Biodiversity as a Measure of Differences between Organic and Conventional Farming: a Case Study

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Natural ecosystems are a structural and functional association of biotic-abiotic components within a physic-chemical environment. Such a dynamical aspect gives to natural surfaces the ability to maintain high qualitative properties of constitutive resources (water, air, soil), of land (landscape) and of habitat (for animal and vegetal species). These properties are fundamental to the concept of sustainability (Lewandowski et al., 1999) and biodiversity is a way to estimate them in a farm context (Bockstaller and Girardin, 1997) and for a comparative use (Caporali et al., 2003).
Biodiversity indicators are largely used for detecting and evaluate the amount and effectiveness of natural surfaces within a farm (Hole et al., 2005). In the following study indicators at plot scale and farm scale were used to compare the effects of organic and conventional management on occurrence of spontaneous vegetation.

Methodology
Biodiversity is a property of a vegetated surface and is commonly evaluated analysing homogeneous (and broadly delimited) surfaces. These surfaces may range from few square meters to hectares and may be cultivated or not. In the cropped case biodiversity is given by weeds, which spatial frequency distribution is observed in the early summer. Spontaneous vegetal formations in farms commonly involve infrastructures as field margins and edges, so that biodiversity evaluation requires a former identification and classification of different structures, requiring a farm-wide survey to identify homogeneous surfaces and successively to recognize vegetal species of each of them. The composition of such formations includes herbaceous, shrubs and trees and can be described in terms of layers. In this case the Braun-Blanquet (1932) method was used.
For the plot-scale biodiversity, indicators selected are herbaceous species richness ***ICh***, namely the number of species for unit area, and diversity ***IDh*** obtained by means of the Shannon-Weaver transformation (***ID = - Σ [Ps log Ps]***, Ps being the species coverage). Similar indices were obtained for the spontaneous vegetal formations, namely species richness (***ICv***, same as before) and diversity (***Idv***), where bushes and trees are included. For the purpose, two couples of farms were identified, to compare a plain to a hilly scenario. In fact, in the hillside, Italian agriculture is more fragmented than in plain and more inclined to move towards organic management. Each couple of farms, an organic and a conventional one, were closed to one another so as to have similar soil, climate and crop production schemes. The farms were all from north-eastern Italy (Province of Bologna) with full and cultivated areas reported in table 1.
In the farms, plots with the same crop (winter wheat) were selected within ordinary crop rotations of the area, including legumes in the case of organic farming. Sampling was performed by means of the moving square method (a 20 cm side frame have been used) to randomly identify sampling areas.

A preliminary survey over the farm surface also allowed to identify 8 vegetal formations in the plain scenario and 17 in the hillside.

Table 1 – Size of farm included in the analysis (SAT: Total Farm Surface, SAU: Cropped Surface, in ha)

Farm	Plain - Conv.	Plain - Organic	Hilly - Conv.	Hilly - Organic
SAT	40.1	36.2	73.0	17.9
SAU	38.7	33.0	33.4	13.7

Results

Over the plots any diffusion of weeds were observed both in the conventional and in the organic scenarios. The majority of species found, 24 in total, are dicots and the number of individuals, as expected, are sensitively greater in the organic case than in the conventional (Hole et al., 2005). As it can be observed from table 2 (first row), the difference between plain and hilly scenario is also greater, a difference mitigated by means of the diversity index (table 2 - raw 2).

In the natural formations 75 and 97 species were found, respectively in the plain and hillside. The number of individual for unit surface (IC) was greater in the plain than in the hilly scenario, but the difference between the farm management regime was also relevant.

These results support already known results of literature (Caporali et al., 2003), even if it is not common to find a marked causality of biodiversity in organic farming (Hole et al., 2005).

Table 2 – Values of indicators computed in the farms

Farm	Plain - Conv.	Plain - Organic	Hilly - Conv.	Hilly - Organic
ICh	5.0	18.0	40.0	51.0
IDh	1.61	1.84	1.65	2.36
ICv	24.7	75.9	5.49	25.3
IDv	0.70	1.91	1.12	3.58

Conclusions

Floristic analysis developed in this investigation proved to be easy both in terms of survey and index computability, even if it requires to work at a certain period of the year (late spring in middle latitudes) and a former background in species recognition skills is required. Finally, all the computed indices showed sensitivity to both location (plain vs. hilly) and farm management (conventional vs. organic).

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References

Braun-Blanquet J. 1934, Plant sociology. McGraw Hill.

Bockstaller C. et al. 1997. Use of agroecological indicators for the evaluation of farming systems. Eur. J. Agron. 7:261-270.

Boller et al. 2004, Ecological infrastructures. Ideabook on functional biodiversity at the farm level. Temperate zone of Europe. Eschikon 28. www.ldl.ch.

Caporali et al. 2003. Indicators of cropping system diversity in organic and conventional farms in central Italy. Int. J. of Agr. Sustain. 1:67-72.

Hole D.G. et al. 2005. Does organic farming benefit biodiversity? Biological Conservation 122:113-130.

Lewandowski I., et al. 1999. Sustainable crop production: definition and methodological approach for assessing and implementing sustainability. Crop Sci. 39:184-193.

Shannon C.E., Weaver W. 1963. The mathematical theory of communication. Univ. Illinois Press.