Indian Journal of Animal Sciences **84** (8): 891–896, August 2014/Article

Expert system for dairy cattle management

H RAVISANKAR[1], V S G R NAIDU[2], K SIVARAJU[3], B JOHN BABU[4] and PVVS SIVARAO[5]

Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh 533 105 India

Received: 19 December 2013; Accepted: 2 June 2014

ABSTRACT

India is basically an agriculture country and the dairy sector plays a significant role in supplementing family income and generating employment in the rural areas, particularly among the landless, small and marginal farmers and farm women, besides providing cheap and nutritious food to millions of people. In India, the total milk production is extremely poor in terms of productivity in the world due to lack of proper extension system. Even though, information on various aspects of dairy cattle management is available, they are not reaching the required area of the farm units / farmers. To address this problem, a rule based expert system for dairy cattle management was developed with user friendly menus. This system interacts with users in two ways. As a decision support tool, the user can interact with the system using some arranged rules which are collection of if / then rules, collected from experts in the veterinary field. Using these rules, a knowledge base was designed for the expert system and programming codes were writeen in VB. Net. The proposed expert system provides instant access of the required knowledge on selected parameters, viz. feeding, breeding, diseases, cattle shed management, milking, fodder cultivation and health management. This expert system is useful as an online guide to the users who are involved in animal husbandry and dairy management.

Key words: Cattle and Dairy management, Information, Software, Expert system

India is the largest milk producer in the world. Milk production in India increased from 17 million tonnes in 1950–51 to 121.8 million tonnes in 2010–11. In Andhra Pradesh, the current milk production is at 11.25 million tones and the targeted to reach 15 million tons by 2020. Government of Andhra Pradesh has plans to set up over 900 mini diaries with focus on supply chain. Over Rs 723 crores investments proposed in Andhra Pradesh for bulk milk cooling units and Rs 965 crores for fodder development schemes. To make livestock rearing is viable and remunerative, the productivity of the animals has to be increased. The main reasons for low productivity are inadequate availability of feeds and fodder, good animal health care, breeding services and the extension services. For enhancing productivity of the animals, the basic requirements are the increased availability of feed and fodder resources throughout the year, breeding facilities, health care services and effective knowledge dissemination systems which must be supported by animal husbandry, research and other departments.

Even though, information on various aspects of dairy cattle management is available, they are not reaching the required area of the farm units / farmers. Unfortunately, specialist assistance is not always available when the farmer needs. In order to overcome this problem, "expert systems" have been developed. The primary goal of expert systems research is to help the policy makers, veterinary personnel involved in animal health care, dairy management and end-users i.e., farmers.

Expert systems (Donald 2004, Patterson 2004) also called Knowledge based systems (KBS), are computer programs developed for simulating problem-solving behavior of an expert in a narrow domain or discipline. Expert system development has been accelerated with the increasing availability of special programming languages and expert system shells. These tools are able to speed the time consuming development of expert systems. In agriculture, expert systems unite the accumulated expertise of individual scientific disciplines, e.g. Plant pathology, Entomology, Agronomy, Weed science, etc., (Ravisankar*et al.* 2012, 2014, Naidu *et al.* 2013) into a framework that best addresses the specific, onsite needs of farmers. Expert systems combine the experimental knowledge and experience with intuitive reasoning skills of specialists to aid farmers in making the best decisions for their crops and cattle. Thus, they have tremendous potential in modern agriculture.

The use of information technology in the form of expert system in transfer of information and knowledge on livestock management especially in animal management and dairy sector is one of the areas investigated by many

Present address: [1]Senior Scientist(hravisankar@india.com), [2]Program co-ordinator, KVK, [3]Principal Scientist, [4]Chief Technical Officer, KVK-CTRI, [5]Asst.Chief Technical Officer, KVK-CTRI, Central Tobacco Research Institute, Rajahmundry, Andhra Pradesh.

institutions around the world. The research in the expert system witnessing a vast development in all fields of animal health and dairy. In India, it became essential to have expert systems to transfer the knowledge of veterinary experts to the end users in a simple and easily accessible way as the number of experts with modern technologies is less than their demand in many regions of the India. At present, information technology playing an important role in dissemination of knowledge in animal husbandry. But there is a more scope existed for development of expert systems based on the needs of different clients and locations. A number of expert systems developed for the study and improvement of various aspects of livestock production, research and education. Many of the expert systems on the livestock are for the health care and surveillance (Santos 2002, Garner and Beckett 2005, Rong and Li 2008), dairy farm management (Samer*et al.* 2012, Mojaba*et al.* 2012) and veterinary education (Thangaraju 2007). Garner and Beckett (2005) developed a sophisticated spatial model for foot-and-mouth disease control, which allows the interactions between herds or flocks of different animal species and production type and considers the role that such interactions are likely to play in the epidemiology of a regional outbreak of foot-and-mouth disease. The model allows the users to evaluate the impact of constraints on the availability of resources for mitigations or eradication measures. Two interactive software's, one for the Para Veterinarians and stockman entitled "Animal Health Information System in English and another for the farmers of Maharashtra entitled "Health information system for dairy animals" in Marathi have been developed at the Indian Veterinary Research Institute, Izatnagar for animal health management particularly for animal disease diagnosis (Phand *et al.* 2009). In the present study, a rule based expert system was developed for diagnosis of diseases and accessing the knowledge on dairy cattle management which will be useful to farmers, Gopalamitras, State government policy makers, Para vets, Dairy entrepreneurs, persons involved in the dairy management and will be a ready reckoner for scientist, extension workers and to the veterinary academic institutions.

MATERIALS AND METHODS

The proposed expert system was developed using Visual Basic .Net (Gaddis *et al.* 2003, Balena 2005) as front-end application and Oracle (Deshpande 2004) as back-end application with user-friendly menus. VB .net was chosen because available shells did not provide the flexibility required to experiment with appropriate structures and control mechanisms and also its object oriented nature and its interactive capabilities with the users. The development of an expert system requires the combined efforts of specialists from specific fields of agriculture and can only be accomplished with the cooperation of growers and extension workers who will use them. The first step in building an expert system is knowledge acquisition (Spangler *et al.* 2003).

Knowledgebase acquisition and creation: Knowledge on the dairy cattle management was gathered from the experts including scientists and subject matter specialists (SMS). The overview of proposed expert system was shown in Fig. 1. For this expert system, the subject matter specialist (SMS) belong to – Veterinary science domain who acts as knowledge engineer, codes the knowledge in the form of rules and required parameters to the system. Software experts who are called as system editors receives inputs from support database and facts & rules proposed by knowledge engineer to build knowledge database which acts as a major input to dairy cattle expert engine. The expert enginebuilds on if and then conditions from cattle and dairy knowledge database. The support database consists of information repositories such as Feeding, Breeding, Diseases, Cattle shed management, Milking, Fodder cultivation and Health management. The information available in the support databases is extracted and converts into knowledge which is stored in knowledge database. This knowledge extraction process is a ongoing process. The user interface consists of set of menus which were built

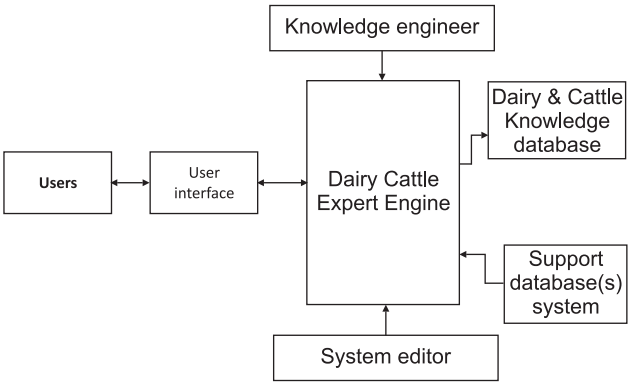

Fig. 1. Overview of dairy cattle expert management system.

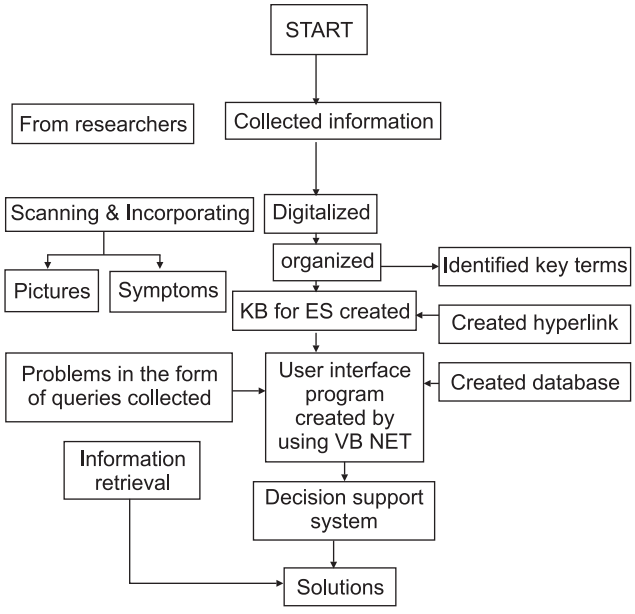

Fig. 2. Information flow of dairy cattle expert system.

based on facts and rules that acts as a bridge between the user and expert engine. Based on the user query(s), the expert engine builds the required knowledge and presents to the user in the form of hyperlinks and images.

The figure 2 represents information flow of dairy cattle expert system. After collecting the information from the experts, it was digitized by scanning & incorporating the images and symptoms related to various modules presented in the system. Key terms were identified in each module for easy searching of the required information. Then knowledge base was created and user interface was developed by VB.net. This system will act not only as a decision support system for identification and diagnosis of various modules but also acts as a information retrieval system by accepting the queries through simple menus and generate the reports.

In this expert system, the software represents knowledge as a set of IF-THEN rules (a knowledge representation approach was adapted to diagnostic expert systems). A rule is a composed of a list of IF conditions and lists of THEN and ELSE statements about appropriate solution to the problem. In other words, rules are made up of 'qualifiers' and 'choices'. A choice is a possible final conclusion of the system (disease). Qualifiers form the conditions that must be met for individual choices areto be selected.

Knowledge Base structure (Fig. 3) includes major modules viz., Feeding, Breeding, Diseases, Cattle shed management, Milking, Fodder cultivation and Health management representing the main areas related to dairy cattle. These modules consist of 55 parameters as shown in figure 4. The Module 'Feeding' consists of Calf feeding, Heifer feeding and Pregnant animal feeding as sub modules; 'Breeding' module includes 'Breeds, Selection of milch animal, Natural service and Reproduction problems' as sub modules; Cattle shed management modules consists of 'Housing, Watering and Cleaning' as sub modules; 'Milking' module includes 'Types of hand milking and Mechanical milking' as sub modules. The module for fodder

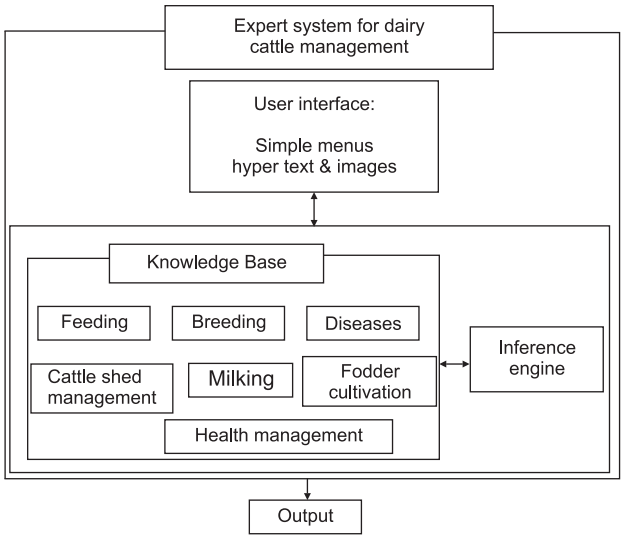

Fig. 3. Expert system functional architecture.

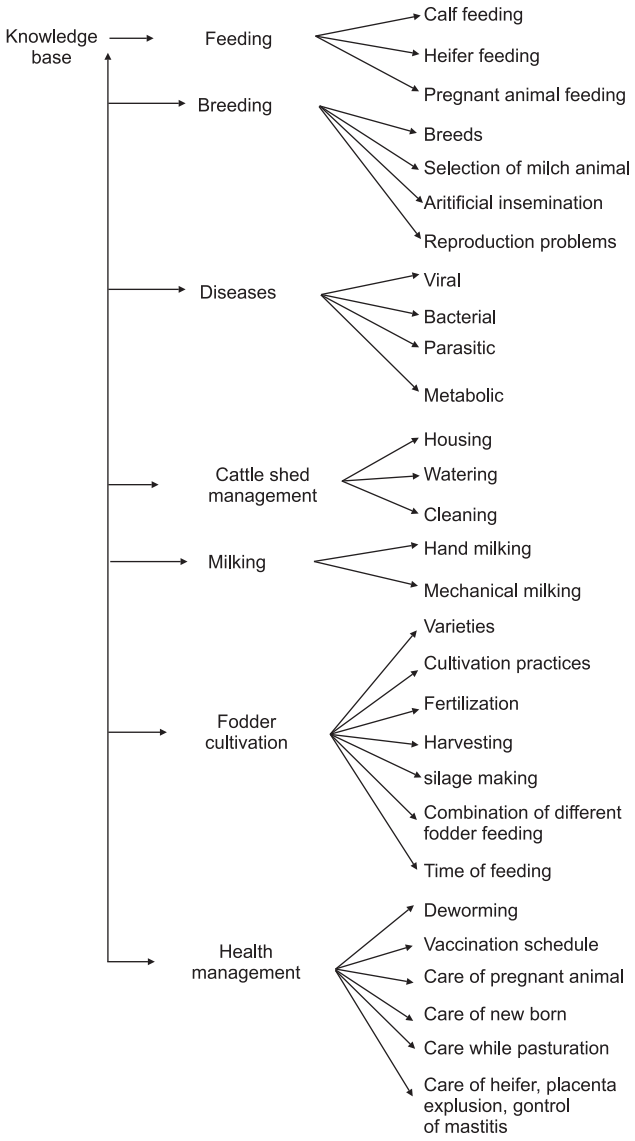

Fig. 4. Parameters used in the designing of knowledge base.

cultivation includes sub-modules indicating the fodder varieties, seed material availability their cultivation and yield potential. The disease module consists of sub-modules including various diseases of calves and all ages of cattle with photographs for accurate disease diagnosis. Furthermore, some sub-modules perform two or three operations and such sub-modules are divided into several parts accordingly. The users of the system can add the parameters from time to time as and when they come across with new information. Thus the proposed system can support for continual update of knowledge from the inputs of stake holders.

To make diagnosis by selecting any one of the module, it is linked to the related recommended measures, which are activated after the identification has been made. The user interacts with the system by making selections on his personal observations when the expert system displays relevant symptoms, which could be in textural and hyper-textual forms. This system is characterized by backward

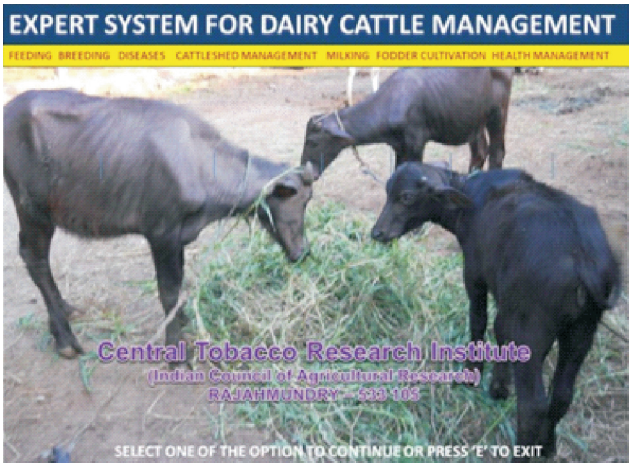

Fig. 5. MDI form

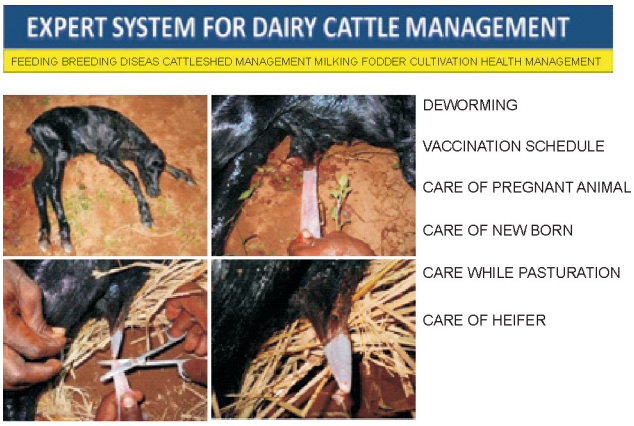

Fig. 6. Report menu.

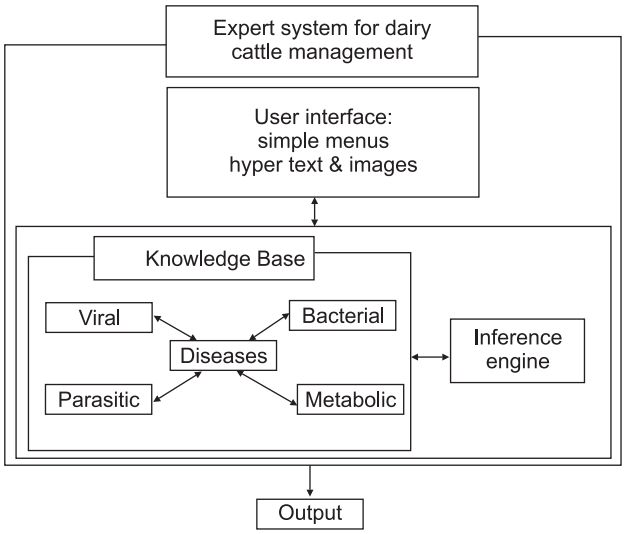

Fig. 7. Expert system for disease identification.

and forward chaining inference methods.

For the easy execution of the system, the user - friendly interface was developed with GUI which allows the user to communicate with the system in a more natural way by permitting the use of simple selection drop down option menus or the use of a restricted language which is close to a natural language and images. Through user-interface, the user is allowed to view, query and advance search for the required information. Reports were designed using 'Crystal reports' by providing flexibility for the user to view selected parameters and take the hard-copy. Interface was provided with the back-end to access the database from 'Oracle' and to enter the new information into it.

Information retrieval: Other part of the system is to retrieve the information from the database by selection of menus without diagnosis and decisions. The modules, viz. feeding, milking, fodder and cultivation and health management are designed in such a way to retrieve the information only.

The multiple document interface (MDI) form of the software (Fig. 5) consists of these seven categories as root of the selection which is considered as primary key. The selection of each attribute is a three level tree like "Feeding-> Calf feeding -> Milk feeding". For example, the user can retrieve the information on an attribute like 'Çare of new born' by selecting the parameter 'Health Management' followed by Çare of new born'. The information with images gets displayed (Fig. 6). For each attribute, the information with the images related to that attribute gets

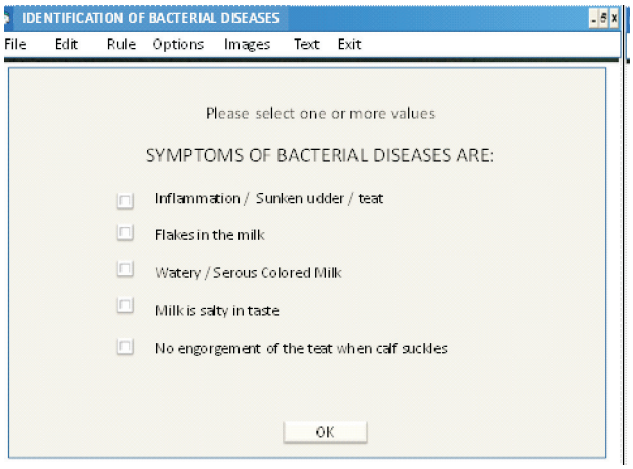

Fig. 8. Selection of symptoms for disease identification.

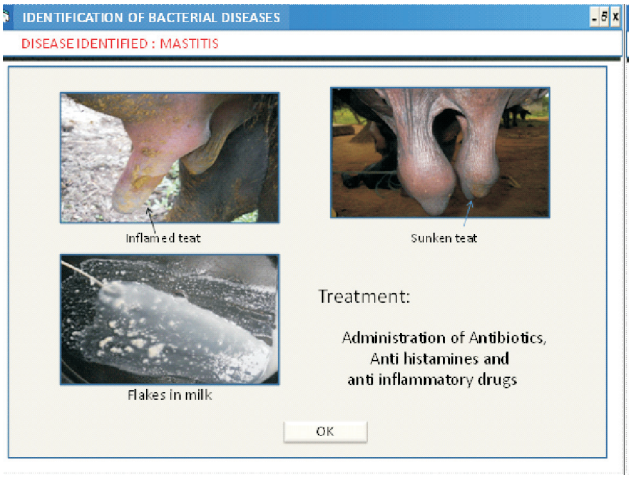

Fig. 9. Disease diagnosis and treatment recommendation screen.

displayed. These fields were created with text boxes for data entry / modification and label boxes for title of the text. The user can embed image(s) for all parameters in the knowledge base itself. The user can view information and generate a hard copy / soft copy of the selected parameter using 'Report' option. The 'information retrieval' is a powerful tool in this system which allows the user to retrieve and generate a report on the selected parameter. According to the selection, the list of the attributes gets displayed. He can view the report for a particular attribute with all images under that parameter

The displayed report will be exported to Microsoft word for storing and a hard copy of the same can be taken. The 'Help' option guides the user to execute the software from the beginning. For executing this software, a PC with pre-loaded software of Visual Basic .Net and Oracle are essential. This is portable software, which makes possible to execute this software in any system. For this, a 'SETUP' program is created (executable file) including all the files and data. Any user can install this software by running this 'SETUP' program and the execution of the software is self-explanatory.

RESULTS AND DISCUSSION

The idea of an expert system is shifting the focus of the research community to knowledge dissemination in contrast to knowledge accumulation. The expert system in combination with powerful personal computers and devices like CD-ROM has the potential to open whole warehouses of accumulated knowledge for cattle management.

The knowledge base has two parts – the heuristic knowledge and taxonomic / real world general knowledge. Heuristic knowledge is the domain expert's knowledge that links between symptoms, causes, indicators, etc., and the pests, diseases or disorders that may be associated with these. The heuristics that link symptoms to diseases are easy to pin-point for the expert.

For example, in developing diagnosis for diseases, we used forward chaining, which starts with facts and then tries to find the goal to support it. At the beginning of each diagnostic process, the user is prompted to select one diagnostic module from the modules presented in the expert system architecture (Fig. 7). For example, if the user has selected the 'diseases' module from MDI form (Fig. 5), then list of four sub modules gets displayedviz., viral, bacterial, parasitic and metabolic. Each sub module was displayed with a list of photographs related to that disease. By seeing the photographs, he can easily select one sub module say 'Bacterial' which in turn consists of many diseases viz., Pastreurelosis, Black quarter, Brucellosis, Mastitis, Listeriosis, etc. The user can identify a particular disease under 'Bacterial' by selecting one or more options as shown in figure 8. For example, questions for 'Mastitis' disease (under Bacterial) would follow this rule.

If 'Inflammation / Sunken Udder / teat'
OR 'Flakes in the milk'
OR 'Watery / Serous coloured milk
OR ' Milk is salty in taste'
OR ' No engorgement of the teat when calf suckles'
THEN

Mastitis disease (Bacteria)

If all the conditions in the IF parts are true, the diagnoses listed in the THEN part of the rules are presented and an image screen with corresponding symptoms is displayed to the user with relevant recommended measures which are stored in text files separately from knowledge base as shown in figure 9. In the knowledge base, pictures are available to illustrate most of the rule qualifiers and goals.

If the choice does not correspond to the observed symptoms, the user can proceed further through the diagnosis. The graphic images help the user to identify with more accuracy the causes of the problem that can be easily depicted with images.

From the researchers point of view, knowledge based systems have a potential to help to organize and synthesize knowledge and information of different types. It is possible to focus and apply diverse avenues of research to solve difficult problems, link together quantitative data, simulation models and basic research results into knowledge base. The present expert system was developed in such a way that an extension agent / farmer can use this expert system very easily and can identify the problems based on the various aspects of cattle health with the help of photographs. This system acts as a tool for management of small dairy units with the required information on various aspects including cattle shed structure, management, fodder and its cultivation and steps to take regular maintenance for high milk yield. The validation and verification of this system was executed and being monitored regularly through the veterinary doctors of KrishiVigyan Kendra (KVK), Central Tobacco Research Institute, Rajahmundry and the persons trained by them in the villages.

The past two decades, importance of animal husbandry has witnessed unprecedented changes around the world and at the same time, the need for knowledge base system on dairy and cattle management was increased for availability of overall information on dairy. In this paper, an expert system for dairy and cattle management was prototyped using Microsoft .net ass front end and oracle as backend technologies. The main purpose of the expert system is to serve as delivery systems for extension of knowledge to the users who can efficiently diagnose and remittance methods from time to time. It also plays an important role in veterinary education and helps in dissemination of up-to-date scientific information in a readily accessible and easily understood form to agricultural researchers, advisers and farmers. This expert system is useful to the farmers, Gopalamitras, Veterinary department of state government, Para vets, Dairy entrepreneurs, persons involved in the dairy management and extension workers in accessing recent information with images. Efforts are on to develop same expert system with language specific for the clientele to cater in a more effective and precise manner. Further

modification and additions to current system will be a continuous process based on the information and impressions received from various sources. At present, the system is being popularized by veterinary doctors of KVK - CTRI, personnel trained by them and gopalamitras and planning to make it web based for global accessing.

REFERENCES

Balena F. 2005. *Programming Microsoft Visual Basic .NET*. Microsoft Press, USA.

Chakrabarti D K and Chakraborty P. 2007. A disease specific expert system for the Indian mango crop. *The Journal of Agricultural Education and Extension* **13** (1): 81–82.

Deshpande P S. 2004. *SQL/PLSQL for Oracle 9i*.Dreamtech Press, New Delhi.

Donald A W. 2004. *A guide to Expert Systems.* Perason Education.

Gaddis T, Lrvine K and Dention B. 2003.*Starting out with VB. Net Programming*.2nd ed., Dream Tech Press, New Delhi.

Garner M G and Beckett S D. 2005. Modeling the spread of foot and mouth disease in Australia. *Australian Veterinary Journal* **83**(12): 758–66.

Mojaba T, Pouria H, Mohamad T and Ali A S. 2012. Predictions of 305–day milk yield in Iranian Dairy cattle using test-day records by artificial neural network. *Indian Journal of Animal Sciences* **82** (5): 511–16.

Naidu V S G R, Ravisankar H, Sandeep Dhagat, VirendraKamalvanshi and Sharma A R. 2013.Expert system for identification of weed seedlings. *Indian Journal of Weed Science* **45** (4): 278–81.

Patterson D W. 2004. Introduction to Artificial Intelligence and Expert Systems. Prentice-Hall, New Delhi.

Phand S, Tiwari R and Sharma M C. 2009. Development of need based Animal Health Information System (AHIS) for veterinary professionals and students. Indian Veterinary Research Institute, Izatnagar.

Ravisankar H, Sreedhar U and Sivaraju K. 2014. Expert system for insect pests of agricultural crops. *Indian Journal of Agricultural Sciences* **84** (5): 607–11.

Ravisankar H, Sivaraju K and Sumankalyani K. 2012. Expert System for identification and management of tobacco diseases. *Indian Journal of Plant protection* **40** (2): 95–98.

Rong L and Li D. 2008. A web based expert system for milch cow disease diagnosis system in China. *Computer and Computing Technologies in Agriculture* **2**: 1441–45.

Samer M, Hatern M, Grimm H, Doluschitz R and Jungbluth T. 2012. An expert system for planning and designing dairy farms in hot climates. *Agricultural Engineering International*: *CIGR Journal* **14** (1): 1–15.

Santos I J. 2002. FMD information management systems as a disease surveillance tool in FMD control and eradication program in the Philippines. *Special Research Journal Edition* **6** (10): 108–15.

Spangler A M, Ray C D and Hamaker K. 2003. Knowledge acquisition for expert system development. *Computers and electronics in agriculture* **4** (1): 23–32.

Thangaraju P. 2007. Veterinary Education, Research and Outreach Programme. The Liberalization Era Foundation day. IVRI, Izatnagar.