Sustainability of crop rotations with oil seed rape

André POUZET, Raymond REAU, Dominique WAGNER,
CETIOM, BP 4, Thiverval-Grignon 78850, France,
pouzet@cetiom.fr, reau@cetiom.fr, wagner@cetiom.fr

ABSTRACT

The European Common Agricultural Policy is shifting an increasing part of the subsidies to eco-conditionality. Henceforth, it becomes essential to evaluate the environmental effect of agricultural practices, and more generally performances of cropping and farming systems, in order to design and to develop more sustainable systems. This assessment is being implemented for the main cropping systems of some French regions, using environmental indicators. Eleven exposure indicators were chosen in order to represent a wide range of specific sustainability objectives dealing with water, soil, air, non-renewable resources, biodiversity and landscape. The results present the sustainability assessment for the crop rotations of Champagne Berrichonne region in the Centre of France, where oil seed rape (OSR) is prevalent into the regional crops rotations. From the water quality point of view, the introduction of OSR into a rotation increases the number of chemicals applications and the quantity of active ingredient applied. Concerning nitrates, due to the introduction of OSR and use of volunteers after harvest, the soil is covered and nitrates are caught during two succeeding autumns. From the non-renewable resources point of view, energetic efficiency is here little modified with the introduction of OSR into a winter wheat based crop rotation. With a long cropping cycle, OSR protects the soil against erosion for a long time. From the biodiversity conservation and landscape protection, OSR flowers contribute to the bee keeping production, as well as to the spring landscape colouring. Nevertheless, OSR and winter cereals simple crop rotations do not offer any cover crop into the agricultural landscape during summer.

Key words : sustainability – exposure indicator - rotation - oil seed rape

INTRODUCTION

In Europe today, food sufficiency is no longer considered as a priority. Present demands towards agriculture concern much more the quality of products, life quality and the quality of landscapes and their environments. That is why the European Community started a policy of rural development (Pouzet, 2001).

In a more and more open economy, with the introduction of the system of single aid/ha set up in the framework of the Agenda 2000, producers have been incited to specialize in activities and productions where they are particularly competitive : for instance more cereals and less oilseed crops. Consequently, they decrease the diversity of their productions and artificialize the environment, which brings about environmental and more generally sustainability problems. A first practical assessment to compare the performance of several rotations has been realized in the “Champagne Berrichonne”, a region in the middle of France (Reau et al., 2002).

MATERIAL AND METHODS

To evaluate the performance of sustainable development, the OECD proposed to study a whole set of impacts. We started from this multi-criteria approach and stressed out the different sets of possible impacts (Girardin, 1997). Following Halberg’s (1999) and Girardin’s (1997) proposals, the indicators were chosen due to their ability to :

- Give to understand the complex reality of the impact of cultural practices on the environment and the utilization of resources,
- Be valid from a scientific point of view,
- Be clear and meaningful for producers,
- Be sensitive to changes in cultural practices, and reflect the expected consequences,
- And be easily computable with non-expensive data to gather.

Considering the presently available methods, the working group proposed eleven indicators gathered in four different fields of main impacts: the use of energy and water resources, the quality of water, soils and air, biodiversity and landscapes.

Table 1. Eleven indicators of sustainability

Energy and water Resources	Quality of waters, soils and air	Biodiversity	Landscape
Energizing efficiency (NRJ) Water consumption (IRR)	Chemical applications (PHY) Active ingredients mass (MAS) Nitrogen balance (SN) Soil cover in autumn (CVA) Humic balance (MO)	Proportion of crops winter/spring (H/P) Annual soil cover (CVT)	Number of crops (NB) Melliferous flowering (FLO)

The values gave us the possibility to compare several rotations for a given indicator, and therefore to classify performance in a particular field. To have a general view and make the performance of a given rotation clearer in the different fields, we chose to transform these values into marks varying between 1 and 9 within a scale of increasing sustainability, according to the relative place of the value between two references. This evaluation was carried out to compare rotations in the framework of an agricultural area. Each of the indicators was estimated within a region on the level of the rotation. For each studied rotation, we described the succession of crops, the management of each crop from the preceding crop to its harvest, as well as the production results obtained.

RESULTS

In “Champagne berrichonne”, oilseed crops are associated to winter cereals in “dry” systems (without irrigation). We present here a system with a sample of five different rotations (Table 2).

Table 2 : Marks obtained for five rotations in the region of “Champagne berrichonne”.

Rotation	NRJ	IRR	PHY	MAS	SN	CVA	MO	H/P	CVT	NB	FLO
W-W	4,9	9	6,6	4,4	2,0	4,7	7,9	5,8	6,5	1,0	1,0
OSR-W	4,8	9	2,9	3,5	2,6	5,9	8,2	5,8	7,0	3,7	4,8
OSR-W-B	5,2	9	3,7	5,2	2,6	5,6	7,8	5,8	6,8	6,3	4,8
S-W-B	5,5	9	6,1	6,5	6,5	4,3	6,5	8,5	4,7	6,3	3,8
OSR-W-S-W	4,9	9	4,8	4,5	4,1	5,6	7,4	7,8	5,5	6,3	7,6

W : wheat OSR : Oil Seed Rape B : Barley

A first analysis shows that certain indicators mark clearly the difference between these five rotations. For example : the number of chemical applications, the period of melliferous flowering, the soil covers and the nitrogen balance. On the other hand, these rotations obtain similar marks when the energizing efficiency and the humic balance are concerned.

The comparison of rotations indicates that the average mark is generally better with the length and diversity of the rotation. The shortest rotations tend to be particularly handicapped by their nitrogen balance, the mass of active ingredients and of course the criterion of the number of crops. The long and diversified rotations tend to offer certain advantages, concerning essentially the number of chemical applications, the nitrogen balance, the period of flowering and the balanced proportion between winter and spring crops.

In the **field of the utilization of resources**, the energizing efficiency (NRJ) of the agricultural production is equivalent for the rotations with winter crops with nitrogen fertilization higher than 150 units, as for instance for winter oil seed rape. In the **field of the quality of waters** (item : MAS, PHY), the introduction of rapeseed penalizes cereal rotations from the point of view of these indicators; in fact, even if crop diversification allows reducing the use of pesticides on cereals, it does not compensate for additional supplies given to rapeseed. It is

explained by the use of rather old herbicides used in high quantities, several applications of insecticides, great applications of anti-slug products, rather systematic applications of chemicals and little developed systematic control. In the **field of the quality of waters** (item : SN, CVA), rapeseed and its volunteer plants following harvest cover the soil over two successive autumns, play the part of nitrate trap and also give the possibility to valorize farm-fertilizers applied in the summer. But they lead to nitrogen balances in the rotation, which are less favorable. A more frequent use of intermediate crops in these rotations could improve the soil cover in autumn. In the **field of the quality of the air and of the soils** (MO, CVT), the introduction of rapeseed in a cereal rotation seems to improve the humic balance of the soil. Considering the similar evolution of the indicator CVT according to the rotations, erosion risks seem to be low in rotations based on winter crops, more particularly in rotations with rapeseed. In the **field of the biodiversity** (CVT, H/P) landscapes bearing winter cereals and winter rapeseed offer the advantage to give a crop cover which lasts over the year for a long period, but which is totally absent at the end of the summer. Rapeseed is an important resource for bees, while contributing to the beekeeping production (indicator FLO). In the **field of the landscapes** (NB, FLO), long and diversified rotations lead to varied rotation systems where the crops are as many variables in the landscape. OSR contributes to give a nice yellow color at the time of flowering, early in the spring.

DISCUSSION

The 11 indicators were not kept for the final classification of rotations. But the priority was given to the 5 indicators to stress out the most important indicators for the sustainable development in the region. In spite of the problems linked to its utilization (Bockstaller and Girardin, 2002), we used the average to compare the rotations globally. These indicators often are simple describers of practices. Therefore, we cannot evaluate an isolated rotation but can only make comparative evaluations. Lastly, these comparative evaluations offer a lack linked to their relativity: they can lead to a certain perfectionism if the rotation under study is already highly performing, and contrarily, they can lead to a certain kind of easy going. These limits raised no major problem since the question dealt with the comparison between long and diversified rotations in comparison with monocultures with very short rotations. In order to widen the possible utilization of these indicators to estimate rotation performance, it is now desirable to improve some of them to help users to make their decisions.

ACKNOWLEDGEMENTS

The chairman of the GCIRC acknowledges J-M. Meynard (INRA), P. Viaux (Arvalis), H. Hébinger, A. Merrien and P. Jouffret (CETIOM) for their assistance in methods or data collection.

REFERENCES

Bockstaller C., Girardin P., 2002: Some methodological issues in the construction of environmental indicators. European Society of Agronomy, VII congress, Cordoba. Book of proceedings, 551-552.

Halberg N., 1999: Indicators of resource use and environmental impacts for use in a decision aid for Danish livestock farmers. Agriculture, Ecosystems and Environment, 76, 17-30.

Girardin P., Bockstaller C., 1997: Les indicateurs agro-écologiques, outils pour évaluer des systèmes de culture. OCL, 4, 6, 419-426.

Girardin P., Bockstaller C., 1999: Indicators : tools to evaluate the environmental impacts for farming systems. Journal of sustainable agriculture, 13(4), 5-21.

Pouzet A., 2001: Systèmes de grandes cultures et environnement. Situation et perspectives d'évolution. CETIOM, 7.

Reau R., Wagner D., Pilorgé E., 2002: Première évaluation environnementale des systèmes de cultures avec oléagineux. Oléoscope, CETIOM, Paris, 24-26.