PRECISION FARMING AND ANIMAL WELFARE

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Globally, agriculture is under unprecedented pressure to meet the twin demands of feeding the rising human population and mitigating the effects of climate change by becoming more efficient and more 'sustainably intensive'. As a recent FAO report[1] put it: "Agriculture will need to produce more food from the same or less land, using less water, energy and other inputs and reducing waste and adverse environmental impacts including greenhouse gas emissions". These pressures are particularly great on livestock production which now uses 70% of available agricultural land and 8% of global water as well as emitting 20% of global greenhouse gases. Yet demand for meat and dairy products continues to rise. Meat production across the world has tripled over the last 4 decades and is projected to increase by 73% by 2050. As of now nearly 60 billion chickens, 1.4 billion pigs and 300 million cattle are killed for meat each year. If this increasing demand is to be met by more efficient production, this will mean that more animals will be reared with less space, less food, less waste and less water. And what does this mean for the welfare of the animals themselves? Even where 'sustainable' is specifically defined to include animal welfare[2] the power of the word 'intensification' is so great that to many people, the idea of livestock farming becoming even more efficient and even more intensive looks like a licence to accelerate and exaggerate the very conditions that they hold responsible for welfare problems such as lameness in cattle and chickens in the first place. Where, if anywhere, does animal welfare fit in to the brave new world of efficiency-driven, climate-friendly farming?

Research at the University of Oxford on the welfare of broiler (meat) chickens aims to show that, by working closely with commercial poultry producers, more efficient farming may actually lead to improvements in animal welfare. This is because some of the greatest improvements in efficiency come from reducing mortality and waste and keeping animals in conditions that make them less likely to be injured or to succumb to disease. These are often exactly the same conditions that improve their welfare. For example, improving the quality of air through good ventilation and the quality of litter under their feet so that it is dry and doesn't give off a lot of ammonia leads to lower mortality, lower levels of foot and leg damage, which in turn means healthier, more comfortable birds[3] and a better quality end product that is safer for humans to eat.

... brave new world of efficiency-driven farming? ...

Of course, animal welfare and efficient agriculture do not always coincide perfectly and there will be improvements in animal welfare that do not necessarily stack up commercially just as there will be efficiency gains that would be unacceptable to the public on welfare grounds, such as crowding the animals into a smaller space. But there is a large area of overlap that has yet to be fully explored. The development of new technologies – sometimes referred to as 'precision farming' – is now showing us that it may be much larger than we previously suspected. What is important for animal welfare is that the economic gains of high standards of animal welfare are built into efficient farming at every step of the way.

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A collaboration between Stephen Roberts and Thomas Nickson in the Department of Engineering Science, and Russell Cain and myself in the Department of Zoology at Oxford has led to the successful development of smartphone software to help farmers manage their flocks more effectively and with higher welfare. The cameras on the smartphones monitor the movements of chicken flocks and the images are analysed on the spot by the phones' computers. The cameras do not track the movements of individual birds (that would be quite overwhelming in a house of 30,000 or more chickens) but each phone simply delivers a 4-number description of flock mobility every 15 minutes. Remarkably, these four numbers, which describe the average movement of a flock and unusual features of the way it moves, allow us to detect flocks in which there is, or will be, a welfare issue. For example, the software can detect whether a flock is made up largely of healthy birds that can all walk around easily or whether the flock contains a proportion of lame birds mixed in with the healthy walkers. It can predict which flocks will have the highest and lowest mortalities and the highest and lowest levels of damaged legs. The software can even predict which flocks will develop damaged legs and feet later on when the chicks are as young as 3 days old when they as yet show no external sign of damage.

... monitor the movements of chicken flocks ...

This ability to pick up health and welfare problems at a very early stage is potentially of great value to farmers as it enables them to intervene and take pre-emptive action before a situation becomes serious. It is also

potentially of great importance in actually reducing the total amount of antibiotics and other medication used in agriculture by enabling famers to target their treatments where they are really needed. At the same time, it is important to stress that no smartphone with a camera can replace a good stockman, but it does provide an extra eye for when he or she cannot be present and is also a way of telling them that things are not going quite as they should be. To respect the privacy of the farm staff, our smartphones do not store visual images – just numbers – so no-one need feel they are being spied on. It's the behaviour of the chickens that interests us.

... intervene and take pre-emptive action ...

Our current research is aimed at exploring further this important interface between health, welfare, behaviour and disease resistance. We are seeing whether our smartphone devices can detect which flocks are carrying specific diseases. Working with Martin Maiden, Frances Colles and Adrian Smith, we are looking at how the statistics of flock movement vary with flocks known to have different levels and genotypes of *Campylobacter, Salmonella, Clostridium* and Coccidia. Precision farming that sets 'efficiency' as its only goal and ignores the implications that this might have for human and animal disease, will be good for no-one. The agriculture of the future, if it is to deliver what is required of it, needs to be set a wide range of goals that includes the health and well-being of both humans and non-humans.

None of these goals will be achieved, however, if farmers cannot also make a living from what they do. So precision agriculture that has animal health and welfare at its heart needs also to take into account the commercial realities of farming in a world of scarcity of feed resources, increasing demand, pressure on land and other constraints. For this reason, we are developing our smartphone system in conjunction with major poultry producers, not only so that they can see the advantages of precision farming with high welfare but also so that we understand what works best for them and can adjust our system to what they need. We currently have commercial trials in the UK, France and the US, all successfully using the system and in each place, the support we have received from the producers themselves has been crucial for the success of our trials. We compare our camera data with what the producers are finding from their own production measurements so that we can give them information that helps them to manage their flocks more efficiently as well as with higher welfare.

... health and well-being of both humans and non-humans ...

Making links between animal welfare and efficient, commercial production does not detract from ethical arguments that animal welfare should be supported because it is of ethical value in its own right, but bolsters and consolidates them. Just as ecologists increasingly put a monetary value on the 'services' or 'natural capital' that a healthy environment provides to make the case for conserving habitats and preventing the loss of biodiversity, so the case for animal welfare based on the benefits it brings to humans, including financial benefits, will be stronger than just hoping that it will somehow come about through consumer pressure alone. Making animal welfare a priority in the efficient farming of the future is much more likely to be achieved if it can be firmly linked to human food security, animal and human health and financial competitiveness. We hope that our inexpensive and easy to use phone app, developed in conjunction with key stakeholders in the farming and food industry, will go some way to doing just that.

References

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3. Dawkins, M.S., et al., Chicken welfare is influence more by housing conditions than stocking density. *Nature* 427:342-344 (2004).