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Cost-benefit analysis: A comparison between conventional and organic olive growing in the Mediterranean Area

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ABSTRACT

The conversion from conventional to organic management of olive growing has many benefits, such as increase of biodiversity, reduction of soil erosion and lower environmental impact. Since olive represents a main crop in the Mediterranean area, from a social, economic as well as environmental point of view, the aim of this paper has been to determine if the conversion from conventional to organic olive growing can increase the profitability of the farmer in Sicilian farms. Economic analysis has been carried out by means of cost-benefit analysis and financial indicators (NPV, B_0/C_0, IRR) show that organic growing would allow a better profitability for organic olive farms respect to conventional ones. This is primarily due to CAP subsidy and to market price of organic olive oil, which is currently 21% higher than the conventional olive oil price.

1. Introduction

The interest shown by public opinion since the late 80s toward environmental and ecological issues has contributed to the identification of innovative technologies, with the aim of reducing environmental impact of human activities (Colantoni et al., 2014; Lanfranchi et al., 2014a; Monarca et al., 2009; Volpe et al., 2014).

Among these, an important role is played by organic farming, this is a cultivation method that produces socio-economic and environmental benefits, contributing to the sustainable development of rural areas (Chinnici et al., 2013; Mzoughi, 2014a). This is due also to the fact that consumers in last years have an increasing demand for environmentally friendly foods and toward nature based tourism (Lanfranchi et al., 2014b).

As defined by the International Federation of Organic Agriculture Movement (IFOAM, 2005), organic agriculture should be based on four general principles: (1) sustain and improve the health of soil, plants, animals, humans and the planet; (2) be based on biological cycles and systems so as to work in harmony with them, while emulating and helping them to sustain themselves; (3) be built on a set of relationships that ensure fairness with regard to the environment and life opportunities; (4) be managed in a prudent and responsible way to protect the health and welfare of present and future generations and the environment.

Conventional agricultural production, in fact, is characterized by a high input of fossil energy that is consumed directly from the farm in the form of fuel and electricity, and indirectly in the production of fertilizers, plant protection products, machinery, etc. causing high emissions of CO_2 into the atmosphere (IPCC, 2006; Kaltsas et al., 2007), conversely, the development of agricultural systems with low energy input such as organic farming helps reduce CO_2 emissions (Pimentel and Pimentel, 1996; Dalgaard et al., 2001; Hülsbergen et al., 2001; Payraudeau and van der Werf, 2005; Mohamad et al., 2014; Rodriguez-Entrena et al., 2014).

There are numerous studies that have analyzed the effects of so-called indirect external effects having as its object a reduction or mitigation of negative environmental externalities generated by conventional agriculture, elements that often evoke much interest on behalf of public opinion (reduction of pollution, soil fertility, erosion, risk of loss of biodiversity, etc.) as attested in the literature (Boatto et al., 2008; Tiezzi, 1999; Travisi and Nijkamp, 2004; Bontempi et al., 2007).

At the European level, the development of organic farming has had a strong boost from the Common Agricultural Policy (CAP), which in recent years has increasingly promoted more environmentally sound methods, trying to implement the multifunctional role of the farm, while producing socio-economic and environmental benefits and contributing to the development of rural areas (Sgroi et al., 2015a). Moreover, consumers are attracted to organic foods as they are produced without synthetic chemicals and

Abbreviations: CAP, Common Agricultural Policy; SPS, Single Payment Scheme; NPV, Net Present Value; IRR, Internal Rate of Return; GPV, Gross Production Value.

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comply with higher standards of animal welfare (Darnhofer et al., 2010 Morris and Winter, 1999).

Policies to encourage the development of organic farming in the European Union started with agri-environmental measures introduced by the MacSharry reform through the adoption of Regulation (EC) No. 2078/92. Currently agri-environmental measures are regulated by Regulation (EC) No. 1698/2005 and continue to play an important role within the second pillar of CAP through their inclusion in the 2007-2013 Rural Development Plan (RDP) of EU Regions.

Organic farming in the world, according to the latest available data (Willer and Lernould, 2014) in 2012 comprised an area of 37.5 million hectares, with an increase of 152.6% compared to the year 2000.

Italy, with 1,167,362 hectares, in 2012 represents the sixth country for organic-farming area in the world and the second in the EU. Analyzing the distribution by type of crop, we may observe that the fodder crops are cultivated on 21.8% of Italian organic-farming area, followed by cereals (18.0%) and olive trees (14.1%) (SINAB, 2014). The olive (*Olea europea* L.), in fact, is a main crop in the Mediterranean area, from a social, economic as well as environmental point of view (Guzmán and Alonso, 2008). Italian organic olive farming is widespread especially in the Southern regions, where the favorable pedo-climatic conditions favor this method of cultivation (Agnese et al., 2008; D'Asaro and Grillone, 2015; D'Asaro et al., 2014), particularly in Sicily that represents, with its 18,554 hectares, the third region for organic olive area.

Since the environmental and social benefits provided by the transition from conventional to organic management of olive groves are varied, such as increasing biodiversity and reducing the use of pesticides (Mader et al., 2002; Tuomisto et al., 2012; Meisterling et al., 2009; Roy et al., 2009; Mzoughi, 2014b), reduction of soil erosion and reduced environmental impact (Alonso et al., 2001; Beaufoy, 2002; Cárdenas et al., 2006), this paper aimed to determine the economic sustainability of organic olive growing as compared to the conventional approach. In particular, a cost-benefit analysis was performed on a conventional Sicilian olive-growing enterprise, hypothesizing its conversion to an organic farming system.

2. Materials and methods

In the present study, the economic feasibility of the introduction of an organically grown olive grove was evaluated as a replacement of a grove cultivated through conventional systems. In particular, an financial analysis was carried out in a representative case study located in the coastal area of western Sicily, by comparing costs and revenues of conventional and biological olive growing.

Considering that the data collected in this research address only the economic features without probabilistic and statistical objectives, as well as in other studies (Tudisca et al., 2015), we have chosen to analyze a representative Sicilian farm. In our analysis we took into consideration only economic aspects of costs but not the social and environmental ones as was done in other studies (Sgroi et al., 2015b).

With respect to both the conventional and organic systems, a technical-economic life of the olive-tree plant equal to 40 years was considered, with annual harvest from the fourth year on, whereas a conversion to organic olives was assumed at the fifth year.

There were three phases of this cycle: a first phase, called "plant set-up", with costs outweighing the benefits, which corresponds to the first four years, and during which costs of establishing the plant and the revenues (i.e. cash flows) relative to production at the fourth year were considered; a second phase, called the "increment" identified with the period from the fifth to eleventh year and in which revenues and production costs for each year were calculated; a third phase, called "productive", from the twelfth to the fortieth year.

The planting density was assumed to be 333 plants ha^{-1} (5.00 × 6.00 m) with an average production of olives equal to 49.95 q ha^{-1} for the conventional and 36.63 q ha^{-1} for the organic. Also, an oil yield of 18% of production was assumed, equivalent to 8.99 q ha^{-1} for the conventional with a market price of 380.00 € q^{-1}, whereas oil production amounted to 6.59 q ha^{-1} with a market price of 460 € q^{-1} for the organic. The annual revenues included the value of production (oil sales), the single payment scheme (SPS) according to Regulation (EC) No 73/2009, and, for organic farming, the subsidy on measure 214/b of the Rural Development Plan (RDP) Sicily.

All monetary costs necessary for the production cycle were calculated on a net basis (excluding taxes).

Annual costs and revenues were calculated considering the financial conditions constant for the entire period.

The present value of costs and benefits for each year was determined by financial analysis that assumed a discount rate of 5%, selected on the basis of current market conditions (Iotti and Bonazzi, 2015). From a cost-benefit analysis, the net present value (NPV), obtained by discounting to present all future net benefits (cash flow), the current benefit-cost ratio (B_0/C_0) and the internal rate of return (IRR) were calculated.

In particular, the NPV was calculated according to the formula (Keča et al., 2012):

$$\mathrm{NPV} = \sum_{k=0}^{n} \frac{C_k}{(1+r)^k} \quad (1)$$

where NPV is the net present value; C_k represents the annual cash flow obtained from the difference between revenues and annual costs; k is the time of the cash flow; n corresponds to the duration of the investment (i.e. 40 years); r is the discount rate of 5%.

Accordingly, the investment will be convenient for the farmer if the NPV is greater than zero.

The benefit-cost ratio B_0/C_0 instead highlights the benefits per unit of capital invested (Daneshvar and Kaleibar, 2010). In fact, this criterion consists in dividing the sum of the benefits (revenues) for the sum of the discounted costs (outputs), which are also discounted. If the ratio is greater than one, the project is worthwhile and, for multiple projects, the one having the highest ratio is most preferable.

The IRR is the discount rate that makes the NPV zero, formally, the IRR is the discount rate r for which the following equation is satisfied (Bonazzi and Iotti, 2014; Chabot, 1998):

$$\sum_{k=0}^{n} \frac{C_k}{(1+r)^k} = 0 \quad (2)$$

A project will therefore be acceptable, if the IRR is not lower than the predetermined reference rate (5%).

3. Results and discussion

The comparative analysis of the results obtained from the data for the two cultivation systems, conventional and organic, clearly shows an advantage with the organic farming olive cultivation system. The gross production value (GPV) of the two systems of cultivation, considering Community support, has been calculated on the basis of the three life stages of the olive cultivation (plant set-up increment and productive) (Table 1), with increases in yields from the fourth year on, and resulted, for the conventional olive grove, equal to 1,782,00 € ha^{-1} in the plant set-up phase,