms for the Farm Accountancy Data Network (FADN) in 2003. ISTAT drew a random sample among all the farms collected during the 2000 agricultural census. The only tie set by the ISTAT is that they must represent the five provinces in Campania.

The ISTAT classification provides for typological features and presents a group aggregation of the farms in any province. These groups are defined in accordance with the type of farming (TF) and the economic size (ESU) (Table 3).

Table 3. Sample of farms per European Size Unit and Type of Farming[7]
(RAS studies are bordered)

	ESU classes				
TF	<4	4 - 16	16 - 40	>40	**Total**
Specialist cereals, oilseed and protein crops	17	10	4	1	**32**
General field cropping and mixed cropping	62	63	15	16	**156**
Specialist horticulture	15	29	28	95	**167**
Specialist vineyards	13	12	2	1	**28**
Specialist fruit and citrus fruit	37	63	16	19	**135**
Specialist olives	49	14	4	1	**68**
Various permanent crops combined	34	33	4	9	**80**
Specialist dairying	5	34	19	54	**112**
Specialist cattle-rearing and fattening	4	4	2	0	**10**
Cattle-dairying, rearing and fattening combined	1	3	1	1	**6**
Sheep, goats and other grazing livestock	10	14	3	1	**28**
Specialist granivores	5	3	1	3	**12**
Mixed cropping	37	19	5	9	**70**
Mixed livestock	1	7	1	0	**9**
Field crops grazing livestock combined	3	12	8	2	**25**
Various crops and livestock combined		1		1	**2**
Mixed livestock granivores with various livestock	1			0	**1**
Total	**294**	**321**	**113**	**213**	**941**

ISTAT, 2000

Those farms belonging to a certain typology, identified by the "TF" parameters and "ESU" classes, within the same province, have been considered homogeneous not only for the same type and the economic size defined within the same period, but also for the set of equipment and the production technologies. Among the ISTAT selected typologies, we have excluded those "TF" with livestock breedings (from the "TF" n°. 41 to 90). This was for two reasons: 1) organic livestock is not included in the RDP; 2) the possible alternative techniques for organic livestock are not clear enough, since the community regulation regarding this subject is very recent.

We have individuatlised for any province, the more relevant typologies and linked them to a representative agricultural system (RAS). We chose this method in order to cover as much regional UAA as possible. We excluded those "RAS" whose average "ESU", resulting from the

FADN data, was less than 2. As a consequence, the number of typologies, chosen for any province, varies in relation to the production diversification degree of agriculture.

In order to go back from the sample to all the selected farms, we have calculated the weight of the single "RAS" as a percentage of the farms within the single systems on the total of the ISTAT-INEA sample farms. By applying these percentages to the number of farms in Campania (ISTAT, 2000), we obtained the number of farms classified per "TF" and "ESU" (Table 4). The UAA of the representative systems as well as the cultivations in the single "RAS" have been classified by using the FADN data bank of the past three available years (from 1999 to 2001).

Table 4. Number of farms in Campania per TF and ESU[7] (Total farms in Campania are 248,931, RAS studies are bordered)

TF	ESU classes				
	<4	4-16	16-40	>40	**Total**
Specialist cereals, oilseed and protein crops	4,497	**2,645**	1,058	265	**8,465**
General field cropping and mixed cropping	**16,401**	**16,666**	3,968	4,233	**41,268**
Specialist horticulture	3,968	**7,672**	**7,407**	**25,131**	**44,178**
Specialist vineyards	3,439	3,174	529	265	**7,407**
Specialist fruit and citrus fruit	**9,788**	**16,666**	4,233	5,026	**35,713**
Specialist olives	**12,962**	3,704	1,058	**265**	**17,989**
Various permanent crops combined	**8,994**	**8,730**	1,058	2,381	**21,163**
Specialist dairying	1,323	8,994	5,026	14,285	**29,628**
Specialist cattle-rearing and fattening	1,058	1,058	529	-	**2,645**
Cattle-dairying, rearing and fattening combined	265	794	265	265	**1,587**
Sheep, goats and other grazing livestock	2,645	3,704	794	265	**7,407**
Specialist granivores	1,323	794	265	794	**3,174**
Mixed cropping	9,788	5,026	1,323	2,381	**18,518**
Mixed livestock	265	1,852	265	-	**2,381**
Field crops grazing livestock combined	794	3,174	2,116	529	**6,613**
Various crops and livestock combined	-	265	-	265	**529**
Mixed livestock granivores with various livestock	265	-	-	-	**265**
Total	**77,774**	**84,917**	**29,893**	**56,347**	**248,931**

Our elaborations on ISTAT, 2000

Furthermore, this data bank provided the necessary information to define a preliminary hypothesis concerning the issue of other farm factors such as machinery dimension and availability of family work, as well as land production destination. Since the FADN farms number per class of "TF"/"ESU" is sometimes reduced, the hypothesis of a "RAS", defined in accordance with this information, was then verified by interviewing some experts in every area. The number of farms, some structural features and the productive layout of the farms is indicated in Table 5.

Once the information regarding the "RAS" was defined, a direct interview at 50 farms was carried out in order to collect the farmy family's characteristics as well as the more frequent agricultural structures within the areas under study. Moreover, some detailed information about the cultivation techniques used was collected. Data undergone experts' judgment either to verify the information collected or to set alternative cultivation techniques. The "RAS" so obtained do not identify real farms, but are rather a mock creation, either in terms of factors involved in the production process or of production technologies. This supposition was done, as stated earlier, by using statistical information (ISTAT, INEA, FADN) integrated by the field questionnaire and some experts' interviews.

Table 5. Features of 12 RAS studied

Farm Code	ESU classes	Province	TF	Attitude	UAA (Ha)	Crops (Ha)	LU
AV12_416	4-16	AV	(12) Specialist cereals, oilseed and protein crops	steep	17.7	durum wheat (8,85), oats (8,85)	1.5
CE14_4	<4	CE	(14) General field cropping and mixed cropping	plain	2.75	oats (0,76), maize (1,68), tomato (0,31)	1
BN14_416	4-16	BN	(14) General field cropping and mixed cropping	slightly steep	4.97	durum wheat (1,06), maize (0,75), tomato (0,92), tobacco (1,67), olives (0,57)	1.4
SA20_40	>40	SA	(20) Specialist horticulture	plain	3.63	tomato (0,32), peach (0,37), broccoli (0,49), cauliflower (0,49), fennel (0,65), lettuce (0,65), strawberry (0,66)	1.7
CE20_1640	16-40	CE	(20) Specialist horticulture	plain	0.62	tomato (0,21), fennel (0,2), lettuce (0,21)	1.3
NA20_416	4-16	NA	(20) Specialist horticulture	plain	0.5	tomato (0,11), prickly lettuce (0,15), lettuce (0,24)	0.8
CE32_4	<4	CE	(32) Specialist vineyards	plain	0.93	peach (0,21), apricot (0,72)	0.8
SA32_416	4-16	SA	(32) Specialist vineyards	slightly steep	3.08	peach (1,45), apricot (1,08), hazelnut (0,55)	1
SA33_4	<4	SA	(33) Specialist olives	slightly steep	2.01	olives (2,01)	1.1
BN33_40	>40	BN	(33) Specialist olives	steep	4.02	olives (4,02)	1.7
BN34_4	<4	BN	(34) Specialist fruit and citrus fruit	slightly steep	1.33	olives (0,98), vines (0,35)	1
AV34_416	4-16	AV	(34) Specialist fruit and citrus fruit	steep	4.64	olives (1,88), vines (2,19), hazelnut (0,57)	1.3

5. Method of analysis and results

The method of analysis used was based on a multicriteria approach. Three different criteria were taken into account for evaluating the Campania Rural Development Plan organic measure: economic, environmental and public expenses feasibility. A multicriteria approach was needed because the three criteria involved are conflicting, in the sense that it is not possible to simultaneously achieve the optimal level of each. The general structure of our multicriteria model can be summarized by the following scheme (Figure 5):

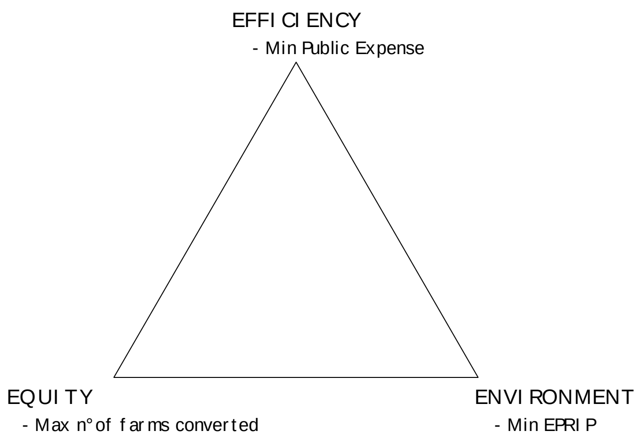

Figure 5. General structure of the multicriteria model

The three objectives above can be considered as attributes of the decision makers' utility function:

U = U(Max Farm Net Revenue, Min Environmental Impact, Min Public Expense).

Maximum utility comes from the simultaneous achievement of the maximum possible utility obtained from each of the criteria of the utility function. Of course, some degree of trade-off between each of the criteria in the utility function will occur. Therefore, a multiple-criteria optimization framework is necessary which allows for choice among different objectives. The trade-off made will depend upon the policy makers preferences.

In order to reach the optimal level of each of the objective taken into account a mixed integer programming model was built[8]:

Optimal $Z = f(Obj_1, Obj_2, Obj_3)$

where Obj_1 (*Max* Farm Net Revenue) is

$$\underset{x}{MAX} \quad TFNR = \sum_i \sum_j FNR_{i,j} * X_{i,j} \quad \forall i, j$$

where *TFNR* is Total Farm Net Revenue; *FNR* is the Farm Net Revenue per each RAS (*i*) and each state of production (*j* is either conventional or organic); and *X* is hectares of production.

Obj_2 (Min Environmental Impact) is:

$$\underset{x}{MIN} \quad TIMP = \sum_i \sum_j IMP_{i,j} * X_{i,j} \quad \forall i, j$$

where *TIMP* is Total Environmental Impact; *IMP* is the Environmental Impact per each RAS (*i*) and each state of production (*j* is either conventional or organic).

Obj_3 (Min Public Expense) is:

$$\underset{x}{MIN} \quad TEXPENSE = \sum_i \sum_j EXPENSE_{i,j} * X_{i,j} \quad \forall i, j$$

where *TEXPENSE* is Total Public Expense for organic production; *EXPENSE* is the Public Expense for organic production per each RAS (*i*). In this model the vector of public expense for conventional farms is nil.

Each objective was solved separately to reach an optimal solution for each criterion considered. They were subject to the following constrains:

$$\sum_i \sum_j \left(a_{kij} \cdot X_{ij}\right) \le b_k \tag{1}$$

$$0 = \sum_i \sum_j X_{ij} - M \cdot Y_j \tag{2}$$

$$1 \ge \sum_j Y_j \tag{3}$$

$$X_{ij} \ge 0$$
$$Y_j = 0 \, or \, 1 \tag{4}$$

where equation 1 represents the k technical coefficient constraints, while equations 2 to 4 serve to make the model choose between conventional or organic production. a^{ij} represents the technical coefficient of the k^{th} resource available; b_k indicates the available amount of the k^{th} resource; M is a sufficiently large scalar; in this case M is land available per each RAS; Y_j indicates a binary variable indexed on the "conventional or organic" set.

Once the model was run optimising each criterion, a set of optimal but conflicting solution was found. In this context a multi-objective approach was implemented to help choose among set of efficient solutions. Such methodology allows to reach the best compromise solutions, instead of the "best" solution, among those Pareto efficient. Compromise Programming[9] choices among solutions with reference to an ideal point which is determined by the optimal values of separate objectives as calculated above. An ideal solution would include the optimal level of each objective.

Since the ideal point is unfeasible by construction, the optimal element, or compromise solution, is given by the efficient solution closest to the ideal point, as measured by Zeleny's Axiom of Choice[10]. Because conflicting objectives make an ideal unfeasible, a compromise solution must be sought from the efficient or compromise set that is in some sense the closest to the ideal[11]. These distances are measured using various metrics and different weights to indicate the relative importance of each objective.

Compromise solutions are found by calculating the distances between each solution and the ideal point. The degree of proximity d_j, between the j^{th} objective and its ideal, is given by:

$$d_j = Z_j^* - Z_j(x)$$

if the j^{th} objective is being maximized, or

$$d_j = Z_j(x) - Z_j^*$$

if the j^th objective is being minimized where Z_j^* denotes the ideal value of the given objective. The degrees of proximity between the different objectives and the ideal values are then added in a composite distance function.

Since the units of measure of different objectives are quite often different, it is necessary to normalize the degrees of proximity in order to facilitate comparisons across objectives. This problem can be resolved by using relative rather than absolute deviations. The degree of proximity is given by:

$$d_j = \frac{\left|Z_j^* - Z_j(\underline{x})\right|}{\left|Z_j^* - Z_{*j}\right|}$$

where Z^*_j is the nadir (or anti-ideal) point for the j^{th} objective. The normalized degree of proximity varies from 0 to 1; therefore, when an objective reaches its ideal the degree of proximity is zero, while it is 1 when an objective reaches its anti-ideal.

The normalized degree of proximity can also be considered as a measure of the percentage of attainment of an objective with reference to its ideal value.

To measure the distance between every solution and its ideal point, the following family of distance metrics, labelled L_p, may be used:

$$L_P(w) = \left[\sum_{j=1}^{n} w_j^P \left| \frac{Z_j^* - Z_j(\underline{x})}{Z_j^* - Z_{*j}} \right|^P \right]^{1/P}$$

that is equivalent to:

$$L_P(w) = \left[\sum_{j=1}^{n} \left(w_j \cdot d_j \right)^P \right]^{1/P}$$

where w_j weighs the importance of the discrepancy between the j^{th} objective and the ideal point. In other words, w_j measures the relative importance of the j^{th} objective in a given situation of choice.

In order to choose the best compromise solution, the family of distance functions can be applied to a set of alternative efficient and feasible solutions. In this way, the alternative with the smallest value for $L_P(w)$ will be the best compromise solution among the ones available, for selected values of the parameters P and w. Parameter P can be considered as a weight of the deviations according with their magnitude. Likewise, w_j becomes the weight for different deviations which indicates the relative importance of the objectives. For different values of P and wj different compromise solutions may be chosen. When three objectives are considered, only L_1, L_2 and L_{inf}=L_3 metrics can be used to calculate the best compromise point among the ones in the compromise set[12].

5.1 The economic criterion

For economic criterion, the maximization of net farm revenue was intended in each of the RAS taken into account. Since it was not possible to associate a specific value to land, and family and entrepreneur labour, the farm net revenue remunerates these three factors (Farm Net Revenue – FNR). FNR was calculated per RAS in the sample under the hypothesis of conventional and, alternatively, organic production technology. Then, a comparison of the two alternative economic performances was performed. In order to calculate the economic results of the selected RAS and, then, to perform the following simulations, the Bilagro[1] software was utilized. It implements the classical calculation method of the farm revenue[13]. The only specification needed is the farm economic performance index involved. As stated before, FNR remunerates land value, family and entrepreneur labour. It was calculated by subtracting the opportunity capital cost to the farm net income. For details concerning the costs and returns and the economic results of the single RAS see Table 6. Per hectare FNR was calculated to compare the economic results among the selected RAS in order to avoid economic size distortions.

Two scenarios were considered for the economic criterion: one took into account the actual subsidies for organic production, while the second hypothesised that no subsidies were available for organic producers. The latter simulates a scenario where public expense is allocated along the organic chain and marketing organization, rather than on supporting organic production. In this way we attempt to verify how crucial public subsidies are in terms of the decision to produce organic instead of conventionally farmed food.

[1] This is a software for calculating farm revenue and was built by the Center for Advanced Education in Economics Policy for Rural Development within the context of a Multiregional Operative Program, titled “Supporting activity to the development facilities for agriculture” Measure 2. Details on the software specification and “MOP” are available at http://www.depa.unina.it/ProgettoPom/ProgettoPom.html.

As a very first scenario, a premium price for organic food was taken into account. Premium prices vary among products. They were collected in market places for the whole set of crops produced in the sample of farms. Thanks to the questionnaires and some experts' judgements, different yields for different crops located in different geographical areas were also taken into account.

Table 6. Economic results of RAS per productive structure

Farm Code	System	UAA	(+) productive activity total revenue	(+) Subsidies/ quantity	(+) Subsidies/ha (CMO)	(+) Org Subsidies (RDP)	*(+) total subsidies*	**(+) Value of total outputs**	(-) total specific costs	(-) other costs	**(-) value of total intermediate costs**	***Net Cash Receipt***	(-) Capital depreciation	***Net Farm Income***	(-) opportunity capitals cost	**Farm Net Revenue**
BN33_40	CONV	4.02	20,100	5,306			*5,306*	**25,406**	3,247	250	**3,497**	***21,909***	3,575	***18,334***	1,887	**16,448**
	ORG		*24,120*	*5,306*		*2,340*	*7,646*	***31,766***	*3,277*	*678*	***3,955***	***27,811***	*3,415*	***24,396***	*1,103*	***23,293***
BN33_4	CONV	1.33	9,335	462			*462*	**9,797**	1,594	-	**1,594**	***8,203***	4,476	***3,727***	1,795	**1,932**
	ORG		*9,436*	*416*		*1,021*	*1,437*	***10,873***	*1,066*	*460*	***1,526***	***9,347***	*4,476*	***4,871***	*1,779*	***3,092***
SA33_4	CONV	2.01	8,040	2,653			*2,653*	**10,693**	1,655	-	**1,655**	***9,039***	3,888	***5,150***	1,561	**3,590**
	ORG		*8,683*	*2,388*		*1,055*	*3,443*	***12,126***	*1,750*	*428*	***2,178***	***9,949***	*3,415*	***6,534***	*1,080*	***5,454***
SA32_416	CONV	3.08	27,361	-			-	**27,361**	2,025	500	**2,525**	***24,836***	4,943	***19,893***	1,737	**18,156**
	ORG		*32,292*	-		*2,349*	*2,349*	***34,641***	*1,322*	*991*	***2,313***	***32,328***	*4,943*	***27,385***	*1,727*	***25,658***
SA20_40	CONV	3.66	27,539	1,091			*1,091*	**28,630**	12,073	500	**12,573**	***16,057***	6,368	***9,689***	2,042	**7,647**
	ORG		*41,197*	*818*		*1,374*	*2,192*	***43,390***	*11,972*	*1,116*	***13,088***	***30,302***	*6,368*	***23,934***	*2,040*	***21,895***
AV12_416	CONV	17.07	7,597	-	5,964		*5,964*	**13,561**	7,158	250	**7,408**	***6,152***	6,285	***- 133***	1,953	**- 2,086**
	ORG		*8,178*	-	*5,964*	*3,107*	*9,071*	***17,248***	*7,084*	*710*	***7,794***	***9,454***	*5,368*	***4,086***	*1,742*	***2,344***
AV34_416	CONV	4.65	35,268	2,482			*2,482*	**37,750**	3,371	250	**3,621**	***34,129***	5,220	***28,909***	2,886	**26,024**
	ORG		*38,828*	*2,482*		*3,232*	*5,714*	***44,542***	*3,684*	*741*	***4,425***	***40,117***	*5,220*	***34,897***	*2,893*	***32,005***
CE32_4	CONV	0.93	8,044	-			-	**8,044**	651	250	**901**	***7,143***	1,987	***5,156***	627	**4,529**
	ORG		*10,284*	-		*837*	*837*	***11,121***	*423*	*710*	***1,133***	***9,988***	*1,987*	***8,002***	*624*	***7,378***
CE20_1640	CONV	0.62	4,586	716			*716*	**5,302**	1,393	250	**1,643**	***3,659***	2,329	***1,329***	601	**728**
	ORG		*5,190*	*537*		*114*	*651*	***5,841***	*1,435*	*741*	***2,176***	***3,665***	*2,329*	***1,336***	*602*	***734***
NA20_416	CONV	0.5	5,165	375			*375*	**5,540**	1,449	250	**1,699**	***3,841***	3,140	***701***	938	**- 237**
	ORG		*6,678*	*281*		*130*	*411*	***7,089***	*1,373*	*741*	***2,114***	***4,976***	*3,140*	***1,836***	*937*	***899***
BN14_416	CONV	5.17	9,884	10,967	899		*11,866*	**21,750**	6,308	500	**6,808**	***14,942***	6,538	***8,405***	2,138	**6,266**
	ORG		*10,085*	*9,019*	*899*	*698*	*10,615*	***20,700***	*6,289*	*1,053*	***7,342***	***13,358***	*6,538*	***6,820***	*2,133*	***4,688***
CE14_4	CONV	2.75	4,459	1,057	1,065		*2,122*	**6,582**	2,034	500	**2,534**	***4,048***	5,354	***- 1,306***	1,649	**- 2,955**
	ORG		*4,531*	*793*	*1,065*	*444*	*2,302*	***6,833***	*2,373*	*991*	***3,364***	***3,469***	*5,354*	***- 1,885***	*1,654*	***- 3,538***

Results of the first simulation (FNR per hectare with organic subsidies) are reported in Figure 6. In this first scenario organic production proves to be more convenient than the conventional counterpart for 10 over the 12 RAS considered. Organic does not result convenient for small and medium sized RAS cereals located in Caserta and Benevento (CE14_4 and BN14_416). These RAS are characterized by a small ESU. In both RAS crops cultivated are tomato, tobacco, olive, corn, and durum wheat. The first two crops do not receive any subsidy for being produced as organic. Income loss for passing by conventional to organic production would be significant[2]. A yield loss brings not only a lower income due to a lower quantity of product sold, but also a lower subsidy due to the fact that conventional aids are linked to quantity produced. Premium price for crops like tomato and tobacco is not enough to compensate yield loss and lack of subsidy.

For the remaining RAS, organic production seems to be more convenient than conventional farming. In more detail, diverse permanent cultivation in the province of Avellino (AV34_416) increases its FNR by 23%, while specialized horticulture in the province of Naples (NA20_416) and Salerno (SA20_40) increases FNR respectively to 212.3 and 186%. Particularly interesting is the result obtained by the RAS NA20_416 whose conventional FNR was negative while the organic was significantly positive. Moreover, for both RAS producing horticulture, premium price for strawberry (+252%) is able to compensate yield losses due to other crops like fennel, broccoli, and tomato.

For the rest of the RAS, the organic technique is more convenient than the conventional, albeit a more modest increase in the FNR. Crops cultivated in these RAS are mainly cereals and olives,

[2] Yield losses for these crops are: -25% for tomatoes ; -15,4% for tobacco; -10% for olives; -10% for corn; and –20% durum wheat.

and are located on hilly areas often referred to as "marginal". The overall FNR calculated is 126,063 euro.

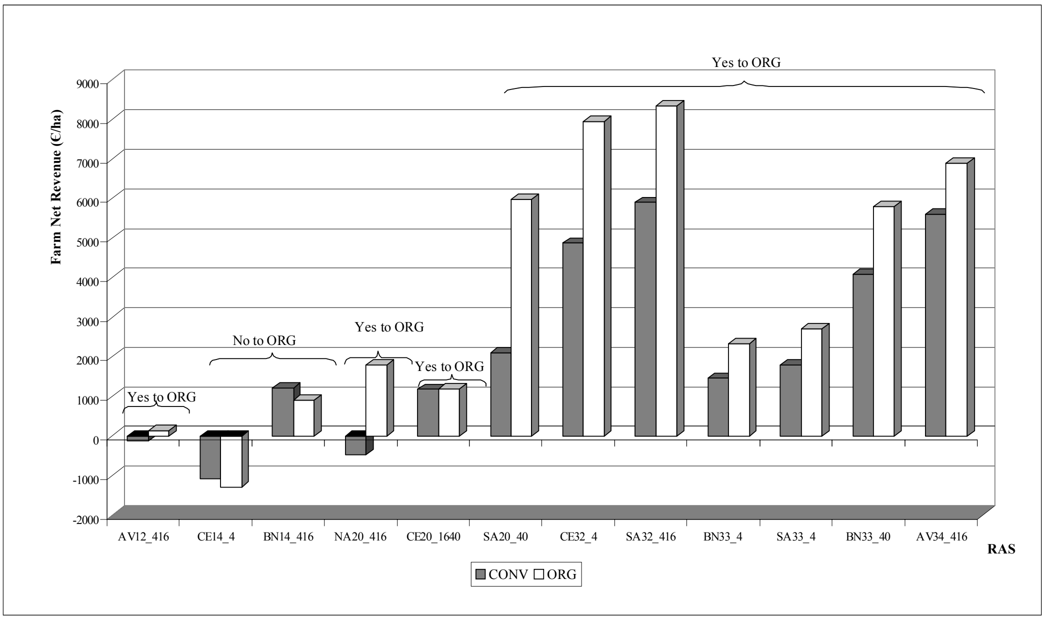

Figure 6. Comparison of conventional and organic farm net revenue per hectare in the scenario "with organic subsidies"

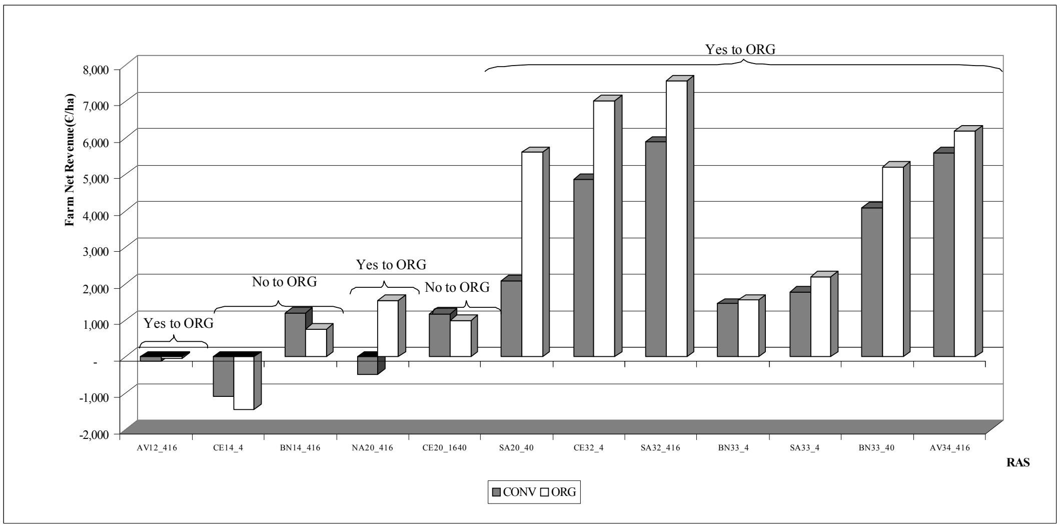

Figure 7. Comparison of conventional and organic farm net revenue per hectare in the scenario "without organic subsidies"

Economic results in the second scenarios (without organic public subsidy) are reported in Figure 7. They confirm the precedent scenario results. Where the incidence of the Campania RDP was higher, the convenience to convert to organic production is lower. In all the cases under study, premium prices seem to be more effective than public subsidy. In fact, for one RAS found is convenient to produce conventionally without subsidies (CE20_1640), while for all the others, premium prices, or the market, assure some extra return and therefore quite a strong convenience in producing organic over conventional (Figure 8).

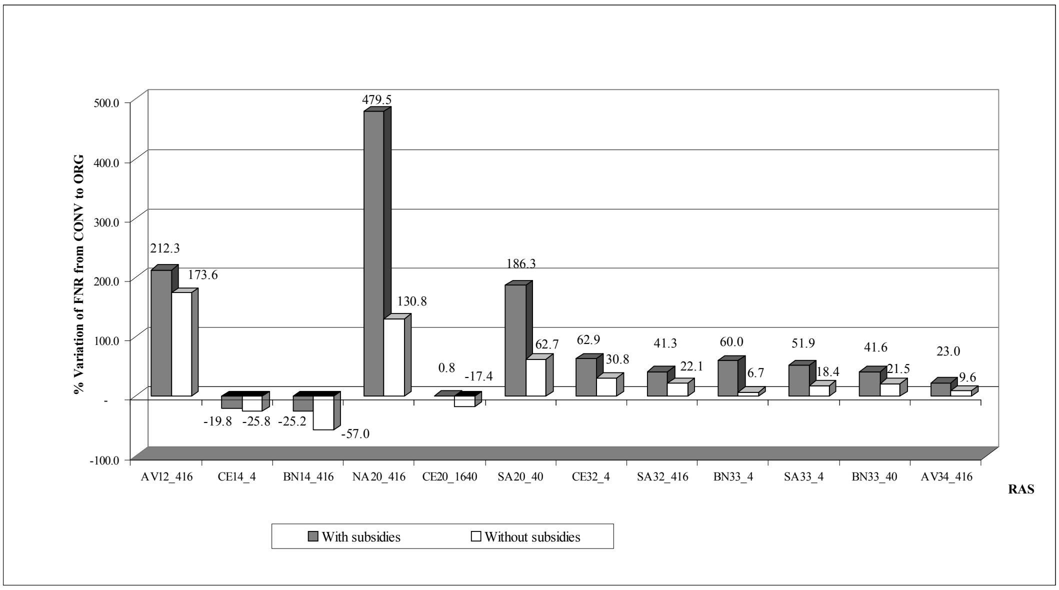

Figure 8. Percentage variation of FNR passing from conventional to organic, for both scenarios.

5.2 The environmental criterion

For the environmental criterion an indicator was taken into account. Literature on environmental indicators is quite widespread[14][15][16][17]. Among others we decided to use a site specific indicator that takes into account the potential environmental risk of using pesticides. The indicator implemented was built up during the CAPER project in 1999[18] by a group of researcher at the Università della Cattolica di Piacenza (Italy). EPRIP (Environmental Potential Risk Indicator for Pesticides) considers the environmental effects of pesticides on different compartments such as: groundwater, surface water, soil, air, toxicological effects on humans, and ecotoxicological effects on aquatic and soil organisms. The purpose of EPRIP is to provide farmer advice and authority management. The methodology used by EPRIP consists of several steps. It is calculated for active ingredients. It is site-specific and takes into account potential risks for man, for earthworms in soil, for algae, crustaceans and fish in surface water by drift and runoff, and for man by volatilisation. EPRIP requires a large and detailed amount of data. Most of it is available in the literature and, when missing, expert judgement helped to fill the gaps in the data.

EPRIP allows for the calculation of an index for each active ingredient used in a process. Then, by summing up the EPRIP index for all the active ingredients used in a technique for a crop, it is possible to obtain an index for each crop cultivated as organic or conventional. The higher the EPRIP index, the higher the environmental impact. Our results, as reported in Table 7, show that conventional production has quite a higher environmental impact compared with the organic counterpart.

As expected, the objective of minimizing the environmental impact of pesticide use is satisfied producing organic for the whole set of RAS selected. In this case the overall FNR is 123,901 euro. The difference between the FNR under this objective and the one obtained by maximizing FNR is 2,162 euro (-1.715%). Such a difference is due to RAS BN14_416 and CE14_4 which are now under organic management according to the environmental impact minimization result. The overall impact so calculated is 167. Under the FNR maximization model it was 808. The two RAS that go from conventional to organic practice produce a significant amount of tomatoes which is one of the least environmentally friendly crops. However, Campania RDP does not provide any subsidy for organic tomato production.

Table 7. EPRIP per hectare, per crop and per technique

		EPRIP/ha/crop/scenario				EPRIP/ha/crop/scenario	
RAS	Crops	**CONV**	**ORG**	RAS	Crops	**CONV**	**ORG**
AV12_416	Oats	-	-	**CE20_1640**	Fennel	116	3
	Durum Wheat	33	-		Lettuce	390	12
	Farm total	**33**	**-**		Tomato	212	12
AV34_416	Hazelnut	-	-		**Farm total**	**718**	**27**
	Olives	-	-	**CE32_4**	Apricot	160	9
	Vineyards	50	4		Peach	168	9
	Farm total	**50**	**4**		**Farm total**	**328**	**18**
BN14_416	Durum Wheat	33	-	**NA20_416**	Lettuce	394	10
	Corn	107	-		Tomato	212	12
	Olives	-	-		Escarol	394	10
	Tomato	163	12		**Farm total**	**1,000**	**32**
	Tobacco	97	2	**SA20_40**	Broccoli	147	23
	Farm total	**400**	**14**		Cauliflower	198	23
BN33_40	Olives	-	-		Fennel	116	3
	Farm total	**-**	**-**		Strawberry	46	8
BN34_4	Olives	33	-		Lettuce	390	10
	Vineyards	51	4		Peach	166	9
	Farm total	**84**	**4**		Tomato	212	12
CE14_4	Oats	-	-		**Farm total**	**1,275**	**88**
	Corn	107	-	**SA32_416**	Apricot	160	9
	Tomato	309	12		Hazelnut	-	-
	Farm total	**416**	**12**		Peach	166	9
SA33_4	Olives	33	-		**Farm total**	**326**	**18**
	Farm total	**33**	**-**				

5.3 The public expense criterion

The last criterion taken into account is minimization of public expense. In this case the model was run minimizing the expense due to organic subsidy only. As expected, the total amount spent is zero, while it was 15,559 euro under FNR maximization and 16,701 euro under environmental impact minimization. Total FNR under this scenario is 110,612 euro. This loss is due to the fact that no more money is supposed to be transferred by the Region to the farms, so FNRs are consequently lower. Environmental impact is 952 because, together with the two RAS that found it more convenient to produce conventionally instead of organically (BN14_416 and CE14_4), another RAS now finds conventional production more profitable (CE16_40), with a consequent higher environmental impact. It is interesting to note that most of the RAS find organic production convenient even without any specific subsidy. One of the results is, therefore, that when a specific market for an organic product is reachable, organic production seems not to need any subsidy.

The very last run of the model was performed to verify how farms would behave when a specific organic market is not reachable or, in other words, when no premium price is taken into consideration, but subsidies for organic farmers are available. The idea underlying this scenario starts from the comparison between the results obtained and the reality observed. Results say that organic production is, in most cases, more convenient than its conventional counterpart even without public subsidies. In this case we should observe a wider number of organic farms in Campania since there is no economic reason to believe that any farm with the same characteristics of those taken as a sample should not convert to organic. What we observe is a relatively small number of organic farms. Under this last scenario the hypothesis we removed was that regarding the presence of the organic market. In fact, we considered different premium price for different crops. Those premium prices were collected in local and national organic market. However, the hypothesis that specific organic markets are reachable for any farm is not realistic. We believe that there are still many difficulties for the single farm to reach a specific organic market that guarantees a premium price. Without it, organic production is not any more profitable than its conventional counterpart. In fact, by running the model maximizing FNR but, this time, without any premium price for any crop, only 3 RAS find organic production more convenient than conventional farming (AV12_416, BN33_40, and SA33_4). All the other RAS would find conventional production more convenient. This is the scenario most farms have to face when deciding whether to convert to organic. The three RAS that find organic convenient are thought to be located in hilly areas producing mainly cereals and olives. Those conditions allow cultivation to be very close to organic since climate and soil conditions control parasites naturally. Organic farming, in this case, rationalizes the use of pesticides and other inputs so that organic becomes more convenient than conventional. In this scenario the overall FNR is lower than in the other scenarios (86,468 euro) with a higher environmental impact (2,434) but a lower public expense (6,501 euro) due, however, to a lack of demand for conversions rather than for a real convenience to produce organic without subsidies.

5.4 The multicriteria approach at work

Once the model was run optimising each criterion, a set of optimal but conflicting solutions was found. A pay-off matrix is reported in Table 8 where the main diagonal represents the "ideal" values. In the compromise programming such an ideal point is so defined, as stated before, in the sense that it would be desired, but it is not feasible.

Table 8. Pay-off matrix

Objectives	FNR	Public Expense	EPRIP
MAX FNR	**126,063**	15,559	808
Min Expense	110,612	**nill**	952
Min EPRIP	123,901	16,701	**167**

At this point the best compromise solution can be calculated by applying the formula reported at the beginning of this paragraph and selecting a weight per each criterion taken into consideration. In theory, decision makers are supposed to select, in an iterative procedure, weights for the criteria considered. Unfortunately, we were not able to interview the Campania policy makers in the proper way, so we selected three different scenarios setting the weights equally important. Then, we doubled in turn the weight for the objectives Results are reported in Table 9.

In order to compare various solutions in the compromise set, distance metrics were calculated which measure distances from the ideal point. As stated earlier, the ideal point is constructed using the maximum value of the FNR maximization, the minimum value of the public expense minimization, and the minimum value of the EPRIP index for the environmental impact minimization.

The distance metrics give a measure of the distance from feasible solution points in the compromise set to the ideal point. Three metrics, L1, L2, and Linf were employed for each of the weights assigned.

Three of the four scenarios analysed select the minimization of the environmental impact as the best compromise solution or strategy. In fact, distance metrics assume lower value with equal weights, and doubling the weight for max FNR and Min EPRIP. The only exception is when the weight on Min expense is doubled. However, the value of public expense in the Min EPRIP scenario can be massively reduced if allocated in a different way. Results of this study seem to suggest that a different allocation of public money for the organic sector may be more efficient. First, the best compromise solution says that minimizing environmental impact of pesticides is the best compromise procedure to increase number of organic farms and, at the same time, to minimise negative externalities of the agricultural sector. To do so, a more accurate strategy to subsidise organic production should be involved. For example, tomato production is one of the most environment impacting crop that, at the present in the Campania DPR, is not subsidised. We believe that a re-allocation of public expense in terms of environmental impact reduction may reduce negative externalities and at the same time save public money to be spent for horizontal and, even more importantly, vertical organic sector integration. On the other hand, if all the farms with the same characteristics of the sample would convert to organic, public funds would not be enough to cover the requests. In fact, total expense would be 133,544,435 euro. For organic agriculture, DPR measure in Campania was allocated, 20,480,000 euro in the year 2003. It is not possible at the moment to distinguish the amount destined to organic and integrate agriculture, but even if the total amount were destined to the organic sector, it would not be possible to cover the financial needs required.

Table 9. Some significant distance metrics calculations among some compromise set points and ideal points for different scenarios

	Unit of measure	*Compromise set values*			Point	
		FNR	EXPENSE	EPRIP	*Ideal*	*Nadir*
MAX FNR	*Euro*	126,063	110,612	123,901	*126,063*	*110,612*
Min Expense	*Euro*	15,559	-	16,701	-	*16,701*
Min EPRIP		808	952	167	*167*	*952*
Metrics					*Weights*	
L1		2	2.00	***1.14***	MAX FNR:	1
L2		1	1.41	***1.01***	Min Expense:	1
Linf		1	1.26	***1.00***	Min EPRIP:	1
					Weights	
L1		2	3.00	***1.28***	MAX FNR:	2
L2		1	2.24	***1.04***	Min Expense:	1
Linf		1	2.08	***1.01***	Min EPRIP:	1
					Weights	
L1		3	***2.00***	2.14	MAX FNR:	1
L2		2	***1.41***	2.00	Min Expense:	2
Linf		2	***1.26***	2.00	Min EPRIP:	1
					Weights	
L1		3	3.00	***1.14***	MAX FNR:	1
L2		2	2.23	***1.01***	Min Expense:	1
Linf		2	2.08	***1.00***	Min EPRIP:	2

6. Concluding remarks

This research allowed us to acquire the main technical and economic information regarding a group of farms located in a Mediterranean area, the Campania region, under the hypothesis of conventional and organic production systems. Such information allowed us to perform some relevant simulations to verify how the Campania Rural Development Plan organic measure lines up to its stated objectives.

Several scenarios were taken into consideration. First, the Campania RDP for the organic sector: subsidies to farms that convert to organic production systems were considered as stated in the RDP. As a second scenario, no subsidies were applied to any of the RAS of the sample.

Starting from the data selected and the result obtained at the farm level, an attempt to evaluate the Campania RDP was performed with a multicriteria procedure (Compromise Programming): farm net revenue to maximise; environmental impact to minimise; public expense to minimise. These three criteria are conflicting in the sense that it would be desirable to reach the optimal level simultaneously, but it is not feasible.

In this section some concluding remarks are stated in order to verify how efficient RDP application has been from the very beginning, taking into account that the Campania Region aims at a wider organic production base accompanied by a massive reduction of negative externalities due to the use of pesticides.

A first result is that 10 of the 12 RAS in the sample would find it convenient to produce organic rather than conventionally. This first result, as expected, confirm the evolution of the organic sector in the last 5 years.

A result, quite relevant in our opinion, is that most of the RAS selected find it convenient to produce organic even when no common subsidies are transferred from the region to the farms. Organic farming represents a strong alternative for all those agricultures suffering competition mainly because of the marginal areas where they are located. Moreover, organic farming seems to represent an efficient and optimal tool to rural development. Based on our empirical results, it seems that these objectives may be reached even without strong public financial support. In fact, the organic market is outing the niche dimension opening through an ever more efficient chain. In recent years, many agents in the agro-food system have decided to convert to organic. However, many are the difficulties those agents have to face ranging from the production to the retail channels[19]..

First of all, access to specific markets, where a premium price for organic products is guaranteed, is not a realistic hypothesis for all the farms. In Campania, there is not yet a common platform where different agents in the organic sector can meet. Moreover, consistent quantities of organic products, quality standards and an efficient working chain would be the necessary push-over to this rising sector.

Results of this work suggest that public funds, as they are spent, would not be sufficient to cover the requests of all the potential farms that find it convenient to convert to organic. Such amounts of money may be destined in a more accurate way: firstly, to those farms producing massive negative externalities, which are in most cases also surplus products in the EU, basing the financial aid allocation on environmental performance; and secondly policy tools that allow horizontal and vertical integration in order to enlarge the productive base and the formation of a common platform where supply and demand can more easily meet.

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