DIALECTE, a comprehensive and quick tool to assess the agro-environmental performance of farms

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ABSTRACT

Solagro has developed DIALECTE, a comprehensive, holistic and quick tool to assess the agro-environmental performance and the ecological sustainability of farms. It is applicable to any type of farming system in Europe. The tool was designed to help farmers identify scopes for improving the sustainability of agricultural production on their farms. DIALECTE's rating system is based on the principles of agroecology, integrated production and organic farming: it favors diversified farming systems, high levels of biodiversity, systems that are adapted to local conditions, and the use of abundant rather than rare resources. The tool calculates 43 agro-environmental indicators to produce (i) a farm-scale approach that assesses the farm's diversity and the management of inputs, and (ii) an assessment of the potential impacts of the farm on water, soil, biodiversity and resource use. DIALECTE is freely accessible, available in several languages on the Internet (http://dialecte.solagro.org). A database allows sharing and comparison of the results.

The methodology and three examples of DIALECTE's implementation are presented. The value of using this kind of tools is discussed.

1 INTRODUCTION

With population growth, the demand for biomass for food, energy and other products (such as biomaterial for the construction industry) is increasing, while the area of agricultural land is decreasing in Europe. Yet, intensive agriculture has shown its limits in complying with the challenge of sustainable production of agricultural products: many regions are confronted with a severe degradation of water quality (contamination of ground water tables and stream waters with nitrate and pesticides), soil erosion and biodiversity loss. Climate change is also a new challenge: farms have to reduce their GHG emissions. In this context, farming systems and farm management have to change, since natural resources are overexploited by intensive farming, and the sustainability of farming systems is currently under debate.

European agriculture has to solve a new equation: it has to be productive, sustainable and keep on providing the ecological services that society expects. The question is how to maintain productivity levels or improve them with a minimum amount of inputs? This goal is part of the Biodiversity Action Plan for Agriculture: "To promote and support low-intensity agricultural systems" (COM, 2001, 162 final – Table 2). Moreover, compliance with European environmental programs (cross-compliance, « Nitrates » Directive, Water Framework Directive, Sustainable use of pesticides directive, European Soil Strategy, the Birds Directive and the Habitats Directive, Biodiversity Action Plan for Agriculture) requires a better use and a significant reduction of agricultural inputs. In this context, Low Input Farming Systems (LIFS) and organic farming (OF) could provide credible answers (Biala, 2008).

Methods and tools to analyze and help with the management of farming systems are needed to take up this challenge, in order to improve the sustainability of farms and to recognize their performance through label or certification systems and to encourage farmers to protect the environment. It is also important to compare the performance of existing intensive agricultural systems, based on optimizing

the productivity of monoculture or short rotation, with multispecies cropping systems, or of organic farms with conventional farms. The environmental and productive efficiency of farms ought to be explained and analyzed to provide relevant advice and offer adapted agro-environmental measures. To this end, Solagro has designed “DIALECTE”, a comprehensive, holistic and quick tool to assess the agro-environmental performance and the ecological sustainability of farms, which is applicable to any type of farming systems in Europe.

The paper presents:

- A description of DIALECTE with its main features
- Three examples of its implementation
- A discussion on DIALECTE’s outcome with perspectives for the future

2. PRESENTATION OF DIALECTE

2.1 DIALECTE’s history

DIALECTE has been developed by Solagro since 1995, with the support of public entities. DIALECTE is adapted and improved on a continuous basis. Up to now, more than 3,000 farms have been evaluated in France, 200 farms are being assessed in other European countries. 1300 farms are validated in the database with an addition of about 300 farms per year. DIALECTE has been freely available on the Internet since 2006. The tool was transferred in different EU countries (Hungaria, Spain and Portugal) in the framework of Leonardo projects (COMPAS, ECODIAG1) and is available in five languages. The objective was to build a tool, easy to implement and affordable, adapted to all types of farming systems to assess the impacts of farming practices on the environment at farm scale.

2.2 Methodology

DIALECTE’s rating system is based on the principles of agroecology, integrated production and organic farming: it favors the diversity of agricultural production within farms, high levels of biodiversity, systems that are adapted to local conditions, recycling, nitrogen symbiotic fixation and the use of abundant rather than rare resources. It takes into account the overall farming system and not only agricultural practices. Fig. 1 shows the aspects of the farming system addressed by DIALECTE.

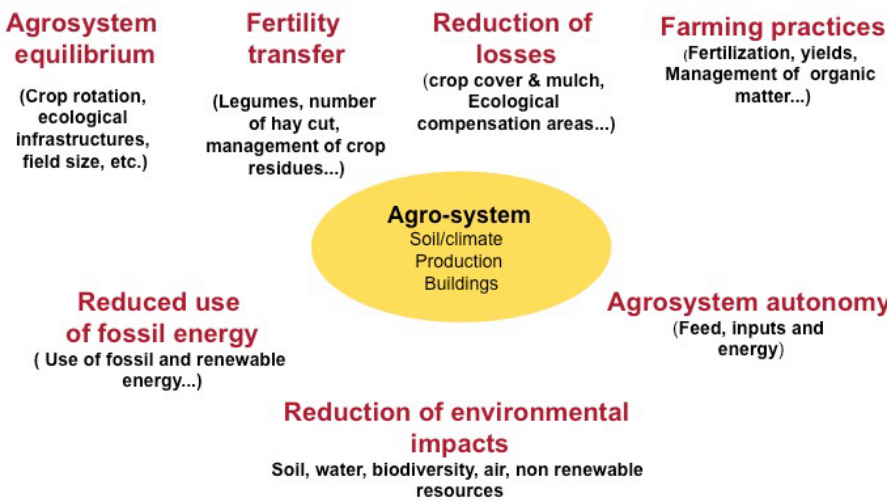

Fig. 1. Agronomic and environmental aspects of farms addressed by Dialecte

[1] *www.ecodiag.eu*

A farm's environmental impacts and sustainability cannot be assessed directly and thus a set of more specific criteria is required (Van der Werf and Petit, 2002). Dialecte uses criteria related to farming practices, input use and the state of the system. The tool calculates 43 agro-environmental indicators to produce (i) a farm-scale approach that assesses the farm's diversity and the management of inputs (Table 1), and (ii) an assessment of the potential impacts of the farm on water, soil, biodiversity and resource use (Table 2). In both approaches, criteria are a combination of several indicators that are calculated from the data collected from a farm survey. A full description of the methodology is available from the Dialecte methodological manual available at http://dialecte.solagro.org/. The indicator selection was done by experts on the basis of a scientific literature review and on the selection of standardized indicators regularly used in environmental and agricultural regulations (e.g. nitrogen balance in the Nitrogen directive or number of pesticide treatments in the Sustainable use of pesticides directive). The sustainability thresholds of the selected indicators are based on the average of French farms, with adaptation to take into account the diversity of farming systems.

Robustness and practicality are the main strenghts of the tool. The weaknesses have to do with the difficulty for the farmers to interpret some of the indicators. That is why comparisons between farms in a collective approach is so important.

Table 1 Criteria and indicators related to the farm's diversity and the management of inputs that constitute the farm-scale approach

FARM-SCALE APPROACH	
Farm diversity	Management of inputs
Three criteria noted on 70 points	*Five criteria noted on 30 points*
Crop diversity (3 indicators – 30 points)	Nitrogen (3 indicators - 7.5 points)
Animal husbandry, diversity of breeding	Phophorus (2 indicators - 3 points)
Feedstuff and fodder autonomy (5 indicators - 22 points)	Water (2 indicators - 8 points)
Ecological infrastructures (2 indicators - 18 points)	Pesticicdes (1 indicator - 7.5 points
	Energy (2 indicators - 6 points)

Table 2 Criteria and indicators used in the thematic approach

THEMATIC APPROACH – *Four criteria*
Water (9 indicators – max 20 points)
Soil (5 indicators - max 20 points)
Biodiversity (4 indicators - max 20 points)
Use of non renewable resources (5 indicators - max 20 points)

To evaluate the strengths and weaknesses of the farming system, this quantitative approach is completed with a qualitative approach that integrates the socio-economic aspects, the farmer's strategy and other technical data. Conducting both quantitative and qualitative approaches allows to identify levers for improvement of the sustainability of farm management (Fig. 2). As a monitoring tool, DIALECTE can evidence trends and developments over time on individual farms.

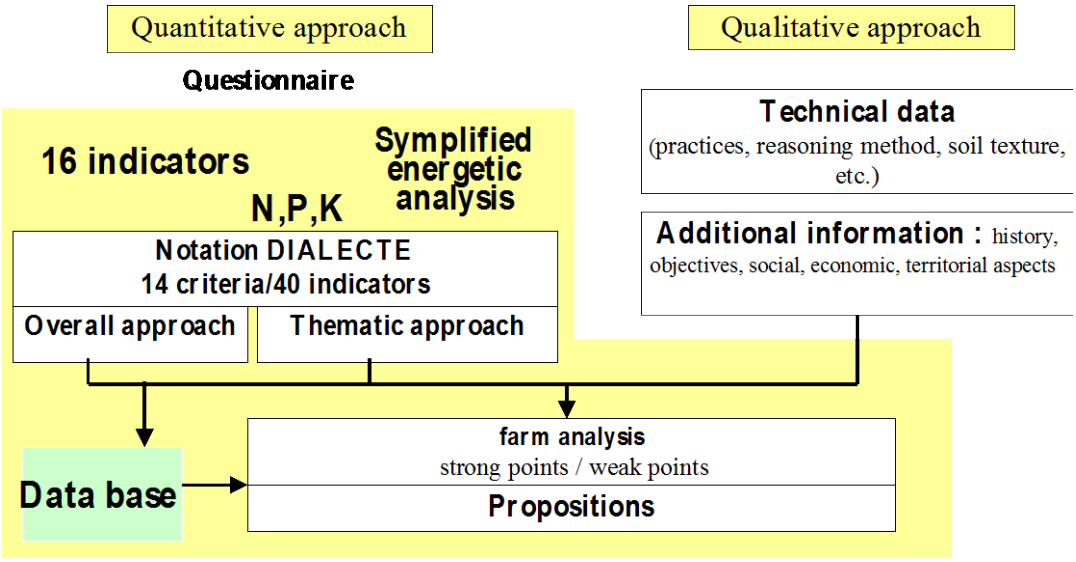

Fig 2. The DIALECTE methodology

2.2 Requirements to use DIALECTE

The data collection method is generally based on a face-to-face discussion with the farmer and a field visit. Farmers are interviewed using a survey form available on the DIALECTE website. Background knowledge in agriculture is necessary to interact with farmers and to validate the collected data, such as farm balances (nutrient, fodder...) and to examine the plausibility of both the input and output variables. One day of work is necessary to assess one farm.

2.3 The use of DIALECTE

DIALECTE's main goal is to provide advice to farmers regarding farm management and the environment. As more than 1,300 farms were surveyed, DIALECTE now constitutes a database of agronomic and environmental references that allow to compare farms according to numerous criteria. It must be kept in mind that environment-friendly farms are over-represented in DIALECTE, with organic farms accounting for half of the database.

Examples of the use of DIALECTE are given below:

- DIALECTE is used in the European research project BioBio[2] that aims to build biodiversity indicators for organic and low input farming systems. All farms in the case studies were assessed with DIALECTE, thus enabling to explore the relationships between biodiversity indicators and DIALECTE outputs in various farming systems across Europe.
- DIALECTE has been used for prospective studies, commissioned by the French Ministry of Environment for the certification of farms and for the environmental labeling of food products.
- DIALECTE is used to assess 40 farms of agricultural schools involved in the Ecophyto project aimed at reducing pesticide use by 50%.
- DIALECTE has been implemented in several collective and territorial projects to characterize High Nature Value farming systems of mountainous areas located in national parks.

[2] *www.biobio-indicator.org*

- DIALECTE is also used to train students from agronomic schools but the farms surveyed do not increment the database when they are not controlled by the teacher

Dialecte's users are mainly organisations working for the development of organic agriculture, since they have a higher awareness of environmental issues (Table. 3); they use DIALECTE for projects of farm conversion from conventional to organic farming.

Table 3 : Type of Dialecte users in 2011

Type of users	**Proportion of evaluations performed**
Organic farming organizations	40%
Solagro	20%
Agricultural Professional Organization	18%
Engineering agencies	12%
Education and teaching	8%
Others	2%

In various research or development projects, Solagro and professional agriculture organisations implement DIALECTE as a first agroenvironmental evaluation. Many vocational schools or engineering schools use Dialecte as a pedagogical tool in order to understand the complexity and the interactions of an agroecosystem.

3. IMPLEMENTING DIALECTE

Three examples are presented showing how the tool is implemented and giving some results of the agro-environmental performances of some farming systems.

3.1 Organic versus conventional dairy farms in France

The DIALECTE database can be used to compare the agro-environmental efficiency of organic farms and conventional farms for the same farming system. Dairy farms have been analyzed as an example. The first farm group is a sample of 121 conventional dairy farms and the second group is an organic one (125 farms). The comparison (see table 4 below) shows that for the main agro-environmental indicators (crop diversity, share of legumes, autonomy, percentage of ecological infrastructures in the UAA, nitrogen surplus, energy consumption per ha), organic farms obtain the best results. It means that organic dairy cattle systems are better adapted to face environmental challenges (water quality, soil fertility, biodiversity). But the energy efficiency is higher in conventional farms due to higher productivity. The share of legumes is a good descriptor of organic farms with generally a share of 20% to 30% of the UAA, as legumes is their main nitrogen source through symbiotic fixation. The share of semi-natural habitats (ecological infrastructures) is also higher in organic farms and must contribute to better ecological services. The ecological sustainability, measured with the final score, is also higher.

Table 4. Environmental efficiency of conventional and organic dairy cattle systems (source: DIALECTE database)

Indicator	Max. thresholds	**Conventional**	**Organic**
Number of farms		121	**125**
UAA in ha		109	**95**
	Mixity of the farm		
Crop diversity and soil coverage			
Crop diversity	10	7	**9**
Share of legumes (% UAA)	33 %	13%	**27%**
Soil coverage in winter (% UAA)	100%	86%	**95%**
Livestock diversity, autonomy			
Livestock diversity (number of herds)	2	1	**1**
Fodder autonomy	100%	90%	**95%**
Concentrate autonomy	100%	24%	**62%**
Ecological infrastructures			
Ecological compensation area (% UAA)	100%	13%	**16%**
Average plot size (maximum 10ha)		5	**5**
	Input management		
Nitrogen			
Controllable N Pressure (mineral and organic) (kg N /ha)	200	133	41
N surplus (kg N /ha UAA)	50	80	**49**
Phosphorus			
Controllable P Pressure (mineral and organic) (kg P2O5/ha)	100	58	**19**
P surplus (kg P2O5/ha UAA)	30	29	**7**
Water for irrigation			
Volume used per farm (1000 m3)	150	22	**3**
Pesticides			
Pesticides (number of treatment/ha UAA)	10	1.3	**0**
Energy			
Consumption (Litre Equivalent Fuel /ha UAA)	1000	533	**272**
Efficiency		1.6	**1.2**
Final score DIALECTE	100	63	**80**

3.2 Comparison of dairy farms in Switzerland and Germany (BioBio project)

The European research project BioBio aims at selecting indicators (plants, earthworms, wild bees and spiders) for assessing farmland biodiversity. Farm management indicators have been surveyed in a sample of 194 farms located in 12 case studies and 11 countries. DIALECTE has provided two main farm management indicators: “nitrogen pressure” and “energy consumption”. Two case studies

(Switzerland and Germany) focused on dairy farms have been compared (see table 5). Indicators offer data to compare the German and the Swiss dairy systems but also organic versus conventional farms.

Swiss farms

The case study for Switzerland is located in Obwalden, in the central part of Switzerland. A total of 19 farms have been surveyed (10 organic and 9 conventional). The average size of Swiss farms is very small, 10 ha plus the summer pastures estimated to 22 ha. The average number of cows is 13, producing 79,000 litres of milk with an average of 6000 l per cow The average total livestock unit (LU) is 22 per farm and stocking density 0.71. The landrace is Brown Swiss. Behind milk production, these farms produced on average 105 kg of live meat per ha including pastures.

Summer pastures produce approximately 30% of the fodder needs. Permanent grasslands produce the other part. These are intensively managed with an average yield estimated between 7 to 9 tons per ha, sometimes with 4 cuts per year. But mineral nitrogen represents only 2% of the fertilization. The nitrogen symbiotic fixation is estimated to amount to 24% of nitrogen inputs (considering 15% of legumes in grasslands). Nitrogen recycling with slurry and manure represents 74% (a small part is bought to neighboring pig and poultry farms).

Taking into account summer pastures, the nitrogen pressure per ha is 83 kg and the nitrogen surplus is 18 kg (7 to 37). The nitrogen pressure is higher in permanent grasslands.

The fodder autonomy is very high: 98% in OF versus 92% in CF. All concentrates are bought and represent 295kg/dairy cow or 5 kg per 100 litres of milk.

The energy consumption is higher in organic farms, 205 equivalent liters of fuel (ELF) per ha of UAA versus 182 ELF for conventional farms, showing higher input uses in organic farms. And the energy efficiency is also higher for conventional farms: 0,08 ELF/l of milk versus 0.09 for organic farms. This efficiency is high compared to French dairy farms with an average of 0,13 (Bochu, 2007).

The main semi-natural habitats are extensive pastures and summer pastures. The semi-natural habitats cover 67% of the UAA in OF versus 74% in CF.

Finally, organic and conventional farms obtain both a high score for ecological sustainability: 86/100 in OF versus 88/100. These dairy farms located in mountains have adopted more or less the same practices.

German farms

The farms are located in Bavaria. These are mixed farming systems with arable land and grassland. There is high pressure on the land for development purposes. A total of 16 farms have been surveyed (8 organic and 8 conventional) with an average size of 54 ha in OF versus 67 ha in CF. The cropping system of these mixed farms is well diversified.

The main production is milk: 175,000 l in OF versus 309,000 l in CF. The average number of milk cows is 34 in OF versus 44 in CF and the average production of milk is lower in OF : 5200 l per cow versus 7100l in CF. The landrace is Simmental. The average total livestock unit (LU) is 51 in OF versus 76 in CF and the stocking density is 1.7 in OF versus 2.4 in CF (from 1.2 to 3.8). The animals graze in only 2 farms. In addition to milk production, these farms produced on average 151 kg of live meat per ha in OF versus 239 in CF.

Part of the grains is consumed by animals (wheat, barley, rye, triticale, oats) and part is sold (wheat, rapes, spelt, bean, pea, sugar beat, potatoes). The average production of grains sold is 38T per farm in OF versus 154 T in CF.

Permanent grasslands are intensively managed with an average yield estimated to 8 tons per ha for permanent grasslands in OF versus 11T in CF. The red clover yield is estimated to 9T in OF versus 12T in CF. The yield of silage maize is estimated to 13.2 T DM in OF versus 15.8 in CF.

The fodder needs are met by permanent grasslands (51% in OF versus 36% in CF), red clover (37% in OF versus 5% in CF) and silage maize (10% in OF versus 60% in CF). The autonomy is total.

The autonomy for concentrates is higher in OF: 90 %, versus 54% in CF. The quantity of concentrates used per 100 litres of milk is lower in OF: 30 kg versus 32 kg in CF, and 1483kg/milk cow in OF versus 1851 in CF.

Mineral nitrogen represents only 46% of the fertilization in CF. The nitrogen symbiotic fixation is estimated to 51% of nitrogen inputs (considering 15% of legumes in grasslands) in OF versus 14% in CF. The share of legumes in the UAA is higher in OF: 29.3% versus 8.9% in CF. The nitrogen recycling with slurry and manure represents 49% in OF versus 40% in CF.

The nitrogen pressure is lower in OF: 176 kg/ha UAA versus 254 kg in CF as the nitrogen surplus is 41 kg (1 to 69) in OF compared to 71 kg (29 to 115) in CF.

The energy consumption is lower in organic farms, 308 equivalent litre of fuel (ELF) per ha of UAA versus 603 ELF for conventional farms, showing higher input uses in conventional farms. And the energy efficiency is also higher for OF : 0,09 ELF/l of milk versus 0.13 for CF, but conventional farms produced more grain and more meat (in these figures all the energy consumption is affected to the milk). So it is difficult to conclude.

The main semi-natural habitats are: extensive grasslands (39%), hedgerows (32%) and grassy strips (28%). The forest edges are not taken into account. The percentage of these SNH in the UAA is 2.8% in OF versus 2.4% in CF. In the end, the score of ecological sustainability is 78 /100 in OF versus 54/100 in CF.

Table 5: Comparison of Swiss and German dairy farms surveyed in the BioBio project with DIALECTE

	Swiss		**Germany**	
	Organic	Conventional	Organic	Conventional
UAA (ha)	9,9	10,4	53,9	66,5
Summer pastures (ha)	19,7	24	0	0
Stocking density (LU/fodder ha)	0,72	0,71	1,70	2,40
milk/cow (l)	5 868	6 082	5 207	7 098
concentrate/dairy cow (kg)	304	228	1 483	1 851
concentrate/litre of milk (kg)	0,05	0,04	0,30	0,32
Energy/litre of milk * (ELF)	0,09	0,08	0,09	0,13
Energy per ha	205	182	308	603
life meat sold/ha (kg)	118	91	151	239
Grains sold /ha (kg)	0	0	540	1880
N pressure	85	81	176	254
N surplus	16	21	41	71
Final score Dialecte	86	88	78	54

Conclusions

The comparison, based on selected indicators, shows clearly the differences between German and Swiss dairy farming systems. German farms are larger and more intensive with a higher stocking density and milk production per cow. German farms used 7 times more concentrates per kg of milk and more energy per ha but in the end their efficiency is comparable. However, it is difficult to

conclude as the tool does not realize energetic allocations between milk, meat and grains. The environmental pressure is higher on German farms with a larger N pressure and N surplus.

The milk system of Swiss dairy farms is based on the use of summer pastures, a high grassland productivity and a low consumption of concentrates. German farms are based on multicropping systems, a high intensity of crops and grasslands and the use of concentrates.

No differences are observed between organic and conventional farms in Switzerland. In Germany, organic farms are less intensive than conventional ones but more intensive than conventional Swiss farms.

3.3 Farms involved in the reduction of pesticides use

The French Ministry of Agriculture has launched a program about the reduction of pesticide use, called Ecophyto 2018 which aims at reducing pesticides use by 50%. In 2012, fourty French vocational schools for agriculture are involved in this action through the General Direction of Education and Research. Each school has to carry out an agroenvironmental evaluation with Dialecte on their own school farm. Solagro is responsible for results valorisation and dissemination. The two following figures show first results based on the Dialecte diagnosis analyses.

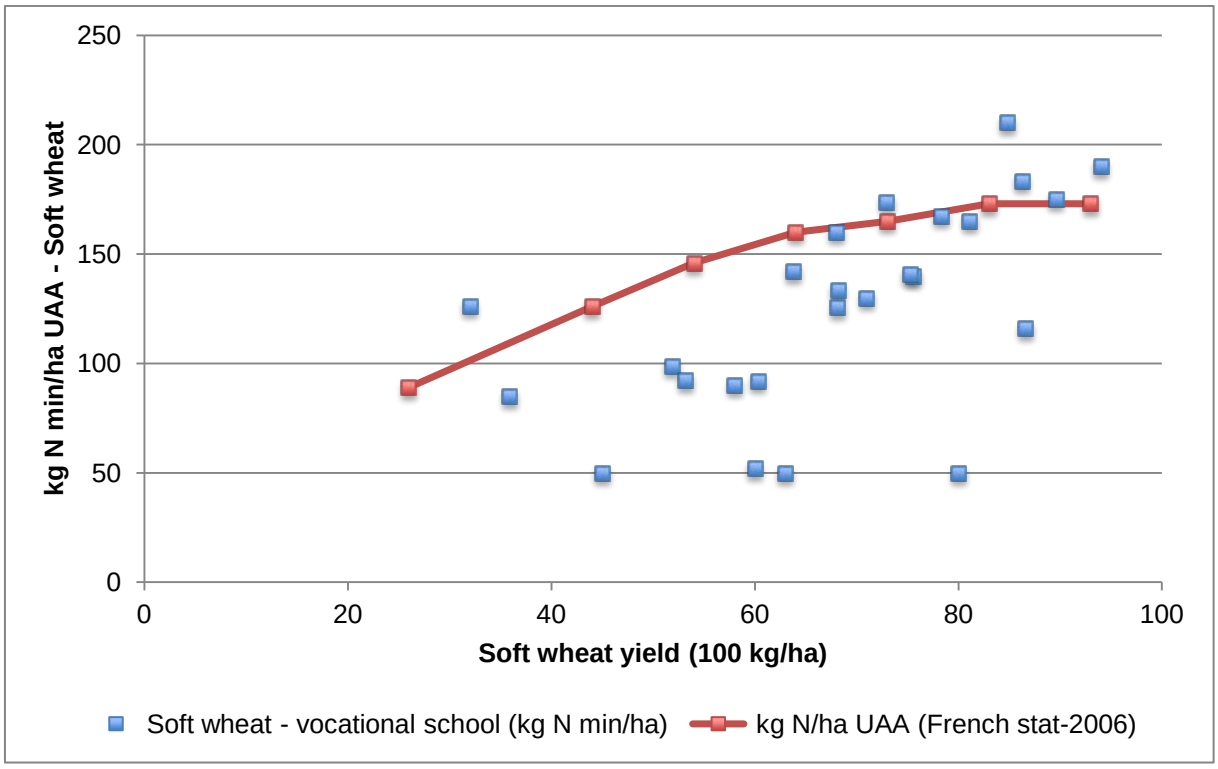

Fig. 3: Performance of the farms involved on Agrienvironmental measures compared to national references concerning nitrogen

The curve (fig 3) represents the consumption of nitrogen mineral fertiliser per hectare of UAA depending on the soft wheat yield and compared with the average of French farms (Agricultural Practices Survey 2006). Most farms present lower quantities of mineral nitrogen fertiliser considering levels of soft wheat yields. School farms are working on optimising mineral fertilisation. Points scattering shows the possibility for improving fertilisation practices.

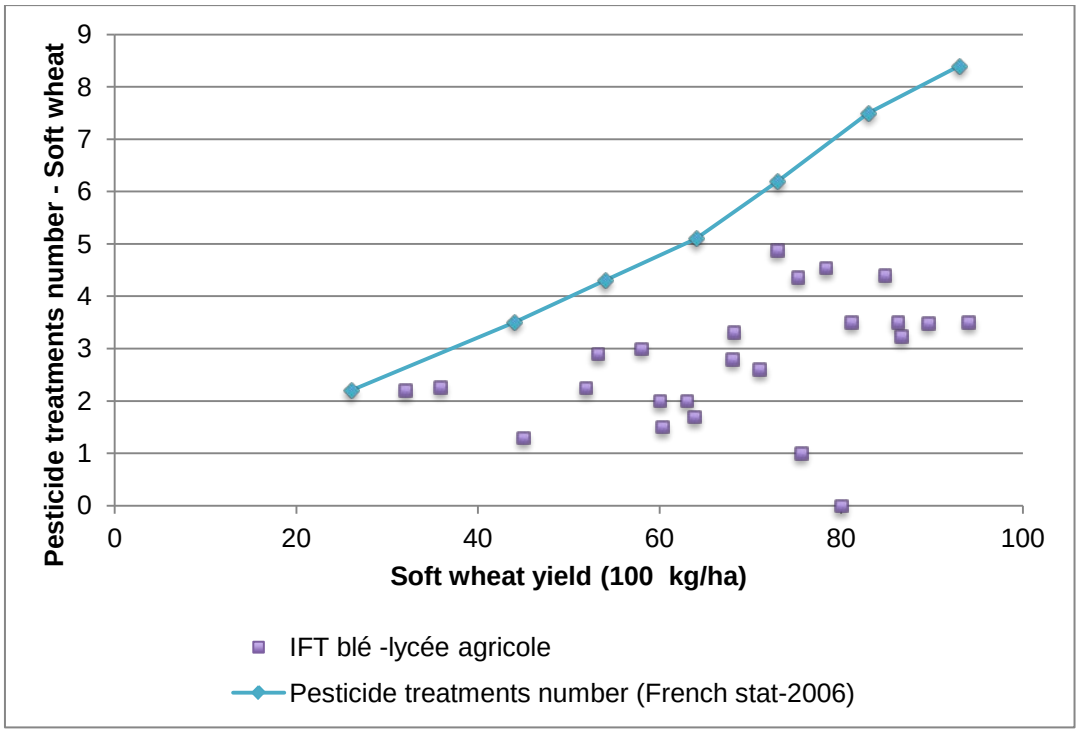

Fig. 4: Performance of the farms involved on AEM compared to national references concerning pesticides use

Based on French statistics (Agricultural Practices Survey, 2006), the curve (fig 4) represents the number of pesticide treatments on soft wheat crops according to the yield level. All school farms are below the average of French farms measuring the effort done. These are only first trends, as the number of pesticide treatments varies widely depending on climate conditions. As for the previous figure, points scattering shows flexibility for optimising pesticide management.

4 DISCUSSION AND CONCLUSION

DIALECTE indicators allow comparing the intensity of farm management, environmental pressures and farm productivity. The 3 examples show that a lower intensity (nitrogen pressure, LU, energy per ha-) of farm practices is generally correlated with a lower pressure on environment (nitrogen balance, pesticides uses). Organic farming is one way of preserving the environment, but it productivity per ha (liter of milk, kg of meat or kg of grain) is generally lower. With regards to efficiency, a great variability exists between farm types and inside a homogenous farm group as well. Efficiency and environmental impacts are also linked with the farmer's skills, natural constraints and global coherence of the farm. More data are necessary to explain how a farm can be at the same time a low input and a high efficiency farming system.

Developing low input (or lower input, or lower external input) and high efficiency agricultural systems is a priority for the future (see figure 5). This objective requires an improvement of farming practices (like nutrient balances, pesticide reduction, renewable energy use, adaptation to the climate and the soil, green manure, direct drilling, grazing period, …) and of farming systems (such as longer crop rotation, legume use, intensification of biodiversity, higher recycling,…).

Tools to analyze farming systems must be implemented to get references for each farm type and each region. Working at a local scale with a group of farms gives the opportunity to compare and share results between farmers.

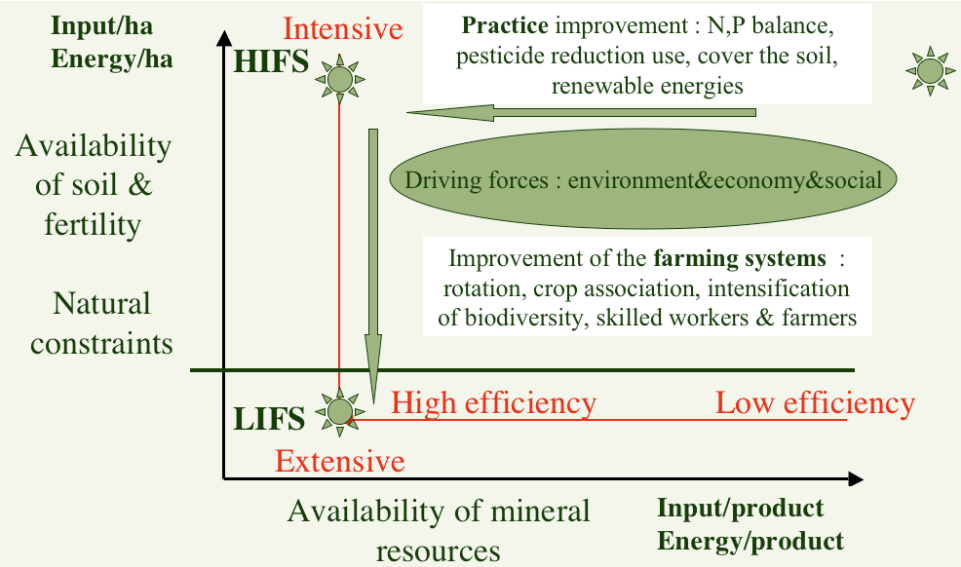

Fig. 5. Improvement of extensity and efficiency of farming systems (HIFS : High Input farming systems, LIFS : Low Input Farming Systems)

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