

## An Environmental Assessment Tool for Organic Viticulture Based on a Fuzzy Expert System

Fragoulis, G.<sup>1</sup>, Trevisan, M.<sup>1</sup>, Di Guardo, A.<sup>2</sup>, Sorce, A.<sup>2</sup>, van der Meer, M.<sup>3</sup>, Weibel, F.<sup>3</sup>, & Capri, E.<sup>1</sup>

Keywords: organic viticulture, environmental indicator, fuzzy logic

### Abstract

*Organic viticulture is an important part of the EU organic farming sector and, according to the most recent surveys, 1.5% of EU wine originates from organic farms, with an upward trend. This paper describes an environmental indicator (EIOVI) that can be reliably used in the management of organic vineyards. The indicator aims to measure all the actual environmental impact produced by an agroecosystem in the spatial boundaries of the farm and produce advice for improving the sustainability of human actions, thus optimizing management options. The EIOVI indicator is the first known tool to evaluate the environmental impact of viticulture. The tool allows the simulation of vineyard management based on six agricultural and ecological modules. It takes into account the different agronomical practices used in organic viticulture (pest and disease management, fertilization and irrigation management, soil management, and machinery use) and estimates the effect of vineyard management on soil organic matter and biodiversity. The fuzzy set theory adopted provides an elegant and quantitative solution to determine cutoff values for input variables and for output results. The hierarchical structure of this technique, through the use of decision rules and by combining weighted fuzzy values, allows the aggregation of indices into first-level fuzzy indicators and then into a second-level fuzzy indicator for the whole system. The system has a modular structure and thus provides a synthetic indicator reflecting the overall impact for the whole system as well as detailed information through its six modules.*

*The fuzzy expert system reflects an expert perception of the potential environmental impact of organic viticulture. Despite the fact that the theory behind the indicator is quite exhaustive, the tool is presented with an easy-to-use graphic user interface (GUI) that requires only basic input data which are not too expensive or difficult for users to obtain, be they vine growers, consultants, or scientists.*

*The objective of an agroecological indicator is to render reality intelligible and the objective of an expert system is the simulation of human actions. Thus, the validation of the indicator requires the determination of its value to potential users. Initial testing has been performed using 20 simulations for six Swiss wine-growing estates. The results of these tests were promising; EIOVI motivates managers to consider the wine-*

---

<sup>1</sup>Istituto di Chimica Agraria ed Ambientale, Università Cattolica del Sacro Cuore, Via Emilia Parmense 84, 29100 Piacenza, Italy

<sup>2</sup> Informatica Ambientale S.r.l., Via Teodosio, 13, 20131 Milan, Italy

<sup>3</sup>Forschungsinstitut für Biologischen Landbau, Ackerstrasse, 5070 Frick, Switzerland

*growing estate as a whole by sub-summarizing all aspects of management. The visualization of results is very tangible and clearly shows how management could be improved. If some improvements to the tool are implemented, EIOVI could also be used for management planning and will be a helpful assessment tool for vine growers, consultants, environmental agencies, and scientists. The tool could even be extended to other branches of agricultural production by including perennial cultures, vegetable crops, crop rotation, or livestock husbandry. Stakeholders such as farmers' associations and decision makers have already been contacted and new farm testing will be carried out with the new release of the software.*