Precision livestock farming: could it drive the livestock sector in the wrong direction?

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Abstract

Precision Livestock Farming (PLF) is more likely to be used in large-scale intensive systems in which there is limited potential for delivering satisfactory welfare outcomes. Indeed, PLF may entrench the use of such systems by making them easier to manage. PLF can help prevent poor welfare by identifying early onset of disease and stressful situations, but it may be unable to respond to changing concepts of animal welfare. Mellor (2016) argues it is necessary not only to minimise negative experiences but also "to provide animals with opportunities to have positive experiences" that can arise when animals are kept in "spacious, stimulus-rich environments". Will PLF be able to contribute to such systems?

If PLF is mainly used in the intensive sector, it will be facilitating systems that tend to overproduce and undermine the environment. A Netherlands Presidency paper (2016) states that difficulties in the EU pig and dairy sectors stem from over-production. Intensive livestock production is dependent on feeding cereals to animals which convert them inefficiently into meat. Intensive production's demand for cereals has fuelled intensive crop production which has led to soil degradation, water pollution and biodiversity loss. The FAO (2013) warns that further use of cereals as feed could undermine food security. PLF must shift towards supporting systems that provide positive experiences for animals and primarily use animals to convert inedible materials – grass, by-products, food waste – into food we can eat.

Keywords: precision livestock farming, animal welfare, intensive livestock production, cereals

Introduction

Precision Livestock Farming (PLF) can have a beneficial impact on the health and welfare of animals, for example in enabling early detection of disease or problems such as poor gait score in broilers or malfunctioning of automated equipment for instance feeder and drinker lines. Such early warning systems allow the timely implementation of mitigation strategies (e.g. Berckmans D, 2014; Ben Sassi et al, 2016).

The literature indicates that PLF technologies are mainly used in intensive livestock systems, particularly in intensive pig, poultry and dairy production (e.g. Berckmans D, 2014; Ben Sassi et al, 2016; Tullo et al, 2016). There is a danger that, in facilitating the management of intensive systems, PLF could entrench the use of systems that have low potential for delivering good welfare outcomes.

Could PLF entrench intensive livestock systems with low potential for good welfare?

Intensive livestock production can be broadly defined as the use of systems in which animals are: (i) confined in cages or narrow stalls or are kept at high stocking densities; (ii) subject to genetic selection for fast growth rates or high yields; and/or (iii) subject to mutilations such as tail docking or beak trimming in order to adapt them to systems that fail to respond to their needs. In intensive systems the performance of normal behaviour is impeded to such an extent that welfare is compromised.

The concept of 'welfare potential' is important in this context. Extensive indoor systems and outdoor systems have the potential, if well-designed and well-managed, to deliver good welfare outcomes. In contrast, even where stockmanship is good, intensive systems have little potential to provide satisfactory welfare; welfare problems are inherent in these systems. For example, the UK Farm Animal Welfare Council (2010), an independent body appointed to advise the government, has suggested that it may not be possible to maintain today's egg output of around 300 eggs in the laying cycle while attaining bone strength sufficient to reduce hens' current high vulnerability to bone fractures.

Research shows the importance for welfare of providing suitable enrichment materials for pigs to allow expression of species relevant behaviours (e.g. Spoolder et al, 2011). However, in intensive pig production growing pigs are often housed on fully slatted floors with no effective enrichment materials. As a result the pigs are unable to perform their natural investigation and manipulation behaviours. The absence of enrichment materials and the resultant inability to perform certain key behaviours is the largest risk for tail biting (EFSA, 2007). PLF may be able to detect the first signs of incipient tail biting but there is a danger that this could be seen as a substitute for addressing the root causes of tail biting such as housing pigs in barren conditions.

PLF can be used in the dairy sector to detect lameness. This is of course helpful. However, it is possible that this and other applications of PLF will mainly be used in the intensive, high yielding, zero-grazed dairy sector. This sector is highly problematic in health and welfare terms. High yielding cows produce 10,000 litres or more per annum. The European Food Safety Authority (EFSA) has concluded that: "Long term genetic selection for high milk yield is the major factor causing poor welfare, in particular health problems, in dairy cows" (EFSA, 2009). EFSA added: "The genetic component underlying milk yield has also been found to be positively correlated with the incidence of lameness, mastitis, reproductive disorders and metabolic disorders".

High yielding cows tend to be housed indoors all year round even during the grass-growing season. EFSA has stressed that: "If dairy cows are not kept on pasture for parts of the year, i.e. they are permanently on a zero-grazing system, there is an increased risk of lameness, hoof problems, teat tramp, mastitis, metritis, dystocia, ketosis, retained placenta and some bacterial infections" (EFSA, 2009). Other research too has highlighted the health and welfare problems that are associated with zero-grazing (De Vries et al, 2015; Arnott et al, 2017). In a high priority recommendation EFSA stated that "When possible, dairy cows and heifers should be given access to well managed pasture or other suitable outdoor conditions, at least during summer time or dry weather" (EFSA, 2009).

If PLF technologies can support pasture–based dairying, for example by enabling ready detection of lameness in cows kept on pasture, it will indeed contribute to a system that has a high potential for delivering good health and welfare outcomes. If, however, PLF is used to facilitate the management of high yielding, zero-grazing systems it will help embed systems that have very low potential for achieving satisfactory health and welfare outcomes.

PLF can be used to detect high gait scores in broiler facilities (Ben Sassi et al, 2016). While undoubtedly helpful, this tackles the symptoms not the root cause of the high prevalence of leg disorders in broilers. The primary risk factor for broiler leg problems is high growth rate (Knowles et al, 2008). A European Commission report states that EFSA has "pointed out that around 30% of commercial intensively reared broilers presented leg abnormalities. These biomechanical limitations are a likely consequence of the morphological changes such as the rapid growth of breast muscle moving the centre of gravity forwards and the relatively short legs in relation to the birds' bodyweight. That scientific opinion evidenced how the bones of a fast-growing selected strain are more porous and less mineralised than those of a slower-growing control strain" (European Commission, 2016). EFSA has stressed the need to reduce the proportion of birds with the higher gait scores "even if this objective may require them to reduce growth rate" (EFSA, 2010).

There is a danger that PLF will be used to ameliorate animal welfare within systems that have very limited potential for achieving good welfare and, in so doing, entrench the use of such systems. If that is the case PDF will be failing to respond to Article 13 of the Treaty on the Functioning of the European Union. Article 13 requires the EU and the Member States when formulating and implementing policies on, *inter alia*, agriculture, research and technological development to "pay full regard to the welfare requirements of animals". Legally, the word "full" is of particular importance.

PLF is also poorly equipped to respond to developing concepts of animal welfare. PLF tends to focus on preventing poor welfare rather than on promoting positively good outcomes. However, this minimalist approach is increasingly being queried. There is a growing recognition of the need to take a less narrow view of what constitutes good welfare.

The UK Farm Animal Welfare Council stresses that all farm animals should have 'a life worth living' and a growing number should have 'a good life' (FAWC, 2009). It states that "each farm animal should have a life that is worth living to the animal itself, and not just to its human keeper". It adds that 'a life worth living' requires meeting wants, not just needs.

A recent paper stresses that it is necessary not only to minimise negative experiences but also "to provide the animals with opportunities to have positive experiences" (Mellor, 2016). Such experiences can arise "when animals are kept with congenial others in spacious, stimulus-rich and safe environments which provide opportunities for them to engage in behaviours they find rewarding. These behaviours may include environment-focused exploration and food acquisition activities as well as animal-to-animal interactive activities, all of which can generate various forms of comfort, pleasure, interest, confidence and a sense of control."

Could PLF entrench unsustainable livestock systems?

In primarily supporting intensive production, PLF is furthering systems that are inherently resource-inefficient and that undermine food security and the natural resources on which the future well-being of farming depends. In addition, these intensive livestock systems are dependent on routine preventive use of antibiotics. These aspects will now be examined in detail.

Intensive livestock production is widely assumed to be efficient in part because of its ability to raise a large number of animals in a relatively small space. However, intensive livestock production is inherently inefficient due to its dependence on feeding human-edible crops to animals.

Intensively raised animals are mainly fed on concentrates which are predominantly made up of cereals and vegetable proteins such as soybean meal. For pigs farmed intensively nearly all the feed is concentrates (Mekonnen & Hoekstra 2012). The same is true for intensively produced broiler chickens and laying hens in most regions. In intensive broilers and layers, and in pig production, grains contribute more than 50% of total dry matter (DM) intake, while oil seed cakes range from 9-25% of DM intake (Mottet et al, 2017).

Grain comprises a high proportion of the diet of intensively raised cattle. Data from DairyCo (2013) in the UK shows that high-output cows receive 2629 kg DM/cow/year of non-forage feed while cows at grass receive much less – 1087 kg DM/cow/year. In U.S. beef feedlots the usual practice is to gradually decrease the proportion of forage in the feed over time, eventually reaching rations that can be as high as 90% grain (Shields & Orme-Evans, 2015). In feedlot systems in OECD countries, grains account for 72% of dry matter intake (Mottet et al, 2017).

Substantial quantities of cereals and soy are used as animal feed. European Commission (2017) data show that 55% of EU cereal production is used as animal feed. Globally the figure is 36% (Cassidy et al, 2013). 98% of global soybean meal is used as animal feed (Soyatech, 2017).

Animals convert cereals very inefficiently into meat and milk. Smil (2000) and Lundqvist et al (2008) calculate that on average 1700 calories/capita/day are fed to animals globally but of these only 500 calories/ capita/day are delivered for human consumption as meat and dairy products. This means that for every 100 calories fed to animals in the form of human-edible crops, we receive just 30 calories in the form of meat and dairy products.

A report by the United Nations Environment Programme (2009) suggests that the conversion rate may be even lower. It estimates that a kilo of cereals provides six times as many calories if eaten directly by people than if it is fed to livestock. This indicates that for every 100 calories fed to animals in the form of human-edible crops we receive just 17 calories in the form of meat and dairy products.

Cassidy et al (2013) have calculated calorie and protein conversion rates for different types of animal products when human-edible grain is fed to animals. Their study found that for meat the conversion efficiency is poorer than the 17-30% indicated by earlier studies. It concludes that for every 100 calories of grain fed to animals, we get only about 40 new calories of milk, 22 calories of eggs, 12 of chicken, 10 of pork, or 3 of beef. Similarly for every 100 grams of grain protein fed to animals, we get only about 43 new grams of protein in milk, 35 in eggs, 40 in chicken, 10 in pork, or 5 in beef.

Alexander et al (2017) report that, due to poor conversion rates of crops into meat and milk, livestock production is the largest contributor to losses from the food system of the energy and protein embodied in harvested crops. This study shows that the use of human-edible crops as livestock feed is responsible for greater losses of energy and protein than consumer waste. Mottet et al (2017) show that extensive ruminant grazing systems use less human-edible feed per unit of nutrition produced than industrial monogastric systems or feedlot cattle production.

The sheer scale of the losses entailed in feeding cereals to animals means that this practice is increasingly being recognised as undermining food security. The United Nations Food and Agriculture Organisation (FAO) (2011) states: "When livestock are raised in intensive systems, they convert carbohydrates and protein that might otherwise be eaten directly by humans and use them to produce a smaller quantity of energy and protein. In these situations, livestock can be said to reduce the food balance". The FAO (2013) warns that further use of cereals as animal feed could threaten food security by reducing the grain available for human consumption. While PLF can improve the poor conversion rates of intensive livestock production, it is simply making an inherently inefficient system somewhat less inefficient.

Intensive livestock production's huge demand for cereals has led to the intensification of crop production which, with its monocultures and agro-chemicals, has led to the pollution and overuse of water (Mekonnen & Hoekstra, 2012), soil degradation (Edmonson et al, 2014; Tsiafouli et al, 2015) and biodiversity loss (World Health Organization and Secretariat of the Convention on Biological Diversity, 2015).

Recent studies argue that the only efficient role of livestock is to convert materials that we cannot consume - such as grass, by-products, crop residues and unavoidable food waste - into edible food (Bajželj et al, 2014; Schader et al, 2015). The latter write that "environmental pressures from livestock production could be reduced by focusing on grassland-based ruminant production and by reducing the amount of primary feedstuffs derived from cropland in both ruminant and monogastric feeding rations".

PLF aims to improve product yields in intensive livestock systems (Berckmans, 2014). However, important parts of the EU's intensive livestock sector are suffering from overproduction which tends to depress prices and so undermine farmers' livelihoods. A

Netherlands Presidency paper (2016) states that difficulties in the EU pig and dairy sectors stem from over-production.

A Joint Scientific Opinion by EFSA and the European Medicines Agency (2017) states that "the stress associated with intensive, indoor, large scale production may lead to an increased risk of livestock contracting disease." PLF mainly operates in the intensive sector which tends to depend on routine use of antimicrobials to prevent the diseases that are common in the high density, stressful conditions of intensive production (European Medicines Agency, 2006; O'Neill, 2016). PLF may be able to reduce the use of antimicrobials by identifying individual sick animals at an early stage (Berckmans, 2014) but it is questionable whether it can reduce antimicrobial use to the much lower levels that are the norm in extensive systems (e.g. Danish Ministry of Agriculture, 2014). Data from Denmark show that, although antimicrobial use has been much reduced in Denmark's intensive pig sector, it remains very much higher than in Denmark's organic pig sector.

Conclusion

PLF mainly operates in the intensive sector. By alerting farmers to problems at an early stage it can to a degree improve animal welfare and system efficiency. However, such improvements are made within a system that has inherently low potential for good welfare and is inherently inefficient due to its dependence on feeding human-edible cereals to animals. PLF may primarily be used to enhance the viability of intensive livestock production, to make it more feasible to keep very large herds or flocks in stressful, high density conditions with poor levels of welfare. PLF needs to find a role for itself in supporting an increased uptake of extensive farming which has much greater potential for delivering food security, environmental sustainability and good animal welfare than the intensive model.

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