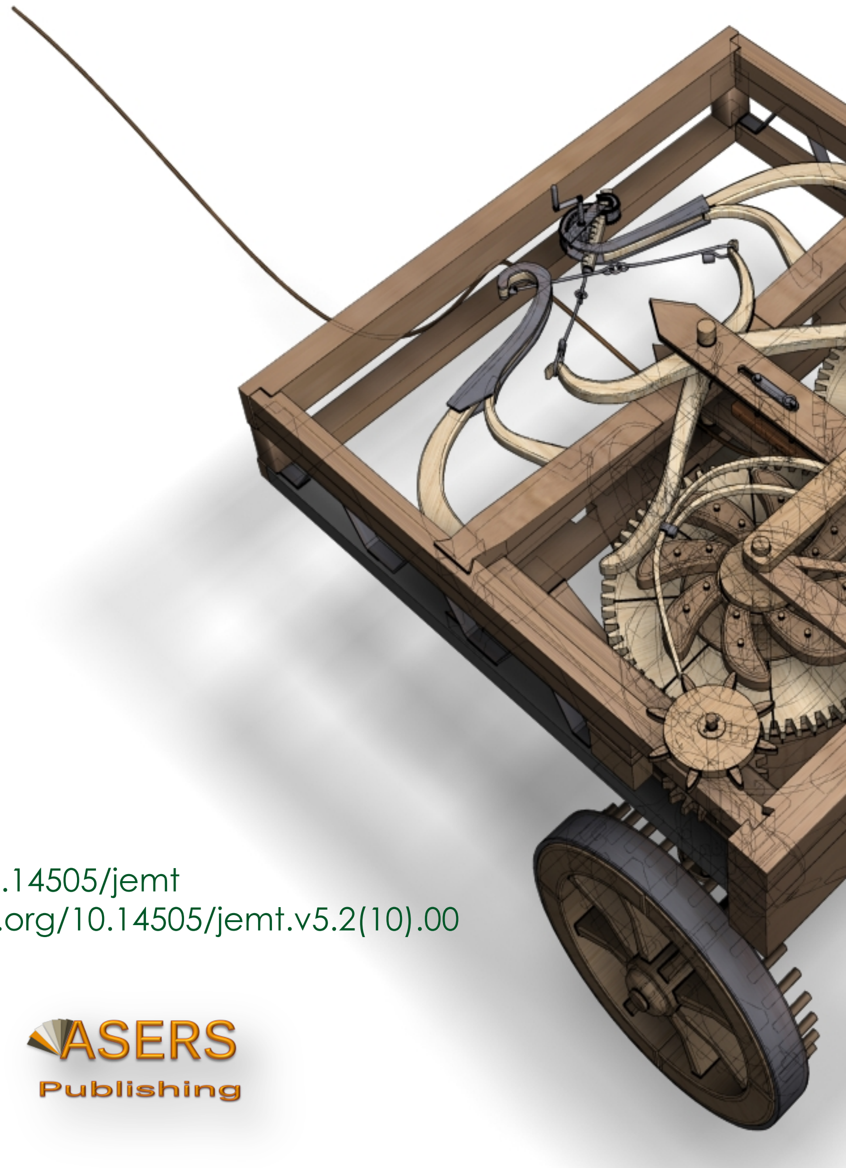
ASERS

Journal of Environmental Management and Tourism



Biannually

Volume V
Issue 2(10)
Winter 2014

ISSN 2068 – 7729
Journal **DOI:** http://dx.doi.org/10.14505/jemt
Journal's Issue **DOI:** http://dx.doi.org/10.14505/jemt.v5.2(10).00

ASERS Publishing

Winter 2014
Volume V, Issue 2(10)

ASERS Publishing
http://www.asers.eu/asers-publishing
ISSN 2068 – 7729
Journal DOI: http://dx.doi.org/10.14505/jemt

Contents:

Call for Papers
Summer_Issue 2015

Journal of Environmental Management and Tourism

Journal of Environmental Management and Tourism is a young interdisciplinary research journal, aimed to publish articles and original research papers that should contribute to the development of both experimental and theoretical nature in the field of Environmental Management and Tourism Sciences.

Journal will publish original research and seeks to cover a wide range of topics regarding environmental management and engineering, environmental management and health, environmental chemistry, environmental protection technologies (water, air, soil), pollution reduction at source and waste minimization, energy and environment, modelling, simulation and optimization for environmental protection; environmental biotechnology, environmental education and sustainable development, environmental strategies and policies, etc. This topic may include the fields indicated above, but are not limited to these.

Authors are encouraged to submit high quality, original works that discuss the latest developments in environmental management research and application with the certain scope to share experiences and research findings and to stimulate more ideas and useful insights regarding current best-practices and future directions in environmental management.

Journal of Environmental Management and Tourism is indexed in SCOPUS, RePEC, CEEOL, ProQuest, EBSCO and Cabell Directory databases.

All the papers will be first considered by the Editors for general relevance, originality and significance. If accepted for review, papers will then be subject to double blind peer review.

Deadline for submission:	30th April 2015
Expected publication date:	June 2015
Website:	www.asers.eu/journals/jemt/
E-mail:	jemt@asers.eu

To prepare your paper for submission, please see full author guidelines in the following file: JEMT_Full_Paper_Template.doc, then send it via email at jemt@asers.eu.

DOI: http://dx.doi.org/10.14505/jemt.v5.2(10).01

AGRICULTURALRESOURCES ALLOCATION AND ENVIRONMENTAL SUSTAINABILITY

Alessio Emanuele BIONDO
University of Catania, Italy
ae.biondo@unict.it
Luigi BONAVENTURA
University of Catania, Italy
lbonaventura@lex.unict.it

Suggested Citation:

Biondo, A.E., Bonaventura, L. (2014). Agricultural resources allocation and environmental sustainability, *Journal of Environmental Management and Tourism*, (Volume V, Winter), 2(10): 105-113. doi:10.14505/jemt.v5.2(10).01. Available from: http://www.asers.eu/ journals/jemt/curent-issue.

Article's History:

Received November, 2014; *Revised* November, 2014; *Accepted* December, 2014.

Abstract:

This paper shows the direct linkage existing between the environmental sustainability and the diffusion of organic agriculture. The reason is that the environmental impact of organic agriculture is different and somehow less polluting than industrial (let us say, traditional) one. Moreover, the former delivers also healthier food, according to part of the literature. Thus, seeking for sustainability, the policy-maker may find easier to influence the allocation of natural resources in favour of the organic cultivation as an instrument to care Nature. In order to claim this rationale, a model of resource allocation is presented and the golden rule derived. The paper finally shows that organic agriculture generates a global positive externality, which implicitly measures the relevance of the balancing intervention on resources allocation.

Keywords: sustainability, organic food, organic agriculture, externalities.

JEL Classification:Q18

1. Environmental sustainability and agriculture

One of the easiest direct link between Nature and the economic system refers to agricultural activities. It is true that the progress induces producers to apply industrial ingredients and techniques to the primary sector, such as technologies, processes, and factors of production but, however, the land cultivation still appears the most naturalistic way to exploit natural resources. Surprisingly, at a careful sight, one could argue that traditional agricultural techniques are far from being undoubtedly respectful of the environment. It is very difficult to define properly what sustainable agriculture is (Cobb *et al*., 1999, provide a detailed review about this issue), but it is quite simple to understand that the need for always more abundant quantities, combined to the required aesthetical beauty of agricultural products (often uncoupled with quality and taste) pushed techniques and productive processes toward dangerous conducts, such as the adoption of chemical substances that damage both products and land while are harmful for consumers. Roughly speaking, one can conclude that products from agriculture (and similar argument could be referred about livestock) are not so natural as they could appear at first sight.

Thus, the agricultural production is sometimes looked at a sort of artefact, because of the mixed adoption of heterogeneous ingredients and techniques that may differ from a, let us say, "prefect, rural and genuine portrait". This feeling has deeply contributed to the development of the organic approach to the set of agricultural activities, looking for a return to a genuine non-industrial approach to the primary sector. Relevant differences between traditional and organic products are inherent to the choice of ingredients and techniques adopted in cultivation. The International Federation of Organic Agriculture Movements defined an *organic system* (IFOAM, 2009) on the basis of its *capability to sustain the health of soil, ecosystems, and people*. The exclusive usage of completely natural ingredients, the exclusion of pesticides, chemical additives or any other industrial technique, makes (in theory) the organic production much healthier and less polluting. It is very important to notice that this paper will build upon the assumption that the definition of organic agriculture, organic products and organic food corresponds to such a portrait. This paper will not try to make a precise comparison between (actual) organic and industrial agriculture, in order to demonstrate which one is the best. Here, we will not argue analytically all of the set of chemical substances or review the processes, the conducts, and the technology adopted in the primary sector, looking for specific differences in order to quantify, by means of exact calculations or empirical data, the economic value of the difference in the environmental impact caused by both types of agricultural activity. This paper is directed exclusively to show a policy implication that may emerge clearly if the reader is aware that the organic agriculture is more sustainable than the industrial one in the sense that, however and no matter how much, the former is less polluting than the latter.

Further, the reader should understand that if an immediate benefit arising if from agriculture came just healthy food and products would be a longer and a happier social development. However, part of literature still questions the real existence of health advantages of organic food compared to industrial agriculture (see Dangour *et al.*, 2009 and 2010). Here we will not try to solve arguments like these, because a complete nutritional comparison is not possible and goes far beyond the goal of the present article. Therefore, given that it is not the main topic, we will leave this aspect as a simple intuition. Barlett (1989) noticed, however, that industrial agriculture heavily adopts processed fertilizers and technologies with greater impact, increasingly substituting human contribution or animal labour with machinery. Stolze *et al.* (2000) reported the effects of the organic agriculture in comparison with traditional cultivations one. Their results show that, in most cases and even if with great variability, the environmental impact of organic agriculture is lower than traditional ones. Following OECDs (2003) classification, the consequences of the organic agriculture on the natural capital depend on the way that biological systems interact with Nature (Shepherd et al., 2003): e.g., treatments for cultivations go to the soil, and from the latter to deeper substrates, and so on. Similarly, fruits, flowers, insects, will be involved in related consequences. Mäder *et al*. (2002) confirmed that organic agriculture is more efficient in terms of energy and other inputs, which improves soil fertility, reduces emissions, widen biodiversity, and is also safer for farmers (Pimentel *et al.*, 2005). Consistently with these results, many contributions are well focused in demonstrating adverse consequences of the traditional approach to agriculture: declining land fertility, diminishing effectiveness of chemical pesticides, increasing environmental risks for human health and Nature (see, *inter alia*, Dupraz 1997, Matson *et al*. 1997, Altieri 1998, Drinkwater *et al*. 1998, Tilman 1998, Mishra *et al*. 1999, Popp and Rudstrom 2000, Boschma *et al.*2001, Pretty *et al.* 2001, Melfou and Papanagioutou 2003).

The point here is that the sustainability characterization of the organic agriculture is somehow undeniable: the definition itself of the concept of organic product implies that its producer has to pursue production in such a way that is *per se* more sustainable than the traditional one. This creates a combination of multiple positive effects: not only does organic production provide most likely healthier food, but also it is less polluting. This means that a generalized adoption of organic agriculture would induce both higher welfare and cleaner environment, simultaneously. The reader must be aware that here we will not proceed with a deep investigation aimed to show how close the actual contemporary organic production is to this theoretical definition. We will develop our analysis by considering that the definition of organic agriculture is correct. Probably, also in some organic production some pollutant is adopted, whereas it is not correct to simply treat all of the “traditional” agricultural activities as the same (from the very extensive conventional low input farming, which is almost as environmental friendly as organic farming, to mixed farming, to very input intensive farming and even farming that uses techniques like precision farming or genetically modified plant species or both together). The point is simply that industrial agriculture is cheaper than the organic one and therefore producers prefer the former since, due to the lack of correct information, customers will buy their (apparently) cheaper goods. Referring to the informative problem behind the food choice, many surveys have been carried out, showing that consumers notions about organic quality is fundamental in motivating their choice, along with the attention to the natural system and the concern for environmental protection. As Campbell and Liepins (2001) and Dabbert *et al*. (2004) among many others, point out, organic agriculture is based upon values of sustainability, recycling, and natural welfare. These issues are particularly delicate, since it is very important to consider the question of the perceived quality of organic products in order to address proficiently the attention in terms of policy (Darrington, 1999, Reavell 1999, UNDP 2000). The amount of resources that are allocated in traditional agricultural activities cannot be instantly reallocated in organic agricultural productions, since a lot of constraints: many lock-in effects for technological investments, very strong habits, yield differentials. Part of the literature investigates the difference existing in yields from organic and industrial agriculture, see *inter alia* Badgley *et al.* (2007), De Ponti *et al.* (2012), and Seufert *et al.* (2012). Of course, if such a substitution were possible, a very high increase in environmental quality would be obtained. However, it can be said that even a partial shift toward organic processes can obtain significant results: the agricultural production would be coupled to better environmental conditions -i.e. a positive externality emerges because environmental conditions (for example in terms of land fertility and pollution reduction) are improved. In other words, the organic agriculture affects positively environmental quality and this, in turn, without taxes, permits, environmental standards, and other constraints gives rise to a positive naturalistic externality: sustainability is at work, the system is sustainable while it is profitable. Put in the perspective suggested by the European Commission (2004), organic farming ensures two positive impacts on the society: on one hand organic farming is a method for producing food products, but on the other it is known to deliver public goods, primarily environmental benefits, and also public health, social and rural development and animal welfare.

This paper provides a theoretical model to show that, given that the organic approach to the primary sector is less polluting than the industrial one, the adoption of policies that enhance the conversion of the primary sector to organic farming may obtain relevant results in terms of sustainability. In this sense it refers also to the existing debate in literature about the public support measures for organic farming (see *inter alia* Sanders *et al.*, 2011), but our model adds a theoretical perspective of the externality generation: the point is that the quality of the environment and a greater respect of natural ecosystems belong to the definition itself of organic agriculture, whereas the industrial approach cares just about economic efficiency. Thus, from a private point of view, the market fails because nobody pays for the environmental damage. From a collective perspective, the policy-maker may decide to induce a conversion in the primary sector in favour of organic procedures: this may generate a positive externality that compensate both the higher costs of cleaner agricultural productions and the lower yields in terms of better environmental quality. Moreover, even if an undeniable proof of the superiority of organic food (both in terms of nutrition and health effects in the medium-long run) is not available yet, these policies would at the end result in higher environmental quality associated to (at least) non-worse food, that means a superior social equilibrium. A theoretical model of resource exploitation is provided to show the choice between environmental care (i.e., organic agriculture) and traditional agriculture. Then, the problem is restated to derive the optimal allocation rule for natural resources. The model will show conditions for optimal use and underline the value of the aforementioned externality. The paper is structured as it follows: section two presents the model and section three concludes with some policy implications.

2. The model

Before proceeding to the model description, we have to present a couple of interpretative assumptions. First of all, our model will not discuss how to divide resources among sectors in the economy. It, instead, will take as given the amount of natural resources that the economy devotes to the primary sector, and will show how the organic production can give rise to a positive external effect that would make the entire system more sustainable. Theoretically speaking, the organic agriculture can produce as much as the traditional one, but with higher costs. Truly, in order to maintain unaltered the total amount of production, organic agriculture needs more resources than the industrial one, per unit of final good. This means that, even if it is possible to assume the total amount of natural resources that the economy devotes to the primary sector as given (e.g. the quantity of land), the overall amount of resources (i.e. including capital and labour) should be assumed as increasing if the total agricultural production has to remain constant. We will consider perfect substitutability for the allocation of natural resources within the primary sector, between organic and traditional agriculture. Thus, as long as land is distracted by the traditional agriculture and devoted to the organic one, produced output can remain the same, at higher production costs (because of other needed factors of production), and the environmental impact is reduced. A trade off then rises: the choice is reduced to the efficient allocation of natural capital between two processes within the primary sector, that is, how to mix the use of available natural resources. Two extreme positions can be imagined: either the entire available natural capital $\overline{N}$ is devoted to industrial agriculture (the traditional agriculture), or it is devoted to organic production. In both cases we can reach the same amount of produced output (even if in case of organic agriculture this is obtained with higher costs) but, as long as industrial agriculture is abandoned, a positive externality in terms of naturalistic preservation is generated. Attention will be focused on the optimal internal solution (-i.e. a mix of both) to check the externality of organic production and to evaluate it somehow. Finally, let us assume that there will not be any natural capital left unused. Building upon

Hartman (1976) and Cacho (2001), it is possible to write the net present gains obtained from Natural capital allocated to the primary sector as:

$$V = N\int_0^T o(N,t)e^{-rt}dt + (\overline{N} - N)\int_0^T a(N,t)e^{-rt}dt \qquad (1)$$

with $0 < N \leq \overline{N}$. In eq. (1), we indicated by N the amount of natural capital devoted to organic production, whose output is expressed by the function o(·), and by ($\overline{N}$ – N) the amount of natural capital devoted to traditional agriculture, whose output is the function a(·). Thus, we can write the discounted gains from organic production as $\int_0^T o(N,t)e^{-rt}dt$, whereas $\int_0^T a(N,t)e^{-rt}dt$ are the discounted gains obtained from the traditional agriculture. The maximization of eq. (1) with respect to N, gives

$$\frac{\partial V}{\partial N} = N\frac{d}{dN}\int_0^T o(N,t)e^{-rt}dt + \int_0^T o(N,t)e^{-rt}dt + (\overline{N} - N)\frac{d}{dN}\int_0^T a(N,t)e^{-rt}dt - \int_0^T a(N,t)e^{-rt}dt = 0 \qquad (2)$$

This FOC can be easily restated as:

$$N\frac{d}{dN}\int_0^T o(N,t)e^{-rt}dt + \int_0^T o(N,t)e^{-rt}dt = \int_0^T a(N,t)e^{-rt}dt - (\overline{N} - N)\frac{d}{dN}\int_0^T a(N,t)e^{-rt}dt \qquad (3)$$

that is to say that, in equilibrium, the marginal value of benefits arising from the organic agriculture (on the left) must equal the flow of benefits arising from traditional agricultural production (on the right). It is worth to notice that, in case one wants to relax the simplistic assumption of no conversion costs between organic and industrial agriculture, the eq.(3) can include them.

The allocative choice of natural capital between organic and traditional agriculture generates an externality, whose description follows. When a producer decides to adopt an organic process, resources are used in such a way that pollutes less. The reader should be aware that our model cannot demonstrate how less the organic agriculture is polluting compared to industrial one. We are simply assuming (as part of the reviewed literature shows) that organic agriculture has a lower environmental impact and, thus, preserves Nature somehow. This may enhance land fertility for future use, because it is reasonable that in a cleaner environment, the regenerative capacity of natural ecosystem itself will be able to operate more actively. It is finally worth to notice that the voided pollution is something that is unintended: it is obtained automatically as a characteristic of the process. In other words, it is a direct, spontaneous and unremunerated consequence of the production of organic output.

Therefore, at an aggregate level, the part of natural capital devoted to organic agriculture will exert its impact in terms of naturalistic care: it will improve environmental conditions and thus will induce environmental sustainability. It is useful to be precise on the economic implication of this rationale: in economic terms, market prices of organic goods are decided, as usual, by demand-supply interaction between utility-maximizing consumers and profit-maximizing firms. The choice to produce organic food, as well as the choice to buy it, is taken by market participants according to their incentives. An external effect rises due to the circumstance that the organic production generates less pollution: no market prices will pay this unintended reduction of pollution, which is automatically generated by the allocative decision. In eq. (3), its value is expressed by the last term on the right hand side, *i.e.* $(\overline{N} - N)\frac{d}{dN}\int_0^T a(N,t)e^{-rt}dt$.

This external impact represents a trade-off: when environmental care is not sufficient, an increase in the N share improves the total economic value because it makes the environment cleaner, adding prospective value in terms of higher productivity of land; alternatively, when the quality of the environment is good enough, a further resource allocation in organic production would result in a revenue smaller than the cost of reducing its possible alternative industrial agriculture use. Along with these two phases the sign will change and, therefore, the externality can assume either a positive or a negative value: it depends on the marginal value of organic production per unit of natural resources devoted to it. In other words, when nature is degraded, the additional devotion of resources to the organic production induces environmental care and, in turn, causes an increase in the productivity of land and in environmental conditions. In this case, the sign of the externality is positive. When the naturalistic equilibrium has been restored, additional environmental care has no actual effect on land productivity and Nature status, and the externality is equal to zero. Finally, an excess in the devotion of resources to organic production could not improve environmental quality (and productivity of land) above a certain threshold, and therefore, the marginal revenues from organic agriculture will not be sufficient to compensate the marginal loss from the opportunity cost of the cheaper industrial agricultural goods left unproduced. In this case, the externality will be negative.

2.1 The golden rule

We now proceed to build the optimal allocation rule. Consider, at first, the monetary benefit flow arising from traditional agriculture. It is a net profit, which results from the following:

$$a(N,t) = (p^a - c^a)q^a(\cdot) \tag{4}$$

where p^a is the final market price of the traditional agricultural output, c^a the cost, and $q^a(\cdot)$ the produced quantity. Secondly, let us define the same flow referred to the organic production:

$$o(N,t) = (p^o - c^o)q^o(\cdot) \tag{5}$$

Both *a*(N, t) and *o*(N, t) are functions of time by means of the time-specific condition of the environment. More precisely, $q^a(\cdot)$ and $q^o(\cdot)$ are monotonic concave production functions of the amount of resources allocated to their respective sector, and the environmental degradation affects the productivity of those resources. We will simply hypothesize that degradation is a quantitative variable, which means that the more the resources are depleted, the lower their productivity and the smaller the usable quantity for both productions in the subsequent periods. This depletion law is not influenced in the same way by both sectors because the organic production contributes to the regeneration of resources as explained before. Thus, the degradation of nature (R) varies in time according to:

$$\dot{R} = \lambda_1 q^a - \lambda_2 q^o \tag{6}$$

with $\lambda_1 > \lambda_2$ and $\lambda_1, \lambda_2 \in (0,1)$. Following the simplest approach, we do not consider pollution explicitly. We simply state that the traditional agriculture causes degradation equal to the λ_1-share of its produced quantity, whereas the organic agriculture recovers an amount of resources equal to the λ_2-share of its produced quantity (which can eventually be considered the net result of the positive effects after production withdrawal). This type of simplification allows us to determine that the total amount of resources devoted to agricultural sector ($\bar{N}$) can be divided between both productions, is a part of total natural capital (NK) net of the degradation:

$$\bar{N} = NK - R \tag{7}$$

Of course, once $\bar{N}$ has been determined, N-share is allocated to the organic production (o), and ($\bar{N}$ – N)-share is allocated to the traditional agriculture. Ultimately, this problem is configured as an optimal control problem: the functional in eq. (1) to be maximized can be conveniently expressed as

$$W = N\int_0^T (p^o - c^o)q^o(N)e^{-rt}dt + (\bar{N} - N)\int_0^T (p^a - c^a)q^a(\bar{N} - N)e^{-rt}dt \tag{8}$$

with $0 < N \leq \bar{N}$, as before. Now, we consider that the policy-maker chooses N period by period without being influenced continuously by the dynamics of the state variable $\dot{R}$ in this choice. This assumption should appear acceptable because the policy-maker chooses the environmental policy when the effects of what is being decided are still unknown and, however, not fully shown. Therefore the temporal effectiveness of environmental decisions is not actually measurable and thus the policy-makers are blinded by the time interactions of his own policies: the presumed direction of consequences can just be inferred. Therefore, the time derivative of the co-state variable of the problem is zero (i.e. $\dot{\mu}(t) = 0$). Sometimes the system is perturbed by rules or regulations established in international conferences or by international standards as discrete variables that interfere with the equilibrium of the system. These characteristics, however, will be neglected here and will be analysed in further research. Here, we simply need to find the optimal value that in each period, independently of other periods, maximizes eq. (8) subject to the joint constraint that represents the dynamic evolution of degradation and the balance of natural capital. This can be obtained by rewriting eq. (6) taking in account the eq. (7) and by expressing $q^a(\cdot)$ and $q^o(\cdot)$ with their arguments (allocated resources):

$$\dot{R} = \lambda_1 q^a (NK - R - N) - \lambda_2 q^o (N) \tag{9}$$

The accessory conditions are about initial values of the state variable and the terminal time (finite):

$$R(0) = R_0 \geq 0, R(T) = R_T > 0, T \; free \tag{10}$$

These conditions generalize the model, introducing the idea that at the beginning, no degradation exists; further, it provides the opportunity to imagine any dynamic path that leads to a restriction on the amount of resources available for allocation, as specified in eq. 8. After simplifying the notation, and posing $p^i - c^i = x^i,\ i = o,a$, the current-value Hamiltonian of the problem is:

$$H^C = \left[Nx^o q^o + (NK - R - N)x^a q^a\right] + \mu(t)\left(\lambda_1 q^a - \lambda_2 q^o\right) \tag{11}$$

The transversality condition shows that a weak sustainability approach has been adopted, which implies that environmental degradation attains stability in our model (i.e. $\dot{R} = 0$). Then, in equilibrium, at the end of time T, it must be true that:

$$\mu(T) = 0 \tag{12}$$

The first necessary condition for the maximization leads to (indicating by q^i_j partial derivatives of *q* functions with respect to the *j*-variable in the *i*-sector):

$$\mu(t) = \frac{x^o(q^o + Nq^o_N) - x^a[q^a + (NK - R - N)q^a_N]}{\lambda_1 q^a_N - \lambda_2 q^o_N} \tag{13}$$

which is no longer a function of time. The second necessary condition for the maximization is:

$$-x^a q^a - (NK - R - N)x^a q^a_R - \mu(t)\lambda_1 q^a_R = -\dot{\mu}(t) + r\mu(t) \tag{14}$$

which can be reduced to:

$$x^a q^a + (NK - R - N)x^a q^a_R + \mu(\lambda_1 q^a_R + r) = 0 \tag{15}$$

because we know from eq. (13) that μ is independent of time. Substituting eq. (13) in eq. (15) and rearranging, we obtain:

$$\frac{x^o(q^o + Nq^o_N) - x^a[q^a + (NK - R - N)q^a_N]}{\lambda_1 q^a_N - \lambda_2 q^o_N} = -\frac{x^a q^a + (NK - R - N)x^a q^a_R}{\lambda_1 q^a_R + r} \tag{16}$$

In order to obtain the optimal value for N, let us begin by analysing the numerator on LHS of eq. (16). After rearrangement, it can be written as:

$$x^o q^o - x^a q^a + Nx^o q^o_N - (NK - R - N)x^a q^a_N \tag{17}$$

where, $x^o q^o - x^a q^a$ is the net economic differential between values of agricultural production obtained in both ways, and $Nx^o q^o_N - (NK - R - N)x^a q^a_N$ is the net marginal economic differential between both productions. The denominator of the LHS of eq. (16), instead, is actually the net marginal degradation, i.e. the marginal impact of the control variable on the state variable. The numerator of the right-hand side (RHS) of eq. (16) represents the net market value of traditional agricultural products added to the total value of environmental degradation impact on traditional production itself. Finally, in the RHS denominator, we find the interest rate, r, plus the marginal impact capacity of degradation on traditional production. Finally, eq. (16) can be rearranged to obtain the optimal allocation rule:

$$N(t) = \frac{x^a q^a (1+Z) + (NK - R) x^a (q_N^a + Z q_R^a) - x^o q^o}{x^o q_N^o + x^a (q_N^a + Z q_R^a)} \tag{18}$$

where $Z = \frac{d\dot{R}/dN}{\lambda_1 q_R^a + r}$ represents the Relative Externality Index REI: the impact of N on $\dot{R}$ divided by the total opportunity cost of traditional agricultural production, i.e. the sum between the marginal degradation impact on traditional production and the interest rate. In the final moment, t = T, Z = 0, and eq. (18) becomes:

$$N(T) = \frac{x^a q^a + (NK - R) x^a q_N^a - x^o q^o}{x^o q_N^o + x^a q_N^a} \tag{19}$$

which can be demonstrated to be a lower value compared to eq. (18). A theoretical explanation of the difference between eqs. (18) and (19) is helpful to discuss how the externality works inside the optimal allocation rule. Following what has been said about eq. (4), one can argue that, when degradation is high, the final impact on the allocation rule in eq. (18) is positive on the optimal value for N, which increases: this comes with the basic idea of the model, that the allocation must be devoted to organic production to obtain an improvement in the environmental conditions. In contrast, when environmental quality is high, the corresponding value for N will be lower, allowing a more robust allocation of natural resources for traditional agriculture. This rationale confirms that the externality value is inversely correlated to the environmental quality and can automatically affect the decision of resource allocation between two agricultural productive processes.

3. Conclusions and policy suggestions

This model shows that a source of sustainability may consist in the conversion from industrial traditional processes to organic agricultural productions in the primary sector. The policy-maker should drive this change because private firms may have not the right incentive to develop organic production due to conversion costs and smaller profits. In fact, higher costs of production may discourage the conversion in a context of incomplete diffusion of organic food and products. Organic agriculture could greatly help in developing higher environmental standards and reducing pollution being, instead, an important activity of the economy. Put in another way, higher costs of organic production play as a price for environmental sustainability, as ingredients for a cleaner environment. It is worth to notice that our model did not present any analysis of consumer utility: a very problematic question arises about the awareness of consumers of nutritional properties and health consequences related to the use of industrial and organic food. Of course, the policy intervention should first of all reinforce the knowledge of possible benefits and measure the gain in environmental and health status terms of organic conversion. Further, the correct dissemination of knowledge may help consumer choosing the best alternative (see Biondo 2014 for such an approach).

The main result of the paper may seem to neglect other existing means available in order to obtain environmental sustainability, instead to move to organic production -i.e. environmental constraints, technological standards, and so on. This is certainly true, but the point is that the model wants to underline how the shift to organic agriculture allows for an automatic generation of sustainability, always paid by the economy, but indirectly: whereas a technological constraint, or an environmental regulation implies higher costs (and therefore higher consumer prices) for the standard (industrial) agricultural products, organic production has higher costs, but preserves environment and gives better and healthier food. Thus, a policy oriented to stimulate the organic production may be preferable because it obtains multiple results compared to the environmental regulation.

An important assumption is that the policy-maker chooses the allocation of resources period by period, independently of the previous decisions. In real circumstances, adopted environmental policies are blinded by the effect of the previous ones: the great ignorance about the effects and consequences of decisions and actions made, reduces the chances of any policy-maker to be perfectly conscious of what is going on. Of course, this aspect can be modified, and further research will be conducted with a continuous time model with discrete perturbations that modify rules or policy targets. A second policy conclusion that can be drawn is referred to incentives and improvements in favour of organic agriculture: an example can refer to the abatement of conversion costs. Once again, the model can account for these costs, but their presence would just complicate the allocation rule without changing its fundamental rationale. Thus, consequently, another implication is to maintain high environmental protective standards for traditional production in the primary sector in such a way that the conversion is as easy and as low cost as possible. Further research will be devoted to the theoretically appealing case of temporal consistency constraint that forces a dynamic trajectory for the optimal allocation rule. In this case, resource allocation is influenced by previous (and following) periods decisions. The model will accordingly change into a more complicate framework that (possibly) will derive more detailed suggestions.

References

[1] Altieri, M.A. (1998). Ecological impacts of industrial agriculture and the possibilities for truly sustainable farming. *Monthly Labor Review*, 50 (3): 60-72.

[2] Barlett, P., Industrial Agriculture, in S. Plattner, ed. (1989). Economic Anthropology. Stanford, CA: Stanford University Press.

[3] Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M.J., Avilés-Vázquez, K., Samulon, A., Perfecto, I. (2007): Organic agriculture and the global food supply, *Renewable Agriculture and Food Systems*, 22(2): 86-108.

[4] Biondo, A.E. (2014). Organic Food and the Double Adverse Selection: Ignorance and Social Welfare, *Agroecology and Sustainable Food Systems*, 38(2): 230–242.

[5] Boschma, M., Joaris, A. and Vidal, C. (2001). Agriculture and Environment. Concentration of livestock production. European Commission, Brussels.

[6] Cacho, O. (2001). An Analysis of Externalities in Agroforestry Systems in the Presence of Land Degradation, *Ecological Economics*, 39(1): 131-143.

[7] Campbell, H., Liepins, R. (2001). Naming organics: understanding organic standards in New Zealand as a discursive field, *Sociologia Ruralis*,4121-39.

[8] Coase, R.H. (1960). The problem of Social Cost, *Journal of Law and Economics*, 3: 1-44.

[9] Cobb, D., Dolman, P. and ORiordan, T. (1999). Interpretations of Sustainable Agriculture in the UK, *Progress in Human Geography*, 23(2): 209-235.

[10] Dabbert, S., Hring, A.M., Zanoli, R. (2004). Organic Farming. Policies and Prospects, Zed, London.

[11] Dangour, A.D., Dodhia, S.K., Hayter, A., Allen, E., Lock, K., Uauy, R. (2009): Nutritional quality of organic foods: a systematic review, *American Journal of Clinical Nutrition*,90(3): 680-685, doi: 10.3945/ajcn.2009.28041

[12] Dangour, A.D., K. Lock, A. Hayter, A. Aikenhead, E. Allen, E., Uauy, R. (2010): Nutrition-related health effects of organic foods: a systematic review, American Journal of Clinical Nutrition, 92: 203-210.

[13] Darrington H. (1999). Going Organic, *Food Manufacture*, 74 (4): 38-39.

[14] De Ponti, T., Rijk, B., Ittersum, M.K. (2012): The crop yield gap between organic and conventional agriculture, Agricultural Systems, 108: 1-9.

[15] Drinkwater, L.E., Wagoner, P. and Sarrantonio, M.(1998). Legume-based cropping systems have reduced carbon and nitrogen losses, *Nature*, 396: 262-265.

[16] Dupraz, P. (1997). La spcialisation des exploitations agricoles: changements techniques et prix des facteurs, *Cahiers dconomie et Sociologie Rurales*, 45: 93-122.

[17] Hartman, R.(1976). The harvesting decision when a standing forest has value, *Economic Inquiry*, 14(1): 52-58.

[18] Mäder, P., Fliessbach, A., Dubois, D., Gunst, L., Fried, P., Niggli, U. (2002).Soil fertility and biodiversity in organic farming, *Science,* 296: 1694-1697.

[19] Matson, P.A., Parton, W.J., Power, A.G. and Swift, M.J.(1997). Agricultural intensification and ecosystems properties, *Science,* 277: 504-509.

[20] Melfou, K. and Papanagioutou, E.(2003). Total factor productivity adjusted for a detrimental input, *Agricultural Economics Review*, 4(2): 5-18.

[21] Mishra, A.K., El-Osta, H.S., Steele, Ch.J.(1999). Factors affecting the profitability of limited resource and other small farms, *Agricultural Finance Review*, 59: 77-91.

[22] Pimentel, D., Hepperly, P., Hanson, J., Douds, D., and Seidel, R.(2005). Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems, *Bioscience,* 55(7): 573-582.

[23] Popp, M., and Rudstrom, M.(2000). Crop enterprise diversification and specialty crops, *Agricultural Finance Review*, 60: 85-98.

[24] Pretty, J.N., Brett, C., Gee, D., Hine, R.E., Mason, C.F., Morison, J.I.L., Rayment, M.D., van der Bijl, G. and Dobbs, T.(2001). Policy challenges and priorities for internalizing the externalities of modern agriculture, *Journal of Environmental Planning and Management*, 44(2): 263-283.

[25] Reavell H.(1999). The wholesome quest, *World of Ingredients*, 58: 60-61.

[26] Sanders, J., Stolze, M., Padel, S. (2011). Use and efficiency of public support measures addressing organic farming, Study report, Thünen Institute, Braunschweig.

[27] Seufert, V., Ramankutty, N., Foley, J.A. (2012). Comparing the yields of organic and conventional agriculture, *Nature*, 485: 229 – 232, doi:10.1038/nature11069.

[28] Shepherd, M., Pearce, B., Cormack, B., Philipps, L., Cuttle, S., Bhogal, A., Costigan, P., and Unwin, R.(2003). An assessment of the environmental impacts of organic farming, ADAS Wolverhampton.

[29] Stolze, M., Piorr, A., Hring, A., Dabbert, S. (2000).The Environmental Impacts of Organic Farming in Europe, Organic Farming in Europe: Economics and Policy, 6, Stuttgart-Hohenheim: University of Hohenheim/Department of Farm Economics 410.

[30] Tilman, D.(1998). The greening of the green revolution, Nature, 396: 211-212.

*** OECD. (2003). Agriculture and Biodiversity. Developing Indicators for Policy Analysis, OECD Publications, Paris.

*** Commission of the European Communities (2004). European Action Plan for Organic Food and Farming, Commission Staff Working Document – Annex to the Communication from the Commission {COM(2004)415 final}.

*** IFOAM (International Federation of Organic Agriculture Movements) (2009). What is organic agriculture? Accessed on June 27, 2012 at: http://www.ifoam.org/growingorganic/definitions/doa/index.html

*** UNDP. (2000). Changing consumption and production patterns: Organic agriculture, Commission on Sustainable Development: 8th Session, 24 April 5 May 2000, New York.

ASERS

Web: www.asers.eu
URL: http://www.asers.eu/asers-publishing
E-mail: asers@asers.eu
ISSN 2068 – 7729
Journal DOI: http://dx.doi.org/10.14505/jemt