The shape of welfare: Using precision livestock farming to promote value pluralism in animal welfare

I. Werkheiser[1,*]
[1]*Department of Philosophy, University of Texas Rio Grande Valley, Edinburg, TX, USA*
[*]Corresponding author: Ian Werkheiser, ian.werkheiser@utrgv.edu

Abstract

There is some disagreement about whether animal welfare will be helped or hindered by Precision Livestock Farming technologies in the small but important and growing literature on the ethics of PLF. This paper will argue that these disagreements are sometimes based not on disagreements about current or future empirical facts, but rather different concepts of "welfare," some of which are in tension with one another. At the same time, the discourse around current and future PLF technologies also promises an increase in transparency and traceability of animals through their lives and food production by farmers, governments, and consumers. This paper argues that this transparency and traceability also allows for a partial resolution of the above disagreements around animal welfare, or at least a step forward in the discourse around it. It can do this by creating complex pictures of welfare down to the level of individual animals that can then be used to examine tradeoffs and to inform activism and preference expression by everyone in the food system. We will look at objections to this picture on various grounds, but ultimately this paper argues that the information provided by PLF technologies is useful not only to farmers but to people at every stage of the food system. This information can facilitate discourse and public deliberation around animal welfare, and allow people to better understand and act on the plural values we have toward our relationships with and uses of non-human animals.

Introduction

Precision Livestock Farming (PLF), also called Smart Farming, or subsumed under the larger category of Precision Agriculture, is a suite of quite different technologies including both currently available technological artifacts and processes as well as speculative possibilities. At minimum, PLF technologies monitor various aspects of livestock at the level of the individual animal (hence the "precision"). That information can be provided as-is to livestock managers so that they can make decisions remotely, perhaps from a mobile device (see, e.g., Benjamin and Yick 2019; Berckmans 2017; Neethirajan and Kemp 2021; Norton et al., 2019). Much of the interest around PLF however derives from other uses of that data, including machine learning to identify correlations and predictions more quickly than a human could (particularly when dealing with a large number of animals) or which humans might miss entirely, and connecting that data and analysis with automatic adjustments to inputs (for example, temperature, light levels, feed, water, medicine, etc.) to create closed feedback loops allowing much more automation and less need for constant monitoring and decision-making by people (e.g. Frost et al., 2003; Fernandes et al., 2020; Gauthier et al., 2022). PLF is often discussed in terms of increased efficiency as the exact needs of individual animals can be met just in time, rather than overestimating needs such as food or medicine (Pomar et al., 2009 and 2011). It is also discussed as a way for animal operations to get much larger, whether as a response to market incentives or to meet the probable growth in global demand for food and particularly animal protein (estimated to double by 2050 by the Food and Agriculture Organization of the UN, 2019), while still maintaining qualities associated with good husbandry, such as lower ecological impact, quality of the meat and other products produced, or the welfare of the animals on the farm (Benjamin and Yik 2019; Tullo et al., 2019; Lovarelli et al., 2020). Given the potential benefits of PLF, at least many of these technologies are plausibly on the cusp of widespread

adoption in developed countries, though unanticipated technical problems, cost, and resistance from users may delay this adoption.

All of these have been examined in the small but important and growing literature on the ethics of PLF, including questions about the ways in which the technology encourages farm concentration into fewer large, more industrial farms at the expense of smaller, family-owned farms; or the changing job skills required to work on farms using PLF and the effects this might have on the agricultural workforce and the social sustainability of farming. In this paper we will focus on the possible effects of PLF on animal welfare. In section one, we will look at the work on animal welfare that directly considers or is highly relevant to PLF. With this as background, in section two we will argue that despite some work to the contrary, animal welfare is an inherently complex concept, and that some aspects of animal welfare that we (and the animal in question) would desire are in tension with other equally desirable aspects. In section three, we will look at the possibility of PLF technologies to address these tensions by creating transparent, complex pictures of welfare for individual animals, which can then be used to examine tradeoffs and to inform activism and preference expression by everyone in the food system. In section four we will look at objections to this picture on various grounds. Ultimately, this paper argues that the information provided by PLF technologies is useful not only to farmers but to people at every stage of the food system, from production to distribution to preparation to consumption. This information can facilitate discourse and public deliberation around animal welfare, and allow people to better understand and act on the plural values we have toward our relationships with and uses of non-human animals.

Animal welfare in PLF

The degree to which PLF can improve animal welfare, whether it is as an influential paper put it, "An engineer's daydream or nightmare, an animal's friend or foe, and a farmer's panacea or pitfall" (Wathes et al., 2008) is a matter of some debate, in part because as another paper on the topic says, "Much of the technology is still being developed and has not yet been widely enough applied in practice for its full implications to be clear. Precision agriculture as applied to livestock is therefore at a crucial stage where its impact on animal welfare could become either positive or negative" (Dawkins 2021). Some papers argue that the ability to monitor animals, their environment, and their outputs continuously for various signs of distress or desire, and then either inform people who can address these issues or automatically make adjustments to the animals' environments will naturally be a way to increase animal welfare. (e.g. Berckmans 2014; Vasseur 2017; Norton et al., 2019; Li et al., 2020) Others have argued that there may be unanticipated effects which could ultimately harm animal welfare overall. One such possible effect is the further objectification of the animals, resulting in a reduced level of care and husbandry (Bos et al., 2018) and the loss of the kinds of particular relationships of care that people responsible to animals have with them (Werkheiser 2018).

Some of these concerns will no doubt be settled as the technology develops, so that they can either be eventually dismissed or addressed and mitigated once they are more fully understood, rather than speculated about. Indeed, some of these speculative concerns will hopefully shape the development of future PLF technologies, such that hazards can be avoided or reduced (see, e.g., Thompson et al., 2021). Even given all this, however, there will be some remainder of distrust and disagreement over animal welfare under various PLF systems. This is because large elements of what counts as "animal welfare" are contested, including what would satisfy a minimal level of welfare, how welfare should be measured, when we would even consider welfare to be improving or diminishing, and what an ideal of animal welfare looks like.

Differing conceptions of animal welfare

As just mentioned, there is serious disagreement among people committed to animal welfare about what the term even refers to, let alone how to pursue it. This disagreement is not merely a set of differing values,

interests, and models on the part of animal welfarists. Rather, different visions of animal welfare are actually in tension with one another, such that pursuing one will *reduce* another, placing animal welfare activists in direct conflict.

As the philosopher Paul Thompson has pointed out, the "three domains" model of animal welfare common among many animal scientists and veterinarians has unavoidable tensions built into it, though this is underdiscussed by people who use the model. The domains of concern for animal welfare in this model are the body, the mind, and the nature of the animal. The body includes typical concerns of veterinary medicine, including mortality, morbidity, and growth and development. The mind includes cognitive measures of the experiences of the animal, including pain, suffering, frustration, and stress. The nature of the animal includes behaviors that the animal typically engages in, including (for chickens) nesting, wing flapping, dust bathing, and perching. An example of tensions arising in this model is whether to allow those chickens to go outside. Being outside allows chickens to engage in many species-typical behaviors such as hunting for insects. However, being outside will have more ambiguous mental effects as they can enjoy satisfying curiosity while also increasing their stress as they respond to predators passing overhead. Physically, being outside is unambiguously hazardous, as chickens are made vulnerable to injury, disease, predation, and death. Here pursuing one of these domains actually reduces welfare in one or more of the others (Thompson 2015). An example from PLF technology is using sensors to monitor and autocorrect conditions in a chicken's environment, such as food being made available when it is hungry, or adjustments to temperature and light levels based on stress signals. These would doubtless reduce the stress the animal is experiencing, but would do so by creating a more artificial environment unlike the one in which a chicken is likely to engage in species-specific behaviors. Unavoidable tensions exist between optimal environments or quantities of food provided for an animal's bodily health, mental pleasure and satisfaction, and species typical behaviors. This should not surprise us, as most of us would easily grant that the same is true for humans as well as chickens.

Some authors, such as Bernard Rollin, are optimistic that people interested in animal welfare will be able to reach a consensus to move forward (see, e.g., Rollin 1981 and 1995), and given the poor welfare conditions of many animals in livestock farming today, it is highly likely that important changes could be made that would be widely applauded by anyone concerned with animal welfare. Yet these differences remain, and it is unlikely that, for example, people who want to minimize the mental suffering of animals will convince those interested in letting animals lead as "natural" a life as possible to breed blind chickens or alter the DNA of pigs to minimize stress hormone production. Fortunately, the high degree of monitoring and traceability possible with PLF allows for clarity at a minimum, and possibly a way forward.

The shape of welfare

While many questions remain about the ways PLF will develop in the future, there are two predictable trends which can help us find a way forward through conflicting conceptions of animal welfare. The first is an increase in the ability to monitor individual animals, which is nearly a definition of PLF and is being pursued by a host of engineers and designers. The second is the increased ability to store and use that data for a variety of analyses and tracking. As a technical matter, this second trend is merely a matter of equipping the PLF systems with memory for long-term storage, and making that stored data accessible for analysis and manipulation. As a social matter, however, the second trend might face some difficulties, as will be discussed in the next section. Passing over those for now, however, these two trends lead to the possibility for transparency of the welfare of the animal prior to slaughter, and the traceability of meat or other animal products back through the entire chain of their distribution and production. A common promise of PLF is that the close monitoring of animals will allow farmers, veterinarians, and other users of the technology to ensure the animals' welfare and that welfare concerns can be built into the system to address distress faster and more directly than people could at a large operation (Benjamin and Yik 2019). Others writing on PLF have

emphasized the potential for data to be saved and shared, allowing for consumers, regulators, public health officials, and others interested in the origin of particular animal products to trace them with high accuracy and security using blockchain and similar technology, whether that is to trace disease for recalls or to purchase products that come from animals that had a high degree of welfare (Neethirajan and Kemp 2021).

Bringing these trends together with the discussion in the previous section about differing conceptions of welfare and the plurality of values around it, it would be quite feasible in principle to monitor the welfare of the animals behind a given carton of eggs or steak at the grocery store, and to display it to consumers. The difficulty as mentioned above is the differing conceptions of welfare. Fortunately, due to the wealth of data generated and the ability to analyze it in different ways, there is no need to settle on a single concept of animal welfare. Rather, this technology can accommodate – and even promote – value pluralism by monitoring a wide variety of different animal welfare metrics and displaying all of them. One way to do this would be a report card, with scores for different kinds of welfare – this animal was healthy throughout its life but due to being isolated had a lower score for environmental stimulation and socialization with conspecifics, whereas this animal lived in a small group outside but experienced some diseases that had to be treated with antibiotics.

However, a report card might imply that it would be possible to get a maximum score in all categories. To better represent the tensions between differing goals, another option that seems promising is a multi-axis "spider chart," also known as a "radar chart," with multiple radii for the different welfare measures and distance from the center indicating magnitude. This has several advantages over a scorecard. One is that it creates a recognizable polygon that people can look for and understand as a salient indication that it is emphasizing the things they care about. Another is that by putting axes opposite from one another, it is easier to indicate that they are in tension. Indeed, if these scores are used not only as a label to be observed passively but also as something to be manipulated for learning, perhaps in an app that will let you search for products matching the shape of welfare you want, or to help learn about tradeoffs in animal welfare, learners would be able to see how pulling one axis tended to decrease its counterpart in many cases.

Objections

There are several likely objections to creating these shapes of welfare, coming from the perspectives of animal activists, consumers, and producers, which I will address here. It bears mentioning first however that there are other possible objections from regulators, international trade organizations, and other groups that are beyond the scope of this brief essay on the topic. However, responses would be along the same lines as the ones below and as discussed in the conclusion.

From animal rights activists, there is likely to be a concern that promoting the "welfare" of animals which are exploited and killed for products will provide a fig leaf to ignore the moral question of whether to engage in these practices at all. This is certainly possible, and is a critique that can be leveled against any animal welfare reform, but as Paul Thompson has pointed out, the questions of whether it is ever acceptable to consume animal products, or whether it is acceptable to do so with present-day methods for raising livestock, are logically independent from the question of how present-day livestock systems can be modified in order to improve animal welfare. That third question matters, and importantly it matters from the perspective of the animals (Thompson 2015, pp. 134-137). A related concern is that this focuses too much on consumer choice, implying that this is the best or even a possible way to address systemic problems, which some people deny. A potential comfort for those with this concern might be that if the maximum score on these metrics are impossible to achieve in a livestock operation, or if the overall magnitude of these shapes do not increase over time after implementing them because consumer preference is not expressed or does not affect producers, this might help their argument for systemic and policy-based change. When advocating for those policy changes, these shapes and the differing conceptions of welfare would still have the

possibility of facilitating that conversation in productive ways that acknowledges the plurality of values people have around animal welfare. There might also be concerns that a particular welfare measure is irrelevant or counterproductive. As we saw in section two, however, there simply are mutually incommensurate but individually plausible conceptions of animal welfare. Including them in this object allows for public discussion about tradeoffs and other public reasons that encourage engagement with the issue, rather than a single welfare score that might be simply ignored if some people thought it did not represent their values.

From consumers, there is likely to be a concern that they do not want this level of information, while other consumers are likely to complain that it does not provide enough information to make them confident about their purchase – a common dilemma about transparency and labelling initiatives. One response is that the minimal amount of engagement required is *quite* minimal – a graph with a polygonal shape traced out inside it on the side of a product or a QR code linking to the graph, either of which can be ignored. However, it also allows for much deeper engagement than is currently possible. Using an app, consumers would be able to understand the reasoning and measurement that went into the score, the meaning of the different axes, and perhaps (though this might be a conflict with concerns in the next paragraph) access to the detailed data used to make these assessments for this particular product, and the animal it comes from. Over time, these shapes might have some effect even on those that do not directly engage with them, but they both allow for and do not require in-depth engagement.

From producers, there is a likely concern about creating, storing, and providing this data. It might require too much work on their part, and opens them up to regulation, the loss of trade secrets, and consumer pressure that might harm their operation. These are real concerns, and are quite common with regulation and monitoring schemes. As such, there are several well-known roads for us to go down. If the benefit of this labelling is not too overwhelmingly high and the harm of not following it is not too catastrophic, then it could be voluntary, much like organic or fair-trade labels. Like those labels assessment would need to be conducted by a third party, but producers could then choose to opt in or not, and market preference might encourage more to do so over time. If we decide democratically that the label is too important to permit voluntary compliance, compensation could be given to producers to account for any losses or to help them transition. It is also worth pointing out that if PLF becomes widely adopted, the transition would be much simpler for farmers who are already gathering and storing the data internally than it would be currently. Either way, the security, reliability, and affordability of gaining and using the information would be important problems to solve but not insurmountable ones. There might also be concerns that the label does not actually reflect the animal welfare work done on a particular livestock operation, such as the relationship a farmer has built up over time with their animals. This invisibility of the work on a farm by an external assessment is a common concern (along with the expense of regulation) in the "better than organic" movement among small-scale farmers who are not certified organic (see, e.g., Follett 2009). To address this concern it is important to incorporate not only the voices of veterinarians, animal scientists and consumers in the creation of these shapes, but to also bring in a wide variety of stockpeople and farmers from quite different operations with quite different sizes. The inclusion of more axes to reflect their values, and careful consensus building around how the axes will be assessed, can reduce the worry that these shapes miss out on what they know.

Conclusions

A common theme emerges from many of the responses to the concerns in the previous section: this chart and the shapes it produces are a kind of "boundary object" (Star and Griesemer 1989), which promotes and facilitates public conversation between groups with quite different values and concepts. People are motivated to make sure the shapes are useful to them, and in order to do so they must articulate their values

in this shared framework, and acknowledge that other values and concepts are at play. It also opens up the possibility of adaptive management, in which groups and individuals with differing values and concepts can agree to a common metric and use different tactics to promote it while revisiting the metric periodically to ensure that increasing it does in fact promote these disparate values. In this way, it is possible for diverse actors with a plurality of values to coordinate their actions (see Norton 2005 for a detailed description of this process) and work toward common goals that benefit everyone by their own lights. Allowing people to prioritize the shape of welfare that is most meaningful to them, working together to increase the overall size of the shapes (thus increasing welfare overall), and having open conversations about the tradeoffs between these values would be an important contribution of PLF to animal welfare beyond the immediate benefits usually discussed in the engineering and design literature on the topic.

References

Benjamin, M., and Yik, S. (2019) Precision livestock farming in swine welfare: A review for swine practitioners. *Animals* 9(4), 133.

Berckmans, D. (2014) Precision livestock farming technologies for welfare management in intensive livestock systems. *Revue Scientifique et Technique* 33(1), 189-196.

Berckmans, D. (2017) General introduction to precision livestock farming. *Animal Frontiers* 7(1), 6-11.

Bos, J.M., Bovenkerk, B., Feindt, P.H., and Van Dam, Y.K. (2018) The quantified animal: Precision livestock farming and the ethical implications of objectification. *Food Ethics* 2, 77-92.

Dawkins, M.S. (2021) Does smart farming improve or damage animal welfare? Technology and what animals want. *Frontiers in Animal Science* 2, 736536.

Fernandes, A.F.A., Dórea, J.R.R., and Rosa, G.J.D.M. (2020) Image analysis and computer vision applications in animal sciences: An overview. *Frontiers in Veterinary Science* 7, 551269.

Follett, J.R. (2009) Choosing a food future: Differentiating among alternative food options. *Journal of Agricultural and Environmental Ethics* 22(1), 31.

Frost, A.R., Parsons, D.J., Stacey, K.F., Robertson, A.P., Welch, S.K., Filmer, D., and Fothergill, A. (2003) Progress towards the development of an integrated management system for broiler chicken production. *Computers and Electronics in Agriculture* 39(3), 227-240.

Gauthier, R., Largouët, C., and Dourmad, J.-Y. (2022) Prediction of litter performance in lactating sows using machine learning, for precision livestock farming. *Computers and Electronics in Agriculture* 196, 106876.

Li, N., Ren, Z., Li, D., and Zeng, L. (2020) Automated techniques for monitoring the behaviour and welfare of broilers and laying hens: Towards the goal of precision livestock farming. *Animal* 14(3), 617-625.

Lovarelli, D., Bacenetti, J., and Guarino, M. (2020) A review on dairy cattle farming: Is precision livestock farming the compromise for an environmental, economic and social sustainable production? *Journal of Cleaner Production* 262, 121409.

Food and Agriculture Organization of the United Nations (2019) Meat and meat products. *https://www.fao.org/ag/againfo/themes/en/meat/home.html*. Last accessed: May 2022.

Neethirajan, S., and Kemp, B. (2021) Digital livestock farming. *Sensing and Bio-Sensing Research* 32, 100408.

Norton, B.G. (2005) *Sustainability: A philosophy of adaptive ecosystem management*. University of Chicago Press.

Norton, T., Chen, C., Larsen, M.L.V., and Berckmans, D. (2019) Precision livestock farming: Building 'digital representations' to bring the animals closer to the farmer. *Animal* 13(12), 3009-3017.

Pomar, C., Hauschild, L., Zhang, G.-H., Pomar, J., and Lovatto, P.A. (2009) Applying precision feeding techniques in growing-finishing pig operations. *Revista Brasileira de Zootecnia* 38, 226-237.

Pomar, C., Hauschild, L., Zhang, G.H., Pomar, J., and Lovatto, P.A. (2011) Precision feeding can significantly reduce feeding cost and nutrient excretion in growing animals. *Modelling Nutrient Digestion and Utilisation in Farm Animals*, 327-334.

Star, S.L., and Griesemer, J.R. (1989) Institutional ecology,translations' and boundary objects: Amateurs and professionals in berkeley's museum of vertebrate zoology, 1907-39. *Social Studies of Science* 19(3), 387-420.

Thompson, P.B. (2015) *From field to fork: Food ethics for everyone.* Oxford University Press, USA.

Thompson, P.B., Thorp, L., Ginsburg, B.L., Zivku, T.M., and Benjamin, M. (2021) Early ethical assessment: An application to the sustainability of swine body scanners. *Sustainability* 13(24), 14003.

Tullo, E., Finzi, A., and Guarino, M. (2019) Environmental impact of livestock farming and precision livestock farming as a mitigation strategy. *Science of the Total Environment* 650, 2751-2760.

Vasseur, E. (2017) Animal behavior and well-being symposium: Optimizing outcome measures of welfare in dairy cattle assessment. *Journal of Animal Science* 95(3), 1365-1371.

Wathes, C.M., Kristensen, H.H., Aerts, J.M., and Berckmans, D. (2008) Is precision livestock farming an engineer's daydream or nightmare, an animal's friend or foe, and a farmer's panacea or pitfall? *Computers and Electronics in Agriculture* 64(1), 2-10.

Werkheiser, I. (2018) Precision livestock farming and farmers' duties to livestock. *Journal of Agricultural and Environmental Ethics* 31, 181-195.