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# Invited review: Qualitative research in dairy science—A narrative review

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## ABSTRACT

The use of qualitative research in dairy science has increased considerably in recent years, providing the opportunity to inform research and practice. This review aims to enhance the accessibility of qualitative research among a range of audiences and specifically: (1) provide an overview of what qualitative research is and the value it can bring to scientific inquiries in the dairy context, (2) illustrate the emergence of qualitative dairy science research in the past 15 to 20 years, (3) outline the role of the researcher and key philosophical assumptions underlying qualitative research, (4) describe qualitative research approaches and methods used in dairy science research, and (5) highlight key aspects of qualitative inquiry used to ensure research trustworthiness. Qualitative approaches in dairy science enable researchers to understand myriad topics including stakeholder relationships, decision-making, and behaviors regarding dairy cattle management, animal welfare, and disease prevention and control measures. Approaches that were used often for qualitative data collection were individual interviews and focus groups, and variations of thematic analysis were common analytical frameworks. To assess public values, attitudes, and perceptions, mixed methods questionnaires that combined quantitative data with qualitative data from open-ended questions were used regularly. Although still used infrequently, action research and participatory approaches have the potential to bridge the research-implementation gap by facilitating group-based learning and on-farm changes. Some publications described the philosophical assumptions inherent to qualitative research, and many authors included reflexivity and positionality statements. Although a comprehensive description of strategies to meet trustworthiness criteria for qualitative research was uncommon, many publications mentioned certain aspects of trustworthiness, such as member checking, researcher triangulation, and the recording of reflexive notes. Qualitative research has been used to deepen our understanding of phenomena relevant to the dairy sector and has opened the door for a broad array of new opportunities. In addition to having merit on its own, qualitative research can guide, inform, and expand on quantitative research, and an understanding of the core pillars of qualitative research can foster interdisciplinary collaborations.

**Key words:** research paradigms, behavior change, ethnography, mixed methods

## INTRODUCTION

Dairy science research has traditionally focused on the natural sciences, with little attention given to social science approaches, including qualitative research. However, in the past 15 to 20 years, qualitative research has entered the field and provided insights into values, beliefs, attitudes, perceptions, and experiences held by people involved with the dairy sector, as well as by members of the public. Understanding the core pillars of qualitative research can enable a critical reflection and constructive debate among researchers regarding the value and limitations of these approaches. Further, awareness of the opportunities for knowledge generation through qualitative research can facilitate further recognition and foster interdisciplinary research. Therefore, the specific objectives of this review were to (1) provide an overview of what qualitative research is and the value it can bring to scientific inquiries in the dairy context, (2) illustrate the emergence of qualitative dairy science research in the past 15 to 20 years, (3) outline the role of the researcher and key philosophical assumptions underlying qualitative research, (4) describe qualitative research approaches and methods used in dairy science research, and (5) highlight key aspects of qualitative inquiry used to ensure research trustworthiness. Through these objectives, we aim to increase the accessibility of qualitative research among a range of audiences. We use examples from the literature to illus-

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trate the main aspects of our objectives and to demonstrate how qualitative research has been used in dairy science. Further, we provide recommendations and calls to action that can guide future research, enhance the quality and richness of qualitative approaches in dairy science, and improve the synergies between different scientific approaches, searching for explanations and solutions to identified challenges related to the dairy sector.

## WHAT IS QUALITATIVE RESEARCH?

Definitions of qualitative research abound and vary in terms of complexity. For the purposes of this review, we use an adaptation of the broad definition provided by Nkwi et al. (2001): Qualitative research involves any research that uses data that do not indicate numerical values. Hence, a hallmark of qualitative research is making sense of words and observations (Miles et al., 2020), instead of focusing on numbers and statistics. Qualitative data can stem from a variety of sources, including audio, observations, images, and text (Ryan and Bernard, 2000).

To illustrate, consider how dairy producers, veterinarians, and other stakeholders (i.e., people who are directly involved, interested in, or affected by the dairy sector) make decisions related to dairy cattle management. These decisions are made within a complex environment and are influenced by internal (e.g., a person's values, beliefs, and attitudes) or external (e.g., regulatory or financial pressures) factors (Ritter et al., 2017; Biesheuvel et al., 2021). The complexity and difficulty of numerically assessing most of these influences might make it impossible to describe them using statistics. Instead, understanding what, why, and how internal or external factors affect dairy sector stakeholders, and thus dairy cattle care, often calls for qualitative research approaches that allow for in-depth inquiry. For example, while management practices on dairy farms may be described using a quantitative survey with large sample sizes and representative sampling, qualitative methods can provide the necessary depth to understand the reasons behind these practices, or how the involved stakeholders (e.g., farm owners, employees) experience their daily routines. Hence, qualitative research provides a unique research lens and set of methodologies that can support our understanding of concepts and phenomena that cannot be understood through quantitative means. As such, qualitative and quantitative approaches complement each other, and both are necessary to understand the complexities of the dairy sector. Further, both approaches are directly relevant for practice and informing extension and communication strategies.

## EMERGENCE OF QUALITATIVE RESEARCH IN DAIRY SCIENCE

To explore the emergence of qualitative research in dairy science over time, we used PubMed to search the published literature. We included peer-reviewed journals whose aim and scope are focused on dairy production, management, health, and welfare and thus are likely to be accessed by a variety of audiences within the dairy sector. We conducted a preliminary search to identify the journals that had the most hits using search terms aligned with our objectives, which we then selected for further review. Therefore, on June 1, 2022, we searched the journals *Animal*, *Animals (Basel)*, *Frontiers in Veterinary Science*, *Journal of Dairy Science*, *PloS One*, *Preventive Veterinary Medicine*, and *The Veterinary Record* for the following search terms in the title, abstract, and keywords (asterisks were used to truncate words): (qualitative OR focus group* OR interview* OR "participant observation*") AND (dairy) AND (cattle OR cow* OR calf OR calves OR bull* OR heifer*). No limitations were placed on the publication date. In total, the search identified 313 articles, which were all written in English. We then reviewed the title, abstracts, and full texts (where applicable) to identify articles that were related to the dairy sector and used qualitative methods to analyze and report data. As such, we excluded articles that described developing quantitative tools (e.g., a questionnaire) by using qualitative methods (e.g., focus groups) unless the qualitative data were also reported in the article. Further, we excluded articles that focused on dairy product (e.g., cheese, milk) perceptions and preferences by members of the public unless related to farm management practices. After review, 99 articles met our inclusion criteria. Although this collection of articles is not exhaustive, and the number of publications reporting qualitative dairy science research is likely underestimated, this search demonstrates a clear trend, with most qualitative studies having been published in the past decade (Figure 1).

Approximately 47% of the studies used data collected in Europe, with many originating in the UK (18% of all reviewed studies) and the Nordic countries (13%). Furthermore, 37% of the studies used data from Canada (20%), the United States (15%), or both countries (2%). Topics addressed ranged from disease prevention and control to fertility, animal welfare, and antimicrobial use (Table 1).

The most common stakeholder groups that took part in qualitative research studies were dairy producers (Svensson et al., 2018; Croyle et al., 2019; Fischer et al., 2019; Smid et al., 2021) and veterinarians (Richens et al., 2016; Shortall et al., 2016; Brocket et al., 2021; Padda et al., 2021). Examples of

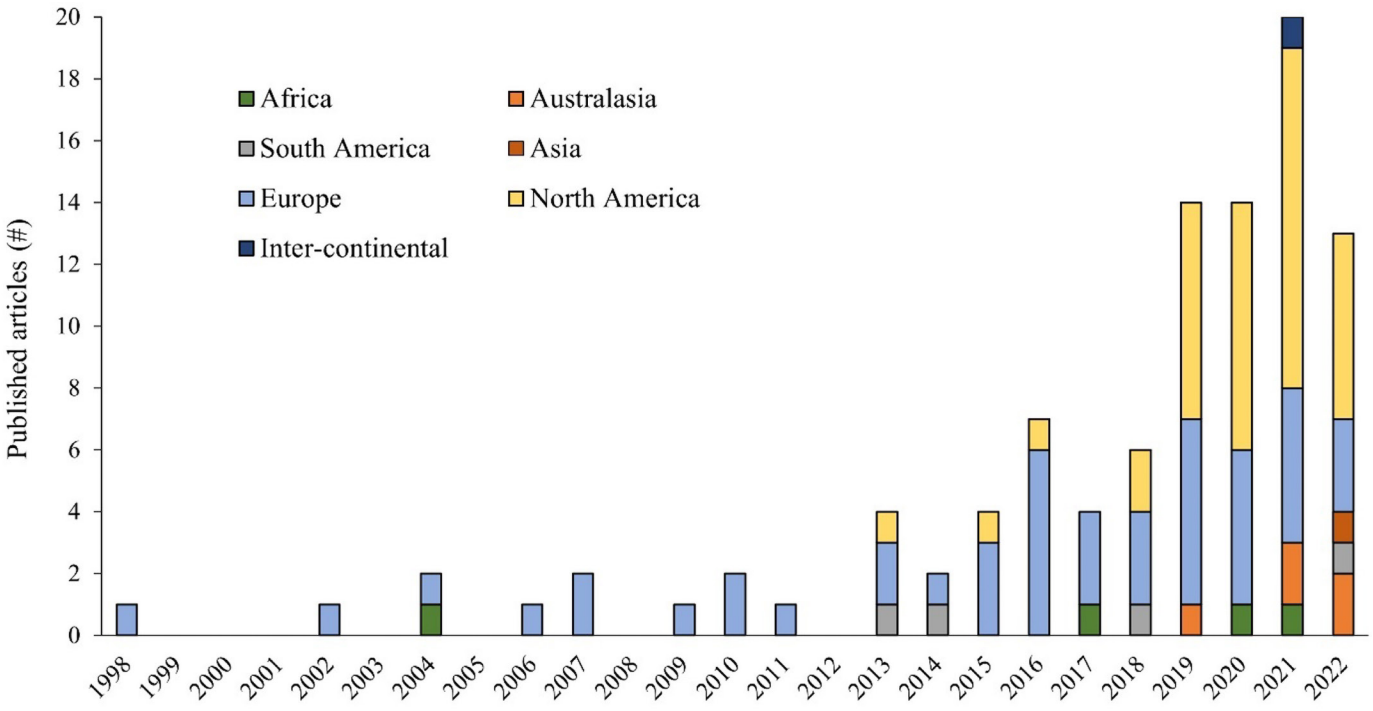


**Figure 1.** Timeline of peer-reviewed journal articles reporting qualitative data related to dairy science, stratified by the location where the research was conducted. The literature search was conducted on June 1, 2022, and included the following journals: *Animal*, *Animals (Basel)*, *Frontiers in Veterinary Science*, *Journal of Dairy Science*, *PloS One*, *Preventive Veterinary Medicine*, and *Veterinary Record*.

less frequently involved stakeholder groups included hoof trimmers (Wynands et al., 2021), farm workers (Kates et al., 2021), extension agents (Hötzel and Sneddon, 2013), dairy consultants (Olmos et al., 2018), slaughterhouse managers (Rell et al., 2020), researchers (Merenda et al., 2022), and members of the public (Ly et al., 2021).

## PHILOSOPHICAL ASSUMPTIONS

Qualitative researchers place importance on the acknowledgment and discussion of different paradigms [i.e., worldviews (Creswell, 2009)]. Paradigms describe the assumptions that researchers carry about the nature of reality and knowledge. Hence, different paradigms in-

**Table 1.** Examples of dairy science topics that have been investigated using qualitative research methods[1]

| Dairy science topic | Examples of peer-reviewed scientific articles |
|---|---|
| General disease prevention and control, biosecurity | Brennan et al., 2016; Shortall et al., 2016; Brock et al., 2021 |
| Udder health | Jansen et al., 2010; Belage et al., 2019; Shock et al., 2020 |
| Lameness | Wynands et al., 2021, 2022; Knauss et al., 2022 |
| Transition cow management | Mills et al., 2020b; Redfern et al., 2021 |
| Johne's disease | Ritter et al., 2016; Roche et al., 2019; Robinson, 2020 |
| Fertility | Brocket et al., 2021; Ooi et al., 2021 |
| Cattle welfare | Croyle et al., 2019; Chen and Weary, 2022 |
| Euthanasia | Wagner et al., 2020a,b; Merenda et al., 2022 |
| Calf management, mortality, health, and welfare | Vaarst and Sørensen, 2009; Sumner and von Keyserlingk, 2018; Palczynski et al., 2020, 2021; Russell et al., 2022 |
| Antimicrobial use | Golding et al., 2019; Wemette et al., 2020; Padda et al., 2021 |
| Veterinarian-producer relationship, veterinary advisory | Duval et al., 2017; Svensson et al., 2018; Bard et al., 2019 |
| Other examples | Nematode control: vande Velde et al., 2018; bovine tuberculosis: Hodge et al., 2020; producers' social referents: Mills et al., 2021; outdoor access: Smid et al., 2021 |

[1]This list is illustrative and not exhaustive. Additional examples can be found in the reference list.

**Table 2.** Elements of different research paradigms including the application of a hypothetical dairy science research study[1]

| | Paradigm | | | |
|---|---|---|---|---|
| Paradigm elements | (Post-)positivism | Constructivism | Advocacy and participatory | Pragmatism |
| Epistemology (theory of knowledge) | Objectivity, distance, and impartiality | Closeness between researchers and participants | Collaboration between researchers and participants | Practicality—data collection is driven by what works |
| Ontology (theory of reality) | Singular reality | Multiple realities | Multiple social and political realities (e.g., findings are negotiated with participants). | Singular and multiple realities are considered |
| Methodology (process of research) | Deductive (e.g., hypothesis testing) | Inductive (e.g., pattern identification and theory generation) | Participatory, development of research and cyclical review of results with participants. | Combination of approaches |
| Example of a hypothetical research study with the objective to understand dairy producers' motivators and barriers to participate in a voluntary disease control program | Researchers distribute a questionnaire to producers to assess motivators and barriers for program enrollment. Study participants select predefined answers to generate quantitative data. | Researchers audio-record interviews with producers asking open-ended questions about motivators and barriers for program enrollment. Interviews are coded to identify common themes within the data. | Researchers work with producers to collaboratively develop a program that accounts for producers' motivators and barriers. | Researchers use a quantitative questionnaire and qualitative interviews to assess producers' motivators and barriers for program enrollment. |

[1]Adapted from Creswell and Plano Clark (2007), p. 24.

fluence how people act in the world and how researchers gather information (i.e., data) about the world (Tracy, 2020). Key philosophical assumptions folded into paradigms include epistemology (theory of knowledge) and ontology (theory of reality). It is beyond the scope of this review to outline the broad range of paradigms, ontologies, and epistemologies whose descriptions are continuously evolving and often depend on the research discipline and individual perspectives. However, Table 2 provides an overview of some key philosophical assumptions, and examples most relevant to dairy science are highlighted in the following paragraphs.

Traditionally, dairy science aimed for an objective stance [i.e., an objective epistemology that is aligned with a (post-)positivist paradigm], using instruments and methodologies to minimize bias (Creswell and Plano Clark, 2018; see dairy science examples from Buczinski and Vandeweerd, 2016; Hristov et al., 2019). However, this perspective can also guide aspects of qualitative research if the goal is to represent the content of the data objectively. For example, Braun and Clarke (2022) argued that this objectivity logic underpins coding reliability (i.e., intercoder reliability) testing. As such, some authors calculated agreement between different researchers who analyzed the same data set, such as interview transcripts or written statements. For example, Svennesen et al. (2019) calculated Cohen's kappa coefficients to assess the intercoder reliability of codes assigned to written responses from mastitis experts.

In contrast, constructivists agree that individuals seek an understanding of the world around them, that they develop subjective meanings of their experiences, and that, therefore, multiple realities exist (Creswell and Poth, 2018). Consequently, constructivists acknowledge the influence of their own subjectivity as they co-construct understanding with research participants. For instance, to understand Australian producers' barriers to rearing nonreplacement male calves, Vicic et al. (2022) used a constructivist approach and developed study results through contributions by both the participants and researchers.

Critical realism has been described either as a paradigm (Palczynski et al., 2020) or ontology (Moon and Blackman, 2014) and is, therefore, an example of the ongoing deliberation of terms in qualitative research. Although, for this reason, it was not included as a paradigm in Table 2, critical realism has arguably been the most common approach used in qualitative dairy science research (e.g., Sumner et al., 2018; Mills et al., 2020b; Wilson et al., 2021). The views of critical realism fall between (post-)positivism and constructivism. As such, Maxwell (2012) is referenced by Wynands et al. (2021, p. 11891) who stated in their study on lameness management that "critical realism . . . [acknowledges] that a real world exists and our understanding of the world is constructed through our perspective and worldview." Further, Palczynski et al. (2020) conducted an interview study on colostrum management and argued that for critical realists, objective facts and subjective perceptions are equally important and real when aiming to understand sector stakeholders' management decisions and actions. In another example, Koralesky et al. (2021) used realistic evaluation to assess an intervention aiming to improve colostrum management through

standard operating procedures. Realistic evaluation is a theory-driven approach used to evaluate how programs or interventions work by identifying contextual features (e.g., demographics, knowledge, and interpersonal relationships) underlying causal mechanisms (i.e., how people respond to the program and use program resources), and program outcomes (Pawson and Tilly, 1997). By understanding how underlying mechanisms and contexts interact, the authors were able to describe what aspects of the intervention worked, for whom, how, and in which circumstances.

Advocacy and participatory paradigms have traditionally focused on underrepresented and suppressed groups, aiming to elevate the voices of these individuals (Creswell, 2009). In dairy science research, these approaches can facilitate collaboration among stakeholders throughout the research process, instead of developing and imposing recommendations and regulations through top-down approaches. For example, van Dijk et al. (2017) enabled dairy producers to develop an antimicrobial stewardship policy by adopting a participatory policy-making approach. Similarly, Morgans et al. (2021) initiated a producer-led participatory project with the goal of reducing antimicrobial use. Following a multistage participatory approach, Wynands et al. (2022) engaged individuals considered to be key lameness management advisers (i.e., veterinarians, hoof trimmers, and nutritionists) in developing lameness action strategies.

Pragmatism is embraced by many researchers who combine different methods (e.g., qualitative and quantitative approaches; Tashakkori and Teddlie, 2003; Yardley and Bishop, 2007), although the reviewed dairy science literature generally did not specifically state the paradigm under which this research was conducted. The fundamental idea of pragmatism is to employ what works to answer a research question, and that methodological choice should be guided by a practical and applied research philosophy (Tashakkori and Teddlie, 2003; Creswell and Plano Clark, 2018). Therefore, many of the articles using qualitative and quantitative methods to assess public values, attitudes, and perceptions related to dairy management practices could arguably fall under this paradigm. Recent examples include questionnaires that were administered to members of the public regarding gene editing (Yunes et al., 2021), cow-calf management systems (Sirovica et al., 2022), and adaptations for mitigating heat stress (Hendricks et al., 2022).

## THE ROLE OF THE RESEARCHER

Quantitative studies are generally designed and conducted with the aim to minimize bias and researcher influence. Hence, in quantitative research, the researcher aims to be an objective entity. In contrast, qualitative researchers generally acknowledge that observations are registered through the researcher, and factors such as the researcher's background and biases influence the study (Tracy, 2020). Figure 2 outlines an example of how the role of the researcher connects to the qualitative research process.

### *Reflexivity or Positionality Statements*

Reflexivity or positionality statements are increasingly included in peer-reviewed publications to allow the reader to understand the factors that influence how the researcher conducts a study (Creswell and Miller, 2000). Reflexivity or positionality statements in qualitative dairy science literature commonly included the researchers' academic background and research interests, experience with the dairy sector and dairy farming, the relationship to participants, and acknowledgment of potential researcher bias (Wilson et al., 2021; Neave et al., 2022; Saraceni et al., 2022). Few articles also included the specific philosophical assumptions (e.g., paradigms) that guided the research (Mills et al., 2020b; Koralesky et al., 2021).

### *Authors' Positionality Statement*

Similar to other qualitative research, the background, experiences, and biases of the authors involved in this review influenced its content. Therefore, we believe it important to reflect on our own positionality. All authors of this paper have experience in and connections to the dairy sector, which often funds the authors' research. CR and DK have veterinary degrees; KK holds a degree in applied animal biology; and CR, JS, SR, and DK have graduate degrees in epidemiology. All of these fields are traditionally quantitatively oriented. However, all authors regularly conduct qualitative or mixed methods research guided by different paradigms and apply a variety of methodologies. CR holds a Canada research chair connecting traditional epidemiological research with qualitative approaches to enhance understanding of stakeholders' decision-making related to topics such as disease control, antimicrobial use, and animal welfare. Her broad aim is to support the development of strategies that foster a sustainable dairy sector. KK is a postdoctoral fellow aiming to improve the welfare of animals by conducting research with people who care for or about animals in a variety of settings, including dairy farms, animal shelters, and the community. JS focuses on using qualitative methods to investigate dairy producer perspectives through interviews, such as their perspectives on the use of pain control for

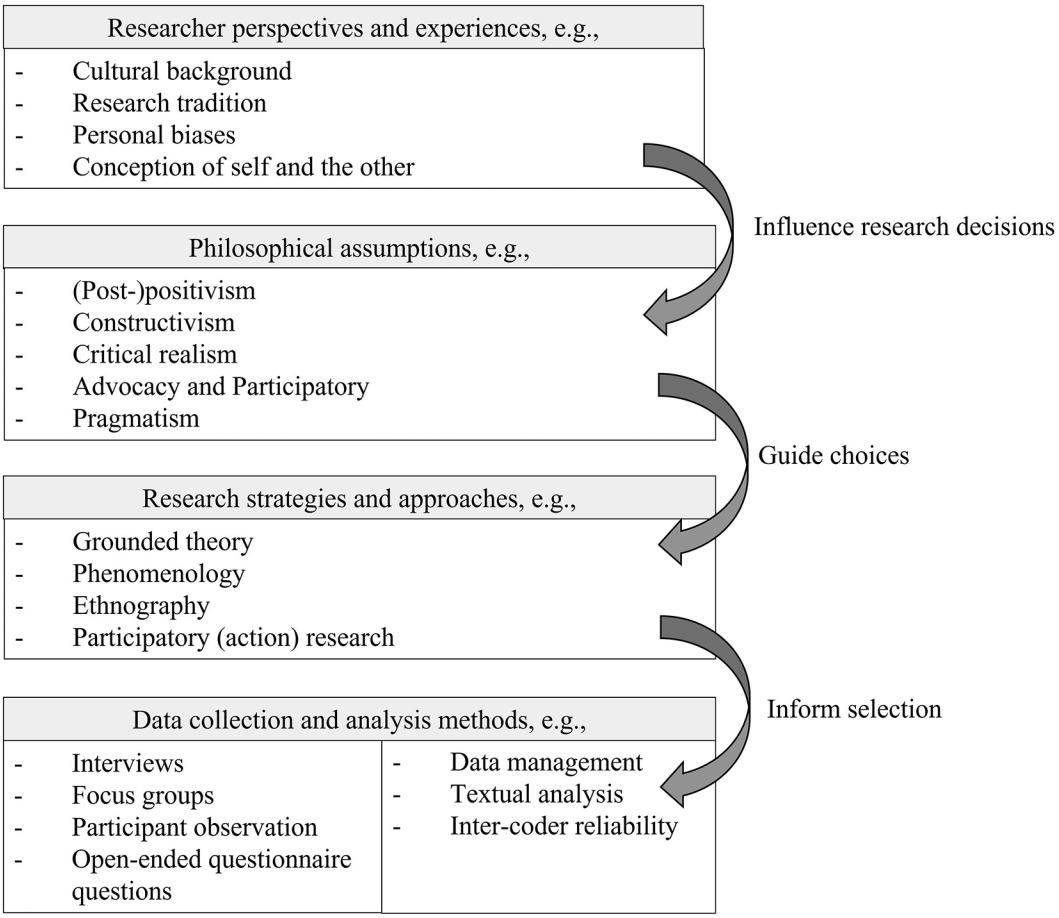


**Figure 2.** Example of how the role of the researcher connects to the qualitative research process. Adapted from Denzin and Lincoln (2011), p. 12, and Creswell and Poth (2018), p. 17.

disbudding. SR leads a private research consulting firm, which focuses on studying animal health and welfare and scientific communication. He works closely with farmer, veterinarian, and other farm advisory organizations internationally. MV is a senior researcher with a background in veterinary science, organic agriculture, systems research, and anthropology. Collaborating with people and actors who care for these matters, she aims to explore the shared lives of animals and humans through research in on-farm and real-life settings. DK holds a dairy cattle health research chair funded by Dairy Farmers of Ontario. He spends most of his professional time doing applied field-based research for the Canadian dairy cattle industry in the areas of health, management, and welfare.

## RESEARCH APPROACHES

In alignment with their philosophical assumptions and their research objectives, researchers select corresponding research approaches. Although in the reviewed literature the particular approach was often not described, the following paragraphs include examples of the specified approaches in dairy science research. For instance, Ritter et al. (2016) and Vicic et al. (2022) used grounded theory to explore producers' attitudes toward Johne's disease prevention and control and barriers to using nonreplacement calves, respectively. The goal of grounded theory is to develop an explanatory theory that reveals a concept or process that is fundamental to the research question (Chun Tie et al., 2019).

Saraceni et al. (2022) developed a study inspired by phenomenology, an approach that emphasizes how participants experience certain phenomena. In their study, producers' internal lived experiences with dehorning or disbudding methods were explored through interviews.

Ethnographic studies require the researcher to immerse themselves in a culture, organization, or setting for an extended period of time (Creswell and Poth, 2018). For example, an ethnographic study conducted over a 12-mo period used data collected from over 160 h of participant observations alongside individual

interviews to understand veterinary medicine use on 3 UK dairy farms (Rees et al., 2021). Similarly, in a mini-ethnographic case study in China, the first author lived on 2 dairy farms and participated in daily farm practices for a total of approximately 2 mo while collecting data (Chen and Weary, 2022). Holloway et al. (2014) reported the interactions between cows, people, and milking robots by spending extended periods of time on dairy farms that either already had a robot in place or converted from conventional milking to robotic milking during the research phase.

Action research and many participatory approaches aim to empower participants and create change through collaboration between researchers and participants. Therefore, these strategies are commonly aligned with an advocacy and participatory paradigm, even when not explicitly stated. For example, Duval et al. (2016) encouraged producers to select specific production indicators on their farms to monitor with researchers. Vaarst et al. (2007) established participatory-focused farmer groups (i.e., stable schools) with 5 or 6 farms connected to each group. Over one year, 2 visits were made to each farm with the aim to promote animal health and phase out antimicrobial use through a common learning approach.

Case studies are characterized through a focus on an individual case (or cases), with the aim to explore a particular issue or using the case(s) as a specific illustration (Creswell and Poth, 2018). For example, Proudfoot et al. (2022) conducted a participatory case study that enabled dairy producers and other stakeholders to initiate a process of collaboratively developing solutions to the surplus calf issue in Atlantic Canada. Koralesky et al. (2021) used a multiple case study on 5 farms over 8 mo to evaluate an intervention aiming to improve colostrum management through interviews, participant observation, document analysis, and field notes.

## MIXED METHODS RESEARCH

Qualitative and quantitative methods have their strengths and limitations. By combining them into mixed methods research, scientists can overcome shortcomings, and develop projects that allow for breadth and depth. Including qualitative and quantitative aspects in the same questionnaire (i.e., using a convergent design) was commonly done to assess public values, attitudes, and perceptions toward dairy farm management practices (e.g., Yunes et al., 2021; Hendricks et al., 2022; Sirovica et al., 2022). Furthermore, qualitative research can be used to explain quantitative findings using an explanatory sequential design, as done by Belage et al. (2017), who initially used a quantitative approach to describe the implementation of milking practices in Canadian dairy herds and concluded that many producers do not adopt (or only partially adopt) recommended measures. The authors then followed up on these findings with producer focus groups to identify specific barriers to adoption that can be targeted through extension and training efforts. Another example of mixed methods research is provided by Ekakoro et al. (2019). In this exploratory sequential study, data derived from focus groups that explored dairy (and beef) producers' perceptions regarding the Veterinary Feed Directive were used to develop a quantitative questionnaire. The questionnaire addressed the same research objective and was distributed to Tennessee cattle producers. This approach is commonly used to enhance the validity of a questionnaire (McLeod et al., 2000; Nassar-McMillan and Borders, 2002) and, for Ekakoro et al. (2019), enabled authors to discuss quantitative and qualitative insights in conjunction.

### Research Ethics

As research involving animals requires ethical approval to ensure best practices (CCAC, 2013), research involving humans needs to consider moral and ethical standards and follow the overall principle of avoiding harm (physical, emotional, social, and professional) to participants. Qualitative dairy science research often involves both private and professional lives and human interrelations, not only concerning the often-asymmetric relationship between the researcher and those participating in the research but also concerning participants in the environment (e.g., in a focus group interview, during an ethnographic study). As such, qualitative data collection and data handling have their own challenges (e.g., regarding participant anonymity, confidentiality, and interpersonal relationships). However, it is beyond the scope of this review to elaborate further on these considerations, and we refer to the institutional research ethics boards and existing literature on this topic (see, for example, Allmark et al., 2009; Sanjari et al., 2014; Iphofen, 2018).

### Data Collection

The most common data collection approaches in qualitative dairy science research included individual interviews and focus groups. Sometimes, these approaches were combined with participant observation, field notes, or document review. The collection of responses to open-ended questionnaire questions was relatively common, especially to explore public values, attitudes, and perceptions.

During one-on-one individual interviews, a researcher or facilitator asks questions regarding a specific topic

of interest, providing the participant the opportunity to steer the conversation into directions most relevant to them within the topic. Many of the reviewed studies used individual interviews for data collection, including Saraceni et al. (2022), whose study focus was on producers' experienced history using pain control for disbudding and dehorning of calves, and vande Velde et al. (2018) who explored the adoption of sustainable gastrointestinal nematode control practices.

Focus group interviews are another common data collection method, with focus groups being either homogeneous (i.e., the group consists of the same type of sector stakeholders, as seen in Wagner et al., 2020b) or heterogeneous (i.e., consisting of different types of stakeholders within the same focus group; Merenda et al., 2022). Whereas one-on-one interviews allow a focus on the individual and are often more appropriate for sensitive topics that participants might not want to discuss in a group setting (e.g., producer mental health; Hagen et al., 2022), an advantage of focus groups is the opportunity for a dynamic discussion among participants. Therefore, focus groups are especially suitable for sharing opinions and more general experiences (Sumner and von Keyserlingk, 2018; Roche et al., 2019), or for the generation and discussion of abstract ideas, such as the future of the dairy sector (Ritter et al., 2020).

During individual interviews or focus groups, a semi-structured interview guide was generally used to ensure that the most relevant questions were addressed but allowed the participant to guide the direction of the conversation. Interview guides were sometimes provided within the article or as supplemental material (Wagner et al., 2020a,b; Wilson et al., 2021; Neave et al., 2022; Skjølstrup et al., 2022). Further, aids such as photo-elicitation (Mills et al., 2020b) or the use of sticky notes (Ritter et al., 2020) were means to facilitate conversations or elicit discussions. Remote data collection was done in some instances, for example using the telephone for individual interviews (Neave et al., 2022) or teleconferencing software to conduct focus groups (Smid et al., 2022). Although remote qualitative data collection may have its constraints in terms of limitations to the researcher-participant relationship and challenges with virtual data collection, this method allows the inclusion of stakeholders from physically distant regions, potentially reduces the time required from participants due to lack of travel, and specifically allowed qualitative research to continue during the COVID-19 pandemic.

Participant observations, field notes, and document review were rarely described as a means of collecting qualitative data. Some exceptions included the observation of veterinarian advisory consultations (Bard et al., 2019), as well as observations and field notes taken during ethnographic studies in Canada (Ida et al., 2023) and China (Chen and Weary, 2022) to understand producers' perspectives on antimicrobial use and animal welfare, respectively. Further, Koralesky et al. (2021) used participant observation and reviewed standard operating procedures to inform their research objectives regarding colostrum management, whereas Knauss et al. (2022) used field notes and observations to explore producer perceptions toward lameness.

Written responses to open-ended questionnaire questions were commonly used to investigate values, attitudes, perceptions, expectations, or awareness of dairy cattle management practices among members of the public (Cardoso et al., 2017; Sirovica et al., 2022). These responses add a valuable qualitative aspect to an often otherwise quantitative questionnaire; however, compared with more interactive qualitative data collection methods, some of the depth within answers from individuals is arguably forfeited for the benefit of being able to obtain a larger number of responses.

### Selection of Participants

The aim of qualitative research is not to statistically describe frequencies or associations, but rather to focus on an in-depth understanding of human experiences and behavior. Hence, qualitative research has a different approach to participant recruitment, including how to determine what is considered an adequate sample size. For qualitative dairy science studies involving extensive field observations, focus was given to very few study locations (Holloway et al., 2014; Chen and Weary, 2022). To determine the required sample size for individual interviews or focus groups, the criterion of data saturation (theoretical saturation) was commonly used. Originally, the criterion of data saturation has been specific to grounded theory, and the appropriateness of transferring this criterion to other methodologies is debated (O'Reilly and Parker, 2013; Braun and Clarke, 2021). Data saturation indicates at which point additional data collection efforts (e.g., interviews or focus groups) are unlikely to yield further meaningful insights (Green and Thorogood, 2018). For example, Mulkerrins et al. (2022) achieved data saturation after interviewing 10 Irish producers about their experiences using compact calving, and analysis of producer group meetings on antimicrobial use reached data saturation after 5 meeting transcripts (Morgans et al., 2021).

Qualitative research uses various sampling strategies. This includes convenience sampling, which is characterized by including participants in the study who are convenient to recruit and anticipated to provide meaningful information. For example, Sumner and von Keyserlingk (2018) conducted focus groups as part of a continuing education workshop with the research aim

to explore cattle veterinarians' perspectives on calf welfare. Further, purposive sampling can be used to target groups of participants that can best inform a study. This was done by Koralesky and Fraser (2019) who selected participants with specific roles in the process of on-farm emergency slaughter, and by Palczynski et al. (2021) who recruited individuals directly involved in calf rearing and advisers providing expert advice on dairy farms. Asking enrolled participants to identify (and refer) potential future participants is described as snowball or chain referral sampling and was, for example, used by Hötzel and Sneddon (2013) in their study exploring the role of extensionists in producers' adoption of pain relief during dehorning.

Statistical representativeness of participants and the generalizability of findings are not the goal of qualitative research; instead, transferability is a trustworthiness criterion of qualitative research and is described in more detail later. As such, qualitative research embraces the contextual nature of collecting data from a specific population, an aim that differs from quantitative research. Whereas quantitative research aims to generalize findings to a larger population, qualitative research provides the opportunity to transfer findings to similar contexts.

### Data Analysis

Audio-recorded data (e.g., interview conversations) were generally transcribed before analysis. Thematic analysis appeared to be the most common data analysis method (Rink et al., 2019; McFarland et al., 2020; Shock et al., 2020; Neave et al., 2022), and few authors used analytic methods inspired by grounded theory (Jansen et al., 2010; Ritter et al., 2016; Duval et al., 2017; Vicic et al., 2022). Inductive coding was generally used (Vaarst and Sørensen, 2009; Duval et al., 2017; Rees et al., 2021; Jackson et al., 2022; Skjølstrup et al., 2022), which means that the researchers created codes and themes "bottom-up" across interviews. When applying a grounded theory approach, patterns in the data can be identified across all interviews into a so-called paradigmatic model or model of understanding, where a common story is developed showing the complexity and potential lines and conflictual areas in the researched field (Strauss and Corbin, 1998). Using inductive coding is different from having pre-defined codes as is the case with deductive analysis. The latter was, for example, used by Brennan et al. (2016) as a secondary step following inductive analysis to explore dairy producers' attitudes and beliefs toward the implementation of cattle disease prevention and control measures. Similar to Hötzel and Sneddon (2013) and Ooi et al. (2021), Brennan et al. (2016) used the Theory of Planned Behavior as their theoretical framework. Other authors referred to the Health Belief Model (Jansen and Lam, 2012) and the Social Ecological Model (Shortall et al., 2016) to explain farmer behavior. These theories can provide a useful framework for data collection and analysis. Specific software, such as NVivo (Skjølstrup et al., 2022), ATLAS.ti (Roche et al., 2019), Quirkos (Wynands et al., 2021), or Mindjet MindManager (Duval et al., 2017), was commonly used to organize coding.

Although not always specified in the reviewed articles, different types of thematic analysis exist. For example, Braun and Clarke (2022) distinguished reflexive, coding reliability, and codebook thematic analysis. Reflexive thematic analysis embraces researcher subjectivity, allows for a theoretically flexible approach, and was used by Jackson et al. (2022) to understand public preferences toward 3 different farming scenarios. For reliability thematic analysis, intercoder agreement (as a percentage or kappa value) of codes applied to the same text by different coders is typically calculated (Svennesen et al., 2019; Cobo-Angel et al., 2021). For codebook thematic analysis, authors arrange codes in a structured (hierarchical) codebook (Mills et al., 2021; Wilson et al., 2021). Template analysis, which has been described as a codebook approach (Braun and Clarke, 2022), was the choice for data analysis by, for example, Ooi et al. (2021) and Smid et al. (2022). Template analysis emphasizes the use of hierarchical coding but remains flexible to adapt the structure to the needs of a particular study (Brooks et al., 2015). Sumner and von Keyserlingk (2018) used applied thematic analysis as described by Guest et al. (2012), which can involve multiple analytical techniques.

Observations, document review, or field notes can add context to analysis of transcripts and can be used as a reference throughout analysis (Bard et al., 2019; Koralesky et al., 2021; Chen and Weary, 2022; Knauss et al., 2022).

Qualitative data conceptualization is an analytical process that aims to go beyond the sorting of codes into themes based on a common topic or domain (e.g., motivators for change, barriers for change). In their study on public preferences for different dairy farming systems, Jackson et al. (2022) pursued qualitative data conceptualization through coding using semantic (i.e., identifying surface meaning) and latent (i.e., underlying) approaches. Similarly, Ida et al. (2023) described using a latent approach to organize codes into themes and subthemes while taking producers' underlying ideas that potentially informed their responses related to antimicrobial use into consideration. Hence, data conceptualization includes an interpretive component, with the aim to delve further into the broader sig-

nificance of the codes, themes, and observations that have been revealed (Broom, 2021). In another example, Knauss et al. (2022) described how a formal consensus development process between researchers resulted in the conceptualization of the deeper meanings of the interviews surrounding lameness prevention and control. Their approach allowed them to demonstrate the importance of one-on-one tailored advice based on 5 specific producer characteristics (i.e., the overwhelmed producer, the eager producer, the collaborative producer, the transitioning producer, and the convenient producer).

### Trustworthiness

Research, regardless of whether it is quantitative or qualitative, should be conducted in a manner that yields meaningful results. In quantitative research, this is achieved by taking a rigorous approach to maximize validity and reliability. Similarly, qualitative research should aim to attain high levels of trustworthiness, which Lincoln and Guba (1985) elaborated on by introducing the concepts of credibility, dependability, transferability, and confirmability. Similar concepts have been described, for example by Maxwell (1992), and since then have guided research in dairy science (Roche et al., 2019). Adhering to the criteria of trustworthiness can provide information about the steps researchers took to ensure rigorous research practices.

### Credibility

Credibility, often described as the corresponding concept to internal validity in quantitative research, is concerned with the "confidence in the truth of the findings" (Ulin et al., 2005, p. 25) and is high if the researchers represent participant views accurately (Tobin and Begley, 2004). In qualitative dairy science, prolonged engagement with participants, such as demonstrated in ethnographic studies (Rees et al., 2021; Chen and Weary, 2022; Ida et al., 2023) can enhance credibility. Further, in individual or focus group interviews, researchers have aimed to increase credibility through member checking, i.e., providing participants the option for feedback on a verbal summary of the main points at the end of the interview (Skjølstrup et al., 2022), on interview transcripts (Russell et al., 2022), or on a written summary of the study's findings (Vaarst et al., 2007; Smid et al., 2022). Further, in qualitative dairy science publications, the inclusion of participant quotes is typical to support the authors' claims and conclusions.

Combining different types of data collected from multiple angles (i.e., triangulation) was initially proposed to reduce research bias and converge on a single reality (Tracy, 2020). Therefore, many argue that researcher triangulation (i.e., multiple researchers involved in the research process) enhances credibility (Lincoln and Guba, 1985) and dependability (Ulin et al., 2005) by reducing subjectivity. Although the attempt to reduce subjectivity has been critiqued as corresponding too closely to positivistic notions of validity and reliability, researcher triangulation also allows different perspectives and epistemological assumptions to inform the research results (Rothbauer, 2008). Researcher triangulation was, for example, followed in a study aiming to understand development of and adherence to standard operating procedures, in which 2 researchers attended all interviews and were involved in the data analysis and interpretation (Mills et al., 2020a). Similarly, the use of overlapping methods for data collection or data collection triangulation can contribute to a study's credibility (Lincoln and Guba, 1985) and can include qualitative and quantitative data. This was demonstrated by Rink et al. (2019) who assessed producer perceptions of the Farmers Assuring Responsible Management program in the United States. However, even within qualitative research settings, data collection triangulation is possible. For example, McFarland et al. (2020) supplemented and triangulated data from 5 individual interviews with data from 4 focus groups to understand Irish producers' decision-making regarding the submission of samples to governmental animal health surveillance laboratories.

External review through peer debriefing by scientists without direct involvement in the research project can also enhance credibility and was used by Wynands et al. (2021) in their study on lameness management. In peer debriefing, peers (e.g., external qualitative dairy science researchers) are instructed to review the research and analytical process, assess the consistency of logic and connectedness to the data, and help expose aspects of the research that otherwise might not have been discussed (Lincoln and Guba, 1985; Guest et al., 2012).

### Dependability

Dependability refers to a qualitative research process that is logical, clearly documented, and traceable (Tobin and Begley, 2004). In quantitative research, these steps contribute to the reliability and replicability of findings. Given the specific contexts in which qualitative research is generally conducted, replication might not be possible nor desired. However, high levels of dependability allow others to understand and evaluate whether proper research practices were followed (Shenton, 2004) and replicate the process that led to the research findings (Ulin et al., 2005). In addition to an

in-depth methodological description in any publication, establishing audit trails is a means of establishing dependability (Nowell et al., 2017). For example, Roche et al. (2019) created an audit trail through an ongoing log of notes describing the research process in understanding dairy producers' and veterinarians' perceptions of Johne's disease control. Similarly, memoing (i.e., keeping reflexive notes) to outline researcher thoughts and choices (Wynands et al., 2021) can contribute to establishing an audit trail and the dependability of qualitative research in dairy science. Other sources that can add to an audit trail include raw data (e.g., audio recordings), transcripts, or field notes.

### Transferability

Transferability, which is the corresponding criterion for generalizability in quantitative research, describes the extent to which inferences can be made about other populations. The concept of generalizability has even been challenged in quantitative research, arguing that all observations depend on the specific contexts in which they occur (Erlandson et al., 1993; Polit and Beck, 2020). Transferability is even more debated in qualitative research, which is inherently concerned with rich, contextualized understandings of phenomena. Substantial contextual differences exist between countries, for example, in terms of farm size, management systems, laws, and disease prevalence. Thus, many studies provided key demographic characteristics of participants (and their farms, where applicable; Duval et al., 2017; McFarland et al., 2020; Skjølstrup et al., 2022) that can help the reader compare participants to different contexts. Further, Mulkerrins et al. (2022) provided comprehensive information on dairy farming and extension services in Ireland, whereas most articles kept descriptions shorter, assumingly to align the article with the publisher's goal for brevity. Providing comprehensive information and details is one aspect of thick description, which allows the reader to visualize details of the participants and the study setting and evaluate the transferability of study results. Another aspect of thick description often includes long quotes in publications to present participant voices to establish a sense of visualization and, hence, verisimilitude in the reader (Ponterotto, 2006). Indeed, participant quotes were a key feature of many reviewed qualitative dairy studies.

Some argue that it is possible to apply evidence when contexts are similar (Tolley et al., 2016) and that qualitative research is well suited to develop higher-level concepts and theories that are not particular to a specific setting (Glaser, 2002; Misco, 2007). Broom (2021) argued that if qualitative data are conceptualized well, they can help with transferability, in the sense that the study results can illustrate what the data mean at a broader level. Qualitative research about cattle diseases provides a case for this type of transferability. Regarding Johne's disease, producers perceived some control measures to be unrealistic to implement in Canadian (Roche et al., 2019) and UK contexts (Robinson, 2020). Also in Canada and the UK, research on transition cow management identified the need for research to involve advisers in addition to veterinarians, including nutritionists and consultants (Mills et al., 2020b; Redfern et al., 2021). These findings could be applied to and further refine existing theories about disease management, as well as provide insight into new research questions, for example, examining how disease control measures are developed and if they could be participatory.

### Confirmability

Quantitative researchers often assume the objectivity of their findings. However, the intrusion of researcher bias is unavoidable, even in quantitative research, as tests or questionnaires are designed and data are collected, measured, analyzed, and interpreted by researchers. Confirmability is the qualitative analog to objectivity, although the consideration in question is the extent to which the investigator acknowledges their own biases and predispositions (Miles and Huberman, 1994). As such, Nowell et al. (2017) argued that confirmability can be established by following criteria for credibility, transferability, and dependability.

## FUTURE DIRECTIONS

Qualitative research has opened the door to a broad array of new opportunities in dairy science. In this section, we summarize our review and discuss future directions for qualitative inquiry.

In the reviewed articles, individual interviews, focus groups, and different variations of thematic analysis were most commonly used for data collection and analysis. These methods allowed researchers to understand stakeholders' behavior regarding general dairy cattle management, animal welfare, disease prevention, and control measures and provided insights into stakeholders' professional relationships.

Philosophical assumptions inherent to qualitative research were often not explicitly described in the reviewed literature, although positionality and reflexivity statements were more common. Qualitative research that is conducted without a clear recognition of the underlying principles and assumptions of the discipline is at risk of compromised trustworthiness. Therefore, it is important that publications include how the

paradigm and its underlying assumptions informed the research and that references are provided for the different analytical and methodological approaches. The involvement of a transdisciplinary research team, including social scientists, can help to increase the quality and trustworthiness of a study.

Many of the reviewed articles described some aspects addressing the study's credibility, dependability, and transferability, but a comprehensive account of the strategies taken to establish trustworthiness was uncommon. Researchers can increase the trust in qualitative research and the reader's ability to evaluate transferability by adhering to thorough reporting in any publication. Although available reporting standards are not applicable to all qualitative research depending upon the paradigmatic, methodological, and analytical assumptions, these guidelines can help develop a scientific publication that considers and reports relevant aspects. Examples of qualitative reporting standards include consolidated criteria for reporting qualitative research (Tong et al., 2007) for interviews and focus groups or standards for reporting qualitative research (O'Brien et al., 2014).

Despite the undeniable value that individual interviews, focus groups, and thematic analysis have brought to dairy science, an expansive spectrum of qualitative approaches exists that can provide additional insights. Although still uncommon, some authors conducted ethnographic studies, adding further depth to the inquiry through immersive observation of participants and their actions. Therefore, future dairy science research should consider ethnographic approaches when the researchers' aim is to understand and position the behaviors of a culture-sharing group (e.g., producers) in the complex context of the dairy sector. Few studies applied action research and participatory approaches, which go beyond understanding stakeholders' behavior and often result in on-farm changes through the involvement of producers and their advisers in the design and implementation of research. Hence, these approaches may help bridge the research-implementation gap that can be a bottleneck for improvements in any field, including dairy science. To understand the values, attitudes, and perceptions of members of the public, mixed methods questionnaires were common and revealed that members of the public have concerns about dairy cattle welfare, including cow-calf management. These questionnaires can inform the directions of the dairy sector aiming to meet public expectations and maintain the social license to operate. Future studies could further explore qualitative avenues to incorporate the voices of members of the public through different methodologies, and depending on the research objective, foster a direct dialog and partnership between the dairy sector and members of the public.

The primary goal of this review was to increase the accessibility of qualitative research among different audiences using specific examples, rather than providing a synthesis of all available qualitative dairy science literature. In the future, a systematic review could be useful to explore more specific research questions, or further highlight specific research topics and approaches that are currently underrepresented in qualitative inquiry.

## CONCLUSIONS

Qualitative approaches have been used to investigate diverse topics in dairy science, and the spectrum of their application ranged from long-term immersion into dairy communities to analyzing a large number of questionnaire responses. As either stand-alone studies or by employing a mixed methods approach, researchers gained in-depth understandings of stakeholders' decision-making or used participatory approaches to include stakeholders in the process of developing best practices. When choosing a qualitative study design, consideration must be given to the specific philosophical assumptions, data collection, and analysis approaches. When well conducted, qualitative research offers a new lens that has great merit on its own but can also foster interdisciplinary collaborations by guiding, informing, or expanding on quantitative research.

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