Sow Reproductive Analysis for Local Areas and Zones via Automated Recording Information System (SALAZAR IS)

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Abstract

A user-friendly, prototype web-based information system (WBIS) was developed using propriety software (Windows Operating System, Internet Information Services (IIS) for the webserver, Microsoft Visual Studio C#, ASP.net framework and Microsoft SQL for Database Server) to assist the backyard hog raisers in evaluating and analyzing the reproductive performance and disorders in the farm. A farm survey was conducted to acquire basic information together with the problems and farmers' needs. Programs for data encoding, user interface, and database backups were developed. The developed WBIS was piloted on some farms in different municipalities of the 3rd district of Pampanga, the Philippines. The result of the pilot application shown that WBIS could run on the internet on different platforms (PC/laptop, android, and IOS smartphones) and can serve as a cheaper alternative of the costly software and operating system for existing breeding monitoring system for the sow.

Therefore, the WBIS, also known as **S**ow Reproductive **A**nalysis for **L**ocal **A**reas and **Z**ones via **A**utomated **R**ecording Information System, (**SALAZARIS)**, with further improvement and updating can deliver an efficient tool and guide for backyard farmer to improve their sow's productivity in the future.

Introduction

The Philippines has a PHP 200 billion hog enterprise and is the second main contributor to Philippine agriculture, next to rice regardless of being exclusive without government subsidy. The majority, approximately 63 percent of industry are farmed through smallhold level hog raising operation withinside the country that need a great deal of enhancement, Yan (2020).

As reported by the Philippine Statistics Authority, January 2020 the key regions for pig production are CALABARZON, Central Luzon, and Northern Mindanao posted with positive growth and these regions contributed 43.1 percent of the country's total hog production. In Central Luzon, Pampanga was registered constantly to be the third top in hog production among the provinces in Region III for the beyond ten (10) years from 2010 to 2019. Swine breeding herd management is the key factor in hog raising to provide an awfully good litter size. There are technical parameters to assess and gauge the reproductive performance of the sow like litter index, piglets born alive, litter size at weaning, preweaning mortality, and the like. With proper and strict implementation of husbandry management within the breeding herd, the reproductive performance of sows will improve and maximize the extent of production.

Record keeping also plays an essential role in breeding management. Data or information recorded must be interpreted to a logical technical figure and these are analyzed and evaluated to ascertain any weaknesses or failures within the operation of the farm. Automated record keeping may be a tool that would assist smallholder hog raisers to calculate and analyze the information gathered and to utilize the obligatory adjustment or decision on the farm.

Information technology plays a crucial role in the development of modern society and social life. A browser based information system is an data system that uses cyberspace technologies for delivering

information and services to users. And as mentioned by the department of agriculture secretary, that the creation of a web-based information support system will provide more efficient sourcing of agriculture information and data, enable faster reporting, and enhance decision support mechanisms (DA Communications Group, 2020).

With the application of this technology smallholder hog raisers using the *beta version* will have a greater opportunity to evaluate and monitor the reproductive performance of its sows and also the level of production of its farm. Hence, the generation of a web-based information system (WBIS) for smallholder piggeries and DA local units in Pampanga, will provide an information system that is user-friendly and a basic tool to boost the swine breeding management for smallhold swine raisers. And to assist the DA municipalities in monitoring the hog production of its raisers. The main objective of this study was to generate a user-friendly web-based information system that evaluates and analyzes the sow reproductive efficiency of the 3rd district of Pampanga, the Philippines. Specifically, it aims to; create a color-coded map monitoring system of hog production performance for local government units.

Materials And Methods

Backyard hog raisers

Thirty (30) smallhold swine raisers, having five (5) to ten (10) sows who had different management and husbandry practices were identified and selected by the Livestock Inspectors and Municipal Agriculturists from the 3rd District of Pampanga.

Farm Survey

The farm owners were interviewed using a pre-evaluation questionnaire regarding the present situation of manual data collection and recording on how the manual system assisted in farm management.

System design and implementation

Architecture

The system was developed by the author with the assistance of an expert IT programmer, as a web-based software application. Started with the admin/user login process passing via the Internet to the webserver. After that, the webserver responded by opening the system to the client for data encoding.

Business rules

The data recorded in the system was taken from the previous sow card or daily recorded data and were based on real events. The events in order were the date of mating, the due date of farrowing, the actual date of farrowing, litter size, stillbirth, mummified, piglets born alive, average birth weight, fostering, and pre-weaning mortality, weaning date, the total number of weaned and weaning weight. The outcome of the different events was reflected in the individual sow technical result and eventually were displayed in the sow herd technical result. Hence, all the occurrences that were transpired between the time the sows were entered the herd were recorded until their succeeding farrowing, where their status will be updated.

Mapping

The base maps of Pampanga were downloaded from www.philgis.org (free GIS data for the Philippines). The maps of the municipalities with their barangays of the 3rd District of Pampanga were on a color-coded scheme as an indication of the reproductive performance or disorders of the local area. The CAO/MAO (as admin) and hog raiser (as a user) were logged in/registered in their corresponding city/municipality and barangay, respectively.

The color-coding was used are green, yellow, and red. Green will indicate the very satisfactory performance of the herd and the local area. The yellow was designated as satisfactory performance and was served as a signal warning for the reproductive performance of the area. Red was specified as a poor reproductive performance of the herd and was served as an attention call for the livestock inspector or CAO/MAO of the local area.

Database analysis and design

The system was examined using occurrences associated with herd management factors. The interactive database was apportioned into three groups: standing, operation, and value. The database server was used was Microsoft SQL (Rouse, 2019 and Hughes, 2019) and manipulated by a website developed with ASP.net framework (C# Visual Studio IDE, n.d., A software development framework. (n.d.). Microsoft) and Microsoft Visual Studio C# (Microsoft Visual Studio, and C# Visual Studio IDE. (n.d.) running on Internet Information System (IIS) (IIS Internet Information Services Definition. December 2013. Techterms.Com) webserver with a website address http://www.salazaris.com

Data import

The set of data that was used in the study was the latest data recorded or the existing data on swine breeding herd management from different smallhold farms in municipalities of the 3rd district of Pampanga.

Context Diagram

A context diagram is a top-level data flow diagram. It only contains one process mode that generalizes the function of the entire system concerning the external entities. It shows the entire system at a glance, numbering the major functions.

Entity-relationship Diagrams

Entity-relationship (ER) diagrams (ERDs) provide a way to document the entities in a database, along with the attributes that describe them. A completed entity-relationship diagram represents the overall plan of a database. Good for describing the layout of a stored-data system, it is relatively simple and familiar, a good communication tool.

System development

The whole system was developed using proprietary software: Windows Operating System (Windows Definition. (n.d.). and Techterms.Com), Internet Information Services (IIS) for the webserver (IIS Internet Information Services Definition. December 2013. Techterms.Com), Microsoft Visual Studio C#, ASP.net framework (C# Visual Studio IDE, n.d.). A software development framework. (n.d.). Microsoft), and Microsoft SQL for Database Server (Rouse, 2019 and Hughes, 2019). The developed system will be placed in service under the URL: http://www.salazaris.com.

Testing and pilot implementation

The program was tested, evaluated, and validated using *beta version* by the smallholder hog raisers who had never used any automated breeding herd management software before, concerning user satisfaction of the developed package. After that, the raiser respondents will answer the post-evaluation questionnaire to determine the satisfactory response to the developed system.

SYSTEM IMPLEMENTATION

This chapter is the carrying out of the Architecture stage, Business rules stage, and Mapping stage. It was carried out using Windows Operating System, Internet Information Services (IIS) for the webserver, Microsoft Visual Studio C#, ASP.net framework and Microsoft SQL for Database Server. The Web-based development was chosen for it allows flexibility through platform independence that allows the Sow Reproductive Analysis Information System to run on different operating systems. It was also classified as Proprietary Software through the use of ASP.NET a server-side web application framework designed for web development that produces dynamic web pages, which means there is completely no cost in the development of the system. Windows Operating System provided the graphical user interface while CSS was used for describing the presentation of Web pages, including colors, layout, and fonts. It allows one to adapt the presentation to different types of devices, such as large screens, small screens. Microsoft

Visual Studio is an integrated development environment (IDE) creating programs in one of many languages, including **C#**, for the NET Framework. It offers a set of tools that helps to write and modify the code of programs, and also detect and correct errors in programs. ASP.NET has also the capability to communicate with Microsoft SQL, the most used relational database management system (RDBMS) that supports a wide variety of transaction processing, business intelligence, and analytics applications in corporate IT environments.

Results And Discussion

Farm Survey

The thirty (30) smallhold swine raisers, having five (5) to ten (10) sows that were identified and selected by their respective Livestock Inspectors and Municipal Agriculturists from the 3rd District of Pampanga were all asked of their management practices implemented in the farm. The farm owners/managers were also interviewed using a pre-evaluation questionnaire regarding the present situation of manual data collection and recording on how the manual system assisted in farm management.

Based on the information gathered, most of the smallhold swine raisers do not have proper documentation or record keeping. They were just listing down or encoding on a sheet of a calendar or ordinary notebook, some of them just wrote it in the wall, the events happened such as date of breeding/AI, date of farrowing, number of piglets born, and the list of medicines used. Most of the farmers were not also familiar with the automated recording and did not even use any breeding management software due to a lack of computer skills. Furthermore, the backyard hog raisers agreed upon that manual system cause difficulties and time-consuming in calculating, evaluating, and analyzing the reproductive performance of the farm.

Business rules

The scheme of the rules in the system was based on the conditions in the information system evaluated from the farm survey and desired by the hog raisers. As business rules are essential to moving the real business operation into the cybernetic environment of web-based information system (WBIS). The routes and phases of data generation in the farm system or farm management, particularly in breeding practices must be understood. All significant occurrences should be encoded and recorded, Kasetsart (2010). The users (Farm Owners, City/Municipal Agriculturist Officer) will login first and register the specific sows (detailed information of the sow) and encode the necessary events such as breeding, farrowing and weaning. All data encoded will be automatically calculated and displayed in the individual sow and sow herd technical results.

The flow line of events in a swine breeding herd management in the present study is shown in Figure 1 and explains all probable occurrences for breeder sows. The lines with arrows specify the direction for different occasions. The structure of the two-headed arrow line shows that the events can be switched.

Example of which, the pregnancy confirmation occurrence does not happen unless the breeding event occurred, or the weaning event happens only after the lactation event takes place.

Data import

Since not all of the backyard hog raisers have a proper data recording on breeding management or the breeding events were not encoded, incomplete old data set of few hog raisers were used in the system. The sample transaction records shown in Tables 1, 2, and 3 have to be maneuvered by the business rule in Figure 1 in noting corresponding events and dates together with the equivalent litter number created by the system. Therefore, the system used these records for generating individual sow and sow herd technical reports. Table 1 displays the color-coded breeding events, the green color indicates that the sow is bred ones and confirmed pregnant after two (2) heat checks performed, twenty-one days after breeding. The yellow color implies that the sow is bred twice, it is also an indication that the sow experience reheats or repeat, a manifestation that there might be a problem in breeding practices, either human error or physiological disorders. The red color signifies that the sow is bred thrice an indication that the sow reheats again or experience repeat twice. Furthermore, it also speaks not only of human errors and of physiological disorders but also indicates the economic impact in terms of feed consumption due to an increase of non-productive days or lost days.

Table 1
An example of breeding transaction records.

Breeding							
No.	1		2		3		Due date
	Date	Boar	Date	Date	Boar	Date	
1	**1/24/2011**	**Duroc**	**3/29/2011**	**Pt Du**	**7/26/2011**	**Pt Du**	11/17/2011
2	**12/20/2011**	**Pt Du**	**1/21/2012**	**Large White**			5/14/2012

Table 2
An example of farrowing transaction records.

Farrowing								
No.	Date	Litter size	SB	MM	Piglets Born Alive	Ave. Birth Wt.	Foster	
							(+)	(-)
1	11/17/2011	6	0	0	6	1.52	0	0
2	5/14/2012	0	0	0	0	0	0	0

Table 3
An example of weaning transaction records.

Weaning				
No.	PWM	Weaning date	Total No. of weaned	Weaning weight
1	0	12/15/2011	6	7.8
2	0	5/19/2012	0	0

Mapping

Figure 2 shows the mapping interface of the system in the study. This would serve as a monitoring and evaluation system for the local government units on their swine production within its premises. The colored Pampanga map was the default color, while the green color of a particular municipality in the 3rd District indicates that the backyard hog raisers of the barangays of the certain municipality had a very high satisfactory or excellent in operation on breeding or reproductive management. Moreover, those municipalities would turn yellow would show that some barangays were operating at a satisfactory level, which means that some hog raisers had problems in management or physiological disorders in their livestock. The municipalities that would turn red would determine the poor performance of the backyard hog raisers, not only in the physiological aspects of the animals but also in herd management, environmental factors, and other factors that would affect the operation such as animal husbandry practices. This also signifies the need for regular monitoring and extension services of the livestock technicians of local units and veterinary services. Moreover, this would also serve as a yearly performance monitoring report on pig production.

Testing and pilot implementation

The outcomes reveal that trialed smallhold hog raisers were mostly pleased with basic uses, such as data encoding, generating technical results and tracing disorders or problems of the individual sows in particular, and the whole farm in general. And also most of them consented that the developed information would hasten the calculation and evaluation of the reproductive performance and resolving the problems in breeding management. However, some hog raisers suggested the inclusion of swine diseases and its treatments, the announcements about swine production training and seminars. And the quick response of the municipal agriculturist or livestock inspectors and technicians upon seeing and knowing the monitoring map indicating the alarming status of the farm.

Database design

The database design is shown in the entity-relationship diagram (E-R diagram) as displayed in Figure 3. The factual and actual information inside the operation entity (Parity2) covers procedures that agree with the production and business rule and had a relationship with various information or record values such as SowRecord and SowBreed and serve as a reference. The SowRecord entity keeps a record of individual sow origin and the farm owner and recorded the status in Parity2 entity. The SowBreed entity saves all

types of breeds of swine, purebred, crossbreed, and even hybrids that will be needed in sow registration and Parity2 entities.

User interface

The different platforms (pc, android smartphone, and IOS phone) where users can use and access the web-based information system are displayed in Figure 4. The dialogue tree as presented in Figure 5, displays the operation, usage, and functionality of the developed web-based information system (WBIS). The home page interface and the about page interface of the system shown in Figure 6. The about interface tells about the function and purpose of the system. The Farm Administration interface shows the input data system such as breeding and farrowing events and displayed as a data input interface shown in Figure 7. When the user opens the window for the individual swine, the system will display the parity or litter details of the sow, the system reveals the different events of an individual sow.

Parameters technical result

The accounts from the system show the technical results both fact and real-time analysis, can be an individual sow technical report, sow herd technical report, or geographical presentation. For the performance of each sow such as actual litter index, litter size at weaning, and non-productive days will be reflected at individual sow technical result (ISTR). The technical parameters for the sow herd or performance of the farm displayed at sow herd technical result, monthly and yearly reports. Both individual sow and sow herd technical reports are compared with the national production standard in swine production. The specific parameter/s are automatically highlighted if it does not meet the production standard. These would help the smallhold hog raisers deal with current farm situations, disorders detection, and farm viability. Thus, the hog raisers use the reports as a policy in making decisions and to make necessary regulations in their management to enhance their revenues. As mentioned by Parisutthikul, S. et al., (2010) a system should be designed to link between the analysis of value and the origin of data to show the appropriate information. Also, adjusted litter weight at 21 days should be included that could offset the low piglets born alive to have a very good average sow reproductive performance. Even if there is a low PBA size but having weaned a high litter weight can still present a good sow reproductive performance. In this study Sow Productivity Index (SPI) could be constructed based on the set parameters described in the system are as follows: (high piglets born alive + high average birth weight + average weaning weight + adjusted 21-day litter weight). Figures 8 and 9 show the sample technical results, indicating the performance of a particular sow and the occurrence on the farm.

Conclusion

In conclusion, the present study introduces the creation of a user-friendly, prototype web-based information system for the reporting and geographical presentation of reproductive performance and disorders in breeding management and practices and pig production. The system assists and facilitate to reduce the human error and assist to make an immediate action for the physiological disorders and

problems of the breeding sows. It is a tool for inexperienced backyard hog raisers with computer and information technology. All fundamental data is accessible via the internet reducing the time of data collection and reporting. With this findings, the developed and generated user-friendly, prototype web-based information system would be a great help in augmenting and improving the swine productivity and increase the level of technical efficiency of smallhold hog raisers, through proper recording, appropriate judgment, and strict monitoring and implementation of good animal husbandry in breeding practices that lead to excellent reproductive performance. The system allows sow herd technical report to be observed via the internet and thus by the municipal agriculturist, livestock inspector, and animal technician of the local government unit, saving traveling time to visit the smallhold farm.

Declarations

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Conflicts of interest/Competing interests

The authors have no conflict of interest to disclose.

Ethics approval

Not applicable for this section

Consent to participate

Not applicable for this section

Consent for publication

Not applicable for this section

Availability of data and material

Not applicable for this section

Code availability

Not applicable for this section

Authors' contributions

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by JOEL C. SALAZAR and CLARO N. MINGALA. All authors read and approved the final manuscript.

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Figures

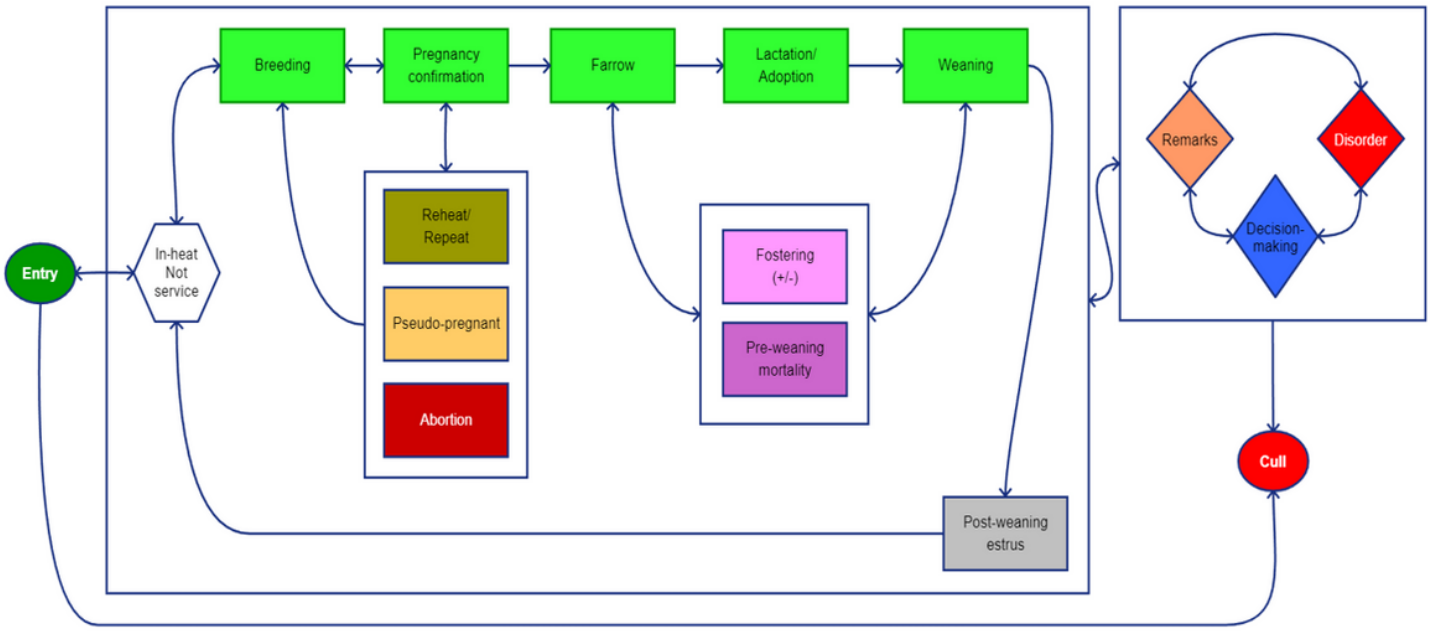


Figure 1

Flowchart of events in the swine breeding herd system.

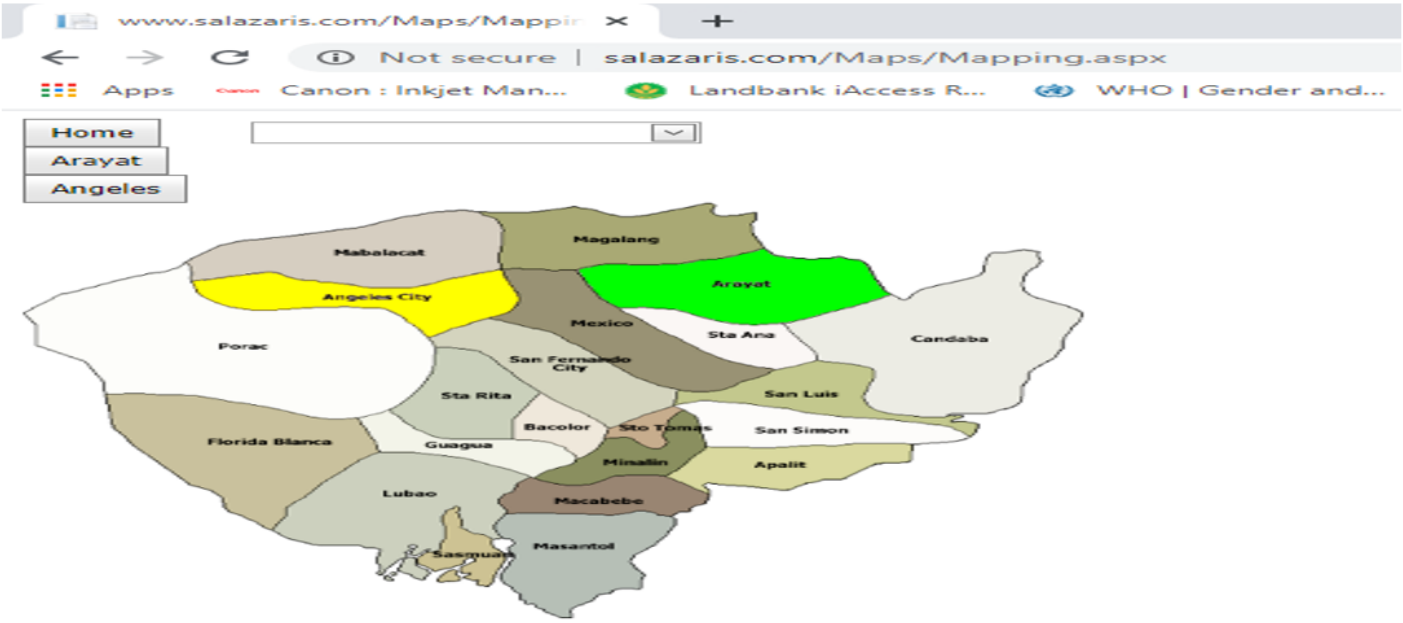


Figure 2

Sample screenshot of the mapping interface

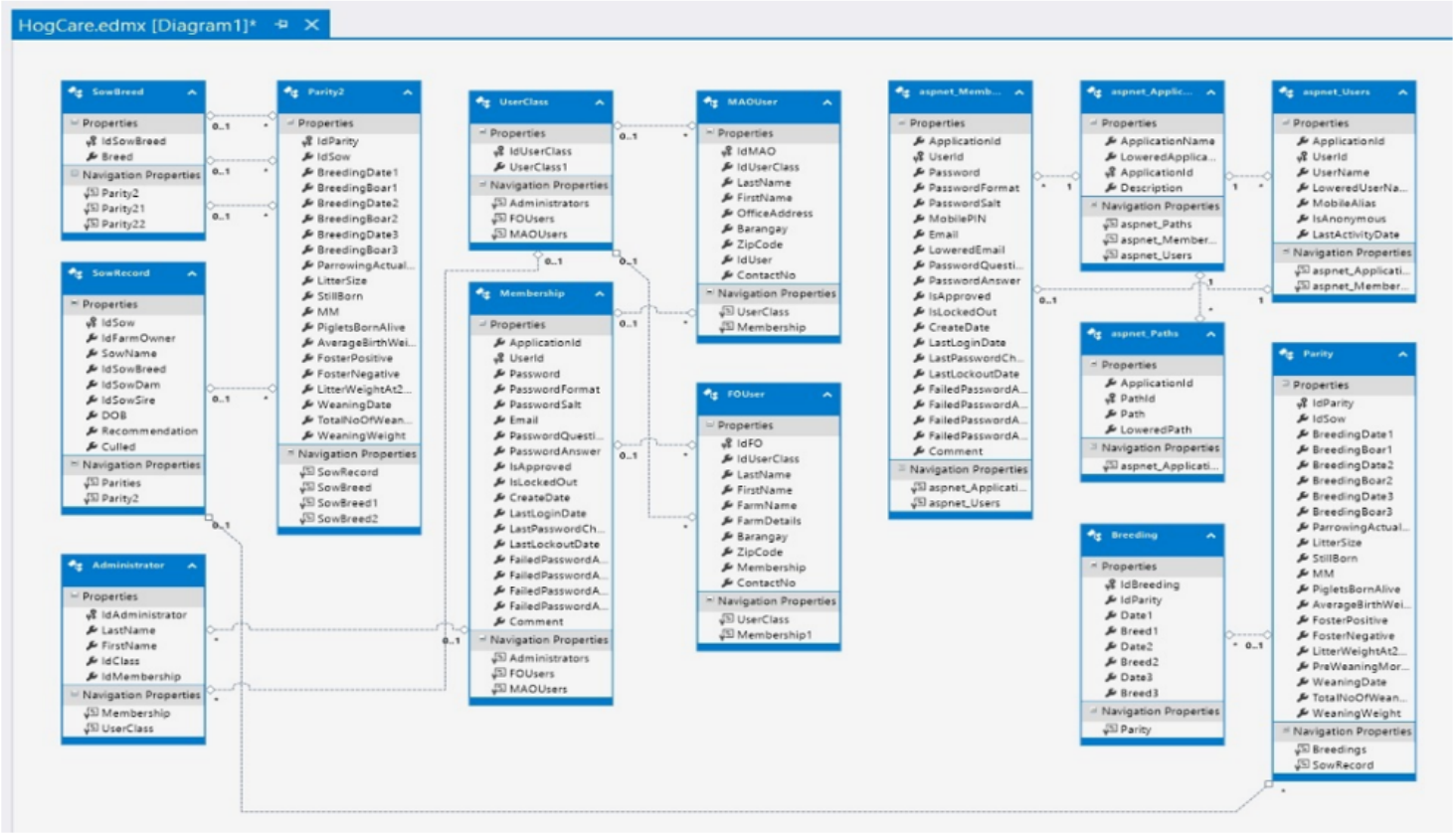


Figure 3

Relation Data Diagram

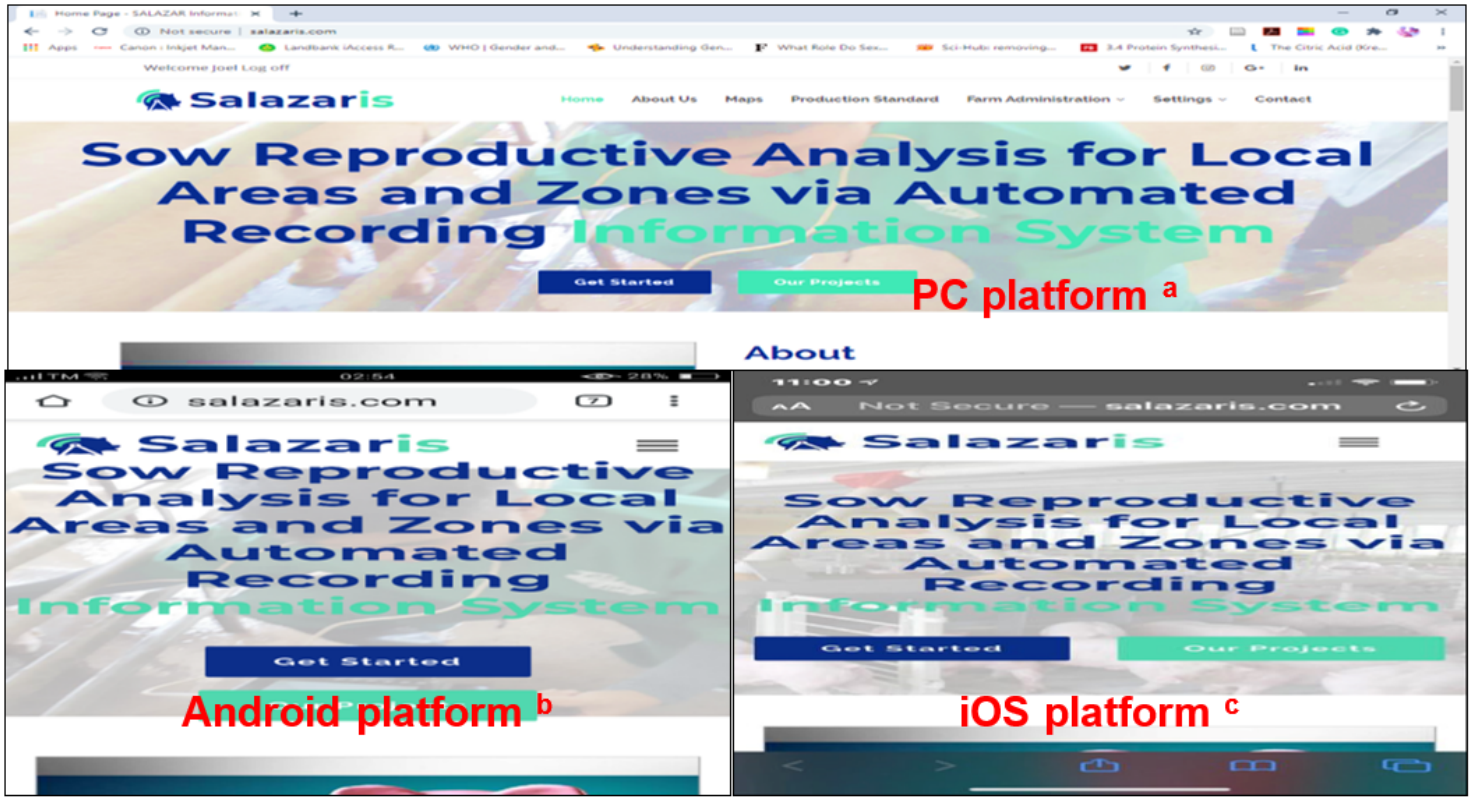


Figure 4

The developed web-based information system on a different platform. PC/laptop platform [a], Android platform [b], iOS platform [c]

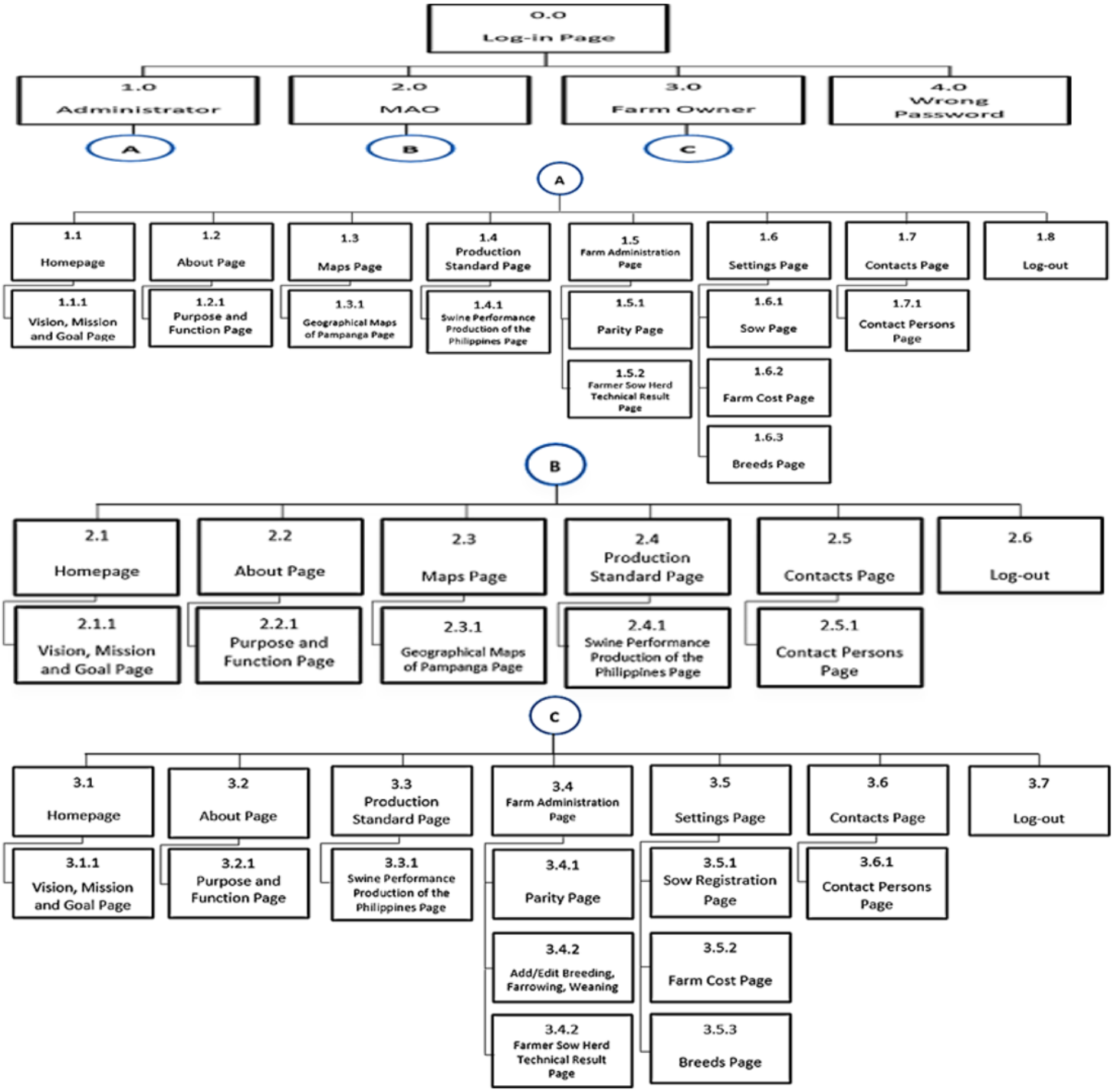


Figure 5

Dialogue Tree

Figure 6

Sample screenshot of home and about page interface

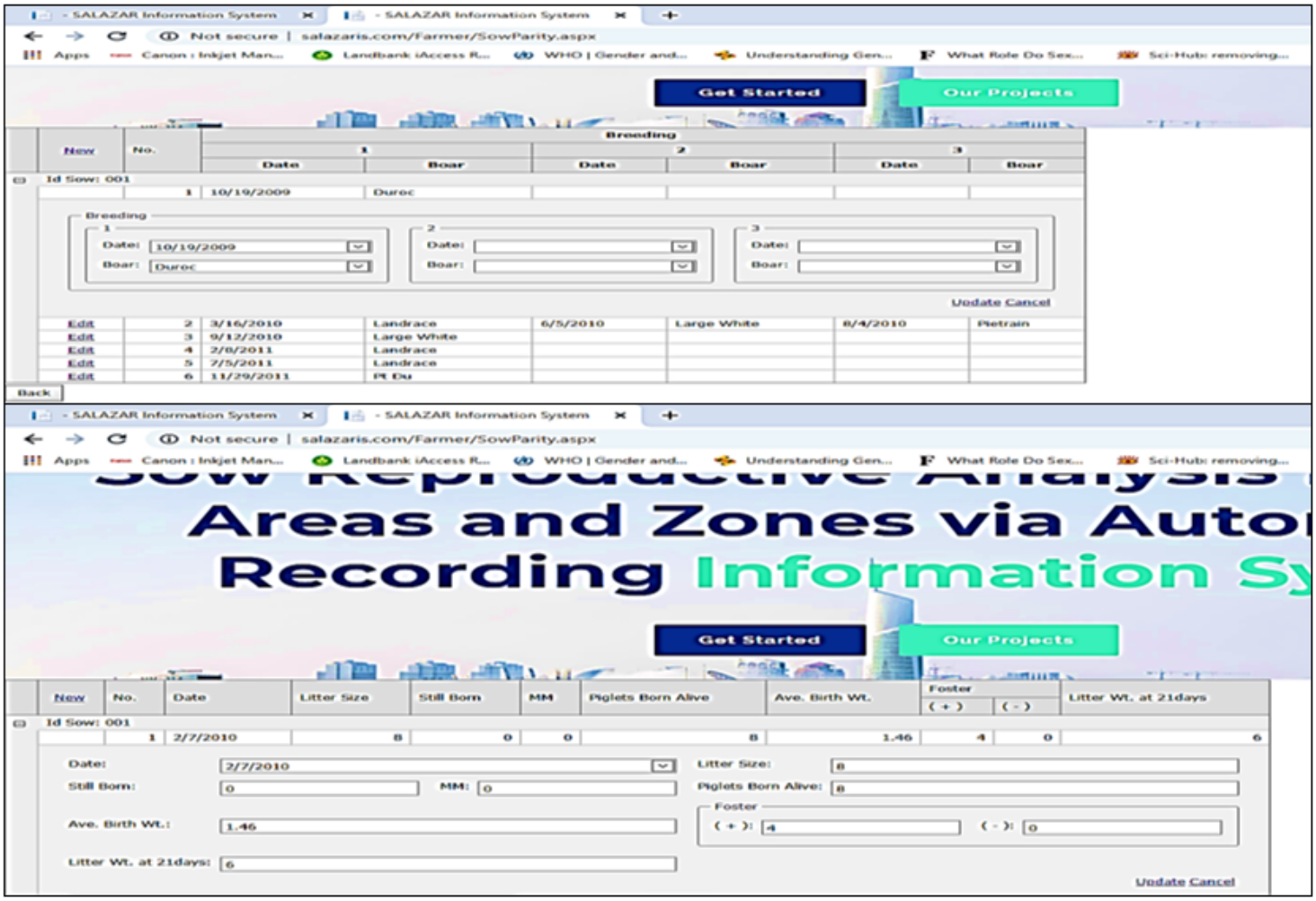


Figure 7

Sample screenshot of breeding and farrowing data input

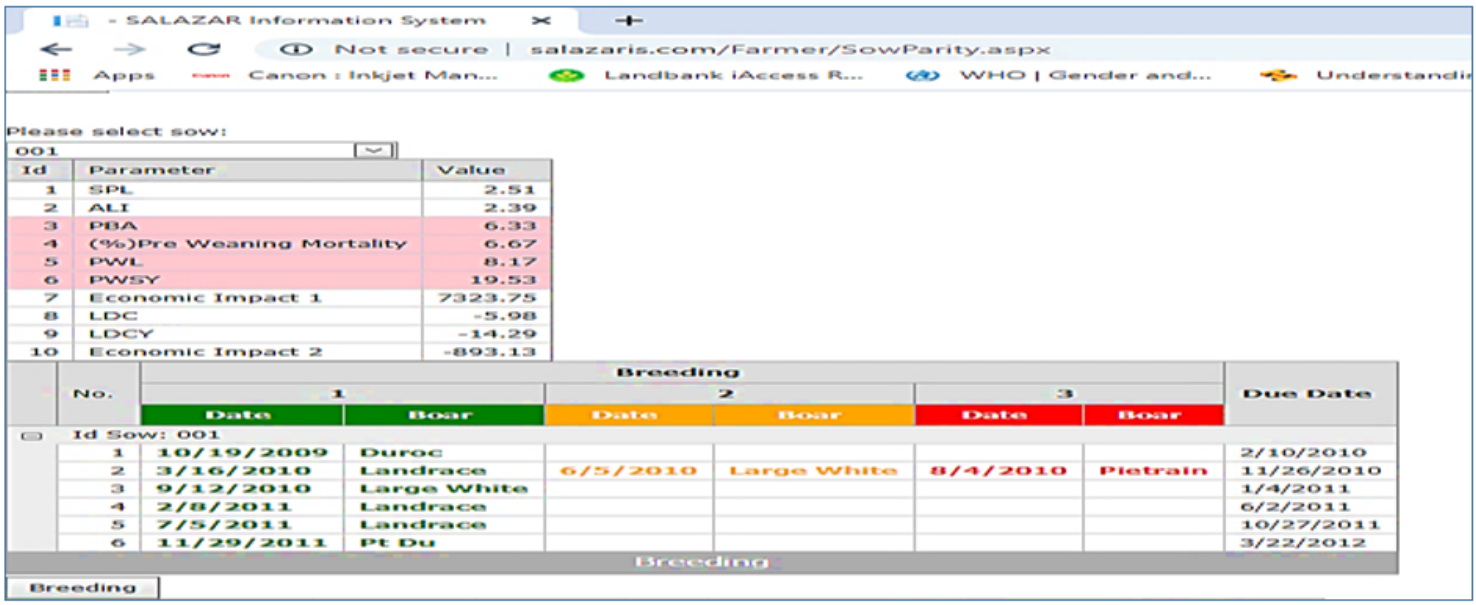
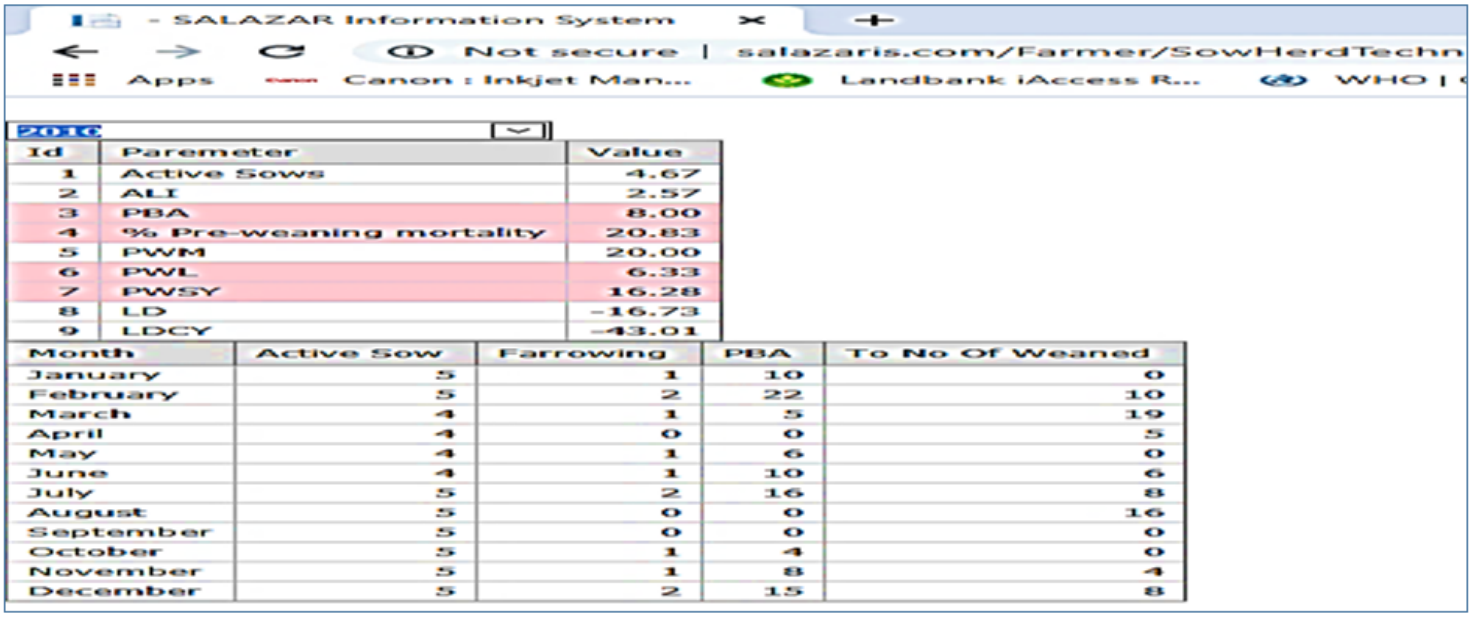


Figure 8

Sample screenshot of individual technical result



- SALAZAR Information System

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2010

Id	Paremeter	Value
1	Active Sows	4.67
2	ALI	2.57
3	PBA	8.00
4	% Pre-weaning mortality	20.83
5	PWM	20.00
6	PWL	6.33
7	PWSY	16.28
8	LD	-16.73
9	LDCY	-43.01

Month	Active Sow	Farrowing	PBA	To No Of Weaned
January	5	1	10	0
February	5	2	22	10
March	4	1	5	19
April	4	0	0	5
May	4	1	6	0
June	4	1	10	6
July	5	2	16	8
August	5	0	0	16
September	5	0	0	0
October	5	1	4	0
November	5	1	8	4
December	5	2	15	8

Figure 9

Sample screenshot of sow herd technical report.