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A qualitative survey approach to investigating beef and dairy veterinarians' needs in relation to technologies on farms

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ABSTRACT

Globally, farmers are being increasingly encouraged to use technologies. Consequently, veterinarians often use farm data and technologies to provide farmers with advice. Yet very few studies have sought to understand veterinarians' perceptions of data and technologies on farms. The aim of this study was to understand veterinarians' experiences and opinions on data and technology on beef and dairy farms. An online qualitative survey was conducted with a convenience sample of 36 and 24 veterinarians from the United Kingdom and Ireland, respectively. The data were analysed using reflexive thematic analysis to generate four themes: (1) Improving veterinary advice through data; (2) Ensuring stock person skills are retained; (3) Longevity of technology; and (4) Solving social problems on farms. We show that technologies and data can make veterinarians feel more confident in the advice they give to farmers. However, the quality and quantity of data collected on cattle farms were highly variable. Furthermore, veterinarians were concerned that farmers can become over-reliant on technologies by not using their stockperson skills. As herd sizes increase, technologies can help to improve working conditions on farms with multiple employees of various skillsets. Veterinarians would like innovations that can help them to demonstrate their competence, influence farmers' behaviour, and ensure sustainability of the beef and dairy industries.

Implications

This study investigated veterinarians' experiences of data and technology use on beef and dairy farms using a qualitative survey. We show that technologies and data can make veterinarians feel more confident in the advice they give to farmers. However, the quality and quantity of data collected on cattle farms were highly variable. Furthermore, veterinarians were concerned that farmers can become over-reliant on technologies, some of which were considered unreliable and unsustainable. The research highlights that veterinarians would like innovations that can help them to demonstrate their competence, influence farmers' behaviour, and ensure sustainability of the beef and dairy industries.

Introduction

Veterinarians have a major role in improving herd health, performance, and welfare by providing support to cattle farmers worldwide (Ruston et al., 2016; Doidge et al., 2020a; Gerber et al., 2020; Mills et al., 2021). Globally, the cattle veterinarian profession is in the process of development with a move from a reactive role, stepping in when disease is detected, towards a proactive herd health advisor role (Ruston et al., 2016; Woodward et al., 2019; Bonnaud and Fortané, 2021). This herd health advisor role aims for greater engagement with veterinary herd health management and disease prevention (Hall and Wapenaar, 2012; Svensson et al., 2022). Use of farm performance data and technologies is often an essential part of veterinary herd health management (Woodward et al., 2019; Svensson et al., 2022). Therefore, veterinarians' skills are evolving to include interpreting data and using technologies for improved decision-making on farms (Eastwood et al., 2019a).

Interpreting farm data may be useful for identifying farms with good animal welfare (Sandgren et al., 2009; Nyman et al., 2011; De Vries et al., 2014), reducing antibiotic use (Hommerich et al., 2019) and calf mortality (Santman-Berends et al., 2014; Hyde et al., 2020). However, farm data recording remains a global challenge (Mee, 2013; Opoola et al., 2019), and the types and quantity of data collected on beef and dairy farms tend to be variable (Escobar and

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Demeritt, 2017; Doidge et al., 2021). Similarly, there are many technologies available for cattle farmers including automatic milking systems, automatic feeders, accelerometers, electronic identification (**EID**) readers, and various computer software (Lovarelli et al., 2020; Costa et al., 2021). Moreno et al., 2024 show that there are several classes of farm technologies, such as automation, communication, resource-based, and biotechnologies. Technology can be defined as an umbrella term that includes "higher-tech" and "lower-tech" technologies, as well as progressive ideas (Barrett and Rose, 2022). Farmers are being increasingly encouraged to use these technologies; however, globally, uptake is still relatively low for many technologies (Groher et al., 2020; Palma-Molina et al., 2023). Research suggests that this might be because technologies for farms are often developed without considering the implications and needs for the end-users (Eastwood et al., 2019b).

As farm data and technologies may be used by veterinarians (Woodward et al., 2019; Mills et al., 2021), it is important to consider their needs when developing new tools. However, it can be difficult for users to articulate their needs through direct questioning as they are often not consciously aware of the need (Patnaik and Becker, 1999). Instead, researchers can generate users' needs by understanding their experiences, values, perspectives, and dreams. This requires a qualitative approach which explores what currently works well and future goals (Bergvall-Kåreborn and Ståhlbröst, 2009).

The qualitative survey method has gained recognition in the social sciences recently due to its flexibility in approaching research questions, ability to capture perspectives from different groups in geographically dispersed areas, and ability to provide felt anonymity (Braun et al., 2021). Yet, in the veterinary sciences, fully qualitative surveys remain an underutilised method compared to focus groups or interviews. Whilst some researchers have used mixed-methods surveys (Quain et al., 2021), surveys that give precedence to qualitative questions and values are rare (Dürnberger, 2020). Despite this, qualitative surveys can produce rich descriptions of respondents' experiences and perspectives (Braun et al., 2021) and are therefore a valuable research method for identifying users' needs.

Very few studies have sought to understand veterinarians' perceptions of data and technologies on farms for any livestock species (Giersberg and Meijboom, 2021; Giersberg and Meijboom, 2023). Only one study has investigated veterinarians' perceptions of technologies on beef farms to our knowledge (Makinde et al., 2022), indicating a lack of breadth of knowledge in this area. Furthermore, the previous study was conducted in Canada, and due to the contextual nature of qualitative research, these views may not reflect those of European veterinarians. For example, in Canada, it is a requirement for beef cattle to be fitted with radio frequency identification ear tags (Makinde et al., 2022), but this is not a requirement in the United Kingdom (**UK**) and has only very recently been introduced for cattle born in Ireland from 2022 onwards (Government of Ireland, 2020). To our knowledge, there have been no studies that have investigated veterinarians' perceptions of technologies on dairy farms.

In contrast, studies investigating the perceptions and experiences towards technologies of people who offer other advisory services to farmers are well documented (Fielke et al., 2020). Research suggests that farm advisors now often provide digitally integrated advice, which means they use and interact with farm technologies and the data they produce (Klerkx, 2021). Advisors have suggested that technologies can improve production and efficiency of farms (Barrett and Rose, 2022). Newton et al., 2020 show the important role that intermediaries, such as farm advisors, have in helping dairy farmers to benefit from their data. However, some advisors view the digitalisation of agriculture as a threat or disruption to their profession (Charatsari et al., 2022). The role of farm advisors is therefore complex, being interpreted both as key for increasing the digitalisation of farms, and as counter-productive to technological innovation (Higgins and Bryant, 2020). Most of these studies tend to focus on advisors who are not veterinarians. The professional role of veterinarians in animal health is likely to create additional complexity in their views of farm technologies. Thus, our aim was to understand veterinarians' experiences and opinions on data and technology on beef and dairy farms in the UK and Ireland. We did not limit our investigation to a specific class of technology. By doing so, we were able to generate veterinarians' needs regarding technologies on cattle farms.

Material and methods

Data collection

An online qualitative survey was used to collect data. Traditional qualitative methods such as focus groups may not be suitable for time-poor participants such as veterinarians because they can be relatively inflexible in terms of timing. We chose to use an online qualitative survey as it gives participants control over their level of participation. They can choose the amount of time they spend, when, and where they wish to complete the survey (Braun et al., 2021). Thus, the qualitative survey may be a more accessible method to allow a diversity of veterinarians to participate. The qualitative survey data collection method has successfully been used to understand the perspectives of other professions that have limited time availability, such as dentists and physicians (Herrler et al., 2022).

The respondents were informed that the goal of the survey was to better understand their experiences and opinions of data and technology use in beef and dairy farming. The online survey included ten open-ended questions. The questions were related to experiences with using technologies for youngstock and adult cattle, experiences with using data and the impact on veterinary advice. We informed the respondents that we were interested in their views on any types of technology used on farms and gave some examples such as farm management software, an automatic milking system, activity monitor, or a thermometer. We added the examples so that veterinarians were aware that they could write about more primitive technologies. There was also a question about their future goals in relation to youngstock health and welfare. There was a section on demographic information at the beginning of the survey to collect information on gender, age, country, and time spent working with beef and dairy cattle. The qualitative questions used in the survey are available in the Supplementary Material S1. The survey was piloted with three veterinarians who worked in the UK. From their responses, we made the wording of some of our questions more specific. The time taken to complete the survey was dependent on the level of detail the respondent went into, but it was suggested that participants should spend 10–15 minutes.

Sampling approach

The target sample was veterinarians in the UK and Ireland who spend time working with beef or dairy cattle. A convenience sampling approach was used. The survey was opened in the UK first to check the quality of the data and have a more informed estimate of sample size requirements before also opening in Ireland. This was because we expected a similar level of detail in the responses from Irish veterinarians. In the UK, the emails of veterinary practices which treat cattle were collected from the Royal College of Veterinary Surgeons website (n = 529). An email was sent with a recruitment letter inviting veterinarians to complete the survey. The

survey was also advertised on Twitter. The survey was open between 6 May 2022 and 12 August 2022. The respondents did not receive an incentive for completion of the survey.

In Ireland, veterinary practitioners (n = 893) who deliver on-farm consults as part of the Animal Health Ireland cattle health programmes (such as bovine viral disease, mastitis management, Johne's disease, and parasite control) and opted-in to being contacted about future work were invited to take part via email with a recruitment letter attached. The survey was open between 5 August 2022 and 7 September 2022. Respondents did not receive an incentive for completion of the survey.

We did not aim to achieve statistical representativeness, but to sample a diversity of respondents. We used the information power concept to determine our sample size (Malterud et al., 2016). The information power concept suggests that the more information power a sample holds regarding a research question, the smaller the required sample size. This depends on factors such as experience of the researcher, quality of the dialogue, and aim of the study. We wanted to ensure we had multiple respondents from Ireland and the UK in case there were social or cultural differences in experiences and perspectives. The adequacy of the sample size was a process of ongoing interpretation during the data collection period (Braun and Clarke, 2021b). We initially estimated that we would need approximately 20–30 respondents each from the UK and Ireland to achieve the study aim, based on our experience and other surveys of health professionals (Braun and Clarke, 2021b; Herrler et al., 2022). When we had collected thirty responses from the UK survey, we inspected the data and determined that if we obtained a similar-sized dataset in Ireland then this would be rich enough to answer the research question. We inspected the data from the Irish survey after 24 responses and believed that this was adequate for our study aim.

Data analysis

Veterinarians' responses were imported into a Microsoft Excel spreadsheet. This was then imported into NVivo (NVivo qualitative data analysis Software; QSR International Pty Ltd. Version 12, 2018) for data analysis. We analysed the data using reflexive thematic analysis (Braun and Clarke, 2019) with a critical realist perspective (Braun and Clarke, 2021a). We recognise that we have access to respondents' perspectives and representations of reality, and this is based on their social, historical, and cultural context. For example, veterinarians may have used the same technology but are likely to have different subjective perspectives and experiences of that technology. We also interpreted the survey responses using our own social and cultural background.

The survey responses were read by CD to familiarise herself with the data. She then coded the data in an iterative process. Coding was inductive (derived from the data) and semantic (descriptive). Codes were clustered together to generate initial themes which represented patterns of shared meaning. CD critically reflected on the themes through discussions with JK and coding was revisited until the final themes were developed. These were then discussed further with AB.

To generate the veterinarians' needs of technologies on beef and dairy farms, we used the Desmet and Fokkinga, 2020 needs typology as a framework. Needs relate to overall goals, motivations, and desires (e.g., security) rather than technical requirements (e.g., padlock, waterproofing) (Patnaik and Becker, 1999). Therefore, needs tend to be broader and less influenced by trends compared to requirements. Several researchers have attempted to group psychological needs into meaningful categories, which are known as typologies (Reiss, 2004; Desmet and Fokkinga, 2020). As a result, Desmet and Fokkinga, 2020 have produced a design-focused need typology by reviewing existing psychological need typologies. The typology includes thirteen fundamental needs and 52 sub-needs which can be used to help inform innovation design. Some examples of the needs include autonomy (i.e., being the cause of your actions), competence (i.e., exercising your skills and knowledge) and purpose (i.e., having meaning to your life) (Desmet and Fokkinga, 2020). A needs extraction approach was used by CD, where information generated from the final themes were mapped against the needs typology to identify the most relevant needs in relation to farm technologies (Pollmann et al., 2018). The needs were then discussed with all authors.

Reflexivity

Since we take a critical realist stance during the study, we must reflect on our positionality and how this affects data interpretation. CD had roles in study design, analysis and writing of the original manuscript. She is a female, English postdoctoral researcher based in the UK. She is not a veterinarian but has conducted studies and worked with farm animal veterinarians in the UK. A relationship with the respondents was not established prior to the study commencement. Her previous research with beef and dairy farmers shaped the research questions that were constructed. She did not have experience working with veterinarians in Ireland prior to this study. Because of this, she ensured that the study design and analysis were checked by an author familiar with the Irish context (AB). JK is a veterinarian and senior researcher and has previous experience working with farm animal veterinarians and conducting studies on beef and dairy farms.

Results

Demographics and general information

Sixty veterinarians provided responses to the survey, of which 36 were from the UK and 24 were from Ireland (Table 1). All respondents completed every question in the survey. The level of detail provided in the survey responses varied depending on the experiences of the veterinarians. For example, the question about experiences with technologies for the management of youngstock tended to generate shorter responses compared to the question about technologies for the management of adult cattle. The veterinarians mentioned a variety of technologies in response to the survey questions. This included sensor technology (e.g., activity

Table 1
Summary of the cattle veterinarian respondent demographics.

Variable	N (%)
Sex	
Female	23 (38%)
Male	37 (62%)
Country of practice (respondents could choose more than one option)	
England	28 (47%)
Scotland	6 (10%)
Wales	5 (8%)
Northern Ireland	1 (2%)
Republic of Ireland	24 (40%)
Age	
30 or under	7 (12%)
31–40	24 (40%)
41–50	12 (20%)
51–60	7 (12%)
61–70	7 (12%)
71+	3 (5%)
Percentage of time spent	Mean (SD)
Working with beef cattle	33.5 (24.7)
Working with beef cattle in an advisory role	21.5 (22.2)
Working with dairy cattle	47.7 (30.7)
Working with dairy cattle in an advisory role	30.5 (26.9)

collars, ear tags to measure temperature), automation technology (e.g., automatic feeders, automatic milking systems), and data capture technology (e.g., EID readers, software, and apps).

Themes

Four themes were generated from the analysis, which are summarised in Table 2. The themes are then further described in the following sections.

Improving veterinary advice through data

This theme centres on the advice that veterinarians give their beef and dairy clients. The sub-theme "Facilitating a proactive approach to herd health" illustrates the type of advice veterinarians would like to give their clients, whereas the sub-theme "Improving the quality of data recording" shows the barriers to giving this advice. The final sub-theme "Confidence in providing advice" indicates the impact of data and technology on the advice that veterinarians provide.

Facilitating a proactive approach to herd health. Most of the veterinarians' goals were related to applying a more proactive approach to disease management on farms. They wanted to move away from their traditional "firefighting" role where they discussed treatments and towards a preventative advisory role. This was usually because veterinarians wanted to promote better health and welfare of cattle. However, many of the veterinarians mentioned that their main reason for visiting farms was to treat problems, rather than prevent problems.

> "Promote better health and welfare on farm. Encourage farmers to prevent disease rather than acting when it's an issue" (Veterinarian #56, Male, Ireland)
> "Moving toward working on a more herd level management as opposed to the typical 'fire fighting' role of treating ill animals" (Veterinarian #23, Female, UK)

A preventative approach aligned with a further goal of reducing the need for antibiotics on farms.

> "I would like to be more involved in an advisory role that enables the herd managers/owners to rear animals without recourse to antibiotics or any medical/chemical use" (Veterinarian #45, Male, Ireland)
> "I guess my main fundamental aim of advice is to move the farm to a more proactive preventative approach and weaning them off the need for antibiotic therapy as much as possible." (Veterinarian #4, Male, UK)

Reasons for moving towards a preventive approach and reducing antibiotic use included improving public perceptions of the cattle industry and the impact on society.

> "This [improving infrastructure] could significantly reduce antibiotic use in youngstock which the public would like to see and would be good use of tax payers money for society!" (Veterinarian #33, Male, UK)

Finally, veterinarians suggested that a proactive approach to herd management requires engagement between the farmer and the veterinarian. Advice needs to be clearly communicated to farmers in order for changes to be made on farms.

> "Farmers are very open to making changes, if the benefits and how much input is well explained at the beginning and that the practice offer ongoing support to adapt to individual circumstances." (Veterinarian #41, Male, Ireland)

However, it appeared that it can be difficult to get farmers to use veterinarians' advisory services. There was sometimes very little engagement and communication between farmers and veterinarians. Therefore, some veterinarians illustrated how they used technologies such as mobile applications to facilitate communication with farmers and help to arrange visits.

> "The farmer has to believe we can improve their calf health and get us involved" (Veterinarian #6, Male, UK)
> "We use phone / WhatsApp reminders of action timing on farms and follow up with visits" (Veterinarian #48, Male, Ireland)

Improving the quality of data recording. Most veterinarians highlighted that data were important for their advisory role on farms. The types of data that veterinarians found useful included weight (daily live weight gain), activity (through accelerometers/pedometers), and temperature (via thermometers). The veterinarians were highly dependent on the farmers data recording.

> "Mastitis, lameness and fertility data is always a good starting point, but it relies on good input from the farmer initially." (Veterinarian #29, Female, UK)

Many of the veterinarians complained about the state of data recording on beef and dairy farms. Data recording on farms was seen as highly variable. First, there was an issue with the quantity of data available. Veterinarians mentioned that some farms recorded very little data:

> "Most beef units have virtually no data" (Veterinarian #6, Male, UK)
> "Medicine data. Not always easy to obtain for youngstock. Poor records of treatments... Would be beneficial in the future that more data was collected for youngstock" (Veterinarian #10, Female, UK)
> "Herd app/ Agrinet (far superior in my opinion) are great but lots of farmers are not inputting the info so of limited use." (Veterinarian #59, Female, Ireland)

Second, there was an issue with the quality of the data recorded on farms. Veterinarians suggested that records were not always complete. They felt that they could not always trust some farmers' data.

> "If I trust someone to record things reliably then I will trust the data more than haphazard people." (Veterinarian #26, Female, UK)
> "Generally poor recording of clinical data e.g., mastitis, lameness, cases of BRD etc. Some "enthusiasts" will record on some

Table 2
Summary of the themes generated from the analysis of survey responses from cattle veterinarians.

Theme	Sub-theme	Summary
Improving veterinary advice through data	Facilitating a proactive approach to herd health	Veterinarians would like to provide preventative advice to promote better health and welfare.
	Improving the quality of data recording	Data was often highly variable and poorly recorded on farms.
	Confidence in providing advice	The availability of data affects the advice that veterinarians can give their clients.
Ensuring stock person skills are retained		Veterinarians were concerned that farmers may become over-reliant on technologies.
Longevity of technology		Technologies need to be improved to ensure long-term use and a return on investment.
Solving social problems on farms		As herd sizes increase, technologies can help to improve working conditions on farms.

hard management software but frequently not a complete data set." (Veterinarian #41, Male, Ireland)

Third, data were often in an inaccessible format for veterinarians to use. Often data were presented to veterinarians in a paper-based format, which meant that veterinarians had to spend time inputting data into computer software. However, some veterinarians did not have time to do this and therefore, paper-based records were not used.

"The one issue is whether the data is in a usable format, as I am not as positive about the situation when I am doing manual data input from paper to computer on my evenings and weekends." (Veterinarian #4, Male, UK)

"Collars/bolus for monitoring fertility and health - poor ability for me to access and use info" (Veterinarian #59, Female, Ireland)

One difference between the experiences of veterinarians in Ireland and the UK was that the Irish veterinarians have access to a dashboard via the Irish Cattle Breeding Federation (**ICBF**) in which milk recording data are input (ICBF, 2023). The dashboard includes interactive graphs which help the veterinarian interpret the data and the Irish veterinarians had positive experiences of using this. In contrast, the veterinarians in the UK mentioned that the milk recording data could often be in a format which was not easily interpretable.

"Milk recording data (ICBF) [is an] essential tool. . .allows a large quantity of data to be handled on spread sheets etc." (Veterinarian #41, Male, Ireland)

"Data only useful if it is available and in a useful format. Reviewing milk recording data before a visit can give a lot of pointers to success or otherwise of the farming system e.g., nutrition, mastitis management, transition cow management, but only if it is presented in an easily interpreted form. Sometimes we have a lot of data but no analysis and no decisions!" (Veterinarian #15, Male, UK)

Another reason for the lack of data recording was that farmers may not value the data they are collecting.

"A lot of weighing seems to be seen as a chore in relation to fulfilling task in relation to a payment scheme, value of data in relation to stock performance not realised" (Veterinarian #54, Male, Ireland)

Some veterinarians suggested that technologies may be able to help farmers with data recording. For example, apps can help farmers to record at the cow-side and automatic milking systems can collect data automatically. Furthermore, farm software enabled veterinarians to analyse data quickly and easily.

"Tag reader in parlours, drafting systems [automatic gates to sort cows into pens], modern parlours (automatic cluster removal, cluster flush etc). Hydraulic crushes-head gates, foot lifters etc, phone app with herd info, medicines recording etc. All make handling cattle and recording data easier on man and beast meaning its more likely to be done promptly and properly" (Veterinarian #39, Female, Ireland)

However, technologies were rarely adopted on beef farms and for youngstock. In particular, many of the Irish veterinarians mentioned that they had very limited experience with using technologies on farms. The lack of software and technologies used may be a barrier to high-quality data collection and the subsequent analysis of data by veterinarians. In contrast, veterinarians tended to have more experience with technologies that aid the management of adult dairy cattle, especially in the UK. This included activity collars and automatic milking systems.

"I do less beef work but typically find beef farmers are less engaged with animal tech" (Veterinarian #36, Female, UK)
"No experience in this age group [youngstock]" (Veterinarian #49, Male, Ireland)

Where technology was used, the veterinarian may or may not be given access to the data it produces.

"Also, more farms are using team viewer so we can access their management systems remotely" (Veterinarian #17, Female, UK)
"Only technology used is collar monitoring in dairy cows, I don't get access to data, only called when health issue raised by monitors" (Veterinarian #54, Male, Ireland)

A further challenge of using technology to collect data was that the datasets that were produced do not integrate easily together.

"Need to link in with existing technology e.g., Uniform for dairy, Herdwatch for beef. Constantly frustrated when cattle industry initiatives set up independently without being able to link in easily." (Veterinarian #12, Female, UK)

Confidence in providing advice. The majority of veterinarians mentioned that the availability of data has a positive impact on their ability to give advice. The following quotes demonstrate how on-farm data can give veterinarians confidence in the advice they provide to farmers.

"Yes, on farms where data is minimal it is difficult to advise on improvements to the health or management of the herd as focus areas are unknown." (Veterinarian #9, Female, UK)
"Good data helps us to be more confident in making a recommendation. If we are going to recommend a treatment or vaccine, we can be more confident it is likely to work" (Veterinarian #14, Male, UK)

Some veterinarians suggested that sufficient data allowed them to make more informed decisions and improve their advice. For example, the data available may change the advice they give to farmers. Therefore, data allowed veterinarians to tailor their advice to the individual farm. Advice was seen as more useful if it was specific to each farm.

"[Data] Can help you assess husbandry on farm and might change what you'd recommend in terms of vaccines/dosing/hygiene practices etc" (Veterinarian #39, Female, Ireland)
"Better data gives me more confidence in being able to correctly advise the Farm on management issues. Poorer data leads to advice that may not be as focused to that farm's individual needs" (Veterinarian #32, Male, UK)

Veterinarians were able to back up their advice with evidence if data were available on the farm, which made their advice appear more trustworthy. This helped veterinarians to encourage farmers to adopt new management practices.

"Technology will help record relevant data and help to explain to farmers about issues that may be on farm" (Veterinarian #56, Male, Ireland)
"If data available it usually makes management decisions easier and more obvious. You can pick the easy wins, show the client what is costing them the most money and cost of intervention." (Veterinarian #25, Female, UK)

Furthermore, the data could provide veterinarians with evidence of the value of their advice, which is important if they would like to move to an advisory role. For example, Veterinarian #53 (Male, Ireland) mentioned that technologies could give them the "*ability to explain with a simple cost benefit analysis*" which would allow them to "*convince clients the true value of vaccination and good housing*".

"Growth rates help provide evidence as to how pneumonia/scours knocks them even if they don't perceive a problem" (Veterinarian #23, Female, UK)

Ensuring stock person skills are retained

Veterinarians valued the experiential knowledge that farmers had about their cattle. These skills allowed farmers to identify sick cattle. Many veterinarians believed that technologies, such as activity sensors, could enhance farmers' stock person skills; for example, by providing early warnings of diseases on farms.

"Heat and health collars very good indicator of disease and picks up issues early on in the disease process. Also, very useful to monitor response to treatment" (Veterinarian #57, Female, Ireland)

However, some veterinarians also expressed concerns that farmers may over-rely on technologies. They recounted experiences where farmers put so much trust in their technologies that they no longer used their own skills:

"Consider them [technologies] useful up to a point, there is no substitute for good herdmanship, some people put too much faith in their technologies to the detriment of good judgement." (Veterinarian #50, Male, Ireland)

"Heat detection collars, as a negative some farmers expectations are very high and see this as low input from themselves so stop becoming involved in heat detection. However, others embrace the information available and become more involved." (Veterinarian #10, Female, UK)

There was also a concern that technologies could potentially de-skill farmers. That is, technologies may prevent farmers from developing experiential knowledge of their cattle.

"IMHO [In my honest opinion] farm support is too focussed on providing funding for 'sexy' capital items, rather than fostering a highly skilled agriculture workforce. Technology certainly has its place but should be appropriate and not de-skill farmers." (Veterinarian #2, Male, UK)

Therefore, veterinarians' perspective on farm technologies was that they should be used in conjunction with – rather than a replacement of – stock person skills. That is, farmers still need to monitor the technology they use, observe their youngstock, and respond to any signals appropriately.

"Computerised milk feeders are both brilliant and disastrous! If installed and managed properly calves will do well. If installed in the wrong place and not managed by a good stock man. huge problems can develop quickly." (Veterinarian #41, Male, Ireland)

"Activity collars - sometimes they are a hindrance if farmers do not watch cattle too, but a good adjunct to a good stockman for picking up heats and sick cows when no overt signs" (Veterinarian #25, Female, UK)

Some of the veterinarians suggested that appropriate technology use on farms can be aided by veterinary engagement.

"Automatic calf feeders – carry some risks of Cryptosporidium and so attention to detail with hygiene is essential – again Veterinarian input is critical here." (Veterinarian #33, Male, UK)

Longevity of technology

Many of the veterinarians showed an awareness of the financial costs of technologies and that many farmers may struggle to afford the adoption of technology. They saw farm technologies as an asset that needed to demonstrate a return in investment. As highlighted by Veterinarian 1, this was a particular problem for non-reusable technologies intended for youngstock.

"Challenge with all wearable technology in this sector is the price point - how much is worth paying for something which is only used for a short period of an animal's life." (Veterinarian #1, Male, UK)

Technologies may be more likely to be used if it can be kept up to date after the initial investment. For example, Veterinarian #18 (Male, UK) mentioned that "*Uniform agri [dairy cow management programme] is constantly being updated and is very useful*". The software was seen as an investment that will be used long-term because the technology will not become outdated quickly. However, some veterinarians recounted experiences where farmers bought technologies but were not used long-term. This shows that investment in technologies was not always economically sustainable.

"Often too delicate or frustrating. I have happy memories of seeing an EID reader being used by herdsman as a very expensive blue pipe for moving cattle." (Veterinarian #2, Male, UK)

Some veterinarians in the UK talked about how farmers used grants to invest in technologies such as EID readers. However, they highlighted that one of the reasons that farmers underutilise these technologies was that farmers often get little support to learn to use technologies.

"I've found many farms have invested in EID technology through government grant schemes, but they are difficult to set up and collect data from, so they often go unused. More assistance is needed to train farmers in the use of EID technology" (Veterinarian #9, Female, UK)

One of the reasons for not using technologies was that some were not robust to the farm environment. The respondents gave examples of automatic weigh scales and thermometer tags.

"Ear probe thermometer tags - seemed very fragile and broke easily, difficult to fit" (Veterinarian #7, Male, UK)
"Automatic weigh scales (didn't work very well as got clogged with straw)" (Veterinarian #26, Female, UK)

Another issue was that some technologies produced unreliable data. One example given by veterinarians in the UK was technologies that measure calf temperature. Another example given by an Irish veterinarian was that there may be a delay in farmers' receiving data from technologies because of problems with the connectivity of technologies.

"We did "play" with the in-ear calf temperature tags but there were issues with Sn [sensitivity] and Sp [specificity]and I had nearly forgotten about them!" (Veterinarian #33, Male, UK)
"Sometimes dairy cows not within range and farmer doesn't get useful data on time" (Veterinarian #37, Female, Ireland)

Some veterinarians mentioned that apps or software could be difficult to use, which can impact their adoption on farms.

"I've yet to find a user-friendly app/book etc. for management of dairy calves." (Veterinarian #39, Female, Ireland)

Some of the veterinarians also expressed interest in innovations that could improve the productivity and longevity of cattle. Therefore, technologies may help farms to become more environmentally sustainable.

"Embryos can be placed in lower genetic animals and this will speed up the rate of genetic improvement and allow farms to become more efficient, reducing the carbon footprint and producing more food from less inputs." (Veterinarian #18, Male, UK)

"Improving the health of young stock and avoiding disease makes farms more viable as it lengthens the lifespan of cows and therefore reducing CO2 emissions" (Veterinarian #48, Male, Ireland)

Solving social problems on farms

The final theme draws on veterinarians' perceptions on how technologies may provide social benefits to farms, especially those with larger herd sizes. In developed countries, including the UK and Ireland, the size of herds has been increasing whilst the number of herds has been decreasing (Barkema et al., 2015; Läpple and Sirr, 2019; Kelly et al., 2020). The larger herd sizes require a greater number of staff employed on farms. Some of the veterinarians considered the usefulness of technologies in relation to the different types of staff on farms. Staff employed on the farms may not be permanent and have variable levels of stock-keeping skills. Sensor technologies could aid inexperienced staff to identify sick animals and reduce the risk of disease outbreaks.

"When they were available, we found the ear tag thermometers extremely useful where there were large numbers of calves being reared or where multiple different staff were involved. It was easy for the staff to identify calves with temperatures allowing early action." (Veterinarian #9, Female, UK)
"Activity monitoring systems (collars/pedometers/cow manager eartag), these are particularly useful as herd size has increased and staff availability and skill/experience levels are mixed" (Veterinarian #18, Male, UK)

The larger herd sizes also meant that farmers need to spend more time observing cattle. Veterinarians thought that technologies could help farmers to save labour by reducing the time needed for tasks. This could enhance the work-life balance for farmers. For example, veterinarians suggested that technologies such as cameras and calving alert systems allowed farmers to spend more time at home or away from the farm.

"Heat detection - very useful time saving tool." (Veterinarian #57, Female, Ireland)
"Calving alert systems e.g., Moocall are rated by some of our farmers and probably improve work/life balance." (Veterinarian #2, Male, UK)

Data collection was seen as a labour-intensive task. Therefore, technology and software were perceived as a necessity on larger farms because of the need to collect and analyse large volumes of data.

"Nothing replaces a good stock person, [technology] just makes it easier for him to work with bigger numbers" (Veterinarian #41, Male, Ireland)
"Farms with large numbers of staff can record breeding events and medicine usage effectively, rather than it having to be added manually to a diary or computer which often means it isn't done when the staff are busy." (Veterinarian #9, Female, UK)

Some veterinarians thought that technologies may help to improve animal welfare by aiding tasks which are usually labour intensive. For example, Veterinarian #24 (Male, UK) described heat detection aids and rumination monitoring systems as acting as an "*extra pair of eyes*". Furthermore, technologies can be used to identify the early onset of diseases that may otherwise be missed on larger farms.

"Automatic milk feeding stations help to detect early onset of pneumonia before obvious clinical symptoms in milk reared calves e.g., calf rearers or on large dairy farms" (Veterinarian #27, Female, UK)

"Robots milking and data recording collars - labour saving and flagging behaviour issues" (Veterinarian #49, Male, Ireland)

Some veterinarians also suggested that innovations could improve animal welfare in relation to calf housing. The trend for larger herd sizes had led many veterinarians to be concerned about the stocking density of youngstock housing. Veterinarians thought that higher stocking densities increased the risk of diseases such as pneumonia. As a result, some veterinarians pushed for greater regulation of youngstock housing and technologies that could act as an assessment of housing. For example, Veterinarian #59 (Female, Ireland) mentioned that her goal was to improve housing which could be achieved by "*better tools to assess housing, calculate airflow etc*.".

"Would like to see the expansion in cow numbers being mirrored by expansion in good quality calf housing." (Veterinarian #29, Female, UK)
"I would like to see more pressure from milk buyers/supermarkets/legislation to enforce suitable youngstock accommodation is provided" (Veterinarian #18, Male, UK)
"If environment measurement technology were more available that could be used easily, so as to improve animal welfare and this be a requirement for product sales from the producer" (Veterinarian #45, Male, Ireland)

Finally, veterinarians suggested that technologies could improve the safety conditions when working on farms. For example, technologies that aid with cattle handling can enhance safety for both farmers and veterinarians when working with cattle. They can also make tasks easier for farmers and veterinarians to perform.

"Modern calving gates and crushes [are useful], basic level of equipment of farms needs to be compulsory and inspected to ensure safety. Some farms are death traps and older employers' attitudes are very poor in terms of advocating for change." (Veterinarian #39, Female, Ireland)

Mapping veterinarians' needs

The themes were mapped against the design-based needs typology and three main psychological needs were identified: competence, impact, and security. The definitions of these needs are presented in Table 3 and the narratives within the themes which reflect the psychological needs and sub-needs are presented in Table 4. For example, the narrative that the availability of data can improve veterinarians' knowledge was presented in the first theme "Improving veterinary advice through data". This narrative expresses the psychological need for competence as veterinarians want to improve their knowledge and understanding. These needs are then further discussed in the next section.

Discussion

This study used qualitative survey data to understand veterinarians' experiences and perspectives on data and technology on dairy and beef farms. We show that technologies and data can make veterinarians feel more confident in the advice they give to farmers. However, the quality and quantity of data collected on cattle farms were highly variable. Furthermore, veterinarians were concerned that farmers can become over-reliant on technologies, some of which were considered unreliable and unsustainable. Technologies were also seen to alleviate staffing issues and improve work-life balance on farms. The experiences and opinions that the veterinarians expressed were used to generate their needs

Table 3
Definitions of cattle veterinarians' psychological needs related to technologies on beef and dairy farms (source: Desmet and Fokkinga, 2020).

Need	Definition	Sub-needs
Competence	Having control over your environment and being able to exercise your skills to master challenges, rather than feeling that you are incompetent or ineffective.	Knowledge and understanding Environmental control
Impact	Seeing that your actions or ideas have an impact on the world and contribute to something, rather than seeing that you have no influence and do not contribute to anything.	Influence Contribution
Security	Feeling that your conditions and environment keep you safe from harm and threats, rather than feeling that the world is dangerous, risky or a place of uncertainty.	Physical safety Financial security Social stability Conservation

Table 4
The narratives within each theme which reflect needs and sub-needs expressed by cattle veterinarians.

Theme	Narrative	Need expressed
Improving veterinary advice through data	Availability of data can improve veterinarians' knowledge	Competence (Knowledge and understanding)
	Veterinarians want to give advice about youngstock housing	Competence (Environmental control)
	Veterinarians would like to have improved communication with farmers	Impact (Influence)
	Veterinarians would like to give advice to contribute to improved animal health and welfare	Impact (Contribution)
	Veterinarians would like to move towards an advisory role	Security (Social stability)
	Data could provide veterinarians with evidence of the value of their advice	Security (Financial security)
	Veterinarians would like to give antibiotic stewardship advice to farmers	Security (Conservation)
Ensuring stockperson skills are retained	Veterinarians would like to influence how technologies are used by farmers	Impact (Influence)
	Veterinarians were concerned about farmers' abilities to exercise their stock-keeping skills	Competence (Knowledge and understanding)
Longevity of technology	Veterinarians experienced unreliable technologies that were not robust to the farm environment	Security (Social stability)
	Technologies need to have return in investment	Security (Financial security)
	Technologies could help farmers become more environmentally sustainable	Security (Conservation)
Solving social problems on the farm	Technologies can help to resolve challenges with labour availability	Security (Social stability)
	Some veterinarians pushed for greater regulation of youngstock housing	Competence (Environmental control)

around technologies on cattle farms by mapping them onto the design-centred needs typology (Desmet and Fokkinga, 2020) which we will now discuss further.

Competence

One of the fundamental needs that veterinarians demonstrated was competence. Competence is related to veterinarians' feelings about the knowledge they have and their ability to exercise their skills. Svensson et al., 2022 show that veterinarians view herd health management as a task that requires a high level of skill. The presence of high-quality data supports veterinarians to exercise this herd health management skill. However, our findings suggest that accessible data are often lacking on beef and dairy farms in Ireland and the UK. The theme "improving veterinary advice through data" showed that the availability of data can improve veterinarians' knowledge and understanding of individual farms. This may be why veterinarians felt more confident giving advice to farmers when they had access to good-quality data. Therefore, farm data enhance veterinarians' psychological need for competence. In contrast, technologies that are difficult to use and impractical, harm veterinarians' need for competence. To allow veterinarians to use their herd health management skills and feel that they are competent, veterinarians need innovations that improve the quality of data collection on farms in a format that is readily accessible for them. For example, data capture technologies that connect data collection with data interpretation could be used (Doidge et al., 2023b).

A sub-need within competence is having control of your environment. Veterinarians in our study often gave advice about improving youngstock housing and were concerned about increasing herd sizes with little infrastructure investment. Though technologies to help control the environment of cattle housing exist (Lovarelli et al., 2020), these are often not used by farmers. For example, many dairy farmers in the UK do not measure the environmental temperature of calf housing and do not use mechanical ventilation (Mahendran et al., 2022). The veterinarians in our study thought that they did not have much control over youngstock environment, and some felt the need for housing regulations to assist with this. The systems that farmers can house calves in (e.g., sheds, polytunnels, hutches) have different environmental disadvantages (Mahendran et al., 2023). Until further scientific evidence is generated, this lack of evidence could also be a challenge in providing preventative advice to farmers.

We also show that veterinarians were concerned about how automation and sensor technologies could affect farmers' abilities to exercise their stock-keeping skills. Therefore, technologies may harm farmers' psychological need for competence. Technologies and data can shape farmers' knowledge and skills (Butler and Holloway, 2016). Furthermore, farmers place value in their stock-keeping skills and see these skills as part of their identity (Doidge et al., 2023a). However, our study suggests that farmers may not realise that they could lose their stock-keeping skills due to technology use. This highlights the importance of understanding the needs of multiple types of users. Burton et al., 2012 propose that it is important to consider the design of farm systems and structures to maintain stock-keeping skills. Similarly, we suggest that developers of new technologies should consider how they can aid – rather than act as a replacement for – stock-keeping skills (Kaler and Ruston, 2019).

Impact

Another fundamental need that was expressed by veterinarians was impact, which relates to how veterinarians have an influence or contribution to society (Desmet and Fokkinga, 2020). We show that one of the veterinarians' key goals was to contribute to improved cattle health and welfare by providing preventive advice to farmers. However, veterinary advice is often not implemented on farms (Shortall et al., 2016; Svensson et al., 2019). It can be difficult for veterinarians to influence changes in farmers' behaviour (Ruston et al., 2016). Being able to tailor advice to the individual farmer world view may increase the likelihood of farmers adhering to the advice (Bard et al., 2019). Furthermore, advice is more likely

to be adopted if the veterinarian is trustworthy and the advice is seen as credible (Bard et al., 2019; Svensson et al., 2019). Our study shows that data can be used to identify salient problems on farms so that advice can be tailored. Therefore, farm-level data can lead to greater veterinary impact on farms. Innovations such as decision support tools may provide veterinarians with greater influence over cattle health and welfare if they could demonstrate the positive impact of veterinary advice.

The veterinarians in this study also suggested that they needed influence on the way technologies were used on farms. Unintended consequences of technologies on farms, such as over-reliance and poor hygiene, may be avoided with appropriate veterinary advice. This requires engagement with the farmer, but veterinarians in our study suggested that this was often missing. Previous studies show that veterinarians do not have regular visits to beef farms (Doidge et al., 2020b) and dairy farms (Shortall et al., 2016; Mahendran et al., 2022) when the farmers do not see veterinarians as having a preventive role on farms. Furthermore, veterinarians often lack the appropriate communication skills for discussing preventative advice with farmers (Shortall et al., 2016).

Methods of effective communication may facilitate veterinarians to have a greater contribution to technology use on cattle farms. It has been shown that a move away from a top-down, "expert-led" approach and towards a client-centred, collaborative communication approach which focuses on farmer motivations and goals leads to improved adoption of veterinary advice (Bard et al., 2019; Svensson et al., 2019). Another method of effective communication mentioned by veterinarians in this study was the use of digital platforms. Similarly, Fielke et al., 2020 suggested that communication between farmers and advisors will become increasingly technologically mediated. In human health, there is a growing use of mHealth technologies, such as telemedicine platforms, to provide health-promoting messages (Lupton, 2012). Similar technologies could be used in veterinary medicine; however, this would require further veterinarian training (Smith et al., 2022). How health promotion messages are conveyed to farmers on digital platforms would also require investigation (Lupton, 2012).

Security

The fundamental need of security was also expressed by veterinarians in this study. Security is defined as minimising risks and uncertainties, and feeling safe from harm (Desmet and Fokkinga, 2020). We see this conveyed by veterinarians as wanting a sustainable beef and dairy industry. There are three pillars of sustainability: economic, environmental, and social (Purvis et al., 2019); all of which were mentioned by veterinarians in our study.

Social sustainability refers to social and working conditions. For example, veterinarians wanted to have an advisory role on farms to secure their position on farms and be able to uphold standards in cattle health and welfare. A previous study of veterinarians in the UK showed that the move towards a farm animal advisory role had only been partial (Ruston et al., 2016). 7 years on, our study shows that moving to this advisory role is still a goal for many veterinarians, suggesting that the progress remains slow. Thus, this is an area in which potential innovations may wish to focus to meet veterinarians' advisory needs to ensure social stability in the veterinary profession. To do so, there needs to be further conceptualisation of the role that veterinary advice has on farmer decision-making (Kvam et al., 2022; Sutherland and Labarthe, 2022). Adoption of technologies on farms can change the role of veterinarians in advisory services (Eastwood et al., 2019a). Similarly, research has shown that the transition to technology use on farms can shift the roles and responsibilities of farm advisors (Charatsari et al., 2022). Advisors need to adapt their skills to meet the demands of technology-driven farms; otherwise, their role on the farm can become obsolete (Metta et al., 2022). At present, research into farm advisory services rarely considers veterinary services (Klerkx and Jansen, 2010; Sutherland and Labarthe, 2022).

Some veterinarians experienced unreliable technologies and data on farms. This harms veterinarians' psychological need for security because it leads to uncertainties such as errors in data which could have an impact on decision-making. This affects the continued use of technologies on farms, as farmers and veterinarians may lose confidence in technologies and the data they produce (Eastwood and Renwick, 2020). This was also identified by Canadian beef veterinarians (Makinde et al., 2022), which suggests that this issue could be present in multiple countries. To ensure the psychological need for security is not harmed, innovations need to be tested multiple times in real-life settings and improved upon before they are marketed to farmers.

The increase in herd size on farms impacts social sustainability as it leads to greater numbers of staff being employed on farms. However, farmers face challenges around the availability of skilled farm workers in Ireland and the UK (Kelly et al., 2020). Veterinarians suggested that technologies can be used to meet this challenge. For example, automated technologies may improve labour efficiency, and decision-making technologies can be used to reduce the need for skilled workers (Dela Rue et al., 2019). Farms with technologies may be able to attract more workers because they may provide a better work-life balance and a safer working environment (Eastwood et al., 2018).

Financial security was a sub-need which was highlighted as a key concern for veterinarians. The economic margins of cattle farming, particularly beef farming and youngstock rearing, were a barrier towards technology adoption. This was also highlighted as a barrier of technology adoption by Canadian veterinarians (Makinde et al., 2022). Furthermore, there is very little evidence around the value that technologies can bring to farm businesses (Steeneveld et al., 2015; Lovarelli et al., 2020). There were also concerns about the financial security of the veterinary profession because farmers may not value the advisory role that veterinarians are providing. Technologies need to demonstrate how they can provide value on farms and may also benefit from showing the value of veterinary advice. One way of doing this is to determine the Value of Information, which is calculated as the outcome of the decision using information from technology and/or veterinary advice minus the outcome of the decision without this extra information (Rojo-Gimeno et al., 2019). Veterinarians may also need to learn techniques to assess the 'value proposition' of technologies, in which they conduct a review of the costs and benefits of the technology (Ayre et al., 2019).

Environmental sustainability was one of the reasons that veterinarians gave for wanting to improve youngstock health and welfare on farms. Precision livestock farming technologies are thought to indirectly contribute to environmental sustainability by enhancing efficiency on farms, usually by improving animal health (Tullo et al., 2019). However, there is a lack of evidence around the direct environmental impact of livestock technologies (Tullo et al., 2019; Lovarelli et al., 2020). For example, data from Irish dairy farms showed that milk recording enhanced economic and social sustainability but not environmental sustainability (Balaine et al., 2020). Further evidence on the direct impact of technologies on environmental sustainability may increase technology adoption on farms.

Another aspect of environmental sustainability highlighted by veterinarians was antibiotic resistance. Conservation is a sub-need of security and is represented by veterinarians as a need to conserve the ability of available antibiotics to treat diseases. Veterinarians would like to minimise the risk of antibiotic resistance by giving antibiotic stewardship advice to farmers (Farrell

et al., 2023). Research shows that there is scope to improve responsible antibiotic use on beef and dairy farms (Higham et al., 2018; Doidge et al., 2020a; Martin et al., 2020). Reducing antibiotic resistance is also a priority for farmers and policy makers in Ireland and the UK (Magalhães-Sant'Ana et al., 2017; Doidge et al., 2020b; Meunier et al., 2020). Therefore, technologies that can assist with minimising the risks of antibiotic resistance may be of use to multiple stakeholders in the bovine industry. One example could be more rapid diagnostic tests to ensure the appropriate antibiotics are prescribed (Farrell et al., 2023).

Implications for innovation

Veterinarians demonstrated the needs to exercise their knowledge and skills, to influence farmers and contribute to the industry, and to minimise risks. When designing innovations, researchers should consider which of these needs will be achieved and ensure these needs are not harmed. To help meet the psychological need of competence, technologies could include ways to track progress of advisory measures and provide positive feedback (Sailer et al., 2017). This would also help to achieve the psychological need of impact as veterinarians will see how their advice influences the farm performance. Furthermore, when developing a new farm technology, the user experience from the veterinarian's perspective should be investigated to ensure that it is simple to use and does not harm the competence need.

The study shows how important it is to include the needs of multiple stakeholders when developing tools. The veterinarians in this study highlighted needs such as impact that were not identified by farmers in previous studies (Doidge et al., 2024). Studies that investigate technology use on livestock farms tend to look at the farmers' perspective. Farmers' views on technology use are important as they are often the main users of the technology, and it is usually their decision to invest in technologies on their farm (Borchers and Bewley, 2015). However, our study shows that veterinarians also have an important role in how technologies and the data they produce are used on farms. Similar to other farm advisors (Eastwood et al., 2019a), veterinarians may play a part in helping farmers to generate value from their technologies. Therefore, we suggest that more studies should be conducted which seek to understand veterinarians' perspective of technology use on livestock farms.

Study reflections

Using an online qualitative survey as the data collection method may exclude participants who do not have literacy skills (Braun et al., 2021). In the survey, we told respondents not to worry about spelling and grammatical errors to attempt to address this. Furthermore, veterinarians are a highly educated population and therefore it is likely that most are literate. The online delivery of the survey may also exclude potential respondents who do not have digital devices. However, the age proportions were similar to those reported in large-scale national surveys of the veterinary profession in Ireland (O'Brien et al., 2021) and the UK (Robinson et al., 2019).

We conducted this study with veterinarians practising in Ireland and the UK because this allowed us to understand the views of veterinarians in different countries where we could carry out the survey in the English language. By investigating different countries, we could explore social or cultural differences around veterinary involvement in technology adoption on farms. It appeared that the surveyed sample of veterinarians in the UK was able to describe a wider range of experiences around using technologies on beef and dairy farms compared with the sample of veterinarians in Ireland. This was reflected in the presentation of the findings as there were fewer quotes from Irish veterinarians compared with UK veterinarians. However, Irish veterinarians were still represented in all the themes generated in this study.

Another difference in Irish and UK veterinarians' experiences of data and technologies was the presence of a milk recording dashboard in Ireland (ICBF, 2023). This was an example of a tool that can help to satisfy the psychological needs of the veterinarians. The dashboard enabled Irish veterinarians to easily interpret milk recording data and fulfil the need of competence by improving their understanding of individual farms. It also enabled them to fulfil the need of impact by providing advice based on their interpretations of the data.

We used a broad conceptualisation of farm technology in this study in order to understand a large range of experiences. If we focused on a specific type of technology, such as precision livestock technologies, we may limit the information that veterinarians could provide as some beef and dairy farmers do not use these (Doidge et al., 2023b). Furthermore, in our previous research with dairy farmers, they often talked about simple technologies such as colostrum refractometers (Doidge et al., 2023a) and we wanted to ensure that we provided similar opportunities for veterinarians in this study. However, a study that focuses on a specific type of technology could provide more nuanced results for that technology and could be considered for future research.

Conclusions

We used a qualitative survey method to understand veterinarians' experiences and perceptions of technology and data on beef and dairy farms. The findings show that data and technologies allowed veterinarians to provide proactive herd health advice to farmers, but the quality of data collected on farms was a barrier to achieving this. Veterinarians were concerned that technologies could deskill farmers if used to replace good stockperson skills, but thought they were useful in large herds with multiple employees of various skillsets. The findings were mapped onto a design-focused need typology to show that veterinarians would like innovations that achieved the psychological needs of competence (i.e., demonstrating their knowledge), impact (i.e., influencing farmers) and security (i.e., sustainability and stability). Whilst farmers' needs are important as they are often the main users of data and technologies on beef and dairy farms, we show that veterinarians can also play a key role in how technologies and data are used on farms. We suggest the veterinarians' needs of competence, impact, and security are considered when designing technologies for beef and dairy farms that are likely to require veterinary input so that farmers and veterinarians can jointly improve animal health and welfare.

Supplementary material

Supplementary material to this article can be found online at https://doi.org/10.1016/j.animal.2024.101124.

Ethics approval

The study was approved by the University of Nottingham School of Veterinary Medicine and Science Ethics Committee (no. 3509 211202). Participants provided informed consent by selecting tick boxes at the beginning of the survey.

Data and model availability statement

None of the data were deposited in an official repository. The data are confidential due to the nature of qualitative data possibly containing identifiable information.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) did not use any AI and AI-assisted technologies.

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Declaration of interest

None.

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