FARM ANIMAL WELL BEING

13th Boehringer Ingelheim Expert Forum

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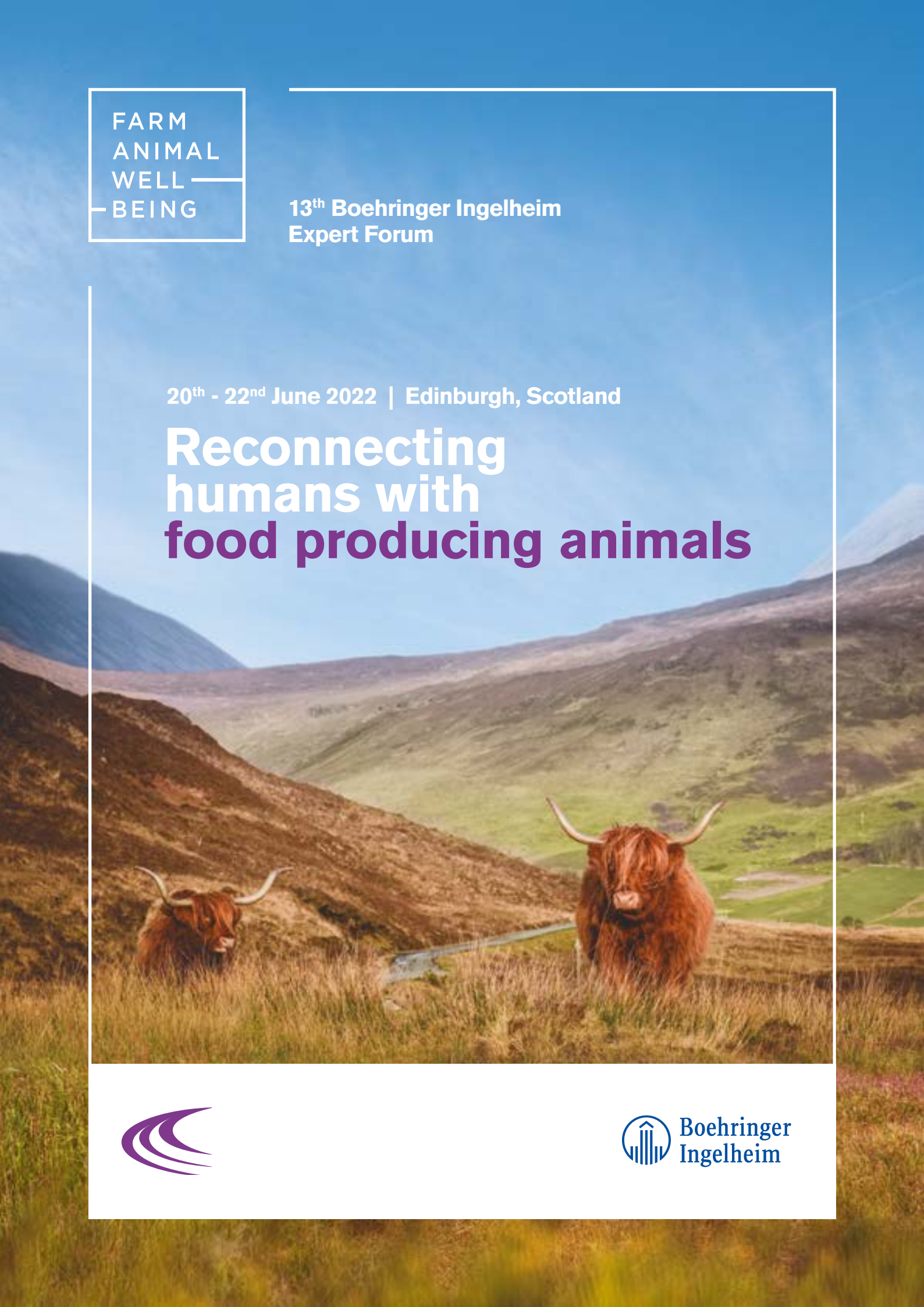
Reconnecting humans with food producing animals



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FARM ANIMAL WELL BEING

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FARM ANIMAL WELL BEING

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Dr Emma Roe BSc PhD is an Associate Professor in Human Geography at the University of Southampton and Honorary Research Fellow at the School of Veterinary Sciences, University of Bristol. She is a leading trans-disciplinary more-than-human geographies scholar within the field of animal geographies and agro-food studies. Current research is related to Global Challenges including creating a carbon-neutral agro-food system, tackling the rise in anti-microbial resistance and most recently supporting a return to public transport through and beyond the Covid-19 pandemic. She is often found working with those outside her discipline (veterinary science, microbiology, health science, rural studies, anthropology, sociology and economics, artists) and with community and industry partners where relevant. She is co-author with Henry Buller of Food and Animal Welfare (Bloomsbury, 2018) that is the first wide-ranging study to explore the economies, cultures and politics of food through the lens of Animal Welfare and a co-editor of Participatory Research in a More-Than-Human World (Routledge, 2017). Her work has received research funding from the UK Economic and Social Research Council, UK Arts and Humanities Research Council, the European Commission, the British Academy, the Wellcome Trust, the Global Challenges Research Fund, and the Animal Welfare Foundation. She has written over 30 peer-reviewed journal articles, book-chapters, reports and short articles. She was awarded an Understanding Animal Research Openness Award in 2020 for The Mouse Exchange.

How the wider world learns of on-farm welfare through the economies, cultures and politics of the agro-food network

Animal welfare offers a vital lens through which to explore the economies, cultures and politics of food (Buller and Roe 2018). From the practicalities and limitations of establishing a basic standard of care for livestock, to the ethics of selling welfare as a product in the supermarket, it is worth exploring how animal welfare is defined, advocated, assessed, and implemented by farmers, veterinarians, distributors, and consumers. Therefore, whilst on-farm welfare is a practice of care that is achieved through practices of human-animal interaction, I will discuss the various ways that the wider world learns about it and which in turn shapes on-farm practice. How does farm animal welfare gain visibility that can continue to sustain and support improvement in on-farm welfare?

By exploring the economies, cultures and politics of food through the lens of animal welfare, this can give us understanding of how the consumer and the citizen learns about and gives cultural, economic and political value to food animal welfare, and also the limitations of these efforts. Drawing upon empirical research conducted through a number of funded research projects over the last 15 years, I chart the development of welfare standards and criteria within the food sector, identifying the key but very different roles that legislation, retailing and NGOs have played in that development. I consider the processes and practices of assurance and labelling.

Assembling welfare through the agro-food network.

The growing visibility of farm animal health and welfare in the food chain results from two principles. Firstly, the need for food chain actors, from producers to retailers, to demonstrate to consumers and citizens verifiable conformity to both public and private regulation governing the treatment of farm animals. And, secondly the desire among food chain actors to segment food markets thus establishing differential pricing structures.

In this paper I consider the mechanisms of that commodification and marketing by examining the manner in which farm animal welfare is assembled through the food supply chain (as opposed to how it is practiced on the farm). This is presented in the form of four frames:

1. Diligence and responsibility;
2. Segmentation;
3. Assurance;
4. Labelling.

An important point here is that welfare is assembled within the agro-food network. Different actors assemble it and give normative meaning in the different ways it is assembled scientifically, ethically, aesthetically, commercially, through practices of care, through anthropomorphic sensibility, through broader notions of food quality, through a sense of responsibility and so on. For these assemblages to be accepted by all relevant parties, a degree of convergence over objectives is required, certain conventions need to be established and certain material forms, objects and devices have to be agreed upon. But I also show how specific market devices – in this case, certificates, brochures, audit forms, inspections, brands – play an important role in establishing and formalising the conventions that enable the welfare of farmed animals to become marketable.

This approach sits alongside other examples of how markets can be 'civilised', including Miele and Lever (2013) who investigate the development of the Welfare Quality© assessment protocol as just such a 'techno-ethical device' for enabling the marketization of animal welfare. Both demonstrate how quality conventions assemble through commonly agreed rules and practices of engagement, the materiality of the animals, their corporeality and behaviour with socially constructed notions of product quality and collective social performance. Together, these constitute a set of standards, which renders a particular 'quality' economic and thereby marketable.

Limits to animal welfare labelling

Through taking this approach to understanding how welfare is assembled within the agro-food network, it leads us to examine in close detail the work that the visibility of animal welfare at the end point of the commercial food chain, the point of sale, can achieve in food chain and welfare governance. What is the role of food product labelling and the demand-driven market they serve as a viable and additional form of both food chain and welfare governance?

It is, for example, clear that the EU ban on battery cages has done a great deal more for raising the capacity for improved welfare in egg production than labelling per se. Labels, are staged, assembled and carefully framed both in terms of content and presentation. They are designed to be persuasive rather than prohibitive, to encourage rather than to exclude. Moreover, they tell us what we want to hear. One of the arguments against a 'method of slaughter' label, which many concerned about the prevalence of non-stun slaughter have argued for, is that it would reveal how much meat from non-stunned products enters the conventional, rather than the specialist, food system.

In some ways, it seems a complicated route: to target consumers – to impact producers – to improve the lives of animals. As long as these animal lives are a marketable commodity, this has certain logic to it. Indeed, the competitive power of labels and brands has undeniably been a significant force in achieving market-based improvements in welfare standards in certain areas as retailers and food chain actors effectively compete to outbid each other in the quality and reach of their assurance, seemingly independently of the consumers themselves.

On the other hand, consumers, certainly of animal products need to be more aware of how these products are produced and of the connectivity the lives of consumed and consumer share. Consumers are concerned about animal welfare, yet many do not feel responsible for it, preferring to exercise what Harper and Henson (2001) have called a 'voluntary ignorance' or to transfer responsibility to other actors. More should be done to actively challenge their reluctance to think about the workings of animal husbandry.

Increasingly, the proliferation of market-driven schemes, culminating in labels and brands, marks a retreat from more regulatory forms of welfare governance, so effective in the EU banning of battery cages. Yet, in this, labels and the assurance schemes behind them, act as fetishes which, for Freidberg (2003b: 33), protect as much as reveal, shielding retailers and food companies from the glare of adverse media interest. On its own, ethical consumption is also a form of calculation that reinforces identity but arguably has little transformative power. On the other hand, consumers, certainly of animal products need to be more aware of how these products are produced and of the connectivity the lives of consumed and consumer share. Consumers are concerned about animal welfare, yet many do not feel responsible for it, preferring to exercise what Harper and Henson (2001) have called a 'voluntary ignorance' or to transfer responsibility to other actors. More should be done to actively challenge their reluctance to think about the workings of animal husbandry.

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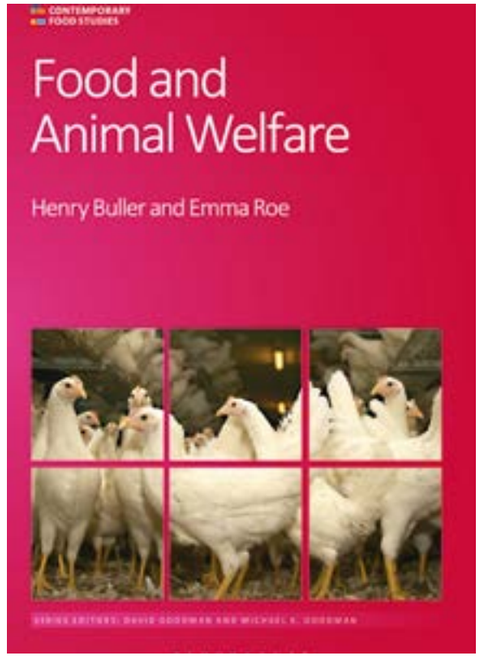
Further transformations? Three connectivities – sentient materialities, animal welfare science innovations and One Health/One Welfare.

I have emphasised the importance of seeing food production and food consumption, not as distinct arenas of policy or practice, but rather as connected and interrelated two-way processes, involving the co-presence of the sentient animal, whether in living body or in final product and the sentient human, carer or consumer. Looking to the future, and returning to the broad lens of the economies, cultures and politics of food I propose opportunities of further transformation in food animal welfare through three connectivities.

The first is the concept of 'sentient materialities' that embraces the challenges of economising animal-based protein production, processing and consumption by fully engaging with the animal as a sentient material body. It is a concept sensitive to the events of encounter between humans and animals, and human eater and animal-based food protein.

The second is empirical through ongoing innovation in animal welfare science that will introduce new ways of knowing the animal and of using and communicating that knowing within the food sector.

The third is a novel policy framework. – One Health/One Welfare for joining up human health and welfare with food animal health and welfare in a more holistic and arguably mutually reinforcing way.



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FARM ANIMAL WELL BEING

Dr. Jennifer Van Os
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What would a cow prefer?

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Jennifer Van Os is an Assistant Professor of Dairy Science and Extension Specialist in Animal Welfare at the University of Wisconsin-Madison, USA. With her 40% research and 60% extension appointment, she conducts applied research and translates scientific findings to stakeholders.

Dr. Van Os received her PhD in the interdisciplinary Animal Behavior graduate program at the University of California-Davis, USA and conducted postdoctoral research in the Animal Welfare Program at the University of British Columbia, Canada. The research in her lab at UW-Madison focuses on understanding, evaluating, and improving the welfare of dairy animals. By measuring behavioral and physiological outcomes, we can learn to understand the cow or calf's perspective and improve their welfare. The goal of Dr. Van Os' extension program is to promote best practices in management and housing to help the dairy industry adapt as our scientific knowledge about animal welfare continues to grow.

The mission of my applied research and extension-outreach program is to improve our understanding of animal welfare and to incorporate this knowledge into best practices on dairy farms. My lab's motto is "giving cows a voice through science." By using scientific techniques such as preference and motivation testing, we can give farmed animals the opportunity to express what they prefer and what is important to them. By designing experiments to ask the animals questions thoughtfully, we can gain insights into their needs and thereby improve their welfare. Such research has revealed knowledge about what dairy cows prefer regarding aspects of their care, including housing environments, management and husbandry practices, and the way they are directly handled by human caretakers.

Voting with their feet

An analogy for preference testing is letting animals "vote with their feet." Preference can be evaluated either in short-term testing scenarios (e.g., Y-mazes) or by observing the animals' behavior in their home environments. When animals spend more time with one option or choose it more frequently, we infer their preference.

A limitation of preference testing, however, is that the outcomes merely represent a ranked choice among the options provided. It is not always clear whether the more chosen resource is the better preferred of two desirable options or the less aversive of two undesirable options (i.e., "the lesser of two evils"). For example, dairy cows tested in a Y-maze preferred a handler who stood quietly compared to one who hit and shouted at them; however, this test could not distinguish between two aversive options (a handler who shouted vs. one who applied an electric prod; Pajor et al., 2003). The options offered in a preference test should be chosen carefully using hypotheses based on inferences from existing literature or by considering the natural history of the species.

How much is it worth to them?

Motivation testing can provide additional insights into how much an animal values something (i.e., access to a resource or opportunity to perform specific behaviors). This concept is based on consumer demand theory, with animals asked to "pay a price" by performing work to gain access (e.g., pushing increasingly heavy weights, pressing a button or lever an increasing number of times,

Figure 1. On a Wisconsin summer day with cloud cover, some dry cows have chosen to leave the freestall barn for the pasture. (Photo: Kim Reuscher, Van Os lab)

or navigating obstacles). The assumption is that the more important something is to an animal, the harder they would be willing to work to gain access. Conversely, motivation testing can also be used to assess the aversiveness of an experience, with animals working harder to avoid or get away from something they find negative.

Do cows prefer barns or pasture? The answer is both, or it depends

Motivation and preference tests have provided insights into the importance of pasture access for dairy cows. Members of the public often expect dairy cows to be housed on or have access to pasture (Schuppli et al., 2014). In addition to evaluating human stakeholders' expectations for pasture access, however, it is important to ask the animals themselves how much they value this type of environment. When cows in freestall housing were given the opportunity to push a weighted gate to access pasture, they were willing to push increasingly heavy weights corresponding to the levels they pushed to access fresh feed indoors after a period of deprivation (von Keyserlingk et al., 2017).

This study established that pasture access is equally important to cows as access to their typical total mixed ration when hungry. Should we conclude that because pasture access is important to cows, they should always be housed on pasture?

The answer is that the story is more complex. Other studies using preference testing provided important contextual insights. When cows were given free choice between a freestall barn and pasture, they spent time in both environments. Their preference for pasture depended both on time of day and outdoor weather conditions. Cows expressed the strongest preference for pasture overnight, where they mainly spent their time lying down rather than grazing (Legrand et al., 2009), likely because this environment provided both a soft resting surface and space to adopt a range of lying postures. During the daytime, cows spent much of their time indoors, where they had ad libitum feed access. Critically, the barn provided protection from both rain and warm, sunny weather (Legrand et al., 2009; Falk et al., 2012), and the magnitude of the cows' preference for the barn increased in such conditions.

Adult cows typically spend at least half of their daily time budget lying down. This behavior is important to cows and commonly measured as an indicator of "cow comfort." Shelter from the elements, including rain and sun, and a dry resting space are important for cow welfare. Cows avoid lying down on wet surfaces, so when the only surface available is wet bedding or mud, lying time dramatically decreases (Chen [Van Os] et al., 2017). Preference and motivation testing have also revealed how important shade is to cows. Even after being forced to stand for 12 hours, pastured cows chose to continue standing up when offered shade, rather than lying down in the sun (Schütz et al., 2008). When faced with such tradeoffs, animals' choices can reveal how important various resources or behaviors are to them.

In a subsequent study, pastured cows were given pairwise choices in a Y-maze. They preferred shade compared to ambient summer conditions (Schütz et al., 2011), which was unsurprising given their previously established motivation to seek shade. Surprisingly, they also preferred shade compared to unshaded sprinklers, despite the latter providing more effective heat stress abatement. This illustrates the importance of understanding cows' preferences to design housing environments appropriately and avoid creating tradeoffs between important resources (Van Os 2019). Indeed, we found that when freestall-housed cows did not have to face such a tradeoff, they preferred shaded sprinklers compared to shade alone, with the former providing more effective heat stress abatement (Chen [Van Os] et al., 2013).

These studies reveal that, from a cow's perspective, one environment is not always superior to another, but rather that many factors affect their preferences and welfare under different circumstances. Ideally, offering cows choices in their environments, such as a barn in conjunction with pasture access, allows individual animals the freedom to express their context-dependent preferences (Figure 1).

Brushes provide opportunities to express natural behaviors indoors

Confined cattle can experience negative emotions such as boredom or frustration and perform abnormal behaviors when their housing environments lack adequate outlets for expressing natural behaviors. Beef cattle in feedlots are commonly fed high-concentrate, low-roughage diets to promote rapid gain. However, such diets can result in cattle performing abnormal oral behaviors, perhaps as a result of reduced time spent eating and insufficient expression of natural foraging behaviors.

We tested heifers' motivation to obtain hay when fed low- vs. high-roughage diets, hypothesizing that the former would be more motivated to obtain hay by pushing heavier weights (Van Os et al., 2018). In addition to finding support for our hypothesis, we unexpectedly observed the first documented evidence of cattle performing contrafreeloading. In this phenomenon, animals willingly work to gain access to a resource, even when it is simultaneously freely available – in this case, for heifers in the high-roughage treatment who had free access to hay. This finding illustrates that cattle housed in confinement may be willing to perform tasks used in motivation tests for other reasons, underscoring the

importance of including a control treatment to account for this phenomenon.

A growing number of dairy farms have begun providing brushes to dairy cows in confinement housing. Although for some farmers the motivation is largely based on improving cow hygiene and thus milk quality, recent studies have demonstrated the importance of brushes for animal welfare by providing a substrate to express natural behaviors. As in the study evaluating cows' motivation to access pasture, cows were equally willing to push increasingly heavy weights to gain access to a rotating mechanical brush as they were to push weights to access fresh feed after a period of deprivation (McConnachie et al., 2018). This study also incorporated a control treatment, demonstrating that cows were less willing to push weights to enter an empty pen compared to accessing the more valued resources of feed or a brush.

Brushes are less commonly provided to younger age classes of cattle, such as weaned dairy heifers, who are not yet productive or profitable. We investigated the provision of simple, non-rotating brushes (Figure 2**)** to this age group, which may be a more economical option for farmers to implement. Heifers naïve to brushes began using them within 4 minutes, on average, with some using them as soon as 8 seconds after first exposure (Van Os et al., 2021). We observed heifers over time and found no preferences for either brush-mounting orientation or bristle stiffness. The lack of preferences provided useful practical information, suggesting that farmers have flexibility in how they could choose to provide stationary brushes to heifers. Also noteworthy was the observation that heifers continued to use the brushes over time, not only for grooming themselves, but also for oral manipulation, illustrating that stationary brushes can provide a relevant, appropriate outlet for multiple natural behaviors.

In conclusion, these examples illustrate how asking a cow (or a heifer) what she prefers can provide useful insights into understanding how we can modify animal care practices to promote opportunities for good welfare.

Figure 2. Weaned dairy heifers explore a deck-scrub brush mounted to the wall of the pen. Simple, stationary brushes can provide opportunities for young cattle to express the natural behaviors of both grooming and oral manipulation. Heifers showed no preference for brush-mounting orientation or bristle stiffness, suggesting dairy farmers have flexibility in how they can provide this resource to cattle. (Photo: Kaylee Anderson, Van Os lab)

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FARM ANIMAL WELL BEING

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Dr David Beggs graduated from The University of Melbourne in 1990 and worked initially in Smithton, Tasmania. In 1992, he moved to the Warrnambool Veterinary Clinic, where he was a partner from 1994 to 2008 and now works as a part-time associate. Dr Beggs holds a Master of Veterinary Studies degree in Dairy Cattle Medicine and Production. He has worked for more than 20 years as a mixed-species rural practitioner, and has researched and consulted in dairy herd health. Nowadays, he holds positions as a senior lecturer in cattle at the University of Melbourne and Scientific Officer of the Australian Cattle Veterinarians, where he edits the journal and organizes conferences. He is an Associate Editor of the Australian Veterinary Journal and past Convenor of the Australian Veterinary Association Annual Conference. He sits on the Victorian Veterinary Practitioners Registration Board of Victoria and the Victorian Government Animal Welfare Advisory Committee. As a software developer he is the author of several computer software programs including the widely used “Dairy Data” and “Bull Reporter”, and the recently released Biocheck® and WelfareCheck®.

In 2017 he was awarded Fellowship of the Australian Veterinary Association for service to the profession and he recently completed a PhD on the topic “Ensuring dairy cow welfare with increasing scale of production”.

Dr. David Beggs
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Do cows think grass tastes good?

Debates surrounding the quality of an animal’s life involve philosophical and ethical considerations which by their nature involve differing views surrounding the appropriate use of animals.

Whether or not cows like the taste of grass seems a simple question on the surface, perhaps with a fairly straight forward answer. But this simple question belies a greater question of what else do cows like, and what do they dislike, and how can we give them a life worth living?

Animal welfare vs animal ethics

Defining exactly what constitutes animal welfare is not necessarily simple. There is a commonly agreed definition of animal welfare adopted by the World Organization for Animal Health (OIE) and many other organizations worldwide:

“Animal welfare means how an animal is coping with the conditions in which it lives. An animal is in a good state of welfare if (as indicated by scientific evidence) it is healthy, comfortable, well nourished, safe, able to express innate behaviour, and if it is not suffering from unpleasant states such as pain, fear, and distress. Good animal welfare requires disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and humane slaughter/killing. Animal welfare refers to the state of the animal; the treatment that an animal receives is covered by other terms such as animal care, animal husbandry, and humane treatment.”

Notice that this definition is all about how the animal perceives its own condition - it is not about whether the animal should be there in the first place. The reason we worry about animal welfare in the first place is because we want the animals to be happy. And that’s an important point – Animal Welfare is all about how the ANIMAL feels – not how we humans feel.

“Animal welfare science” is about understanding how an animal is experiencing life, from the animal’s point of view, without particular regard for the animal’s ultimate use. It is an evidence-based science.

“Animal ethics” is a good term to describe how humans think of our use of animals. By definition, a person’s view about farming, or indeed any other animal ethics question, is an ethical construct based largely on a person’s culture and individual experience.

The ethics of eating livestock

When pictures of pretty scenes with cows eating grass are shown to consumers, many associate this with good animal welfare. However, beautiful scenery can be misleading, and there are community concerns about the animal welfare challenges associated with pasture-based farming, which we need to take seriously, not only to make sure we are looking after our cows in the best way possible, but also to manage the risks associated with maintaining social license.

Whilst it may seem obvious to anyone who has watched a cow graze that cows do indeed like the taste of grass, it is important that we also look at the animal welfare "sacrifices" they make in order to do so.

In Australia, 95% or more of our dairy cows live their entire adult lives outside. The pleasures of eating grass have to be looked at in the context of long walks, climatic challenges, and the social aspects of living in large herds.

Good welfare for both humans and animals does not involve being 100% happy, 100% of the time. In fact, humans often make huge sacrifices to achieve outcomes that make them feel good – and at least in my mind - the maths doesn't often add up. How can it be that some individuals consider that the huge vast and intense negative experiences they put themselves through in training are worth it, just to win a sporting game?

It's interesting to note that the magnitude of sacrifice humans make is often proportional to the respect they get or the reward they receive – this is different to animal welfare debate where sacrifices are not generally embraced!

The first part of animal welfare science is about avoiding unnecessary suffering of animals in our custody. Notice the word UNNECCESSARY. Some suffering is necessary. If you look at all the wild animals that we don't farm, they probably all suffer a fair bit. Not many birds die in their nest, surrounded by their loving family. Most wild animals die of predation, starvation, disease or injury or some horrible combination of those things. If they were in our custody, we would not call it humane.

To measure animal welfare in a meaningful way, we need a system that can handle both positive and negative aspects of how animals are feeling. Do cows seek episodes of pleasure, or do they simply crave contentment?

Providing a good life for our livestock – a life worth living – is an important focus of animal welfare scientists the world over. It is my personal view that we do a reasonably good job of this – and that things are improving with time.

But animal welfare is more than just providing a life worth living – it's also about providing a humane death.

Death is perhaps the point of biggest tension

Animal welfare vs animal ethics

Many humans decide not to eat farmed species of livestock for what they perceive as animal welfare reasons – but the ethics of eating food derived from cropping vs livestock are not always as simple as they might seem.

After recent bushfires in Australia we have been forced to consider the animal loss when large tracts of land have been cleared suddenly, by fire. The animal welfare cost when land is intentionally cleared for cropping, and the commensurate loss in biodiversity seems to be rarely considered.

between animal ethics and animal welfare science. People anthropomorphise death and project our fears and emotions onto other things far more than anything else, and with much greater fervour. It has been a theme of many poets through the ages, that our need to avoid death and suffering in others actually stems from a fear of our own death. Killing an animal seems so close and so real. Because of this, some people like to live their lives through a philosophy of causing as little death as possible. The further death is away form us the less we have to think about it.

But from an animal welfare science point of view, providing a humane death with minimal unnecessary suffering is a good thing. The timing of death is not an animal welfare issue – it's an ethical one about how we humans feel. The animal no longer minds. Farmers do not celebrate the animal welfare outcomes that are achieved if slaughter is delayed by a few days because of a holdup at the slaughterhouse.

I think I might feel differently about this if there was evidence that cows had an expectation of the future. I don't think cows spend their time looking forward to their first grandchild entering the herd, or indeed worrying about what the future holds for her. Evidence suggests that cows live mostly in the moment. Cows remember the past, and they try to put themselves in situations where they were comfortable, and to avoid situations that caused a negative affective state. But evidence that they have a concept of, or worry about the future, for most other species, is scant. Evidence also suggests that people would be happier if they lived more in the moment too!

With a canola crop, the lovely yellow flowers that give us feelings of comfort and awe are present for only one month of the year, and then there are no flowers for 11 months - so all the bees die. If insecticides are used that kill all the insects, who is morally responsible for the birds and animals that starve as a result? If the ground is ploughed in one season and then intentionally burned in another, destroying all naturally occurring wildlife and insects, is this humane or ethical? A disadvantage of cropping is the animal welfare impacts on non-target species. An advantage livestock farming has is the biodiversity that can co-exist can be quite significant.

The Quadruple bottom line

The triple bottom line was a catch phrase from the 90s. It consists of People, Place and Planet. The triple bottom line aims to measure the financial, social, and environmental performance of a company over time. I think we need to be preparing for the quadruple bottom line of People, Place and Planet and Pride.

Where Pride is all about how we feel about the things we do – and society won't tolerate activities where the pride score is too low and social license is lost. Animal welfare will be a big part of that. It's important that those involved in farming are able to express pride in what they do.

I think our farmers should celebrate the positive animal welfare outcomes that can be associated with pasture-based farming, and all the biodiversity that it allows. I love that there are magpies, foxes, snakes, trees, ducks and more all able to co-exist on our local dairy farms. I'm sure that we can improve our animal welfare, and also that we must. Continuous improvement and time. Pressure and time.

But for the moment, I am content with the ethics of farming where cows can choose to walk, sit or eat for most of the day. Where they can be members of a herd and feel the satisfaction of social interaction. Where they can experience moments of pleasure along with moments of pain and where they can experience contentment, even if it's not 100% of the time. Where cows can have a life worth living.

Whilst I respect their right to hold them, I don't agree with the beliefs of people who hold the view we shouldn't farm animals. Particularly the view that because we have to eventually kill them, we shouldn't have had them in the first place. I worry that the philosophy of avoiding death at all costs is misguided, because death and suffering still happen with food crops and plant-based fibre, it's just a step further out of site. It's also largely out of our control. And death and suffering happen at least as much on our unfarmed land as our farmed land.

My view is that we should be able to farm in such a way that the burden of animal suffering in the world isn't markedly increased by our farming activities and I'm sure that animal welfare science has a big part to play in that debate.

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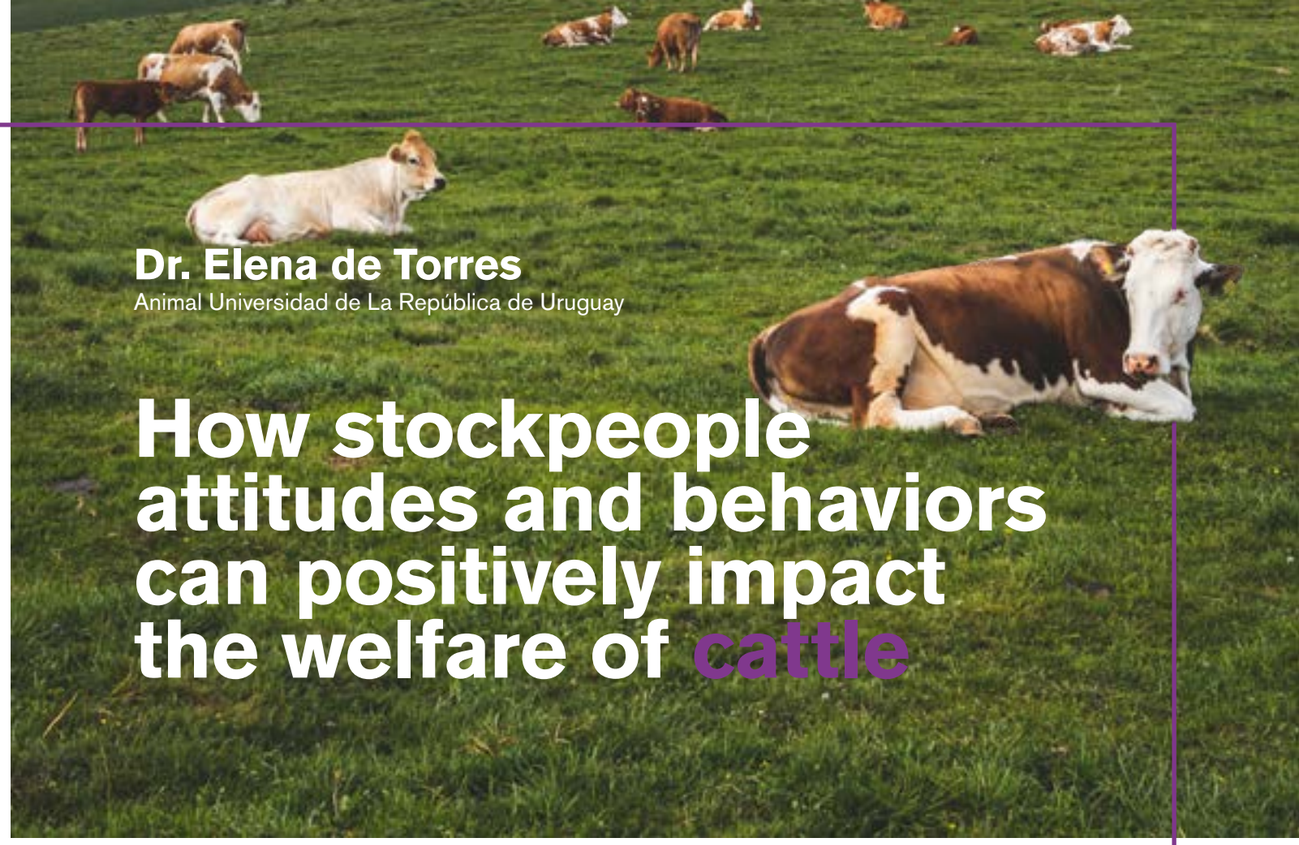
FARM ANIMAL WELL BEING



Dr. Elena de Torres
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How stockpeople attitudes and behaviors can positively impact the welfare of cattle

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She holds a MSc in Animal Production witha particular interest in udder health. Elena mainly specialized in dairy production medicine, and manages her own private practice serving and providing consultation services to farms all around Uruguay with particular emphasis on mastitis control and animal welfare. She is also an active member of the OIE Animal Welfare Collaborating Center for the Americas. This Center in Uruguay focuses on training veterinarians, producers and stockpeople in animal welfare best practices. She has a special interest in the One Health concept and reducing antimicrobial usage.

It's well known that human-animal interactions have different effects on animal welfare, behavior and thus on productive and health indicators.

Waiblinger et al (2006) and Ellingsen et al (2014) said that human-animal relationships (HAR) can be defined as "the degree of relation or distance that exists between an animal and a human being, perceived, developed and expressed through their mutual behavior". As Mota et al (2020) presented, farm animals may perceive interaction with humans as: negative, when they fear people, avoiding contact with them; neutral, when the fear level is low but animals still avoid contact; and positive, when fear is absent, and animals allow physical contact (Claxton 2011; des Roches et al 2016). Poor HAR is associated with reduced milk production, and poor percentage of protein and fat (Seabrook 1984; Waiblinger et al (2002), Hemsworth et al (2000). A positive HAR causes no fear in the animals, they are easier to handle and there are less risks of getting hurt for the stockpeople.

There are many factors that can influence the HAR, for example: housing, the breed, herd health, and stockpeople.

Cow housing

The inadequate design of animal housing for animal handling affects HAR. Therefore, there are various factors we need to consider when designing suitable animal facilities. Firstly, in grazing systems tracks or races are important as they are used on a daily basis. Many things have to be considered: width, shape, material, distances between paddocks and milking parlor, and sharp angles that may hinder proper animal circulation. These factors can determine the flow and the speed at which cattle are brought to the milking parlor. It can affect how the stockperson handles the cows.

Secondly, the milking parlor has to be designed in a way to allow agile circulation for the cows. If they move voluntarily, this is beneficial as the cows will spend less time in the parlor which is preferred from an animal welfare and production perspective. We can't forget the waiting area, where there might be high incidence of heat stress especially in the summertime. In many cases, the incidence of heat stress can be mitigated by shade, mist sprayed by sprinklers, and fans. All of these considerations make

milking more comfortable for the cows and the stockpeople. Consequently, increasing HAR.

In areas with a high concentration of animals, such as the dry cow and calving areas or pens, we have to ask ourselves: Can the cow lay down properly? Is there easy access to water buckets/ troughs? What are the bedding materials? Is there shade? Is there enough air circulation/ ventilation? How is manure removed? etc. All of these features can alter animal handling and animal behavior around humans.

Another aspect to think about before designing a farm is how the machinery will circulate on the farm while feeding, where the feed is going to be stored etc. because if the tractor circulates in the same places where the cows do, there may be an accumulation of mud in those areas. Mud is an animal welfare aspect that influences lying times and dirtiness scores, especially in grazing systems.

Cow breed

Many times, especially in the summertime cows are over their thermal comfort levels. This inflates the incidence of disease which consequently increases the size of the sick herd and generates additional work. Each breed has its own thermal comfort index, therefore farmers should select the adequate breed for the type of climate in their country. Different breeds also have different behavioral patterns. Thus, this should be included in the training of new stockpeople to promote positive HAR. Moreover, Andersen et al (2006) indicates that genetic origin partly explains differences in HAR within a herd or between breeds.

Herd health

Disease diagnosis on a farm goes hand in hand with the established routine. If the sanitary conditions aren't adequate, for example, udder health may be an issue, which means cows need to be treated, they need to be milked separately, which all adds time and effort to the stockperson's workload. Another example is lameness. If you have a high incidence of lameness, the cows walk slower and it's essential for the stockpeople to take their time when moving the cows. They have to make sure they don't stand too long on hard surfaces, such as a concrete slab. These lame cows will also affect the circulation in the parlor.

Additionally, if the stockpeople are always nervous, that increases the risk of aggressive handling which makes it dangerous for them. This also affects total milking time as the cows are afraid and they don't circulate as well. A nervous stockperson also provokes the cows to defecate more often (Sirven, 2018). Heifers that have faced negative handling and were more reactive during handling had higher dirtiness scores and these were associated with lower pregnancy rates (Ceballos et al 2018).

Stockpeople

Firstly, it's important to consider the behavior of the stockpeople to the animals and of the animals to the stockpeople. There are attitudes related with their past experiences, culture, knowledge, personality, and motivation, which all affect HAR. For instance, Arias and Śpinka (2005) found lower milk yields per lactation and higher veterinary costs on farms with noisier stockpeople.

Secondly, cows can recognize individual humans and they will be quiet and have "natural movements" with those that treat them well. They are also more likely to approach those who treat them well than those who behave aggressively towards them.

Conclusions

To sum up, we should contemplate mental health, degree of empathy, teamwork, social relationships, previous animal handling experiences and many other factors when trying to work with the right stockpeople as they affect HAR which in turn influences the farm overall.

As mentioned above, the research has demonstrated that HAR can have distinct effects on animal welfare, behavior and production. Therefore, let's think of these factors before: designing our facilities, selecting the breed, and training our stockpeople to improve human-animal interactions. Improving HAR will enhance the quality of life for both the stockpeople and the animals, and consequently reducing risk of accidents, improving production and innocuous good quality milk.

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Prof. Cathy Dwyer
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How can we assess positive welfare in ruminants?

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Cathy was appointed Professor of Animal Behaviour and Animal Welfare at SRUC (Scotland's Rural College) in Edinburgh in 2011, and has a joint appointment with the Royal (Dick) School of Veterinary Studies where she is the Director of the Jeanne Marchig International Centre for Animal Welfare Education (JMICAWE) since 2016. In 2019 she was also appointed by Scottish Government to Chair the Scottish Animal Welfare Commission which provides independent scientific advice to Ministers. She also sits on a number of advisory bodies for Government, retailers and NGOs to provide animal welfare advice.

Cathy manages a number of research projects concentrating on parturition, mother-offspring interactions and behavioural development in sheep, human-animal interactions and welfare in horses, and welfare in extensively managed species. As part of the work of JMICAWE she is involved in building partnerships and providing education in animal welfare to vets/vet students in UK and abroad, particularly in Asia. In addition to undergraduate teaching, Cathy teaches on the University of Edinburgh MSc courses in Applied Animal Behaviour and Welfare, and International Animal Welfare Ethics and Law. She has supervised 11 PhD students to completion and is currently supervising 7 PhD students.

Before moving north to Scotland in 1994, Cathy was awarded her PhD from the Royal Veterinary College in London in 1992 for studies of prenatal nutrition and maternal effects on foetal development in pigs. She worked as a postdoctoral research assistant at the Royal Veterinary College and at Massey University, New Zealand, investigating foetal development in guinea pigs and mice. Cathy has a degree in Physiology from the University of Bristol, UK.

Over the last 10-15 years a new term has entered the vocabulary of animal welfare scientists and is starting to be used more widely by others too. This is the concept of positive animal welfare.

If we believe that some species are sentient, and so capable of experiencing pain, distress and harms, then it doesn't seem logical to conclude that they cannot feel the more positive emotions of pleasure, comfort and contentment. In 2009, the UK's Farm Animal Welfare Council considered the past, present and future of animal welfare, and outlined the continuum of welfare from very poor to very good, with the upper end of spectrum considered to be one that offers animals the opportunity to live a 'Good Life' (FAWC, 2009). Thus, good animal welfare is not achieved merely by eliminating negative emotional states but requires us to also consider and provide opportunities for positive experiences. Increasingly conceptions of animal welfare, such as the Five Domains model, has begun to consider the ways in which positive emotions can be experienced by animals, such as the pleasures of eating tasty food, or the comfort of a dry, well-bedded resting area (Mellor et al., 2020).

A good life, therefore, is achieved when the balance of positive experiences outweighs any negative experiences over the animal's life. However, with the acceptance of positive animal welfare as something to be strived for, new questions need to be addressed: for example, what is positive welfare for animals? How can this be achieved on farm? And what does it look like or how can it be measured and assessed? In this paper I will briefly discuss studies that have tried to address these questions for ruminants.

What is positive animal welfare?

A recent review of the literature (Lawrence et al., 2019), suggested that there are four key features discussed in considerations of positive animal welfare: 1) the ability of animals to experience positive emotions (described as what animals like by Yeates and Main, 2008); 2) positive affective engagement (which considers animal motivation and goal-directed behaviour, or what animals want; Yeates & Main, 2008); 3) quality of life, which considers the balance of positive over negative experiences and 4) happiness, which considers a full life perspective on animal welfare.

Recognition that animals can experience positive emotions or affective states is not new. Charles Darwin wrote about joy and pleasure in animals in 1872, and most owners of pets will describe

the play or excitement a dog might demonstrate when the owner arrives home in terms of the animal showing enjoyment, pleasure or fun. The process of Qualitative Behavioural Assessment (QBA) also explicitly includes positive terms, such as contentment, relaxation or comfort, in its use to assess farm animal welfare (Wemelsfelder, 2007). However, although these terms are becoming increasingly accepted as applying to animals, scientific methods to assess them are still lacking and, as with negative emotions, there is no 'gold standard' on which emotions can be assessed.

Positive affective engagement (as coined by Mellor, 2015), provides a means of determining why emotions might have evolved in animals, by linking them to goal-directed behaviour. The animal is rewarded by positive emotional states when it engages in behaviours that will increase its evolutionary fitness, such as engaging in positive social contact which can enhance group cohesion or offspring survival, or the pleasures associated with hunting or seeking food. Conversely, the animal experiences negative emotions, such as pain or fear, to drive it to avoid damaging interactions or to evade a predator. In animal welfare this serves as an explanation for why expression of highly motivated behaviours is part of good animal welfare, not just because it avoids anxiety and distress when absent, but because it is associated with positive emotions when animals can dustbathe, build a nest or engage in social interactions (Edgar et al., 2013). Fraser and Duncan (1998) consider that negative emotions or motivational states serve to address animal needs (such as hunger or thirst), whereas positive motivational affective states, such as exploration, allow animals to exploit opportunities. Lawrence et al (2019) also draw parallels with studies of human emotions that consider positive emotions to allow a broader array of learning and engagement.

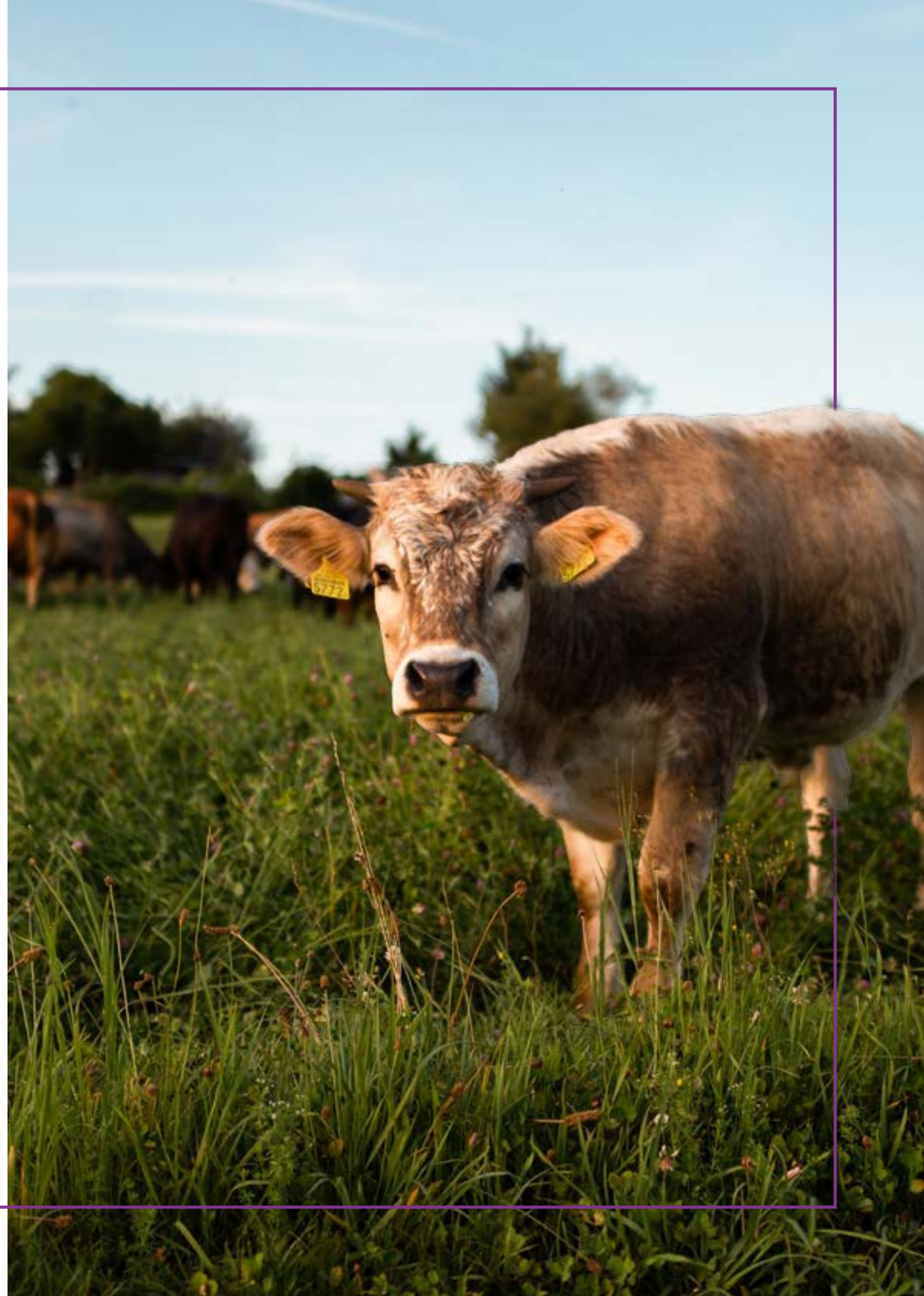
The concept of Quality of Life was included in the FAWC report (2009) and has been influential in reconsidering animal welfare thinking in both scientific approaches and application by retailer schemes. This has extended the concept, which has been widely used in human medicine, beyond physical quality of life to consider also the balance of affective states in an animal. However, a particular challenge of this concept, yet to be adequately resolved, is how different emotional experiences of animals can be measured, aggregated and an overall quality of life assessment achieved. In companion animals, often scales for Quality of Life are developed to aid end of life care and euthanasia decisions, although these are largely based on owner perceptions of current state, and physical abilities of the animal, rather than assessments of affective state.

The fourth feature of positive animal welfare is happiness. This considers the whole life of the animal and was described by Yeates and Main (2008) of being composed of a pleasant life, an engaged life and a meaningful life (drawing on concepts of human happiness). This extends the idea of what constitutes good welfare beyond pleasurable sensations and being able to get what the animal wants, to include meaning or purpose, sometimes described as 'agency'. This helps to define why a life where negative emotions have been removed may still not provide a good life if opportunities to engage and explore, to allow meaning to a life, are not present. Webb et al., (2018) define animal happiness as a long-term stable trait that reflects the balance of positive and negative states and 'how the animal feels most of the time'.

How can positive welfare be achieved on farm?

Most studies that have considered positive welfare have focused on what resources might allow positive affective engagement and the expression of positive emotions in animals (Yeates and Main, 2008; Edgar et al., 2013). These studies argue that providing animals with resources for which they are highly motivated to engage and go beyond what animals 'need' to provide those things than animals 'want' or 'like' can allow opportunities for good welfare. For laying hens, Edgar et al. (2013) developed the ideas of Comfort, Pleasure, Confidence and Interest outlined as key to positive animal welfare in the FAWC (2009) report by assessing which resources might be provided to hens to allow these states to be achieved. In addition, they considered a fifth opportunity, that of having a Healthy Life, as being an integral part of a good life. This approach provided a list of resources at different levels which should provide a good life for hens.

In collaboration with researchers at University of Bristol and Royal Agricultural University in the UK, we have also considered application of this 'resource-tiers' approach to ruminants by addressing the opportunities for a good life required by dairy cows and sheep. A similar approach has been applied to beef cattle among



other species (Rowe and Mullan, 2022). For positive animal welfare, in both dairy cattle and sheep, Comfort was considered to be achieved by allowing animals choices in their physical and thermal environment, and choice of feeding, watering, and other environmental features. For dairy cows, choice in when to be milked was also considered to be an aspect of positive animal welfare. For both ruminant species, Pleasure was thought to be achieved through opportunity for animals to express play and positive social interactions with conspecifics, and through the maintenance of the mother-offspring bond. Confidence was developed in dairy cows and sheep through positive stock-keeper interactions and experiences, and through positive learning and experience with the herd or flock to build resilience. Interest was achieved through providing opportunities for positive enrichment, and choice of pasture or feed. A healthy life was considered to be achieved if stock-workers had a good knowledge of individual animal habits, preferences and personalities, were able to achieve effective management of day-to-day health and welfare, and carried out positive genetic selection to improve health and welfare. The presence of resources can be readily assessed as part of farm assurance and were based on stakeholder assessments and review of the literature. However, whether application of higher levels of resources truly result in improved positive animal welfare is still be tested. **Can positive welfare be assessed on farm?**

As described above, although we can provide animals with key opportunities based on what we believe should achieve positive affective states and 'happiness' in ruminants, this does not tell us how individual animals are using the resources, or whether they in fact do cause animals to have a good life. In recent scientific developments of animal welfare assessment, there has been a focus on animal-based indicators, or outcomes, rather than inputs or resource provision. Thus, although we could assess the numbers and types of opportunities for a good life provided to ruminants against the categories defined above, we may also want to derive indicators of good welfare and positive affective states, in the same way that indicators of negative welfare state have been developed (e.g. in the Welfare Quality® and AWIN projects).

In collaboration with researchers in Italy (Matiello et al., 2019), we reviewed the literature for evidence of animal-based indicators that might be used to assess positive emotions. Many of the assessment methods reflect the resource tiers approach, and were associated with engagement with environmental choices, lying in postures indicating comfort or lying synchronously, ruminating, playing, exploring, using enrichment objects and self-grooming.

Other indicators were less resource-specific and were based on measures that may reflect positive affective states such as facial expressions, ear and eye postures, low-frequency vocalisations, tail-wagging, positive affective engagement with other animals or humans (such as rubbing and contact solicitation) and through the use of QBA. This latter approach also appears in the ruminant welfare assessment schemes of Welfare Quality (dairy and beef cattle) and AWIN (sheep and goats), where it is considered the only practical and reliable method for assessing positive affective states to date.

Conclusions

Provision of a Good Life for farm animals, rather than just removing negative experience, is becoming increasingly a goal of retailers and a desire of consumers. In order to demonstrate that animals do indeed have a good life, there is still research to be done to understand what animals want, how this can be delivered on farm and what positive animal welfare looks like when it is present.

Two main approaches have been suggested here: firstly a resource or input-based approach, which considers what aspects of the environment may allow an animal to express agency, resulting in comfort, pleasure, confidence, interest and a healthy life. This can provide levels of assessment on farm based on the provision of different levels of input. The second approach is based on animal-based or outcome assessments and looks for behaviours in individual animals that seem indicative of positive emotional states. It is relevant to note that both approaches focus predominantly on views of positive animal welfare that consider positive emotions (the second approach) and positive affective engagement (the first approach) and less on methods to assess Quality of Life or happiness.

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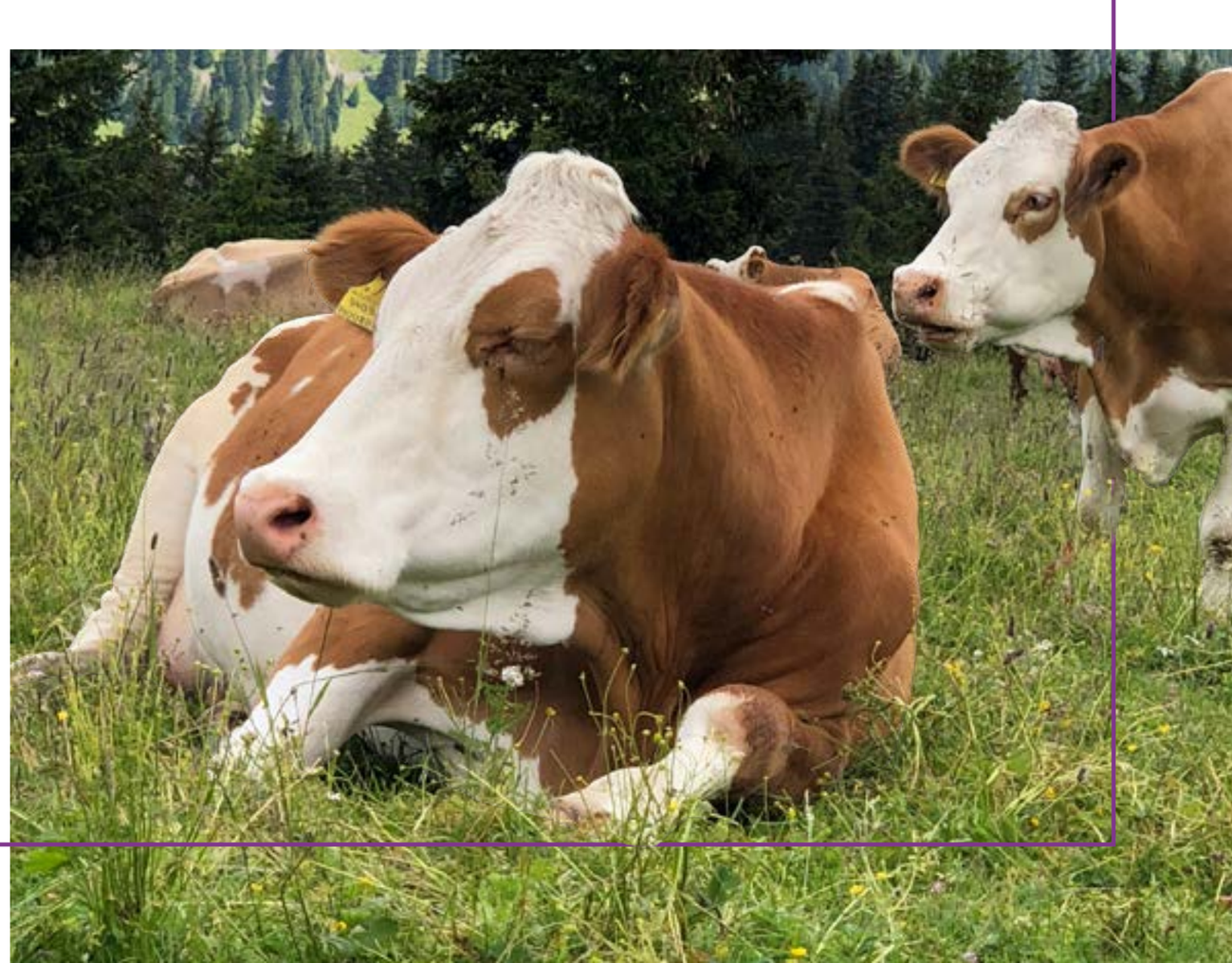

FARM ANIMAL WELL BEING

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Human–animal interactions: effects, challenges and progress

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Dr. Maria Camila Ceballos graduated in Animal Science at the National University of Colombia. She received her Master's and Ph.D. degrees in Applied Animal Behaviour and Animal Welfare from the São Paulo State University (UNESP) in Brazil. Then, she started working at the University of Pennsylvania, USA, as a post-doctoral researcher. Currently, Maria Camila is an Assistant Professor in Beef Cattle Welfare and Behavior at the University of Calgary, Faculty of Veterinary Medicine. Her main research fields are evaluating and finding strategies to improve animal welfare, human-animal interaction, and cattle temperament.

Human-animal interaction in livestock production systems

Human-animal interactions in livestock production systems can involve tactile, visual, olfactory, and auditory stimuli and they can be classified as positive, neutral, or negative (Waiblinger et al., 2006). Farm animals react to human characteristics and can learn to associate the presence and behaviour of humans with the handling received (Hemsworth et al., 2018). In general, aversive actions lead to negative responses, such as the increase of animals' fear of humans (Archarya et al., 2022).

This increase in fear is not only because human presence may represent a threat (Paranhos da Costa and Tarazona, 2011), but also, because some of the routine management practices on farms have an aversive character including vaccinations, administering medications, surgical interventions, and transportation (Archarya et al., 2022, Hemsworth and Coleman, 2011). If these activities are combined with high-pitched sounds (e.g., whistling, shouting, clapping, shaking rattles and banging tools on a solid surface) and tactile interactions such as electric prods and striking the animals, humans will be perceived as being aversive (Pajor et al., 2000; Pajor et al., 2003; Honorato et al., 2012).

Negative experiences should be avoided when handling animals (Tarazona et al., 2020) because they learn to avoid stressful situations, and fear has a crucial role in this learning process (Hemsworth et al., 1996; Rushen et al., 1999). There is a direct relationship between negative interactions and animals' fear of humans, with a consequent reduction in productive performance in various species. For example, negative human-animal interactions were related to lower pregnancy rates and milk production in cattle (Hemsworth et al., 2002; Ceballos et al., 2018a); lower growth rates and adverse effects on pig reproduction (Hemsworth et al., 1981, 1986); and reductions in feed conversion rates and egg production in chickens and laying hens, respectively (Jones, 1993; Hemsworth et al., 1994a; Barnett et al., 1992). However, animals' fear of humans can decrease through learning processes, such as habituation (with exposure to humans in a neutral context) and operant conditioning with positive rewards (Petherick et al., 2009; Archarya et al., 2022).

Therefore, minimizing negative interactions with animals is an important strategy to reduce animals' fear and improve productivity (Hemsworth, 2007).

Attitudes and Behaviour

Attitudes are important in predicting human behaviour. Attitudes are learned and modified, and a human's attitude towards animals directly influences how they treat animals (Hemsworth and Coleman, 2011) and have a fundamental role in animals developing fear of humans (Hemsworth et al., 2002). In most cases, workers' attitudes and consequent "bad behaviours" in livestock production systems do not occur by intentional cruelty. In contrast, most of these behaviours are due to a lack of knowledge and are considered harmless by the worker; consequently, they are common in animal production (Hemsworth, 2007).

Based on the theory of cognitive dissonance (Festinger, 1957), there is a reciprocal relationship between people's attitudes and behaviours. Therefore, attitudes not only influence behaviour, but also the opposite is true. Once a person performs a particular behaviour, there is a tendency to modify their attitudes relevant to the realization of this behaviour (Hemsworth and Coleman, 2011). Stockperson attitudes towards animals can influence work characteristics and, consequently, its performance (Hemsworth et al., 2002). Therefore, a poor attitude towards animals will create handling difficulties, reduce work motivation, and affect execution of the job (Alencar et al., 2007). For example, a poor attitude towards animals can affect the willingness to inspect them and intervene quickly when animals have a problem (Hemsworth, 2007).

Work development

According to Blumberg and Pringle (1982), development of people's work is influenced by three factors: capacity, opportunity, and willingness. "Capacity" includes variables such as skills, health and knowledge; "opportunity" includes working conditions, available equipment and tools, co-workers actions and organizational policies and rules; and "willingness" includes motivation, satisfaction and attitude towards job and animals (Hemsworth and Coleman, 2011; Coleman and Hemsworth, 2014). Performance at work depends mainly on a combination of motivation, technical knowledge, skills and the opportunity to perform the job. Low motivation will limit performance at work, regardless of the individual's technical skills and knowledge (Hemsworth, 2007). The impact of these characteristics on the overall job performance is clear. However, their effects on stockperson's behaviour, and its impact on the behaviour and performance of animals are less obvious and require investigation (Hemsworth, 2007). Complex factors that determine human behaviour, such as personality and self-esteem, should also be considered when hiring a stockperson in a livestock production system (Boivin et al., 2003). Some stockpersons personality traits are directly related to their attitudes towards animals (Coleman et al., 2000; Waiblinger et al., 2002; Hanna et al., 2009).

Training

Human behaviour consists of four elements: action performed, target to which the action is directed, the context in which the action is performed, and time in which it is performed (Fishbein and Ajzen, 2010). Thus, to promote a change in human behaviour, it is necessary to acquire knowledge and skills and change habits, attitudes, and beliefs. According to Hemsworth and Coleman (2011), to provoke a change in a person's behaviour, it is necessary to act on personal and external factors relevant to the behavioural situation that one wishes to change.

In swine and cattle production systems, evaluating effects of employee training programs (involving behavioural and cognitive techniques) on attitudes and behaviour improved human-animal interactions (Hemsworth et al., 2002; Coleman et al., 2000; Hemsworth, 2003; Ceballos et al., 2018b). For example, some people who had this type of training performed a higher number of positive behaviours towards animals, plus decreased negative behaviours, compared to those who did not receive this training (Hemsworth, et al., 1994b; Coleman et al., 2000; Hemsworth et al., 2002, Ceballos et al., 2018b).

Stockperson training programs, especially aimed at changing attitudes and behaviours, are effective in doing so, improve handling skills and consequently, decrease animals' fear of humans. Improving animal handling yields benefits for both animals and workers, improving welfare and productivity for both. Additionally, improvements in the human-animal relationship have potential to increase stockperson motivation and, therefore, enhance their work performance.

In conclusion, specialized training programs targeting attitudes and behaviours towards animals offer an excellent opportunity to improve human-animal interactions in livestock industries (Ceballos et al., 2018b).

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Reflection on computing assisted livestock management and cattle well-being

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Chris grew up on a dairy farm and maintained a passionate interest in lactation during an education at Nottingham and Cambridge Universities followed by a research career at the Hannah Research Institute in Ayr, Scotland. In 2007 he joined Copenhagen University as Professor of Animal Physiology, and now Emeritus Professor. Since 2016 he has run a consultancy service focused on scientific communication and inspiration in the animal sciences, based once again in Scotland.

As a scientist, his ambitions focus on food security (feeding our expanding global population) and animal welfare (caring for our food production animals, including through the use of modern technologies). He is passionate about trying to understand all aspects of lactation in all mammalian species. Outside of research he loves sports (especially golf), music and art. Food is a real passion, and so is gardening. What does he not like? Intolerance! Cheap food policies that encourage obesity. Technologies that encourage people to go through life without seeing and appreciating it, and those who preach about different aspects of life without properly understanding them.

A calm approach to dairy farming

As a boy growing up on a small dairy farm I always had a favourite cow. I could easily recognize her, I knew her name, I felt I understood her personality and shared her emotions, and I believed that I would know when she was not feeling quite right. This was not too difficult, after all, we started farming with around a dozen cows. Later, when that number had risen to a couple of hundred it became rather more difficult, and I wonder how I would get on if we were still farming and had expanded to a thousand or more. I am sure you get my point: the relationship between man and dairy cow has changed significantly in my lifetime, and there is a significant danger that the individual animal could become unrecognizable, nothing more than a number on a spreadsheet. Keep calm, I tell myself, help is at hand!

We have technologies that identify our animals for us and monitor their activity, and beyond that have the potential to estimate their metabolic state and detect deviations from normal physiology (ie pathological conditions, disease). Very many animals can be monitored in this way at relatively modest cost, and the process can happen continuously such that deviations happening in individual animals across time can be detected with comparative ease. In short, we have the potential to significantly improve well-being, to achieve a state of “calm farming” where our cows are contented, unhurried and focused on little more than eating and socialising, whilst we as husbandry staff are similarly relaxed and unstressed, secure in the knowledge that those animals which most require special care and attention will be identified for us by the sensors they unknowingly carry. Computing Assisted Livestock Management (CALM) is an approach that transforms technology use from the now well-established estrous detection modality into a full management support system. By minimising stress in the operation, the productive capacities of individual cows are maximised and their ability to avoid and, when necessary, cope with physiological and pathological challenges are maximised, and on the relatively rare occasion that coping fails, the problem can be detected quickly and resolved by appropriate intervention from husbandry staff or veterinarian, guided by the information provided by the monitoring.

Technologies

Estrous detection is achieved using a combination of radiofrequency identification (RFID) to identify each animal together with

activity monitoring (essentially step-counting) using a tri-axial accelerometer (which detects movement in three dimensions). This type of sensor is incredibly small and cheap, and if you have a modern smartphone you will have one.

Algorithms that convert the motion data into steps are now very well established, as are the data reduction processes that, locally within the sensor, reduce the massive amounts of raw data into small packages that can be transmitted wirelessly using modest battery power. What has also now been achieved is further interrogation of the accelerometer data to identify "signatures" associated with activities such as eating and ruminating, and others such as grooming could follow. We have gone beyond steps! Adding a gyroscope gives better identification of lying and standing, and by placing the technology in a rumen bolus (the accelerometer can be almost anywhere) one can also add temperature to monitor drinking behaviour (rumen temperature drops when the cow drinks). This "at cow" sensing is already powerful but can be supplemented by "near cow" video, audio or positional monitoring as well as "from cow" biomarker monitoring of milk or, potentially, saliva, nasal secretion, sweat or hair (all of which can potentially be obtained automatically by robot arms and which together provide "observation windows" ranging from minutes to months).

For a full account of what is already possible or likely to become possible, see Further Reading, below.

Barriers to adoption

Whilst technology has advanced, the ways in which it is used have not. There are now many estrous detection systems on the market, and farmers buy them because they are persuaded by the argument (perhaps now spurious) that short calving intervals are more economic. Some systems also offer health monitoring, with focus on mastitis, lameness and metabolic disease. These benefits are less easy to quantify and hence market: figures exist for the costs of specific diseases, but we cannot easily quantify for the farmer the economic benefits of good health (although clearly they do exist).

Faced with a plethora of competing claims from different manufacturers the farmer might be forgiven for thinking that he is going to have to invest several times over and then follow and interpret a number of different outputs in order to gain most benefit. Regrettably there is some truth in that, for the systems do not speak to each other and it is the farmer who is left to interpret the information. A number of external drivers exist that could push or pull the adoption of health and welfare sensing technologies, but it is not clear that any of these actually have the power to stimulate widespread adoption (the consumer demands better welfare but will not necessarily pay for it, national and international bodies seek to improve welfare but do so in uncoordinated ways, national breeding programmes have not yet embraced what could be achieved).

Routes to success

The EU funding of our COST Action enabled us (the DairyCare Consortium) to bring together biologists and technologists to successfully accelerate sensor technology development, and we would contend that further collaboration across disciplines, industries and organisations will be key to its adoption. At a research and development level, economists need to be deeply involved in order to properly assess costs and benefits, something that has not yet happened in an independent way. The notion that "data has value" needs to be re-assessed, so as to progress beyond the simplistic approach that it can be sold. The real value is to the animal and the farmer but associated industries, processors, retailers and ultimately consumers will all benefit and so must be included in the scenario.

Large farms are the more obvious users of well-being technologies, but small farms can and must also be included. To those of us who participated in DairyCare, the way forward appears simple, because we can see a way of making life calm and easy for the farmer and those who support him. Rather than purchasing, implementing and maintaining the technologies himself, he would enter into a contract with a service provider who would place appropriate technologies (if necessary from different manufacturers) on farm, obtain and analyse the data and use it to support on farm management (principally identifying those cows that need attention) and also obtain added value from the data by, for example, improving feeding and breeding (in collaboration with those industries), optimising product quality along the dairy foods chain (in collaboration with processors and retailers) and supporting national/international welfare enhancement programmes.

Since the service provider would contract to numerous farms the "large farm only" issue is resolved, and the cost of the contract would take into account the additional incomes that the provider can generate from the data. we would envisage that the service provider could be an independent company but could also be a large veterinary practitioner, national breeding organisation, farmer cooperative or similar.

Further reading

In the last few years there have been numerous review articles concerned with the development and implementation of sensor technologies into livestock agriculture, commonly referred to as Precision Livestock Farming (PLF: Berckmans, 2014). I am not personally persuaded that "precision" is an appropriate endpoint, given the inevitable variability that exists between individual animals, nevertheless, the acronym has become popular. The outputs from the DairyCare COST Action mentioned above have been published as a 2020 Special Issue of the Journal of Dairy Research (see Knight, 2020 and subsequent articles) and the same Journal has also published related reviews of sensor technologies (Caja, 2016), biomarker technologies (de Almeida, 2019; Zachut, 2020) and individual cow management (Maltz, 2020). As Editor of that Journal, I am happy to recommend all of these!

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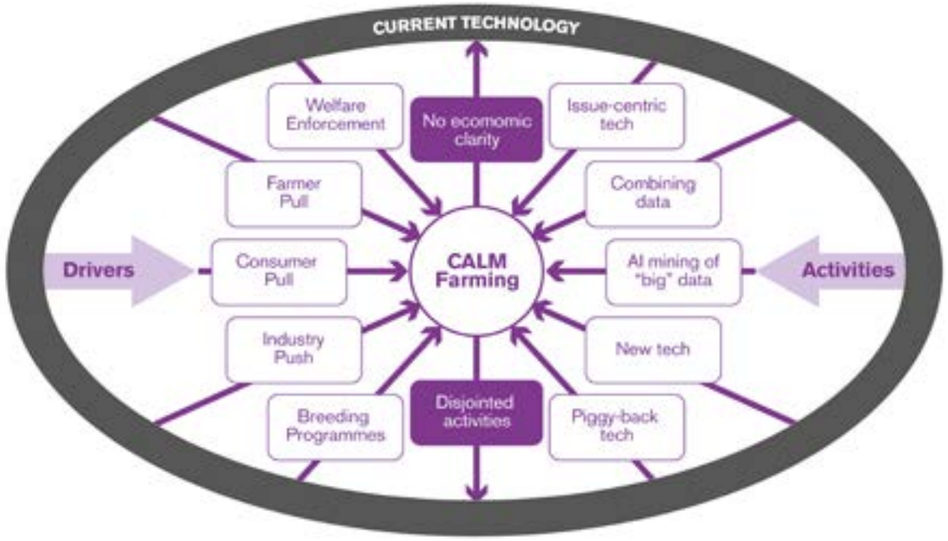

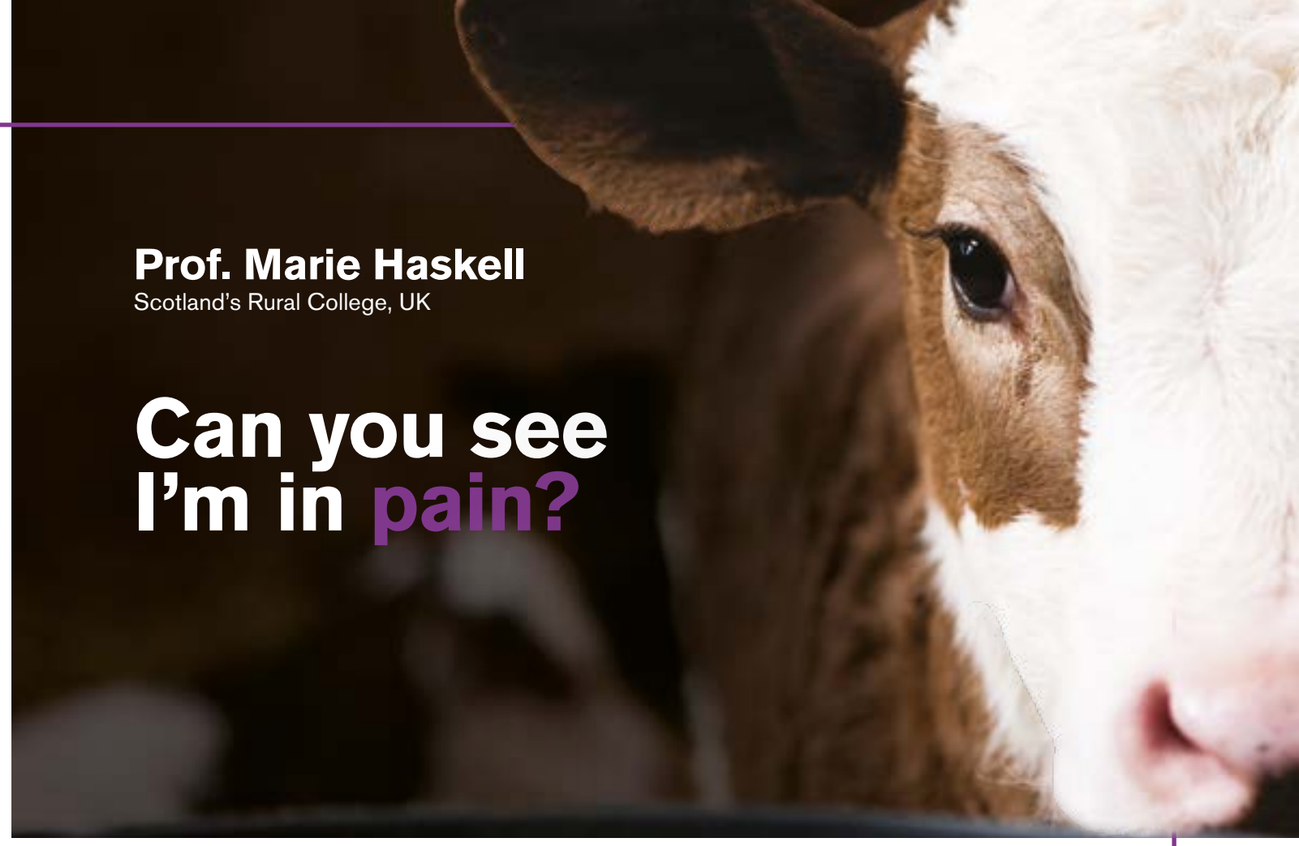

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Can you see I'm in pain?

Prof Marie Haskell
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Marie Haskell is a member of the Animal Behaviour and Welfare Team at SRUCand is currently a Senior Researcher at SRUC. She has worked at SRUC (formerly SAC) and theRoslin Institute. Shehas extensive experience of research into dairy cow welfarewith a particular focus on the effectsof housing and management. Past projects have included assessing effects of continuous housing, organic farming and genetic selection for robustness. She has also carried out work into creating new welfare assessment measures, with a particular focus on animal behaviour. With students and other colleagues she has created protocols for assessing approachability, aggression and social behaviour in cattle. Additionally,Marie has been involved in studies that havecharacterisedtemperament or personalityin cattle, the underlying genetics of personality and temperament, the learning and cognitive abilities of animals with the overall aim of understanding how personality and related traits affect welfare, healthand productivity.

Using facial and behavioural expression to detect pain in cattle

The experience of pain due to disease or injury is clearly a negative experience. Pain is associated with poor welfare, but the effect of pain on feeding, resting and general well-being can lead to poor growth and productivity. Therefore, it is clearly in the interests of farmers and veterinarians to be able to identify animals that are experiencing pain so that they can be treated. However, it is not always easy to identify when animals are in pain (Flecknell, 2008). Pain in cattle and sheep is particularly difficult to identify because they are described as being a stoical species, and as such, not showing signs of pain (Gleerup et al., 2015). It is thought that this lack of expression evolved because the outward expression of pain that might attract the attentions of predators. However, this makes life difficult for the farmer and veterinarians.

The understanding that pain is an emotional state (i.e. has psychological as well as sensory aspects) has opened up the use of behavioural and psychological methods to assess emotional state. The use of facial expressions to assess emotional states is a line of research that has received a lot of attention recently. However, the idea that emotions can be seen in facialexpressions has a very long history. In his book 'Expression of Emotions in Man and Animals' published in 1872, Charles Darwin proposed that not only are the 'basic' emotions (such as fear, anger and happiness) present in all human cultures, but they are also present in animals. He also argued that facial expressions are key indicators of these emotional states.

Facial action coding systems

After Darwin, the first scientific studies to quantify relationship between the movements of the different parts of the face and the emotional experience were carried out in humans by Ekman and colleagues (e.g Ekman and Friesen, 1978). Their first step was to determine how each facial muscle moved when each of the basic emotions was displayed. This work showed that certain parts of the face (such as the mouth, the eyebrows etc.) behaved in particular ways in the expression of different emotions. The description of how each muscle moves is the basis of the facial action coding system (FACS) developed by these authors. The term facial action unit (FAU) was used to describe the key muscles or groups of muscles that contribute to the expression of different emotions.

Grimace scales

As emotions are internal states, they were traditionally thought to be almost impossible to study in animals. However, in recent decades, new methodologies to investigate emotional states have been developed that involve the assessment of behavioural and physiological changes in animals. The study of how facial expressions relate to emotional experience is a key line of work. Research into the facial expressions associated with pain in rodents was among the first to be carried out (e.g. Langford et al., 2010). The study showed that changes in particular FAUs could be used to detect pain in mice and rats. Tightening around the eyes, nose and cheeks, wide ear posture and outward-pointing whisker posture was associated with mice in pain compared to pain-free mice. The scales used to illustrate these expression are known as 'grimace scales'. This approach has been used in many other species, and 'grimace scales' or 'pain face' methods now exist for a number of laboratory animal species as well as for pigs and sheep.

Expression of pain in cattle

The expression of pain has also been assessed in cattle. A study by Gleerup et at (2015) assessed behavioural changes and facial expressions in dairy cattle associated with pain due to disease or surgery. Cows in pain showed more tension in the eyes, cheeks and nostrils and were less responsive to their surroundings. However, detection of pain in cattle is not easy. As discussed above, cattle are 'stoical' and avoid showing outward expressions of pain. Studies in our group have had limited success in detecting pain due to lameness or mastitis (Haskell and Hunter, 2019; Adie and Haskell, unpublished data) although the tightening of the eyes showed some indication of pain (Figure 1). It is likely that severe pain cannot be masked but more subtle signs are more difficult to detect.

Additionally, when an observer is present in the cattle housing to collect images, they may be seen as a mild threat, which may cause animals to involuntarily reduce expressions of pain.

Use of technology

The use of technology and computer vision techniques to detect emotion in the facial expressions of animals is a new area of research. The use of computer-based methods for detecting emotional states has a number of key advantages compared with manual inspection of animals, even when a 'grimace scale' is used. Computer vision solutions have the advantage that they can be used remotely, so the animals can be observed in an undisturbed state and no 'threatening' human is involved. These systems can also monitor animals continuously and over long periods of time. This would allow for subtle changes in behaviour or expression to be detected. Originally, these computer vision algorithms were developed for use with humans in individual identity recognition systems and increasingly to detect emotional states.

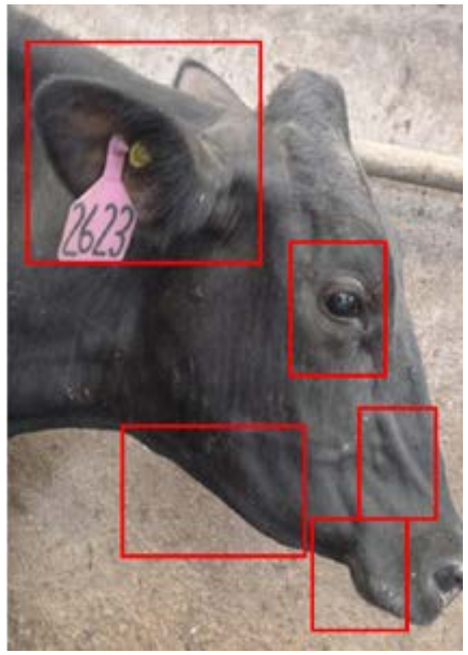

Figure 1. Image of the facial expression of a lame dairy cow. Key facial action units are outlined showing (from top) ears, eyes, chin, face and lips (Haskell and Hunter, 2019).

There are a number of steps involved in the development of these systems. Firstly, the software must be capable of identifying the key features or 'biometrics' of the animal's face from whatever angle the face is presented to the camera (Figure 2). Ideally, the animal would present its face directly to the camera, whilst alone and without dirt or bedding obscuring any part of its face. Clearly, in free moving animals, this is a major challenge. A very time-consuming element of this type of research involves creating a 'library' of animal faces to allow the geometry of the faces and the relevant facial action units to be recognised by the algorithm. Then, the system must 'learn' how to recognise emotional states. To do this, images from animals experiencing emotion and in neutral states are captured and compared to 'train' the algorithm using advanced computer analysis methods. This type of research is in the early stages, but shows great promise.

Further developments should also consider how changes in dynamic behavioural expression of pain and other states can be detected, as well as detecting changes in the facial expression of a static animal.

Conclusions

There is a long history of research into the identification of emotional states from facial expression and behavioural changes. The development of 'grimace scales' has been very important, particularly in laboratory animals. The use of these systems in cattle has been limited, perhaps because of stoical nature of this species. The development of systems based on machine vision methods, that can recognise changes in facial expression show great promise, as these systems can monitor animals remotely and continuously. These systems are still in the development phase, and there is a there is a great deal of research to be done to create a system that can be used in real-life farming situations. However, there is huge potential for improving the welfare of cattle and other animals by using automated computer vision systems that detect pain, stress and other emotional states.

Figure 2. Biometric analysis of the face of a pig. (Photo: Emma Baxter from 'EmotiPig' project).

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Which sensor technology for cattle welfare assessment?

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Animal welfare assessment tools are needed to identify welfare problems and monitor progress when animal welfare improvement strategies are implemented. Also, a growing number of citizens in many countries are concerned about the welfare of farm animals and this offer an opportunity for the development of labeling schemes to enhance farm animal welfare. Indeed, several organizations including NGOs, private companies and public institutions have developed a variety of labeling schemes in many countries. Obviously, labelling schemes require the use of welfare assessment tools.

There is a growing interest in the potential of Precision Livestock Farming (PLF) technology to improve welfare assessment and labeling schemes for cattle and available PLF technologies can already provide useful information (Schillings et al., 2021; Stygar et al., 2021). Indeed, most “conventional” -i.e., not using PLF- animal welfare assessment tools can identify existing welfare issues but do not anticipate welfare problem to implement preventing measures. Also, they provide information for only a short window of time and are intended to monitor welfare at a group level, with less attention given to individual animals. PLF technology, on the other hand, has the potential to continuously monitor individual animals and provide early-warning signals to prevent welfare problems. In a recent paper, Stygar et al. (2021) reviewed the commercially available PLF technologies that can be used to provide information on dairy cattle welfare. According to their results, PLF technology that can help measure activity, feeding and drinking behavior, physical condition, and some health-related welfare issues is already available in the market and has been validated.

However, there are several issues that require further work before PLF technology can be widely used to assess cattle welfare. Some of these issues are related to the extent to what PLF provides valid and comprehensive information on cattle welfare, while others relate to consumers’ perception about PLF. One limitation of the use of PLF technology to assess cattle welfare is that, whereas some of the technologies -mainly those that measure lying, standing and rumination- have a high performance, others -including those that measure active behaviour such as walking, body condition score and health parameters such as mastitis- appear to have low performance (Stygar et al., 2021). Although PLF systems were initially developed for use in more intensive systems (Berckmans, 2014), there is no reason why they should not be used in extensive

systems. For example, PLF technologies can provide continuous monitoring of the animals and facilitate the detection of injured or sick animal. Also, PLF technologies that monitor foraging behavior could help to identify or even predict when and where forage is likely to be limited. As proposed by Rutter (2014), the integration of virtual fence technology with other sensors, both on and off the animal, along with external data such as weather forecasts, should allow smart systems to be developed that dynamically monitor and control grazing in a way like traditional, human-based shepherding. Such a system could act as a "virtual shepherd" (Campbell et al., 2020). Therefore, PLF can help farmers to make extensive systems more efficient without necessarily making them more intensive (Rutter, 2016). In summary, currently available PLF technology can be useful to assess cattle welfare, both in intensive and in extensive systems. However, there is a need to develop and validate new technologies that can provide information on the behaviour aspects of welfare, as well as on positive indicators of cattle welfare. Furthermore, it is important to bear in mind that, although PLF technologies have a great potential to support farmers, they are not a substitute for farmers' skills, and experienced stockpeople with a direct knowledge of animals' needs and behavior can accomplish many things technology cannot (Meuret and Provenza 2015). PLF data are sometimes difficult to interpret, and the use of applications may need appropriate training and a significant investment (Rutter, 2016). Finally, consumers' concerns about the use of PLF should be addressed.

Figure 1. IDA accelerometry collars for dairy cows provide daily information on the time the cow spends standing, lying, eating, ruminating, and walking. Credits: COVAP (Valle de los Pedroches Livestock Cooperative), Farm Huerta Chica, Dos Torres, Andalucía (Spain).

Figure 2. DeLaval VMS™ V310 Milking robot provides the following information: milk yield, average milk flow rate, quarter milk yield, quarter milk flow, conductivity, blood detection of, SCC (DeLaval OCC), milk progesterone (DeLaval Herd Navigator). Credits: COVAP (Valle de los Pedroches Livestock Cooperative). Pozoblanco, Andalucía (Spain).

ClearFarm

The European Union's Horizon 2020 research and innovationprogramme has funded two projects with the objective of developing innovative approaches and appropriate business models to monitor farm animal welfare using PLF technologies: TechCare (led by the Scotland's Rural College, SRUC) and ClearFarm (led by the Autonomous University of Barcelona, UAB). Whereas TechCare covers sheep and goats, ClearFarm focuses on pigs and dairy cattle.

The overall objective of ClearFarm is to co-design, develop and validate a software platform powered by smart farming technology to provide animal welfare and environmental information for all the stakeholders in the production chain, including consumers. To do so, Clear Farm will (1) identify the needs and requirements of consumers and producers about animal welfare and (2) develop new approaches based on PLF technologies that help monitoring animal welfare (including behaviour, stress and other welfare indicators) and the reduction of pollutants from farming.

Further information on the Clear Farm project as well as a list of publications and several practice abstracts related to the use of PLF technologies to assess animal welfare can be found at www.clearfarm.eu.

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