Slovenian dairy farmers' view on breeding goals

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Abstract

This study examines the influence of socio-demographic factors on the breeding goals of dairy farmers and their clustering in Slovenia. It is important to understand farmers' perspectives on breeding objectives, as they may differ from those of other stakeholders involved in breeding. Involving farmers in the process of setting breeding goals can improve the use of selection tools and confidence in the selection process. A mixed methods approach was used. As focus groups are a useful qualitative method to quickly obtain in-depth information on participants' attitudes and opinions on the topic under study, the aim of using focus groups was to find out farmers' views on breeding target traits. To obtain views that are representative of the population, we conducted a quantitative survey to determine how preferences regarding breeding objectives vary across the cattle breeding community, focusing on the role of farmers' socio-demographic factors. Three focus groups with 30 participants explored farmers' needs, attitudes towards genomic selection, barriers and benefits to adoption, the structure of the Total Merit Index and preferences in breeding objectives. An online questionnaire distributed to Slovenian dairy farmers received 212 responses. A cluster analysis based on the distribution of the weights of the trait categories in the Total Merit Index identified three different groups of farmers. Despite the differences, animal health, animal welfare and reproduction traits dominated across the sample, while environmental and meat traits were considered less important. The quantitative analysis revealed that new environmental traits are less important, which is attributed to societal pressure and negative perceptions of the environmental impact of dairy farming. In the focus group discussions, reservations were expressed about traits such as greenhouse gas emissions, reflecting societal sentiment and the constraints of farming. This study demonstrates the importance of combining qualitative and quantitative methods to gain a comprehensive understanding. The results show that farmers aspire to a new structure of Total Merit Index that includes several trait categories, with milk production traits being the most important. Three distinct groups of farmers emerged, each with their own focus. Animal health and welfare were seen as the most important traits, while new traits such as environmental traits were viewed less positively. The results of the study can help to develop new breeding goals and increase the confidence of breeders in the selection process through active engagement.

Key words: breeding goals, traits, total merit index, dairy cattle breeders.
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Introduction

Genomic selection has transformed dairy cattle breeding, enabling farmers to achieve higher annual rates of genetic gain by using genomically tested animals in their herds. This approach also makes it possible to select for traits that are difficult to measure, such as feed efficiency, methane emissions, and energy balance. By optimizing mating plans, genomic selection helps to maximize genetic gain while controlling inbreeding, ensuring accurate pedigrees 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). Despite these advances, farmers' preferences regarding key traits in their herds are often overlooked when developing breeding goals (Nielsen and Amer, 2007; Ahlman *et al*., 2014). Recognizing the importance of understanding these preferences, Martin-Collado *et al*. (2021) introduced a reference measure to assess farmers' attitudes towards breeding tools. This emphasizes the need for farmers to actively participate in the design of breeding objectives together with stakeholders, as such participation increases the acceptance of the resulting tools and objectives (Hill, 2016). Breeders, who play a crucial role in determining the genetic direction of future generations, have a major influence on the future of the breed through their selection decisions.

In past centuries, the focus of dairy cattle breeding programs has been predominantly on milk production and composition, which has led to unfavourable genetic consequences for 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, reliance on a limited number of dairy breeds and a small number of sires within breeds has contributed to a decline in genetic diversity, leading to problems such as inbreeding depression and an increasing incidence of recessive genetic diseases. By de-emphasizing milk yield and focusing on a broader range of traits, long-term genetic variability can be improved (Brito *et al*., 2021). The dairy industry therefore needs to refine its selection indices to place more emphasis on traits related to animal welfare, health, longevity, environmental efficiency (e.g. lower methane emissions) and resilience (de Hass *et al*., 2021). Some countries, particularly in Western Europe, North America, Australia and New Zealand, have already started to implement these broader breeding objectives (Miglior *et al*., 2017; Cole and VanRaden, 2018). A review of various studies on breeding challenges highlights the following key traits in dairy farming: Production (milk yield, fat and protein yield, somatic cell count, longevity); Reproduction (fertility, calving interval, ease of calving, perinatal mortality); Health and welfare (disease resistance, immune response, adaptability, survival); Environmental traits (climate adaptation, feed efficiency, methane emissions) and conformation traits (udder traits, feet and leg traits, locomotion) (Meijer *et al*., 2015).

Research shows that farmers' openness to innovation is influenced by personal factors such as age, education and income, as well as farm characteristics such as size, production systems and conditions (Padel *et al*., 2015; Roussy *et al*., 2017; Läpple and Thorne, 2019). Younger, wealthier and better educated farmers, especially those with larger farms, are more open to innovation (Naspetti *et al*., 2017; Skjerve *et al*., 2018). Fertility is often prioritized by farmers (Byrne *et al*., 2016; Slagboom *et al*., 2016), with older farmers focusing on production traits and younger ones on functional traits (Martin-Collado *et al*., 2015). Most research has focused on farmers' views on bioeconomic models of animal traits (Byrne *et al*., 2016; Fuerst-Waltl *et al*., 2016; Paakala *et al*., 2018; Martin-Collado *et al*., 2015) and theoretical identification of traits (Gutierrez-Reinoso *et al*., 2021), while socio-demographic influences on the development of breeding tools have been overlooked, especially in countries with small herds (Skjerve *et al*., 2018). Therefore, a more in-depth study of these factors is crucial, as underscored in the research by Skjerve *et al*. (2018).

The aim of this study is to investigate the influence of socio-demographic factors on dairy farmers' preferences for breeding traits, with a particular focus on new environmental

traits. Furthermore, it will be investigated how these preferences differ within dairy farmers in Slovenia.

Material and methods

A mixed methods approach was used. Focus groups to gather in-depth opinions on selection tools, genomic selection and breeding traits. The focus groups were led by a social scientist experienced in qualitative analysis and moderated by a researcher unknown to the participants to ensure an unbiased discussion. Twenty-seven farmers took part in the focus groups, which were conducted online in the context of COVID-19. Participants discussed selection needs, genomic selection knowledge and preferences for breeding goals. The data was evaluated using thematic analysis, identifying key topics such as productivity, resistance and functionality. For the quantitative approach, an online survey was distributed via email and social media in August and December 2021. The survey, in which 212 people participated, assessed farmers' preferences for various breeding traits using a seven-point Likert scale. The traits included production, reproduction, health, environment and functional traits. Respondents also indicated their desired weighting of traits in an overall merit index. Socio-demographic and farm characteristics were collected to investigate how these factors influence characteristic preferences.

The statistical analyses were carried out using SAS (Version 9.4, SAS Institute, Cary, NC, USA) and IBM SPSS Statistics (Version 25). Using data from 212 respondents, farmer groups were identified based on their preferred composition of a Total Merit Index. A two-stage cluster analysis was performed in SPSS. First, a hierarchical technique (Ward method with squared Euclidean distances) was used to determine the number of clusters and their centers. Then a non-hierarchical *k*-means method was applied using the identified cluster centers as starting points. The differences between the groups of farmers were analysed using the non-parametric Kruskal-Wallis test, as the proportions of characteristics in the Total Merit Index were not normally distributed.

Basic statistics were calculated for individual traits and trait groups such as milk production, reproduction and health. General linear models (SAS, GLM procedure) were used to investigate the relationship between farmer/farm characteristics and trait preferences. Mean differences were tested using the "pdiff" option of the "LS means" statement and adjusted 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; μ s the overall mean; A_i is the fixed effect of a farmer's age (i=2 classes; <40, ≥40); 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; <8000 kg, 8000–9000 kg, 9001–10000 kg, >10000); H_l is the fixed effect of herd size (l=4 classes: <24 dairy cows, 24–42, 43–60, >60); and e_{ijklm} is the random residual. The residuals were assumed to be normally distributed with a mean of zero and variances of σ_e.

Results

The study investigated the preferences of dairy farmers in Slovenia with regard to target breeding goals and breeding traits, using both quantitative and qualitative methods. Table 1 shows the socio-economic characteristics of the farmers in the sample together with the characteristics of their farms. Of the 212 farmers interviewed, the majority were conventional producers, with only one certified for organic farming. In addition, 62.3% of

Table 1. Farmer and farm characteristics of the sample (n = 212).

Characteristics	n	%	Characteristics	Mean	SD	Median	CV
Gender of respondents			Land owned and rented (ha)	48.2	47.6	36.0	99.1
Female	45	21.2					
Male	167	78.8					
Age of respondents			No. of livestock	102.6	59.1	97.0	57.5
< 40	96	45.3					
> 40	116	54.7	No. of cattle	51.3	27.1	50.0	52.7
Education of respondents							
Primary and vocational school	20	9.4					
Secondary education[1]	107	50.5	Milk yield (kg of milk in standard lactation)	8768.0	1691.0	9000.0	20.4
Higher education[2]	85	40.1					
Production system							
Conventional	211	99.5					
Organic	1	0.5					
Farm with limited environmental factors?			Milk production per cow in 2020 (kg of milk per year)	8844.0	1807.0	9000.0	19.3
Yes	132	62.3					
No	80	37.7					

[1]Vocational secondary education, Technical and vocational secondary education, General secondary education
[2]Vocational college, Bachelor's degree, Master's degree, PhD degree

respondents farmed in less-favoured areas. The average farm size was 48.2 hectares of owned and leased agricultural land, with an average of 97 cattle (including cows, heifers, breeding bulls, fattening bulls and calves) and 50 dairy cows. In 2020, the average milk production per cow was 8,844.5 kg.

The composition of the current Total Merit Index (TMI) for the Holstein breed and the changes proposed by farmers are shown in Figure 1. The current TMI includes milk

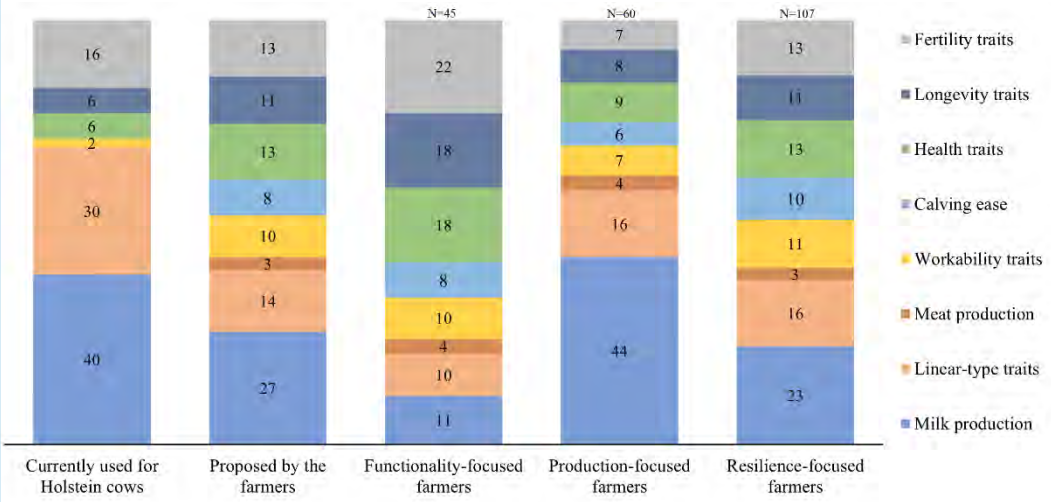

Figure 1. Composition of the Total Merit Index currently used for the Holstein breed and the share of a group of traits in the Total Merit Index proposed by farmers.

traits (40%), linear-type traits (30%), health traits (6%), longevity traits (6%), workability traits (2%) and fertility traits (16%). On average, farmers were in favour of decreasing the emphasis on milk production (27%), linear-type traits (14%) and fertility traits (13%), while they wanted to increase the proportion of traits for health (13%), longevity (11%) and workability traits (10%). They were also in favour of including incorporating new traits such as meat production (3%) and calving ease (8%).

The cluster analysis identified three groups of respondents (Figure 1): Functionality-oriented farmers who prioritised fertility (22%), longevity (18%) and health (18%). This group consisted of 45 respondents (21%), mainly middle-aged, with secondary education (44.0%) or higher education (46.6%). In 2020, they kept an average of 50 dairy cows with a milk yield of 8,306 kg per cow. The production-oriented farmers focused more on milk production (44%) and linear traits (16%). This group included 60 respondents (28.3%), who were predominantly older and had a secondary (43.3%) or higher education (53.3%). In 2020, they kept an average of 46 Holsteins with a milk yield of 8,671 kg per cow. Resilience-oriented farmers include breeders who have reduced the proportion of milk production (23%) in favour of traits such as fertility (13%), health (13%), longevity (11%) and workability (11%). This group accounted for 50.4% of respondents, most of whom were younger and had a secondary (57.0%) or higher education (29.1%). In 2020, they kept 54 dairy cows with a milk yield of 8,995 kg per cow.

The discussions in the focus groups reflected these findings. Functionality-oriented farmers advocated placing less emphasis on milk production and instead promoting traits such as fertility, longevity and health to ensure stable production, with a typical comment being: *"The cows are in the barn to give milk. As cessation of production due to health problems or death is a major problem, the proportion of longevity and fertility should be increased"* (farmer 2, male, 57 years old, secondary school). Production-oriented farmers, often referred to as traditionalists, were more inclined to increase milk production, as one participant explained: *"The cow is there to be milked. The share of production should not be reduced, but increased a little, and the share for conformation traits should be added. Fertility is irrelevant because we have no data, we should put it in the frame."* (farmer 3, male, 31 years old, bachelor degree). However, the majority of focus group participants were resilience-oriented farmers who advocated a balanced approach to breeding goals. One farmer emphasized the importance of long-term profitability: *"We should find the golden mean between the different traits. We need 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, like me, you have extreme milkers and then health problems arise? It is important to make a profit in the long term."* (farmer 1, male, 38 years old, Master degree).

Figure 2 shows that respondents ranked animal health and welfare as the most important traits (M = 6.32, SD = 0.71), followed by reproduction (M = 6.16, SD = 0.78). Meat production traits received the lowest scores (M = 4.14; SD = 1.63). The environmental traits were rated lower, with methane emissions (M = 4.62) and energy metabolism (M = 5.43) being rated particularly negatively. Some farmers dismissed these traits as "media agitation" or "environmental extremist mania," as one participant commented: "The issue of methane emissions and greenhouse gases is complete nonsense, because agriculture is not to blame" (farmer 6, male, 38 years old, Master degree). Farmers with a lower level of education rated traits such as climate adaptation and methane emissions higher, while larger herd owners and those with higher milk yields attached greater importance to traits such as consumption capacity and feed efficiency.

In this study, the preferences of Slovenian dairy farmers regarding breeding goals and breeding traits were investigated using a mixed methods approach. Focus

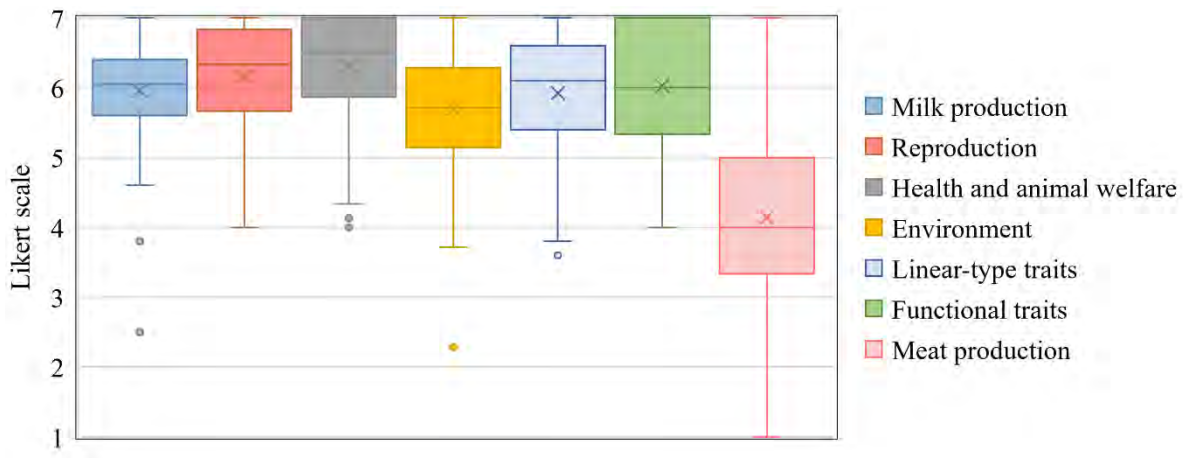

Figure 2. Farmers' preferences for a group of traits. Boxplots show the mean (solid lines), median (x), first and third quartiles (in the boxes), dispersion and outliers (dot) for farmers' preferences for a group of traits (N=212).

Discussion

groups provided an in-depth understanding of farmers' views, while the quantitative survey revealed the differences in these preferences, particularly in relation to socio-demographic factors. The results show that the majority of dairy farmers want to develop a new Total Merit Index, placing the greatest weight on milk production traits. However, there is a clear shift away from the German structure of the index, which emphasizes milk production (36%), to the Dutch approach, which gives less weight to production traits (28%; EuroGenomics, 2022). The differences between the selection indices of the individual countries are due to different economic conditions, traits recorded, and breeds used (Miglior *et al.*, 2017; Cole and VanRaden, 2018; EuroGenomics, 2022).

Relying only on average preferences does not adequately capture the diversity of farmers (Martin-Collado *et al.*, 2015). In this study, three different types of farmers were identified, although no significant differences in socio-demographic characteristics were found. While previous studies have emphasized farmers' strong preference for milk production traits (Skjerve *et al.*, 2018; Martin-Collado *et al.*, 2015), this study found a shift among Slovenian dairy farmers, who now place more emphasis on functional traits. Milk production and linear-type traits, which currently dominate in the Total Merit Index, are becoming less important.

The analysis of the focus groups revealed that farmers have a more negative attitude towards environmental traits than indicated in the survey. This discrepancy mirrors the findings of other Slovenian studies in which negative attitudes are attributed to ignorance of environmental issues and fear of increased regulatory pressure (Benedičič *et al.*, 2022; Purcell *et al.*, 2023). Less educated, older farmers with smaller herds who are concerned about the environmental impact of their practises were particularly worried about potential EU regulations on methane emissions. Dealing with environmental features remains a challenge as many farmers view them with scepticism due to public pressure on agriculture (Erjavec and Erjavec, 2020; van der Ploeg, 2020). Effective communication tailored to different groups of farmers can help to promote acceptance of environmental breeding goals and facilitate positive changes in dairy cow breeding. New traits need to be introduced for direct selection of environmental traits, such as methane emissions (Klopčič and Kuipers, 2009).

Overall, farmers consider all breeding traits to be important, although they attach less importance to environmental traits. This is consistent with the findings of Wallenbeck *et al*. (2013), who showed that farmers prioritize traits directly related to profitability, such as feet and legs, health and longevity, while they place less importance on traits such as methane production. Understanding these preferences allows farmers to adapt to new trends, improve animal welfare and effectively manage market volatility (Benedičič *et al*., 2022). Animal health, welfare and reproductive traits were most important, while meat production was least important, as dairy farmers focus mainly on milk. These results reflect previous research highlighting reproductive traits as crucial for profitability (Martin-Collado *et al*., 2015; Skjerve *et al*., 2018). Slovenian farmers, especially those in less-favoured areas with limited expansion opportunities, consider animal welfare as crucial for maximizing production (Benedičič *et al*., 2022). The relatively low importance given to environmental breeding traits could be due to the fact that they are new and farmers are not familiar with them. However, as the focus group results show, farmers are increasingly aware of the need to strike a balance between environmental sustainability and profitability to ensure the long-term viability of their farming practices.

Conclusions

This study on the breeding goal preferences of Slovenian dairy farmers emphasizes the value of integrating qualitative and quantitative methods to gain a comprehensive understanding of the topic. The results show that farmers aspire to a redesigned Total Merit Index that includes several trait categories, with milk production traits being the most important. However, farmers' preferences for the proposed Total Merit Index varied, leading to the identification of three distinct groups: those who prioritize production traits, those who emphasize functional traits, and those who focus on resilience. Above all, animal health and welfare proved to be the most important traits, while new traits, especially environmental ones, were met with less enthusiasm. The study also found that certain traits, such as greenhouse gas emissions, were perceived negatively, highlighting the need for targeted communication strategies to promote their acceptance. These findings can inform the development of new breeding goals and programs and increase breeders' confidence in their selection processes by actively involving them in decision-making.

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