ABSTRACT

The aim of the study was to determine the role played by farmers’ sociodemographic factors in the characteristics of dairy farmers’ breeding goals and how they are clustered in Slovenia. Understanding how farmers formulate their breeding objectives is crucial because their perspectives may diverge from those of the stakeholders engaged in selection and breeding. Involving farmers in the process of setting breeding goals can improve the use of selection tools and confidence in the selection process. For a more complete picture of how farmers view breeding work, their expectations, and the changes they would prefer to see in the future in terms of new traits and a total merit index, a mixed methods approach was used. Initially, 3 focus groups with 30 participants were conducted on the following main topics: farmers’ needs and attitudes regarding genomic selection, the main barriers and advantages to adopting genomic selection, the design of a total merit index, and preferences for breeding goals. To generalize the results to the whole population, an additional online questionnaire was sent to dairy farmers affiliated with Slovenian breeding associations, with 212 farmers responding. Based on how the farmers distributed weights across the trait categories in the total merit index, a cluster analysis identifies 3 distinct groups of farmers. Milk production proved to be an important common factor for all farmers, especially production-focused ones. Functionality-focused farmers expressed the strongest preference for fertility (22%), longevity (18%), and animal health (18%), whereas resilience-focused farmers concentrated on fertility (13%), health (13%), longevity (11%), and workability (11%). Yet, the results also showed that dairy farmers hold quite similar preferences for breeding goal traits, with animal health and welfare, reproductive traits, dominating across the sample and environmental and meat traits being the least important. The quantitative analysis of the preference for new environmental traits showed that farmers express less importance to them due to pressure and negative public opinion about the environmental impact of dairy farming. The focus group participants, although acknowledging that adaptation to climate change and heat stress will be essential, were even more negative about traits related to greenhouse gas emissions, which can be attributed to negative public opinion and constraints on agricultural activity.

Key words: breeding goal traits, dairy breeders, mixed methods

INTRODUCTION

Genomic selection has radically changed the way dairy cattle are bred by helping farmers to achieve higher annual rates of genetic gain by using genomically tested animals in their herds. It also allows selection for difficult to measure traits such as feed conversion, methane emissions, and energy balance, using mating plans to optimize the rate of genetic gain while controlling inbreeding, obtaining certainty about the pedigree of individual cows, and avoiding genetic defects (Pryce and Hayes, 2012; Schefers and Weigel, 2012; Schöpke and Swalve, 2016; Seidel et al., 2020; Gutierrez-Reinoso et al., 2021). Farmers’ views on important traits in dairy cattle for their herds are often overlooked when developing breeding goals (Nielsen and Amer, 2007; Ahlman et al., 2014), demonstrating the importance of understanding their preferences. To facilitate the design of effective breeding programs, Martin-Collado et al. (2021) introduced a reference measure that evaluates farmers’ attitudes to animal breeding tools. Understanding farmers’ preferences is essential for the successful development of appropriate breeding goals for sustainable and resilient dairy production and the wider use of selection tools. This means it is desirable that farmers participate in the development of breeding objectives together with the stakeholders involved in selection and breeding work. If users are actively involved in the decision-making process when developing a service or product, acceptance of the resulting objectives and tools is usually higher (Hill, 2016). Over-
all, breeders play a crucial role in shaping the genetic makeup of a population by selecting the parents of the next generation, and their decisions have an effect on the future of the breed.

Many scientists emphasize that milk production and milk composition have been the main selection goals in dairy cattle-breeding programs over the past few centuries, resulting in unfavorable genetic responses in traits such as fertility, health, longevity, and environmental sensitivity (Nielsen and Amer, 2007; Nielsen et al., 2014; Miglior et al., 2017; Brito et al., 2021; Gutierrez-Reinoso et al., 2021). In addition, the use of a limited number of dairy breeds and a small number of sire within breeds has led to a significant decrease in genetic diversity as an outcome of inbreeding. The consequences of inbreeding appear in the form of inbreeding depression among the offspring and an increase in undesirable recessive diseases. If selection indices place less emphasis on milk yield but select for many other important traits, greater genetic variability can be expected in the long-term (i.e., the more diverse genetic composition of individual animals; Brito et al., 2021). Therefore, the dairy industry needs to refine selection indices and breeding goal traits to put stronger emphasis on traits related to animal welfare, health, longevity, environmental efficiency (e.g., methane emissions and feed efficiency), and overall resilience (de Haas et al., 2021). Genetic selection for some of these breeding goals has already been implemented around the world (e.g., Miglior et al., 2017; Cole and VanRaden, 2018) and certain countries have placed greater emphasis on these novel traits, especially in Western Europe, North America, Australia, and New Zealand. A recent review of studies on different traits that also addresses the main challenges related to traits in breeding goals shows the following groups of traits in dairy farming: (1) production (milk yield, fat and protein yield, SCC, longevity); (2) reproduction (fertility, calving interval, ease of birth, perinatal death); (3) health and welfare (disease resistance, immune response, survival, longevity, adaptability, mastitis, metritis, placental retention, abomasal displacement, ketosis, lameness, hypocalcemia); (4) environment (climate adaptation, feed efficiency, energy metabolism, methane emissions, hypoxia, altitude adaptation, heat stress); and (5) linear-type traits (udder traits, feet and leg traits, height, angularity, body depth, body condition, locomotion; Meijer et al., 2015).

Previous studies show that farmers’ views on innovation are influenced by many personal (e.g., age) and socio-economic factors (e.g., income, assets, education) as well as farm characteristics (production systems, farm size, farming conditions; Padel et al., 2015; Roussy et al., 2017; Läpple and Thorne, 2019). They show that younger (under 40 years old), better-educated (university), and higher-income farmers, who have more information to better assess innovation and reduce its uncertainty, are generally more innovative (Padel et al., 2015; Roussy et al., 2017; Läpple and Thorne, 2019), as are farmers with larger and more intensively stocked conventional farms (Roussy et al., 2017; Läpple and Thorne, 2019), or organic farmers who are often more educated and open to innovations targeting greater innovation in the field of sustainability than conventional farmers (Naspetti et al., 2017; Skjerve et al., 2018). When comparing overall rankings of breeding goals traits, fertility traits were usually the most strongly preferred traits among dairy farmers (Byrne et al., 2016; Slagboom et al., 2016). In an Australian study on genomic selection, age was found to be the sole sociodemographic factor that differentiated the selection of breeding goal traits. Older farmers preferred production-oriented traits than younger ones, who preferred functional traits (Martin-Collado et al., 2015). With regard to farm types, a Danish study (Slagboom et al., 2016) shows, in contrast to a Norwegian (Skjerve et al., 2018) and a Swedish study (Ahlman et al., 2014), that organic dairy farmers were more often found in production-oriented clusters.

To date, the focus of studies has only been on analyzing farmers’ view on the bio-economic model of animal traits (Byrne et al., 2016; Fuerst-Waltl et al., 2016; Paakala et al., 2018; Martin-Collado et al., 2015), and on the theoretical identification of a comprehensive group of relevant traits that address current breeding challenges (Gutierrez-Reinoso et al., 2021). Nevertheless, the significance of sociodemographic factors in shaping breeding tools and establishing a comprehensive set of important traits for livestock production has largely been overlooked, particularly in countries characterized by small dairy herds and relatively limited genetic data. Therefore, a deeper exploration of these factors becomes essential, as underscored in the research by Skjerve et al. (2018).

Some studies have investigated the differences in farmers’ preferences with respect to improving dairy cow breeding goal traits using farmer typologies. Martin-Collado and colleagues (2015) analyzed Australian dairy farmers’ preferences for cow trait improvement in 2014, identifying 3 farmer types: (1) production-focused farmers who expressed the strongest preference of all for improvements in protein yield, lactation persistency, feed efficiency, cow live weight, and milking speed; (2) functionality-focused farmers with the strongest preference for improvements in mastitis, lameness, and calving difficulty; and (3) type-focused farmers with the strongest preference for mammary system and type.

A study by Skjerve and colleagues (2018) among Norwegian dairy farmers, who have similar small herds
to Slovenian dairy farmers, detected 4 different preference clusters with a mix of systematic and intrinsic effects on breeding goal trait priorities: milk production, meat production and functionality, fertility and efficiency, robustness and health, and milk production and health. The study found that dairy cattle breeding in Norway aims for both higher milk production and improved functional traits. A recent study shows that in Finland longevity, conformation, and yield were favored less, and health and fertility favored more (Paakala et al., 2020).

The studies underline the diverse preferences of farmers regarding breeding objectives for dairy cattle. According to these studies, farmer's objectives differ considerably from the total merit index. Therefore, conducting specific studies focusing on dairy farmers' preferences is crucial for gaining a comprehensive understanding of their preferences for breeding traits and selection criteria. Although some studies examined the overall ranking of breeding goal traits (Martin-Collado et al., 2015; Skjerfe et al., 2018; Paakala et al., 2020), previous research suggests that analyzing the share of groups of traits in the total merit index may provide a more accurate insight into the preferred breeding goals of dairy cattle farmers (Byrne et al., 2016; Fuerst-Waltl et al., 2016).

The aim of this study was to determine the role of farmers' sociodemographic factors in dairy farmers' preferences for breeding traits, especially novel traits in dairy cattle such as environmental traits. In addition, the study aimed to explore how these preferences vary across the dairy farming community. Our hypothesis was that older (over 40 years old), less educated farmers, and farmers with lower milk production per cow prefer milk production traits.

**MATERIALS AND METHODS**

A mixed methods approach was used. As focus groups are a useful qualitative method for quickly gathering in-depth information about the attitudes and opinions of the participants on the topic under study, the objective of using focus groups was to find out farmers’ views on breeding goal traits. To obtain views that are representative of the population, we conducted a quantitative survey to determine how preferences regarding breeding goals traits vary across the cattle farmer community, focusing on the role of farmers’ sociodemographic factors.

**Qualitative Approach: Focus Groups**

First, we conducted focus groups, a method for collecting in-depth opinions and views from several people on a topic that is known in advance and not so well researched (Rubin and Rubin, 2005). One social scientist (KE) with experience in qualitative data analysis was part of the research team, which comprised researchers with experience in cattle-breeding research (AU, MK). All 3 authors are female. Two researchers (KE, MK) hold PhDs, whereas the first author is pursuing a PhD. All 3 focus groups were moderated by the second author (KE), who was unknown to the participants other than the knowledge that she works as a researcher at the University of Novo mesto. Assumptions or biases discovered during the analysis and paper preparation were discussed with co-authors, and reflexivity was established by maintaining a research log with justifications for decisions made during data analysis and interpretation. Before starting the study, a pilot focus group was conducted to ensure that questions were phrased in such ways that the research objectives were met.

The aim of these focus groups was to determine the farmers’ opinions on selection tools, genomic selection, and breeding goal traits in particular. In these groups, we highlighted the following issues: farmers’ needs regarding selection; knowledge and understanding of genomic selection; farmers’ attitudes to genomic selection and genomically tested animals; the main obstacles and advantages in the introduction of genomic selection in Holstein in Slovenia; the design of a total merit index and preferences for breeding goals. Farmers were invited by cattle-breeding associations and groups of cattle breeders by email and via a social network (Facebook), with 27 responding. Three focus groups were conducted in March 2021 using the Zoom application because it was impossible to conduct them in person due to the protective measures related to COVID-19. The focus groups lasted around 120 min, were recorded, and the participants’ statements were transcribed. The focus groups involved 7 women and 20 men, 5 of whom had completed secondary school, and 15 colleges and universities. Six held a master’s degree and one a doctorate. Four participants had up to 50 dairy cows, 18 between 50 and 100 dairy cows, and 5 between 100 and 150 dairy cows. Twelve participants had production dairy cows with a milk yield (kg milk in standard lactation) of between 9,000 and 10,000, 7 participants between 8,000 and 9,000, 7 participants between 10,000 and 11,000, 3 participants between 11,000 and 12,000, and one participant over 12,000.

The data were analyzed using thematic analysis, the most common analysis for qualitative data relied on to find common patterns in a database (Rubin and Rubin, 2005). The coding process for systematically categorizing the focus group transcripts involved reading through the transcripts, applying codes to the focus group excerpts (inductive coding), conducting various
rounds of coding, grouping the codes according to the key themes identified as productivity, resistance and functionality, and the subsequent interpretations. The analysis was conducted by 2 independent researchers. Any problems with the data analysis and coding were discussed and resolved by consensus. To better link the results of the quantitative and qualitative analyses, the results of the qualitative analysis are presented in a way that builds on and interprets the quantitative data. Direct quotes from participants are included to illustrate the key points, highlight themes, and support our interpretations.

**Quantitative Approach: Online Survey**

Farmers were invited to complete the online survey (Supplemental File S1, https://repositorij.uni-lj.si/IzpisGradiva.php?id=149247; Ule and Kloppičić, 2023) on August 25, 2021, by email (approximately 1,000 email addresses) and via social networks (Facebook). We administered a structured questionnaire using the survey tool 1KA (https://www.1ka.si/d/en), available online. Due to the lack of response, the invitation to participate was re-issued in December 2021. The questionnaire was reviewed by 5 independent reviewers and a pre-test study was conducted with 10 respondents to see how farmers understood the terminology used in the questionnaire, which led us to simplify some statements. The responses from the pre-test were not included in the data analyzed for this article.

The survey involved 212 respondents, of whom 78.7% (n = 286) were male, and 45.3% (n = 96) were younger than 40 years, which is representative of dairy farmers in Slovenia (Glač, 2021; Table 1). In the survey, 50.5% of participating farmers had completed secondary education, whereas 40.1% had a higher education (vocational college, bachelor’s degree, master’s degree, PhD degree). The electronic nature of the survey played a crucial role in attracting respondents through email and social networks, effectively reaching out to a segment of the population that is well-versed with computers and actively engaged in social media. This group typically possesses higher levels of education, explaining the greater representation of individuals who had completed secondary education or held university degree in the survey.

To assess the farmers’ trait preferences, a comprehensive group of relevant traits addressing current breeding challenges was adopted from Gutierrez-Reinoso et al. (2021) and supplemented with traits taken from Interbull (2021) using a 7-level Likert scale from 1 = very unimportant to 7 = very important: production (milk yield, fat and protein yield [milk solids], fat and protein content, SCC, lifetime, longevity), reproduction (calving interval, age at first calving, insemination index, ease of birth, perinatal death), health and animal welfare (disease resistance, immune response, survival, longevity, adaptability, mastitis, metritis, placental retention, abomasal dilatation, lameness, hypocalcemia), environment (climate adaptation, heat stress, feed efficiency, consumption capacity, energy metabolism, methane emissions), linear-type traits (udder traits, feet and leg traits, height, angularity, rump angle, body depth, body condition, locomotion, udder conformation traits), functional traits (milkability, animal temperament).

The second part was about a total merit index. To further define the farmers’ preferred categories of traits within the proportion of the total merit index, farmers were asked what percentage weights milk production,
meat production, linear-type, workability traits, calving ease, health, longevity and reproduction should have to come closer to their desired breeding goals. The last group of variables were sociodemographic characteristics (sex, age, education) and characteristics of the farm (production system, farm with limited environmental factors, main breed in the herd, land owned and rented, number of livestock, number of dairy cows, milk yield (kg of milk in standard lactation), and farm milk production per cow in 2020 (in kg of milk per year).

Ethical Consideration

The Commission for Postgraduate Studies at the Biotechnical Faculty of the University of Ljubljana (reference number: 5–469/19 VJJ) approved this study. Participation in the qualitative and quantitative survey was voluntary. All participants were informed in advance about the objectives of this study, the method of data collection, the person responsible and the use of the data from the survey for research purposes. They had the possibility to withdraw from the survey at any time.

Statistical Analysis

The statistical analyses were performed with the SAS package, version 9.4 (SAS Institute Inc., Cary, NC) and IBM SPSS Statistics (version 25).

Farmer groups were identified based on their desired composition of a total merit index, using the complete set of 212 respondents. Cluster analysis was performed in 2 stages with SPSS. First, a hierarchical technique was used to identify the number of clusters and to profile the cluster centers. The algorithm employed in the hierarchical technique was Ward’s method based on squared Euclidean distances. Second, the observations were clustered by a nonhierarchical method (k-means) with the cluster centers from the hierarchical results used as the initial seed points. A nonparametric Kruskal-Wallis test was used to analyze differences between groups of farmers because the proportion of trait categories in the total merit index was not normally distributed.

Basic statistics were obtained for individual traits as well as for a set of traits such as milk production, reproduction, health, and animal welfare). The relationship between farmer and farm characteristics and trait preferences was analyzed using general linear models (GLM; SAS, procedure). The differences between means were evaluated using the pdiff option of the least squares means statement in the GLM procedure and adjusted for multiple comparisons using the Tukey-Kramer method. We used the following model:

\[ y_{ijklm} = \mu + A_i + E_j + M_k + H_l + e_{ijklm}, \]

where \( y_{ijklm} \) is the trait of interest; \( \mu \) is the overall mean; \( A_i \) is the fixed effect of age of a farmer (\( i = 2 \) classes; \(<40, \geq 40 \text{ yr of age})\); \( E_j \) is the fixed effect of the \( j \)th class of education (\( j = 3 \) classes; primary and vocational school, secondary education, higher education); \( M_k \) is the fixed effect of milk production level (\( k = 4 \) classes; \(<8,000, 8,000–9,000, 9,001–10,000, \geq10,000 \text{ kg})\); \( H_l \) is the fixed effect of herd size (\( l = 4 \) classes; 24, 24–42, 43–60, \( \geq60 \) dairy cows); and \( e_{ijklm} \) is the random residual. Residuals were assumed to be normally distributed with a mean of zero and variances of \( \sigma^2 \).

RESULTS

Table 1 presents the socio-economic characteristics of the farmers in the sample as well as the characteristics of their farms. Of the 212 respondents, most were conventional producers and only 1 held a certificate for organic production. Further, 62.3% of all respondents farming in less-favored areas. The average farm size included in the sample was 48.2 ha of owned and rented agricultural land, the average number of cattle (cows, heifers, breeding bulls, fattening bulls, calves) was 97.0, the average number of dairy cows was 50.0, while the average farm milk production per cow in 2020 was 8,844.5 kg of milk.

Figure 1 shows the composition of the total merit index currently used for the Holstein breed and the share of groups of traits in the total merit index proposed by the farmers. The existing total merit index for the Holstein breed includes milk traits (40%; milk, protein and fat yield [kg], fat and protein content [%]), linear-type traits (30%; rump height, rear-leg set, fore udder attachment, front teat length, rump angle, rear udder height, udder depth, udder support, chest width, front teat placement, rear teat placement, rear-leg rear view, foot angle), health traits (6%; SCC), longevity traits (6%; longevity), workability traits (2%; milking speed), and fertility traits (16%; age at first calving, calving interval). On average, breeders want a lower share compared with the existing index for milk production (27%), linear-type traits (14%), and fertility (13%). They want a bigger share for health (13%), longevity (11%), and workability traits (10%). They also want to include meat production (3%) and calving ease (8%) in the total merit index.

Three clusters of respondents were retained from the cluster analysis (Figure 1). These were named according to differences in the total merit index composition between and within clusters: (1) functionality-focused farmers, (2) production-focused farmers, and (3) resilience-focused farmers.
The first cluster, functionality-focused farmers, mostly considers the characteristics of fertility (22%), longevity (18%), and health (18%). This group includes 45 respondents (21%), most of whom were middle-aged and had a secondary school (44.0%) or higher education (46.6%). In 2020, on average they kept 50 dairy cows and produced 8,306 kg of milk per cow.

In the second cluster, production-oriented farmers, more attention is paid to milk production (44%) and linear characteristics (16%). This cluster includes 60 respondents (28.3%), most of whom were older and had a secondary school (43.3%) or higher education (53.3%). In 2020, on average they kept 46 Holsteins, and their cows produced 8,671 kg of milk.

The last cluster, resilience-focused farmers, includes breeders who had reduced the share of milk production (23%) and concentrated on fertility (13%), health (13%), longevity (11%), and workability (11%). This is the largest group, accounting for 50.4% of all respondents, most of whom were younger and had a secondary school (57.0%) or higher education (29.1%). In 2020, on average they kept 54 dairy cows with a milk yield of 8,995 kg per cow.

Representatives of functionally oriented farmers in focus groups also expressed that they want to reduce the share of milk production traits in the total merit index and increase the share of fertility, longevity, and health of the dairy cow. They argued this is necessary to ensure stable milk production because the cessation of milking due to health problems and death is a major problem. A typical statement was made by farmer 2 (male, 57 years, secondary school): “The cows are in the barn to give milk. Since stopping production due to death or health problems is a big problem, the percentage of longevity and fertility should be increased.”

Some focus group participants belonged to the production-focused farmers who were in favor of increasing milk production, arguing that they want to improve the milk yield and linear traits. They may be called traditionalists, arguing that it is necessary to insist on a high proportion of the milk production trait as milk production is the main objective of dairy cows that brings them an income. A typical statement was made by farmer 3 (male, 31 years, bachelor’s degree): “The cow is there to be milked. The share in production should not be reduced but increased a little, and the share for forms should be added. Fertility is irrelevant because we do not have data, we should put it in the frame.”

Analysis of the focus group statements revealed that the majority of participants are resilience-focused farmers, believing it is necessary to secure production and profitability over the long-term. These farmers stated they were in favor of reducing milk production traits in the total merit index and looking for a balance between different traits because they had large herds and their cows produced high milk yields. A typical statement was made by farmer 1 (male, 38 years, master’s de-
“We should find the golden mean among different traits. We have to include everything from health, fertility, temperament, milk flow to physical traits so that we do not over-exploit cows in the long run. What good is it if you have extreme milkers, as I do, and then problems with health occur? It is important to make a profit in the long run.”

Figure 2 shows that the survey respondents rated the importance of most of the breeding goal traits very similarly, with health and animal welfare proving to be the most important traits (mean = 6.32, SD = 0.71), followed by reproduction (mean = 6.16, SD = 0.78). Meat production traits received the lowest average score among the traits (mean = 4.14; SD = 1.63).

Analysis of the focus group statements showed that farmers attach a relatively high level of importance to different breeding goals traits because they wish to see a change in the index, believing that other traits, not only milk production, are important for market success. A typical statement was made by farmer 4 (female, 52 years, master’s degree): “I don’t know... milk production is important, but also fat, protein, height and weight, particularly hoof health. Besides milk production, health, disease resistance and longevity are also important. Many things are important to have a good business, to have success, not only milk production. It would be good to change the index.” The statements also showed the interviewees are aware that the new traits are “difficult to assess and difficult to measure,” as farmer 5 (male 38 years, master’s degree) noted.

In addition to traits related to meat production, farmers in survey also scored lower on traits related to the environment (mean = 5.69, SD = 0.89): climate adaptation (mean = 5.58), heat stress (mean = 6.10), consumption capacity (mean = 6.43), feed efficiency (mean = 6.26), methane emissions (mean = 4.62), and energy metabolism (mean = 5.43).

The analysis of the focus group statements showed that the farmers evaluated environmental traits differently due to their varying direct effects on financial benefits. For example, the breeding goals traits that envisage a direct financial effect, such as climate adaptation, heat stress, consumption capacity, and feed efficiency, were rated higher than other environmental traits such as methane emissions and energy metabolism. A typical statement was made by farmer 5 (male, 38 years, master’s degree): “I would be happy if we included something new. I suggest that we make cows easier to withstand extreme conditions and tolerance to heat stress.” Environmental traits such as methane emissions and energy metabolism were not only rated as less important, but also characterized very negatively as being a product of media baiting, consumer nonsense, and environmental extremist madness. A typical statement was made by farmer 6 (male, 38 years, master’s degree): “The issue about methane emissions and greenhouse gases is complete nonsense because agriculture is not to blame for them. As much as agriculture emits them, it also absorbs them through crop production. This is the madness of the environmental extremists.”

Mean values determined by the least squares method and P-values for the effects of breeders’ age, education, herd size, and milk production are shown in Table 2. Breeders with the lowest level of education attach greater importance to climate adaptation, heat stress, consumption capacity, and methane emissions than...
breeders with higher education levels. We also observed significant differences in the assessment of their importance depending on the herd size. Breeders with between 24 and 60 dairy cattle (classes 2 and 3) attach greater importance to climate adaptation and consumption capacity than breeders with fewer than 24 and more than 60 dairy cows. For farms with a lower milk yield (less than 8,000 kg in 2020), climate adaptation is less important (5.31) than for the others (5.91–5.99). In this group of traits, methane emission has the lowest score. We also observed significant differences in this trait between farms with different production levels as farms with the lowest milk yield deviate the most in terms of the lowest score. Energy metabolism was the most statistically significant when estimated by those who had an average of between 8,000 – 9,000 kg milk per cow in 2020.

**DISCUSSION**

This study investigated dairy farmers’ preference for breeding goal traits in Slovenia. The use of mixed methods proved valuable as the focus group analysis provided in-depth farmers’ views on breeding goals traits, and the quantitative survey showed how preferences regarding breeding goals traits vary within farmers, focusing on the role of farmers’ sociodemographic factors.

The results show that the entire cattle farmer population wishes to compose a new total merit index from different proportions of categories of traits, with the largest share for milk production traits. Comparing the composition of the total merit index desired by breeders, we see that we are moving away from the German structure of the total merit index which focuses on milk production (36%). Instead, we are moving toward the Dutch index, which assigns less weight to production traits (only 28%; EuroGenomics, 2022). Selection indices are always different within and between countries because the economic conditions, traits covered, and breeds used are not the same everywhere (Miglior et al., 2017; Cole and VanRaden, 2018; EuroGenomics, 2022).

Relying solely on average preferences is insufficient to fully capture the diverse groups of farmers with distinct requirements (Martin-Collado et al., 2015), underscoring the importance of exploring farmers’ varying perspectives on breeding goals. Although this study identified 3 farmer types, we observed no substantial differences found in sociodemographic characteristics, aligning with the findings of Martin-Collado et al. (2015) and suggesting the existence of other unexamined factors that influence farmers’ preference patterns. The hypothesis that older (over 40 years old), less formally educated farmers, and farmers with lower milk production per cow prefer milk production traits was rejected because in this group we also found farmers with a secondary school and a higher education. This is not consistent with the findings of Martin-Collado et al. (2015) who showed that older farmers prefer production-oriented traits. In fact, younger, better-educated, and higher-income farmers, who possess information to better assess innovation and reduce its uncertainty, are generally more innovative (Meijer et al., 2015; Roussy et al., 2017; Läpple and Thorne, 2019), as was confirmed by the resilience-focused farmers.

Studies by Skjerve et al. (2018) and Martin-Collado et al. (2015) found that farmers place a high value on milk production. In the Norwegian study, 2 out of 4 clusters of farmers valued milk production highly,
whereas the other 2 clusters valued fertility or efficiency and robustness or health. In the Australian study, a cluster of farmers focused on milk production dominated, followed by farmers focused on functionality, and farmers focused on linear-type traits. Our research provides a contrasting perspective to previous studies that emphasized primarily milk production. In examining the preferences of Slovenian dairy farmers, we found a notable shift in trend: The focus is now also on functional traits, whereas milk production and linear-type traits, which currently account for 70% of the total merit index, are declining.

The analysis of the focus groups revealed that some farmers held more negative views on environmental traits than indicated in the quantitative survey. This is confirmed by another Slovenian study, which found that farmers in the focus groups expressed mostly negative attitudes to environmental measures (Benedičič et al., 2022). Compared with an online questionnaire, focus groups allow participants to express themselves more freely and explain their answers in more detail. The lower interest in environmental aspects can partly be explained by ignorance of them (Benedičič et al., 2022) because there are new aspects that have not been monitored before but are also feared by farmers due to increasing negative public pressure on agriculture, especially dairy farming (Purcell et al., 2023).

This apparently contradictory result can be explained by the interviewees’ statements. In particular, less educated, older individuals with smaller herd sizes place a higher priority on methane emissions compared with their peers. This preference stems from their awareness that their production practices are less environmentally friendly and their concern about possible European Union or state regulations on emissions reduction, which they see as a threat to their farming practices.

The interviewees’ statements explain the seemingly contradictory result that less educated, older people with a smaller herd size consider methane emissions to be more important than other farmers. These farmers perceive their production to be less environmentally friendly and are afraid of European Union or state measures to reduce emissions, which they see as a threat to how they approach farming. Carrying out complex measurements of ammonia and greenhouse gas emissions is another problem. Some scientists even argue that the adoption of environmental values and measures in agriculture is one of the biggest challenges facing modern agriculture in the European Union (Erjavec and Erjavec, 2020; van der Ploeg, 2020). Therefore, systematically planned communication aimed at different groups of farmers may help promote the acceptance also of the environmental breeding goal traits as a key trait and value in agriculture and positive changes in the breeding of dairy cows that reduce greenhouse gas. New traits need to be included to more strongly emphasize the environmental impact of farming. All the results reported were obtained without a specific selection for environmental traits but as an indirect response to the current breeding goals for each species, which entail a combination of health, growth, and (feeding) efficiency. If one wants to select directly for environmental traits, it is necessary to include new traits, e.g., the nitrogen and phosphorus content of meat and milk, and methane emissions of individual dairy cows (Klopčič and Kuipers, 2009).

Analysis of farmers’ trait preferences shows that all groups of breeding traits are generally important for the entire cattle-breeding population. Still, they ascribed relatively lower importance to some traits within these groups, especially to some environmental traits. This finding is consistent with a study by Wallenbeck et al. (2013), which reported that over 80% of farmers considered feet and legs, health traits, ease of calving, and longevity to be directly related to profitability. In contrast, only 32% of farmers felt that methane production and carcass classification had a noticeable effect on profitability. Farmers’ understanding of the importance of traits that directly affect profitability is closely related to their ability to adapt to new trends in animal husbandry, improve animal welfare, and effectively manage agricultural market volatility (Benedičič et al., 2022). This understanding enables farmers to proactively respond to changing practices and technologies and ensure that their farms remain competitive, sustainable, and resilient to daily changes, public demands, and global trends.

Animal health and welfare and reproduction traits were identified as the most important breeding goal traits, and meat production as the least important, which is not surprising given that dairy farmers are not focused on meat production. In other studies (Martin-Collado et al., 2015; Slagboom et al., 2016; Skjerde et al., 2018), reproduction or fertility traits were detected as some of the most important breeding goal traits because reproductive issues have a major effect on the profitability of milk production (Skjerde et al., 2018). In line with the findings of Martin-Collado et al. (2015), who identified the reduction of mastitis as the most strongly preferred trait, Slovenian farmers also ascribe the greatest importance to animal health and welfare. Because most Slovenian farmers farming in less-favored areas and can only expand their production to a restricted extent, they usually understand animals as an economic resource that must be protected as much as possible in many respects to maximize production.
(Benedičič et al., 2022). It may thus be argued that the traits attributed with the greatest importance were also those traits that the farmers most strongly associated with profitability. The low overall importance of breeding goal traits of the novel traits environment may have several explanations, including the fact that these breeding goal traits were new and unknown to most farmers surveyed, who are hostile to environmental issues, as also revealed by their rejection of the environmental measures provided in the Common Agricultural Policy (Benedičič et al., 2022). Examination of specific characteristics within the environmental category, such as methane emissions and heat stress, shows that farmers with primary education and medium-sized herds tend to place greater importance on these traits. This preference may be attributed to a lack of familiarity with these specific traits and concern about potential new regulations and restrictions related to environmental sustainability: Farmers’ views of housing systems for cattle. Ital. J. Anim. Sci. 21:18–30. https://doi.org/10.1080/1829601X.2021.2005470.


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