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PRECISION PIG FARMING: NEW PERSPECTIVES FOR EFFICIENT ANIMAL PRODUCTION

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ABSTRACT

Modern pig farming is constantly evolving, driven by demands for increased productivity, animal welfare, and environmental sustainability. In this context, precision pig farming (SP) emerges as an innovative approach, which aims to monitor and manage pigs individually through digital technologies, promoting efficiency in production and improvement in decision-making processes. This article aims to investigate how precision pig farming, through the use of technologies, can help in the pig sector. The methodology was based on a narrative review of the literature, based on the survey of information contained in published scientific and technical publications. The results point to the main technologies involved, such as sensors, cameras, Artificial Intelligence (AI), Internet of Things (IoT) and RFID, highlighting their contributions to productivity, animal welfare and sustainability. It is concluded that PS represents a promising advance, and its adoption requires investment, technical training and public incentive policies.

Keywords: Precision pig farming. Technologies. Animal welfare. Sustainable production. Automation.

INTRODUCTION

Pig farming is considered one of the most important segments in agribusiness in Brazil. The relevance of pig farming in the agricultural sector continues to grow due to the use of technological resources. According to ABPA (Brazilian Association of Animal Protein, 2020), in 2019 81% of Brazilian pork was destined for the domestic market, with a *per capita* consumption of 15 kg. Many factors such as the use of new technologies in the pig sector were essential to obtain good results in the Brazilian scenario.

Modern pig farming is constantly evolving, driven by demands for increased productivity, animal welfare, and environmental sustainability. The modernization of pig farming has made it

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possible to support the expansion of pig production, where new technologies allow for more guarantee of health, reduction of environmental impacts, food safety, as well as providing animal welfare (INDUSTRIAL PIG FARMING, 2017).

According to Machado (2018), producing well and precision in productivity are important requirements in pig farming, since these aspects contribute to the technological evolution of the pig sector. In view of the mentioned context, the use of Information and Communication Technologies (ICTs) can be an important tool within the different production models in pig farming, generating high perspectives of precision in this agribusiness sector.

According to Cavalheiro et al. (2018), they highlighted that the use of technology represents a channel for access to information, being a source of knowledge and also a possibility of opportunities for agribusiness segments. Therefore, ICTs (especially the Internet) have become a constant need in the pig sector. The advancement of automation, artificial intelligence (AI), internet of things (IoT), and environmental and physiological sensors, have made it possible to collect and analyze data in real time, reducing losses, optimizing resources, and ensuring greater traceability.

In the national and international scenario, a potential development of the pig production chain is observed, where there is a connection to market demands and demands, highlighting sanitary and nutritional aspects, as well as the management of the production environment, directed to the introduction of new technologies whose objective is to improve the quality of products (PANDORFI et al., 2020).

This article focuses on discussing the new perspectives of precision pig farming and its practical application in Brazilian production systems aiming at more guarantee of health, reduction of environmental impacts, food safety, as well as providing animal welfare.

OBJECTIVE

To investigate how precision pig farming, through the adoption of advanced technologies and innovative management practices, can increase production efficiency, promote sustainability and ensure animal welfare in swine production.

METHODOLOGY

This study consists of a narrative review of the literature, based on the survey of information contained in recent scientific and technical publications. For the construction of this review, articles, theses, dissertations, and technical documents available in databases such as Scopus, Scielo, Web of Science, Google Scholar, and ResearchGate were used, in addition to

specific materials such as "Technologies for the Production of Fish, Poultry, and Swine: Solutions Based on Applied Research" (Sbardella et al., 2024) "Information and Communication Technologies" (Brusamarelo et al., 2024) and the article "Information and Communication Technologies in Pig Farming" (UFPB, 2023).

The inclusion criteria for the selection of materials considered published studies that address the application of Information and Communication Technologies (ICTs) in pig farming, with emphasis on sensors, automation, artificial intelligence (AI), internet of things (IoT) and animal welfare. Priority was given to studies that analyze the use of exogenous enzymes in swine nutrition (Dereck, 2020;

Souza, 2021), solid-state fermentation as a technological alternative (Giacomel, 2022), evaluation of the body condition of sows (Calegari, 2023), handling and transportation of pigs (Pereira, 2014), in addition to the incorporation of co-products in pig feed, such as glycerin (Leite, 2015) and cottonseed meal (Silva, 2019).

The data collection stage consisted of reading and interpreting the selected materials, focusing on the identification of content that evidences the impact of technological innovations in pig farming. To organize the analysis, the studies were classified according to their specific contribution in the axes of management, nutrition and swine health.

DEVELOPMENT

Precision pig farming seeks to integrate technologies, biotechnologies, and management strategies to optimize production performance, ensure animal welfare, and increase the sustainability of production systems. In this context, several advances have been studied, from the use of alternative co-products to the application of tools for individualized nutritional and sanitary control.

EXOGENOUS ENZYMES AND THE USE OF DDGS IN SWINE NUTRITION:

Soluble Distillers Dried Grains (DDGS) represent a promising alternative in swine nutrition, especially as a protein source. However, the high fiber content makes it difficult to fully use it. Recent studies have shown that the inclusion of exogenous enzymes such as xylanase and β-glucanase improves the digestibility of diets with DDGS, resulting in greater energy and protein availability (Dereck, 2020; Souza, 2021). These interactions, however, are nonlinear, requiring precise protocols that correlate levels of enzyme inclusion and DDGS contents.

SOLID STATE FERMENTATION AS A TECHNOLOGICAL ALTERNATIVE:

Solid-state fermentation emerges as an effective biotechnological tool in the modification of fibrous co-products such as DDGS. Through the action of selected microorganisms, it was possible to reduce fiber levels and increase nitrogen metabolizability, reflecting in improvements in the energy values of the diets and in zootechnical performance, especially in growing pigs (Giacomel, 2022).

This technology still requires standardization of protocols and selection of more effective strains, but it has great potential within precision pig farming.

ASSESSMENT OF BODY CONDITION: LIMITS AND OPPORTUNITIES:

The correct assessment of the body condition of sows is essential for nutritional and management decisions. However, conventional methods, such as visual scoring, caliper, and ultrasonography, still lack precision and correlation with productive indicators, especially in primiparous sows (Calegari, 2023). The development of automated tools based on artificial intelligence can represent the future for this monitoring, contributing to the individualization of reproductive and nutritional management.

PIG TRANSPORT: WELFARE AND CARCASS QUALITY:

In the pre-slaughter stage, transportation represents a critical factor for the well-being and quality of the meat. In Mato Grosso, the ideal density of 251 kg/m² proved to be effective in minimizing stress and injuries, ensuring better qualitative parameters of pork (Pereira, 2014). The adoption of thermal sensors, real-time monitoring, and dynamic density adjustments can be strategies aligned with precision pig farming to mitigate economic losses and ensure animal welfare.

CO-PRODUCTS IN THE DIET: GLYCERIN AND COTTONSEED MEAL:

The incorporation of co-products such as glycerin and cottonseed meal reflects the effort of precision pig farming to seek viable alternative ingredients. Glycerin demonstrated high energy value and good digestibility up to levels of 15% inclusion (Leite, 2015), while cottonseed meal, despite digestive limitations, did not compromise finishing performance when used in a balanced way (Silva, 2019). Such ingredients, combined with dynamic diet formulation systems, contribute to cost reduction and greater environmental sustainability.

FINAL CONSIDERATIONS

Precision pig farming presents itself as a promising model for the modernization of production systems, by integrating emerging technologies, automation and sustainable

practices. The adoption of resources such as exogenous enzymes, solid-state fermentation, physiological sensors, artificial intelligence, and rational use of co-products reveals a significant advance towards more efficient, ethical, and environmentally responsible production.

By promoting animal welfare, reducing environmental impacts, and increasing process traceability, these technologies also meet the requirements of national and international consumer markets, making Brazilian pig farming more competitive. However, challenges still persist, such as the standardization of protocols, technical training of producers, and implementation costs.

Thus, continuous investments in research, rural extension and public policies are essential to consolidate precision pig farming as an effective reality in the Brazilian countryside, contributing not only to zootechnical performance, but also to the construction of a more sustainable production chain aligned with the principles of animal welfare.

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