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Web-based Information System for Management of Swine Breeding Herd Farm

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ABSTRACT

A Web-based Information System (WIS) was developed using open source software (Linux Operating System, Apache web server, MySQL and PHP, which are collectively known as LAMP) to assist swine breeding herd management in data recording and tracing, as well as in problem diagnosis. A farm survey was conducted to obtain basic information including problems and farmers' needs. The existing available computer program was analyzed to design a new system. Programs for data importing, user interface and various reports and graphs, as well as data exporting and database backups were developed. Then, data was tested from the available PigLIVE program used on a farm in Nakornpathom province. The developed WIS was pilot implemented on six farms in Ubonratchatani province. The results of the pilot implementation indicated that WIS could be operated on the Internet, the Intranet or on a stand-alone computer. In addition, it could eliminate the cost of the swine breeding herd management software and the operating system and increase the efficiency of data access on the farm. Based on recommendations from targeted end users, WIS will be updated and expanded to provide an efficient tool for swine breeding herd management in the future.

Keywords: computer-based recording system, open source software, swine breeding herd, web-based information system

INTRODUCTION

Swine breeding herd management programs are mostly commercial software packages. The software provides a rudimentary mechanism for recording and tracking data, and diagnosing the cause of production problems (Dial, 1990). The indices obtained from data analysis help to inform on the farm status and indicate its economic survival (Deen, 2002). Traditional commercial software packages, both imported and developed by Thais, are closed systems without revealing the algorithm and index calculation; therefore, the users cannot modify them. Inevitably, a new version of such a program creates more expenditure for users. Although the program can analyze the data well, users do not know how to prioritize the indices and their relationships. Information analysis requires experienced staff and has no definite pattern (Poonperm *et al.*, 2006).

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The program is not used to its full capability and training on record keeping is lacking. Therefore, users in Thailand cannot use it efficiently (Damrongwatanapokin *et al*., 2000).

Information systems developed using open source software are both effective and efficient in their methods of information organization (Hilton, 2003), which leads to low operating costs and continuous development. Currently, there is a rapidly increasing trend of developing Web-based Information Systems (WIS) for business and e-commerce applications (Raphulu *et al*., 2004).

The rationale for web-based expert system applications being widely utilized is that the Internet is readily accessible, while allowing a user to add, access, navigate and link, as well as providing a common multimedia interface. Applications are portable and emerging protocols support co-operation along with knowledge based systems (KBS). Such applications can be easier and more effective to use than traditional applications (Gregor *et al*., 1999; Duan *et al*., 2005; Zetian *et al*., 2005).

Hence, the development of a WIS for swine breeding herd management in Thailand, by using open source software, will provide farmers with an information system that is user friendly, reduces information system costs and increases data access efficiency. A developed WIS would be a basic tool, improved to serve the farm requirements for business sustainability and self-reliance. Therefore, this study focused on the use of open source software as a method to develop a swine breeding herd management system.

MATERIALS AND METHODS

Farm survey

Seven pig farms in Ubonratchathani, Srisaket, Mukdaharn and Nakornpathom provinces were randomly selected. The farm managers were interviewed on their routine usage of the PigLive program or other swine breeding herd management programs. Information was collected on how the program(s) assisted in farm management, how data were recorded daily, satisfaction with the program used and desired features not available in the existing program and problems faced. The surveyed data were analyzed qualitatively using a systems approach to generate concepts and guidelines for the system design and development of an open source system.

System design and development

Architecture

The system was developed as a three-tier application, where the tasks of the application were divided between three distributed tiers (Ramirez, 2000; Jensen, 2001). The system process started with the user sending the request through a web-browser, passing via the Internet to the web server. After that, the web server responded by sending requested information back via the Internet to the client.

Business rules

The data recorded in the system were taken from the boar card, sow card or the daily recorded data and were based on real events. The events in order were: entry, service, pregnant examination, abortion, farrowing, foster, preweaned death, adoption, weaning, skip heat, not in pig, part wean, infected pigs and culling. Therefore, all the events that occurred between the time a female entered the herd and her first farrowing event were grouped in the zero parity record. Subsequent events for the female were then recorded in parity record one until her second farrowing, where her status was updated to parity record two and so on (PigCHAMP, 1999).

Database analysis and design

The system was analyzed using events associated with farm management factors associated with biological and breeding. The relational database was divided into three groups: status, transaction and value. The database server

used MySQL (MySQL AB, 2006), with Apache as the web server. The packages MySQL, PHP(The PHP Group, 2006), and Apache were operated under the Linux Operating System (Volkerding, 2006).

Data import

The Paradox database file was converted into Microsoft Access. Then, the input program was created by PHP and used Open Database Connectivity (ODBC) to connect data access that was transferred into the database of MySQL. The data import program imported the data from the status table and the event history table of the PigLIVE database. Then, the individual data were separated accordingly into the tables of events already designed. The set of data used in the study was the existing data on swine breeding herd management for 254 sows collected from swine farms in Nakornpathom province. The data consisted of two files: a status file and a history file, containing 407 and 6,526 records, respectively.

Report

The report package was designed to show farm production efficiency and assist daily management and was composed of a performance monitoring report, a management list report, an event list report and a graph report. The relevant formulae for the indices were obtained from PigCHAMP (undated), Udomprasert (1994) and Stalder (2002).

System development

The whole system was developed using open source software: Linux Operating System, Apache for the web server, MySQL and PHP, which are collectively known by the acronym LAMP (XAMPP, 2007). The developed system was placed in service under the URL: http://www.agri.ubu.ac.th/~wis-swinemax/.

Testing and pilot implementation

The program was tested and evaluated by three experienced farmers and was consequently validated by three other farmers who had never used farm management software before, with respect to user satisfaction of the developed package.

RESULTS AND DISCUSSION

Farm survey

Four out of the seven pig farms surveyed used the PigLIVE program. The main reports farmers always used were the performance monitoring, service, weaning and farrowing reports. These reports indicated the overall efficiency of farm management (Table 1). However, other reports were used on some farms, such as the action list and parity distribution reports.

On each farm surveyed, the program of stand-alone software was installed under the Windows operating system. On half of the surveyed farms, the owners entered the data themselves to ensure data accuracy and due to a lack of available experts for this task. Only one farm filled in the data daily, while others did it on

Table 1 Frequency of items in PigLIVE report used by the farmers.

Item	Frequency of use
Monitoring report	Used by every farm surveyed
Service report	Used by every farm surveyed
Weaning report	Used by every farm surveyed
Farrowing report	Used by every farm surveyed
Parity distribution report	Occasionally used
Group service report	Rarely used
Action list report	Occasionally used

a weekly basis (Table 2). One problem observed on every farm was the difficulty in reading ear tags that resulted in inconsistencies in the data recorded.

Three farms surveyed in Ubonratchathani did not use herd management software, due to budget restrictions, a lack of computer skills, and an incomplete card index system. The farms under contract did not require a computer program because the data were recorded according to the form assigned by the company.

The survey found that every farm using the swine breeding herd software was satisfied with it to a certain level, and farmers realized that the collected data in the program were necessary for their farm management. However, they recommended that the program should also record the qualification of the person working at each event, particularly, the mating events, since knowledge, skill, attitude and dependability of workers have been reported to influence the level of reproductive performance (Levis, 2007). Some farms needed to collect data in PDAs (personal digital assistants) for convenience in recording and looking at the data during working time. In addition, they also needed a program that could present data graphically. The survey results helped in system planning and in designing the basic modules within the limited time available.

Business rules

The design of the rules in the system was based on the requirements in the information system analyzed from the farm survey and literature reviews, as business rules are fundamental to transfer the real business operation into the virtual world of the computer. The processes and stages of data generation in the farm system must be understood. All important events should be recorded. At each step of the process, a decision must be made to cull or to keep (Toft, 1998; Plà, 2007). A process designed for such a system needs an expert to run it (Doaliang *et al*., 2002).

The flow line of events in a swine breeding herd system developed in the current study is shown in Figure 1 and illustrates all possible events for sows. The lines with arrows indicate the sequence for different events. A two-headed arrow line indicates that the sequence of events can be reversed. For example, the mating event (1) does not occur unless the entry event (0) has occurred, or the farrow event (4) occurs only after the mating event (1) has taken place.

Data import

Data examination revealed that the input data in the status table (407 records), and the data in the event history table (6,526 records) equaled the entries in the old data set. As an example, the actual transaction records shown in Table 3 have to be controlled by the business rules in Figure 1 in recording corresponding events and dates together with the required parity number created by the program. Consequently, the program used these records for generating different reports.

Table 2 Some key information gathered from different farms using PigLive.

Farm location	Experience/skill	Data integrity	Satisfaction	Frequency of data recording	Recorded by
Ubonratchathani	High	Good	Moderate	Weekly	Unskilled employee
Srisaket	High	Very good	High	Daily	Skilled staff
Mukdaharn	Very high	Good	Moderate	Weekly	Owner
Nakhonpathom	Moderate	Good	Moderate	Weekly	Owner

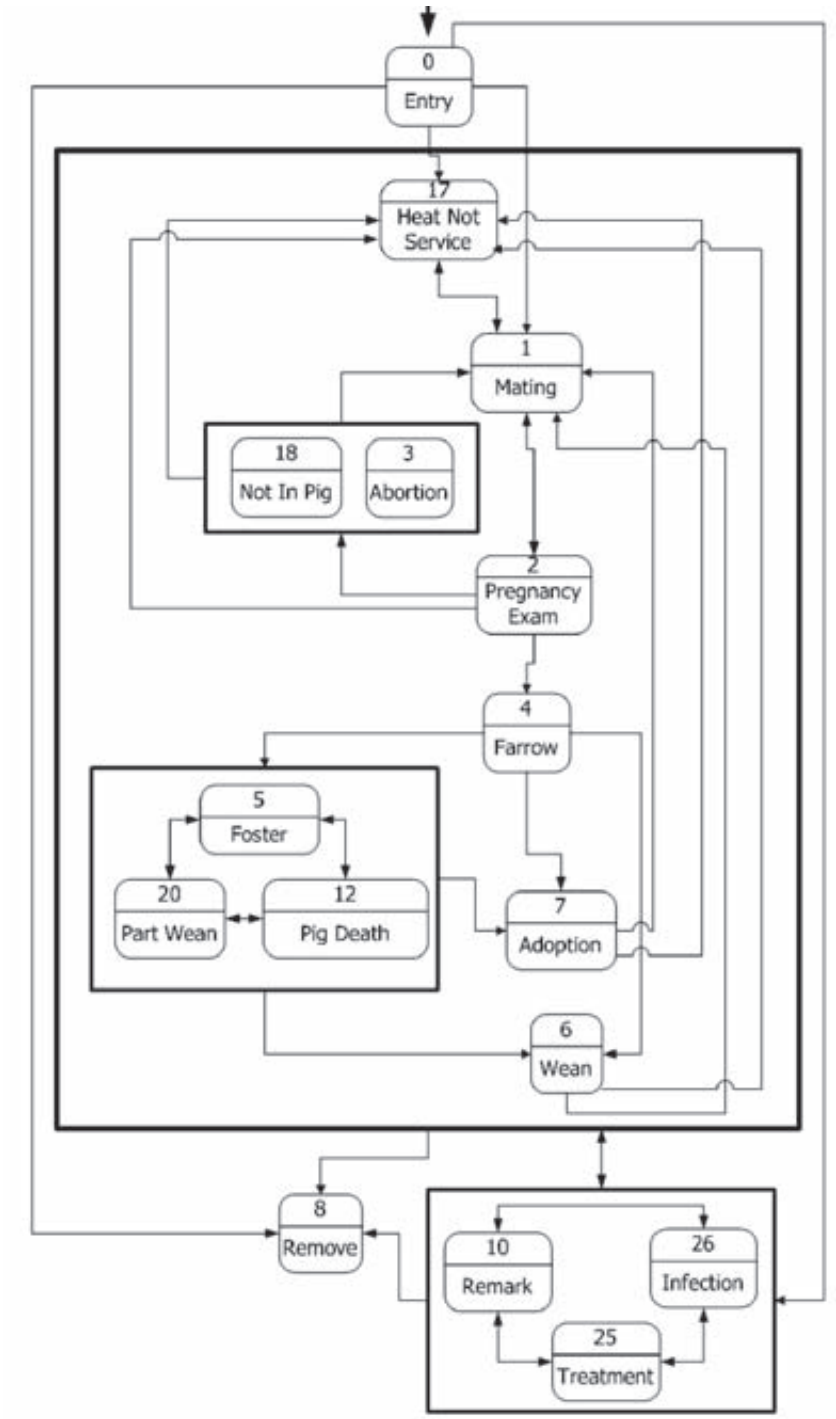


Figure 1 Flowchart of events in the swine breeding herd system.

Table 3 An example of the transaction records.

Parity	Date	Event
2	2002/10/6	Farrow
↑	2002/6/11	Mating
↑	2002/6/11	Mating
↑	2002/6/11	Mating
↑	2002/6/7	Wean
↑	2002/5/21	Preweaned death
↑	2002/5/20	Part wean
1	2002/5/17	Farrow
↑	2002/1/21	Mating
↑	2002/1/21	Mating
↑	2002/1/21	Mating
0	2002/1/1	Entry

The reports on an individual swine's history from the developed program were sampled and compared with the same reports from the PigLIVE program. The results indicated that there was no significant difference between the two programs.

Testing and pilot implementation

The results revealed that tested farmers were generally satisfied with basic uses, such as data recording, reporting and tracing problem sows. The hyperlink was a special feature that satisfied all users. However, experienced farmers suggested the inclusion of as many hyperlinks as possible, to improve support for on-screen analysis. The installation seemed to be difficult for the farmers, since a computer expert was needed for this task (Table 4). If computer system access is adequate on the farm, the system provides faster data recording, improves the benefits of information for operating and reduces the time lag between data gathering and reporting (Deen, 2002).

Inference process

The inference process is an information model. The modeling system is composed of a database system, configuration system, business rules, report system, user interface, import-export data and database backup (Figure 2). The process mimics the management of a breeding herd, which is divided into three major components: 1) swine events, 2) report monitoring for efficiency evaluation and 3) reports assisting operations. The interface of these three groups can be linked to the relevant information page.

Figure 3 illustrates the inference process of the program. The system administrator determines the farm and units in the system. In this research study, the system required that one farm have only one unit. Then, a user account was added. If former data existed, then the administrator imported the data into the new system.

Table 4 Satisfaction evaluation of farmers in program testing and pilot implementation.

Criterion	Satisfaction level	
	Expert	Novice
Data recording	Moderate	Moderate
Adequacy of reporting	Moderate	High
Hyperlink feature	Very high	Very high
User friendly	High	High
Ability to trace problem sows	Moderate	Moderate
Reduce human errors	Moderate	High
Reduce training task	High	Moderate
Adequacy in basic use	High	High
Installation	Difficult	Difficult

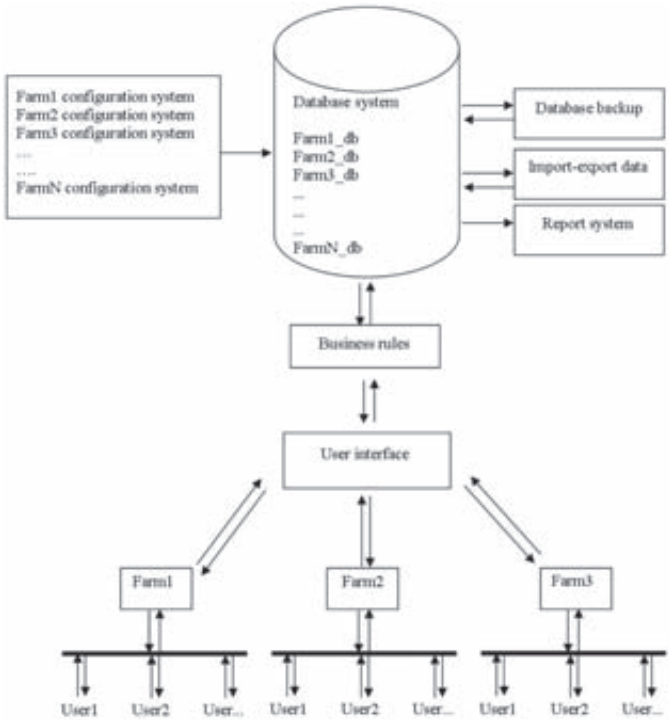


Figure 2 Diagrammatic representation of the major components of the designed swine management system.

Figure 3 Inference process for the swine breeding herd management system.

Before accessing the system, the user has to login and choose the menu for inputting new data and enter the data in the order of events occurring on the farm (for example, entry, service, farrowing, foster and wean). The main reports that can be obtained are a history report, performance monitoring report and management list report.

Database design

The database design is partly illustrated in the entity relationship diagram (E-R diagram) as shown in Figure 4. The data inside the transaction entity (brd_event transaction) comprises events that agree with the business rules and have a relationship with various event values, such as mating events (brd_event01) and pregnancy exam (brd_event02). The mgt_swine_master entity keeps a record of individual pig status and also has a relationship with the brd_event_transaction entity.

User interface

Figure 5 is an example of a web page request and response scenario. Here, the input data system is displayed as a data input interface. While entering data, the system allows a navigation link to individual swine in order to easily check the validity of the recorded data. Also, when the user opens the window for an individual swine, the system can upload images of the swine and data at different events with an unlimited number of images.

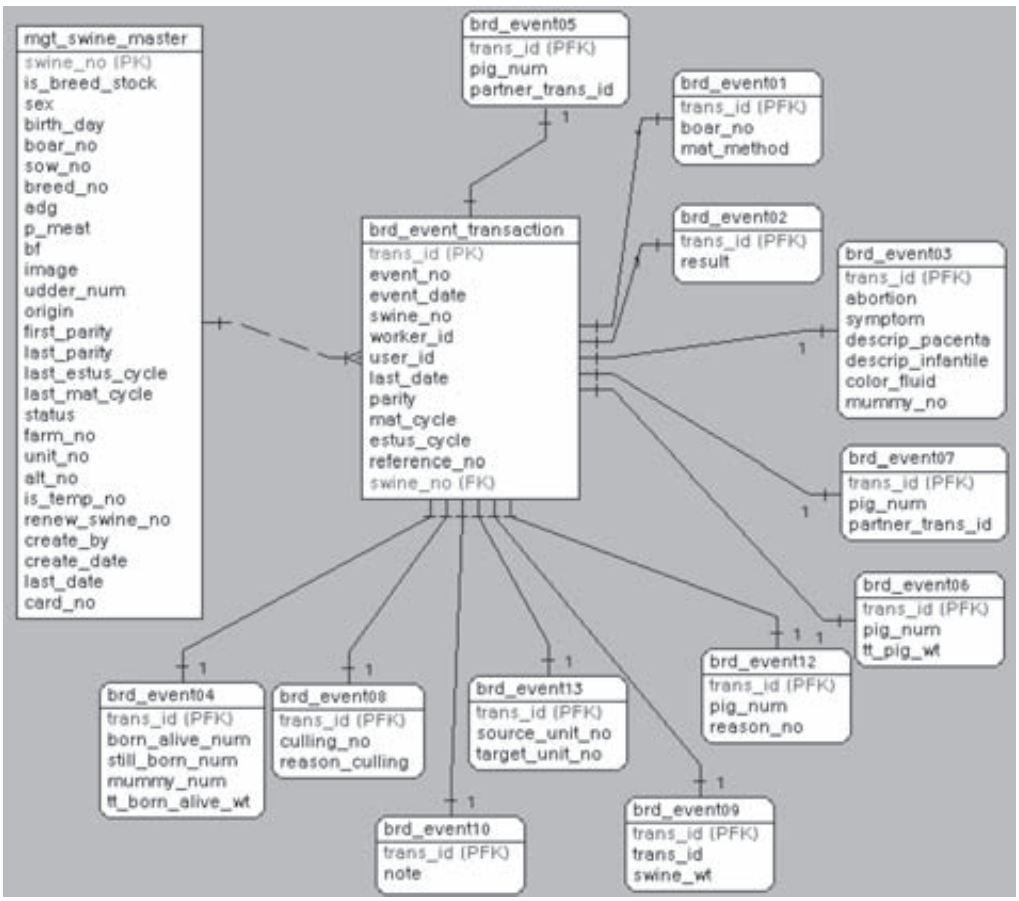


Figure 4 E-R diagram of the swine breeding herd management system.

Data export

The development of a data export program is a very important feature, since it allows the existing data to be used in other applications. All important data can be exported as a text file.

Reporting

The reports from the system show both facts and analysis, and can be a performance monitoring report, management list report, event list report or a graphical report. These help farmers deal with farm status, problem identification and farm viability. Thus, the producers use the indices as a guideline to adjust their management procedures to improve their profit. The system was designed to link between the analysis of value and the origin of the data, using the principles of hyperlink as suggested by Thomson *et al*. (1998) to show the appropriate information (Figure 5). For example, the user can link from the index showing the performance monitoring report to other reports and to individual swine history. This feature allows users to feel like they are walking around the farm while interacting with the system.

Performance monitoring report

The system was designed to evaluate performance during a specified period of time - daily, weekly, monthly, quarterly and yearly. There were four main reporting points: breeding, farrowing, weaning and population performance (Figure 6).

Management list report

This group of reports assists in daily operations and includes a sow farrowing report, sow mating report, sow pregnancy report and history report. The reports can be color-coded to assist the farmer in daily operations, as the report indicates when action is required (Figure 7).

Event list report

These reports help the user to search data for each event, such as servicing, weaning, farrowing, and culling (Figure 8).

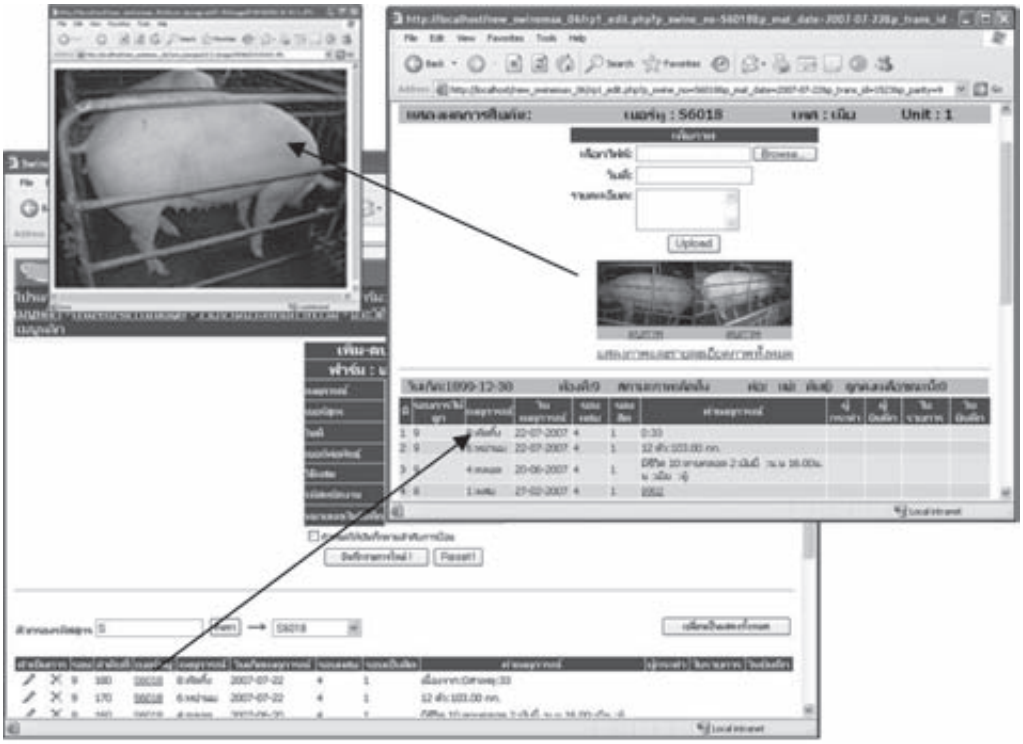


Figure 5 Sample screen shot of the user interface.

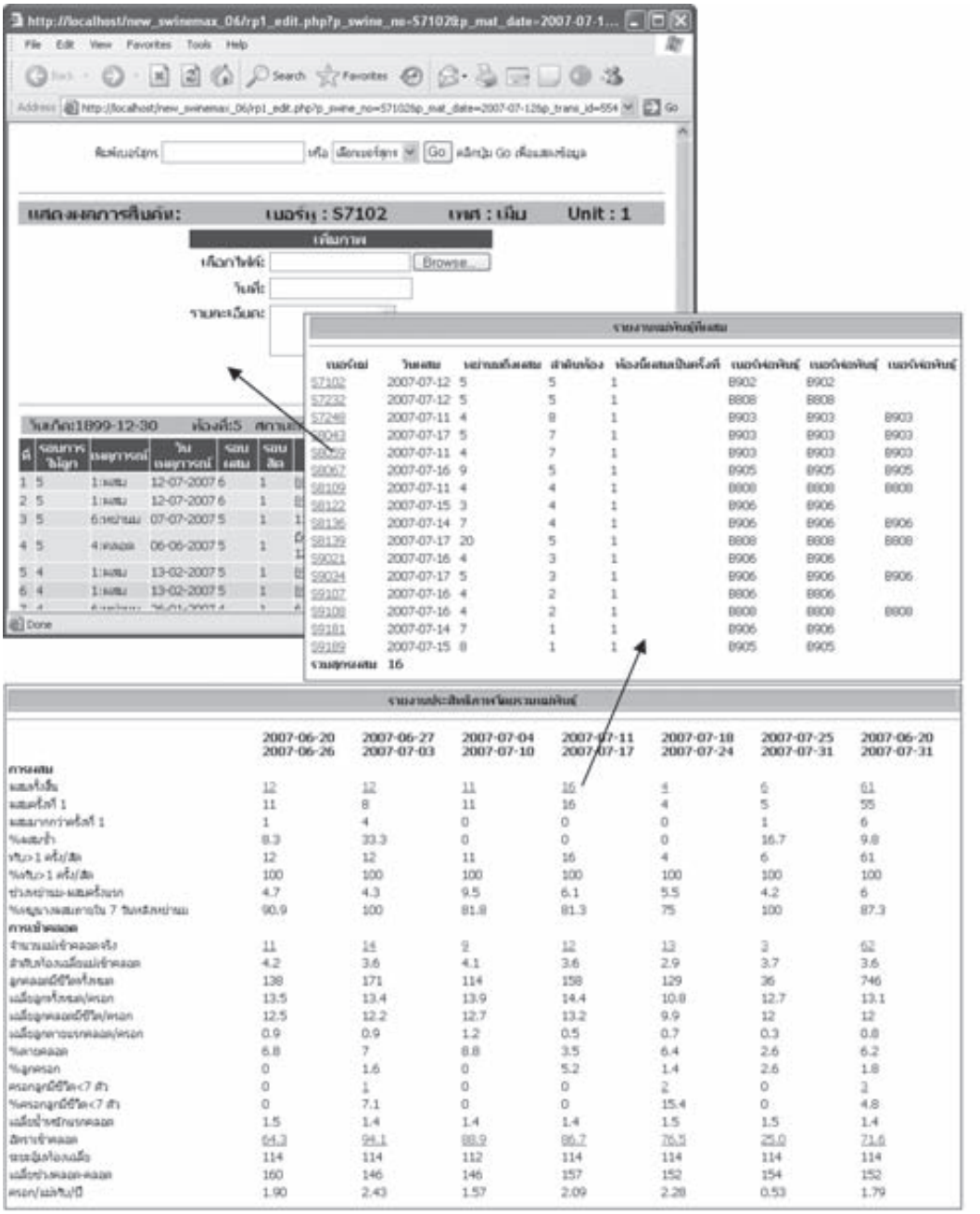
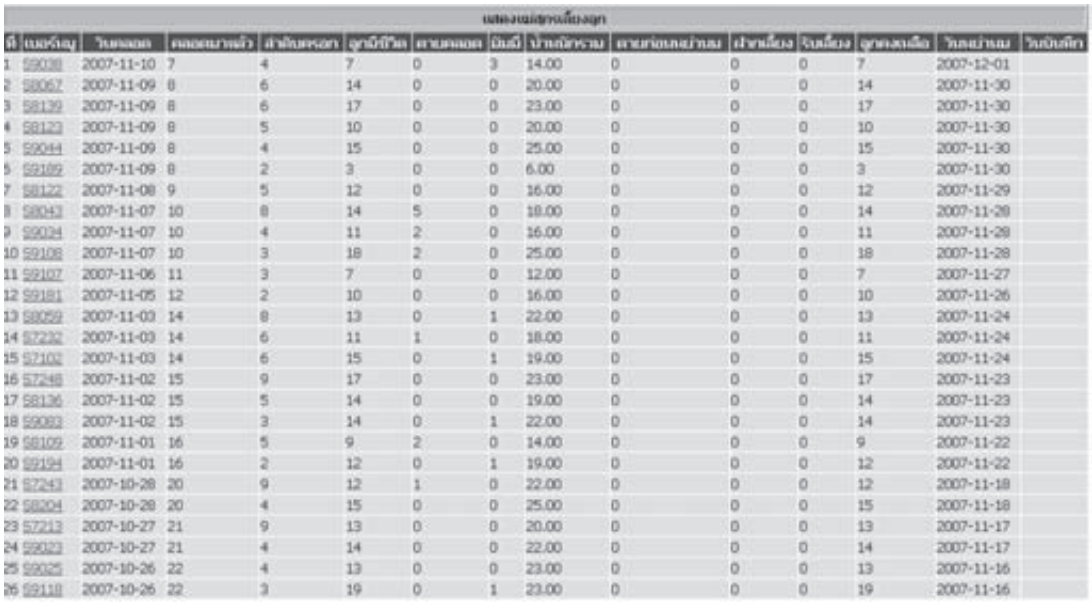


Figure 6 Sample screen shot of a performance monitoring report.



ที่	เบอร์หมู	วันผสม	ผสมยากี่ตัว	สำหรับครอก	ลูกมีชีวิต	ตายแรกคลอด	มัมมี่	น้ำหนักรวม	ตายก่อนหย่านม	ทำหมัน	จับเลี้ยง	ลูกหย่านม	วันหย่านม	วันบันทึก
1	S9038	2007-11-10	7	4	7	0	3	14.00	0	0	0	7	2007-12-01	
2	S8067	2007-11-09	8	6	14	0	0	20.00	0	0	0	14	2007-11-30	
3	S8139	2007-11-09	8	6	17	0	0	23.00	0	0	0	17	2007-11-30	
4	S8123	2007-11-09	8	5	10	0	0	20.00	0	0	0	10	2007-11-30	
5	S9044	2007-11-09	8	4	15	0	0	25.00	0	0	0	15	2007-11-30	
6	S9189	2007-11-09	8	2	3	0	0	6.00	0	0	0	3	2007-11-30	
7	S8122	2007-11-08	9	5	12	0	0	16.00	0	0	0	12	2007-11-29	
8	S8043	2007-11-07	10	8	14	5	0	18.00	0	0	0	14	2007-11-28	
9	S9034	2007-11-07	10	4	11	2	0	16.00	0	0	0	11	2007-11-28	
10	S9108	2007-11-07	10	3	18	2	0	25.00	0	0	0	18	2007-11-28	
11	S9107	2007-11-06	11	3	7	0	0	12.00	0	0	0	7	2007-11-27	
12	S9181	2007-11-05	12	2	10	0	0	16.00	0	0	0	10	2007-11-26	
13	S8059	2007-11-03	14	8	13	0	1	22.00	0	0	0	13	2007-11-24	
14	S7232	2007-11-03	14	6	11	1	0	18.00	0	0	0	11	2007-11-24	
15	S7102	2007-11-03	14	6	15	0	1	19.00	0	0	0	15	2007-11-24	
16	S7248	2007-11-02	15	9	17	0	0	23.00	0	0	0	17	2007-11-23	
17	S8136	2007-11-02	15	5	14	0	0	19.00	0	0	0	14	2007-11-23	
18	S9083	2007-11-02	15	3	14	0	1	22.00	0	0	0	14	2007-11-23	
19	S8109	2007-11-01	16	5	9	2	0	14.00	0	0	0	9	2007-11-22	
20	S9194	2007-11-01	16	2	12	0	1	19.00	0	0	0	12	2007-11-22	
21	S7243	2007-10-28	20	9	12	1	0	22.00	0	0	0	12	2007-11-18	
22	S8204	2007-10-28	20	4	15	0	0	25.00	0	0	0	15	2007-11-18	
23	S7213	2007-10-27	21	9	13	0	0	20.00	0	0	0	13	2007-11-17	
24	S9023	2007-10-27	21	4	14	0	0	22.00	0	0	0	14	2007-11-17	
25	S9025	2007-10-26	22	4	13	0	0	23.00	0	0	0	13	2007-11-16	
26	S9118	2007-10-26	22	3	19	0	1	23.00	0	0	0	19	2007-11-16	

Figure 7 Sample screen shot of a management list report.

รายงานคัดทิ้ง

ที่	Parity	เบอร์หมู	เหตุการณ์	วันเหตุการณ์	รอบผสม	รอบสัด	ค่าเหตุการณ์	ผู้บันทึก	วันบันทึก	ใบรายการ
1	2	S9158	8:คัดทิ้ง	2007-08-08	2	1		1				
2	8	S7138	8:คัดทิ้ง	2007-08-05	5	1		1				
3	6	S7121	8:คัดทิ้ง	2007-07-29	4	1		1				
4	8	S7128	8:คัดทิ้ง	2007-07-22	5	1		1				
5	7	S8081	8:คัดทิ้ง	2007-07-22	5	1		1				
6	9	S6018	8:คัดทิ้ง	2007-07-22	4	1		1				
7	4	S8063	8:คัดทิ้ง	2007-07-16	6	1	1	1				
8	8	S7001	8:คัดทิ้ง	2007-07-14	5	1		1				
9	5	S7010	8:คัดทิ้ง	2007-07-14	5	1		1				
10	2	S9104	8:คัดทิ้ง	2007-07-12	2	1		1				
11	5	S6040	8:คัดทิ้ง	2007-07-02	5	1		1				
12	8	S7109	8:คัดทิ้ง	2007-06-28	5	1		1				
13	8	S7230	8:คัดทิ้ง	2007-06-21	5	1		1				
14	1	S9197	8:คัดทิ้ง	2007-06-19	1	1		1				
15	3	S9010	8:คัดทิ้ง	2007-06-07	3	1		1				
16	6	S8022	8:คัดทิ้ง	2007-05-20	4	1		1				
17	9	S6047	8:คัดทิ้ง	2007-05-08	4	1		1				
18	10	S5073	8:คัดทิ้ง	2007-05-08	3	1		1				
19	1	S9124	8:คัดทิ้ง	2007-05-03	2	3		1				

Figure 8 Example of an event list report.

Graph report

This report allows a farm manager and staff to see trends in overall data easily. If interesting points are found, the system can navigate a link to the relevant report and show the report as a graph (Figure 9).

Reports in graphical form can be presented on farrowing rates, pig weaning, average parity and any other information required.

CONCLUSION

This paper presents the development of a web-based system for the management of a swine breeding herd. The system developed allows the use of hyperlinks to gather detailed information. The information is extracted and processed from a central database using web access. The system is user-friendly, reducing input errors with a cross

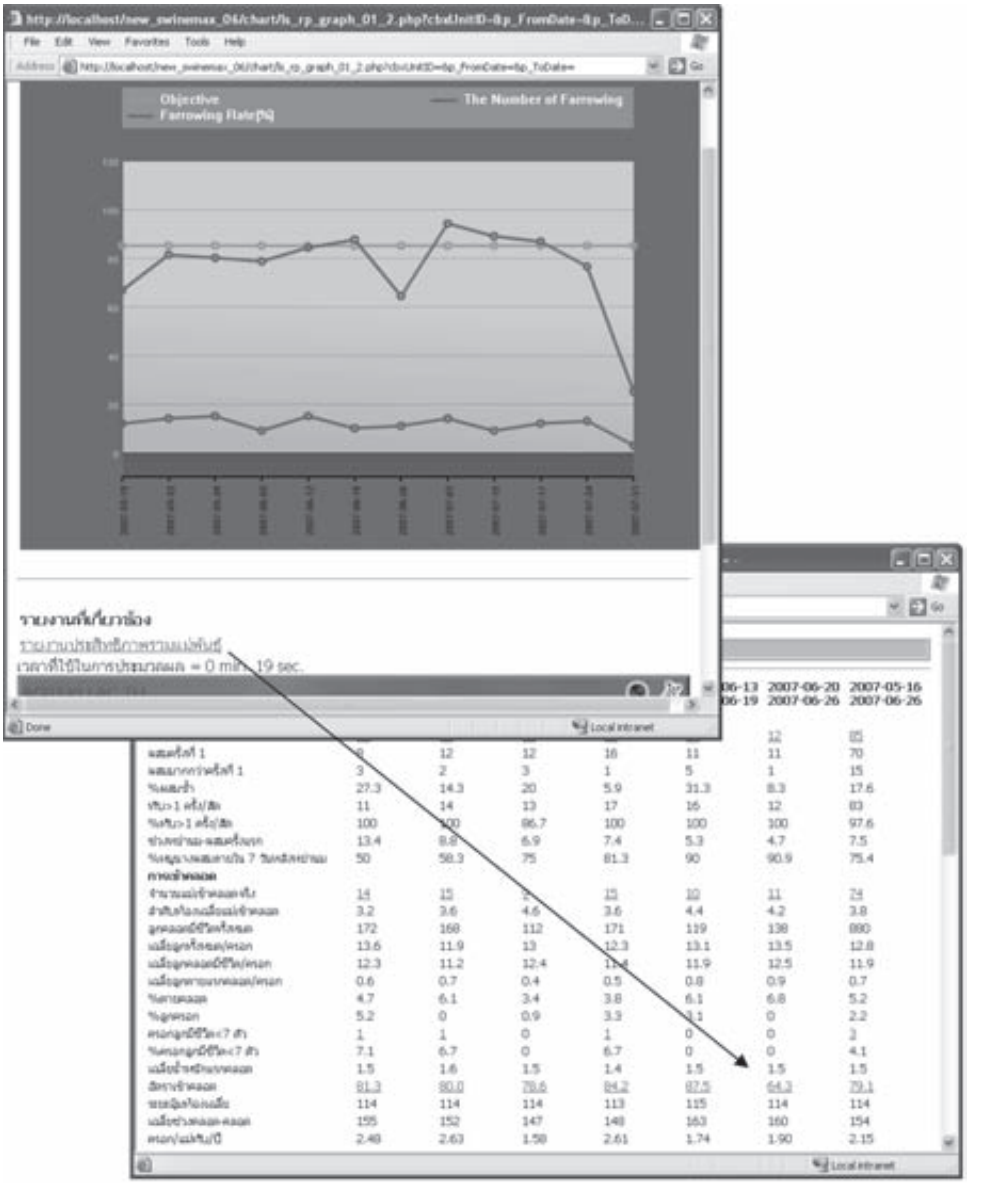


Figure 9 Sample screen shot of a graph linked to the relevant report.

check system helping farmers to understand various indices better. It is a tool for inexperienced users and those unfamiliar with computer technology. Essential data is available via the Internet from a central server, reducing the time lag between data collection and reporting. Imagery data allows a farmer to record data that is not numeric. The system allows data to be observed via the Internet and thus by farm advisors and veterinarians, saving traveling time to visit the farm. Where there is only an Intranet or a stand-alone computer system, the database can be sent to farm consultants through e-mail. The system can monitor staff operations. The algorithm used in this software can be applied to other areas, such as beef cattle, dairy farms, and the broiler and egg production industries.

However, further improvements should be considered. Testing the system, with actual data from one farm in Ubonratchathani, involved a large database of more than 100,000 records, so significantly reducing the processing speed is a requirement. Therefore, the index design of the database should be numeric instead of alphabetical to improve the speed. Opinions and knowledge from experts are needed to improve the system; therefore, the government should support the development of software to increase its usage rate.

In summary, the swine breeding herd management program used open source software to develop a system suitable for use via the Internet, Intranet or stand-alone and a successful pilot implementation has been completed. Both the strong and weak points of the system have been discussed and improvements are needed. The project provided a prototype for the future development of a WIS for swine breeding herd management.

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