

Algorithms for Calculating the Indices Determining the Production Efficiency of Swine Breeding Herds: Pigs Weaned Per Sow Per Year and Litters Per Sow Per Year

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ABSTRACT

This research aimed to develop algorithms for calculating some important indices that determine the reproductive and production efficiency of swine breeding herds. Algorithms were developed for litters per mated female per year (LMFY) and pigs weaned per mated female per year (PWMFY). Both algorithms can be used to develop an information system for swine breeding herd management by using open source software. The open source software used in this research was XAMPP for Linux. The data used for testing came from the database of PigLive program from a swine farm in Nakornpathom province. The data consisted of two tables containing details on status and history, with 407 and 6,526 records, respectively. The data was imported into the new system that had been developed using a web-based system. Though the comparison of the indices did not agree exactly with the ones reported from the PigLive program based on monthly periods, the values obtained were similar with the same trends. The algorithm developed had five steps: 1) date management, 2) calculation of production, 3) data management to calculate an average mated female inventory (AMFI), 4) calculation formula and 5) presentation of the results.

Keywords: algorithm, average mated female inventory, litters per sow per year, pigs weaned per sow per year, production efficiency

INTRODUCTION

The best measurement of reproductive efficiency in swine breeding herds is the number of pigs weaned per mated female per year (PWMFY), which is dependent on the number of litters per mated female per year (LMFY) and the number of pigs weaned per sow (Dial *et al.*, 1992; Koketsu, 2002).

Swine producers and programmers have defined a formula for an index to support universal understanding of information in the swine industry (Udomprasert, 1994; PigCHAMP, 1996; Stalder, 2002; Fearon, 2005). However, no report has been found that details the procedure used to derive the index.

Under real conditions, the index calculation involves using a large amount of data

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relating to time periods, thus making calculation by hand very difficult.

Therefore, this research attempted to study and develop algorithms for calculating certain indices involved in production and reproductive efficiency. These algorithms could then be used as a part of program development for swine farm management with open source software. Thus, this study forms a basis for studying different characteristics of swine breeding herds that should benefit the sustainable development of swine production in Thailand.

MATERIALS AND METHODS

Database system analysis and design

The program used in the study was XAMPP for Linux (Seidler, 2008), which comprises Apache, MySQL, PHP & PEAR and phpMyAdmin. MySQL, PHP and Apache operate under the Linux Operating System (Volkerding, 2006). These are freely available software packages. Data were reviewed and classified into patterns, types and their correlation. An entity relationship diagram (ERD) was analyzed and designed.

Data collection

The set of data used in the study was existing data collected on pigs at a farm in Nakorn Pathom province. The data consisted of two files, namely a status file and a history file, containing 407 and 6,526 records, respectively.

Data import program development

The data was imported to a web-based system (WS) and inspected for accuracy by comparing it with farm data, such as sow cards. The events of herd entry, mating, pregnancy diagnosis, skip heat, abortion, farrowing, fostering, pig weaned, part weaned, pig death, pig infected, not in pig and culling were recorded.

Algorithm development for index calculating

The algorithm was designed by sequence for calculating LMFY and PWFY, using the formulae below. The indices came from the performance monitoring report and the formulae for the indices were obtained from PigCHAMP (1996) and Udomprasert (1994).

Average mated female inventory

AMFI was calculated using Equation 1 (PigCHAMP, 1996) :

$$\frac{\text{Sum of mated female days in period}}{\text{Days in period}} \quad (1)$$

Litters/mated female/year

LMFY was calculated using Equation 2 (Udomprasert, 1994):

$$\left(\frac{\text{Sum of litters in period}}{\text{Average mated female 114 days ago}} \right) \times \frac{365}{\text{days in period}} \quad (2)$$

Pigs weaned/mated female/year

PWFY was calculated using Equation 3 (Udomprasert, 1994):

$$\left(\frac{\text{Sum of pigs weaned in period}}{\text{Average mated female 140 days ago}} \right) \times \frac{365}{\text{days in period}} \quad (3)$$

Index comparison

The index values from the equations were compared to the ones from the PigLive program using the same database and periods.

RESULTS

Database analysis and design

The data was divided into three groups: status, transaction and value. The database design is partly illustrated in the entity relationship diagram (ERD) shown in Figure 1. The program imported the data from the status table and the event history table of the PigLive database. The

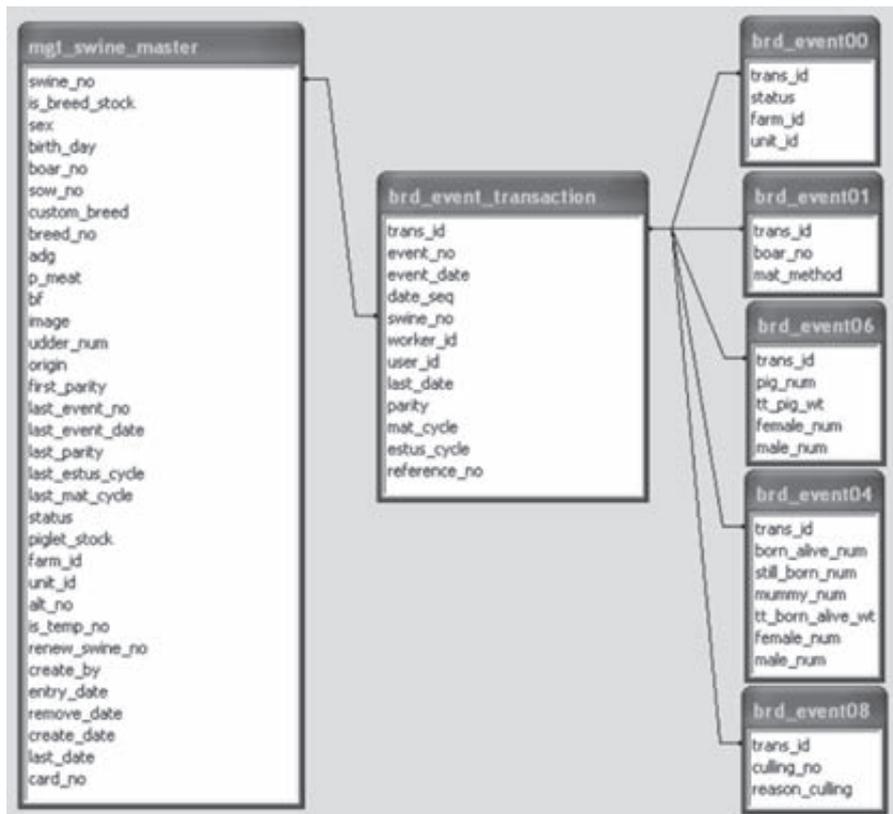


Figure 1 Entity relationship diagram of the developed system.

data to be recorded in the system was brought in from the respective information recorded on the boar card, sow card or in the daily recorded data. The record system followed the same order as occurred under real conditions. The events were: entry, service, pregnant examination, abortion, farrowing, foster, preweaning death, adoption, weaning, skip heat, not in pig, part wean, infected pigs and culling. Data examination revealed that the number of records in the status table (407 records) and in the event history table (6,526 records) were the same as in the original PigLive database.

Algorithm for calculation of average mated female inventory (AMFI)

The AMFI value is important as it is required for calculating PWMFY and LMFY based

on the AMFI value back at day 140 and day 114, respectively. Generally, sows will be replaced and culled throughout time, resulting in an inconsistent number of pigs. Therefore, the average calculation of the mated females within the period is related with the events of entry date, first mating, remove date and the period to be reported (start date and end date). The measurement of the sow days requires the algorithm to be self-adjusting between entry date or first mating and the start date, remove date and end date. If any sows do not appear during the period, they will not be counted, as shown in Figure 2.

The field study revealed that there were some sows that were inactive for a long time but had not been removed from the system. Such events occurred with the sows that had been culled from the herd without recording the events in the

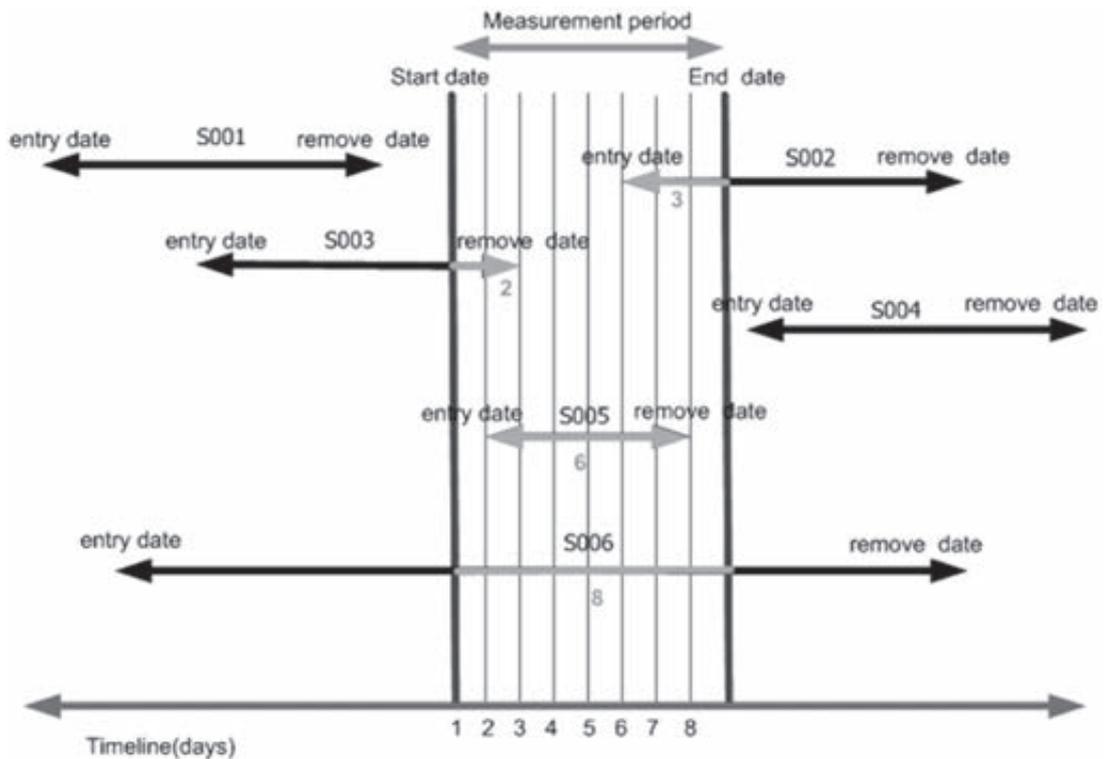


Figure 2 Example showing how to count sow days to calculate AMFI.

computer system. If the program were unable to detect these events, the results would be in error, as the number of sows in the report would be more than it should be. This would result in the calculated AMFI value being more than the real value. Hence, the farmers were advised to check the real number of sows with the number recorded in the computer. In this study, an error of 5-10 % for pigs without active data was found. These pigs with 201 d inactivity would be filtered out when the AMFI was calculated. The AMFI was calculated from counted pigs with at least one mating record. The flow chart representing the calculation of AMFI is shown in Figure 3.

Algorithm for calculation of litters per mated female per year (LMFY)

The algorithm for the calculation of LMFY was separated into two phases, with the first for counting the litters per measurement

period, as shown in the performance monitoring report, and the second for computing AMFI 114 d prior, as shown in Figure 4. The flow chart for calculating LMFY is shown in Figure 5.

Algorithm for calculation of pigs weaned per mated female per year (PVMFY)

The PVMFY calculation was divided into two phases, with the first being the calculation to count the number of pigs weaned within the measurement period. The second calculation was to compute AMFI 140 d prior, as shown in Figure 6. The flow chart for the calculation of PVMFY is shown in Figure 7. The value of 140 d is a theoretical value generally used for the farrowing interval, which is equal to the sum of the post-weaning days to re-breeding (5 d), gestation period (114 d) and weaning age (21 d), assuming a farrowing rate of 100% with the number of litters being 2.6 per sow per year.

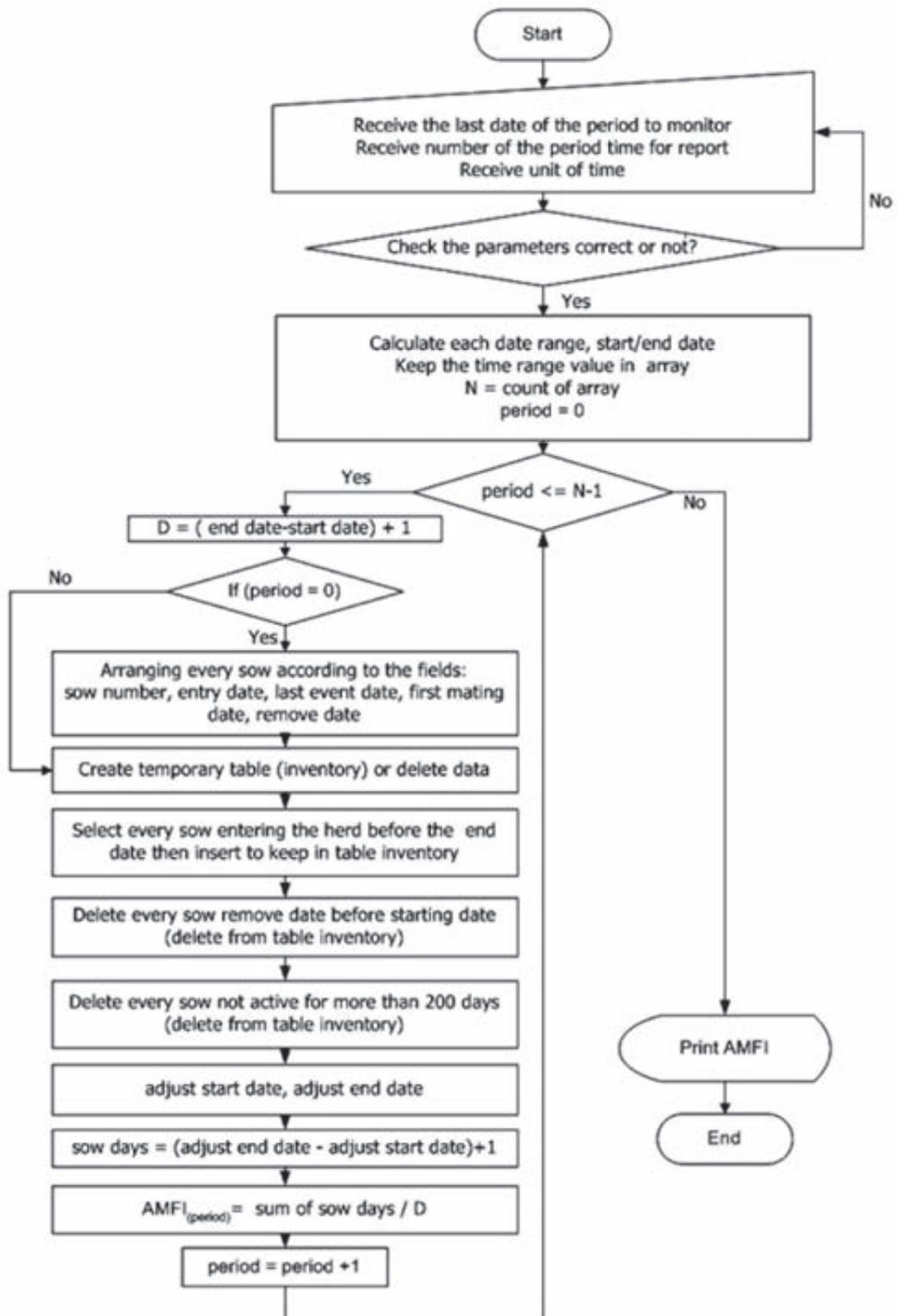


Figure 3 Flow chart of calculation of average mated female inventory.

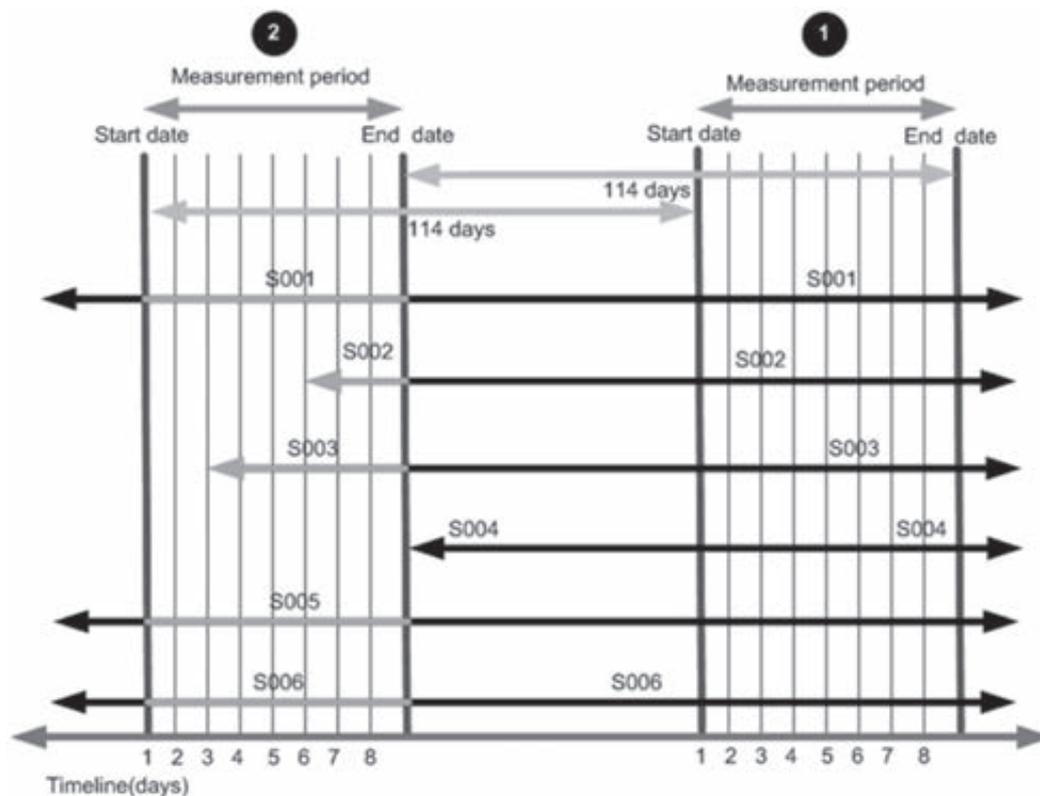


Figure 4 An example of counting litters and sow days in the herd to compute litters per mated female per year.

Algorithm comparison

The program tested eight one-month periods between 1 March 2007 and 31 October 2007. The results revealed that the values of average female inventory (AFI) were the same as obtained by the PigLive program. Figure 8 shows that the AFI values, including inactive sows (the removed sows from the farm but not yet deleted from the computer, shown in Figure 8 by the white bar), were higher than the ones obtained from PigLive. These figures only show AFI calculations, not AMFI, because PigLive can not show AMFI.

The results revealed that the value of LMFY from the different programs was similar (Figure 9).

The results suggested that the value of PWMFY from the different programs was similar (Figure 10).

DISCUSSION

The algorithms developed to calculate the indices of AMFI, PWMFY and LMFY were tested over eight one-month periods in the performance monitoring report. The index developed did not agree exactly with the one reported using the PigLive program for every period; however, the values were close and showed the same trend.

The calculation of AMFI significantly affected PWMFY and LMFY if the original formula was used with the AMFI value of 140 d and 114 d, respectively. Human errors are common when a sow is removed from the herd but the relevant event record is not removed at the same time from the computer system (5-10% error). This error causes the number of sows in the computer

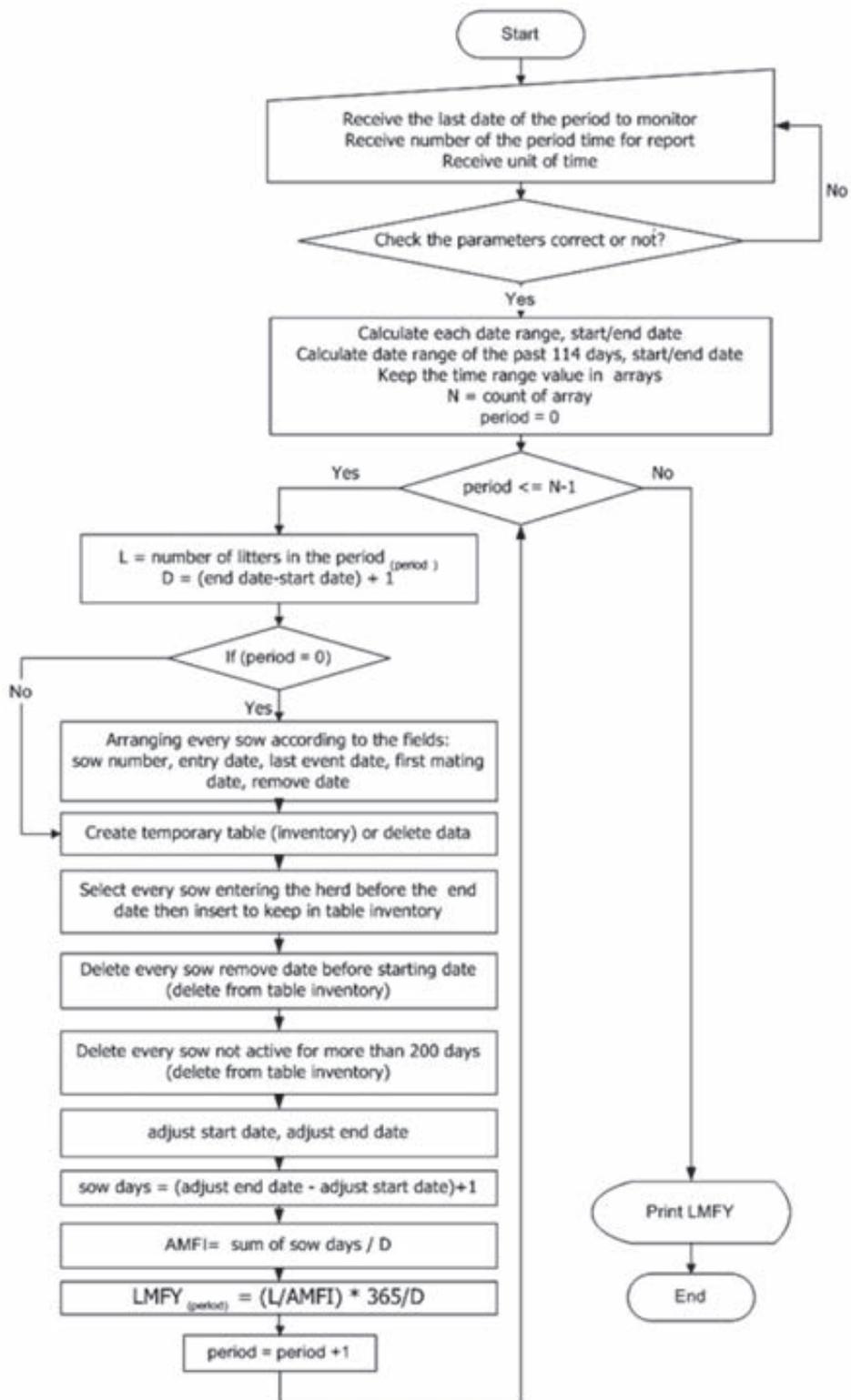


Figure 5 Flow chart of litters per mated female per year calculation.

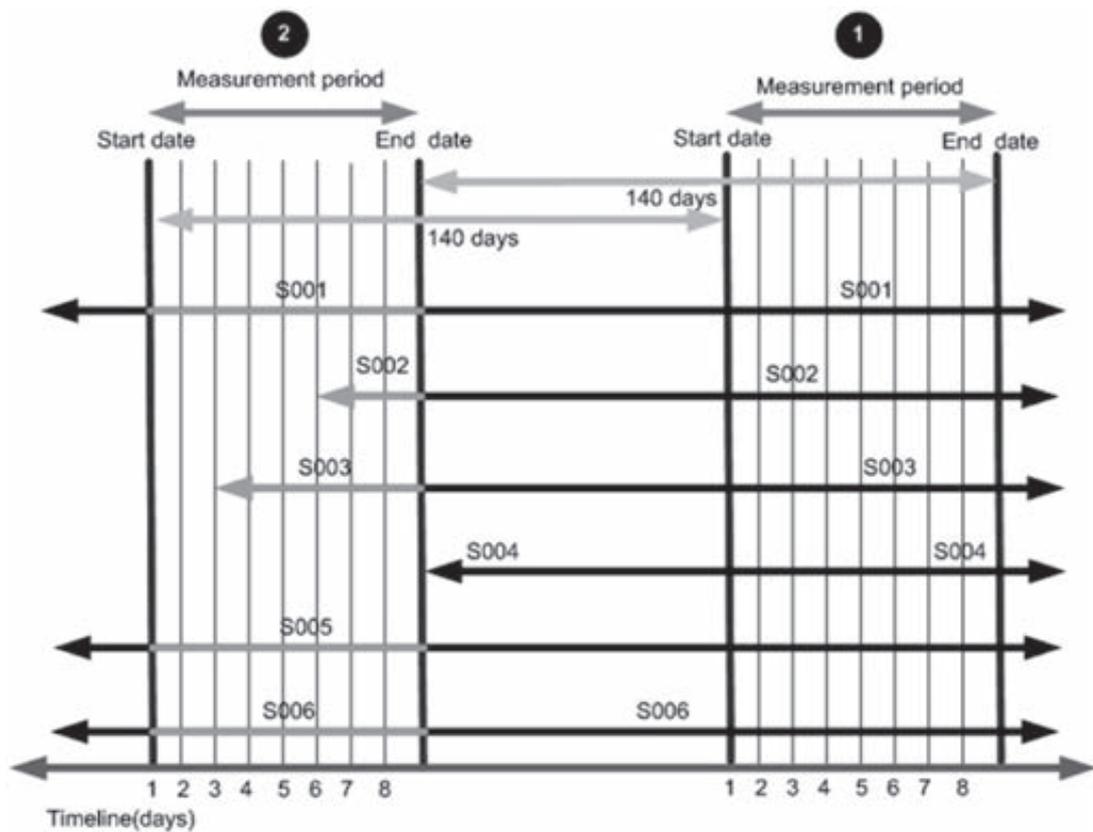


Figure 6 Example of counting pigs weaned and sow days for calculating pigs weaned per mated female per year.

system to be higher than the real figure. If data has been accumulating, the value of AMFI or AFI will be higher, causing the value of PWMFY and LMFY to be lower than the real one. In the PigLive program, if there is an inactive sow for more than about 200 d, the sow will be filtered out, which is considered a good feature of the program.

Although the swine breeding farm management program has a function that can monitor inactive sows, farmers are often not interested in using this function, and thus, they are unaware that the incorrect number of sows is left in the computer system. Therefore, to reduce errors due to this situation, the system should show each sows inactivity (for a period of about 160 d after the last event) in the performance monitoring report that farmers use.

The new web-based system that was developed can include links between the index and its related details, allowing the user to understand the origin of the data (Thomson *et al.*, 1998; Gregor *et al.*, 1999). If the information provided in the indices were developed to allow graphical presentation, together with the statistical data as components of the productivity tree, it would enhance problem analysis of the swine farm. However, each program may have differences in the algorithms (Dial, 2007). The swine management program should show more details of LMFY or PWMFY and allow tracing back to the problem sow. This would help farmers to address the problem of low-efficiency sows.

The design of an efficient algorithm is necessary because of the complexity of the data.

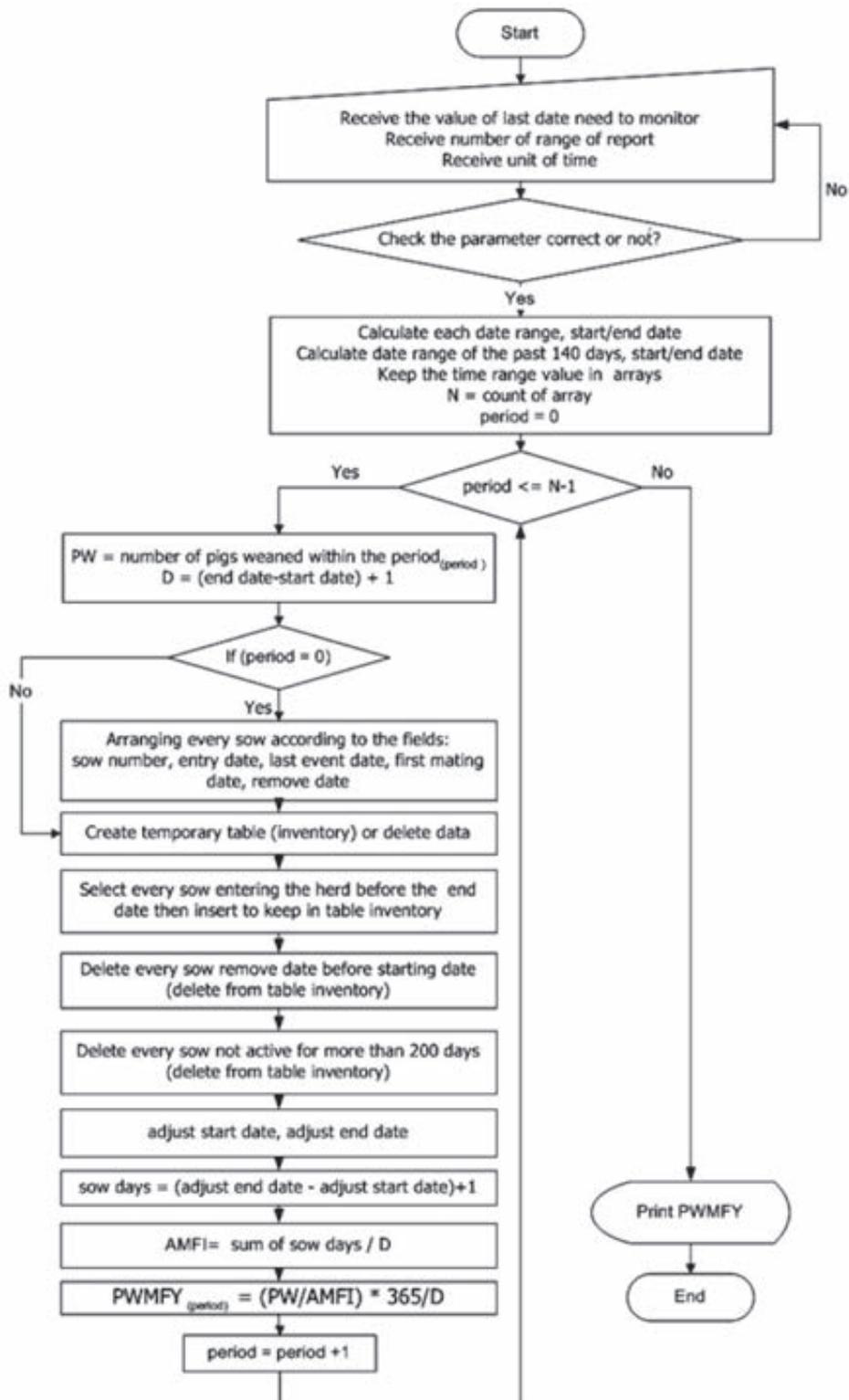


Figure 7 Flow chart of pigs weaned per mated female per year calculation.

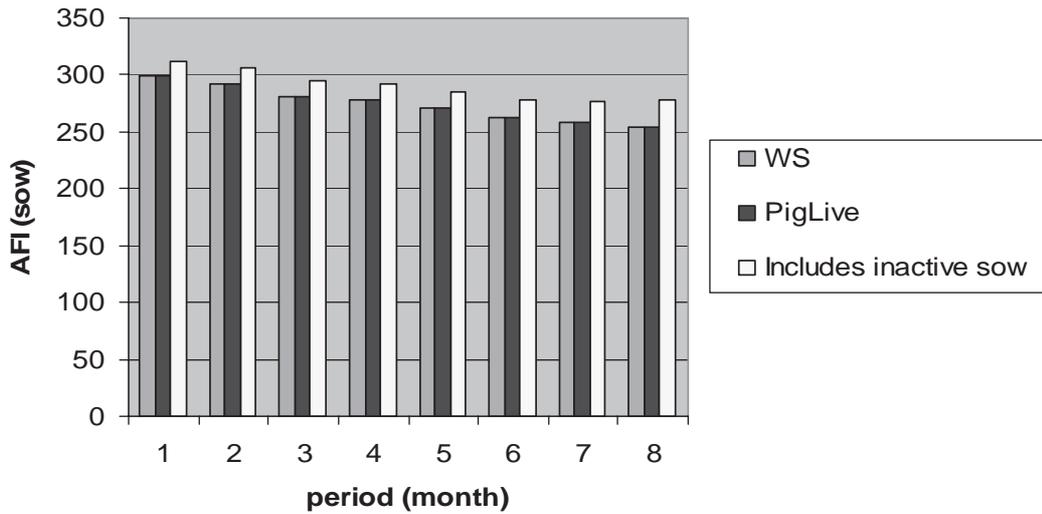


Figure 8 Comparison of average female inventory calculated by different Methods (WS = web-based system).

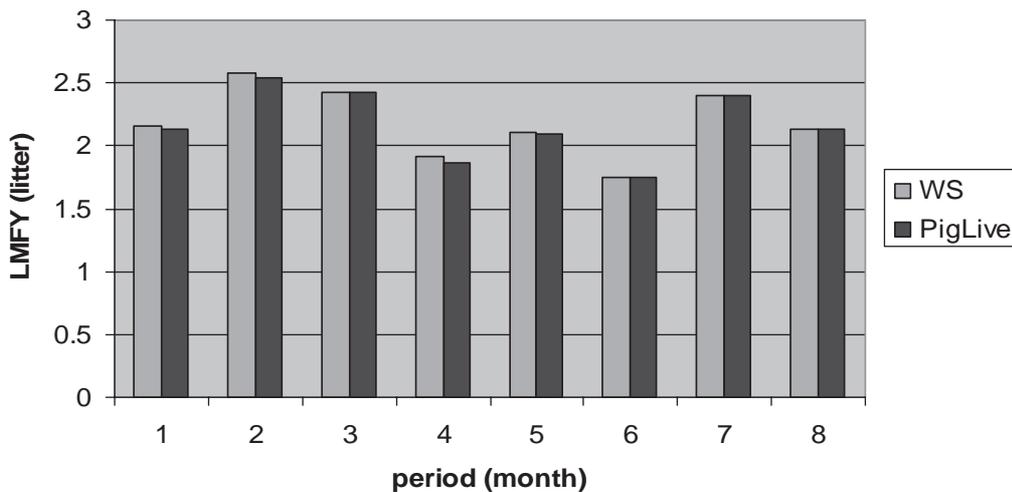


Figure 9 Comparison of litters per mated female per year calculated by different methods.

Thus, research on ways to increase data processing efficiency should be supported.

The calculation algorithm to determine the index values of AMFI, AFI, LMFY and PWMFY will benefit people involved in the swine industry, by helping them to understand the background of these indices.

CONCLUSION

1. The three algorithms to calculate the indices of AMFI, LMFY and PWMFY were developed from existing formulae and the simulation of a sow inventory, based on real data available from one farm.

The developed algorithms had five major steps:

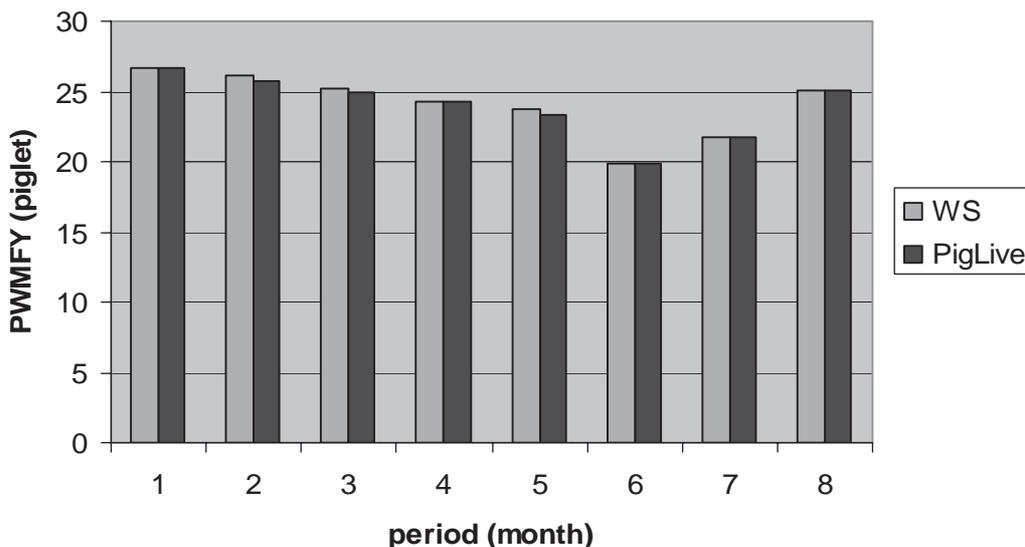


Figure 10 Comparison of pigs weaned per mated female per year calculated by different methods.

Step 1 date period for management, this can be divided into two groups:

1.1 the date system shown in the report that will be used in step 2.

1.2 the date system that is set to 114 or 140 d prior that will be used in step 3.

Step 2 the sum production amount needs to be calculated for litter number or number of pigs weaned.

Step 3 arranging of the data on every sow in the database and the required data of: sow number, entry date, last event date, first mating date, removal date and the measured period (start date and end date). The date is then adjusted to enable the sow days to be calculated for computing the next AMFI. This step takes a long time to process, as data is accessed from different tables and sows with inactive data need to be filtered out.

Step 4 use the values from steps 2 and 3 to calculate the formula.

Step 5 show results.

2. These algorithms were validated using databases of the PigLive program from a swine farm and yielded promising results when compared to the PigLive program.

3. This work will be a guideline for improving advanced algorithms to calculate other indices, which will be useful in conducting research on the characteristics of swine breeding herds. In addition, it will be applied in information systems for swine breeding herd management.

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