Appropriate method to assess the sustainability of organic farming systems

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Abstract: *Despite the recent strong development of organic farming and its growing importance, there is a lack of methods for assessing the sustainability of this form of agriculture. A lot of methods for assessing the sustainability of farms have been produced; but most often these methods are intended for conventional farming systems and therefore take little account of the specificity of organic farming. In this communication we propose a method for assessing farm's sustainability suitable for organic farming. This method relies on one side of the agricultural sustainability principles, and the other side on the principles and characteristics of organic farming. The results of application of this method on 15 farms in the region of Midi-Pyrenees region show that it takes into account very well the agro-ecological and socio-territorial specificities of organic farming. But improvements are required in terms of taking into account the variability of production systems in organic farming.*

Keywords: *Sustainability, Organic farming, Assessment, Farm, Indicators*

Introduction

Agricultural researchers and professionals widely recognise the importance of sustainable agriculture and the need to make this operational, i.e. to develop appropriate methods to measure sustainability of farming system (Webster, 1997; Kropff et al., 2001; Van Calker et al., 2006; Gafsi et al., 2006). There is an abundant scientific literature on the topic of sustainability assessment (Zander and Kachele, 1999; Andreoli and Tellarini, 2000; Rigby et al., 2001; Heller and Keoleian, 2003; Ness et al. 2007; Sydorovuch and Wossink, 2008). Consequently an increasing variety of evaluation methods for assessing the sustainability, notably at the farm's level, has been produced (Van der Werf and Petit, 2002; Bockstaller et al. 2009).

But most often these methods are intended for conventional farming systems and therefore take little account of the specificity of organic farming. While it is conventional agriculture which raises more concerns over the adverse effects of cropping and farming systems such as water pollution by nitrates and pesticides, and gaseous emissions due to nitrogen inputs. But sustainability is not just a matter of treating adverse effects of productivism. Other factors outside the conventional system can lead to lack of sustainability. Despite not having the negative effects of productivism, organic farming can present lack of sustainability. The sustainability of organic farming systems needs therefore to be appreciated. However in fact, the sustainability of organic farming is addressed in the context of comparison between organic, integrated and conventional farming systems, using the same sets of indicators (Vereijken, 1997; Pacini et al., 2003). In France there are currently a dozen indicator-based methods used by professional actors and teaching, but none are specific to organic farming.

This contrasts with the emphasis today in organic farming and its recent dynamics of development. Over the past fifteen years, organic farming has been in France a very strong development both at the production level and at the demand of organic products. In 1995, 3600 organic farms were farming roughly 130 000 ha, in 2008, it was 13 298 farms on 583 799 ha, (2,12% of the total national Usable agricultural area). In the meantime, food processing and marketing companies using an organic label had grown from 700 to 7 398 (Agence Bio, 2009). The gross market of organic products has the same dynamics; the average annual growth is more than 10% since 1999, whence the global

food market was growing by 3% yearly. Besides, as evidenced by the decisions of the *Grenelle de l'Environnement* Forum in 2007 and the French national plan for the development of organic farming ("*Organic farming: Towards 2012*", Ministry of Agriculture[1]), Organic farming is now seen as a sustainable alternative to conventional agriculture. But despite this general context of development, organic farmers demonstrate several technical, economic, organizational, ..., difficulties. This raises the following questions: these farms are they sustainable? How to assess their sustainability?

In this communication, we propose a method for assessing farm's sustainability suitable for organic farming. This method relies on one side of the indicator-based methods of farms' sustainability and the other side on the principles and characteristics of organic farming. It is based on a comprehensive and systemic approach to sustainable farming. The concept of sustainability is presented in three dimensions (economic, environmental and social); each one includes some components that are, themselves, divided in several indicators. The three dimensions of sustainability are now well known and they are the subject of a consensus between different actors both scientific and professional. Our methodological work focuses so on the levels of components and indicators. It consists of four steps: (i) determination of list of components, for each dimension, that reveal the specificity of organic farming systems; (ii) identification and selection of set of indicators for each component; (iii) estimation of relative weights of different components in the overall sustainability measure, which is crucial in the aggregation process; (iv) setting thresholds and scoring system for each indicator. To illustrate possible applications of the proposed method, we studied the sustainability of selected farms in the region of Midi-Pyrenees region (southern France). These farms are chosen regarding their dimension and their production systems orientation. Our objective is mainly to demonstrate how the proposed method could be used and to assess its performances.

This communication proceeds as fellow: the theoretical framework for our analysis is presented in section 2, where we review the relevant literature on agricultural sustainability assessment and organic farming principles. Section 3 discusses the specifics of the research design including the method design and the fieldwork presentation. In section 4, we present the results of the application of the proposed method to a sample of organic farms. We conclude in section 5 with the discussion of our findings regarding the method, its application in the case study, and its applicability in other contexts.

Theoretical framework of sustainability assessment of organic farming systems

Sustainability and sustainability measures

The need for definition of sustainable agriculture is a prerequisite for developing an assessment framework. Although there is no single definition of sustainability, there are major common features that are defined (e.g., Hansen and Jones, 1996; Park and Seaton, 1996, Rigby et al., 2001; Godard and Hubert, 2002). Sustainable agriculture should be the ability of farming systems to maintain its productivity and usefulness to society in the long term. This means that sustainable agriculture includes both the long-term viability of farming system itself, and the contribution of this farming system to the sustainability of the territory and the communities to which it belongs. The second aspect in this definition is crucial for the meaning of sustainable agriculture, and it must be considered in our assessment framework of sustainability of organic farming systems. It places farmers squarely within the local social fabric; offering local services; maintaining and creating jobs in the rural space; contributing to rural planning; developing environmental services; dealing with negative external effects on the environment; etc. To take care of those two aspects (i.e. viability of farming system and its contribution to the sustainability of the territory), a sustainable farming system must at the same time be economically viable, ecologically sound, and socially responsible (Ikerd, 1997). Consequently, an assessment framework of sustainability requires an integrated and holistic approach which addressing in the same time different and competing objectives (Van de

[1] The plan aims to increase of surfaces to reach in 2012, 6 % of cultivated areas, to provide aids for conversion, farmers' training, etc.

Fliert and Braun, 2002; Gafsi et al., 2006).

Assessing the sustainability of farming systems represents a process of making operational the concept of sustainability. It is a key issue for the implementation of policies and practices aiming at revealing sustainable forms of farming systems. A great number of studies have attempted to develop methodological frameworks for the assessment of sustainability of farming system (Ness et al., 2007; Sadok et al., 2007; Bockstaller et al., 2009). Many studies propose to measure sustainability by the means of a set of indicators. These methods start from the three dimensions of sustainability (economic, social and environmental). Each dimension is broken down into several components, which are identified and selected. Within each component, one or more indicators are defined and measured. For example, economic sustainability can be measured by global agricultural revenue per unit of family labour, but also by some others indicators representing capital efficiency, financial autonomy, and specialisation (Vilain, 2008).

Indicators are usually used in aggregate form at the levels of components or dimensions. The assessment of sustainability of farming systems then involves identifying meaningful components and indicators for each dimension of sustainability, and finding a single system scoring that would allow combining these indicators and components into aggregate sustainability measures. The aggregation process, related to integrated and holistic approach of sustainability, leads us to look for a compromising solution, which may bring a balance among different dimensions of sustainability. Most holistic approaches of sustainability assessment give the same weight to the three dimensions. But differences between these approaches appear in the choice of components and indicators, and the weight given to different components.

Organic farming principles

Organic farming is defined as a form of agriculture, which do not use chemical inputs in its production process, and enhancing the biological and ecological processes to promote soil fertility and good health of animals and plants. It involves holistic view and relies on ecological processes, biodiversity and cycles adapted to local conditions rather than the use of external inputs with adverse effects. It aims also to promote fair relationships and a good quality of life for all involved. According to IFOAM[2], the basic principles of organic farming are:

- The principle of the health: organic farming should sustain and enhance the health of the soil, plant, animal and human as one and indivisible.
- The principle of ecology: organic farming should be based on living ecological systems and cycles, work with them, emulate them, and sustain them.
- The principle of fairness: organic farming should build on relationships the ensure fairness at all levels and to all parties - farmers, workers, processors, distributors, traders and consumers.
- The principle of care: organic farming should be managed in a precautionary and responsible manner to protect the health and well being of current and future generations and the environment.

These principles are declined then in more specific goals and targets like as the focus on organic matter in soil, the diversity and length of rotations, complementarities between legume crops and cereals as well as between crops and livestock, adaptation of species and races to local conditions, linkages between farmers and consumers, contribution to the local dynamics, etc.

[2] http://www.ifoam.org/about_ifoam/principles/index.html (accessed January 2010)

Design of method for sustainability assessment of organic farming systems

Indicator-based method for the sustainability assessment of organic farming

We opted for an integrated and holistic approach which includes the three dimensions of sustainability: economic, socio-territorial, and agro-ecological dimensions. Since the range of sustainability components associated with farming system, within these three dimensions, is potential very wide, the selection of specific components that would be included in our method was a delicate issue. In order to select components of sustainability common to the organic farming systems and conventional systems, we are based on available indicator-based methods for the assessment of sustainability. Eight indicator-based methods were examined for this purpose. Then for the other components specific to the organic farming systems, we have built it based on the principles of organic farming and respecting the overall coherence of agricultural sustainability. We selected for each dimension four global components (Fig. 1).

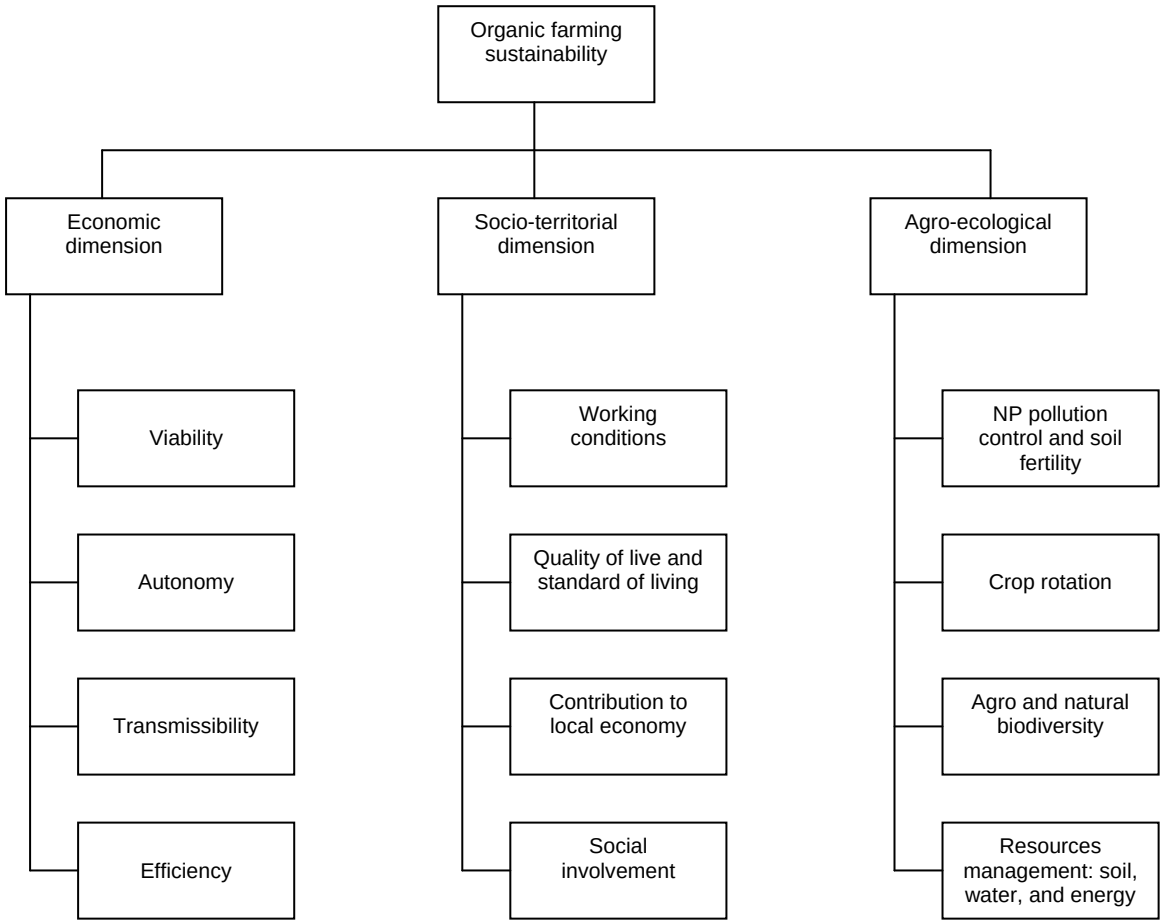


Figure 1. Components of agricultural sustainability.

Economic sustainability dimension includes components relevant to economic situation of the farming system and its ability to continue in the long term. This dimension isn't a specific one of organic farming systems, so we used the same components given by the IDEA method (Zahm et al., 2004; Vilain, 2008). First of all, the farm should be profitable without taking economic risk to be sustainable. So the viability component includes two aspects: the agricultural revenue per unit of labour and the farm's specialisation. The farm should also have a degree of autonomy from the debt and also in relation to subsidies and public aids, particularly the Common Agricultural Policy (CAP) payments. One key of farming system sustainability relies in the economical transmissibility of the farm. The farm will be easily transmitted whereas it has a small economic size (asset value per unit of labour), while large and flourishing farms disappear at the end of farmers career. Finally, the farm will be more sustainable if it increases its farming system efficiency, which will be measured by gross

results per capital. Good efficiency means that farm get more autonomy from providers which would make it less vulnerable to external market fluctuations.

Both social and ecological dimensions are more specific to organic farming systems. So we have selected components according to sustainable agriculture principles and organic farming principles.

Social dimension of sustainability views farmers in two distinct roles: as producers, and members of local society. It is then common to distinguish two types of social dimensions (Gafsi et al., 2006; Van Calker et al., 2006; Vilain, 2008): internal social sustainability and external social sustainability. The internal one deals with work conditions within the farm, the quality of live enjoyed by the farmer, and the living standard offered by the farming system for farmer and his family. The external social dimension relates to the farming system's contribution to the sustainability of its territory and community. This contribution would be in the economic and the social levels and consists of a number of different aspects. Contributions to local economy include permanents and seasonal jobs created on farm, prospects of transmission and continuity of farm, direct marketing contributing to the local economy and creating additional jobs, providing more services in the context of multifunctionality (service provided to local communities, agro-tourism, teaching farm, etc.). For example, on-farm agro tourism activities may have some positive impact on local communities and also provide an additional income for farmer. Social involvements comprise farmer's participation and responsibilities taken in local organisations, regular contact with consumers because people not only consume agricultural products but are also involved in their production, participation to local and professional networks which lead to sharing experiences, and participation to collective actions on joint working, investment group or collective marketing of agricultural products.

Agro-ecological dimension of sustainability examines the propensity of the farming system to combine efficient use of natural resources and minimal environmental cost. It measures the ability of farms to be more or less autonomous in relation to the use of energy and non-renewable resources. But what is also important, according to the principles of the organic farming, is the farm's ability to use and improve agro-ecological complementarities of different productions respecting the balance of the ecosystem. So if it is accepted that the organic farming system causes little risk of pollution, it remains that the great challenge of this system is to better utilize internal resources and agro-ecological balances. The first two components address this issue, particularly the management of soil fertility using organic matter, diversity and length of crop rotations and the use of leguminous plants in rotations. Agro-ecological sustainability requires also a particular attention to the agro and natural biodiversities both at planting hedges which are safe havens for insects and predators zoophagous, plant and animal diversity, and adaptation of species and races to local agro-ecological conditions. Finally, the sustainability of farm depends on farmers' practices concerning resources management, particularly the soil, water and energy management.

The next step was to select an appropriate list of indicators for each component. We are based on the existing indicator-based methods to select relevant indicators. Each indicator receives a mark. The sum of marks for various indicators in one component constitutes the global mark for it. By this way we can estimate the relative weights of different components in the overall sustainability measure. All components haven't the same weight (total of mark), but the three dimensions have the same weight. The sum of marks for different components in one dimension must be 100 point. In order to get this balance between sustainability dimensions, we had set a thresholds and scoring system for each indicator.

The final mark for the overall sustainability is the limiting factor, i.e. the lowest among the three dimension marks. It is important de underline that the dynamic orientation towards sustainable agriculture is to undertaken through three dimensions - economic, social-territorial and agro-ecological – simultaneously. Being successful on only one dimension is not enough to reach sustainability. We can not compensate for the weakness of one dimension by good marks in others.

Survey design and case study

To illustrate possible applications of the proposed method, we studied the sustainability of selected farms in the region of Midi-Pyrenees region. To do this, we developed a questionnaire to gather information necessary to assess the sustainability of farms, i.e. to measure each indicator and give it a mark. The questionnaire consists of two sections. At the beginning, general information about farmer (age, education, professional experience, etc.) and farming system (size, types of productions, marketing modes, etc.) are asked. The next section was designed to extract information necessary to various sustainability indicators. The questionnaire is designed to being administrated during an interview with the farmer.

Farms are chosen in the Midi-Pyrenees region, in south western France. A large region with a diversified agriculture: cow and sheep breeding, crops, mixed farming, fruit and vegetable production, wine making etc. Except for small very fertile natural regions, the agriculture of Midi-Pyrenees is not very productive. The environment (soils, climate, slopes…) makes the intensification more difficult here than for other French regions, either for crops or breeding. These characteristics and constraints are also valid for organic farming. Data has been collected from 15 farms. The sample has not been made in the aim of being a strict representativity of organic farming in Midi-Pyrenees, but we focused on main production systems (crops, breeding, and mixing farming) and introduced variety through the size of farms, duration in organic farming, marketing modes. The farming area is from 34 to 210 ha. 4 farms mainly breed cattle, 8 have crops, and 3 are in mixed farming. Half of farms have direct marketing modes. Only three farmers had converted to organic farming before 1999 (this date symbolise the undertaken of French procedure of sustainable agriculture, which encourage the conversion to organic farming).

Application of the method

Here we aim to demonstrate how our proposed method could be used and to assess its performances. Firstly the application of this method has proved easy to implement. The two-hour interview with the farmer enough to get information required all indicators and to measure then the sustainability of his/her farm.

Then, the results of the fifteen farms studied show that the proposed method has good sensitivity which allows to observe the differences in sustainability between farms (Fig. 2). The overall sustainability mark varies from 27 to 56 and corresponds to the lowest mark among the three dimensions' marks: economic, socio-territorial and agro-ecological. This criterion is important in assessing the performance of a measurement tool, since it captures the small differences between farms in the process of improving sustainability. Moreover, these differences are not only captured between different production systems, but also within the same production system. Figure 3 shows the change in rating sustainability in three different systems: crops, breeding, mixing farming. As can be seen there is considerable variability within each of the three systems.

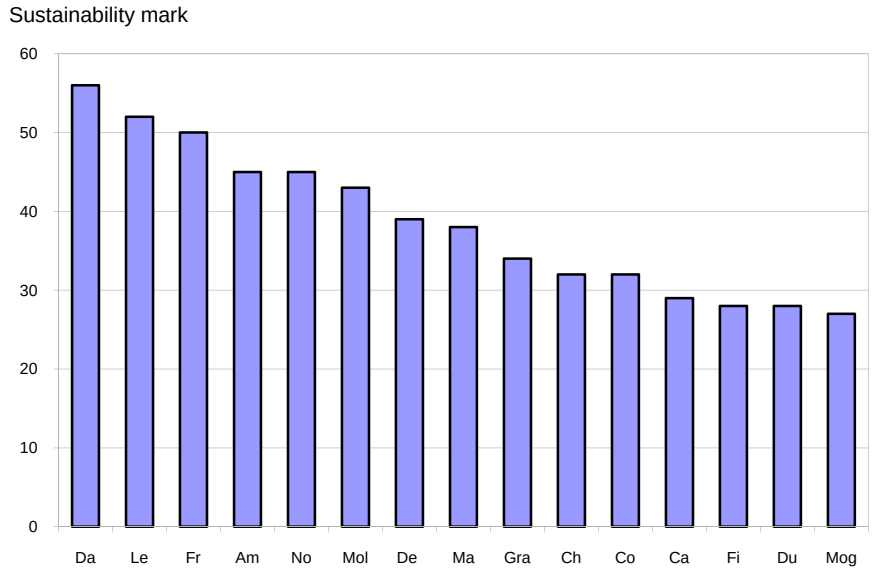


Figure 2. Sustainability rates in the farms surveyed.

The proposed method can reflect quite accurately the differences in farming practices. A radar presentation can view synthetically these differences on the twelve components of sustainability. The two farms presented belong to the same system of production that the mixed system, but they have different levels of sustainability (Fig. 4). Farm Da has a high area of sustainability compared to the average of all farms. By contrast, farm Mog has a low sustainability area. For this farm, except the components of viability and NP pollution control-soil fertility, all other components are at levels below the group.

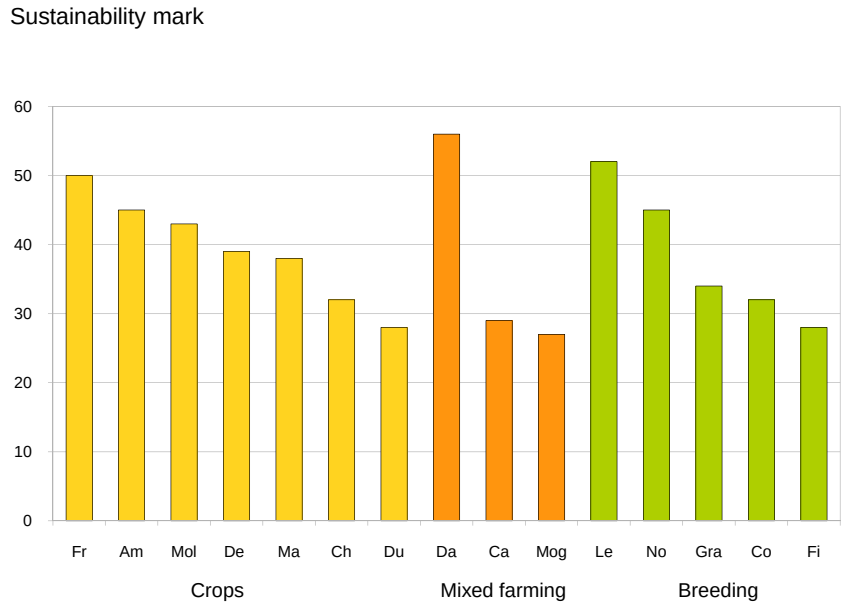
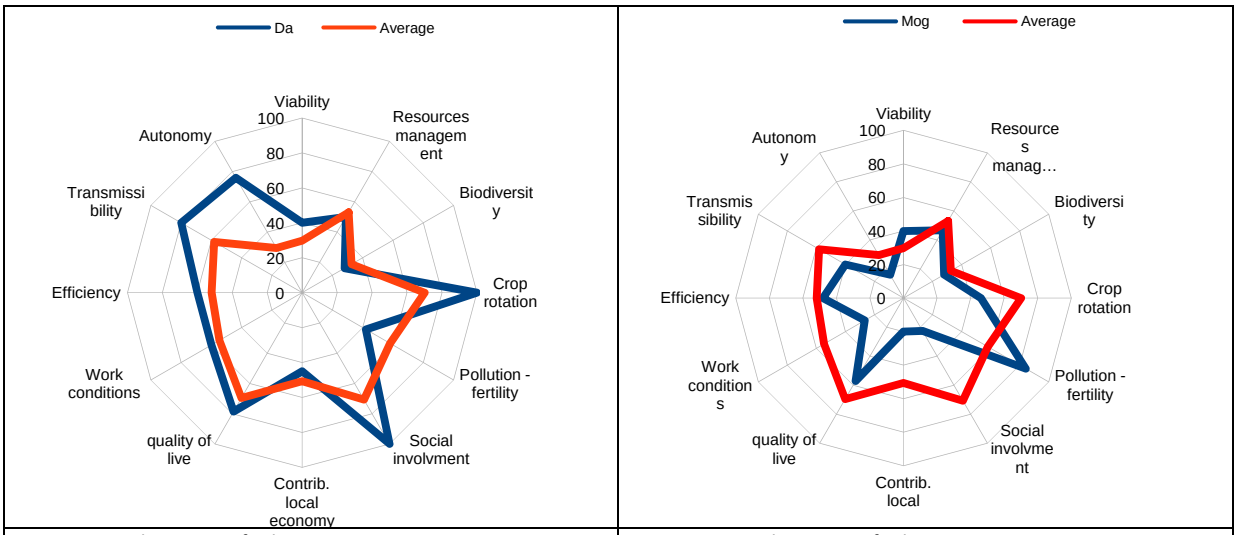


Figure 3. Sustainability rates ordered per production systems.

The results show also that the methodological work take into account very well the agronomic specificity of organic farming in terms of integrated approach, soil fertility, long rotations and diversification. Farmers who use many agro-ecological complementarities in their farming systems, by opting for long rotations and the improvement of technical aspects without systematic use of organic fertilizers, have obtained good marks in the agro-ecological sustainability. However, who have opted to simplify their farming systems by choosing a pattern of conventional agriculture (specialization, short rotations, heavy use of inputs) had a low level of sustainability. Similarly,

regarding the socio-territorial sustainability, farmers who have direct contact with consumers and are well integrated into local networks have important marks.



Farm Da : 147 ha, 2 Unit of Labour. Crops: beans, bread wheat, soybean, sunflower, clover 14 suckling cow; Pasture : 7 ha permanent pasture, 15 ha temporary pasture. Turnover: 147 000 euros	***Farm Mog*** : 205 ha, 2 Unit of Labour. Crops: bread wheat, sunflower, barley 20 suckling cows; 15 ha of main fodder area, including 7 ha of corn. Turnover: 263 000 euros

Figure 4. Radar presentation of sustainability rates in two farms.

An overall look to sustainability rates in all farms shows a fairly low to medium level. Scores range from 27 to 56. But this reflects the lower value of the three components. Farms have obviously higher values for other dimensions. For example, farm Co has a sustainability score of 32, which corresponds to the note of the economic dimension. This farm has good marks in socio-territorial and agro-ecological dimensions, respectively 71 and 63. The lowest rating corresponds in 9 cases out of 15 to note the economic sustainability, in 5 cases to note the agro-ecological sustainability and for one case to the socio-territorial sustainability. The economic sustainability is the one in which the grading varies the most (28 to 65), and is also the worst (average: 42). Only four farms are above average. Generally, on average the farms in the sample have a weak economical viability (income per worker) and financial autonomy due to debt; they are rather dependant on public subsidies (notably CAP) and quite specialized, but are easy to pass on, and have good production efficiency.

Discussion and conclusions

Taking into account the specificities of the organic farming systems is very important for the development of an effective sustainability assessment tool for such systems. In this paper we propose an indicator-based method dedicated to treatment of these specificities. The results of its application in selected farms in Midi-Pyrenees region show the relevance of this method, particularly in the social and ecological dimensions where there is a need to have indicators suitable for organic farming.

Thus, for the ecological dimension, the issue of autonomy of the production system and its consistency with the characteristics of the ecological system has been well identified in the farms and well measured by the indicators. This is a crucial issue for the organic farming that goes beyond the environmental concerns (environmental protection and natural resources) to associate strongly with the agronomic aspects and the productive dimension of agricultural system. For this reason we chosen to call this dimension “agro-ecological” and not only “ecological” what is usual in the sustainability literature. It is also in the same spirit that we have chosen the name of “socio-territorial” dimension instead of “social” dimension. Indeed, the basic principles of organic agriculture encourage farmers to have a high involvement in the territorial and local level. This

occurs through active participation in local networks, the principle of fairness and contact producers - consumers. The assessment method proposed offers indicators dedicated to this topic. The results illustrate the practices of farmers in this area, resulting in a higher mark of the socio-territorial sustainability.

Overall we can have a degree of satisfaction with the relevance of this method, but improvements are required in terms of taking into account the variability of production systems in organic farming. These systems, in Midi-Pyrenees region like as in France, present a very large variability ranging from market-garden crops and arboriculture to cropping systems or livestock systems. Indeed, all the farms surveyed have common production systems (crop, breeding, mixing farming). But specific production systems such as market-garden crops or fruit growing and viticulture have not been studied. But these systems require many adjustments, particularly in agro-ecological indicators.

In conclusion, we can say that the current development of organic farming requires backup from scientists, policymakers and other stakeholders to facilitate the evolution of these farming systems towards sustainable paths. The built of a method for assessing the sustainability of these systems is an action undertaken in this regard. This method has the required elements to be easily used by actors. It is a diagnostic method easy to use, relevant to the principles of sustainability and organic farming, and synthetic. However, this method remains to be validated in other contexts and other production systems, which could be the subject of further research.

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