WEB-BASED DAIRY CATTLE'S FEEDING ALLOCATION SYSTEM

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ABSTRACT

Dairy farming industry plays an important role in agriculture structures adjustment in Malaysia due to the growing demand for livestock and dairy products. In the cattle farm management, cattle feeding are the most important task in dairy farming. However, there exist several problems specifically in determining the quantity and proportion of feeding concentrates to sustain the cattle needs. Therefore, decision making system is required to assist the farmers. Thus, this paper proposed the dairy cattle's feeding allocation system to determine the sufficient amount of dietary nutrients and feeding concentrates in cattle feeding. The prototype of this system is constructed using software prototyping methodology as well as structured method for data modeling. The prototype is expected to decrease workload and reduce redundancy for making decisions in cattle feeding. It is not only support dairy farmers to make a right decision for allocating feeding concentrates in cattle feeding but potentially become one of information centre and learning resources to help farmers to develop their own expertise.

KEYWORDS*: web-based decision making, decision support systems, decision tree, decision making, cattle feeding.*

1.0 INTRODUCTION

Malaysian government has emphasized the research and development in local agriculture sector. Focus on the Malaysian Agricultural sector was renewed following the Malaysia economic crisis in 1998 (Shariffaden, 2000). The exchange rate of Malaysian Ringgit issues uncovered the weakness of the Malaysian food supply and at the same time increased the awareness of the importance of the local agricultural sector. Essentially, agriculture remains as an important

sector of Malaysian's economy. It contributes directly to the national gross domestic product and provides employment for the country's population. One of the important integral components of agriculture sector in Malaysia is dairy farming. Under the 7th Malaysian plan (1999-2000), Malaysia had targeted to achieve 10 percent self-sufficiency in liquid milk by the year 2000, and 30 percent by the year 2010 (Panandam and Raymond, 2005).

A Malaysian food consumption pattern has changed because of rapid expansion of Malaysian economy over the past two decades. The need for foods, especially for wheat-based products, livestock, dairy products, sugar and vegetables, is expected to continue to increase (Warr *et.al*., 2008). However domestic productions are unable to uphold with the rising demand. Furthermore, Malaysia relies heavily on imports for its dairy needs. The local dairy industry does not produce sufficient quantities of fresh fluid milk to satisfy Malaysia's fresh milk needs. Because of Malaysia's limited domestic agricultural production and a growing demand for many products, imports have been a major source of Malaysia's food supply (Warr *et.al*., 2008). Apparently, the beef and dairy industries are small in Malaysia. Although livestock industry is not a major contributor to foreign exchange earner for the state, it is playing a significant role in providing food for local consumption. In term of state Gross Domestic Product (GDP), livestock industry contributes about 4 percent which is equivalent to total production value of more than RM 406.17 million (Eli *et.al*., 2001). There are many factors constraining growth in these industries (Noordin *et.al*., 2004). In addition, the beef and dairy industries consist mainly of smallholders with relatively small group sizes. As a result, it is difficult for the industries to achieve productivity gains and economies of scale, and to compete with imports. Therefore, the government has introduced and encourages systematic and modern farming practices through National Agriculture Policy (NAP3, 1999).

Dairy farms are farms where dairy cattle are domestically bred for milk or dairy production. Dairy cattle consists of several categories namely cattle, heifers, cow and bulls. Different categories requires different amount of proteins and concentrated feeding for them. The quality and quantity of milk produced is directly proportional to the amount of proteins within concentrated feedings for cattle feeding. Therefore, cattle feeding are the most essential part in dairy farming. Since food allocation for dairy cattle is associated with the amount of protein nutrients needed for the cattle based on the body weight, therefore determining the amount of protein contained in the feeding concentrates is important. The amount of protein is used to determine

the sum of feeding concentrates. Though, there exist several problems in determining the quantity of feeding concentrates that should be given for feeding purpose. Most of dairy farmers are still practicing on manual calculation of feeding concentrates quantity. Due to the existing practice, several consequences have been observed. However, manual calculation often takes a lot of time. Farmers or users need to refer to the Feeding Standard table in order to determine the required protein for the cattle. It is then followed by the calculation of the total amount of food mixture which is equivalent to the protein required for the cattle. This procedure requires a farmer's effort to check the standard table and to calculate.

Moreover, different categories of cattle body weight requires different amount of protein to sustain the cattle's growth. Meanwhile, milk production also requires different amount of feeding concentrates. If there are a lot of categories of cattle body weight in dairy farm, the farmers need to keep referring to the Feeding Standard table to determine the required amount of protein. Farmers are also need to calculate the food mixture rations for different current cattle body weight. Therefore the calculation process becomes redundant and gruesome for the farmers in the farm. Most of the dairy farmer still practicing ad libitum style. The feeding concentrates is poured on a certain place for cattle feeding without considering only the real amount of feeding concentrates with certain amount of protein required for cattle feeding. Therefore, the food becomes wasted and lots of money is spent to buy more cattle food for mixture and feeding.

On the other hand, there is much effort to bring the agricultural community online in Malaysia with the rise of internet usability. Malaysian Ministry of Agriculture has introduced the Third National Agricultural Policy 1998-2010 (NAP3). NAP3 (1999) identified several issues and challenges to help tackle the problem of foreign food dependency. It is expected that information technology will play an important role in the acquisition and dissemination of new knowledge and technologies to motivate the involvement of youth in the agricultural sector (Deraman and Bahar, 2000). Consequently, a new technological solution is needed to work in parallel with the government efforts to help educate and inform the farmers and smallholders. To date, it can be said that there are a number of agricultural resource sites available on the Internet. It is an essence to design the user interface that accommodates both farmer and researcher in the laboratory.

From this viewpoint, in this paper the web-based decision making system is developed to improve the availability of cattle feeding

decision making and the accessibilities of the information to support the dairy farmers. The decision underlying to this system were generated and evaluated by the decision trees analysis. This system is able to assists dairy farmers to suggest the type of cattle food for dairy cattle feeding. Decision tree analysis is used to infer the solution to the decision problems. The prototype of the system was developed to test the functionality of the system. The remainder of this paper is divided into five sections. Section II explains the prerequisite studies. Section III is spent to describe the proposed application. The results from the development of the proposed system and its discussions are provided in Section IV. Section V gives the conclusions.

2.0 PREREQUISITE STUDIES

Decision Support System (DSS) can be defined as a system under a control of at least one decision maker to provide assistance in decision making process. DSS are computer technology solutions that can be used to support complex decision making and problem solving (Shim *et.al*., 2002). Research in this area has typically focused on the role of information technology to improve the efficiency of decision making. A user makes a decision and can improve the effectiveness of that decision (Pearson and Shim, 1995). The early framework of DSS was introduced in 1971 by Gorry and Scott-Morton as depicted as in Table 1. The framework shows the degree of decision structure and the type of control managerial, operational or strategic planning. Decision making process ranges from highly structured to highly unstructured. Structured decision is routinely made and the problems are typically repetitive for which standard solutions can be achieved. On the other hand, unstructured decisions are fuzzy, complex problems which do not have definite solutions. The decision support system provides the users with a structured set of tools to impart structure to portions of the decision-making situation and to improve the effectiveness of the decision outcome (Marakas, 1999). The system involves data collection from system user and analyzes the data to generate output in the form of suggested information for the user to make decision on it more easily. DSS benefits the users by enlarging the users' capability to process the information and knowledge in the decision making process.

Web based application can be defined as application software that can be found on the web site (Shelly, *et.al*., 2006). The users will be able to access the web application at anytime and anywhere as long as there is Intranet or Internet connection. User's information will be stored in a web application server. The reason of web application popularity among computer clients the update or maintenance of web application does

not require distributing and installing software in the client's computer. The use of web based application is extensive It can be implemented from business-to-business electronic commerce until enterprise resource management and so forth. More than that, the Internet is one of important medium to distribute information and knowledge among community. To optimize the potential of the web based application, the World-wide Web and global Internet provide a technology platform for further extending the capabilities and deployment of computerized decision support. The release of the HTML 2.0 specifications with form tags and tables was a turning point in the development of web-based DSS. In addition to Web-based, model-driven DSS, researchers were reporting Web access to data warehouses. DSS Research Resources was started as a web-based collection of bookmarks. By 1995, the World-Wide Web was recognized by a number of software developers and academics as a serious platform for implementing all types of DSS.

Decision analysis problems can be represented graphically through the influence diagrams and decision trees. Decision-tree analysis (Raiffa, 1968) has emerged over the years as an effective and useful tool in decision-making. Ever since, its applications to a variety of problems from numerous disciplines have grown (Haimes, 1990). Decision tree is a graphical way of depicting actions that are to occur based on combinations of multiple conditions (Stevens, 1991). It is a decision support tool used to help system analyst to make a clear view of the specifications easily than understanding flowcharts. Decision tree analysis is useful to managers choosing among various courses of action when the choice (or sequence of choices) will ultimately lead to some uncertain consequences.

In the dairy farm management, there are numbers decision supports applications have been researched and developed. For instance, a DAIRYPRO was developed to help dairy farmers to make strategic decisions about the farm (Kerr *et.al*., 1999). David (1994) constructed a decision support system for dairy farmers and advisors where the model are capable to model the dairy herd and take into account the practical circumstances of the farm business. An online decision support system for dairy farm was developed to help dairy farmers and respective persons to enable the accessibility of latest information and technology for dairy business planning (Savilionis, 2007). Halachmi *et.al.*, in 1997 develop a modeling technique for individual voluntary food intake based on body weight and milk production. From the literature it can be conclude that the dairy farm management decision supports are needed and the research are still continuing to gain the benefits to the dairy farm industries.

Table 1 Gorry and Scott Morton's framework for Decision Support (Gorry and Scott-Morton, 1971)

Control	Operational Control	Managerial Control	Strategic Planning	Technology Support Needed
Structured	e.g. accounts receivable, order entry	e.g.short-term forecasting	e.g. financial management	MIS, mathematical models, transaction processing
Semi-structured	e.g. production scheduling	e.g. credit evaluation	e.g. mergers and acquisitions	DSS
Unstructured	e.g. approving loans	e.g. recruiting an executive	e.g. new technology development	DSS, ES, Neural Networks
Technology Support Needed	MIS, Management Science	Management Science, DSS, ES, EIS	EIS, ES, neural networks	

3.0 DAIRY CATTLE FEEDING ALLOCATION SYSTEM

Allocating Dairy Cattle's feed is a structured decision since the procedures for obtaining the best solution are known. The development of the systems involved the four phase of decision making process based on Simon's model (1977). In addition this system also designed as web-based to deliver the decision support information to their respective online user. System functionality design for Dairy Cattle's Feeding Allocation System in this study is presented in context diagram shown in Figure 1.

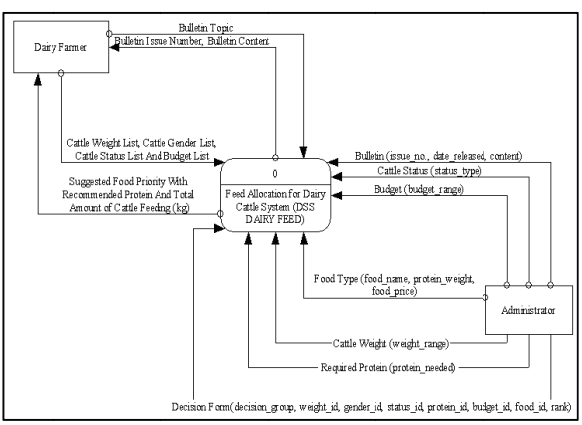

Figure 1 Context diagram for Dairy Cattle's Feeding Allocation System

Dairy Cattle's Feeding Allocation System was developed using Internet programming language and SQL language. PHP and java script were used in the programming. Personal web server tool was used for the

implementation of the application package of EasyPHP in the systems development. The package includes an Apache server, a MySQL database and the PHP extension. The architecture design of Dairy Cattle's Feeding Allocation System consists of Administrator, Dairy Farmers (System User), DSS Dairy Feed system and a database. Figure 3 shows the architecture design of Dairy Cattle's Feeding Allocation System. Dairy Farmers will be user to request cattle food for cattle feeding from the system. The middle-tier, also known as web server will send the user requests to the database containing records of protein requirement in various food packages and cattle status. The web server is then sent the query results back to the user.

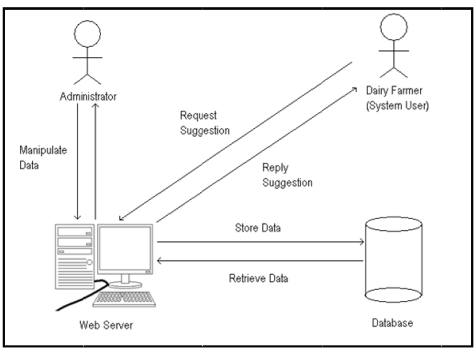

Figure 2 Architecture design for Dairy Cattle's Feeding Allocation System

DSS Dairy Feed uses three-tier client/server architecture to implement the system. Three-tier client/server architecture consists of user interface tier embedded in client computer only or user's workstation environment. The database management system environment tier is in the server environment and the middle tier located between client interface tier and database management system environment tier (White, 2001). The user makes request using Graphical User Interface in client interface tier to access DSS Dairy Feed system which located in the middle tier of application server. The middle tier will send the user query to the database and return the results to the user. Schussel (1995) states that three-tier architecture is much more scalable than two-tier architecture. This is due to the ability to expand the computer network connected to middle tier or database without disturbing or affect the data in database. Three-tier architecture allows mixing and matching in different types of combinational sequence to satisfy any computer needs. The cost of installation for maintaining software is far cheaper than maintaining software on hundreds of PC's.

The decision analysis for Dairy Cattle's Feeding Allocation System was constructed using decision tree technique. The criterion use for generating the decision are tabulated in Table 2. Figure 3 shows decision tree analysis diagram for cattle's feed. A decision tree takes as input an object or situation described by a set of properties, and outputs a yes/no decision (Park, 2010). Decision trees therefore represent Boolean functions. Functions with a larger range of outputs can also be represented in the tree (Russell and Norvig, 1998). The diagram consists of two major elements namely the decision points or nodes represented by rectangular shape and actions at the end of the branches. Decision points or nodes represent the decisions to be made whereas for the actions it contains action's descriptions to be taken connected to a node by an arrow. Every node can have one or more decisions and actions but every action is connected to a single node.

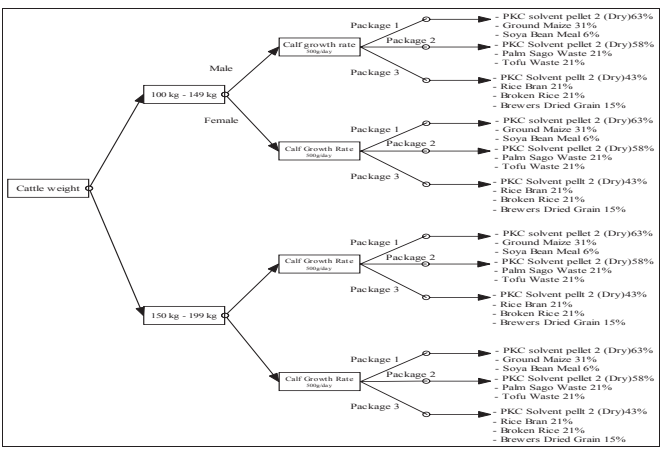

Figure 3 Decision Tree Analysis

The allocation of cattle food is based on cattle weight, cattle gender, cattle status and budget range to get the allocation decision. In pre-existing feeding concentrates rations, the dairy farmers need to determine the amount of proteins needed for dairy cattle. The amount of protein has been grouped into several categories based on the cattle weight. Dairy farmers also need to decide which cattle food is best suited for the cattle with affordable price.

Table 2 Decision Criterion (System Input)

No	Criterion
1	Cattle Weight
2	Gender
3	Growth Rate
4	Budget Rate

Table 3 Decision Result

No.	Item
1.	Protein Needed
2.	Rank of solution
3.	The food's name
4.	Protein weight
5.	The price
6.	Number of cattle
7.	The food quantity
8.	Total food price

4.0 RESULTS AND DISCUSSIONS

Food Allocation for Dairy Cattle System (DSS Dairy Feed) system is a web based application that runs online and enables the users, particularly the farmers and the Department of Agriculture representative to determine the appropriate amount of feeding concentrates for dairy cattle feeding. The allocation amount is based on the calculation of protein needed in each body weight category of the cattle. The information gathered from the system interface are then used to infer the conclusion. In pre-existing feeding concentrates rations, the dairy farmers need to determine the amount of proteins needed for dairy cattle. The amount of protein has been grouped into several categories based on the cattle weight.

To start the decision making, first, the dairy farmers have to choose which type of dairy feeding they wish to use in cattle feeding. After determining the amount of protein contained in the selected dairy feeding, the farmers will calculate the quantity of food type using Pearson Square method or Simultaneous Equation method or Linear Programming method. The feeding mixture must be equivalent to the required protein in dairy feeding. Finally, the farmers will either use mixing machine to mix the selected food or just pour into a tank or mix it manually. The feeding mixture become feeding concentrates and is ready for cattle feeding.

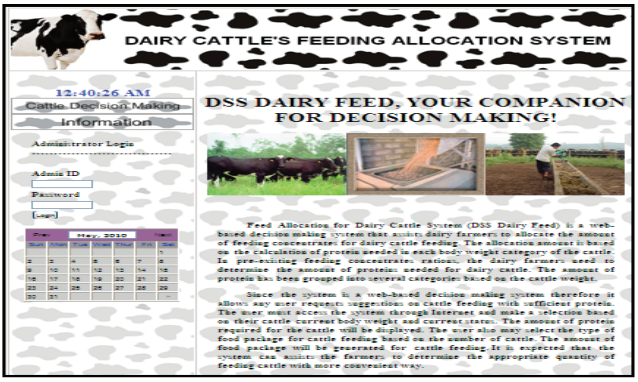

Figure 4 Main page of Dairy Cattle's feeding Allocation System

Figure 4 shows the main page of the system. There are three important modules that support the functionality of this system. There are Cattle Decision Making Module, Administrator Module and Bulletin Module. The cattle decision making module provides the decision making facility for user who wishes to request a suggested decision for cattle feeding. The module is developed based on DSS structure and generates the output based on decision tree. The user is required to select their current cattle body weight as well as cattle gender followed by cattle status and budget range to obtain the suggested decisions on cattle feeding. The user can also enter cattle number to calculate food quantity and total food price for the cattle.

The administrator module permits the system administrator to manipulate data of the system through insert, update or delete actions. These three actions will be performed on the category of cattle status, budget, food type, bulletin, cattle weight and required protein for cattle feeding. The bulletin module shows a list of previous and the latest dairy cattle information file in PDF format with downloadable link each. The user can simply save the file into the computer if the user wishes to save the file for future reading.

In Cattle Decision Making module, records of the four criteria are listed in the table with radio button. The user is required to choose one selection by clicking a radio button from each criterion. Figure 6 shows four criteria with one radio button ticked for each criterion. After the selection, the user is again required to click submit button to obtain suggestion on cattle feeding.

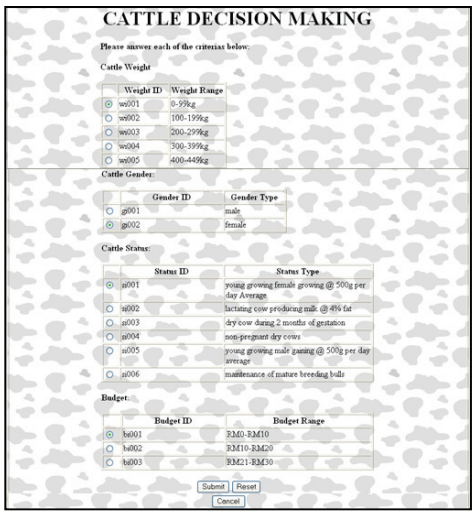

Figure 5 Cattle Decision Making with selection for each criterion

After the submission, the user will be brought to output page of cattle decision making module. The system will refer to the decision table on the database and display a list of food suggestion on cattle feeding as shown as in Figure 6. In this page, the user may enter the number of cattle to be fed and calculate food quantity for each of the food type listed.

Figure 6 Cattle feed allocation output.

5.0 CONCLUSIONS

Dairy Cattle's Feeding Allocation System is constructed to cope with current problems among dairy farmers on selecting suitable food type for cattle feeding containing sufficient amount of required protein for the cattle. The system also provides calculation of food quantity along

with total food price based on cattle number entered by the user. The prototype is expected to decrease workload and reduce redundancy for making decisions in cattle feeding. By using this system the farmers need not to calculate and determine themselves about the amount of food mixtures allocated to the cattle. Furthermore, this system are able to provide resources about feed allocation in cattle feeding among multiple dairy farmers throughout the network. Therefore any information about cattle feeding can be distributed with no boundaries. The other information for farming management among dairy farmers are provided such as steps for mixing the chosen feeding package, ways to store the mixed concentrated feeding in effective way and so forth.

Despite the rapid Internet evolution in Malaysia, the farming community is hot getting its full benefit due to many factors. Efforts to get community use the Internet without the availability of proper resources and appropriate content are ineffective. Consequently, it can be concluded that DSS Dairy Feed is a combination of web based application and DSS characteristic. The online system enable easier access and helpful in decision making. The system assists the decision maker to decide the appropriate quantity of feeding concentrates in different type of food package provides the precise amount of protein for the cattle. Therefore the system provides the users more optional on providing sufficient nutrients in cattle feeding. Hence this system provides worldwide accessibility by means to share information and farming practices, especially in Malaysia.

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