

**INFORMATION AND DECISION IN AGRICULTURE : HOW
RELEVANCE IN MANAGEMENT DIAGNOSIS IS IMPROVED BY
AN EXPERT SYSTEM**

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Abstract: This paper describes the experiment of modelizing and computerizing the management diagnosis of a farm carried out by 9 advisory centers with the Ecole Nationale d'Ingénieurs en Techniques Agricoles de Bordeaux. The tool chosen for computerizing the reasoning process was an expert system based on production rules, on a micro-computer. The authors first describe the aims of the expert system and the methodology used. Then, they draw the following conclusions. Fine-tuning the expert system to bring it up to a professional level requires a specific method of work and a homogenous information system. Moreover, the quality of diagnosis depends on the one hand on the transcription of human reasoning and on the other hand on information used to evaluate references, that is to say standard references and normative references. The authors define these two terms before showing that the relevance of the diagnosis depends on these references. Finally, they try to show that it is possible to improve the definition of a reference as well as the way of using it in order to provide the farmer with a more evolved Information System.

Keywords: expert system, standards, references

Introduction

Faced with increasing uncertainty as to the future, many farmers now apprehend their role in the world as real businessmen; these are the "agri-managers" or "innovating-farmers". They need, in order to make optimum choices, a regular evaluation of their farm's performances. As early as the beginning of the nighteen eighties, farmers were under pressure to take management decisions in the context of the agricultural crisis. This remains the situation today. French national production has, indeed, reached the excess level and, now, seeking of maximum production no longer means maximum profits. From 1984, the Common Agriculture Policy has gradually imposed quotas in order to reduce the level of production. The development has forced farmers to adapt their management policy : improving productivity and production through technical mastery is no longer sufficient. Nowadays, uncertainty prevails : in order to manage a farm successfully, the farmer must be able to adapt very quickly to changes in the economic environment. He must continually modify his choices

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concerning : investments, production, personal expenses ... In short, to cope with a more and more uncertain environment, the farmer needs to evaluate the economic situation of his farm regularly, i.e. set up an economic diagnosis, so that he can take the best decisions at the best moment.

This diagnosis, which is, in fact, an evaluation of the farm's situation, requires the collection and treatment of several kinds of economic data. The analysis relies, indeed, on technical data as well as on financial data. Based on existing information, the goal of the analysis is to provide the farmer with results which can help him to take his decisions.

In France, the functioning of the Information System (IS) in agriculture is such that all management information is collected and treated by external experts : the advisory centers. This is quite different from industry and results from the specific situation of the agricultural world. Contrary to other diagnoses on a farm, the management diagnosis can, therefore, be easily formalized and systematized.

Even if the use of computers has become usual in agricultural management, classic software in agriculture is not adapted to systematizing human reasoning. It is necessary to apply new methodology : the use of artificial intelligence, and more particularly, the expert system. Though the expert system, it is possible to automatize the management diagnosis on a farm and, therefore, to provide the farmer with a more evolved Information System.

In the first part of our presentation we will define the aims of the expert system, then describe the methodology used in setting up the automatized diagnosis. In the second part, we will examine the role of the information system in the expert system to show how the relevance of the diagnosis depends on information.

1. The Use of an Expert System to Improve Management Diagnosis in a Farm

As stated earlier, farmers need a comprehensive diagnosis which can be regularly used. However, in order to define such a diagnosis, it is necessary to set up, to systematise, then to automatize a comprehensive diagnosis method.

1.1 A comprehensive diagnosis method is necessary to build a diagnosis expert system

This task was carried out by a team at the E.N.I.T.A. with the help of nine advisory centers in the north of France, which represent more than 7000 farmers who wanted to automatize their economic diagnosis. The goal targeted by the team was to systematise a diagnosis suitable to all kinds of farms. The data used was mainly accounting data, complemented with technical information and references from outside the farm.

To set up the diagnosis, a method designed to take into consideration all possible cases for a specific problem was used. To utilize this method, which requires a global vision of the problem, the expert team (one person in each centre) referred back to its own concrete experience. In order to identify all the information necessary for the diagnosis, they studied technical as well as economic and financial areas. The diagnosis was split in six parts. Utilizing the same methodology, each part was independently analysed and included three steps : presentation, explanation, and commentary.

1.2 results and limits

The experience began in 1989. One year was necessary to build the expert system, and the experience continues since this year with an annual maintenance and evolution of the diagnosis built.

According to advisory centers the automatized diagnosis is reliable, fast and impartial. In the centers view, there is no major difference between the commentary of a " manual " diagnosis and that of the automatized one. Results are quite similar in so far as the reasoning and the presentation of the commentary are nearly the same. One of our stated aims is, therefore, achieved : conclusions show that the artificial diagnosis is as reliable as the " manual " one.

According to farmers' responses, three advantages can be identified in the automatized commentary. Firstly, the commentary is quite short : five or six pages. Like businessmen, farmers want and need to have condensed information : the length of the commentary seems, therefore, well adapted to their needs. Secondly, the graphs add extra value to the commentary. Even if they are merely a presentation of the results, they are easily comprehended by the farmer. They are all the more appreciated in that they often do not exist in the " manual " commentary. Thirdly, the farmer is interested in the link between technical and economic results because the farmer is above all a technician : the approach used by the expert system is, therefore, suited to his way of thinking.

Even if the expert system is appreciated, it is still incomplete in transcribing human reasoning. It has two main limits : the modelization of the reasoning and the information used. The consequence of these limits is the simplification of human reasoning.

First of all, to automatize the diagnosis with an expert system, it is necessary to make a model of that diagnosis. That means to describe and to formalize it in order to create a model. Unfortunately, the formalization of the diagnosis unavoidably simplifies human reasoning. The structure of the diagnosis, and its automatization method (If... then...) have, indeed, simplifying effects.

The second limit concerns information used in the expert system. As all the information cannot be introduced, the system is necessarily somewhat imprecise. To achieve a common basis used in the diagnosis, it is impossible to consider all information existing in reality. Therefore, the more the field of information was limited, the poorer the transcription of human reasoning.

Currently, most studies are carried out to improve the modelization of reasoning but only a few of them are based on information. People are rather inclined to focus their work on the modelization of reasoning to provide the farmer with " the " proper decision. We think that the expert system must be used in another way : it must complement the farmer's information system (IS). The expert system depends above all on the IS which it is built upon. That is why the authors have chosen an " information approach ".

In our opinion, the relevance of an expert system depends as much on the reasoning transcribed by the computer as on the information used in this reasoning. Instead of criticising the expert system's low level of intelligence, and attributing its weakness to an imprecise modelization, the authors think it would be better to work on information in order to add extra value to the system.

2. The Relevance of a Diagnosis Depends on References

As previously mentioned, the expert system uses technical, economic and financial information (essentially from accounting) and some references. It is now interesting to describe more precisely what information is. In fact, the term, which is ambiguous, can be broken down into two aspects (PEAUCELLE,1988) :

- a material part, the "signifier", which is the "visible" and transferable part of information (words, codes, symbols...).
- a conceptual part, the "signified", which represents what is understood from the information. (we use the terms of sense, semantic content, idea...).

According to G. Bateson, "une information est une différence qui crée une différence" ("information is a difference which creates a difference "). That means information can be defined as the difference brought about by a message which changes the receptor's behaviour, which is adapted to his new state of knowledge. J.C. Courbon (1993) shortens this definition of information by the following :

Information = Data (sign + code) + Interpretation model.

We can therefore say that information is different from data in so far as it isn't neutral.

2.1 The modelization of information

The commentary of the expert system utilizes above all accounting information concerning the farm. However, to perfect the diagnosis, it is necessary to collect, in addition, technical information

on the farm and its environment : the legal status of the property, land distribution, the annual weather pattern ... To achieve this aim the authors were obliged to solve two central problems :

- * the homogenisation of the conceptual part of information

The analysis determines which kind of information must be used but a selection of information is nevertheless necessary. Indeed, several types of information of the same nature can be used to present or explain a result. For example, the current profit can be used to explain the performance of a farm for one accounting period as can the net profit or the global margin. Moreover, one term can have several significations. So a choice must be made and this depends on three factors : the unanimity of experts opinions, the availability of information, and its immediate utility.

A set of homogenised information which has the same signification for all users is also determined. However, this does not mean that this information has the same value.

- * the standardisation of the material part of information

The necessary information in the expert system is either numerical (value, ratio...) or symbolic (a string such as the name of the farm, the production system ...). This information must be defined in a determined order and format so that the expert system can read them. Thereafter, once its signification has been defined (the homogenisation) the information must be standardised in its presentation.

All advisory centers had their own IS : this was, therefore, incompatible with our aims of homogenisation and standardisation. That is why the authors built a new IS, specific to the expert system. We named it the "unique grid" because of its presentation. The unique grid is represented by a file or ordered tables.

2.2 The use of references

References have the same characteristics as information : they have a material and a conceptual part but they also play a special role in so far as they allow for an explanation and an interpretation of the results. Two main characteristics of references should be noted. Firstly, as opposed to "internal information" (technical, accountable or financial data), stemming from the farm itself, references are "external information". Secondly, the use of a reference depends not only on its semantic content but also on its value.

Therefore, references are technical, economic or financial information whose value is used as a measure of comparison in order to explain the results. To interpret a result, most of the commentary comes from a comparison with references. This phase is often wrongly compared with intelligence because the software appears to be quite similar to human reasoning, that is to say nuances are introduced. In fact, the commentary includes expressions such as quite good, rather bad ... In the commentary, references are essential because they are used to assess the results : they are the basis of the evaluation produced.

Two kinds of references can be distinguished :

- * standard references : they represent indicators from the average of a set of farms. For example, the average profit margin for all corn farms whose turnover is more than 1 million. To build these standards, the authors use the same indicators as those on the farm. A statistical average of all individual indicators is taken.
- * normative references : they are the result of the reasoning and the experience of the experts and are not necessarily the result of a sample average. These references can, moreover, be produced from new indicators which are not used at the farm level. For example, to assess the current profits of a farm, the average of all current profits is not used but rather two new ratios : current profits / gross profits and production / gross profits which represent the material part of the reference. Thereafter, each ratio is attributed a specific value which is the conceptual part of the reference and, at that point, it is possible to say whether the current profits figure is good, quite good, quite bad or bad. To obtain such an evaluation, it is necessary to establish a certain number of thresholds. They correspond to values chosen by the experts to determine the level at which the commentary must change. For example, in the E.N.I.T.A. software, for current profits, one of the thresholds is fixed

at 15 % and 15 000 F. This means that the result is judged good if the current profits increase by more than 15 % and more than 15 000 F.

Therefore, references appear as important as the reasoning produced in the expert system.

2.3 References determine diagnosis relevance

As is true with the other information, references used in the expert system require a common definition of their material part. But this is not sufficient : references imply a specific problem relating to the choice of their value (their conceptual part). The use of references is based on the comparison between their value and farm indicators. The relevance of the commentary depends on this comparison : this explains why the conceptual part of references is essential.

For normative references, the conceptual part is defined by the experts. It is a result of human reasoning divisible into two parts :

The first is the objective part. The value is determined by the experts relying on their experience and their knowledge of the problem. Even if this value does not precisely correspond to a statistical calculation, the result is quite similar.

The second part is the subjective reasoning. The expert actually gives his opinion about the value of the normative reference. Having an idea of the performance the farm should achieve, he consequently assesses the optimal value of the reference. Therefore, the expert establishes the value more on a feeling (based on his own IS) than on a calculation.

For standard references, the conceptual part is given by a statistical treatment. Therefore, they are very often considered as "good" references.

The main problem for a references is that it's value is determinant in the diagnosis. A quality approach for references must define how the value of references are determined.

For standard references, the value is the result of a calculation : it is determined by means of a statistical tool which provides the average of an indicator for comparable farms. Contrary to normative references, standards can vary from one farm to another. For example, the wheat yields standard comes from an average of data collected in wheat-cultivating farms. But this average is different for each geographic area, so this disparity reappears in the values of standards.

A standard can be universal concerning its material part but its value can not be definitely fixed. Standard references are "external information" but they are linked to the farm in so far as the specific geographic and economic situation of the farm determines the value of the standard. Therefore, each advisory center must determine its own standard values to set up its diagnosis.

As they are the results of calculations, standard references appear to be more reliable than normative references, which are partially subjective. However, the representativity of the calculated average may itself pose a problem. The representativity of standard references determines the relevance of the comparison with the farm indicator. In our example, the yield standard must be representative of the yields obtained on comparable farms for the comparison to make any sense. Representativity is a major problem which has, as yet, rarely been treated in agriculture (Sebillotte, 1991). In most cases, not taking this into account is harmful to the comparison because the sample is often taken from heterogeneous situations. The larger the sample, the more it is representative but the less it is relevant.

For normative references, the value results from a compromise between observations (objective reasoning) which could be considered with the same rules than standard references, and the aim to be achieved (subjective reasoning).

Therefore, in order to get "good" references, an approach with three levels is advanced :

1. a choice of a sample which provides a sufficient representativity.
2. an harmonisation of definition around references.
3. a visualisation and calculation rules for references.

The choice and the setting up of references is not indifferent to the relevance of the diagnosis. The use of references is based on comparisons. From the comparison between the value of the reference and the value of the farm indicator there results an explanation (increase or decrease) or an

assessment (good, quit good, quite bad...). That is why the value of the reference determines the relevance of the commentary. Nevertheless, a relevant value obtained for a reference does not necessarily mean a relevant diagnosis : the use of references also plays a great role.

Conclusion

Even if the automatized diagnosis of agricultural farms already produces quite good results, two ways of improving the diagnosis remain possible. The first one concerns the modelization of human reasoning and the second, the definition of a more relevant IS.

The second was chosen in defining our research. Information in an expert system is essential : a large part of the commentary depends on the comparison of farm indicators with references. This is why it is necessary to define precisely what a reference is. The two parts (material and conceptual parts) of the reference must be clearly distinguished. The definition of the conceptual part must include not only the semantic content but also the value of the reference.

Unfortunately, a universal reference is impossible. The heterogeneity of the agricultural world requires differentiating references area to area, size to size etc... Therefore, to work at a collective level, it is first necessary to get a specific approach for references. This means to normalize the definition (the material part) of the reference and then to define specific values (the conceptual part). The material part of a reference can be applied to several areas but the value of this reference is dependent on the context in which it is used.

For getting references which could be used in a diagnosis, three conditions must be precised : the choice of a sample, the definition of references and the statistical treatment. With this method, the authors lessen the problems of commentary breaks around the value of references. Such a way is perhaps less ambitious than improving a reasoning process, but gives in a short time better results.

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