Precision Livestock Farming Technologies for Pig Welfare - Policy Spotlight

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Precision Livestock Farming Technologies for Pig Welfare

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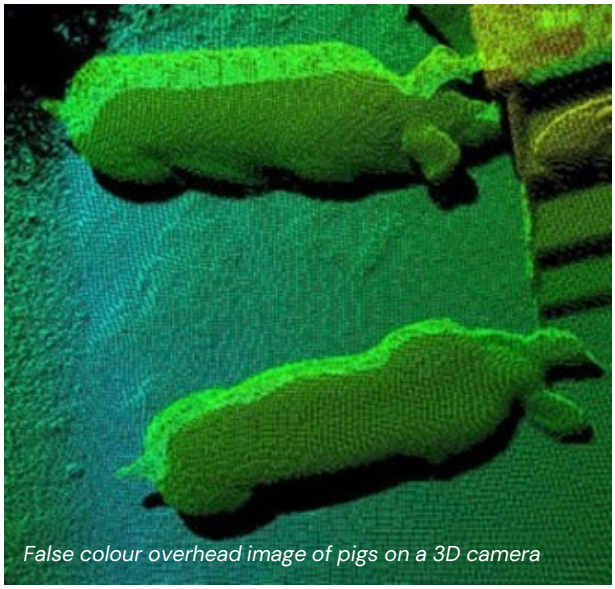
This Policy Spotlight considers the implications of the expansion of Precision Livestock Farming technologies to monitor pig health and behaviour.



False colour overhead image of pigs on a 3D camera

Key Takeaways

- Sensor technology and analytics to monitor pigs and their environment to better manage production is becoming commercially available with a lot more in the academic and SME research pipeline.
- Machine vision cameras use the latest 'deep learning' approaches to monitor growth and behaviour. Disease monitoring is also possible through the detection of sound (coughs) and disease specific volatile gases.
- Interfaces which integrate information from different sensors and provide timely, intuitive, actionable management information in one place are essential.
- Cost concerns mean that large integrated pork producers and breeding companies are among early adopters.
- 24/7 behaviour monitoring on farm could provide a higher standard of welfare assessment than the current 'gold standard' of in-person spot-checks.

Introduction

Precision Livestock Farming (PLF) is the use of sensor technology combined with analytic software to provide information to farmers and other supply chain stakeholders to support management decisions[1].

The novel and timely information produced by PLF has potential to improve management, production efficiency, animal health and welfare and to reduce waste and improve sustainability. Feasibility and cost-effectiveness of technology and sensor deployment differs between livestock species. This various from individual on-animal sensors (with ID and accelerometers for activity) used in dairy cows to building/room level sensors (cameras)[1] to monitor poultry.

In the pig sector, the use of PLF technology is not yet widespread. Some sows have radio-frequency identity tags (RFID) tags for use with electronic feeders during gestation. Unlike in sheep[2] (and soon cattle[3]) where RFID is mandatory and creates PLF opportunities, there is no requirement for growing pigs to have ID and producers have not taken this up voluntarily.

Equipment and techniques

Sow RFID is currently used to ensure that each sow gets her feed ration. Visit frequency and timing data from these electronic sow feeders has potential to be used to monitor health and welfare, particularly as it relates to social behaviour..

On-animal sensors present practical challenges in groups of growing pigs. Passive RFID ear tags are small enough but tags with batteries and sensors (accelerometers) are too large so damage ears and/or are bitten off by groupmates. Collars are similarly impractical. Much of the research effort has instead focussed on pen-level sensors.

Microphones used to quantify coughs to detect respiratory disease have been the first to market[4]. Sensors to detect the mix of organic gases in the air unique to specific pig diseases are also being developed[13]. But cameras have been the major focus of PLF research in pigs. Rapid improvements in machine vision in recent years using convolutional neural networks (also known as 'deep learning' or 'artificial intelligence') can now be trained to find and track pigs and to recognise certain behaviours [5,6].

Machine vision cameras over pig pens have been developed to measure weight, and therefore growth[7], as well as pig location/activity. This allows researchers to look at pen occupancy patterns such as use of lying areas, feeder, drinker and basic social measures like clustering. More recently, a series of studies have developed machine vision systems to detect specific single behaviours including gait, posture, social interactions, social aggression and tail biting [6,6,8].

No machine vision system is yet able to distinguish the full range of complex behaviours, although some integration is beginning[9]. Standard colour video cameras are cheaper, but 3D (depth sensing) cameras can be more reliable at detecting pigs - and basic postures like lying, standing or mounting - against a variety of different colour backgrounds, and despite shadow and changing light conditions.

The latest innovations involve detecting subtle features or behaviours like tail posture [10,11] and facial expressions[12], both of which have potential to assess animal emotions and welfare.

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Validation and data interpretation

Although PLF academic papers show the potential, in practice very few PLF technologies are robust, validated and commercially available. A recent review[14] highlighted that only 5% of commercially available sensor systems had been externally validated.

For example, most machine vision research papers use data from one pen of pigs to train deep learning neural networks to find and track pigs, and perhaps also to recognise one behaviour[14]. Its capacity to work with other groups of pigs, on different farms, or under different light conditions is never tested, and the next paper rarely builds on the last one.

Beyond this, the problem of data interpretation remains. Are there some sensor readings which are diagnostic of a specific problem on any farm (like a blood test for a specific disease)? Or does the system need to learn what is normal for that specific pen, building or farm before being able to spot anomalies? When an anomaly is detected, what does it mean, and how should the farmer respond? To answer these questions requires validation trials against ground truth measures at multiple commercial farms over an extended period [15], and few such studies exist [6,11].

A final and essential aspect of commercialisation is a user-friendly interface for farmers [16] and expert advisors such as vets, breeders and nutritionists. This should provide information on data trends and highlight anomalies to provide easy-to-understand actionable management information.

Commercial considerations

PLF systems have costs for installation, maintenance and ongoing fees for software and support. Farmer age and mindset also affect uptake, and there is a perception that PLF is time consuming to use. Early adopters are often large integrated companies with the resources to invest in trial systems at their R&D farms to gain market advantage[17]. PLF systems which measure key performance indicators relating directly to profitability of a farming enterprise (growth rate, product quality, efficiency, disease diagnostics) have had greater penetration.

Animal welfare assessment can 'piggy back' on PLF systems for another purpose to add value. For example, machine vision cameras placed over pens to weigh pigs[7] can also be used to monitor tail posture[10,11], and other behaviours, potentially providing early warning of a variety of health and welfare problems[18].

24/7 automatic monitoring of some welfare indicators could be a considerable improvement on the current welfare assessment 'gold standard' of regular in-person farm inspections.

Practical and ethical concerns

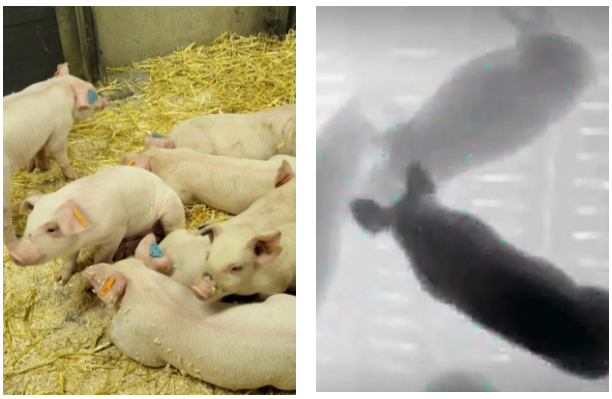
PLF has many potential benefits, but some practical and ethical concerns have been raised which we must guard against[21]. We might over-rely on technology to monitor animals, or on indicators which can be automatically measured while missing other aspects, which a skilled person would detect. Good human-animal relationships are themselves an aspect of welfare[6].

Increased use of technology could replace traditional skills of good husbandry and stockpersonship, leading to job losses (or deskilling). Increased automation and industrialisation of livestock industries could drive out smaller farmers. Injury to animals might be caused by on-animal devices (e.g. larger eartags; collars) and finally there are concerns over data ownership and privacy.

Individual pig monitoring

As growing pigs do not usually have ear tags, machine vision approaches for biometric individual identity (e.g. 'face recognition') are in development[19]. This would enable automatic tracking of individual pigs while avoiding the need for tags. Tags come with purchase and labour costs, can cause ear damage (which is painful and reduces carcass value), and tags result in concerns over clean removal to ensure food hygiene at slaughter.

Biometric ID, linked with automated behavioural measurement, could also enable breeding companies to access new rich phenotypic information to select against problem behaviours such as aggression or tail biting, further benefiting animal welfare[20].



Left: RFID ear tagged pigs; Right: 'Greyscale 3D camera image- standing pigs are closer to the camera so appear darker than lying pigs

Recommendations:

- Animal production and efficiency will likely drive adoption of PLF, but there are opportunities for welfare assessment to add value.
- Commercialisation of promising technologies first requires validation at scale under real farm conditions.
- We must guard against potential ethical downsides of PLF: the loss of husbandry skills or jobs, or poor animal welfare due to over-reliance on automated monitoring.

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