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Conference Paper

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The Research Institute for Agriculture Economy and Rural Development (ICEADR), Bucharest

Suggested Citation: Toma, Camelia (2015) : Agro-environmental diagnosis on the crop family farm: Case study, In: Agrarian Economy and Rural Development - Realities and Perspectives for Romania. 6th Edition of the International Symposium, November 2015, Bucharest, The Research Institute for Agricultural Economy and Rural Development (ICEADR), Bucharest, pp. 315-322

This Version is available at:

<https://hdl.handle.net/10419/163319>

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AGRO-ENVIRONMENTAL DIAGNOSIS ON THE CROP FAMILY FARM –CASE STUDY–

TOMA CAMELIA¹

Abstract: *The utilization of a diagnosis method of the farm influence on the environment is quite opportune in the present context: (i) The environment is a strong component of agricultural policies and a diagnosis is needed to guide the implementation actions (agro-environmental measures, CAP subsidies, high value environmental certification, recognition of high natural value agricultural systems, conversion to organic farming, etc.); (ii) The impact of production techniques upon the environment becomes increasingly necessary to be evaluated along the quality product chains. The purpose of the method is to establish the current environment condition at a given moment, to put into evidence the ecological systems, to identify the risky practices and to suggest improvement modalities to farmers. At the same time, the diagnosis has the capacity to evaluate: (i) “the value added” of the environment, through a better nitrogen and organic fertilizers management; (ii) own natural resources (soil, weather, biodiversity, etc.); (iii) pressure upon water and energy, etc.; (iv) negative and positive effects upon the local eco-systems. The method has a double approach: a global one – analysis of the farm system and its practices (30 indicators, on a scale of 1 to 100 scores) and a thematic one – impact of the farming activity upon the different environment compartments (23 indicators, from 1 to 20 scores). The “DIALECT” method used for the agro-environmental diagnosis on a crop production farm yielded interesting results, specific to the Romanian agriculture, and certain indicators were comparable to the environmental indicators of similar groups of European agricultural holdings.*

Key words: *The DIALECT method, farm, agro-environmental diagnostic, questionnaires, indicators*

INTRODUCTION

The global warming phenomenon, which can adversely impact the sustainable development of human society in general, and of agriculture in particular, threatening the population’s food security and health, became a new science, which aroused the interest of both researchers and governments. These reached the conclusion that only by the joint efforts of the economic and political powers of each state in part, we can initiate a collective action in order to reduce these effects.

The climate change in Romania is considered into a European context; taking into consideration the regional conditions, temperature increase will be stronger in summer time, while in the north-eastern part of Europe, the strongest temperature increase is expected during the winter.

Global warming currently implies two main problems for mankind, namely:

-on one hand, the ***need for a drastic diminution of greenhouse gas emissions*** in order to stabilize the concentration of these gases in the atmosphere – thus hindering the anthropic influence upon the climate system and making it possible for the natural ecosystems to get adapted in a natural way - and,

-on the other hand, the ***need to get adapted to the climate change*** effects, while having in view that these effects are already visible and unavoidable due to the climate system inertia, regardless of the result of actions targeting the diminution of emissions.

Agriculture is one of the most exposed sectors to these changes as it is dependent on the weather conditions.

These changes modify the circuit of water in nature and influence the amount of rainfall, in the sense that it will be more rain in certain parts, while in other parts there will be drought, hurricanes, storms or tornadoes.

Weather variations across the years represent one of the main causes of the fluctuating average yields of crops and one of the inherent risks of agriculture.

Hence, what are the foreseeable effects of the weather changes upon the agricultural systems? (fig.1)

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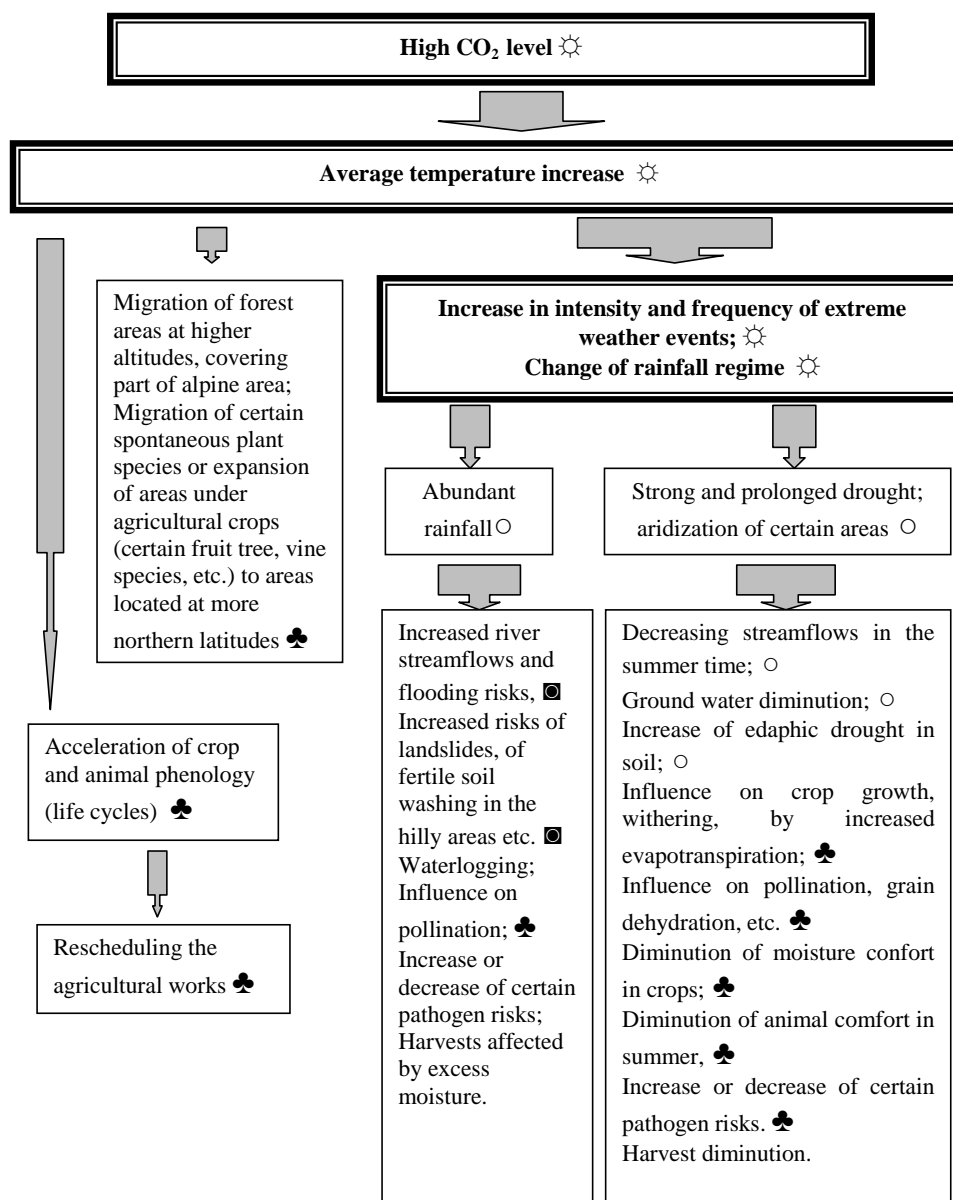


Figure 1. Foreseeable effects of weather changes upon the agricultural systems

Source: Author's processing of data from "Infographie-Quels sont les effets attendus du changement climatique", www.agriculture.gouv.fr, last accessing 05.11.2015 [10]

Note: ☀ = Weather parameter; ♣ = Agro-environmental indicator; ○ = induced effect; ■ = effect induced by extreme events

The European Environment Agency (EEA, 1999) developed the Method DPSIR (Driving Force – Pressures - State – Impact - Response), which represents an analytical framework to describe and understand the linkages between the economic and environmental activities, under the form of a set of 35 indicators integrating the environmental aspects in the agricultural, forestry and water management policies in the rural area.

The Institute for Soil Science and Agro-chemistry Research proposed a research project TOGI [9] whose main objective is the adaptation and application of the DPSIR Community methodology at local and regional level.

The evaluation criteria of agro-environmental indicators refer to the relevance for policy evaluation, response capacity, analytical base, data accessibility and measurability, interpretation facility and cost effectiveness.

The following conclusions can be drawn from the project results:

“The development of agro-environmental indicators is facing difficulties in reality:

- The environmental problems are often too complex to be represented by individual parameters (such as landscape diversity),
- Romania’s territory is quite diverse in terms of farm structures (crop, livestock types, etc.), soil characteristics, topographic and climate conditions, farm size and agricultural productivity,
- The relations between agriculture and environment are complex, so that a simplified description is not necessarily useful; the impact of many agricultural processes depends on a wide range of specific local characteristics,
- The lack or insufficiency of data sets prevents/constrains the implementation of the most appropriate concepts/methodologies of indicators, for instance the irrigable area must be used with approximation for water use assessment,
- The required data for state/impact indicators are often unavailable. Furthermore, several indicators from these fields should be based on a mathematical model or approximated data,
- The causal links are not sufficiently understood so as to be represented through indicators.

In spite of these problems, the agro-environmental indicators remain key instruments for environmental reporting in agriculture (and in other fields as well). The limited resources for data collection make it necessary to select a limited set of indicators that can be maintained on long term as part of an agro-environmental information system.”[9]

Environment analysis at farm level through a diagnosis of interactions 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 is quite opportune and complementary in the context of the difficulty to calculate certain agro-environmental indicators at local, regional or national level.

By getting the farmers directly involved in making agro-environmental diagnoses on their own farms, these get more aware of the need to reduce the greenhouse gas emissions and the need to adapt to the climate change effects.

At the same time, at present, the environment is an important component that the agricultural policies take into consideration for conservation and financial support, as well as for the implementation of actions, such as: establishment of criteria for the selection and implementation of agro-environmental measures on the farms, providing CAP subsidies, establishment of high environmental value, recognition of high natural value agricultural systems or of those with environmental constraints, conversion to organic farming, etc.

MATERIALS AND METHODS

The team of specialists [1], [3], [6], [7], [8] 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 has produced 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), which is structured into objectives grouped within three sustainability scales: agro-ecological, socio-territorial and economic [2].

These objectives refer to the agronomic principles of agriculture, i.e. they 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 IDEA system of indicators was taken over and tested by the researchers of the Institute of Agricultural Economics of the Romanian Academy and it represented the main diagnosis tool for certain Romanian agricultural holdings. [4], [5]

The DIALECT method completes the weaknesses of the previous method by including the agro-environmental evaluation at farm level.

This method was developed by the research center "SOLAGRO" from Toulouse, France, in the period 1995-2015 and it is successfully applied on more than 2000 farms from France, from other different countries of the European Union and even from other regions of the world with temperate climate.[13] In the 20 years since the creation of the first version, improved versions were developed, in line with the research works in the field of agro-environment and climate change, while making a performant interface available, totally or partially transposed into the languages of the EU member states and adapted to the new online informatic technologies, so as to be used by any interested person in this field.

This analysis tool establishes the current situation of the environment and reveals the agro-ecological systems, identifies the risky practices and can suggest improvement modalities to farmers. The diagnosis has the capacity to measure the environment "value added", expressed by a better nitrogen and manure management, by the conversion modality to organic farming, the effect of a change in crop rotation, the modality in which certain operations better optimize the use of own natural resources (soil, weather, biodiversity, etc.) and limit the pressure upon resources (water, energy, etc.), while other have a negative impact upon the local ecosystems.

The environment evaluation method at farm level is based on a double approach:

A global approach, which makes an analysis of farm operation, including two themes:

- *farm diversity*;
- *rational utilization of inputs*.

A thematic approach, measuring the impact of farm activity upon different environment components: water, soil, air, biodiversity, resource use, etc.

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

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.

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).

The instruments used by the DIALECT method are the following:

- *a survey questionnaire*, which makes it possible to collect information, mainly quantitative information (crop rotation, livestock herds, evolution of crops and livestock herds, products, etc.), as well as many qualitative information for the description of the environment on the territory of a given farm;
- *a web platform* for data inputting, which makes it possible to automatically calculate the indicators and express the results in pdf format;
- *a utilization manual* of the Dialect site [13].
- *a database* is available on the Internet for all the diagnoses made by different experts, researchers or students from different universities in this field.

This enables the following: comparing the obtained results with those obtained from other similar farms or groups of farms from different countries of the European Union and ensures the development of agro-environmental benchmarks for a given type of farm and/or agricultural area.

RESULTS AND DISCUSSIONS

The diagnosed crop production farm is located in the county Ialomita. The agricultural land is found on the Danube bank, along the Borcea branch. Being located on the eastern migration route of birds, the territory is visited in the transit period, being a feeding and resting area for rare and very rare water and terrestrial bird species". [11]

There is also an area of 5-6 hectares on the territory of this farm totaling 98 hectares, where the red-necked geese (*Branta Ruficollis*) feed and spend the winter.

The farmer applies the Agro-environmental Measure, package 7, which he is currently using. Respecting these rules (and many others, according to the agro-environmental requirements), the crop structure in the year 2014 was the following: 34 ha with wheat, 37 ha with rapeseed and 27 ha with maize, the largest part of arable areas being operating under land lease system.

In the year 2014, the average yields per hectare were 6 tons/ha for wheat, 3 tons/ha rapeseed and 10 tons/ha for maize. According to the obligations assumed in package 7, the farmer left almost 3 tons of maize in different feeding locations for the red-necked geese.

The farm has the entire range of agricultural machinery; it applies conventional technology, with the application of fertilizers and pesticides outside the resting and wintering periods of these migratory aquatic birds.

The herbicide application is minimal, mechanical works for weed control and the "false seeding" method being used.

The direct and indirect energy consumption, expressed in "liters oil equivalent" summed up 392 leqp /ha, accounting for 31% agricultural diesel oil, 50% of the applied fertilizers, 3% of the phyto-sanitary products and 17% of the different materials used (plastic packages, baling wire/string, etc.). The produced energies (3041 leqp/ha) resulted from the obtained harvests.

The ratio of output energy to input energy is medium, i.e. 7.75, while the energy efficiency coefficient specific to the system must range from minimum 5 to maximum 15, so as to be considered a sustainable, green and non-polluting system.

The CORPEN balance revealed a good application rate of chemical fertilizers (114 kg N/ha), compared to the necessary fertilizers for obtaining the respective harvests (118 kg N/ha) and 623 kg N/year were volatilized, i.e. 6 kg de N /UAA ha. (fig. 2)

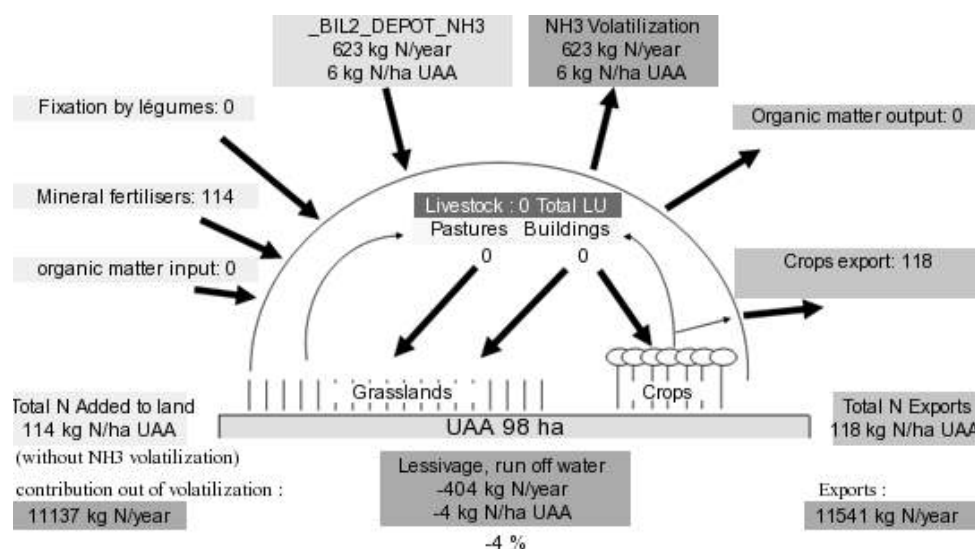


Figure 2. Nitrogen annual flow in the farm(kg N / ha)

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

At farm level, the DIALECT program estimated that **greenhouse gases** resulting from the farm activities totaling 179 tons/year, i.e. 1.83 tons/ha, consisting of 112 tons/year CO₂ and 68 tons/year N₂O, under the form of direct or indirect emissions. (tab. 1)

Table 1. Main sources of GHG emissions from the farm (tones CO₂ equivalent)

Direct and indirect GHG	tons CO ₂ /year	kg CO ₂ /UAA ha	%
Direct GHG emissions from the farming activities, out of which:	97	990	54
-Burning fuels and oils	29.1	297	16
-Direct N ₂ O emissions from soil	65	663	36
-Indirect N ₂ O emissions from soil	2.9	30	2
Indirect GHG emissions from the activities of third parties, out of which:	82.5	841	41
-purchased seeds	0.1	1	0
-manufacturing of chemical fertilizers	61.7	630	30
-manufacturing of pesticides	3.2	33	2
-manufacturing of plastic packages	1.2	12	1
-manufacturing of agricultural machinery and implements	11.8	120	6
-construction materials-buildings	4.5	46	2
TOTAL GHG emissions	179.4	1831	100

The sequestered carbon stock totalled 7 tons/year, accounting for only 4% of total GHG emissions from the farm territory.

According to the DIALECT method, the diagnosis based on the global farm approach cumulated a score of 53 points out of 100 possible points (out of which 22 points are dedicated to the livestock production). From the total score, diversification/specialization in crop production cumulated 31/70 points while input management 22/30 points. The existence of natural infrastructures (green compensation areas and the average parcel size (5.8 ha) obtained a good score (17/18 points),(tab. 2).

Table 2. Overall situation of the farm with respect to the environment. General approach of the farm

Name of indicators	Indicator values	Points farm	Ceiling
TOTAL MIXITY + INPUTS		53	100
1. Farm mixity		31	70
1.a. Diversity of crops and land coverage		10	30
-diversity of crops	3	4	13
-share of legumes	0%	0	7
-land coverage during winter	72%	6	10
1.b. Diversity of livestock, autonomy and ferti. transfers		4	22
-diversity of livestock production	0	0	3
-sufficiency in forage	0%	0	14
-sufficiency in concentrates	0%	0	0
-bought < 50 km	0	0	1
-transfers through organic matter	100%	4	4
1.c. Natural Infrastructures		18	18
-agro-environmental facilities	10%	11	11
-average size of plots (10 ha)	5.8	6	7
2.Input management		22	30
2.a. Nitrogen		5.8	7.5
-controllable nitrate pressure (mineral + organic)	120	1.3	2.5
-Input/output balance for the farm	-4	4.5	4.5
-few fractionation	98	0.0	0.5

2.b.Phosphates		2.9	3.0
-controllable phosphate pressure (mineral + organic)	30	1.4	1.5
-Input/output balance for the farm	-25	1.5	1.5
2.c. Water		6.0	6.0
-volume consumed	0 m ³		
-membership of management system		Without object	Without object
2.d.Pesticides		2.8	7.5
-pesticide pressure (PP)	3.9	2.8	7.5
2.e.Energy		4.5	6,0
-total consumption per ha UAA	392	2.3	3.0
-energy efficiency specific to the system	7.75	2.3	3.0

The global situation and the mixity of the farm is considered as “medium”, and ”high” for the management of inputs.(fig. 3)

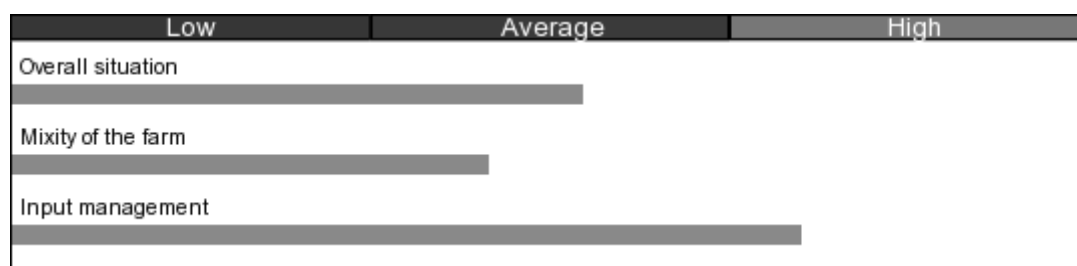


Figure 3. Agri-environmental diagnosis of the farm by the Global Approach

The thematic environment approaches, resulting from the Dialect Balance, qualified the farm as having a “high” impact upon water quality, with 16.6 points out of 20 possible points.

The thematic approach to the ”soil”, ”biodiversity” and consumption of resources” environment component revealed a ”medium” impact with 9.8, 11 and 10.7 out of 20 points.(fig.4)

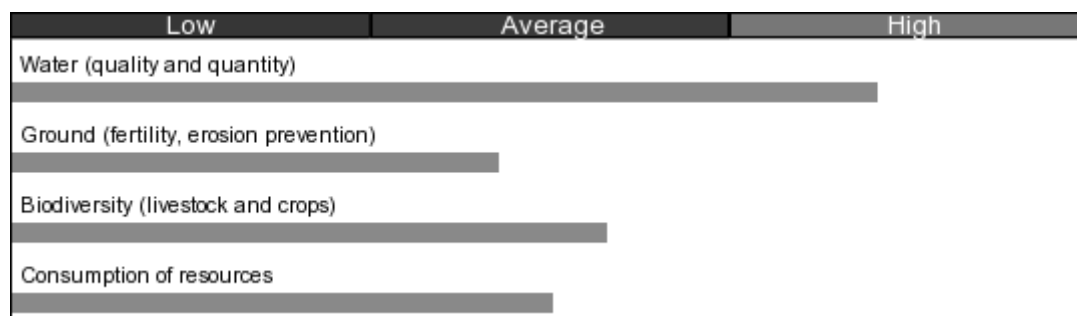


Figure 4. Agro-environmental diagnosis of the farm by the thematic approach

CONCLUSIONS

Agriculture is one of the most affected sectors by global warming, as it is dependent on the weather and climate conditions; at the same time, it is also a polluting agent with chemical fertilizers, pesticides, effluents from the livestock sector and a consumer of direct and indirect energy. In order to measure the impact of human activities upon the environment, as well as to evaluate the climate change effects upon the environment and the population, different sets of indicators were established. The agro-environmental indicators partially respond to the regional and national analysis needs, as the impact of many agricultural processes depends on a whole range of specific local characteristics (heterogeneous relief units, altitude, climate, agricultural production methods, from the most simple to the most sophisticated technologies, etc. The farm agro-

environmental diagnosis method, created by the French experts and made available on a free of charge basis, for online utilization, represents a very easy to apply tool, even by farmers themselves. By their direct involvement in making agro-environmental diagnoses on their own farms, farmers become more aware of the need to drastically reduce the greenhouse gas emissions and of the need to get adapted to the climate change effects.

With the 53 accumulated points, the farm from the Ialomita county, diagnosed through the Dialect Method, is found among the 30% of the farms from the EU sample. The diagnosis results go back to the farmer, and the role of consultancy and researcher expert is only at the beginning.

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