ระบบฐานความรู้เพื่อสนับสนุนการจัดการทรัพยากรที่ดิน : ดินเค็มภาคตะวันออกเฉียงเหนือของประเทศไทย [1/]

A knowledge-based System for Supporting Land Resource Management : Saline soil in Northeast Thailand

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บทคัดย่อ

ระบบฐานความรู้เพื่อสนับสนุนการจัดการทรัพยากรที่ดินในภาคตะวันออกเฉียงเหนือ กรณีการจัดการดินเค็ม เป็นการพัฒนาโปรแกรมมาจาก Expert System Shell คือ wxCLIPS (องค์การ NASA) เป็นการรวบรวมองค์ความรู้ในการกำหนดทางเลือกทั้งวิธีการจัดการฟื้นฟูพื้นที่อย่างถูกต้องตามหลักวิชาการและข้อมูลสนับสนุนอื่นๆ เพื่อให้เกิดความเหมาะสมในการจัดการทรัพยากรดินและแหล่งน้ำในพื้นที่ เพื่อให้เกิดเศรษฐกิจที่ดีของชุมชน อันเป็นพื้นฐานความยั่งยืนในการใช้ประโยชน์ทรัพยากรในพื้นที่ดินเค็มให้เกิดประโยชน์สูงสุด โดยแหล่งความรู้ที่ใช้ส่วนใหญ่ได้มาจากการวิจัย การสัมภาษณ์ผู้เชี่ยวชาญและเอกสาร ข้อมูลของหน่วยงานอื่นๆของส่วนราชการ ซึ่งระบบที่พัฒนาขึ้นประกอบด้วย 8 ส่วน คือ 1) ความรู้เบื้องต้นเกี่ยวกับดินเค็ม 2) เทคโนโลยีทางดินและปุ๋ย 3) เทคนิคการสร้างชั้นตัดการเคลื่อนที่ของเกลือ 4) การใช้สารโพลีเมอร์สังเคราะห์ 5) การปรับปรุงดินโดยใช้พืชพันธุ์พื้นเมือง 6) การเลี้ยงสัตว์ในพื้นที่ดินเค็ม 7) แนวทางการใช้พืชปุ๋ยสดในการปรับปรุงดิน และ 8) การใช้ระบบโพลเดอร์ ซึ่งแต่ละส่วนของระบบฐานความรู้นี้มีคุณสมบัติเป็นโปรแกรมฐานข้อมูลเปิดที่สามารถปรับแก้ไขและปรับเปลี่ยนข้อมูลได้อย่างอิสระ อีกทั้งผู้ใช้สามารถติดต่อกับโปรแกรมได้ง่าย

คำสำคัญ : ระบบฐานความรู้ การจัดการทรัพยากรที่ดิน ดินเค็ม

ABSTRACT

A knowledge-based system has been developed from wxCLIPS, an expert system shell delivered by NASA, to be used as a supporting system in the management of saline soil in Northeast Thailand. This system incorporates knowledge-based with reference to appropriate alternative methodologies in the renewal of saline soil including supportive data and information that are useful to suitably and sustainedly manage soil and water resources and eventually improve community economics. System knowledge-base comprises of knowledge derived from research outcomes, interviewing domain experts, data and information of government and private sectors. The system developed consists of 8 modules, i.e. 1) Saline Soil, 2) Soil-Fertilizer Technology, 3) Cutting-off Zone,

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1/ เอกสารเสนอในการสัมมนาวิชาการระบบเกษตรแห่งชาติ ครั้งที่ 2 เรื่อง "ระบบเกษตรเพื่อการจัดการทรัพยากรและพัฒนาชนบทเชิงบูรณาการ" ระหว่างวันที่ 26-27 สิงหาคม 2545 ณ โรงแรมโฆษะ อ.เมือง จ.ขอนแก่น

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4) Polyvinyl Alcohol: PVA , 5) Indigenous Vegetation, 6) Animal, 7) Green Manure and, 8) Polder System. Each module is an opened-based component that is able to be edited independently.

Key words : Knowledge Based System, Land Resources Management, Saline Soil

INTRODUCTION

Information technology, and in particular, the integration of data base management system, simulation and optimisation models, expert systems, geographic information system and computer graphics, provide some of the tools to support environment assessment. The features of an information system to be used as a tool in environmental assessment studies have been explained in detail in Bosio et al. (1992) . A knowledge based system approach has been adopted, as it allows storing and integrating the abilities necessary in environmental assessment, such as scientific knowledge and technical skills, and making them operational to non-experts. The ideal complete computer system should provide a joint information and documentation system, with tool & for consulting specific knowledge, reading, treating and editing text. It also includes considering models and applying them, reading and preparing graphics, storing numerical data or data base, and linking computations, tables, graphics, etc. In addition, Awad (1996) gives the outline for the file structure requirements for a microcomputer base information retrieval system. There are two possible designs that consist of examining space economy and practicality of implementation.

Expert Systems and its parent field Artificial Intelligence, which were then barely known outside a few specialist academic institutions, are now accepted as parts of most degree courses in computer science (Durkin, 1994) . Expert systems are intended to help solve those problems that are traditionally solved using expert human judgement and experience. Expert system requires a knowledge base within which such expertise is represented, an inference engine to process the knowledge, and an interface to users and developers (Chen, and Sharpe. 1993) . Expert systems are typically classified according to the type of problems to which they are applied. Expert system performed a generic set of tasks, when solving certain types of problem such as prediction or interpretation. Regardless of the application area, given the type of problem, the expert collects and reasons with information in similar ways (Crowe and Mutch,1994) . Expert systems likewise are designed to accomplish generic tasks on the basis of the problem type. Many expert systems are small-scale, developed in a few months and often comprising just hundred rules. However, even relatively straightforward expert systems can still frequently be of great practical and commercial value (Hart, 1996) . Expert system represent an emerging technology that offers to provide such a solution. Wide range of expert systems application have been created in developing countries in various, fields namely, geographic information system and health (McGraw and Harbison-Briggs, 1989; Loh et al., 1994) . Application of know-based system in environmental management has been carried out by Mongkon et al. (1998; 1999) and Suttipong et al. (1998) to investigate groundwater pollution potential from the impact of agricultural activities and the prediction of flash flood due to development in urban areas. The literature as mentioned indicated that applying the knowledge-based system is suitable to solve some problems in environmental and agricultural management.

The aim of this study is to develop a Knowledge-Based System which integrate with various sources of knowledge that can be used to guide users in preparing the way of saline land management and helping in decision making process for appropriate agricultural activities.

SYSTEM DEVELOPMENT APPROACH

The study is divided into two parts. The first part includes the collection of necessary information and the second part is the coding of knowledge for the problem domain. Building up the expert system is an evolutionary process that involves continuous improvement of the system. The development of the expert system mainly consists of three stages: knowledge acquisition, knowledge representation and software implementation.

Knowledge Acquisition

Knowledge acquisition is the process of gathering necessary information for the expert system. The objective is to gain knowledge to comprehend saline land management in and to encode it into the system. Knowledge on the problem that is used to guide the development effort is acquired. In short, it is the process of acquiring knowledge from the experts. Therefore, it includes meetings held with experts to discuss problems. Key concepts and general problem-solving methods used by experts are uncovered in the knowledge acquisition stage. Knowledge acquisition is a bottleneck in the construction of expert systems. The knowledge engineer's job is to act as a go-between to help build an expert system, since the knowledge engineer has far less knowledge of the domain than the expert. However, communication problems impede the process of transferring expertise into the program. The domain expert is the most important source of the knowledge base for establishing the expert system. Moreover, books and other documents are generally available to extract knowledge and also general field observation. Books and established literature from libraries and domain experts from universities and government services were sought as the sources of knowledge.

Knowledge Representation

Production rules are used in the question and sub-menu with knowledge to be expressed in IF/THEN (condition-action) statements. It is a widely used method that has been devised for representing information. In the expert system, all knowledge is structured as rules. Domain knowledge is captured in a set of rules and entered in the system knowledge base. When the IF portion of the rule matches information contained in the working memory, the system performs the action specified in the THEN part of the rule.

Software Implementation

In this study, CLIPS (C Language Integrated Production System) was selected for developing the Know ledge-based System. CLIPS was designed at NASA (National Aeronautic and Space Administration) Johnson Space Center with the specific purpose of providing high portability, low cost, and easy integration with an external system (Giarrantano and Riley, 1994) . CLIPS enables users to work with object-oriented programming capabilities including classes with multiple inheritance, abstraction, encapsulation, poly-morphism, dynamic binding and message passing with message handlers, and to define functions, over-loaded functions and global variables interactively. Furthermore, CLIPS allows a set of constructs to be grouped together to maintain explicit control and to restrict the access of constructs by other modules.

General Features of the Knowledge-based System

One of the features of this Knowledge-based System is that the program is created using menu bar and message box facilities. By using the menu window, answer options to the question have been arranged in a systematic manner for simplicity and the user will find it easier to go through the questioning procedure. The system has several advantages such as the user does not need to know any command names. He is always presented with a valid command list. Meaningful command names, such as "quit", imply the command function. Typing is minimal. This is important for occasional system user who cannot type quickly. The user interface is the most important component of any application. If the interface is well designed, the application will be easy, almost intuitive to use. If the interface is designed poorly, then the user will start looking else where for an easier way to use the product. The system graphical user interface supports high resolution colour screen and interacting with the mouse as well as keyboard. It has multiple windows, which allow different information to be displayed simultaneously on the user's screen. System commands are selected from the menu rather than typing them out.

The Knowledge-based System Structure

The design of the Knowledge-based System structure for supporting land resources management: saline soil in Northeast Thailand comes with more attractive knowledge representation. By experience, an expert forms several sets of rules on a given problem. These sets of rules reflect the skill of the expert on the given problem. For this reason, a set of rules may be applied to the given task when needed, which on the other hand means that the same set of rules is inapplicable to other problems. These, in the case of recommendation on soil resources, a modular structure is implemented in the system as shown in Figure 1. An advantage of the modular structure is that it provides a natural ordering of the domain rule set by a top down approach, where a specific module is used when appropriate. To satisfy this goal, the wxCLIPS is used in the system. The wxCLIPS development uses the fast pattern matching algorithm, developed by Giarratano and Riley (1994) , to implement the forward chaining inference engine.

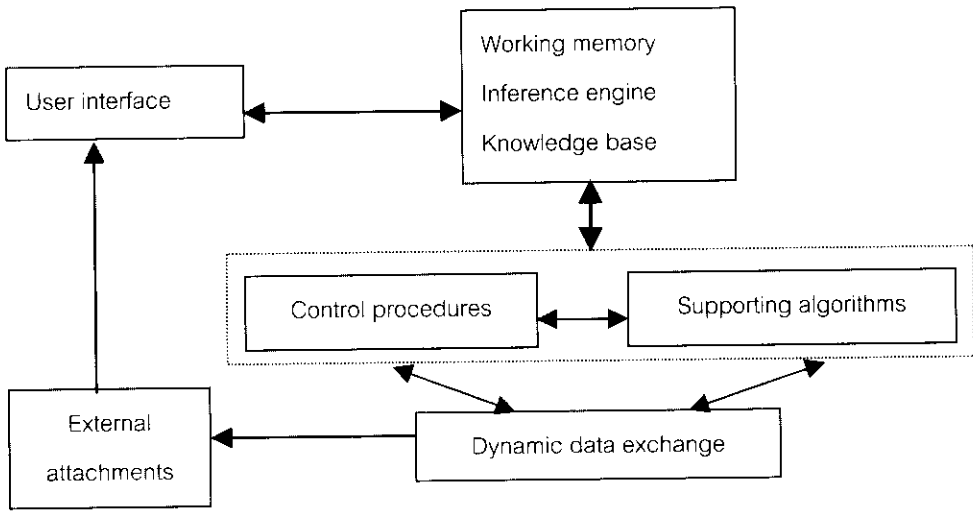

Figure 1. The structure of a general Knowledge-based System (and also used in this system)

The KBSLM development is carried out after wxCLIPS (C Language Integrate Production System) is selected as the software that best meets the requirements of this project. The purpose of this prototype is to validate the Knowledge-based System approach, to confirm the choice of knowledge representation technique and control strategy, and provide a vehicle for knowledge requisition. Different shells use different mechanisms for representing and handling knowledge; some mechanisms, are appropriate for some type of expert system applications but totally inappropriate for others (McKinney et al., 1993) . The wxCLIPS is ideal for the initial prototype of KBSLM. Just as any conventional software, system prototypes in expert system allow users to experiment with requirements and to see how the system supports their work. Prototyping in expert system software development is a means of requirement validation, The benefits of developing a prototype early in the software process have been elaborated by Awad (1996) . According to them, missing user services may be detected, problematic functions may be identified and refined, any inconsistent/incomplete requirements can be identified, and the feasibility and usefulness of the application can be demonstrated to management. The prototype also can be used as a basis for writing the specification.

Prototype Development

In this study, the prototype of KBSLM is illustrated in Figure 2. It is divided into eight main parts: introduction, soil-fertilizer technology, cutting-off zone, Polyvinyl Alcohol: PVA, indigenous vegetation, animal farm, green manure guide and Polder System. The introduction part will help all interested people to produce existing saline soil introduction, to understand affecting salt to plant growth. The last seven main parts: soil-fertilizer technology, cutting-off zone, Polyvinyl Alcohol: PVA, indigenous vegetation, animal farm, green manure guide and Polder System, will be incorporated into the knowledge-based system to help and prepare in manage saline land, to propose the possible mitigation measures and to approach the saline management program.

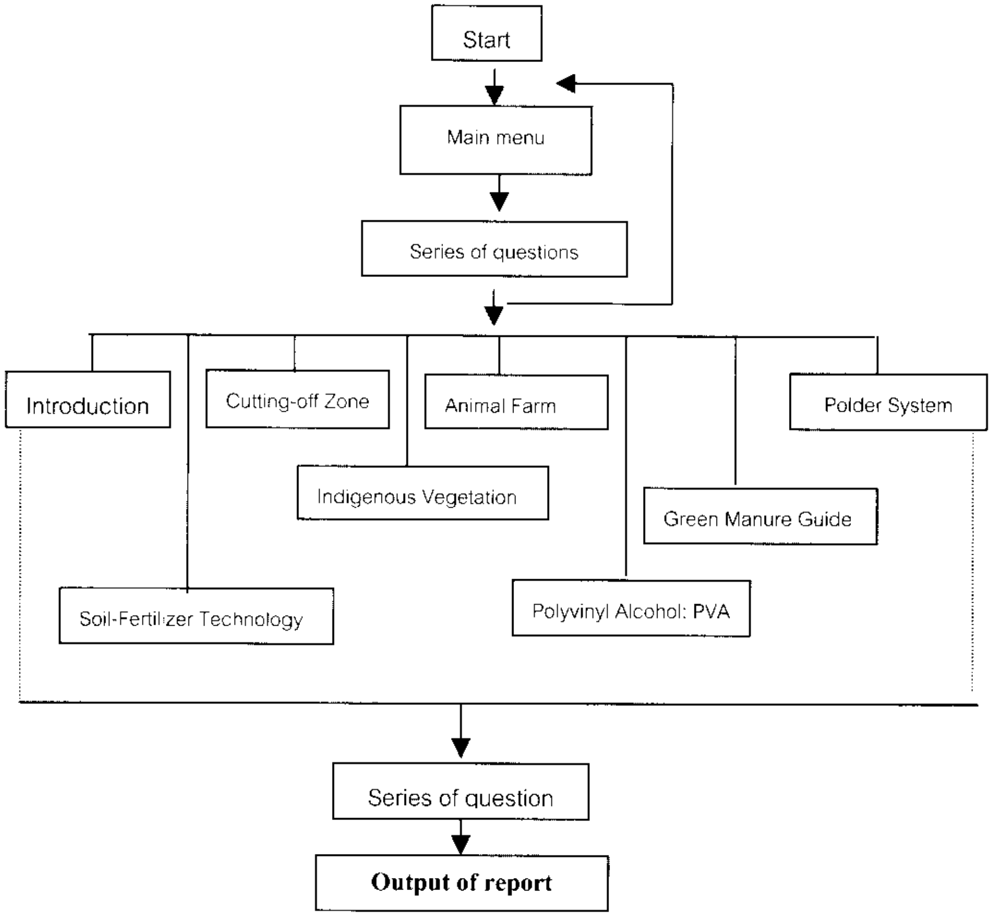

Figure 2. The prototype of knowledge-based system for supporting land resources management (KBSLM)

Rule Base System

The human expert then reasons about the problem by combining the short-term memory (STM) fact with the long-term memory (LTM) knowledge. Using this process, the expert infers new problem information and eventually arrives at conclusions about the problem. Figure 2 shows a backing diagram of the problem solving approach used by an expert. KBSLM is related to knowledge representation technique that best matches the way the expert mentally models the problems of predicting saline affect. In this study, wxCLIPS expert system shell uses rules-based representation. The IF-THEN rule has a goal to look for corrective action of a prediction mode where Action is a parameter that appears in the "then" part of the rules i.e. all the rules that provide a recommendation to the user.

The rules of knowledge-based system expert system in the form of questions, choice, radio-box, slide rule, button or frame are translated into IF-THEN rules. The rules including variables, types, domains and descriptions are used by wxCLIPS. These are the variables shown in table 1. The rule topics used for KBSLM, comprise six parts as shown in figure 2 and table 2.

Table 1: Local and Global Variables Used by KBSLM

No.	Variable Name	Type	Domain	Description
1	MK_TA	global	all functions	sub-frame variables
2	panel1	global	all functions	panel variables
3	tex-win1	global	all functions	text-win variables
4	save,quit,clear	local	button, choice	save, exit, clear function
5	dialog	local	dialog-box	questions function within dialog box
6	choice	local	choice-create	question function within choice list
7	bitmap	global	all function	image variables
8	button	local	frame-button	list information
9	check	local	check-box	list information
10	radio	local	radio-box	question function within radio box

System Operation and Description

A well structured, intuitive user interface allows users to easily access the power of the system. This knowledge-based system provides the same interface philosophy for signal integrity simulation, radiation simulation, and board screening and with multiple levels of user-dialogue and help, an inexperienced user is guided through the design process. Switching to 'expert-mode' allows the experienced user to utilize all of the system without the distraction of active help texts. This allows fast and easy learning on the job, together with maximum productivity. A Windows "look and feel" provides a large working area with a fresh, uncluttered feel, with Windows dialog boxes when running under Windows environment. The flowchart of system operation showing steps to predict soil erosion rate before suggesting users for soil conservation and management can be shown in Figure 3.

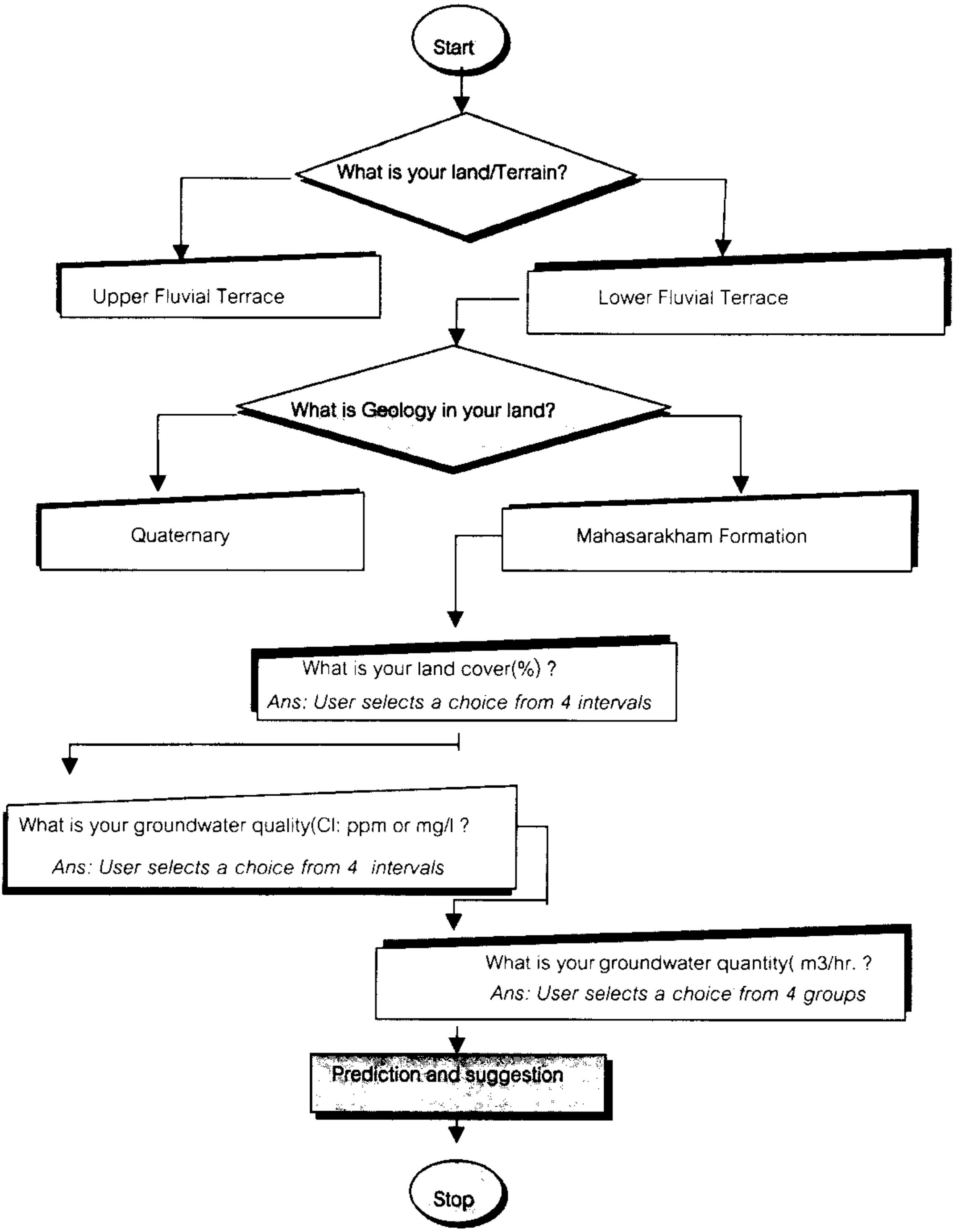

Figure 3. Flowchart of saline land prediction

Table 2 : Examples of Soil and Land Suitability Requirement of Crops incorporated in the System

Crops	Soil texture	Soil Drainage	pH	Soil Depth	Slope class
Rice	SiL-CL	I-MD	5.5-7.5	>50	flat
Oil palm	SC-SiC	MD-W	4.3-6.5	>120	flat to undulating
Rubber	L-C	W	4-6.5	>150	flat to undulating
Pine apple	SL	MD	4	>60	flat
Citrus	SiL-SL	W	6.5-7	>150	flat to undulating
Maize	SiL-CL	MD-W	5.5-8.2	>50	flat to undulating
Soybean	SiL-CL	MD-W	5.5-7.5	>75	flat to undulating
Sweet potato	SiL-CL	MD-W	5.2-8.2	>75	flat to undulating

SC (Sandy Clay), SiC (Silty Clay), CL (Clay Loam), SiL (Silt Loam), SL (Sandy Loam), L (Loam), C (Clay), I (Imperfectly drained), MD (Moderately drained), W (Well drained)

This Knowledge-based System for understanding soil resources regarding agricultural development in peninsular Malaysia is a very user-friendly program. The system uses the window technique for data entry of command. The user is directed to what information is needed using the mouse without the need to remember the command to avoid mistakes during data entry. The user selects the question for the interested information of soil resources for study. The details of the system can be described as follows.

Main Menu of Knowledge-based System

This Knowledge-based System consists of the following eighte major functions: introduction, soil-fertilizer technology, cutting-off zone, Polyvinyl Alcohol: PVA, indigenous vegetation, animal farm, green manure guide and Polder System. Figures 4 and 5 show the major functions of an Knowledge-based System. The user is guided throughout in selecting the interested information. In this study, a prototype Knowledge-based System was built containing rules drawn primarily from knowledge extracted from established literature, field data, and domain experts. All the facts were first listed and then the rules were written to form a small prototype program. Initially this prototype handled a small domain, focussing on only a small portion of the system. Such a prototype is used to give a clear ordeal to approach the larger domain. In other words, it serves as a stepping stone to the design of the larger system. From the small prototype, the program was gradually expanded either within the prototype itself by adding new facts and cleanses locally or by introducing new modules of program linked to the existing prototype. Finally, all these small units of program are linked together to form a single stand alone Knowledge-based System program.

Knowledge-based System Recommendation

This study gives the examples of knowledge base and rule base, which are developed as a tool in the description of soil characteristics. In this case, the Knowledge-based System developed will deal with 1-3 main questions. For each question, the user can select the answer by using the mouse or keyboard. The answer is a choice (1, 2,3..) of either YES or NO depending on each question as illustrated in Figure 6. All information is available in a consistent and plausible framework that links the related factors in a simple logical format of IF-THEN rules. The user can use the screen and the keyboard or mouse to interface with the system. The Knowledge-based System will ask the user the question and display the set of possible answers to be selected.

CONCLUSION

The rules of functions of this Knowledge-based System are translated into form of questions and choice selections. Possible answers for all questions choice selection are shown. Rules for supporting land resources management: saline soil in Northeast Thailand illustrate the principle of factors for predicting saline affect using Knowledge-based System questions. In the prediction, KBSLM has identified the significance of affection and the recommendation.

REFERENCES

Awad, E. M. 1996. *Building Expert System-Principles, Procedures, and Applications.* West Publishing Company. St. Paul, Minnesota, USA.

Bosio, P., G. Calori and G. Finzi. 1992. The development of a knowledge base for air quality models. In *Computer Techniques In Environmental Studies* IV, ed. P. Zannetti, pp 691-704. Computional Mechanics Publications, Southampton, UK.

Chen, Q. and R. Sharpe. 1993. NOISEXPT: An expert systems for noise control in very fast train design. In *Expert System in Environmental Planning*, ed. J. R. Wright, L. L. Winggins, R. K. Jain and T. J. Kim, pp 233-244. Springer-Verlag, New York, USA.

Crowe, A. S. and J. P. Mutch. 1994. An expert systems approach for assessing the potential for pesticide contamination of ground water. *Ground Water* 32: 487-498.

Durkin, J. 1994. *Expert Systems: Design and Development.* Prentice Hall International Inc., Englewood Cliffs, New Jersey, USA.

Giarratano, J. and G. Riley. 1994. *Expert Systems Principle and Programming,* 2nd Ed. PWS Publishing Company, Boston, Massachusetts, USA.

Hart, A. 1986. *Knowledge Acquisition for Expert Systems.* Kogan Page Ltd., London, UK.

Loh, D. K., Y. T. C. Hsieh, Y. K. Choo and D. R. Holtfreich. 1994. Integration of a rule-based of expert system with GIS through a relational database management system for forest resources management. *Computers and Electronics in Agriculture* 11: 215-228.

McGraw, K and K. Harbison-Briggs. 1989. *Knowledge Acquisition: Principles and Guidelines*. Prentice-Hall, Englewood Cliffs, New Jersey, USA.

McKinney, D. C., D. R. Maidment and M. Tanriverdi. 1993. Expert geographic information system for Texas water planning. *Journal of Water Resources Planning and Management* 119: 170-183.

Mongkon, T., M. Daud, M. Z. Bardaie and J. Shamshuddin. 1998. Expert system for predicting groundwater pollution potential from the impact of agricultural activities. *King Mongkut's University of Technology (KMUTT) Research and Development Journal* 21: 77-92.

Mongkon, T., M. Daud, M. Z. Bardaie and J. Shamshuddin. 1999. An application of expert system for comprehension of the groundwater pollution. *Engineering Journal Kasetsart* 12: 74-86.

Suttipong P., M. Daud, M. Z. Bardaie and J. Shamshuddin. 1998. Expert system for predicting flash flood due to development in urban areas. *King Mongkut's University of Technology (KMUTT) Research and Development Journal* 21: 88-100.

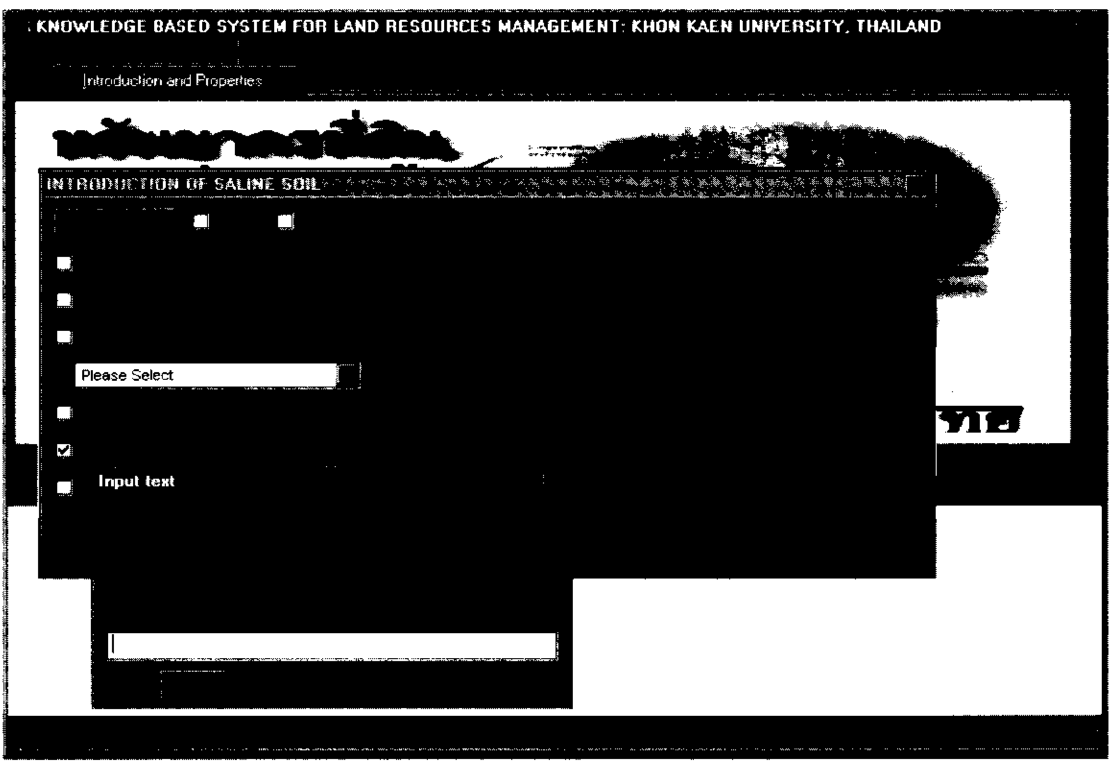

Figure 4 Introduction menu

Knowledge-based System Recommendation

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Hart, A. 1986. *Knowledge Acquisition for Expert Systems.* Kogan Page Ltd., London, UK.

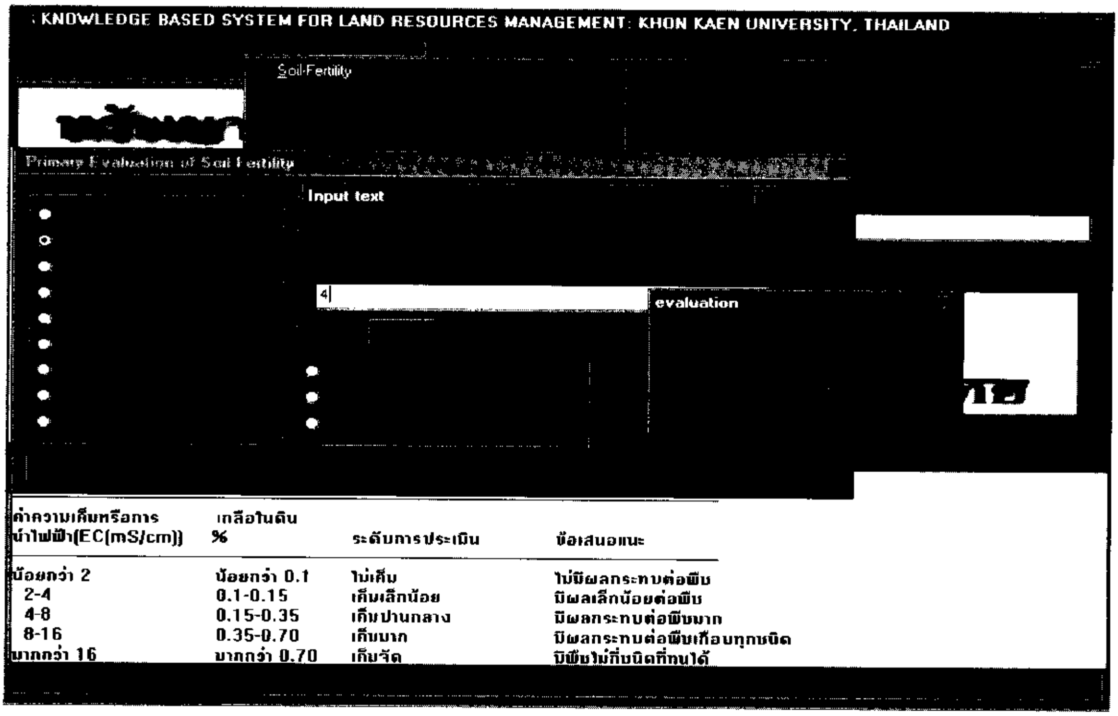

Figure 5 Soil and Fertilizer sub menu

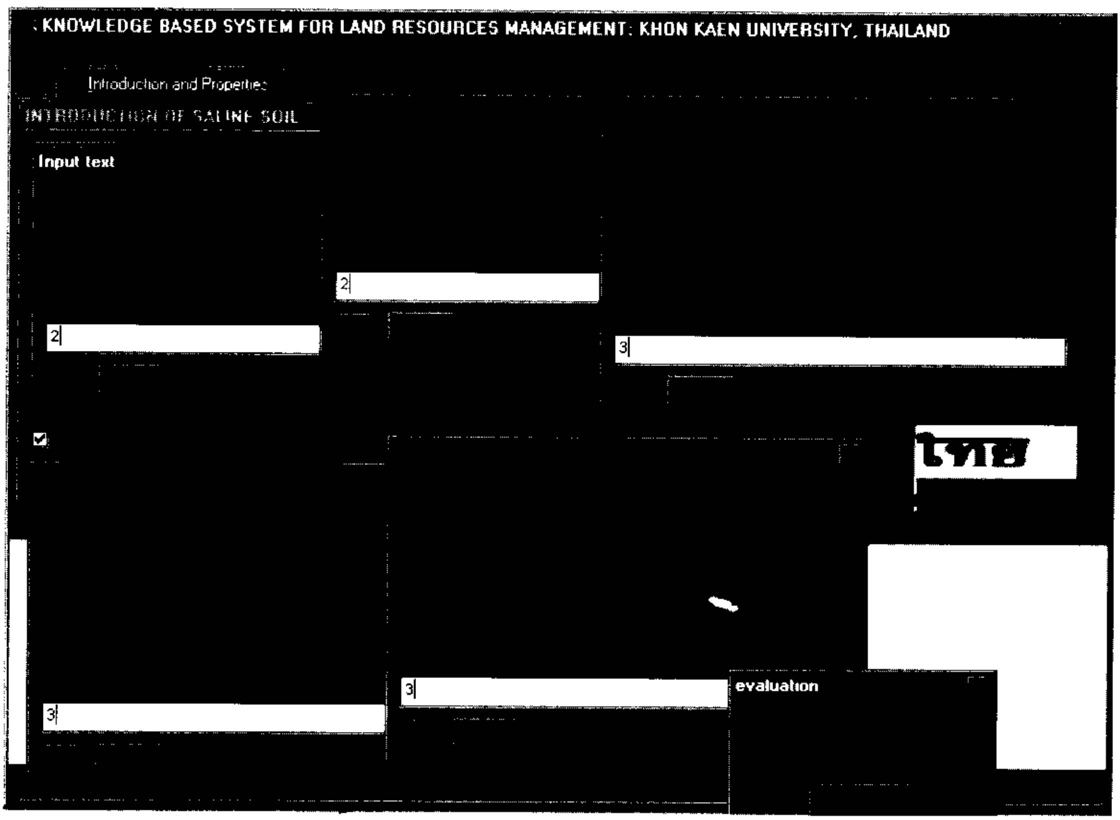

Figure 6 Example of question in prediction