THE USE OF EXPERT SYSTEMS FOR PIG FARMS ADVISORY

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Abstract: Eliscope and Swinytec' are two expert systems applied to pig farm diagnosis. They are supporting the advisors in their activity. We discuss different topics dealing with their use. The conditions of their adaptation to the practical conditions of the advisory activity are studied. After that, we show that these expert systems modify the way advisors are managing their relationship with the farmers and improve the communication between them. We then concentrate on the competence and motivation of the advisors to use the expert systems.

Keywords: expert systems, farm diagnosis, farm advisory, pig farm.

1 Introduction

Our experience in expert systems applications for agricultural extension services is the result of the development of two expert systems for the diagnosis of pig farms. We developed these tools with two firms : CCPA[1] and TECHNA[2]. These firms are « firmes services », a French specific kind of firm in the feed business. They are producing premixes, that they sell to their clients (the feed manufacturers). They are also proposing different sorts of services : feed formulation, feed analysis, technical and scientific advice for the farm management or diagnosis, etc. Finally, they are one of the major producers of agricultural software in France (Wahl, 1994). They were interested in expert systems in order to support the advisors, faced with very complex diagnosis to run and having less and less time to do this. So, we developed with these firms two very interesting but different expert systems for the diagnosis of pig farms. We will rapidly present them, in order to focus on their use.

2 Presentation of Eliscope and Swinytec', two expert systems for the diagnosis of pig farms

2.1 The firms and their projects.

CCPA : Upgrading pig farm results

Several years ago, CCPA developed Planiporc, a pig farm management software. As all the software of its category, Planiporc uses data provided by the farmer to calculate the technical and economic results of the farm and then prints those results in tabular form.

Rapidly, CCPA realised that the presentation of the results in tabular form presented some weaknesses : 1. the message conveyed by a single figure is not explicit enough, 2. the tabular form does not allow a proper hierarchy of data.
So, this firm decided to find a solution to obtained a more value-added formalisation of the results. It decided to develop an expert system, Eliscope, that would permit : 1. to select the results that reveal the presence of troubles in the farm, and to classify them, 2. to try to find the causes of those troubles, 3. to present its conclusion in a well-phrased report.

We must point out the fact that Eliscope works on the only data contained in Planiporc (one of its aims is to save time to its users). One of the consequence is that it limits the thoroughness of the analysis : the diagnosis is incomplete. In the other hand, it is automatically generated.

TECHNA : Formalising a pig farm diagnosis methodology.
Techna's pig specialists are frequently asked by their clients to help them to solve technical problems that occur in pig farms. These specialists considered that the fact of working without a very formalised diagnosis methodology could extend the time necessary to solve a problem. Indeed, when he works without a formal framework of investigation, the advisor biases the analysis : he is oriented by his own experience and sensibility.

So, the pig specialists at Techna started to formalise their diagnosis methodology. Faced with the amount of data they have to manage and with the complexity of their reasonings, they decided to develop an expert system, Swinytec', to make easier the conception of their methodology (the knowledge acquisition) and its practical use.

2.2 The main characteristics of Eliscope and Swinytec'

Major differences and points in common
As we see, both expert systems are applied to pig farm diagnosis, but they have major differences. One of these differences is the depth of their knowledge base : Eliscope uses a limited knowledge base to produce a pre-diagnosis. Swynitec' requires the collection of an important amount of data and permits to generate a thorough diagnosis. Another difference is the way they express their conclusion : a well-phrased report for Eliscope, and a thorough and long causal diagram for Swinytec'.

Nevertheless, they both require the participation of the advisor. CCPA and TECHNA did not want their expert systems to propose solutions to the farmer. They just identify the problems and try to find their causes. So, these expert systems are supporting the advisors, not replacing them.

What is behind these expert systems ?
As any expert system, Swinytec' and Eliscope are simulating the reasoning mechanisms of an expert working on a domain. So, they are based on the double modelling of the domain and of the reasoning mechanisms.
- The domain is represented by a set of elements, characterising the state and/or the evolution of the system, and are connected through relations between cause and effect (causal model).
- The reasoning mechanisms are made explicit and applied to the exploitation of this causal network.

Arsene is the name of a tool we developed to computerise the use of these models. It permits to acquire and to manage the knowledge related to any kind of farm diagnosis (Bourgeat & al, 1991).

2.3 How are these expert systems used ?

The advisor and the farmer read together the report produced by Eliscope. As the troubles are arranged in descending importance, all the troubles mentioned, starting with the worse one, are analysed. Some solutions to improve the pig farm situation finally emerge from this analysis. As we said before, Eliscope uses very global data and can only hint at possible explanations. To be able to

suggest solutions to the pig farmer, the advisor has to investigate thoroughly in many directions : the buildings, the feed, the health, the genetics, ...

Three people are involved in the use of Swinytec' : the expert, the advisor and the farmer. The advisor and the farmer collect the data needed by Swinytec'. The expert analyses the report produced by the expert system, which is a causal diagram. He synthesises it in a few pages, and goes to the farm with the advisor to present his conclusions to the farmer. When Swinytec' will be completely validated, the advisor himself will analyse the report of the expert system.

3 Characteristics of an expert system adapted to the pig farm advisory

Even if the new information technologies are introducing changes in the pig farm consulting, the advisors will always be the main actors of this activity. That is the reason why the collection and processing of data in Eliscope and Swinytec' had to be adapted to their needs and their working conditions.

3.1 The data collection system

Which data ?

We will only discuss the topics related to the collection of the data, considering that all the questions concerning the data that occur during the knowledge acquisition have been resolved.

With Eliscope, an information system (Planiporc) already existed and the data were already collected and computerised.

With Swinytec', the first validations of the data collection system permitted to identify some problems (Droguet 93) :

- Some questions were not clear enough and some units were badly chosen,
- Some data were quite never available, though they were strongly needed for the diagnosis. We removed them from the data collection system, but not from the causal network. When reasoning, Swinytec' will do as if the data were missing (i.e. it will tell the advisor to check this point). Of course, it must be borne in mind that only a minority of data can be removed from the data collection system. In those conditions, there can be a relative independence between the elements of the causal network and those requested in the data collection system.
- The data collection was very long because there were too many data to collect, too many questions to ask to the farmer. Trying to built a very thorough and accurate model of a domain can be intellectually very rich, but it moves experts and cognition specialists away from the field conditions.

As we see, various on-field problems (added to the cognitive ones, that we do not discuss here) involve differences between the expert system reasoning and the experts reasoning. The consequence is a impossibility of the expert system to compare with the experts.

Who collects the data ?

Once more, there was nothing to decide for Eliscope, as the data were already collected.

For Swinytec', we had to decide who would collect the data : the advisor or the farmer. The collection of the whole data set by the farmer is not realistic. First because the evaluation of some of the information to collect is subjective (body condition of the sows, odour in the buildings,...), and requires the participation of a person not belonging to the farm. The other reasons are commercial (importance of the visits to the clients) and psychological (motivation of the farmer). On the other hand, the collection of the data by the farmer would gain time to the advisor. So we decided that the farmer would prepare the answers to the questions supposing an objective answer (1/3 of the data) and the advisor would collect the other information (2/3 of the data).

We also had to decide whether the data would be collected on paper or on a computer. The collection on a computer presents several advantages :
- immediate data error detection,
- no double data entry (paper then computer), time-consuming and likely to generate errors,
- a data collection guided by the expert system reasonings,
- on-farm immediate analysis of the data.

But it also presents some disadvantages : the necessary training of user, the equipment costs, and the difficulty of handling a computer when visiting a pig farm. So we made the following compromise : a part of the data is collected at the office, on a computer or on paper, according the advisor's computer skills, and the rest of the data is collected during the farm visit, on paper.
This obliges to collect all the data the expert system may use. Anyway, if the whole data set was collected directly on the computer, it is hard to say if we would have chosen a data collection guided by the expert system reasonings. This solution seems very attractive. But is not there a risk that the advisor has to run constantly from a part of the farm to the other, as the observations made in a building may be explained by problems that happened an other building ?

This experience taught us the following lesson, that the practical, mundane aspects of in-depth farm diagnosis (such as the opening and closing of doors, the necessary bending over to observe the animals...) weigh heavily on the data collection process, and that such constraints lead to a mandatory compromise between the ideal and the feasible.

3.2 Data processing

For both companies, it was crucial that the advisor keeps a full control of his/her diagnosis and this had a deep influence on the implementation of data processing.

A diagnosis can be described as a 3-step process : 1. Identification of the problems, 2. Search for the causes, 3. Providing solutions. The third step is the most satisfactory for the advisor’s prestige, and has an obvious marketing value. It was thus let to the advisor’s sole responsibility and it was decided that both expert systems were to operate only before this step.

The fact that Eliscope uses a limited amount of data made possible to exploit them very thoroughly. Indeed, the expert system is able to give a structure to the data (weak points, points to control, strong points), to give a hierarchy to the data within the classes (what is the most serious problem ?) and to print the most relevant information. It is then possible to automate the process of adding value to the raw data.
The comments generated by Eliscope may be seen as a general frame made of several, well-identified steps, that the advisor may use to structure his own counseling work : reading of the report, singling out the weak and strong points, analysis of the weak points and proposals for improvements.

Swinytec' examines a large number of indicators, and provides the advisor with a synthesis of the state of the pig farm as a whole and of all its activities. The search for the causes of the problems found in the previous step is shared between the expert system and the advisor. Swinytec' stops when it identifies the possible causes, and does not arrange them according to importance. It is the role of the advisor to synthetise the expert system’s comment, by singling out the causes he/she assesses as the most significant. This sharing of tasks has two reasons :
- In pig farming, the farm environment (building, feeding, breeding) interacts closely with the characteristics of the animals and influences their state of health and level of production. It is therefore difficult to separate the factors likely to account for the observations. This is an example of the principle of the limited rationality of decisions (H.A. Simon, quoted by Le Moigne, 1974), that prevents this phase from being totally automated.

- Techna wanted the advisors to be responsible for their diagnosis. Leaving them a part of the work was the best way to do this.

4 Considerations about the advisors : the effect of expert systems on their activity, the importance of their motivation and skill

4.1 The introduction of a new tool changes the working habits of the advisors and improves the impact of their activity

Expert systems must be considered as new tools that introduce changes in the advisors practices and permit to improve the efficiency of their activity. We noticed this improvement with both expert systems.

With Eliscope, this improvement is especially due to the use, by the advisor, of the report generated by the expert system. When he speaks with the farmer, the advisor tries to communicate him some technical advice : you must check the ventilation, wean the piglets earlier, increase the lactating sow consumption... If the messages conveyed by the expert system are the same as those that his advisors have been repeating to him for several months, it strengthens the advisor's impact.

Other expert systems experiences also conclude that the tools that generate a report used by the advisors have a positive impact : "The improvement of those sessions has been the major effect of these decision support systems thanks to a better interaction between the advisor and the farmer... The data analysis is made easier by the report generator." (Jorgensen et al,1992). We can conclude that there is no doubt that those kind of expert systems improve the communication between the farmer and the advisor.

With Swinytec', the efficiency of the diagnosis itself is improved. We did not conduct any study to compare the time needed to solve problems in a pig farm with and without Swinytec'. All that we can say is that its users are very satisfied with it.

4.2 Motivation and competence of the users

The development of a computer model suitable for farm advice is, though questionably enough, the most easy part of the global task. Convincing the advisory services to adopt and use it is a somewhat more difficult challenge (Mainland & Doyle,1992). Indeed, the adoption of an expert system may be hindered by the following circumstances :
- they may not accept the fact that an expert system cannot give a proper answer to all their problems,
- they may distrust the expert system’s answers,
- they may be discouraged by some of the constraints induced by the expert system.

User involvement in the development process of the system is one answer to the first two situations. In the case of Eliscope, users were invited to participate in the definition of the objectives, and to the knowledge acquisition. As the system had been built by some of them, they easily accepted the system and trust its answers. We may add that user involvement allows Eliscope to be particularly fitted to its users’ needs.

When users are also customers, the question of their involvement is somehow more delicate. In the case of Swinytec’, we had to reject it since the knowledge base was supposed to be confidential. It is only through the presentation of Swinytec’ and its results that users understand that it is not some kind of « magic wand », and that they will be convinced of its robustness, i.e. its ability to perform well in every farm situation.

This robustness may only be obtained through a long phase of validation, that is presently being carried out in 30 farms with very different farming practices. In the first run of validation tests, the

farm model built by Techna had to be deeply altered. There have been less and less modifications, and the present model is certainly robust.

The main constraint of Swinytec' is, for the advisor, the mandatory and heavy task of collecting data. This comes out as a report where causal networks single out and analyze in a detailed way the farm's weak points. This report needs to be used fruitfully enough so that it justifies the collecting work, and a solid training in result analysis is clearly a critical point. The advisor's motivation will depend also on the farmers' feedback, which has been very positive until now (Droguet, 1993).

Motivation is not enough, and must be combined with solid competence. Expert systems, such as the ones we developed, do not replace their users, who must be able to add value to the results through their own actual abilities as farm advisors (Plumelle, 1992).

5 Conclusion

Expert systems will never replace the advisors. They will just allow them to be more relevant and efficient in their advisory work. Following the general evolution of pig farms, extension services will need more and more sophisticated expert systems, that will implement complex reasoning requiring the collection and management of large amounts of data. The advisors will have to be competent enough to use these new tools. At the moment, we are working with CCPA, Techna and other companies, which have decided to join their efforts in the field of expert systems. We have just started to merge Eliscope and Swinytec', and to improve the possibilities offered by those tools.

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2. TECHNA - BP 10 - 44220 COUERON - Tel : 33 2 40 85 41 41 - Fax : 33 2 40 86 44 32

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