Indicating Processes and Performances of Agrosystems : a framework based on a conceptual model and its use in vineyards fields.

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Introduction

Developing and managing eco-efficient cropping systems (4) that produce higher output with less input, requires agrosystems with the following attributes: (i) complexity due to the increasing number of biophysical components in interaction to be considered ; (ii) dynamic, in a changing environment at different time scales ; (iii) multiscale and hierarchy, combining biophysical and technical dimensions at field, farm and landscape levels. Their management and design requires sound indicators of their behaviour in the face of diversity (soils, climate, plant, pathogens, farm type).

Methods

We propose a framework to design, test and use such indicators, which is based on the conceptualization protocol of an Agrosystem (5) and currently implemented on vineyards in transition towards organic or integrated farming (AIDY project). The various types of indicators and their use are summarized in table 1 and illustrated with typical examples (Table 1). The basis of the framework is that an indicator must be designed with regards to (a) the specific aspect of the system for which it provides information, (b) the way to collect and analyse information and (c) the targeted actors/decision. Analysis Indicators must be evaluated for their ability to quantify the system basic processes, either in absolute term or in comparison with a reference system (8). Management Indicators need to improve the system management for a limited cost in term of observation, sampling and analysis. Assessment Indicators must provide scientifically credible information on the performance of the system or on its impacts/services for other systems in a form that can be understood by a stakeholder or a decision maker.

Results and Discussion

Analysis indicators

Example 1a is a short term dynamic daily time step indicator of the soil water deficit experienced by a vineyard and its impact on source-sink relationships (7). It can be derived from field measurement or simulated with a model. Example 1b is an indicator of nitrogen stress experienced by the vine (NNI). It is calculated from the ratio between the actual N content of grapevine aerial parts and a minimal critical N content to elaborate a given biomass (2). Example 2 is a long term dynamic indicator of the soil quality, the Maturity Index, based on abundance and biodiversity of non pathogenic nematodes (3). It is obtained by field sampling and indicate the intensity of physical and chemical perturbations of the soil.

Management indicators.

Example 3 is an expert-based approach for the management of two of the major pathogens of grapevine: powdery mildew and downy mildew (6).

Assessment indicators

This type of indicators has been widely developed for the assessment of environmental performances of cropping and farming systems (for example 4 the Indigo method

Table 1: a framework to design, test and use indicators of a cropping system (XXX: importance of the criteria, ---:not needed)

Type of Indicator	Indicate...			To be assessed for...			Examples
	For Whom	For What	At which scale	Scientific relevance	Cost-Benefit efficiency	Communication effectiveness	
Analysis	Researcher	Understand system's processes/properties	Field, Landscape	XXX	X	---	Ex. 1 a and b Ex. 2
Management	Farmer, Adviser	Characterize system's behaviour	Farm	X	XXX	---	Ex. 3
Assessment	Adviser, Stakeholder, Policy maker	Assess performances and impact on other systems	Farm type, region	XX	X	XXX	Ex. 4 Ex. 5

recently adapted to vineyards, ref 1). Example 5 is the Evaluation Index of Damage in Cluster (EIDC) that can be used to assess the efficiency of crop protection strategy on grapevine cluster (Delbac et al., this volume).

Conclusion

This framework can be used to conceptualize, design and assess an indicator on the basis of it's targeted use, its scientific relevance with regards to the aspect of the agrosystem it is supposed to indicate and the distance between the indicator and the functional variable best quantifying the process. It is currently tested in vineyards, in order to help monitor the transition of a farm toward organic farming (AIDY project) or to prototype low input systems (EcoViti project).

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