

MEASURING THE INFLUENCE OF AGRICULTURAL ACTIVITIES ON THE ENVIRONMENT AT FARM LEVEL - CASE STUDY

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Abstract: *The measuring method takes into consideration the environment at farm level, by making a diagnosis of interactions between the farming activity and the environment. The goal of the method is to establish the current situation of the environment at a certain moment, to reveal the ecological systems and to identify the risky practices. The method uses a double approach: global – analysis of the farm system and its practices (30 indicators, ranging from 1 to 100 scores) and thematic – farming activity impact upon the different environment segments (23 indicators, ranging from 1 to 20 scores). The case study on a livestock production farm revealed quite interesting results, specific to the Romanian agriculture, and certain indicators were comparable to the average indicators of the groups of similar European holdings.*

Key words: *Dialect method; agro-environmental diagnosis; indicators; agricultural holding; Romania.*

INTRODUCTION

The design of a diagnosis tool for agriculture and environment at farm level falls within the general context of the general environmental impact, of human activities, as well as of the sustainable development concept that was a key issue at the Conference of Rio in the year 1992. At international level, a process of environmental certification of enterprises was developed (ISO 14000) and is under way of implementation.

Sustainable agriculture is concerned with capacity of agro-eco-systems to remain productive on long term. Numerous authors defined and studied sustainability from the ecologic, economic and social standpoint. The ecologic sustainability was defined from the perspective of global eco-system conservation or of natural capital conservation under the form of the stock of environmental goods that supplies a flow of goods and services useful to the society [1].

More recently, we have witnessed an intensification of concerns for the loss of the quality of natural capital source functions of agriculture, as a result of erosion phenomena, of the disappearance of beneficial non-vertebrates – predators and pests – in crops or the diminution of organic matter in soil.

These scientific concerns led to the proposal of different methods and methodologies for the evaluation of agriculture impact upon the environment [4], [2].

The team of specialists [2] chose a classical method to evaluate the environmental impact: the interaction matrix for the assessment of the effect of farmer's practices upon the agro-eco-system components. Evaluation modules were developed for impact characterization, and their aggregation produces two types of indicators: *agro-ecological indicators*, which express the influences of a certain practice upon the overall environment components, while the *environmental impact indicators* express the influences of the overall practices upon a given environmental component.

In the following years, the indicator-based methods for the assessment of agriculture impact upon the environment were developed for a wide range of end-users, but mainly for farmers, for the territorial communities and for the decision-makers at communal, regional, national and European level.

Thus, in the year 2004, the IDEA method was applied and improved (Indicators of farm sustainability) [3], which is structured into objectives grouped within three sustainability scales: agro-ecological, socio-territorial and economic. These objectives refer to the agronomic principles of agriculture, i.e. should lead to a *good economic efficiency at the smallest possible ecological cost*, they also refer to the *human ethics and development* and take into consideration the *entrepreneurial function of the farm*.

Each of the three scales is subdivided into three or four components, regrouping 41 composed indicators, each consisting of two-three sub-indicators, summing up more than 100 simple indicators.

The system of indicators from IDEA method was taken over and tested by the researchers of the Institute of Agricultural Economics of the Romanian Academy (Toma, C. *et al*, 2007, 2008, 2009) and it represented the main diagnosis tool for certain Romanian agricultural holdings.

MATERIALS AND METHODS

The sustainable development process in agriculture takes place at different levels of the farming sector, yet the farm, as basic unit of agricultural production in the rural area, is an essential component.

In this context, the environment is investigated at farm level through a diagnosis of the interaction between the farming activity and the environment, in other words a diagnosis of the negative and positive effects of the farm activity upon the environment.

The utilization of a diagnosis method of the natural environment in which the farm operates is quite opportune in the current context:

- The environment currently represents an important component that the agricultural policies have in view for conservation and financial support and thus diagnoses are needed for the guidance of implementation actions (for instance: the agro-environmental measures, CAP subsidies, setting up the environmental certification at a high value, recognition of high natural value agricultural systems or of the systems with environmental constraints, conversion to organic farming, etc.

- It becomes increasingly necessary to know the impact of production techniques upon the environment on the quality product chains, etc.

A first agro-environmental evaluation method (DAE SOLAGRO 1) was developed at the research center "SOLAGRO" from Toulouse, France, in 1995 and used in several central-southern Departments.

In the year 1999, a «Diagnostic Solagro» method was proposed for environment evaluation at farm level through a global, simple and fast to use approach. The method provides performance levels for four «integrating criteria» taking into consideration: the number of production systems (annual crops, perennial crops, stock raising) on the farm, crop diversity, input management and the agricultural and environmental space management [5]

In the next years, this scientific cooperation led to the development of two diagnosis tools, which are more performant, and can be currently accessed and used on-line.

The first tool, DIALOG, is a highly-accurate detailed method, which is applied at parcel scale.

The second tool, DIALECT, is a more synthetic method and can be more easily put into practice at farm level.

Its main purpose is an evaluation of farm impact upon the environment. This analysis tool establishes the present situation of the environment at a given moment and highlights the agro-ecological systems, identifies the risky practices and may suggest the improvement modalities to the farmer.

This diagnosis has the capacity to measure the environmental "value added", as expressed by a better nitrogen and manure management, the modality of conversion to organic farming or the effect of a change in crop rotation.

The diagnoses made on certain farms reveal that there is a great variety of operations that can influence the environment. Certain operations optimizes better than other operations using their own natural resources (soil, weather, biodiversity etc.), limit the pressure on resources (water, energy etc.), while others negatively impact the local eco-systems.

This method can be used on any type of farm in Europe and even in other zones with temperate climate in the world, be it a livestock farm with its own fodder base or a vegetable farm in the proximity of towns.

Its purpose is the following: to foster and enhance diversity, in all its forms, as basis for agriculture productivity and multi-functionality; to develop a soil-related agriculture, adapted to the local conditions; to preserve biodiversity of crops and animals, as driver of agro-eco-systems (recycling of mineral elements, processes that avoid losses, optimization of available stocks of mineral elements, pest control, etc.); to put into value the plentiful resources and preserve the limited resources.

Its general principles consist of: ensuring agriculture sustainability through the minimization of the consumption of non-renewable resources, without exhausting the renewable resources; finding an equilibrium with nature and limiting the chemical control of pests and weeds (greening services); maintaining or increasing soil fertility; maintaining the production factors in good condition, which is absolutely necessary for a good operation of the agro-eco-system (natural pollination of crops by insects, natural drainage, animal welfare, soil fertility, etc.); limiting or avoiding the losses in the system by pollution, soil erosion, nitrogen levigation, etc.; avoiding the disappearance of animal and plant species that are found in the agricultural zones; maintaining the water resources in good condition.

The method makes it possible to make a diagnosis based on ***four principles:***

- a) promoting and emphasizing a global approach to the system, which should facilitate a better integration of interrelations (the black box of the system) between the different factors;
- b) a greater focus on the preventive actions versus curative actions;
- c) an increased interest in all the environment-related aspects;
- d) a quantitative and qualitative approach.

The quality is treated in a literary, holistic modality, which completes and interprets the quantitative, abstract data.

The qualitative analysis makes it possible to locate the farm in its historical, geographical, economic and social context and thus it diminishes the relativity of data and information. Thus it helps complete certain aspects that are not taken into consideration in the quantitative approach, as the environmental information cannot be easily analyzed only with measurable data.

The environment evaluation method is based on a double approach:

- A) A global approach**, which investigates farm operation and comprises two themes:

- *Farm diversity;*

- *Rational use of inputs.*

B) A thematic approach to the environment that measures the impact of farm activity upon the different environment components: water, soil, air, biodiversity, use of resources, etc.

A specific part of the diagnosis was reserved to the *energy analysis* of the farm. Energy is a necessary condition throughout the production process.

The DIALECT tool addresses 3 evaluation levels:

1- Selection of criteria and indicators

The risks of environmental impacts are evaluated by means of agro-environmental indicators. Each theme contains several criteria, including the indicators grouped into sub-criteria. The diagnosis is based on the analysis of 8 criteria and 20 indicators. Each indicator is defined by a calculation modality using quantitative or qualitative variables.

2 – Scoring scale

For certain indicators, it is necessary to define an evaluation scale that includes a *minimum value* and a *maximum value* and the evaluation modality within this scale (linear or non-linear).

3 – Share of criteria and indicators

Regrouping the indicators need to design a score-based codification, so that these can be combined within a certain criterion or theme. The coherence of all indicators in a theme is established by weighting the indicators (Table 1).

Table 1: Structure of DIALECT method, approaches, criteria and indicators

Agro-environmental diagnosis of agricultural holding	
Structure of tool: a double approach	
Global	Thematic
System analysis and its practices	Impact of farming activities upon different environment sectors
“System” diversity: 70 points	
• Crop production diversity: 3 indicators	Water: 9 indicators
• Autonomy of livestock production and of organic matters: 3 indicators	Soil: 5 indicators
• Natural infrastructures: 2 indicators	Biodiversity: 4 indicators
Indicators management: 30 points	
• Nitrogen, Phosphorous, Water, Phyto, Energy: 10 indicators	Use of resources: 5 indicators
• Pressure indicators: 4 indicators	
• Result indicators: 4 indicators	
• Method indicators: 2 indicators	
Score from 1 to 100 points	Score 1 to 20 for each theme

Source: SOLAGRO, 2006. *Manuel d’utilisation Dialecte – Version 2.* 54 p.

The instruments used by the DIALECT method are the following:

- **field survey questionnaire**, which makes it possible to collect information, namely of quantitative nature (crop rotation, animal herds, evolution of crops and animals, products, etc.), as well as many qualitative information for the description of the environment on a given agricultural holding;

- **a web platform for data inputting**, which makes it possible to automatically calculate the indicators and web platform and print the results under pdf form;

- **a User Manual** of the Dialect site [6].

- a **database** is available on Internet for the diagnoses made by different experts, researchers or from different universities in the field.

This makes it possible:

- to compare the obtained results with those obtained by other similar farms or groups of farms from different EU member states.
- to develop agro-environmental benchmarks for a given farm type and/or agricultural area.

These analyses can be made with regard to the general results (evaluation of diversity, risk, impact upon water, etc.), and by a certain indicator.

RESULTS AND DISCUSSIONS

The agro-environmental analysis based on DIALECT method was made on an agricultural holding owned by a natural person in a commune from Gorj county. The locality is located in the north-eastern part of Gorj county, in the Sub-Carpathians from Oltenia, Sub-Carpathian Depression Târgu Jiu - Câmpu Mare - Horezu, on both sides of the national road DN 67, at 40 km from the county capital at 500 m altitude.

The commune is a very old settlement in the county Gorj and it is one of the rural communities at the foot of the Parâng Mountains. Old transhumance centers of the Transylvanian shepherds, who had settled in Oltenia for centuries, these localities represent the southern gate to the Parâng mountains, with a 500-year old rural pastoral life.

Although the investigated holding declares that it practices conventional farming, by its production method and the absence of chemical fertilizers and pesticides it is rather closer to a farm with organic practices.

It uses and maintains agro-ecological infrastructures, maintains and operates the natural pastures, protect soils and old local animal breeds (*Turcana* sheep breed, *Brown* breed in bovines and *Mangalita* pig breed).

Out of the arable area of 1.5 hectares, maize is grown on 0.5 ha and alfalfa on 1 ha.

The fodder base for the herbivorous animals consists of 11 ha of natural pastures into ownership and 50 ha leased in alpine grassland.

The farmer has mechanical equipment for harvesting and baling the natural and cultivated hay, applying only package 1 from the agro-environmental measure.

The agricultural land is fertilized only naturally.

Besides the fodder produced on the farm, the farmer also buys fodder from a distance greater than 50 km, on 60% basis, and concentrated feed in a percentage of 100%.

In the year 2014, the total livestock herds summed up 54 LLU, with the following structure:

- 6 bovine heads, out of which 3 dairy cows;
- 360 sheep heads, out of which 150 mother sheep, 50 young reproduction female sheep, 3 rams and 160 lambs;
- 17 pig heads, out on which one sow, two gilts, 7 fattening piglets and 7 fattening pigs.

The animals and the animal products processed on the farm are 90% sold at fairs and on different urban markets.

The analysis of CORPEN balance sheet reveals a balanced relation between the inputs and outputs of the system, with a positive balance, yet small, between the nitrogen restituted to soil through the organic matters of animal origin and those of vegetable origin (symbiotic nitrogen fixation of cultivated legumes and of those from the spontaneous flora of meadows) and the nitrogen used by the crops and rough fodders. Out of total nitrogen supply, 47% is controllable. The losses in the system through volatilization amount to 14

kg N/ha of UAA and 12 kg N/ha through the levigation of contaminated rain water, as well as of the nitrogen that remained unused in soil (Figure 1).

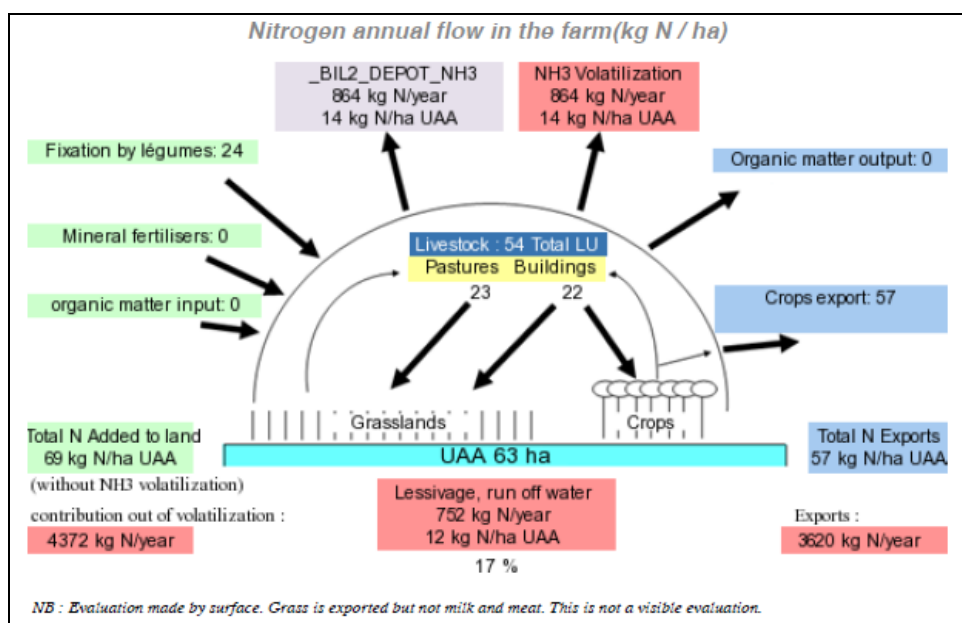


Figure 1: Nitrogen annual flow on the farm (kg N / ha)

Source: Dialecte appraisal, www.dialecte.solagro.org, Toulouse, France, data introduced on-line by the author

The direct and indirect energy inputs in the system (diesel oil, electricity, bought feed, veterinary drugs, mechanization, plastic substances etc.), expressed in litres of oil equivalent, sums up 170 l /ha, versus the produced energy, of only 60 l/ha. 47% of this comes from the 20000 litres of cow and sheep milk, 53% from the 5100 kg live weight meat, 48 kg eggs and 200 kg honey.

The ratio of consumed energy to the produced energy is 0.35, revealing quite low energy efficiency, compared to the maximum value of the method indicator, equal to 3 versus the average value of the Solagro sample, i.e. 1.7. (Table 2)

Table 2: Consumed energy (direct and indirect) and produced energy (litres of oil equivalent)

Consumed energy	l/UAA ha	l/year	%
Diesel oil	10	653	6%
Methane gas	0	0	0%
Electricity	14	894	8%
Irrigation energy	0	0	0%
NPK fertilizers	0	0	0%
Bought feed	87	5499	51%
Veterinary treatments	2	111	1%
Plastics, preservatives, detergents, etc.	56	3504	33%
Buildings	0	29	%
TOTAL INPUTS	170	10689	100%
Produced energy			
Milk	28	1753	47%
Meat (+eggs)	32	1996	53%
Cereals, other vegetable products	0	0	0%
TOTAL OUTPUTS	60	3749	100%

Source: Dialecte appraisal, www.dialect.solagro.org, Toulouse, France, data introduced on-line by the author

The energy used for producing 100 litres of milk was evaluated at 53.4 litres of oil equivalent, while 210 litres of oil equivalent were used for obtaining 100 kg of meat.

From the balance of the yearly flow of greenhouse gases, 2.8 tons of CO₂ /ha resulted, i.e. 176 tons of CO₂ /year, out of which the main sources were the following: enteric fermentation of ruminants (59%), input manufacturing, operation of agricultural equipment and buildings (22%), direct energy consumption (2%) and deficient management of animal dejections (10%). 24% of the content of greenhouse gas emissions produced by the diagnosed farm consists of CO₂ (carbon dioxide), 63% of CH₄ (methane) and 13 % of N₂O (nitrogen oxide).

From the data supplied by the farmer, about 130 tons (dry matter) of rough fodder were produced (FG, tMU), and the theoretical needs calculated by Dialect amounted to 159 tons (FG, tMU), depending on the throughput of animals and on the number of feed days. The purchases totalled 30 tons of dry matter, which represents a relatively balanced consumption compared to estimates.

The diagnosis on the impact of farm activity upon the environment, through the global approach perspective, revealed a score of 80 points out 100 points. The global situation is “good”, the diversity of activities is “good” and the input management is “very good” (Figure 1).

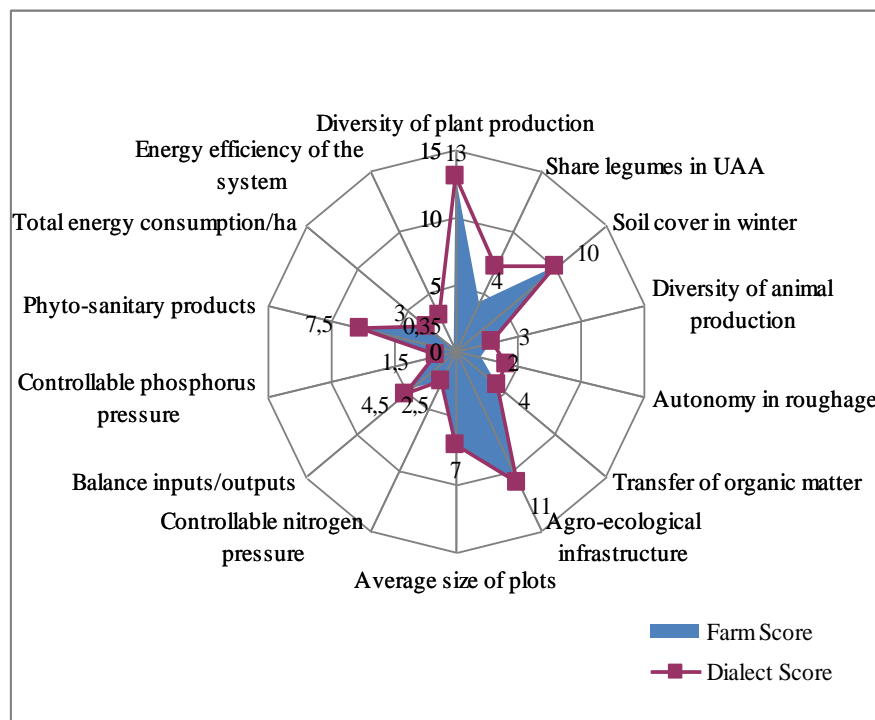


Figure 1: Global situation of farm in relation to the optimum agro-environmental indicators

Source: DIALECT agro-environmental indicators, calculated on the basis of data and information supplied by the author

With the general score of 80 points, the diagnosed farm is among the 40% of farms from the European DIALECT sample.

From the thematic approach point of view regarding the farm impact upon the environment, the farm diagnosis is “very good” for the consumption of resources (17.8/20

points), for water quality (16.7/20 points) and “medium” for animal and plant biodiversity (13.2/20 points).

CONCLUSIONS

The DIALECT method targets a comprehensive and fast diagnosis (agro-environmental audit) at the level of one agricultural farm, the necessary data being obtained through: farmers’ declarations, direct observation and different documents and information available on the web site or at the level of the rural community, for the characterization of the agricultural area and of the environment.

The method permits the identification of agro-environmental benchmarks for a certain type of holding and/or agricultural zone. These analyses can be effected with regard to the general results (evaluation of agricultural diversity, of biodiversity, of the water, soil, air pollution risk, etc.), as well as by a certain specific indicator within the holding.

The paper presents only a limited number of indicators, the diagnosis being much ampler and more comprehensive.

The author of the paper considers that this agro-environmental diagnosis method is useful in the context in which the new NRDP 2014-2020 focuses more on the agro-environmental policies, for the stimulation and education of Romanian farmers to practice an environment-friendly agriculture, to comply with the good agricultural practices, to protect biodiversity and agro-ecological infrastructures, etc.; in case of losses, in the context of complying with the environment protection rules, farmers will get financial compensation from the EU funds, under the new agro-environmental measures.

At the same time, the return of the diagnosis to the farmer will enable him to analyze his own results, his strengths and weaknesses, and he will have the possibility to compare his results to those of other European farmers and to correct the eventual mistakes.

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