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SEcafé: An expert system to support producers of quality coffee

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ABSTRACT :*Expert system is one of the important application branches of Artificial Intelligent. Expert systems are being used in various sectors of agriculture. In this work an expert system for the computer-aided was developed for designing and selection of equipment to pre-processing of coffee, to aim the producers of quality coffee. The knowledge base of this expert system contains 80 equipment registered. A model of MARKOV's chain has been developed to determinate the distribution of four bad working days, or days not workable on paved terrace, considering the climatologic variables. The expert system was evaluated following the conventional expert system evaluation methodologies. The results and the validation indicated that non-expert users are able to design pre-processing coffee system and allow the access to level of knowledge where there is less human resource, decreases of sensible manner the time of designing and selection of equipment to pre-processing of coffee. As a result of the validation indicated that 91% of the evaluators agreed that the expert system aid the tasks and the study of the professional in pre-processing coffee area.*
KEYWORDS - *knowledge, artificial intelligence, design, selection.*

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I. INTRODUCTION

The coffee cultivation is very important to the Brazilian economy. It represents about 2.5% of the total Brazilian exportation.According to [1], the first estimative of the coffee production should be 50,16 millions of bags of 60 kilo of the processed coffee. However, likeanyother crop, the coffee grains can have a quality loss during the pre-processing, due to lack of experience and technical information to producers.

The agriculture is a complex economic activity and includes high risk. The agricultural products are, generally, perishable and climate variations determine tight deadlines and with regard to quality coffee, there are several factors that influence its final quality: soil and climatic characteristics, cultivars, management of crop, harvest, pre-processing, drying and storage [2]. The coffee grainisaproductthat loses its qualitydue to the factorsmentioned above, because most of the Brazilian productionis dried inthe paved terrace. The final quality of coffee is very involved with the aroma of the drink, this happens because of the complexity of the compounds of the coffee, more than 800 volatile compounds make up the formation of the aroma and flavor. The amounts of these volatiles compounds are very dependent of the processing method used [2].

The agriculturalproductionis part of a productive complex that requires the integration of knowledge and information of different sources. To become competitive, the modern producer requires the support of experts and counselors in agricultural process to provide information and aim in the making decision. Unfortunately, the agricultural expert is not always available when the producer needs. To solve this problem, expert systems are being used as a powerful tool to assist the producers in these occasions[5]. Expert systems can be an alternative choice for the private sector due to difficulties encountered in finding the expert person at every time and everywhere and high costs of expert persons [10].

An expert system is a computer program that uses representation of the knowledge to solve problems in domain-specific systems. These systems employ artificial intelligence programming techniques to solve well-defined problems and enhance decision making [7]. Expert systems have been developed for many kinds of applications in agriculture, involving diagnosis, predictions, consultation, control, etc. [10].

This work presents the implementation and evaluation of an expert system developed to provide aims to producers and technicians with information to designing and selection of equipment to preprocessing of coffee of high quality.

II. METHODS

This work was developed at the Department of Agricultural Engineering at Federal University of Viçosa - UFV. The expert system was developed using the language for developing expert systems CLIPS (C Language Integrated Production System), version 6.26, developed by Software Technology Branch of the NASA/Lindon B. Johnson Space Center [3]. This programming tool is designed to facilitate the development of software to model human knowledge [9], and the language CLIPS uses facts, rules based,standard compatibility and inference engine with forward chaining through successive rules implemented in structures like "IF-THEN". The expert system performs according to the inference acquired in the knowledge encoded in that rules.

The SEcafé has a graphical user interface (GUI) developed in Borland Delphi, version 5.0, which offers powerful tools to develop an interface that provide quick access to SEcafé and operates under the Microsoft Windows environment. Computers programs as SEcafé is important to coffee producers because according to [6], a decision support tool can definitely help producers identify the most suitable system and its components, making the whole process simpler and quicker.

2.1 Knowledge acquisition

Maybe the most important aspect of building an expert system is formulating the scope of the problem and gleaning the knowledge from the source, which in this case, is a domain of an expert in a specific domain area to solve the problem. According to [4], the translation of knowledge possessed by the expert into a knowledge base is the bottleneck in the process of knowledge acquisition. In this work, the knowledge has been obtained from two sources: literature reference and expert interviews.

2.2 Literature reference

Part of knowledge base has been acquired from textual information (e.g. equipment information, technical information and terminology, etc.), from literature such as extension booklets, papers, etc. The printed material has allowed more knowledge about the equipment and more effective communication with the experts.

2.3 Expert interviews

In this work, to create a solid knowledge base, most knowledge has been acquired from the experts using conventional interview techniques [4]. The interview techniques allowed the acquisition of the heuristic knowledge that not was present in the printed material. The interviews have been used to define specific tasks and information involved in the process of design and selection of equipment required in a project of pre-processing of coffee of high quality. In these interviews, it has been revised and discussed in depth specific tasks to answer questions or clarify some doubts and to establish a hierarchy of ideas and methods applied in this kind of project.

2.4 Calculation of probability of occurrence of rainy season using Markov's chain

In the proposed expert system has been incorporated into a model for calculating the probability of rainy periods from the climatological information of the region. The user must equip the system with this information.

The model considers as reference the occurrence of four days with precipitation equal to or greater than 1.0 mm. This is important because, from the fourth consecutive day with precipitation, the coffee grains that are being dried on the paved terrace begin to have significant losses of quality due to the fermentation.

Using the Markov's chain has been possible to calculate the probability of workable days on the paved terrace, suitable for drying coffee. According to [7], the main tool for the probabilistic analysis of transitions between dry and wet days is the chain of Markov, widely used in the study the occurrence of daily rainfall, both in abroad and in Brazil. This work hasused the Markov process and the theory of conditional probability to estimate the occurrence of four rainy days.

III. RESULTS

3.1 Interface

The design and the selection starts by asking to the user about the coffee growing area, the maximum productivity, the harvest period and what kind of coffee the user intend produce (Fig. 1).

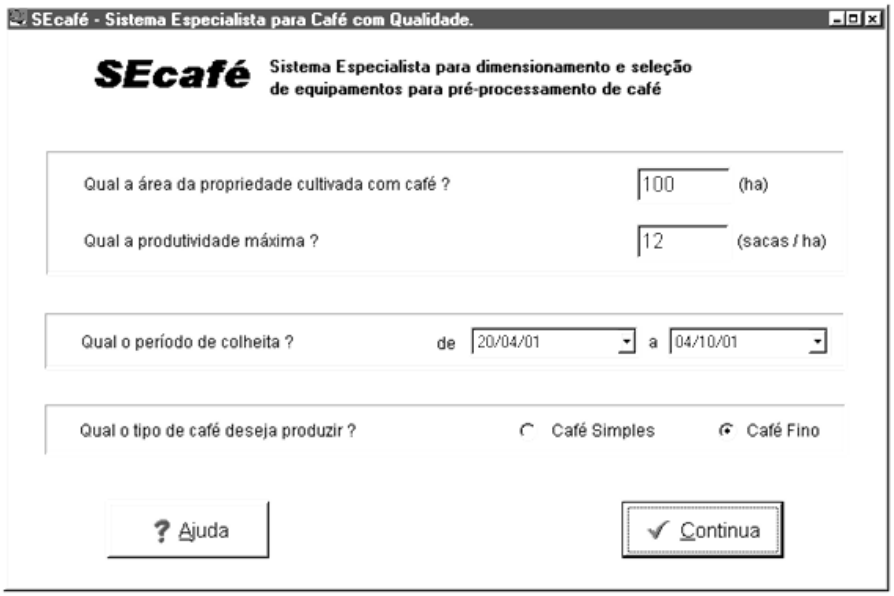

Fig. 1: Start screen.

3.2 The expert system working

The SEcafé works in two steps: (1) it generates a text file with extension ".clp", from the information obtained from the inquiries done to the user in the interface of the program (Fig. 1), and (2) from the interface in Borland Delphi, it actives the expert system in CLIPS language, through a DLL (Dynamic Link Library), and later, it processes the information from the text file generates a list of designed equipment.

The result of the SEcafé is a list with the recommended equipment for a system of preprocessing of high quality coffee. This list is obtained in a text file with extension ".txt", however, it does not display the list directly to the user. The expert system does the reverse process, it reads the text file with extension ".txt" and displays to the user the result in a graphical interface, which can be printed by the user (Fig. 2).

Fig. 2: An example of an interface screen showing the specific selection of designed equipment with the specifications of each equipment, price and contact suppliers.

3.3 System evaluation

To evaluate the SEcafé, the process has been carried out in two steps, in according to Harrison (1991), the verification and validation.

To the verification, it has determined the possible errors in the SEcafé recommendations and ensured that the expert system performed as intended. According to [5], the verification consisted of tracing all pathways to determine their correctness. This was accomplished by running the program many times, giving all the

combinations of possible answers. The result of each recommendation was verified by a different specialist in project of high quality coffee.

To the validation, it has been used the methodology validation by the end users or living testing [10]. The validation team was a group of 15 students from the agricultural engineering course and 4 specialists in coffee area from the National Training Center in Storage – CENTEINAR and UFV. All the students were selected because they were students of postgraduate course with some experience in project of coffee system. Prior to the validation process, comments on ease of use, interface design, functionality and result output were done to the students. Then, to each student was asked to design a project of high quality coffee and, after that, they answered a questionnaire about the expert system. Students working with the SEcafé were able to design system of high quality coffee and 64% of the students answered "excellent", 27% "good" and 9% "regular" about how the recommendations made by the SEcafé are presented to the user. About the designed and selected equipment by the expert system, 45% of the students agreed with the result presented by the SEcafé. All the simulations made by SEcafé were evaluated by the specialists from CENTREINAR and UFV and there was a concordance of 100% in the presented results.

Regarding the environment of the SEcafé, it is presented in the Table 1, the questions done to the evaluators and their answers.

Table 1. Questions and evaluator´s answers regarding to the SEcafé environment

SECAFÉENVIRONMENT	YES	NO
Does the SEcafé present itself?	91%	9%
Are clear the questions asked by SEcafé?	100%	0%
Does the SEcafé facilitate the work or study of a professional of the pre-processing of coffee area?	91%	9%
The manner how the help is provided to the user, with illustrations and explanations, does it facilitate the understanding by the users?	100%	0%

IV. CONCLUSION

All the evaluators and other peoples that used the expert system believed that the SEcafé had management and educational value. As an educational tool, it can augment the traditional educational methodologies for students and coffee producers. Results of the validation indicated that non-expert users were able to make design of high quality coffee system or improve existing systems.

Thus, based in the results, it was concluded that the expert system developed allows: (a) to estimate the cost to implement the system designed; (2) display the help module in order to facilitate the understanding of the user; (3) to avoid the overspending due to the oversizing and the risk of the undersizing; (4) the user interface is easy interaction, facilitating the input of information and understanding of the results; (5) that the SEcafé, besides allowing access to a level of technical expertise in an area where there is shortage human resources, reduces appreciably the time required to design and selection equipment to high quality coffee systems.

Further refinements are under consideration in order to improve the system, based on the suggestions noted in the preliminary evaluation.

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