AN EXPERT SYSTEM FOR COMPREHENSION OF FORAGE CROPS AND UTILIZATION ON PASTURE SYSTEM

Mongkon Ta-oun[1], Mohamed Daud[2], Mohdzohadic[3], Shamshudin Jusup[4]

ABSTRACT

The knowledge based of expert system for comprehension of forage crops and utilization on pasture system could be extracted from domain experts and established literatures for preparing an expert system skeleton. This system was developed by CLIPS program. The skeleton of the expert system is divided into four main parts; information, pasture management and prediction. The introduction part will help user to get general information of forage crops and the important environmental factors of many processes so that user can understand the process components in pasture establishment. The pasture management part explains the principle of managing the pasture for sustainable utility and gaining continuously and sufficiently high yield of crops and animal production. The last part is prediction part, to illustrate principle of factors and algorithms using in decision making / prediction the selection of forage crop varieties on pasture establishment; furthermore, in this part has model for predicting groundwater pollution vulnerability of the existing environment of pasture which will be established.

INTRODUCTION

Forage is still featured as the most prominent ruminant. Sizable quantities of those byproducts are utilized as non-ruminant feed while the remainders, which comprise of mainly fibrous byproducts, are not fully exploited commercially. Low production of ruminants can be attributed to inferior animal breeding base and insufficient supply and low quality feeds. Introduction of improved forage species and improvement of cultural management are continuously being conducted to ensure supply of high quality feeds. As early species of tropical grasses and legumes have been initially recommended for the pasture improvement and development, however adaptation of the said species was very site species (de la Vina and Moog, 1993 and Ly, 1994). Furthermore, the area allotted for pasture development are those that are non-arable crops and the soils are very poor since arable crop lands are always planted to food crops if not converted to residential areas to industries.

Researchers have recognized the limited application of forage crop varieties in selection to pasture system. Thus, this study was limited to collect the knowledge base on information grass for comprehension of forage crops and identifying varieties/species of forage crops that have appropriate adaptation and suitable to decision making for the selection on the pasture establishment depending on each of environment by application of expert system.

Expert system, a type of computer application programs that makes decisions or solves problems in a particular field by using knowledge and analytical rules defined by experts in the field. Human experts solve problem by using a combination of factual knowledge and reasoning ability. In an expert system, these two essentials are contained in two separated but related components, a knowledge base and an inference engine. The knowledge base provides specific facts and rules about the subject, and the inference engine provides the reasoning ability that enables the expert system to form conclusions (Durkin, 1994 and Mercer, 1995).

METHODOLOGY

For this research, the equipment/accessories of computer budged and other feasibility to develop an expert system for comprehension of forage crops and utilization on pasture system supported by Faculty of Engineering, University Putra Malaysia. The materials and the methodological techniques used to development and design the expert system is as follows :

1. To prepare sufficient accessories to compose this study

PC computer Pentium version, color monitor, hard disk at least 1.3 GB, Scanner high resolution, CD-ROM drive double speed, Sound card with speaker, Printer etc.

2. Knowledge acquisition

Knowledge acquisition is the process of gathering necessary information for the expert system. It is the most time consuming aspect for creating a knowledge-based system. In this study, the knowledge acquisition can be devised into two parts; the first part included the collection of necessary information which show in figure 1 and second part is the coding of knowledge for the problem domain experts. The sources of knowledge base can be carried from established literatures and domain experts. The knowledge base consists of text document, picture, graphic with message descriptions, table of forage crop information and etc.

3. Knowledge representation

Production rules will be used in this expert system with knowledge representing in IF/THEN (condition-action) statements. It is widely used method that has been devised

[1]Researcher, [2]Lecture, [3]Professor, Faculty of Engineering, University Putra Malaysia
[4]Professor, Faculty of Agriculture, University Putra Malaysia

for representing this information. In the expert system all the knowledge was constructed as rules. Domain knowledge was captured in a set of rules and entered in the systems knowledge. When the IF portions of the rule matches information contained in the working memory the system performs the action specified in the THEN port of rules.

The example of rule is used in this study
(Defrule tolerance-type
(Acid? acid)
(Grazing? grazing)
(Acid? acid (= high))
(Grazing? grazing (= high))
⇒
(printout display (str-ct "Verano" crlf))

The rule says IF want the forage crop variety which tolerate to high acid soil and high defoliation THEN the pasture establishment, Verano (*Stylosanthes hamata* cv. Verno (L.)) variety should be selected.

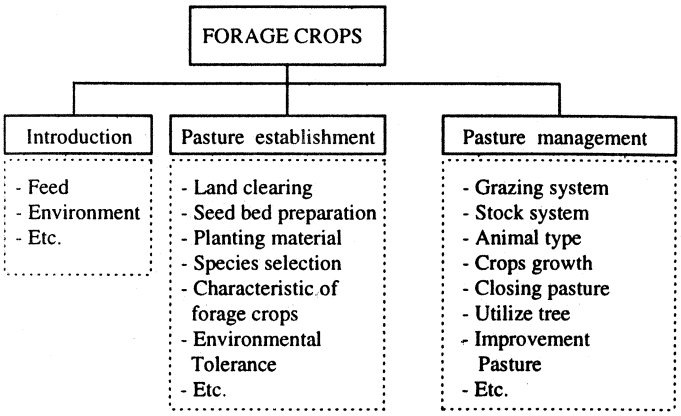

Figure 1. The knowledge base used in the expert system for comprehension of forage crops and utilization on pasture system

4. Selection of the program language and operating system

An application of expert system for this study developed by using CLIPS (C language Integrated Production System). CLIPS is an OPS-like forward chaining production system written in ANCI C> The CLIPS inference engine includes truth maintenance, dynamic rule addition, and customizable conflict resolution called COOL (CLIPS Object Oriented Language) which is directly integrated with the inference engine. This expert system will be developed using a modular programming technique and window capabilities "Toolbox" facilities will be use extensively especially for the input output operations. CLIPS provides a cohesive tool for handling a wide variety of knowledge supporting for three different programming paradigms; rule based, Object oriented and Procedural (Giarratano and Riley 1994, Giarratano 1993, Julian 1994).

CLIPS was selected to create expert system because CLIPS is easy to be used and work able with object oriented which can facility in replication and usable a little time in development. However, it can application color picture, moving picture, and sound on MS window 95 or 97 which can application of developed expert system to use easy which general user uses world wide in the present.

5. Plan of data base system of expert system

An expert system program has function illustration text document, interacting with user. The system can be selected to study in the interesting part of main menu with cross over the knows menus to other interesting menus such as not select basic information of forage crop but select the menu of pasture establishment or prediction etc. In the expert system program there will be sound, colour pictures and moving pictures that are enjoyable in this study and following time to use this program. Moreover, this program can print the interesting data of information of grass and pasture establishment to print out by printer or save to text file.

6. Testing and modifying of expert system program

To improve and modify program, the testing of expert system program will comprise of text documents, pictures, sound, moving pictures, and model for predicting the selection of forage crop varieties and groundwater pollution vulnerability. Which can be checked for finding any errors in this program. Through out, performing the recommendation of domain experts such as crop scientists, system engineers and other relevant in expertise to pasture development projects. The application of this program will give perfect results and useful to general people.

RESULTS AND DISCUSSION

This expert system is an important module for new users of the system. Instead of trying to understand and review on forage crop management from various sources in Malaysia and Thailand, users are able to extract that knowledge from this module. Figure 2 shows the structure of expert system for comprehension of forage crops and utilization on pasture system. On the main frame there are 4 main menus on the menu-bar; introduction, pasture establishment, prediction and pasture management.

INTRODUCTION MENU

Upon clicking any of the main function another screen appears. For the user to choose multiple choices form, for an example, in figure 3 after the introduction function is clicked, the following screen appears and after selecting the forage crop type function the message and picture will be illustrated in the window text area, canvas frame and canvas area.

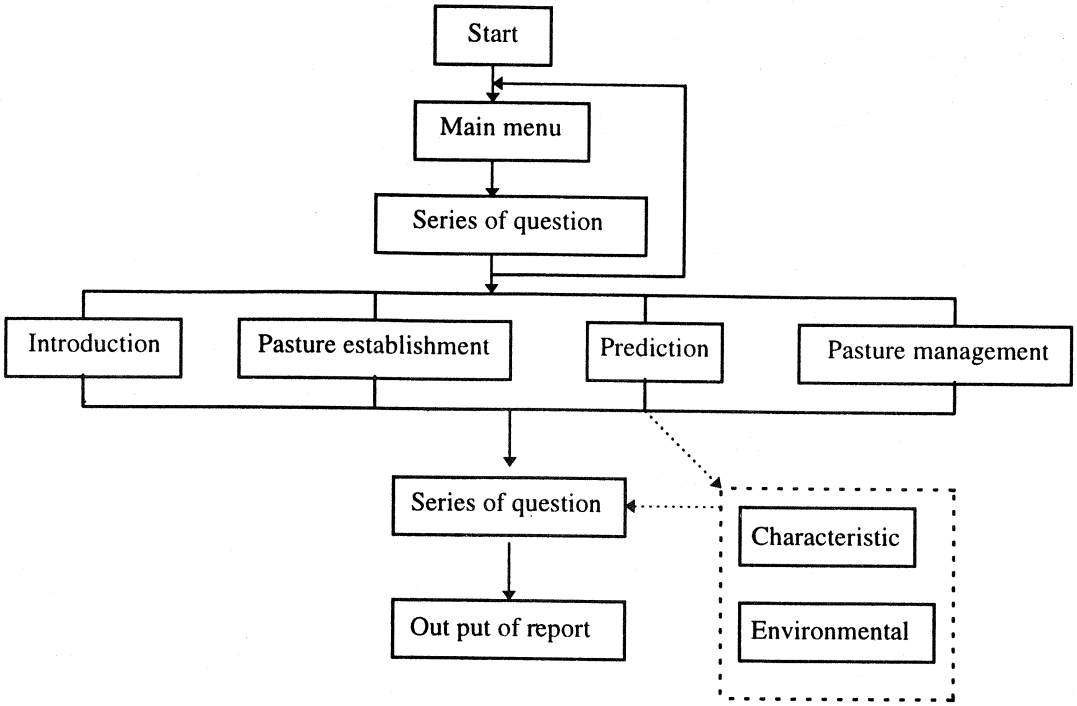

Figure 2. The structure of an expert system for comprehension of forage crops and utilization on pasture system

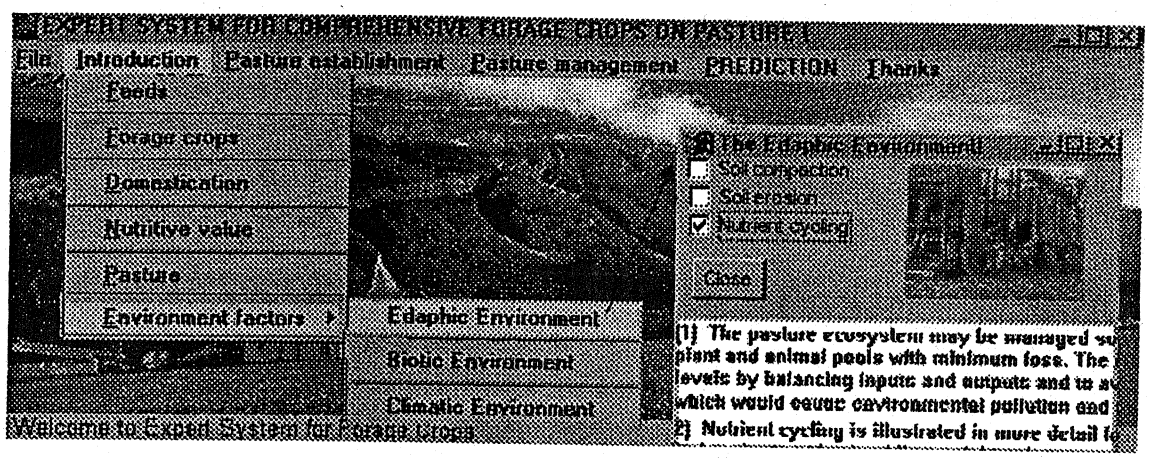

Figure 3. The screen shows the introduction menu and its component function that provide the fundamental information on forage crops.

PASTURE ESTABLISHMENT MENU

The pasture establishment menu composes of various parts as follows; land clearing, seedbed preparation, forage crop type, planting material, rhizobium inoculation, suitable season, sowing practice and nursery preparation. The example of function in the pasture establishment menu, when user select this menu and click the land clearing function then the screen appears as shown in figure 4.

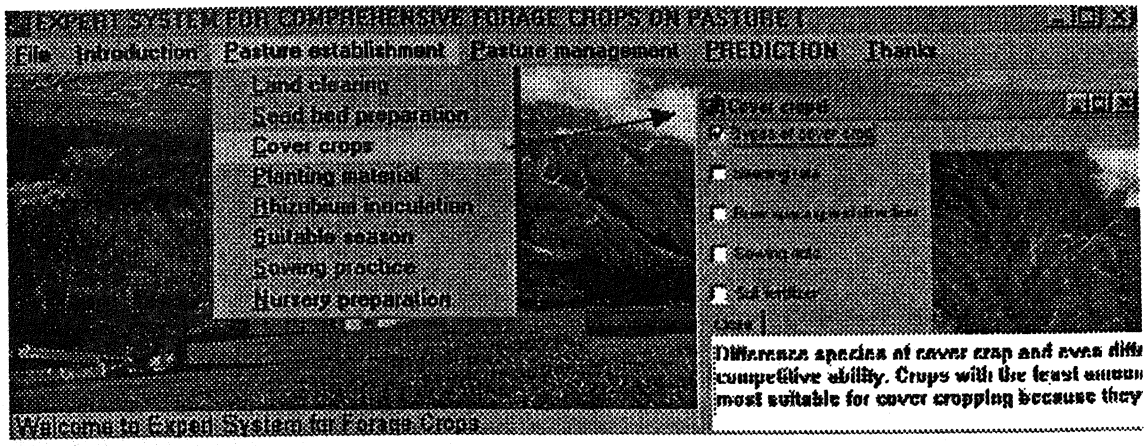

Figure 4. The screen shows the pasture establishment menu and its component function that provides the principle of the processes for pasture establishment.

The programming of the entire screen out put choices is same except for its contents. The following is the sample rules used for the pasture establishment menu;

```
(If case 1210 then
(bind ?*main-frame 1* (frame-crated 0 "Cover crops!" 7 -1 627 460))
(bind ?*text-win* (text-window-create ?*main-frame 1* 0 250 500 250))
(bind ?*panel* (panel-create ?*main-frame 1* 0 530 250))
(panel-set-label-position ?*panel* wxVERTICAL)
(bind ?check-box-create ?*panel* "frame-button-procccmk1" "Types of
cover crop"))
(bind ?check (check-box-create?*panel* "frame-button-procccmk2"
"Seeding rate"))
(bind ?check (check-box-create?*panel* "frame-button-procccmk3"
"Row spacing and direction"))
(bind ?check (check-box-create?*panel* "frame-button-procccmk4"
"Sowing date"))
(bind ?check (check-box-create ?*panel* "frame-button-procccmk4" "Soil
fertilizer"))
(bind ?button (button-create ?*panel* frame-button-procstopmk "Close"))
(window-add-callback ?*main-frame 1* OnSize on-size)
(window-add-callback ?*main-frame 1* OnClose on-Close)
(window-show ?*main-frame 1* 1))

(deffunction frame-button-procccmk1 (?id)
(bind ?*canvas* (canvas-create ?*main-frame 1* 320 25 250 190))
(bind ?*bitmap* (bitmap-load-from-file "ccmk1.bmp"))
(window-add-callback ?*canvas* OnPaint on-paint)
(text-window-load-file ?*text-wint* "ccmk1.txt"))
```

The deffunction command is used to call the screen for the pasture establishment menu. List box get selection is the type of selector used while if the selection is one then following three rules would appear. They are text file, canvas and bitmap-picture.

PASTURE MANAGEMENT MENU

The pasture management menu illustrates the principle of the process for managing the pasture for sustainable utility and gaining continuously and sufficiently high yield of crops and animal productions. This menu consists of eight part e.g. grazing system, stock system, type of animal, crop growth, closing pasture, utilize tree, feed support and improvement pasture. The user will be guided through out in selecting the interested information. As in figure 5, is screen where 8 steps of the pasture management are required. If the user choose the first selection, that is the data selection, another guide screen will appear.

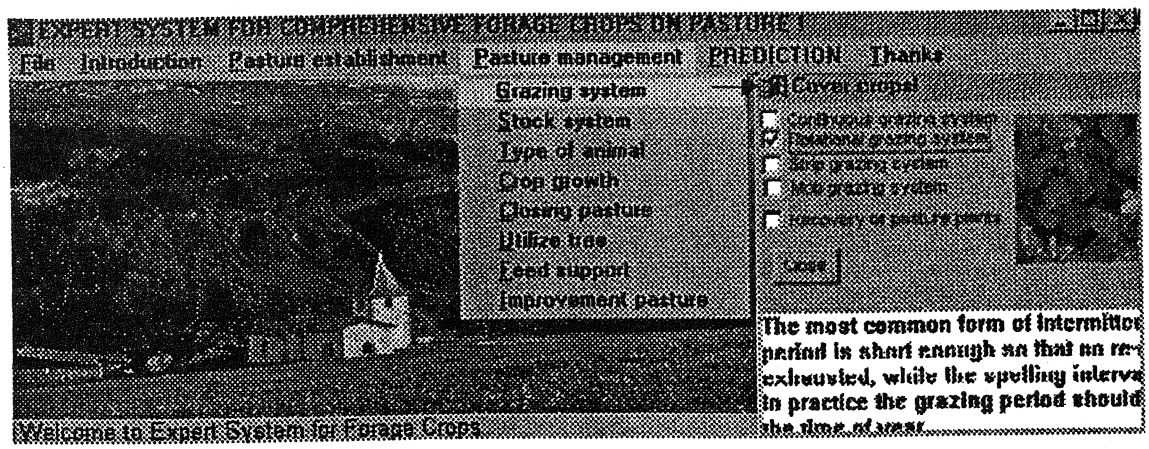

Figure 5 The screen shows the pasture management menu and its component function that provides the principle management for sustainable pasture.

PREDICTION MENU

The prediction menu illustrates the principle of factors and the term of questions for predicting the selection of forage crop varieties, or species on pasture establishment and the modeling for predicting groundwater pollution vulnerability of the existing environmental of pasture establishment by using demonstration slide model. This paper, present only the decision making for the selection of forage crop varieties. All information is available in a consisted and plausible framework that links pasture type and environmental feature to expect using in a simple logical format of IF-THEN rules. The user can use the screen and the keyboard and mouse to interface with the system. The expert system will ask the user with the question and display the set of possible answers to be selected. The example is shown in the figure 6.

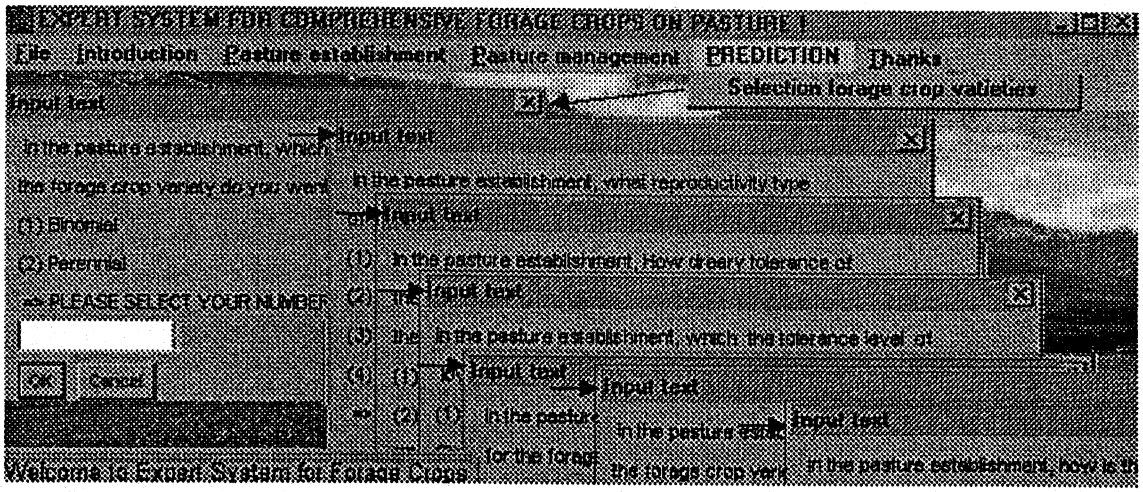

Figure 6. The example of an expert system ask the user to provide the answer of the question for decision making the selection of forage crop varieties on pasture

In this expert system, all the knowledge was structured as rules. Domain knowledge is captured in a set of rules and entered in the systems knowledge base when the IF portion of the rule matches the information contained in the working memory the system performs the action specified in the THEN part of the rules. The rules used in this part of the program for pasture establishment, which was translated, are shown as follows.

Question 1. What is the growth type of forage variety you want to select ?
(1) Binomial
(2) Perennial

Question 2. What is the stem type of the forage crop variety you want to select ?
(1) Straight stem
(2) Creeping stem
(3) Creeping surface stem
(4) Cherub stem
(5) Straight and stolon stem

Question 3. What is the reproductively type of the forage crop variety you want to select ?
(1) Non-reproductively
(2) Cross reproductively
(3) Self reproductively
(4) Semi reproductively

Question 4. What is the droughty tolerance of forage crop variety to the environment of the study area you want to select ?
(1) Slightly
(2) Low tolerance
(3) Medium tolerance
(4) High tolerance

Question 5. What is the tolerance of low temperature of the forage crop variety you want to select ?
(1) Low tolerance
(2) Medium tolerance

Question 6. What is the environment shade tolerance of the forage crop variety you want to select ?
(1) Slightly tolerance
(2) Low tolerance
(3) Medium tolerance
(4) High tolerance

Question 7. What is the flood tolerance of the forage crop variety you want to select ?
(1) Slightly tolerance
(2) Low tolerance
(3) Medium tolerance
(4) High tolerance
(5) Extremely tolerance

Question 8. What is the acid soil tolerance of the forage crop variety you want to select ?
(1) Low acid soil
(2) Medium acid soil
(3) High acid soil
(4) Extremely acid soil

Question 9. What is the alumunium soil tolerance of the forage crop variety you want to select ?
(1) Medium tolerance
(2) High tolerance
(3) Unspecified

Question 10. What is the manganium soil tolerance of the crop variety you want to select ?
(1) Low tolerance
(2) High tolerance
(3) Unspecified

Question 11. What is the saline soil tolerance of the forage crop variety you want to select ?
(1) Low tolerance
(2) High tolerance
(3) Unspecified

Question 12. What is the defoliation (grazing/cutting) tolerance of the crop variety you want to select ?
(1) Medium tolerance
(2) High tolerance
(3) Extreme tolerance

CONCLUSION

An expert system for comprehension of forage crops and utilization on pasture system was developed by CLIPS program. The system provides an example of a qualitative and logic based technique for analysis of complex pasture establishment problems, rather than attempting to predict, in any absolute senses of forage crop management, and to evaluate them. All information is available in a consistent and plausible framework that links pasture type and environment feature to expected using is in a simple logical format of IF-THEN rules. This assessment based on comprehensive of pasture establishment and management by integrated with the limits of the existing environment. It uses logic and rules derived from expert opinions and existing literatures rather than algorithms and numerical models, to arrive at conclusion and there by an assessment of expected the suitable of forage crop varieties / species on pasture establishment. The system can operate with an optimum of data information about the forage crop, and environmental setting by drawing on a generic knowledge and rule as well as a set of data based and a regional geographical information system.

REFERENCE

de la Vina, A.C. and Moog, F.A. 1993. Performance evaluation of forage and pasture species under different Agro-Ecological conditions, In Proceeding of strategies for suitable forage-based livestock production in Southeast Asia, Knon Kaen Thailand, 155-159p.

Durkin, J. 1994. Expert system design and development. Prentice Hall Internation, Inc., London 800p.

Giarratano, J.C. 1993. CLIPS version. Software technology Branch Lyndon B. Johnson Spaccenter, USA, 162 p.

Giarratano, J.C. and G. Riley. 1994. Introduction to CLIPS in Expert system principles and programming. PWS publish company, Boston, 363-400 p.

Julian, S. 1994. User manual for wx CLIPS 1.3. Artificial intelligence application institute, university of Edinburgh, south bride, Scotland 53 p.

Ly, L.V. 1994. Ruminant production in Vietnam and development of forage in small holder farm, In Proceeding of enchancing sustainable livestock-crop production, Nha Trang, Vietnam, 67-72 p.

Mercer, K.G. 1995. An expert system utility for environmental impact assessment in engineering. J. of environmental management 45, 1-23.