EXPERT SYSTEMS - DEVELOPMENT OF AGRICULTURAL INSURANCE TOOL

Nan Anca-Petruţa, Moisuc Diana-Aderina
[1] *Department of Finance, Faculty of Economics and Business Administration, "Babeş-Bolyai" University, Cluj-Napoca, Romania*
[2] *Department of Business Informatics,* Faculty of Economics and Business Administration, "Babeş-Bolyai" University, Cluj-Napoca, Romania
anca_nann@yahoo.com
moisuc_d@yahoo.com

Abstract: *Because of the fact that specialty agricultural assistance is not always available when the farmers need it, we identified expert systems as a strong instrument with an extended potential in agriculture. This started to grow in scale recently, including all socially-economic activity fields, having the role of collecting data regarding different aspects from human experts with the purpose of assisting the user in the necessary steps for solving problems, at the performance level of the expert, making his acquired knowledge and experience available. We opted for a general presentation of the expert systems as well as their necessity, because, the solution to develop the agricultural system can come from artificial intelligence by implementing the expert systems in the field of agricultural insurance, promoting existing insurance products, farmers finding options in depending on their necessities and possibilities. The objective of this article consists of collecting data about different aspects about specific areas of interest of agricultural insurance, preparing the database, a conceptual presentation of a pilot version which will become constantly richer depending on the answers received from agricultural producers, with the clearest exposure of knowledgebase possible. We can justify picking this theme with the fact that even while agricultural insurance plays a very important role in agricultural development, the registered result got from them are modest, reason why solutions need to be found in the scope of developing the agricultural sector. The importance of this consists in the proposal of an immediate viable solution to correspond with the current necessities of agricultural producers and in the proposal of an innovative solution, namely the implementation of expert system in agricultural insurance as a way of promoting insurance products. Our research, even though it treats the subject at an conceptual level, it wants to undertake an attempt to present the necessity and importance of implementing expert systems in agricultural insurance as a solution of development of the Romanian agricultural sector since insurance play an important role in the stimulation of investments in agriculture and in the stabilization of agricultural producers incomes. The results of the study, at a conceptual level, confirms the necessity of aplying expert systems in agricultural insurance because of the benefits which would be created (informing agricultural producers about the existence and importance of agricultural insurance, the development of the insurance market which would lead to the development of agriculture, creation of new insurance products adapted to the needs of the farmers).*

Keywords: *agricultural insurance; expert systems; agriculture.*

JEL classification: *C80; C88; G22; Q14.*

1. Introduction - The Necessity of Implementing Expert Systems in Agricultural Insurance

There are many reasons why the financial domain is so popular for expert system applications. The majority of problems from the finance domain can be split up into quantity and quality parts, and in a sense they can be formulated under some rules, facts, cases, forms or semantic networks. Thus, the financial domain can benefit from the application that uses the technology of expert systems. (Liebowitz, 1998)
(Ganesan, 2006) believes that agricultural production has evolved into a complex business requiring the accumulation and integration of knowledge and information from many diverse sources. Unfortunately, agricultural specialist assistance is not always available when farmer needs it. In order to alleviate this problem, expert systems were identified as a powerful tool with extensive potential in agriculture.
The implementation of expert systems in the agricultural insurance domain could represent an encouragement of development towards agriculture and agricultural insurance because in view of the accomplishment of a modern agriculture, the need of maintaining the financial possibilities in the required conditions of the particularity of agricultural production is necessary. To this effect, the use of expert system in insurance represents a primordial tool for the protection of agricultural producers and farmers, fact why our agricultural sector need to be developed, all the more so that recently new risk have been shown as a result of climate change.
A study realized by Ciurea I.V., Paveliuc-Olariu C., Ungureanu G., Mihalache R. in 2011, which followed the agricultural consultation case from the North-East Region of Romania, 12 years after its establishing using the questionnaires method which were filled by a number of 80 specialists in agricultural consultation from the 6 counties of the North-East Region, emphasizing the following aspects: “All the persons that ensure consultations develop activities with a general character from all agricultural domains. There is an acute lack of specialists, a single person ensuring his services for thousands of farmers... A lack of interest is developed by the local authorities for consulting activities. Specialists are unhappy about their pay level, their limited possibilities of improvement, the high volume of work, the lack of equipment and transport, as well as political interference_in the personnel recruitment process.
The conclusion of this study are other arguments that highlights the necessity of implementing a new informatics system in promoting agricultural insurance, the application of expert system technology within agricultural insurance is as well needed as it is useful due to the informing of agricultures about their existing insurance products and the reproduction of human expert reasoning in a form easy to understand, thus the user, regardless of his level of training, can take a decision that suits him the best in the respective moment.
Before utilizing expert systems in agricultural insurance, in view of following their efficiency, it is necessary to raise a few questions present in Figure 1.
Browsing Figure 1, we can easily find the necessity of implementing expert systems in agricultural insurances because of the high potential of insurance development, the simplicity in its use, but this imposes an initial investment (material and organizational) which implies the involvement of insurance agencies as well as the state, which is not always prompt.

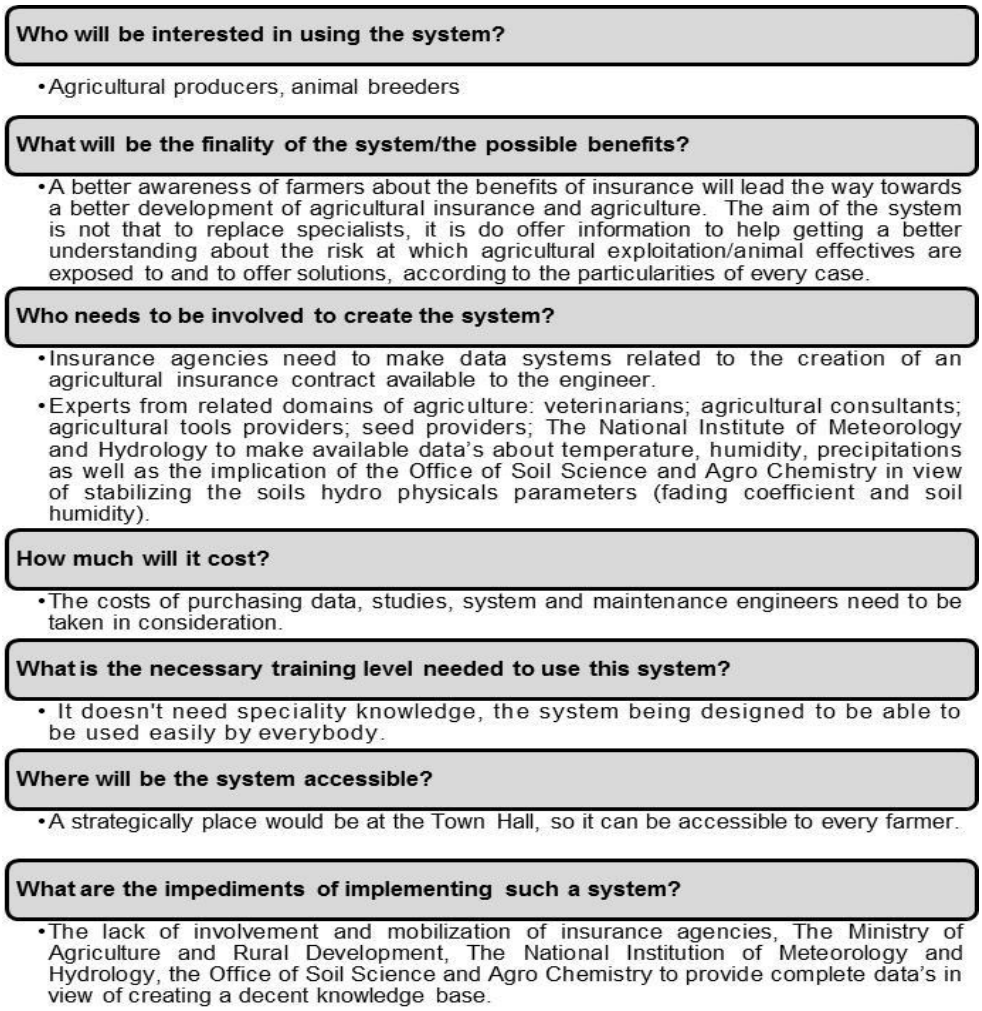

Figure 1: Useful questions before implementing expert systems in agricultural insurance
Source: compiled by the authors

2. Expert system structure

For a better understanding of the working mode of expert systems, next we will describe, briefly, the sequences that need to be gone through to develop the system as well as its components.

Expert systems are composed from two main parts: de development environment which is used to create the components and introduce the knowledge in the system containing elements (the purchase of knowledge module, the inference motor and the knowledge base) which will facilitate the creation of expert system, as well from the consulting environment which is used for counseling and for obtaining specialty knowledge, facilitating the use of the model and offering its users the advice of

experts and answers to their questions (Turban, et al., 2011). Thereby, an interface exists that facilitates explanations as well as facilitating the recommended action.
The architecture of expert system is composed of 3 base components:

- *knowledge base, which is formed from 2 parts;*
- *the rule base which contains the biggest part of the necessary knowledge to solve the problem which is specified;*
- *the facts base formed especially from knowledge specific to the problem that will be solved (formulation of the problem) as well as the resulting facts from a process inference from an inference motor (it contains all of the users data), representing the working memory. Because the systems rules are being created on the base of known fact, the decision process is influenced directly by the availability of the relevant facts. So, it is important that the facts base reflects perfectly reality and show exactly the modifications* made.

In view of preparing a very complex knowledge base, which will be included in the system, official documents or diagrams are being used, using specialty information from experts from within the agricultural insurance field (data related to the creation of an agricultural insurance contract) as well as experts from agricultural related environments. These need to contain in-depth knowledge in the domain, good communication abilities, experience and reputation so that the information offered would offer credibility. The acquired knowledge from experts and other sources will be communicated to the knowledge engineer (specialist in computers), he will be an intermediary between computers and human experts, which will process the information in such a manner that it will be applicable on a computer, creating a database. After the knowledge acquiring, their validity will be checked and a final, coherent database will be generated.
Thus, the expert systems consist of organizing information on different main levels. In Figure 2, we outlined the logical scheme of agricultural crops insurance and animal insurance within expert systems, where every level represents an integrated assembly of sublevels. For example, the level “The risks involved in insurance” from agricultural crops contains the sublevels: hailstone, hoarfrost (the late spring freezing and the early autumn freezing), downpours, storms, hurricanes, landslides, fires started from lightning, from which the farmer picks an option, based on his necessities.
We opted for a simplified schematic representation (on a single level) of the model of perfecting the expert systems in agricultural insurance for a better understanding of its functioning manner, where the system informs the user about the existing insurance conditions and offers an alternative based on the picked options.

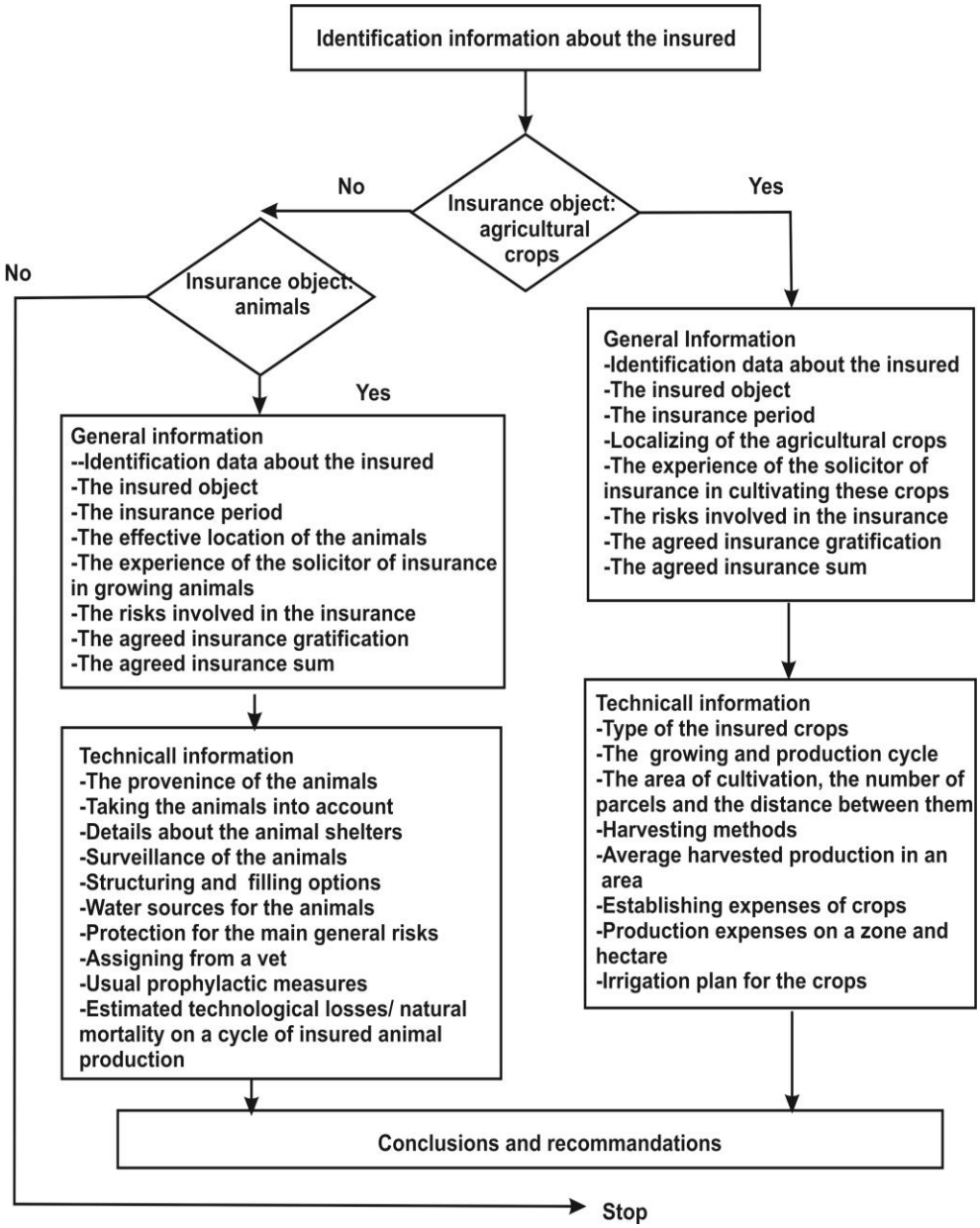

Figure 2. Logical diagram of how an expert system works in agricultural insurance
Source: compiled by the authors

Inference engine: it is a structural control component which picks from the knowledgebase the facts utilized for creating the reasoning in view of obtaining a decision option. The inference engine controls the mode and succession in which the knowledge from the rule base is applied on data from the facts base being a

computing program which applies new rules to facts to generate using induction, new facts which are being added to the knowledgebase or confirming/infirming a hypothesis, or the solution of the problem. Thus, the rule base is being run, searching for the identification of a correspondence between the facts from the conditions or the consequences of the existent rules and information in the knowledgebase. When such a correspondence is identified, the respective rule is used to produce a new knowledge or to confirm a hypothesis. This follows a series of major objectives, the elaboration of the problem solving plan after its necessities, commuting from a control strategy to the next one, the execution of actions provided in the solving plan, depending on the knowledge that we have at our disposal (http://iota.ee.tuiasi.ro/~mgavril/Simpe/L2.htm).

If the reasoning is done well, it can be transposed into the system with the help of the <<IF, THEN>> type rules, this being the most frequent, but we can also find rules which have an <<ELSE>> component which has the meaning to generate, at the end of the logical algorithm the best solutions for the user (agricultural producer) or to formulate a conclusion. Many expert systems have the capacity to explain to the user *why?* (by using motives that were at the base in the process of making an action) and *how?* (by explaining the inference process) reached by using their reasoning to their proposed solutions.

Interface with the user: it ensures the dialogue between the user and computer in an enthralling and easy to understand mode. For the interaction with the user, most systems use graphs or a texts with questions and answers, but they can be more complex by integrating dictionaries. In general though, an imposing scenario which interacts with the user can contain the next additional components (Turban et all, 2011): the subsystem of acquiring of knowledge, the working place (blackboard), the subsystem of explication generating, the subsystem of auto learning (knowledge-refining system).

The subsystem of acquiring of knowledge ensures the communication with the database interface, allowing the user to introduce new knowledge for creating or extending a database.

The subsystem of explication generating allows the following of the systems reasoning and issuing justifications for the obtained solutions, highlighting in this mode the cause of the mistakes or the failure motives, following the behavior of the system and answering question as: How did we get to a particular conclusion? or Why was a particular alternative rejected?

"The working place" is used to record the intermediary results, hypothesis and decisions. Three types of decisions can be recorded on a blackboard: a plan (for example how to approach a problem), an agenda (for example the actions while waiting for the execution potential) and a solution (for example, hypothesis and alternative routes of action which the system generated until now).

Knowledge-refining subsystem needs to be able to analyze motives for the programs' success or failure taking into account the obtained results which can make the knowledgebase better using a more efficient reasoning. Having the capacity of auto learning, the system can improve its behavior in a short time, by changing the rule base.

Such a behavior of the commercial expert systems is experimented at several universities and research centers. But currently it's not mature enough to be used.

After picking a proper tool (the most popular is the Corvid System) the attention shifted to the coding of the knowledgebase, the major concern in this stage being if

the coding process (defining variables, creating the logic blocks and constructing command blocks) is efficient and appropriately operated, to avoid errors. In what concerns the system evaluation, this implies the checking (by ensuring the fact that the knowledgebase contains the acquired data from experts and that no errors appeared in this stage of coding) and validation of the system (by confirming the fact that the system works correctly).

3. Study Case Regarding the use of Expert Systems in the Insurance of Agricultural Crops

After going through the questionnaire made by the expert systems the following information has been obtained: an agricultural producer from the Cluj-Napoca country, Cojocna parish, wants to solicit insurance for his wheat culture on an surface of 2 hectares, the average production obtained that wants to be insured consists of 3.500kg/ha, for the 21.01.2012- 31.08.2012 period. The average obtained production to a hectare in the last 5 years for the agricultural culture that wants to be taken into insurance is presented in table 2.

Table 1. Average production for a hectare (kg) obtained in the last 5 years for wheat

Nr. crt.	Type of agricultural culture	Years				
		2011	2010	2009	2008	2007
1.	Wheat	3.900	3.700	3.500	3.800	2.900

Source: Author processing's

For the agricultural culture insured no damage has been recorded in the previous agricultural year and the risks contained in the insurance are: direct effects of downpours, storms, hurricanes, collapses, landslides, fires started from any reason, the agricultural producer is willing to allocate a budget of 100 lei, not wanting to pay for deductibles.

In view of finding the insurance gratification and the gratification, the expert system will use the data communicated by the user to find the best possible option of insurance on the market taking into consideration his needs, going through a logical algorithm. The system will pick first price quota (%) of the respective culture taking into consideration the tariff group of the culture (wheat), the risks contained into the insurance (direct effects of downpours, storms, hurricanes, collapses, landslides, fires started from any reason) and the grouping of the counties on tariff groups (Cluj) which it will be applied to the cost of the harvest of the entire planted surface, the insurance gratification being obtained.

The expert system will be conceived in such a manner that it will be able to be used with ease by agricultural producers, offering additional explanations where it is required and argumentations for the recommendations it makes.

For example, referring to the risks contained in the insurance, the system offers a clear and explicit definition, compliant with figure 3, thereby so that the agricultural producers can identify the correct risks at which their agricultural exploitations are exposed.

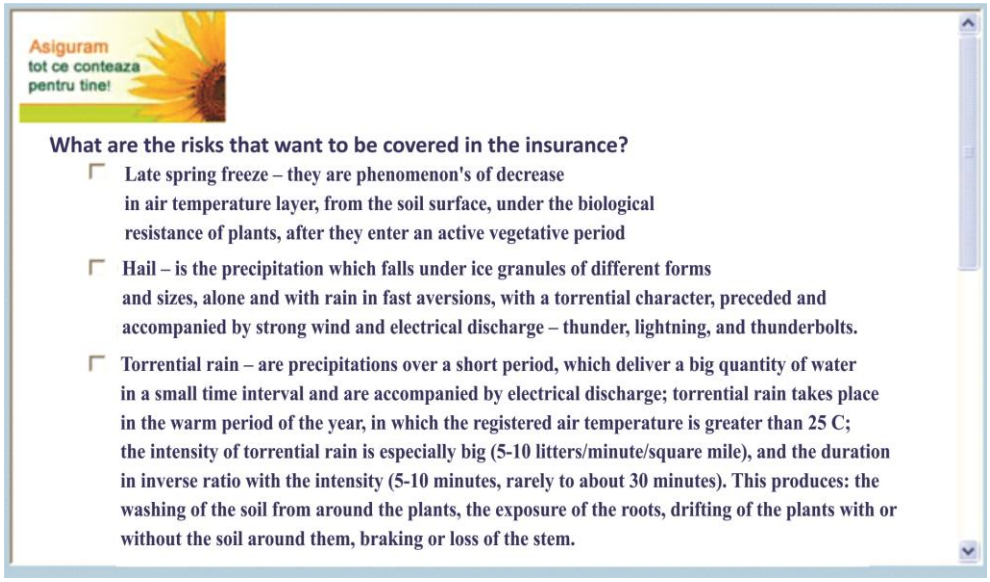

Figure 3: Online questionnaire
Source: screen capture while running the application (Exsys, 2013)

In respect of the results, the expert system will recommend the first 3 insurance agencies which fit the farmers' necessities, arguing the choices made and offering the possibility of sending a solicitation to create an insurance contract on the website of the respective society, pursuant with figure 4.

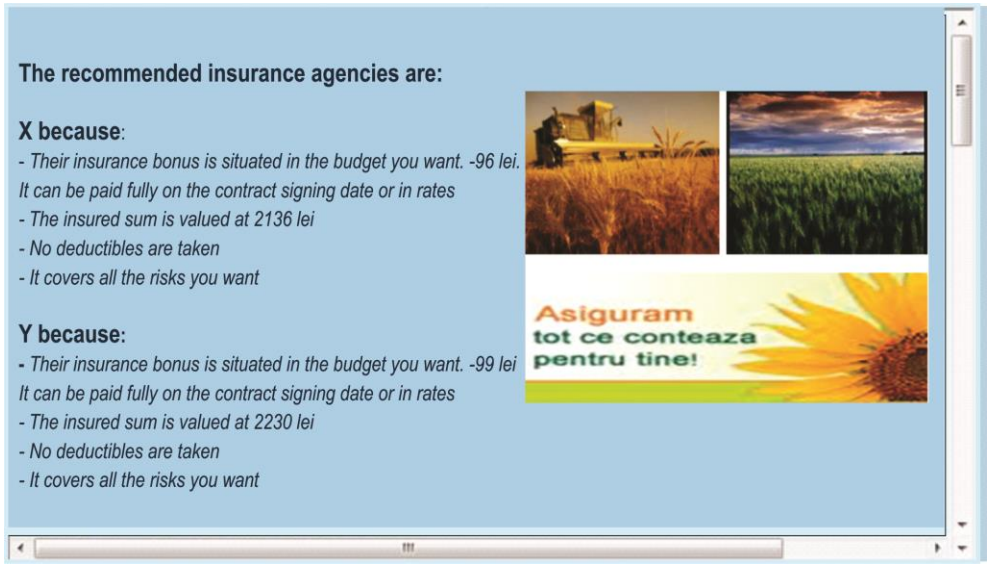

Figure 4: The recommendation of the system
Source: screen capture while running the application (Exsys, 2013)

4. Conclusions

After running through the steps followed by the expert systems, we can easily see the efficiency of implementing artificial intelligence in agricultural insurance, the main benefits being the development of agriculture and insurances by removing the lack of information and the trust of farmers towards insurance so that they will have at their disposal solutions and newly improved information based on the previous experience of the users. Specialty literature from the studied expert systems area, highlights the benefits of implementing expert systems in all the areas of the socioeconomics activity, amongst them agricultural insurance, but, it doesn't deal with the agricultural insurance segment alone, in spite of its importance in the development of agriculture. This fact confirms the added value brought up by the existent article from specialty literature.

Using expert systems in agricultural insurance can contribute to the development of the agricultural sector, bringing immediate and long term benefits, whereas the behavior of the agricultural producers can be followed, their aversion towards the risk and the frequency and intensity of the risks in various regions, making the creation of better insurance products possible which will responds to the needs of the farmers, approached based on the different types of risks specific to agriculture, as well as the extending of the coverage of this products at the full level of the farmers inheritance, these having the role of sustaining in time, the development of the economic sector and maintaining the financial circuit in agriculture.

In point of the future research directions of this area, we can say that the success of applying expert systems in the agricultural insurance domain depends on the understanding of this systems importance, the availability and the capacity of the insurance agencies to support this domain, as well as the involvement of the Commission of Surveillance of Agriculture and the Ministry of Agriculture.

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