PRECISION AGRICULTURE AND PIG FARMING

PETROMAN IONUȚ MIRCEA[1], BOGOȘEL FLORIN DANIEL[2], VĂDUVA LOREDANA[2*]
PETROMAN CORNELIA[2], HĂDĂRUGĂ NICOLETA[1]
[1]University of Life Sciences "King Mihai I" from Timisoara,
Faculty of Faculty of Food Engineering, Timisoara, Romania
[2]University of Life Sciences "King Mihai I" from Timisoara,
Faculty of Management and Rural Tourism, Timisoara, Romania
*Corresponding author's e-mail: loredana_heber@yahoo.com

Abstract: *Precision Agriculture in pig farming is about application of cameras, automatic detection and segmentation, bibliometric analysis, feeder and floor space allowances, living lab methodology, medicine administration, precision livestock farming technologies, smart pig farming, using a multiple output regression convolutional neural network, and vision-based Artificial Intelligence – among others – and their impact on animal welfare, chronic stress, growth performance, and immunity transfer in nursery pigs, piglets, and pigs, in general. The authors discuss the advantages and disadvantages of these new applications.*

Key words*: precision agriculture, pig farming, applications, impact, advantages, disadvantages.*

INTRODUCTION

Precision agriculture is a modern farming management strategy that uses data and technology to optimize field-level management regarding crop farming. Here are some key aspects: analysis and decision-making, i.e., analysing the collected data to make informed decisions about planting, fertilizing, and harvesting; data collection, i.e., using technologies like Global Positioning System (GPS), Geographic Information System (GIS), remote sensing, and drones to gather detailed data on soil conditions, crop health, and environmental factors; resource optimization, i.e., applying the right amounts of inputs (e.g., water, fertilizers, and pesticides) at the right time and place to improve efficiency and reduce waste; sustainability, i.e., enhancing sustainability by minimizing environmental impact and improving crop yields.

Rising demand for pork and growing pig farms make it increasingly difficult for pig farmers to keep track of individual animals. In this context, innovative animal management systems such as precision / smart livestock / pig farming allow farmers to closely monitor their animals' health and welfare [1,7,8,13,17,27,28].

Precision pig farming is about application of cameras, automatic detection and segmentation, bibliometric analysis, feeder and floor space allowances, living lab methodology, medicine administration, precision livestock farming technologies, smart pig farming, using a multiple output regression convolutional neural network, and vision-based Artificial Intelligence – among others – and their impact on animal welfare, chronic stress, growth performance, and immunity transfer in nursery pigs, piglets, and pigs in two different farrowing systems. [12,19,20,26]

MATERIALS AND METHODS

The material used in this paper consists in a corpus of articles on the relationship between precision agriculture and pig farming published in the last two decades years, articles showing its importance through the variety of tools used to optimize agricultural practices. The research method used is corpus analysis.

RESEARCH RESULTS

Precision Agriculture Tools. Precision agriculture employs a variety of tools to optimize farming practices. Here are some key tools used to enhance efficiency, reduce waste, and improve production:

Data analytics software, which analyses collected data to make informed decisions about feeding, harvesting, irrigating, planting, and watering;

Drones equipped with cameras and sensors, which capture high-resolution images and data for crop / livestock monitoring and field analysis;

Global Positioning System / Global Navigation Satellite System, systems which help in precise field / herd mapping, soil sampling, and tractor guidance;

Mobile devices (smartphones and tablets), which are used to access and manage data on-the-go;

Satellite imagery, which provides large-scale data on crop / livestock health, soil / livestock conditions, and environmental factors;

Sensors, which collect real-time soil, weather, and crop / livestock data on various parameters like moisture levels, temperature, and nutrient content;

Variable rate technology, which allows for the precise application of inputs like feed, fertilizers and pesticides based on data collected from the field.

In precision / smart pig farming, they use: 3D cameras [1,6,32], automatic detectors [4,18,24], automatic feeders [3,5,21], automatic weight scales [3,5,21], radio-frequency identification technology, accelerometers [9], automated growth analysis system (ultrasound analysis), convolutional networks [22,32,34], image analysis [18], infrared thermography [2], movement sensors [9], pressure sensors [15], (smart) sensors [7,8], audio and heart rate detectors, audio surveillance system [4], automated cleaning system, automated measurement [33], automated recording [23], automatic recognition, automatic warning [6], bibliometric analysis [13], Bluetooth transmitters, commercial systems, commercial temperature and humidity logger systems, computed tomography, feeder and floor space allowances [11], fertility control, heart girth, heating control, imaging technique, implanted temperature capsules, infrared technology [34], Internet of Things [8], Kinect depth sensors, machine vision technology [30], magnetic resonance imaging, multi-ellipsoid expectation maximization [16], oestrus detection technology, photoplethysmography, printed / sprayed / tagged elements [14], receiver devices in pre-determined zones of interest, smart integrated water meters, temperature detector, vaginal devices, ventilation controls, vision-based Artificial Intelligence [28], and wireless sensor network [9].

Areas Impacted by Precision Agriculture. In pig farming, precision agriculture can impact:

Animal welfare: it allows monitoring pigs' physical and behavioural changes in real-time, helping to ensure their well-being;

Economic efficiency: it can lower production costs and increase profitability by optimizing resource use and improving productivity;

Environmental impact: it helps reduce the environmental footprint by minimizing nutrient excretion and greenhouse gas emissions;

Feed efficiency: it optimises nutrient intake for individual pigs, reducing waste and improving growth rates;

Health monitoring: it allows detecting early signs of illness or stress, promoting timely intervention, and reducing the need for antibiotics.

Literature has focused on the following: behaviour (in general) [17, 30], feeding behaviour [3,14,21], tail biting, temperature [10], welfare [7,17,23], gait kinetics [15], lameness incidence, oestrus [9], onset of farrowing [24], wasting disease, and weight, aggressive behaviour, agonistic behaviour, carcass quality (backfat thickness), chronic stress [29], cold stress, cough, damaging mounting behaviour [18], disease (in general), feeding, girth, growth (performance) [21], hair [29], health, immunity transfer, limb asymmetry index, locomotion [15], meat traits, movement, physiology [17], pregnancy-related behaviour, prolapse syndrome, production [8], respiration rate, respiratory diseases, response to environmental conditions, size, thirst, and water intake.

Categories of Pigs Impacted by Precision Agriculture. Precision agriculture impacts pigs across various categories, enhancing their overall welfare and farm efficiency:

Boars: health and reproductive performance are monitored closely, ensuring high-quality semen and breeding efficiency;

Finishing pigs: nutrient intake is optimised, improving growth rates and meat quality;

Lactating sows: optimal health and milk production are ensured through real-time monitoring, benefiting piglet growth;

Newborn piglets: mortality rates are minimized by early detection of health issues and stress, which supports healthy development;

Pigs raised outdoors: environmental conditions are continuously monitored to maintain comfort and productivity.

In the two decades of research on precision pig farming, they focused on: pigs / swine (in general), sows (in general), fattening / growing pigs, piglets, group-housed pigs, grow-finish pigs, farrowing sows, indoor-housed pigs, lactating sows, livestock sustainability, nursery pigs, and pigs in two different farrowing systems.

In precision / smart livestock / pig farming, specialists have focused mainly on 3D cameras, automatic detectors, automatic feeders, automatic weight scales, and radio-frequency identification technology.

In precision / smart livestock / pig farming, researchers have focused mainly on behaviour (in general), feeding behaviour, tail biting, temperature, and welfare.

In precision / smart livestock / pig farming, scientists have investigated mainly pigs / swine (in general), and sows (in general).

CONCLUSIONS

In precision / smart livestock / pig farming, the main tools use, the main areas investigated, and the main categories of pigs that researchers have focused on are, as expected, related to the economic component of pig farming. Precision agriculture tools are incredibly important in pig farming, transforming pig farming into a more efficient, humane and sustainable industry because: they enhance animal welfare; they generate economic benefits, they improve biosecurity, they increase efficiency, and they support environmental sustainability.

The main areas of precision agriculture in pig farming collectively enhance productivity, sustainability and animal welfare in pig farming due to: behavioural monitoring; biosecurity; environmental control; health monitoring; precision feeding; and resource management. Precision agriculture is paramount across all main categories of pig farming, enhancing the efficiency, sustainability, and welfare of pigs across all farming categories: commercial pig farming; organic pig farming; small-scale or family farms; and sustainable pig farming.

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