Identification of sustainable cropping systems with high multi-sector performances

Violaine Deytieux, Matthieu Hirschy, -Marie-Sophie Petit, Anne Schaub, Nicolas Munier-Jolain, Jacques Caneill

IDENTIFICATION OF SUSTAINABLE CROPPING SYSTEMS WITH HIGH MULTI-SECTOR PERFORMANCES

Violaine DEYTIEUX [1,4] – *Matthieu HIRSCHY* [1] – *Marie-Sophie PETIT* [2] – *Anne SCHAUB* [3] – *Nicolas MUNIER-JOLAIN* [4] – *Jacques CANEILL* [5]

[1] INRA, UE 115 Domaine d'Epoisses, F-21110 Bretenière, France, Violaine.Deytieux@dijon.inra.fr
[2] Chambre d'Agriculture Régionale de Bourgogne, 3 rue du Golf, F-21800 Quétigny, France
[3] Association pour la relance agronomique en Alsace, BP 30022 Schiltigheim, F-67013 Strasbourg, France
[4] INRA, UMR1347 Agroécologie, BP 86510, F-21000 Dijon, France
[5] AgroSup Dijon, UMR1347 Agroécologie, BP 86510, F-21000 Dijon, France

Introduction

Multicriteria assessment is needed to identify promising cropping systems with good performances on different components of sustainability. Some trade-offs between criteria may occur. A better knowledge about the relationship between criteria can help (i) to identify cropping systems with high multi-sector performances (e.g. Castoldi et al., 2010; Firbank et al., 2013), and (ii) to guide policy makers'choices. In this paper, we present the early results from our multi-sector evaluation performed on data collected on cropping systems experiments.

Materials and Methods

Thirteen cropping systems tested in field experiments were assessed using a comprehensive set of criteria and indicators (selected from those used by Sadok et al., 2009), covering various components of sustainability (Table 1).

Table 1. Criteria and indicators used to assess the cropping systems performances

		Criteria	**Assessment variables**
Components of sustainability	Social sustainability	Labour time requirement	Labour time (h. ha^{-1})
		Health Risks	Number of pesticide sprayings with a harmful active ingredient (sprayings. ha^{-1})
	Economic sustainability	Profitability (farmer income)	Semi-Net margin (€. ha^{-1})
	Environmental sustainability	Air Quality (pesticides and GHG emissions)	I-Phy_{air} (Note from 0 to 10; Indigo Method) I_{N2O} (kg N_2O-N. ha^{-1}, Indigo Method)
		Water pollution risks (pesticides and nitrates losses)	I-Phy_{GW} I_{NO3} (Indigo Method)
		Energy conservation	Energy consumption (GJ. ha^{-1}) Energy efficiency
		Soil Quality (organic matter content)	I_{MO} (Note from 0 to 10, Indigo Method)

We associated a local reference to each tested system to take into account the diversity of production situations among sites. The local reference was determined by interviewing a farmer with practices representative of local agriculture.

Results and Discussion

The first analysis revealed few significant relationships, and no strong trade-offs between the criteria assessed. Some cropping systems had reduced environmental impacts associated with pesticide losses in the environment and reduced energy

consumption as compared to the local reference, without reducing the economic profitability, and a few systems had enhanced performances for those three presented indicators (Figure 1). Crop diversification and mechanical weeding were relevant to improve environmental criteria but induced contrasting economic performances.

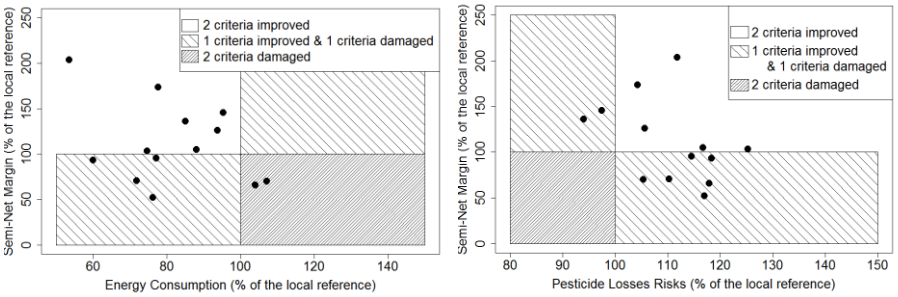

Figure 1. Relationship between a/ Semi-Net Margin and Energy consumption, b/Pesticides losses and Semi-Net Margin. Performances of the tested cropping systems are expressed in percentage of the value of the indicator for a local reference.

Conclusions

These early results are promising. They show the interest of using a local reference when analysing cropping systems tested in different sites. A large number of tested cropping systems and more various production situations have to be included in the analysis to go deeper in our understanding of cropping systems performances, by benefiting from the field experiments involved in the " innovative cropping systems" Joint Network of Technology (Deytieux et al., 2012). More attention will be paid on which components of crop management strategies and/or elements of the production situation determine the performances at the cropping system level.

Acknowledgements

This study was partly funded by the French Ministry of Agriculture, Agri-food and Forestry, through the special account "agriculture and rural development". We thank the experimenters of the "Innovative Cropping Systems" Joint Network of Technology, and the INRA-CIRAD Integrated Pest Management Network.

References

Castoldi, N.- Schmid, A.- Bechini, L.- Binder , C.R.: 2010. Trade-off analysis for agro-ecological indicators: application of Sutainable Solution Space to maize cropping systems in northern Italy, in: 9th European IFSA Symposium, Vienna (Austria), pp. 850-860.

Deytieux, V.- Vivier, C.- Minette, S.- Nolot, J.M.- Piaud, S.- Schaub, A.- Lande, N.- Petit, M.S.- Reau, R.- Fourrié, L.- Fontaine, L.: 2012. Expérimentation de systèmes de culture innovants : avancées méthodologiques et mise en réseau opérationnelle. Innovations Agronomiques. 20, 49-78.

Firbank, L.G.- Elliott, J.- Drake, B.- Cao, Y.- Gooday, R.: 2013. Evidence of sustainable intensification among British farms. Agriculture Ecosystems & Environment. 173, 58-65.

Sadok, W.- Angevin, F.- Bergez, J.-E.- Bockstaller, C.- Colomb, B.- Guichard, L.- Reau, R.- Messean, A.- Dore, T.: 2009. MASC, a qualitative multi-attribute decision model for ex ante assessment of the sustainability of cropping systems. Agronomy for Sustainable Development. 29, 447-461.