BIOMETRIC SENSING INFORMATION TECHNOLOGY AS A TOOL FOR TACKLING THE ANIMAL PRODUCTION CHALLENGES

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Abstract

Information Technology (IT) is a general term that describes any technology that helps to produce, manipulate, store, communicate and/ or disseminate information. This review aims to evaluate Biometric sensing information technology as a tool for tackling animal production challenges. Animal husbandry offers better scope for marginal farmers whose income from agriculture is dwindling fast due to vagaries of monsoon, fragmentation of landholdings, pest problems, poor pricing, etc..The impact of ICT in domestic animal production may not be felt as expected if the information needed by rural farmers is not well communicated. The use of biometric sensors is currently being used to improve the health and well-being of animals and ameliorate behavioral issues. The use of this technology will bring about early detection and treatment of animal disease which lean to more profitability.

Keywords: Biometric sensor, information, technology, Animal Production, and livestock

Introduction

The developments in Information Technology over the past few decades are tremendous and offer great potential in improving animal health through various measures. Such as breed improvement through the appropriate breeding program, institutional credit support, improvement in livestock services. Like AI, vaccination, deworming, etc. and making disease-free zones, utilization of crop residue and fodder production, proper processing, storage, and transportation of animal products, appropriate import and export policies of livestock products and besides these to address the information needs of various farming systems through broad-based extension system, effective disease forecasting, rapid and accurate disease diagnosis, modern therapeutic measures, etc. IT has been used abroad widely to study and improve various aspects of livestock production, research, and education. This review aims to evaluate Biometric sensing information technology as a tool for tackling animal production challenges

Types of Biometric sensors

Biometric sensors monitor behavioral and physiological parameters of livestock

Biometric sensors monitor behavioral and physiological parameters of livestock, allowing farmers to evaluate an animal's health and welfare over time (Neethirajan,2017). Today's wide variety of available biometric sensors is either non-invasive or invasive. Non-invasive sensors, that can be deployed around the barn, include surveillance cameras and sensors in the feeding systems to monitor animal weight and feed intake. Non-invasive sensors also include sensors easily attached to animals, such as pedometers, GPS (global positioning system), and MEMS (microelectromechanical) based activity sensors, that can be used to monitor behavior(Helwatkar*et al*., 2014). Invasive sensors, which are less commonly studied in livestock, typically are swallowed by or implanted in an animal. This class of sensors is useful for monitoring internal physiological measures, such as rumen health, body temperature, and vaginal pressure in dairy cows (Helwatkar*et al*., 2014).

The use of biometric sensors in growth performance and rustling

Livestock farmers are increasinglyutilizing RFID devices, which may be embedded in ear tags and collars or implanted subcutaneously, to monitor a wide variety of behaviors such as general activity, eating, drinking, and rustling (Neethirajan, 2017). Acoustic analysis, using microphones, allows monitoring of vocalizations and coughing, alerting farmers to welfare issues before they become severe. Microphones also have the advantage of being easily and inconspicuously installed in barns to monitor large groups of animals (MungrooNeethirajan,2014. Cameras, similarly, are easy to place in barns and can be used to capture a wide variety of actionable information. Algorithms for video images can detect changes in animals' posture that may indicate lameness and other morbidities (Mahdavian*al et.*,020). Camera image analysis allows monitoring of animal weight, gait, water intake, individual identification, and aggression (Jorquera-Chavez, 2019).

The use of biometric sensors in reducing the impact and spread of disease

One of the most important roles for biometric sensors is in reducing the impact and spread of diseases. These sensors can be used to monitor temperature changes, behavior, sound, and physiological measures including pH, metabolic activity, pathogens, and the presence of toxins or antibiotics in the body. The overuse of antibiotics in livestock agriculture is currently a huge concern with serious repercussions to human health (Mungrooand Neethirajan, 2014). Being able to monitor the presence of antibiotics allows farmers to treat animals for illnesses while providing safe, nutritious animal products to the global population (Neethirajan*et al*., 2018). Biosensing technologies can also be used to detect problematic pathogens such as avian influenza,and coronavirus as stressed by Ahmed *et al.* (2017), and Johne's disease, a detrimental bacterial infection in ruminants which can result to huge economic losses for farmers (Chand *et al*., 2018). Biometric sensors can also detect biomarkers of inflammation for widespread disease monitoring. TIR, for example, has been used on images of feet to detect foot disease (Mahdavian*al et.*, 2020).

Biometric and biological sensors used in various livestock animals

1. Biometric and biological sensors for cattle, sheep, and goat

The use of biometric and biological sensors in the cattle industry has allowed for better monitoring of major welfare concerns as well as facilitating routine husbandry activities and providing valuable insights into productivity measures. Welfare concerns that can be improved through the use of biometric sensors include mastitis, cystic ovarian disease, lameness, displaced abomasum, and ketosis, whilst productivity measures that have been researched for automation include general activity, affective state, estrus detection, and milking behavior (Helwatkar*et al*., 2014). Also helping measure the timing of fertility cycles (estrus) with real-time results is of particular importance for herd maintenance, whilst precision control of nutrition and calorific energy are essential to maximizing milk production. Nutrition and energy balance are essential to efficient milk production by dairy cattle. Circulating levels of non-esterified fatty acids (NEFA) indicate negative energy balance and can be symptomatic of health risks that need to be addressed immediately. Metabolic disorders, indicated by high levels of NEFA in the blood, can lead to loss of appetite, decreased milk production, reproductive issues, mammary infections, and immune system dysfunction. The development of biosensors that would allow rapid biomarker detection and a proactive farmer response would ultimately improve dairy cattle health and welfare while reducing overall resource use. Consumers are growing increasingly concerned about the environmental sustainability of livestock production, especially concerning cattle. Mitigation efforts include biometric sensors that are being investigated as a way to monitor methane emissions (Munoz-Tamayo *et al.*, 2019).

2. Biometric sensors for swine

Biometric sensors are currently being used to improve the health and well-being of animals and ameliorate behavioral issues. Current technologies in common use for swine farming include 2D and 3D cameras, microphones, thermal imaging, accelerometers, radio frequency identification (RFID), and facial recognition.

Acoustic detection technologies have been successful in detecting differences in vocalizations and coughs in swine(Frie*et al.*, 2019). The implementation of sound detection software in a barn would help farmers identify welfare issues such as aggression, tail biting, heat stress, and respiratory illness. The use of acoustic analysis to detect coughing can allow farmers and veterinarians to diagnose respiratory illnesses up to two weeks before they could without the use of sensors. Sound analysis can also distinguish different coughs, such as those of a healthy pig with minor irritation from dust or those of pigs with respiratory illness (Norton *et al.*, 2019). Pig vocalizations are distinct and indicate an affective state (Frie*et al.*, 2019). For instance, pig screams often indicate pain or distress caused by tail-biting or ear-biting, or a piglet being crushed in the farrowing crate. Indicators of positive welfare are growing in popularity as people concerned with animal welfare strive to provide positive environments for animals rather than simply remove painful and stressful events. Pig barking, for example, can be an alert to potential danger but is also used during periods of play, which can, therefore, also be used as an indicator of positive welfare (Norton *et al.*, 2019). Friel *et al.* (2019) found that the duration of vocalizations in pigs is also an important indicator of affective state. Longer calls, especially long grunts, were used in situations of negative valence, whereas shorter duration vocalizations were more common in situations of positive valence. A major welfare concern in the swine industry is aggression among group-housed pigs. To monitor and address concerns over aggression researchers are investigating the use of automated video monitoring and depth imaging track. These technologies generally can monitor overall activity patterns but cannot yet track individual behavioral patterns (Wurtz*et al.*, 2019). One of the biggest obstacles to the more widespread use of biometric sensors in swine is the curious nature of the pigs themselves. Although placing an RFID tag in the ear is the most secure option for pigs, it presents challenges for sensors such as accelerometers. Wireless sensor networks (WSNs) are being implemented in barns to allow communication between ear tags and a base station that will provide data to the farmer regarding pig activity levels, alerting them to locomotion issues for individual animals, and providing temperature readings of individual pigs (Benjamin and Yik, 2019).

3. Biometric and biological sensors for poultry

A major concern with poultry production is the spread of disease. Pathogens spread easily between birds and even between farms. Poultry also requires significantly more accurate temperature control than the other livestock discussed so far. This is both to maintain good health in adult birds and also to promote the proper environment for chick embryonic development (Andrianov*et al*., 2019). As a result, poultry farming is highly reliant upon real-time analysis of data and prompt responses, both of which are key advantages of sensor technologies used in Precision livestock farming (PLF). PLF sensing modules and platforms have the potential to monitor the temperature in animal environments and alert farmers to intervene as needed. In addition to influencing the embryonic development of poultry, temperature also is the primary reason for heat stress in broilers (Bloch *et al.*, 2019). Infrared thermometers have been used to monitor the body temperature of broilers with high accuracy compared with implanted temperature loggers as reported by Bloch *et al.* (2019). Non-invasive heart rate monitors have been used to monitor the incubation temperature according to Andrianov*et al*. (2019). and to detect cardiovascular defects of chicken embryos Khaliduzzaman*et al.* (2019). Smartphone apps with compatible sensors have been developed for easy monitoring of embryo heart rate, which allows farmers to intervene as needed to prevent the loss of embryos during incubation (Phuphanin *et al.*, 2019). Chiro-immunosensors, utilizing chiral gold nanohybrids are promising technology for the detection of multiple pathogens, including avian influenza, fowl adenovirus, and coronavirus(Ahmed *et al.*, 2017).

Conclusion

The use of biometric sensors is currently being used to improve the health and well-being of animals and ameliorate behavioral issues. The use of this technology will bring about early detection and treatment of animal disease which lean to more profitability.

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