

Designing and Creating a New Software Programme for Management in Dairy Farms

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Abstract

The current work presents the findings regarding creating a new software programme for production and reproduction management in dairy farms. Also, it can be used in the accounting department and the genetic breeding of bovine herds. Advanced programmes such as; Visual Basic and Data Base Access were used in the present work to innovate and design a new software programme named Farm-Key for dairy farm management to keep pace with new high technology in the animal production sector. Eight simulation models were developed to plan and manage several dairy farm practices and facilities, such as; animals, nutrition, reproduction, production, vaccination, marketing, management and map. A decision tree was developed for each simulation model, and then the simulation models were integrated into the relevant decision trees. The new application programme is expected to provide fast development, management and cost-effectiveness for management in dairy farms with perfect security. Therefore, the Farm-Key programme could be a tool that allows users to interact with a database, designed for large amounts of information, whose management requires a rigid structure and rational access and processing.

Keywords: *Software programme, Dairy farm, livestock farming, Simulation model*

Introduction

Superior germplasm, better nutrition strategies, health care facilities and improved dairy husbandry practices have boosted milk yield and its quality at a rapid rate (Omer 2022). Per cow, productivity has risen sharply with a considerable increase in the population of dairy animals. The recent era has witnessed the extension of large dairy farms worldwide, especially smart farms which include high-technology constructions, advanced devices and tools, and Apps/ software programmes (Brito *et al.* 2021; Singh *et al.* 2021). On the other hand, the demand for high-quality and increased quantity of milk is of prime concern for all dairy farms. With an increase in the size of animals on a farm, the labour required also rises. The availability of skilled labour at a low wage rate is becoming difficult (Grasseni 2007; Mamane 2022). In the last couple of decades, the cost of management has been reduced to a reasonable level by increasing advanced devices and tools that are managed by special software programmes. The economic availability of these programmes, artificial intelligence, and improved data statistics combined with expert suggestions have created a revolution in livestock farming. Advanced software programmes alongside engineered devices have become alternatives to reduce high labour costs (Barile *et al.* 2022; Santos *et al.* 2022; Singh *et al.* 2022).

In the past two decades, software programmes have been developed to manage dairy cow breeding. There has been an increase in the demand and use of such instruments in recent years. Various products have appeared on the market today, with each of them having its characteristics and properties, able to satisfy breeders' various demands and necessities for data management (Maciuc *et al.* 2015; Kang *et al.* 2021; Tassinari *et al.* 2021).

In the middle of the 80s, the first breeding management software was introduced for dairy cows. With the development of new technologies, breeding practices, and assistance plans, animal husbandry is experiencing new exigencies and tendencies in data management. A variety of applications can be found in nutrition system management, reproduction planning, as well as gynaecological and veterinary health care, also, morphological and genetic evaluation of animals (linear system and genetic indexes) concerning the selection and improvement of breeding animals (Grasseni 2005; Maciuc *et al.* 2015). In this context, software

programmes represent a new and efficient instrument for providing rational and opportune management of different aspects, which are involved in cattle breeding in particular and for populations in general. In the coming years, the farmers' demands will increase and the already existing software will be improved and progressively updated and will also be accompanied by more advanced new software. Some of these are specially developed for technological processes management (feeding, breeding, reproduction, etc.), and others are specialised at a higher level for using new technological processes such as quantitative and qualitative automatic dosage of production, pedometers, etc. (Maciuc *et al.* 2015; Magnusson *et al.* 2022).

Worth mentioning, the traditional management, software products are more and more regarded as flexible instruments for analysis and programming into a technological flow. In other words, these are required functions that allow carrying on a more or less complex analysis and personalized breeding performances to discover the critical points (Maciuc *et al.* 2015; Kang *et al.* 2021).

An examination of the breeders' problems is very important for efficient usage of this instrument and to avoid the possibility, which in many cases has become real, of sub-usage or misuse of software programmes. So, it is necessary to plan the usage of the software programmes, in other words, to establish which departments of a farm will be automated. For the same purpose, there will take place the identification of the data to be tracked and also the human resources (users) respective to technological resources (software-related peripheral units) which will be used. These are some aspects strongly connected between them, since the decision to use a certain technology was made, and means to assure an organisation form and the type of management procedures could determine the possibility of exploitation or not of some certain opportunities provided by software programmes (Samer 2010; Tummers *et al.* 2021).

This work focuses on the latest knowledge and emerging developments in animal welfare-focused software programmes to keep up activities and activity-based welfare assessments like milk production and quality, oestrus, artificial insemination (AI), diseases and others. The use of advanced software programmes and data technologies with expert-based solutions is anticipated to bring out a substantial improvement in existing dairy farming practices.

This work aimed to create a new software programme namely "Farm-Key" for management in dairy farms using Visual Basic. To plan and manage several dairy farm practices and facilities, such as; animals, nutrition, reproduction, production, vaccination, marketing, management and map/view.

Material and methods

Problem and objectives of creating a new software programme for management in dairy farms

The planning and design of dairy farm practices and facilities is a complicated process involving numerous procedures that require time and effort; additionally, mistakes may occur. To accelerate analyses and improve decision-making, computer tools need to be developed that can pre-process data to produce value-added information. A software programme is developed to plan and manage dairy farm facilities, calculate the required number of materials, implement technologies, and calculate costs.

Research Methods

Through Visual Basic and Data Base Access, we created a new software programme/Farm-Key to achieve efficient data management regarding the nutrition, vaccination, milk production and fertility performance, of a farm and also the selection and works carried out based on the official control of the performances but also on directed reproduction, especially through AI. Also, we tried to ensure flexibility for animals' recording with all the upgraded data, with possibilities of adding new data for the same animal, introducing new breeds or lines and identifying animals as easily as possible in the moment of data extraction or creating new databases used for different statistical interpretations, creating origin certificates, data files (savings, security, etc.).

For this purpose, a database management system, Visual Basic and DB Access were used to create the Farm-Key programme and to ensure the independence between data logic relations and their minimum redundancy. This system allows rapid development and provides a low price for data application programmes exploring a complex structure, also providing fast access to dates and strong security of them. In other words, this programme allows the users to interact with a database designed usually for great amounts of dates at its management level to impose not only a rigorous structure but also easy access and rational processing.

Visual Basic can be mainly used by two categories of users: designers and software developers who write Visual Basic applications, and final users who can easily administrate the dates using the user interface. To

run the application, it is necessary to have a computer with Windows 8, 8.1, 10 or 11. Currently, the software cannot run on smartphones.

Key benefits of creating a new software programme for management in dairy farms

The users can get several benefits by using the Farm-key programme, such as; **1)** Easy access to your whole herd, **2)** View comprehensive individual cow records, **3)** Keep milk production on target with accurate quota predictions, **4)** Import milk records, **5)** Milk production and bulk tank analysis reports with forecasting, **6)** Notify movements in the dairy farm, **7)** Eliminate data entry duplication with links to many parlour/heat detection systems, **8)** Access your cow records outside at any time on a tablet, **9)** Prepare action lists for your vet to assist with pre-visit planning, **10)** Record and report for dairy herd health planning, **11)** Records and analyses all cases and treatments for mastitis and lameness, **12)** Print off web format practices record, **13)** Calculate the nutrition level for each group of production, **14)** Current action lists instantly tell you who's due to calve, be served, dried off, ... etc, **15)** Check bloodlines don't cross over with the relations report, **16)** All births, deaths, purchases and sales automatically update the statutory movements book, **17)** An easy-to-read herd fertility chart helps ensure you do not miss any cows getting back into calf, **18)** Keep full young-stock records for both dairy heifers and beef calves, **19)** Analyse your Herd Fertility to monitor submission/conception rates, **20)** get the pedigree registrations, **21)** It is very straightforward to operate and is ideal for herd managers looking to move up from manual records to computerisation, and **22)** New events can be quickly entered into the program, instantly updating a range of reports.

Results

The Farm-Key programme, was designed after the name of the farm of the Faculty of Agriculture, Alexandria University, Egypt (**Figure 1**). Eight simulation models were developed to plan and manage several dairy farm practices and facilities; animals, nutrition, reproduction, production, vaccination, marketing, management and map/view (**Figure 2**). A decision tree was then built for each simulation model, and the simulation models were then integrated into the relevant decision trees. The Visual Basic programming language was also used to develop a programme through simulation models and decision trees. The new application software is expected to provide rapid development, management and cost-effectiveness of management in dairy farms with optimal security. Therefore, the new programme could be a tool that allows users to interact with a database designed for large amounts of information, the management of which requires a strict structure and rational access and processing.

The functions and outcomes for each item in the Farm-Key software programme

Animals

The functions are managing and tracking individual animals within the dairy farm. The outcomes are keeping records of animal identification, health status, breed, and age. Track milk production and monitor any health issues or activity patterns (**Figure 3**).

Nutrition

The functions are planning and monitoring the nutrition requirements for the animals. The outcome is creating customized diet plans for each animal based on their specific needs. Keep track of feed types, quantities, and feeding schedules. Monitor the nutritional intake and adjust diets as necessary (**Figure 4**).



Figure 1. The start page of the farm key programme.



Figure 2. The eight items in the farm-key programme are animals, nutrition, reproduction, production, vaccination, marketing, management and map/view.

 The image shows the 'Animals' form in the application. It has a light green background. At the top, there are input fields for 'Tag Number', 'Animal Name', 'Sex' (a dropdown menu), 'Birthdate' (a date picker showing '8/25/2023'), 'Father ID', 'Breed', 'Weight' (a numeric input showing '0'), and 'Mother ID'. Below these fields is a table with the following headers: 'Tag Number', 'Animal Name', 'Sex', 'Breed', 'Birth Date', 'Father ID', 'Mother ID', and 'Weight'. The table body is currently empty. At the bottom of the form, there are five buttons: 'New', 'Save', 'Edit', 'Delete', and 'Main Menu'.

Figure 3. The animal item is intended for the purpose of maintaining comprehensive records pertaining to animal identification, health status, breed, age, and other relevant details.

Quantity : Kg

Feed Ingredients:

Description	Price	%	Kg
*	0	0	0

Mineral Salts and Food Additives:

Description	Price	%	mg
*	0	0	0

Figure 4. The nutritional item demonstrates an essential role in the strategic management and supervision of the nutritional needs of animals.

Reproduction

The function is to manage the reproduction process of the animals. The outcomes are keeping track of breeding cycles, fertility status, and mating records. Schedule and monitor artificial insemination or natural mating. Monitor pregnancy progress and record expected calving dates (**Figure 4**).

Tag Number : Semen Company : Location No :

AI Date : Bull Name : AI :

T. Number	AI Date	Semen Company	Bull Name	Location No	A I
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Figure 4. The reproductive item serves as a pivotal component in effectively overseeing and controlling the intricate process of animal reproduction.

Production

The functions are monitoring and analysing milk production on the dairy farm. The outcomes are recording daily milk yield from each cow and analysing trends in production. Also, tracking milk parameters such as fat and protein content, and measuring the milk quality by applying several tests, such as; Somatic Cell Count (SCC), Standard Plate Count (SPC), Preliminary in Cubation Counts (PCI) and Lab Pasteurized Count (LPC). Generate reports on milk production performance and identify any abnormalities (**Figure 5**).

Figure 5. Production item, to monitor and analyse milk production on the dairy farm.

Vaccination

The function is managing vaccination schedules and health records. The outcome is recording the vaccination history for each animal. Set up reminders for upcoming vaccinations. Monitor overall herd health status and track any disease outbreaks. Generate vaccination reports for compliance purposes (**Figure 6**).

Figure 6. Vaccination item, to manage vaccination schedules and health records.

Marketing

The functions are tracking market activities and sales of dairy products. The outcomes are managing customer data and sales records. Track product inventory levels. Generate sales reports and analyse market trends. Monitor product pricing and promotions (**Figure 7**).

The screenshot shows a web application window titled "Marketing". At the top, there are input fields for "Buyer Name", "Quantity" (with a value of 0), "Price", and "Delivery Date" (set to 8/25/2021). Below these fields is a large table with the following columns: BuyerName, Quantity, Price, Delivery Day, and Delivery Date. The table is currently empty. At the bottom of the window, there are five buttons: "New", "Save", "Edit", "Delete", and "Main Menu".

Figure 7. Marketing item, to track market activities and sales of dairy products

Management

The functions are assisting in overall farm management and decision-making. The outcomes are providing key metrics and performance indicators for the dairy farm. Monitor financial aspects such as expenses, revenue, and profitability. Generate reports on performance, efficiency, and cost analysis. Assist in long-term planning and business strategy (**Figure 8**).

The screenshot shows a web application window titled "Management". At the top, there is a "Tag Number" dropdown menu and a "Print View" button. Below these is a large table with the following columns: Tag Number, Animal Name, Sex, Breed, Birth Date, Fother ID, Mother ID, and Weight. The table is currently empty.

Figure 8. Management item, to assist in overall farm management and decision-making. There is an option to print all information for the herd on the farm in the current window.

Map/View

The functions provide a visual representation of the farm's layout and data. The outcomes are displaying an interactive map of the farm, including barns, pastures, and infrastructure. Overlay data such as animal locations, feeding stations, or milking stations. Assist in visual analysis of farm operations and resource allocation (**Figure 9**).

Overall, the Farm-Key software program helps dairy farm managers plan and manage various practices and facilities, providing valuable insights, optimizing processes, and ensuring efficient farm operations.



Figure 9. Map/View item, to provide a visual representation of the farm's layout and data.

Discussion

The dairy industry has experienced significant advancements in milk yield and quality, thanks to superior germplasm, improved nutrition strategies, better healthcare facilities, and enhanced dairy husbandry practices (Omer 2022). The expansion of large dairy farms worldwide, particularly smart farms equipped with high-tech constructions, advanced devices and tools, and software programs, has further contributed to increasing productivity (Brito *et al.* 2021; Singh *et al.* 2021). However, the need for high-quality milk in larger quantities poses challenges for dairy farms, particularly in terms of labour availability and cost (Grasseni 2007; Mamane 2022). To address these challenges, the use of advanced software programs and engineered devices has become an alternative to reduce labour costs (Barile *et al.* 2022; Santos *et al.* 2022; Singh *et al.* 2022).

In recent decades, software programs have been developed to manage various aspects of dairy cow breeding, such as nutrition system management, reproduction planning, gynaecological and veterinary health care, and morphological and genetic evaluation of animals (Grasseni 2005; Maciuc *et al.* 2015). These software programs have revolutionized livestock farming by providing efficient management tools and expert-based solutions combined with advanced data analytics and artificial intelligence.

However, to ensure the effective utilization of these software programs and avoid sub-usage or misuse, it is crucial to examine breeders' problems and plan their usage according to the specific needs and resources of the farm (Samer 2010; Tummers *et al.* 2021). This involves identifying the departments to be automated, determining the data to be tracked, and allocating human resources accordingly. The flexibility and adaptability of the software programs allow for personalized analysis and management of breeding performances, enabling breeders to identify critical points and improve their practices (Maciuc *et al.* 2015; Kang *et al.* 2021; Tassinari *et al.* 2021).

In this context, the Farm-Key programme aimed to improve various dairy farming activities and welfare assessments, including milk production and quality, estrus, AI, and disease management. The use of advanced software programs and data technologies, combined with expert-based solutions, can bring substantial improvements to existing dairy farming practices.

The Farm-Key software program offers a comprehensive solution for managing dairy farms and optimizing various practices and facilities. With its range of functions and outcomes, Farm-Key enables dairy farm managers to effectively plan and monitor key aspects of their operations.

One of the crucial functions provided by Farm-Key is animal management. This feature allows managers to keep detailed records of individual animals, including identification, health status, breed, and age. The software also tracks milk production and monitors the animals' health issues or activity patterns. By having access to this information, managers can make informed decisions to improve the overall well-being and productivity of their animals.

Nutrition planning and monitoring is another important function offered by Farm-Key. Managers can create customized diet plans for each animal based on their specific nutritional requirements. The software keeps track of feed types, quantities, and feeding schedules, allowing for precise monitoring of the animals' nutritional intake. Any necessary adjustments to the diets can be made based on the collected data, ensuring that the animals receive optimal nutrition for their well-being and productivity.

The reproduction function of Farm-Key streamlines the management of the breeding process. Managers can easily keep track of breeding cycles, fertility status, and mating records. They can also schedule and monitor artificial insemination or natural mating. Monitoring pregnancy progress and recording expected calving dates helps in efficiently managing the reproduction process and ensuring the growth of the herd.

Farm-Key also offers monitoring and analysis of milk production on the dairy farm. The software records daily milk yield from each cow and analyses production trends. Additionally, it tracks milk parameters such as fat and protein content and conducts various tests to measure milk quality. Reports generated by Farm-Key provide valuable insights into milk production performance, enabling managers to identify any abnormalities and make informed decisions to optimize production.

The software program also helps manage vaccination schedules and health records. Managers can easily record vaccination history for each animal and set up reminders for upcoming vaccinations. Farm-Key enables monitoring of overall herd health status and tracking of disease outbreaks. Furthermore, the software generates vaccination reports for compliance purposes, ensuring that the farm meets industry standards.

Marketing activities and sales of dairy products are also simplified with Farm-key. The software enables tracking of market activities, customer data, and sales records. It also helps monitor product inventory levels and generate sales reports. Analysing market trends, product pricing, and promotions becomes easier, facilitating effective marketing strategies and maximizing sales.

Farm-Key contributes to overall farm management and decision-making with its management function. The software provides key metrics and performance indicators, enabling managers to monitor financial aspects such as expenses, revenue, and profitability. Reports on performance, efficiency, and cost analysis aid in making informed decisions and planning for the long-term success of the farm.

To provide a visual representation of the farm's layout and data, the Farm-key includes the map/view function. This feature displays an interactive map of the farm, highlighting barns, pastures, and infrastructure. Data such as animal locations, feeding stations, or milking stations can be overlaid on the map, facilitating visual analysis of farm operations and resource allocation.

Overall, Farm-key is a powerful software programme that assists dairy farm managers in planning and managing various practices and facilities. By providing valuable insights, optimizing processes, and ensuring efficient farm operations, Farm-key is an essential tool for modern dairy farming.

Conclusion

In conclusion, the development and utilization of advanced software programmes in dairy farming have revolutionized the industry by improving productivity, management efficiency, and animal welfare. The Farm-Key software programme, designed for dairy farm management, offers breeders a robust tool to plan, monitor, and optimize various aspects of their operations. With continued advancements and integration of new technologies, software programmes hold immense potential for the future of dairy farming.

Future vision

Farm-Key Software has been widely recognized as a highly effective tool for managing dairy farms. Its extensive range of features and functionalities has greatly assisted dairy farm managers in optimizing various practices and facilities. Considering the evolving landscape of technology and user preferences, there is a need to develop a future version of Farm-Key, called Farm-Key+, that is fully compatible with ISO standards and can run on Android devices. This upgraded programme will further enhance and streamline the management processes in dairy farms, ensuring maximum efficiency and convenience.

ISO Compatibility: The Farm-key+ software will be designed to comply with ISO standards, ensuring that dairy farm management processes align with international regulations and best practices. This feature will enable farms to achieve and maintain certification, making them more competitive in the global market.

Android Compatibility: Recognizing the increasing popularity of Android devices, Farm-Key+ will be optimized to run smoothly on these platforms. This will provide users with greater flexibility and convenience, allowing them to access and manage farm data anytime, anywhere, using their Android smartphones or tablets.

Enhanced User Interface: Farm-key+ will feature an upgraded user interface that is intuitive, user-friendly, and aesthetically pleasing. The layout will be optimized for touchscreen interactions and intuitive navigation, making it easier for users to access the software's various functions.

Advanced Analytics and Reporting: The analytics and reporting capabilities of Farm-Key+ will be enhanced to provide more comprehensive insights into farm operations. The software will generate detailed reports, including key performance indicators, financial analysis, production trends, and resource allocation. These reports will aid in decision-making, long-term planning, and continuous improvement of the dairy farm.

Data Integration and Interoperability: Farm-Key+ will prioritize data integration and interoperability, allowing seamless integration with other farm management systems and platforms. This will facilitate efficient data exchange and eliminate the need for redundant data entry, saving time and reducing errors.

Cloud-Based Storage and Backup: To ensure data security and accessibility, Farm-Key+ will utilize cloud-based storage and automatic backup functionalities. This will eliminate the risk of data loss and provide convenient access to farm data from multiple devices.

Real-time Monitoring and Alerts: Farm-Key+ will enable real-time monitoring of critical parameters such as animal health, milk production, feed consumption, and vaccination schedules. Managers will receive instant alerts and notifications on their Android devices, allowing them to promptly address any abnormalities or issues.

Machine Learning and AI Integration: To further enhance decision-making and automate certain processes, Farm-Key+ will integrate machine learning and artificial intelligence algorithms. These technologies will analyse historical data, identify patterns, and provide valuable insights and recommendations for improving farm operations and productivity.

Data and Programme Availability

The programme is available by contacting to Corresponding author: mengzhiwangyz@126.com

Statement of animal rights

"Not applicable"

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Disclosure statement

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Authors' contributions

N.N.A.M.H., H.M.H. A.A.S., and M.W. defined the research theme. A.A.S. designed methods. M.A., Y.G., Y.A., A.Z., A.A and O.A. organized the data. A.A.S., N.N.A.M.H., H.M.H. and M.W. interpreted the results and wrote the manuscript. All authors read, reviewed and approved the final manuscript.

Ethics declarations

Consent for publication

All authors gave their consent for publication.

Competing interests

The authors declare that there is no competing interest.

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