

Innovations in beef breeding - opportunities and problems

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Abstract. Today, the world is experiencing an environmental crisis that is far more dangerous than an economic one. The search for and implementation of innovations that support business should also be consistent with their ecological effect. Raising animals for food originated more than 8,500 years ago, and today meat is part of the diet of most people. Beef farming has reached the stage where implementing digital innovations is a necessity. Unfortunately, when implementing new solutions, the effect on nature is often not evaluated. The environmental impacts may be irreversible or difficult to reverse and may require a much higher cost to remedy. The purpose of the research is to compare the profitability of the implemented solutions, in relation to the environmental problems. The results of the study of some of the most widespread innovations can be systematized in several directions. The implementation of animal control systems on pastures could destroy the natural habitat of wild animals and technical solutions should be sought that reduce these impacts. Tracking the behavior and collecting biometric data from the animals can also be done with non-invasive methods, which will be much more humane and will not disturb the ecological balance in relation to the bees. The main problems are related to the access of wild animals to food and water in control systems by restricting pastures and the use of certain frequencies to transmit the biometric data of the animals and their impact on both farmed animals and bees and other species in the wild. In conclusion, the profitability of beef pasture animal husbandry has the possibility to increase without significant damage to nature, if it is approached relatively individually to each specific regional project in Bulgaria.

1 Introductions

Innovations in digital technologies have revolutionized various industries, including beef cattle breeding. Digital solutions offer improved data management, increased operational efficiency, and enhanced decision-making capabilities for breeders. The research aims to

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compare the cost-effectiveness of digital innovations in cattle farming, focusing on software solutions, data farm management and specific examples such as RFID trackers, temperature monitoring boluses and other relevant technologies.

There are arguments about the cost-effectiveness and environmental impact of using digital technologies, such as electric herders, for grazing animals. However, it is important to note that the opinions expressed here are intended to present a balanced view and should not be construed as scientific consensus. Here are some arguments against using digital technology for pasture-raised animals:

1. **Initial Investment Costs:** Implementing digital technologies, including electric herders, often requires significant upfront investment in equipment, infrastructure, and training. These costs can strain the financial resources of small-scale farmers, potentially reducing short-term profitability. In the case of subsidizing, even partially, the implementation of innovations, the payback is sufficiently greater than the usual depreciation charges.

2. **Maintenance and Upkeep:** Digital technologies typically require regular maintenance and software updates to function optimally. The costs associated with servicing and replacing malfunctioning equipment can add to the operational expenses, impacting profitability. This problem, unfortunately, is quite common in practice. The fact is that a large number of farmers, especially in Bulgaria, accept the purchase and implementation of software solutions as a one-time act and do not take enough care of its regular updating. For this and the increasing prevalence of "software as a service" solutions. From a business point of view, this type of solution provides predictability and constancy of costs.

3. **Impact on Animal Welfare:** Electric herders, while efficient at guiding animals, can potentially cause stress or discomfort to animals if not used properly. In some cases, the use of electric herders may negatively affect animal welfare and compromise the reputation of pasture-raised animal products, which may result in reduced profitability. Much more serious is the problem of disturbing the natural habitat of wild grazing animals. The construction of electric shepherds in the semi-mountainous regions, the heights above 1000-1500m. above sea level pose a risk of conflict with wildlife habitat. Defining impact maps is a difficult and quite often too expensive endeavor, as no single GIS system exists. Wildlife access to water could also be severely hampered. This defines electrograzing as an innovation that could disrupt the fragile natural balance in a given region. On the other hand, very often this arrangement can limit the movement of infected wild animals and thus protect herds from diseases. an individual approach is required.

4. **Loss of Traditional Farming Practices:** The adoption of digital technologies in pasture-raised animal systems may lead to a loss of traditional farming practices and a disconnection from nature. Some argue that relying heavily on digital tools can diminish the valuable knowledge and skills passed down through generations, potentially affecting the overall sustainability and resilience of farming systems.

5. **Long-term Economic Viability:** The profitability of pasture-raised animal systems depends not only on short-term gains but also on long-term economic viability. It is essential to assess whether the adoption of digital technologies will provide sustained benefits that outweigh the initial investment and ongoing costs over the lifespan of the farming operation.

It is important to note that these arguments are not universally applicable and should be evaluated within the context of specific farming systems, local conditions, and available resources. Additionally, advancements in digital technologies continue to evolve, and ongoing research and innovation may address some of the concerns raised above.

The following innovative solutions are also considered in the present study.

Software Solutions for Farm Management: Farm management software provides breeders with comprehensive tools for data organization, analysis, and decision-making. These solutions allow for efficient record-keeping, inventory management, financial analysis, and performance monitoring. The cost of implementing farm management software varies

depending on the scale of the operation and the complexity of features required. However, the benefits include streamlined operations, improved resource allocation, and better overall farm management [1].

Example: Farm management software, such as FarmLogs, FermaWeb or AgriWebb, enables breeders to track animal health records, breeding data, feed inventories, and financial transactions in a centralized system, facilitating quick and informed decision-making [7].

Usually in Bulgaria, farmers who invest in a software solution, if it is not dictated by the need to fulfill the requirements of control bodies, are few - no more than 7-12%. The value of the investment under Bulgarian conditions does not exceed 10% of the cost of acquiring a unit of animal, or in other words, it is not more than 1% of the total costs of the company on an annual basis. The software solutions that are offered "as a service" even have a much lower fee. The trend is towards a slow increase in the relative share of farmers who use software solutions for management and analysis. One of the main reasons for this is the lack of prepared personnel using software. It is a fact that a large part of the herd management activities and administration of the documents before the State are outsourced to the Associations or veterinarians.

RFID Trackers: Radio Frequency Identification (RFID) technology has gained popularity in the livestock industry. RFID tags and readers allow breeders to track individual animals, monitor their movement, and collect real-time data. [3] The cost of RFID systems includes tag purchases, reader infrastructure, and data management software. However, the benefits include improved traceability, enhanced biosecurity, and efficient monitoring of animal health and performance.

Here the variety of solutions is greatest. There are solutions that work at different frequencies and standards. From the point of view of the regulations adopted in Bulgaria for official identification, a frequency of 134.2 kHz is used in the HDX and FDH-B standards. The price of the brands used - 1-3 Euro depending on the manufacturer is low enough and allows for easy control and management of the herd. At this frequency, the distance from the reader to the animal (tag) is no more than 70 cm (technical limitation). For management purposes, the UHF frequency is used, 868-902 in Europe and 900-950 in the USA. Which allows readers to work from a greater distance of up to 25 meters for "passive tags" In this case, the price of the brands is approximately the same (the reader is relatively more expensive), but this system allows even better options for herd management.

Example: Breeders can use RFID trackers, such as Allflex or Gallagher, to monitor animal movement, grazing patterns, and access to specific areas, enabling better management of grazing rotations and identifying potential health issues.

Temperature-Monitoring Boluses: Temperature-monitoring boluses provide valuable insights into the health and well-being of individual animals. These ingestible devices measure and transmit core body temperature data, allowing breeders to identify early signs of illness or stress. The cost of temperature-monitoring boluses includes the purchase of the devices and associated data analysis tools. However, the benefits include early disease detection, reduced treatment costs, and improved overall herd health. Monitoring cow health by using temperature-sensing reticular boluses (**TSRB**) is an alternative to rectal temperature monitoring that is easy to use and requires minimal manpower. [4]

Example: Breeders can use temperature-monitoring boluses, such as eCow Bolus or SureSense, to continuously monitor the core body temperature of each animal, providing alerts and insights into potential health issues.

Data Analytics and Predictive Models: Utilizing data analytics and predictive models allows breeders to extract valuable insights from the vast amount of data collected on the farm. By analyzing historical data and current trends, breeders can make informed decisions regarding breeding programs, feed optimization, and animal health management. The cost of implementing data analytics solutions varies based on the complexity of the models and the

level of customization required. However, the benefits include improved efficiency, better resource utilization, and enhanced profitability.

Example: Breeders can employ data analytics software, such as Breedr or HerdInsights, to analyze data related to genetics, performance, and environmental factors, enabling informed decision-making regarding breeding choices, feed management, and overall farm optimization.

2 Methods

The research is based on two types of data. First - official data published by various institutions NSI, DF "Agriculture", Bansik. Second - own, collected through face-to-face interviews, techno-economic tests of various innovations in various farms and business organizations. The research methods used include general scientific research methods, empirical-theoretical and logical-theoretical methods.

Most research on the practical application of innovations has been conducted in regions with relatively few farmers. According to the official statistics in Bulgaria, the most pastures are in the southwestern region. The fact is that there is an uneven distribution of pasture land. This also leads to a distortion of the opportunities of farmers, for whom there is not enough land.

3 Results

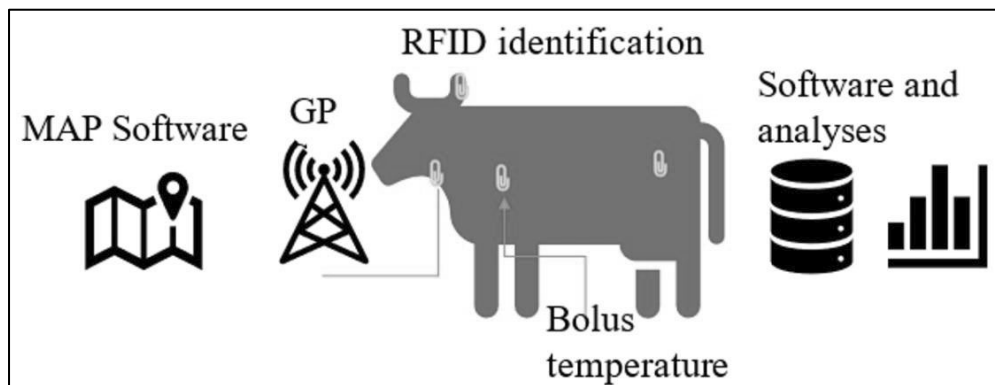


Fig. 1. Forecast technology map

The economic effect of implementing the management systems in Bulgaria is expressed in lowering the cost of production through more correct management of resources by about 5%. The research is incomplete and with insufficient data at the moment, but an experimental new methodology was used. A "forecast technology map" was created for a specific type of animal - cows, sheep - through „Ferma Web“ module costs. Parameterization is for a few specific farms that use it. The data on the cost of raising the costs of each animal are combined, anonymized and compared to the "forecast map" - online. This leads to informed decisions that change the actions of farmers and hence the cost and accordingly the results cannot be relied on, but nevertheless this profitability is taken into account (before the subsidy)

The effect of using means of animal identification is multi-disciplinary. On the one hand, control over their health condition is improved and it is possible to track the costs incurred for their nutrition and all additional activities related to the management of the herd. The profitability of implementing means of identification can be evaluated from the point of view of indirect benefits for management, but in financial terms, in larger herds, it can reach a reduction of management costs by about 7-9%. If UHF tags/readers are implemented, the

effect is up to 12% reduction in animal loss losses. Unfortunately, the welfare of the animals is violated, the stamps are often torn off, lost, replacement is required, which is painful. When increasing the power of the readers, it is possible to destroy too many bees in the region of the emitter (UHF frequency is harmful to insects at high emission power)

Using boluses and all other sensors to transmit biometric information directly from each animal is most effective. "Abdominal boluses" help to monitor the health of the animal and its metabolism. [2] The financial benefit of their use is mainly in the assessment of the quality of nutrition and the fact that the animals receive medical assistance when a minimal problem appears - prevention. In real terms, this can be measured to reduce the cost of treating and killing part of the herd up to 30% of the value of the animals. Here again there is the serious problem of animal welfare. According to studies in Texas, up to 0.5% of animals with the bolus have unpleasant consequences, sometimes fatal. The second major problem with these devices is the battery.[6] It is designed to live a maximum of 5 years and due to the impossibility of being charged, there is a possibility that the animal will not receive real information. Using a "vaginal temperature bolus" to detect estrus and reproductive system diseases has a pretty serious return on investment. With correct operation, the "service period" ie. the period between 2 calvings can be greatly reduced by at least a month. This leads to faster conception and a reduction in losses by 25% of the animal's value, but it also leads to faster "wearing out" of the productive animals. Although estrus is detected with over 90% certainty from an ecological point of view, the effect of this innovation is quite controversial.

At the time of writing this report, not enough research has been conducted on "non-invasive innovations" on Bulgarian farms such as drone footage, herd management software, cameras and AI systems, but initial observations point to lower costs for management with at least another 20%.

4 Conclusion

Digital innovations, including software solutions, RFID trackers, temperature-monitoring boluses, and data analytics tools, offer significant potential for improving cost efficiency in beef cattle breeding. While these technologies may involve initial investments, the long-term benefits in terms of streamlined operations, data-driven decision-making, improved animal health, and enhanced profitability make them worthwhile considerations for breeders. It is essential for breeders to assess the specific requirements of their operations and weigh the costs against the potential benefits to make informed decisions on adopting digital innovations.

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