



# **SUBMISSION**

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## **The use of organic Long Term Experiments to support sustainability assessment. An Italian case study**

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**Submission prepared for presentation at the 2nd International GRAB-IT workshop 2018**  
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## **The use of organic Long Term Experiments to support sustainability assessment. An Italian case study**

### **Short Abstract (50 words)**

In this study we used a qualitative multi-criteria tool combined with data from long term experiments to assess the sustainability of different organic vegetable scenarios applied in small-sized Italian farming systems. The results highlighted that the adoption of well diversified systems are essential to achieve a high level of sustainability

**Key-words:** Agroecology; DEXi-BIOrt; MOVE-LTE; Multi criteria analysis; Vegetable production

### **Extended abstract (750 to 1000-words)**

In recent years multi-criteria analysis (MCA) tools have been increasingly used for the sustainability assessment of both current agriculture systems (ex-post evaluation) and potential scenarios (ex-ante evaluation) as they can consider conflicting criteria and analyze complex problems breaking them down into smaller and simple understandable components using a hierarchical tree structure (Carpani et al., 2012). In particular MCA tools using qualitative information are considered more effective for the management of different data and constraints coming from the multi-dimensional pillars of the sustainability (Sadok et al., 2008).

Organic agriculture is usually perceived as environmental sustainable, but, in reality, under its umbrella many different production systems coexist. They could range from simplified organic systems, similar to the conventional agriculture, to suitable diversified systems characterized by a full implementation of agro-ecological approaches. In this study we used the qualitative multi-criteria DEXi-BIOrt tool (Vazzana et al., 2012), fed with data coming from the long term experiment MOVE-LTE (MONsampolo VEgetable organic Long-Term field Experiment; period: 2001-on going; position: 42° 53' N, 13°48' E) (Campanelli and Canali, 2012), to assess the agroecosystem sustainability of different organic vegetable production scenarios applied in a context of small-sized Italian farming systems located in Marche region.

On the basis of the available information provided by the device, the following three scenarios, having the same four-year crop rotation (tomato - *Lycopersicon esculentum* Mill., melon - *Cucumis melo* L., fennel - *Foeniculum vulgare* M. var. azoricum, lettuce - *Lactuca sativa* L., cauliflower - *Brassica oleracea* L. var. botrytis, bean - *Phaseolus vulgaris* L.) but different management approaches, were identified and evaluated:

i) **CO2007** which is an organic vegetable farm immediately after its organic conversion. In this option, three agro-ecological service crops (ASC) (Canali et al., 2015) were considered in the rotation: hairy vetch (*Vicia villosa* R.) before tomato transplanting, barley (*Hordeum vulgare* L.), before melon, and radish (*Raphanus sativus* L.) before lettuce. Moreover CO2007 is characterized

by the in-farm seedling production, greater amount of off-farm inputs (nitrogen and plant protection products), and the sale of 100% of the products through short chain mechanisms;

ii) **AE2016** that is a farm in which a suitable agro-ecological and natural resource management are applied and in which the organic conversion has been realized since a very long period. This scenario is characterized by the use of ASCs as in CO2007, the in-farm seedling production, the implementation of the in line tillage roller crimper technology (Canali et al., 2013), reduced amount of off-farm inputs, and sale of 100% of the products through short chain mechanisms;

iii) **SU2016** is considered a substitution scenario where a simplified organic management system was adopted for a very long period. This management scenario is considered one of the most common organic system implemented in the Marche region. SU2016 is compared to a conventional system but with the application of the agrochemical products allowed in the organic agriculture. SU2016 has no ASCs, greater amount of off-farm inputs, off-farm seedlings purchasing and the sale of 100% of the products to the large-scale distribution.

DEXi-BIOrt is composed by 28 basic variables (i.e., leaves of the hierarchical tree) that are aggregated by “if-then” decision-rules in order to evaluate the sustainability of four main agroecosystem components (Soil, Water, Biodiversity, and Production) and to assess the overall sustainability of the system (i.e., root variable). The evaluation scale is performed on the basis of three qualitative values: Low for no sustainable systems, Medium for farms reaching the sustainability threshold, High for sustainable systems. In Table 1 the results obtained for the main components and overall sustainability assessment for the selected scenarios are reported.

**Table 1. Main components and overall sustainability assessment obtained with DEXi-BIOrt for the three organic vegetable farming scenarios**

	<b>CO2007</b>	<b>AE2016</b>	<b>SU2016</b>
<b>Overall sustainability</b>	High	High	Low
<b>Soil</b>	Medium	High	High
<b>Water</b>	High	High	High
<b>Biodiversity</b>	High	High	Medium
<b>Production</b>	High	High	Low

The main evaluation differences among the scenarios were principally due to: a better improvement of the soil physical structure in AE2016 and SU2016 (both characterized by a period of 15 years from their organic conversion) compared to CO2007 (only 6 years from the organic conversion) that caused a higher performance for the Soil component; the no-use of ASCs and a lower number of local cultivars in SU2016 that determined a worse performance for the Biodiversity component; a more impacting phytosanitary management and the choice to sell the whole production to large scale distribution without any premium price in SU2016 that caused a lower score for the Production component.

Considering the overall sustainability given by the final aggregation of all the variables, AE2016 and CO2007 were qualified as sustainable while the substitution scenario was considered as a no sustainable system. DEXi-BIOrt has proved to be a valid tool for the sustainability assessment of potential management scenarios to implement in organic vegetable farming systems. The results, in line with several studies (IPES-Food, 2016; Mijatović et al.; 2013), have highlighted that the adoption of diversified systems, the use of cover crops and ASCs, the better management of natural resources, the promotion of biodiversity and short chain mechanisms are essential to achieve a high level of sustainability and to enable a system to remain productive over time.

## Reference Section

Campanelli, G., Canali, S. (2012). Crop production and environmental effects in conventional and organic vegetable farming systems: the case of a long-term experiment in mediterranean conditions (Central Italy). *J. Sustain. Agric.* 36, 599–619.

Canali, S., Diacono, M., Campanelli, G., Montemurro, F. (2015). Organic no-till with roller crimpers: Agro-ecosystem services and applications in organic Mediterranean vegetable productions Sustainable Agriculture Research 4 (3), 70

Canali, S., Campanelli, G., Ciaccia, C., Leteo, F., Testani, E., Montemurro, F. (2013). Conservation tillage strategy based on the roller crimper technology for weed control in Mediterranean vegetable organic cropping systems. European Journal of Agronomy. 50, 11-18

Carpani, M., Bergez, J.E., Monod, H. (2012). Sensitivity analysis of a hierarchical qualitative model for sustainability assessment of cropping systems. Environ Model Softw 27(2),15-22.

IPES-Food (2016). From uniformity to diversity: a paradigm shift from industrial agriculture to diversified agroecological systems. International Panel of Experts on Sustainable Food systems

Mijatović, D., Van Oudenhoven, F., Eyzaguirre, P., Hodgkin, T. (2013). The role of agricultural biodiversity in strengthening resilience to climate change: towards an analytical framework. International Journal of Agricultural Sustainability 11, 95–107. doi:10.1080/14735903.2012.691221

Sadok, W., Angevin, F., Bergez, J.É., Bockstaller, C., Colomb, B., Guichard, L., Reau, R., Dorè, T. (2008). Ex ante assessment of the sustainability of alternative cropping systems: implications for using multi-criteria decision-aid methods. A review. Agron. Sustain. Dev., 28, 163.

Vazzana, C. Moonen, A.C., Bigongiali, F., Bàrberi, P., Lazzerini G., Moschini, V., Colombo, L. (2012). Manuale di DEXI-BIOrt uno strumento per la valutazione agro-ambientale delle aziende orticole biologiche italiane. Progetto SOS-BIO, finanziato dal Ministero delle Politiche Agricole, Alimentari e Forestali

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