Received: 16 May 2023 | Revised: 22 April 2024 | Accepted: 4 May 2024

DOI: 10.1111/1477-9552.12588

ORIGINAL ARTICLE

JAE Journal of Agricultural Economics

Understanding dairy farmers' trade-offs between environmental, social and economic sustainability attributes in feeding systems: The role of farmers' identities

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Funding information
Stiftelsen för Miljöstrategisk Forskning, Grant/Award Number: DIA 2018/24 #8

Abstract

There is scope for improving the sustainability of intensive dairy farms through the uptake of sustainable production practices such as more grass-based feeding systems. Such feeding systems can reduce feed-food competition and the environmental impacts of feed production, among other farm-level and societal benefits. However, empirical research on how farmers' feed choices mis(align) with sustainability transitions and the associated drivers is limited. This paper explores the trade-offs that farmers make between the environmental, social and economic sustainability impacts of grass-based feeding systems based on data from Swedish dairy farmers. Using an identity-based utility framework and a hybrid latent class model, we find substantial heterogeneity in dairy farmers' trade-offs between feed-related sustainability attributes: greenhouse gas emissions, biodiversity, animal welfare, feed self-sufficiency, feed cost and milk yield. Furthermore, our findings demonstrate that farmers who are strongly interested in the environmental and social sustainability impacts of their dairy feeding systems, beyond economic gains, are motivated mainly by their pro-environmental and pro-social identities. Overall, our findings imply that identity-enhancing interventions are promising policy instruments for encouraging the uptake of more grass-based feeding systems.

KEYWORDS
discrete choice experiment, grass-based feed, identity, sustainability, tradeoff

JEL CLASSIFICATION
D91, O33, Q18, Q57

1 | INTRODUCTION

Livestock farming is receiving increased attention in public discourse on the transition towards more sustainable food systems in the EU (Guyomard et al., 2021). In particular, dairy cattle farming, which offers livelihood opportunities and nutrient-rich foods, faces substantial environmental sustainability challenges among other societal concerns (Krizsan et al., 2021; von Greyerz et al., 2023). Notably, dairy farms have negative environmental footprints, including emissions of greenhouse gases (GHGs), which largely stem from feed production and enteric fermentation (Lindberg et al., 2021; Zanni et al., 2022). There are also social and economic sustainability concerns related to the welfare of animals and profitability of farms (Segerkvist et al., 2020). These pressures support the need for transformative changes in dairy and food systems, as reflected in the EU's Common Agricultural Policy (CAP) for 2023 to 2027.

In this paper, we take the case of grass-based feeding systems to examine how farmers' preferences for attributes of sustainable production systems are shaped by their environmental, social and economic identities. Specifically, we investigate how dairy farmers trade off utilities derived from sustainability attributes in their feed choices and the underlying drivers. To conceptualise utilities from feed choices, we developed an identity-based utility framework following identity economics theory (Akerlof & Kranton, 2000, 2005, 2010). We used this framework to derive hypotheses, which were tested using a hybrid latent class model. This model addresses the measurement errors and potential endogeneity bias associated with directly incorporating latent construct indicators into standard choice models (Abou-Zeid & Ben-Akiva, 2014; Sok et al., 2018; Zemo & Termansen, 2022).

The uptake of more grass-based feeding systems is noteworthy from a sustainability perspective. There is significant scope for improving sustainability in intensive dairy farms through feeding strategies that entail the replacement of human-edible feeds such as cereal and legume grains with human-inedible feeds such as grasses and fibrous byproducts (Krizsan et al., 2021; Lindberg et al., 2021). A more grass-based feeding system, where dairy cows are fed a high proportion of forage, especially grass silage, and low proportion of concentrates on a dry matter basis, is promising, especially in areas where byproducts are limited (Karlsson et al., 2020; Patel et al., 2017). In particular, grasses can be grown on marginal lands that are not suitable for food production for human consumption and dairy cows can upcycle grasses into high-quality foods, which can reduce food-feed competition (Bystricky et al., 2023). Additionally, such systems are associated with improvements in grassland biodiversity and related ecosystem services, superior animal welfare, and lower carbon footprints for feed production and imports such as soybeans (Guyomard et al., 2021; Lindberg et al., 2021; von Greyerz et al., 2023). Despite this potential, the implementation of more grass-based systems is relatively sparse in many EU countries, including Sweden, where the forage-to-concentrate ratio in dairy cow feed is approximately 1:1 (Patel et al., 2017).

For studying farmer decisions, there is emerging scientific interest in complementing neoclassical economic models with behavioural insights (Schaub et al., 2023; Wuepper et al., 2023). In this context, *self-identity* (hereafter, identity), which is an individual's sense of self, self-concept or self-image, is one of the latent socio-psychological factors that is attracting interest in explaining farmer motivations and actions (Howley & Ocean, 2021). This interest stems from the long-standing view in social psychology that identity functions as a motivator for behaviour, as derived from the seminal identity theory of Stryker (1968). This theory also posits that one's self consists of different identities that are not mutually exclusive. However, most empirical studies on agriculture (Josefsson et al., 2017; van Dijk et al., 2016; Zemo & Termansen, 2022) have focused on one farmer identity type (e.g., environmental identity), ignoring the potential role of other farmer identities. Importantly, it remains unclear whether identity matters in the uptake of sustainable practices, including feed choices, and how farmers balance environmental, social and economic identity utilities in their choices. In this study, we considered the *environmental, social and economic identities* (i.e., the extent of a dairy farmer's sense of attachment to environmental, social and economic sustainability concerns) associated with intensive dairy farming to capture non-pecuniary 'intrinsic' and pecuniary 'extrinsic' motivations for feed choices.

Beyond the role of identity in explaining choices, an individual's *attitudes towards a behaviour* (i.e., summary evaluation of a behaviour's desirability) may also influence their choices (Fishbein & Ajzen, 2010; Mariel & Arata, 2022). Although the attitude construct has been widely researched in different agricultural settings (see Sok et al., 2021 for a recent review), the role of farmer attitudes within the context of more grass-based feeds and sustainability tradeoffs remains an open question. There is no scientific consensus regarding whether farmer identities and attitudes are empirically related in explaining their choices. One strand of literature views attitude as unrelated to identity when explaining behaviour (e.g., Elahi et al., 2021; Josefsson et al., 2017; van Dijk et al., 2016). Another strand of literature argues that identity and attitude are correlated (e.g., Abu Hatab et al., 2022; Hallajow, 2018; Nash & Wakefield, 2022).

Our paper makes three contributions to the literature. First, based on dairy farmers' feed choices, we quantified farmer tradeoffs between environmental, social and economic sustainability attributes in the uptake of more sustainable agricultural practices. In this sense, we build upon previous studies on sustainability in dairy farming that have largely focused on individual sustainability dimensions in isolation and are unable to provide insights into how farmers balance utilities from different environmental, economic and social sustainability attributes (e.g., Läpple & Thorne, 2019; Zanni et al., 2022). Second, our study adds novel insights to the literature on the behavioural drivers of farmer decision making by documenting how heterogeneity in feed choices relates to differences in farmer identities. This builds upon studies limited to exploring only one aspect of farmer identity to explain decisions while assuming other farmer identities (Josefsson et al., 2017; van Dijk et al., 2016). Relatedly, we also add to the growing empirical literature on identity economics (Binder & Blankenberg, 2022; Howley & Ocean, 2021). Finally, in contrast to the extant literature that has explored farmer identity with the exclusion of attitude and vice versa (e.g., Mariel & Arata, 2022; Zemo & Termansen, 2022), our study accounts for the correlation between farmer identities and attitudes to explain their feed choices. Therefore, our paper also complements and builds upon previous studies that have considered both factors individually (e.g., Elahi et al., 2021; van Dijk et al., 2016). Overall, our core contribution is the finding that different identities play a role in shaping the heterogeneous preferences and tradeoffs farmers are willing to make regarding the uptake of more sustainable practices.

2 | BACKGROUND AND CONCEPTUAL FRAMEWORK

2.1 | Background

Dairy production is one of the most important sectors of Swedish agriculture. Over time, the total number of dairy cows and dairy farms has decreased, whereas the milk yield per cow has increased. Taken together, these results indicate that the sector is becoming increasingly intensive (see Figure A1 in the Appendix S1). This intensification has contributed to a decline in Swedish biodiversity-rich grasslands, which are traditionally maintained by ruminants (von Greyerz et al., 2023). Notably, higher milk yield is partially related to higher feed intensity. The Swedish dairy cow feed ration contains an approximately equal proportion of forage and concentrate on a dry matter basis, on average over a lactation period, despite the potential for feed rations richer in forage (70% or more) without adversely affecting milk yield (Karlsson et al., 2020; Patel et al., 2017).

Intensive feeding with cereals, concentrates, and pulses raises sustainability concerns regarding feed-food competition, emissions associated with feed production and imports, biodiversity preservation, feed self-sufficiency of farms, animal welfare, and so on (Guyomard et al., 2021; Krizsan et al., 2021). For example, approximately 1.2 kg of CO_2-equivalent emissions per kilogram of milk emanate from Swedish high-yield farms when considering all sources of emissions, including emissions from land use changes associated with feed such as soybeans (Lindberg et al., 2021). Notably, over 50% of estimated emissions stem from feed production, representing a significant scope for emission reduction from intensive dairy farms (Lindberg et al., 2021). Therefore, a shift towards more forage-based diets, especially grass-clover silage for indoor feeding and grazed grass during the grazing season with lower grain-based concentrates, is attracting policy interest. In this regard, dairy farmers have been receiving support, including a cattle allowance, agri-environmental payments for grassland management, restoration and cultivation, and an animal welfare allowance as part of the EU's CAP.

2.2 | Conceptual framework

We frame our study within the identity economics theory of Akerlof and Kranton (2000, 2005, 2010), where *self-identity* is integrated into the standard utility framework to explain human choices, especially in settings where choices involve costs and benefits to the decision maker. This identity-augmented utility framework assumes that people gain (or lose) utility by undertaking actions that align with (or deviate from) norms and ideals related to their identity. Furthermore, it assumes that different typologies or "clusters" of people exist, with each cluster having unique norms and ideals. This means that utilities from actions differ across clusters and these differences can be explained by identity differences. Drawing on this theoretical foundation, we develop an identity-based utility framework to conceptualise farmer decisions regarding more grass-based feeding systems (see Appendix 1 for the detailed framework).

3 | MATERIALS AND METHODS

3.1 | Data and sampling

Data were collected from a sample of specialised Swedish dairy farmers through an online survey conducted from late August to early October of 2022. The use of internet-based surveys among Swedish farmers is common and considered an efficient mode of data collection, given that approximately 98% of Sweden's population has internet access (Internetstiftelsen, 2019). This also reduces the potential social desirability bias associated with face-to-face interviews. The survey sample was based on the total population of specialised Swedish dairy farms ($N=2795$), which we considered as the sample frame. We obtained access to 2313 dairy farms that had registered contact information (email and/or mobile phone numbers) on the official register of dairy farms in Sweden, which is administered by Statistics Sweden. We excluded five institutional farms and 56 farms without usable contact details from the list of 2313 dairy farms across the 21 counties in Sweden. Based on this sample, we conducted a pilot survey in July 2022, resulting in a final sample of 2048 dairy farms for the main survey. The survey was conducted with the assistance of a marketing research company that had no stake in the study to preserve the confidentiality and anonymity of the farmers. Therefore, we only received anonymised data from the company.

Farmers were invited to participate in the survey through text messages and emails stating the aims of the survey and providing a link to the questionnaire. The survey consisted

TABLE 1 Summary statistics of farmer and farm characteristics.

Variable	Description	Mean	SD
Age	Age of farmer (years)	51.93	12.19
Gender	1 if farmer is male, 0 if female	0.82	
Higher_education	1 if farmer has a university education, 0 otherwise	0.24	
Dairy_experience	Years of dairy farming	23.41	13.54
Dairy_herd_size	Number of dairy cows	119.19	162.63
Grazing_area	Total grazing land area (hectares)	66.46	93.22
Conventional_system	1 if farmer operates a conventional dairy production system, 0 if certified organic, mixed, or transitioning to organic	0.76	
Grass-based_feed	1 if farmer uses a more grass-based feed (dairy feed ration with over 70% forage, on average over a lactation period and at least 6 grazing hours daily during the grazing season), 0 otherwise	0.21	
Training	1 if the farmer has participated in any feed-related training, 0 otherwise	0.21	
Milk_yield	Average energy-corrected milk yield per cow (kg/year)	10,322.87	1917.17
Dairy_income_share	Proportion of household total disposable income (after tax) from dairy farming (%)	77.58	26.51
Observations		375	

of three components: farmer and farm characteristics, a discrete choice experiment (DCE), and attitude and identity indicators. A total of 375 farmers provided complete responses, resulting in an effective response rate of 18.3%. This is similar to a recent survey conducted in Sweden (Owusu-Sekyere et al., 2022). Table 1 shows descriptive statistics of the sample. The average dairy herd size of 119 cows and share of certified organic farms of 23% in our sample slightly exceed the population average herd size of 102 cows and share of organic farms of 18% in 2021, as reported in the Swedish Board of Agriculture's statistical compilation (Swedish Board of Agriculture, 2022). Notably, the use of grass-based feeds was only 21% on average, despite the potential benefits of such feeds.[1]

3.2 | Discrete choice experiment

We used a DCE to elicit farmer preferences regarding the environmental, social and economic sustainability attributes of dairy feeds. In the DCE design process, we identified several sustainability attributes associated with dairy feeds based on a detailed review of dairy and sustainability literature (Krizsan et al., 2021; Patel et al., 2017; Segerkvist et al., 2020). However, to minimise design complexity, we selected only six attributes based on discussions with animal scientists, seminar participants in an agricultural and food economics research group, and a dairy industry partner in a stakeholder meeting. The selected attributes included GHG emissions and biodiversity (environmental sustainability aspects of feeds), animal welfare and feed self-sufficiency (social sustainability aspects), feed costs and milk yield (economic sustainability aspects).

[1]We define more grass-based feeds as dairy cow feed rations with over 70% forage on average over a lactation period and at least six grazing hours daily during the grazing season. The grazing season is typically from 1 May to 1 October in northern Sweden with at least 60 grazing days; 1 April to 31 October in central Sweden with at least 90 grazing days; and 1 April to 31 October in southern Sweden with at least 120 grazing days according to Swedish animal welfare legislation.

The first attribute, 'GHG emissions', represents the impact on GHG emissions of the proposed dairy feeds compared with a farm's current feed ration. It is expressed as a percentage reduction in the average carbon footprint per kilogram of milk produced by a dairy cow. The second attribute, 'animal welfare', describes the impact on dairy cow welfare of the proposed dairy feeds compared with a farm's current feed. The third attribute, 'feed cost', refers to the impact on feed cost of the proposed dairy feeds compared with a farm's current feed. It is expressed as a percentage reduction in the average feed cost per kilogram of milk.

The fourth attribute, 'biodiversity', describes the impact on diversity of plant and animal species of the proposed dairy feeds compared with a farm's current feed. The fifth attribute, 'feed self-sufficiency', captures the impact on feed self-sufficiency of the proposed dairy feeds compared with a farm's current feed. It is expressed as a percentage increase in the proportion of farm-produced feedstuff for dairy cows. The last attribute, 'milk yield, refers to the impact on milk yields of proposed dairy feeds compared with a farm's current feed. It is expressed as a percentage reduction in the average annual milk production of a dairy cow. The levels of these six attributes are summarised in Table 2.

We used a Bayesian efficient design based on priors from a pilot DCE to minimise the D-error and improve the precision of parameter estimates (Hensher et al., 2015). The design was generated using *Ngene*, resulting in 24 paired choice sets randomly blocked into four blocks of six choice sets. Each choice set had two unlabelled hypothetical options of grass-based feed rations (options A and B) and an opt-out option (option C) (see the sample in Appendix 2). An opt-out option reflecting the current feed ration was included to represent real-world feed choices, where a farmer can choose to keep the current feed ration if it offers greater utility than the proposed options (Hensher et al., 2015). We used a cheap talk script and an opt-out reminder to reduce the hypothetical bias inherent in DCEs.

3.3 | Attitude and identity indicators

Given that latent constructs are difficult to measure directly without errors, we used indicators to measure our latent behavioural constructs. These indicators were guided by both theoretical and empirical applications. Following a well-established scale (Fishbein & Ajzen, 2010), we measured attitudes towards more grass-based feeding systems using four seven-point bipolar items (see Table A1 in the Appendix S1). This scale has been widely applied in the empirical literature (e.g., Sok et al., 2018; van Dijk et al., 2016). Additionally, we adapted the identity measurement scale proposed by Terry et al. (1999) to measure environmental, social and economic identities, as applied in previous studies (Ruepert et al., 2016; Zemo & Termansen, 2022). We used three five-point bipolar measurement items for each of the three identity constructs (see Table A2).

TABLE 2 Attributes and attribute levels.

Attributes	Attribute levels
GHG emissions	0%, 10%, 20% reduction in emission per kilogram of milk
Animal welfare	No improvement, low improvement, high improvement
Feed cost	0%, 10%, 20% reduction in feed cost per kilogram of milk
Biodiversity	No improvement, low improvement, high improvement
Feed self-sufficiency	0%, 10%, 20% increase in feed self-sufficiency per farm
Milk yield	0%, 10%, 20% reduction in milk yield per cow

3.4 | Econometric estimation

Drawing on random utility theory (McFadden, 1974) and identity economics theory (Akerlof & Kranton, 2000, 2005, 2010), we assume that the overall utility from feed choice is derived from the sum of the environmental, social and economic identity utilities associated with feed choice. In this regard, farmers maximise utility in the three dimensions of sustainability and their expected utility is based on the different attributes of the sustainability dimensions (Lancaster, 1966), which they evaluate against their identities. Therefore, the overall utility U_{ijs} that dairy farmer$i$ derives from choosing alternative j in feed ration in choice set s is given by the following standard utility function:

$$U_{ijs} = V_{ijs} + \varepsilon_{ijs} = \text{ASC} + \sum_{k=1}^{K} \beta_{ik} x_{ijks} + \varepsilon_{ijs}, i = 1, \dots, I; j = 1, \dots, J; s = 1, \dots, S. \quad (1)$$

here, V_{ijs} is the observable part of the utility function and ε_{ijs} is the unobservable part, which is assumed to be independent and identically distributed ($i.i.d$). ASC is an alternative-specific constant representing preferences for the status-quo option, which takes a value of one for the status-quo option and zero for the hypothetical feed options. x_{ijks} denotes attribute k in alternative j of choice set s faced by farmer i. β_{ik} is the marginal utility associated with attribute k for farmer i.

We estimated a mixed logit (MXL) model to assess dairy farmers' heterogeneous preferences and tradeoffs between utilities in feed choices by allowing a distribution around the means of the preference parameters in Equation (1) (Hensher et al., 2015). Therefore, β_{ik} becomes $\beta_k + \sigma_{ik}$, where σ_{ik} represents the random variation around the parameter means (see results in Table A3 in the Appendix S1). However, as with standard choice models, this model does not explicitly explain unobserved sources of heterogeneity such as farmer identities and attitudes (Abou-Zeid & Ben-Akiva, 2014).

Theoretically, estimation models that capture individual choices, observable characteristics, and latent socio-psychological factors are more appealing (Abou-Zeid & Ben-Akiva, 2014). However, incorporating latent socio-psychological factors such as attitude and identity, into choice models is not trivial. Although we elicited indicators of farmer identities and attitudes in our survey, directly including these indicators in our choice model raises concerns regarding potential measurement errors and endogeneity bias (Mariel & Arata, 2022). Measurement errors are likely to arise because the indicators are functions of underlying latent constructs and not the constructs themselves. In other words, while we consider the responses to the indicators as manifestations of the underlying farmer identities and attitudes, they are not direct measures of latent variables and could be prone to measurement errors. Similarly, endogeneity may arise because unobserved factors that are correlated with choices may be correlated with responses to the indicators. In this regard, it is arguable that the modelled and random components of utility are correlated (see Vij & Walker, 2016 for an extensive discussion).

Building on the MXL model, we estimated a hybrid latent class choice model that extends the standard choice modelling framework by combining a choice model with a latent variable model (Abou-Zeid & Ben-Akiva, 2014). This model addresses potential measurement errors and endogeneity bias, and allows a better behavioural representation of preference heterogeneity. This informs the growing empirical application of hybrid choice models in recent years (Owusu-Sekyere et al., 2022; Sok et al., 2018; Zemo & Termansen, 2022). The model consists of a latent variable component with measurement and structural functions estimated using a multiple-indicators and multiple-causes (MIMIC) model, and a choice component with utility and latent class membership functions estimated using a latent class model (LCM). The MIMIC model produces scores for the latent variables included in the LCM as explanatory variables. In this manner, the hybrid choice model, which is also known as the integrated choice and latent variable model, avoids the direct inclusion of attitude and identity indicators in the choice model and mitigates associated concerns. Additionally, the parameterisation of latent constructs through the latent variable component of the model prevents the omission of relevant latent variables from the choice model (Abou-Zeid & Ben-Akiva, 2014; Vij & Walker, 2016).

The MIMIC model follows a typical structural equation modelling framework (Diamantopoulos et al., 2008), where the measurement and structural models are estimated simultaneously (see Table 3). The measurement model (confirmatory factor analysis) tests the relationships between our latent variables (attitude and environmental, social and economic identities) and their indicators. The scores of the attitudinal and identity indicators are expressed as the effects of the scores on their corresponding latent constructs.

$$y_{ikl} = \vartheta_{kl}.\, \delta_{ikl} + e_{ikl} \quad i = 1, \ldots, I; k = 1, \ldots, K; l = 1, \ldots, L \tag{2}$$

here, y_{ikl} is the score for dairy farmer i for the kth reflective indicator of the latent variable δ_l. ϑ_{kl} denotes the factor loadings capturing the effect of δ_l on y_{kl}. e_{ikl} denotes the measurement error associated with a given score and is assumed to be $i.i.d$ and uncorrelated across indicators. The structural model tests the effects of farm(er) characteristics on latent attitude and identity constructs.

$$\delta_{il} = \sum_{n=1}^{N} \varphi_{ln} z_{in} + \epsilon_{il} \quad i = 1, \ldots, I; n = 1, \ldots, N; l = 1, \ldots, L \tag{3}$$

here, φ_{ln} is a parameter capturing the effects of the nth farm(er) characteristic z_n on δ_l. The error term ϵ_{il} is assumed to be normally $i.i.d$ and allowed to correlate freely across latent variables. The overall goodness-of-fit of the model was assessed using measures such as chi-square, root-mean-squared error of approximation (RMSEA), comparative fit index (CFI), and standardised root-mean-squared residual (SRMR) (Bagozzi & Yi, 2012).

The LCM assumes that a heterogeneous population of dairy farmers is implicitly sorted into a discrete number of latent classes, and preferences are assumed to be homogeneous within each latent class but heterogeneous across classes (Hensher et al., 2015). Building on Equation (1), the probability of dairy farmer$i$ choosing alternative j in choice set s is conditional on their membership in latent class c. With S choice sets, the probability of the farmer's sequence of feed choices can be expressed in terms of a logistic distribution:

$$P_{ijs} \mid c = \prod_{s=1}^{S} \frac{\exp\left(\boldsymbol{\beta}_c' \boldsymbol{x}_{ijs}\right)}{\sum_{t=1}^{J} \exp\left(\boldsymbol{\beta}_c' \boldsymbol{x}_{its}\right)} \tag{4}$$

where $\boldsymbol{\beta}_c'$ is a vector of class-specific marginal utilities. Given that class membership is probabilistic, we model the probability that farmer i belongs to latent class c using a multinomial logit specification (latent class membership function) as follows:

$$P_{ic} = \frac{\exp\left(\gamma_{0c} + \boldsymbol{\gamma}_{1c}' \boldsymbol{\delta_i} + \boldsymbol{\gamma}_{2c}' \boldsymbol{z_i}\right)}{\sum_{c=1}^{C} \exp\left(\gamma_{0c} + \boldsymbol{\gamma}_{1c}' \boldsymbol{\delta_i} + \boldsymbol{\gamma}_{2c}' \boldsymbol{z_i}\right)} \tag{5}$$

where $\boldsymbol{\delta_i}$ is a vector of the latent variables of dairy farmer i with associated parameters $\boldsymbol{\gamma}_{1c}'$. $\boldsymbol{z_i}$ is a vector of observable farm(er) characteristics of dairy farmer i with associated parameters $\boldsymbol{\gamma}_{2c}'$. γ_{0c} are class-specific constant terms. Based on Equation (5), we estimated different model specifications according to our conceptual framework. First, we estimated a standard LCM without $\boldsymbol{\delta_i}$, assuming away identity and attitude considerations (see Table 4, Model 1). Following our conceptual assumptions that feed choices reflect farmers' underlying identities and that the latter strongly relates to their attitudes, our first hybrid choice model considered the attitude construct as the only element of $\boldsymbol{\delta}_i$ (Table 4, Model 2). To test the conceptual assumptions regarding how differences in farmer identities (and the extent of divergence between ideal and actual efforts in maintaining grass-based feeds) empirically relate to utility from feed choices, environmental, social and economic identities were considered elements of $\boldsymbol{\delta}_i$ without the inclusion of attitude in our second hybrid choice model (Table 4, Model 3).[2] Furthermore, environmental, social and economic identities and attitude constructs were jointly considered elements of $\boldsymbol{\delta}_i$ in our third hybrid choice model to test the assumption that the effects of different identities are partially reflected through farmer attitudes (Table 4, Model 4).[3] Without hybrid LCMs, the potential endogeneity associated with directly incorporating the attitude and identity indicators into Equation (5) is likely to arise due to measurement errors and plausible correlations with the error term, as well as when latent variables are omitted, assuming $\boldsymbol{\gamma}'_{1c} \neq 0$.

The joint (unconditional) probability of farmer i making a sequence of feed choices over C latent classes is the product of (4) and (5), namely the sum of the conditional probabilities over the classes weighted by the probability of belonging to each class.

$$P_i = \sum_{c=1}^{C} \left[\frac{\exp\left(\gamma_{0c} + \boldsymbol{\gamma}'_{1c}\boldsymbol{\delta}_i + \boldsymbol{\gamma}'_{2c}\boldsymbol{z}_i\right)}{\sum_{c=1}^{C} \exp\left(\gamma_{0c} + \boldsymbol{\gamma}'_{1c}\boldsymbol{\delta}_i + \boldsymbol{\gamma}'_{2c}\boldsymbol{z}_i\right)} \right] \left[\prod_{s=1}^{S} \frac{\exp\left(\boldsymbol{\beta}'_c \boldsymbol{x}_{ijs}\right)}{\sum_{t=1}^{J} \exp\left(\boldsymbol{\beta}'_c \boldsymbol{x}_{its}\right)} \right] \tag{6}$$

The log-likelihood for the sample of I dairy farmers is defined as follows:

$$LL = \sum_{i=1}^{I} \ln P_i = \sum_{i=1}^{I} \ln \sum_{c=1}^{C} \left[\frac{\exp\left(\gamma_{0c} + \boldsymbol{\gamma}'_{1c}\boldsymbol{\delta}_i + \boldsymbol{\gamma}'_{2c}\boldsymbol{z}_i\right)}{\sum_{c=1}^{C} \exp\left(\gamma_{0c} + \boldsymbol{\gamma}'_{1c}\boldsymbol{\delta}_i + \boldsymbol{\gamma}'_{2c}\boldsymbol{z}_i\right)} \right] \left[\prod_{s=1}^{S} \frac{\exp\left(\boldsymbol{\beta}'_c \boldsymbol{x}_{ijs}\right)}{\sum_{t=1}^{J} \exp\left(\boldsymbol{\beta}'_c \boldsymbol{x}_{its}\right)} \right] \tag{7}$$

The selection of the optimal number of classes was performed based on the Akaike information criterion (AIC) and Bayesian information criterion (BIC) (Boxall & Adamowicz, 2002). We estimated the tradeoffs dairy farmers make in their feed choices in terms of milk yield per cow (marginal rates of substitution) using the Krinsky-Robb method with 2000 draws (Krinsky & Robb, 1986).

We conducted two robustness checks. First, we tested the sensitivity of our findings assuming class membership probabilities of the dairy farmers are predicted solely by their sequence of feed choices without the inclusion of $\boldsymbol{\delta}_i$ and $\boldsymbol{z}_i$ in Equation (5), as applied in previous studies (Geussens et al., 2019; Oyinbo et al., 2020). The results are presented in Tables A4 and A5. Second, we tested the robustness of our model to possible attribute non-attendance (ANA), a scenario in which farmers do not consider all feed-related sustainability attributes when making their feed choices (Caputo et al., 2018; Lizin et al., 2022). The results are presented in Tables A6 and A7 (see Appendix 3 for methodological details). We estimated all models using Stata 16, except the ANA models, which were estimated using Nlogit 5.

4 | RESULTS AND DISCUSSION

4.1 | MIMIC model results

Table 3 presents the MIMIC model results consisting of estimates of the measurement and structural components of the latent attitude and environmental, social and economic identity

[2]While we laid out our econometric estimation to match our conceptual framework, we note that some elements of the framework can only be indirectly captured in the estimation.

[3]Taking Models 3 and 4 together, we can empirically explore whether identity directly and indirectly (through attitude) explains utility from feed choices, as indicated in our conceptual framework.

TABLE 3 Results of the MIMIC model.

	Attitude	Environmental identity	Social identity	Economic identity
	Coefficient	Coefficient	Coefficient	Coefficient
Measurement component				
Att1	0.795***			
	(0.021)			
Att2	0.893***			
	(0.014)			
Att3	0.882***			
	(0.015)			
Att4	0.889***			
	(0.014)			
Idt_env1		0.893***		
		(0.036)		
Idt_env2		0.626***		
		(0.039)		
Idt_env3		0.599***		
		(0.042)		
Idt_soc1			0.822***	
			(0.032)	
Idt_soc2			0.688***	
			(0.036)	
Idt_soc3			0.740***	
			(0.034)	
Idt_eco1				0.763***
				(0.042)
Idt_eco2				0.647***
				(0.044)
Idt_eco3				0.619***
				(0.044)
Structural component				
Age	−0.051	0.065	0.138	−0.189*
	(0.099)	(0.101)	(0.106)	(0.109)
Gender	−0.067	−0.115**	0.079	0.016
	(0.052)	(0.053)	(0.056)	(0.058)
Education	−0.138**	0.061	0.116**	0.097
	(0.054)	(0.056)	(0.059)	(0.061)
Dairy_experience	−0.009	0.137	0.081	0.048
	(0.100)	(0.102)	(0.108)	(0.111)
Training	0.023	0.119**	−0.057	0.126**
	(0.051)	(0.053)	(0.055)	(0.057)

TABLE 3 (Continued)

	Attitude	Environmental identity	Social identity	Economic identity
	Coefficient	Coefficient	Coefficient	Coefficient
Conventional_system	−0.233***	−0.269***	−0.223***	0.011
	(0.051)	(0.053)	(0.055)	(0.059)
Grazing_area	0.071	0.081	0.048	−0.018
	(0.060)	(0.061)	(0.064)	(0.067)
Dairy_herd_size	−0.138**	−0.046	−0.013	0.176***
	(0061)	(0.063)	(0.066)	(0.068)
Milk_yield	−0.109**	−0.150***	−0.055	0.234***
	(0.053)	(0.054)	(0.057)	(0.058)
Diary_income_share	0.029	−0.036	−0.019	−0.136**
	(0.052)	(0.053)	(0.056)	(0.058)
Explained variance (R^2)	0.11	0.19	0.12	0.19
Disturbance term intercorrelations				
Attitude	1			
Environmental_ identity	0.258***	1		
	(0.058)			
Social_identity	0.250***	0.326***	1	
	(0.053)	(0.042)		
Economic_identity	−0.011	−0.057*	0.078**	1
	(0.046)	(0.034)	(0.031)	
N	375			

Note: ***, **, and * denote significance at the 1%, 5%, and 10% levels, respectively. Standard errors are reported in parentheses.

constructs. We assessed the validity of the latent constructs using average variance extracted (AVE), composite reliability (CR), and squared correlation (SC) among the latent constructs (Hair et al., 2017). The AVE statistics for attitude and environmental, social and economic identities (0.75, 0.52, 0.57, and 0.46, respectively) are above the recommended threshold of 0.5, except for economic identity, which is close to 0.5. The CR statistics (0.92, 0.76, 0.80 and 0.72, respectively) are above the recommended threshold of 0.7. Taken together, the AVE and CR statistics indicate good convergent validity of the latent constructs.[4] The AVEs are above the SCs among the latent constructs, indicating good discriminant validity. Overall, the estimated model exhibits a good fit according to relevant statistics (RMSEA = 0.04, CFI = 0.96, TLI = 0.95, SRMR = 0.04, $\chi^2/\text{df} = 1.59$ with $p = 0.000$).

The estimates of the measurement component indicate that the hypothesised latent attitude and environmental, social and economic identity constructs are positively and significantly correlated with all corresponding indicators, as expected. The structural component estimates indicate that the latent attitudinal construct is negatively and significantly correlated with farmer education, conventional production systems, herd size and milk yield per cow. This implies that respondents with higher educational qualifications and intensive

[4]To examine the reliability of the economic identity construct further, we considered inter-item and item-total correlations (Hair et al., 2017). The inter-item correlations ranged from 0.378 to 0.493, which are above the recommended threshold of 0.3, and the item-total correlations ranged from 0.493 to 0.591. Only one of the indicators was below the threshold of 0.5 for item-total correlation.

dairy farm characteristics (conventional production systems, large herd sizes and high milk yields) were less likely to have positive attitudes towards grass-based feeds. The environmental identity construct is negatively associated with being a male farmer, conventional production systems and milk yield, and positively associated with training. Social identity is positively correlated with farmer education and negatively correlated with conventional production systems. Farmer age and share of dairy income are negatively correlated with the economic identity construct, whereas training, herd size and milk yield are positively correlated with the construct. Overall, a notable pattern is that farmers with more intensive dairy farm characteristics are less likely to have more positive attitudes and stronger pro-environmental and pro-social identities but more likely to have a stronger pro-economic identity. Observable farm(er) characteristics explain the limited variability in each latent construct, which ranges from 11% to 19%. The unexplained variance captured by the disturbance terms is shared between the latent constructs, as indicated by the significant inter-correlations of the disturbance terms. This suggests that farmer attitudes and identities are correlated in explaining their feed choices and the associated tradeoffs, which is in line with our conceptual propositions.

4.2 | Standard and hybrid LCM results

Table 4 presents the results of the standard and hybrid LCMs. Using the relevant information criteria (AIC and BIC) and considering model convergence issues, we selected a two-class model. The parameter estimates were consistent across the models, indicating the robustness of the results. According to the likelihood ratio tests, the hybrid LCMs provided a better fit than the corresponding standard LCM, which informed the choice of the best-fitting hybrid LCM (Model 4) beyond the model's theoretical appeal (Abou-Zeid & Ben-Akiva, 2014). Therefore, we base our discussion on Model 4. The hybrid LCM indicates that the respondent probability of belonging to latent class one (LC1) is 70% on average (30% for latent class two [LC2]). In both classes, the estimates of the utility function highlight that farmers derive significant disutility from feeds associated with milk yield reductions, and in turn, revenue reductions. Additionally, farmers have significant positive preferences for feeds associated with cost reduction, which may enhance the uptake of more grass-based feeds, given that feed costs represent the largest share of variable costs in high-yield dairy farms (Lindberg et al., 2021). In summary, dairy farmers in both classes are sensitive to economic sustainability attributes in their feed choices, reflecting their underlying economic identities.

Although LC1 farmers derive positive and significant utilities from feeds associated with GHG emission reduction, low or high animal welfare improvement, and high biodiversity improvement, which may increase their likelihood of accepting more grass-based feeds, LC2 farmers are indifferent to feeds associated with these attributes. This suggests that only LC1 farmers are sensitive to the environmental and social sustainability impacts of their dairy feeds. Therefore, LC1 farmers appear to have stronger pro-environmental and pro-social identities than LC2 farmers, which agrees with the identity-based utility assumption that farmer choices reflect their underlying identities. On average, LC1 farmers are indifferent to switching from their current feed rations to more grass-based feeds, whereas LC2 farmers derive positive and significant utilities from maintaining their current feeds, as indicated by the ASC estimates. The behavioural responses of the LC2 farmers may also be a consequence of general resistance to change (Dessart et al., 2019).

Beyond identifying the heterogeneous feed choices between LC1 and LC2, it is also important to understand the underlying drivers. To explain the sources of preference heterogeneity between LC1 and LC2, we focus on the estimates of the latent class membership function

TABLE 4 Results of standard and hybrid LCMs.

	Standard LCM		Hybrid LCM					
	Model 1		Model 2		Model 3		Model 4	
	LC 1	LC 2	LC 1	LC 2	LC 1	LC 2	LC 1	LC 2
Class probability	0.76	0.24	0.72	0.28	0.71	0.29	0.70	0.30
Utility function								
ASC	−0.159	2.756***	−0.167	2.126***	−0.180	2.002***	−0.199	1.930***
	(0.154)	(0.689)	(0.163)	(0.480)	(0.166)	(0.448)	(0.170)	(0.388)
GHG emissions reduction	0.027***	0.026	0.028***	0.014	0.028***	0.012	0.028***	0.013
	(0.004)	(0.022)	(0.004)	(0.015)	(0.004)	(0.015)	(0.004)	(0.013)
Animal welfare: low improvement	0.843***	0.195	0.858***	0.235	0.853***	0.260	0.858***	0.259
	(0.098)	(0.410)	(0.104)	(0.330)	(0.104)	(0.296)	(0.107)	(0.277)
Animal welfare: high improvement	0.847***	0.295	0.952***	0.082	0.978***	0.087	1.014***	0.061
	(0.143)	(0.366)	(0.161)	(0.295)	(0.162)	(0.278)	(0.161)	(0.260)
Feed cost reduction	0.037***	0.054***	0.037***	0.050***	0.037***	0.052***	0.037***	0.050***
	(0.004)	(0.019)	(0.004)	(0.016)	(0.004)	(0.015)	(0.004)	(0.014)
Biodiversity: low improvement	−0.357***	−0.025	−0.332***	−0.213	−0.316***	−0.289	−0.306***	−0.338
	(0.088)	(0.388)	(0.094)	(0.323)	(0.094)	(0.286)	(0.094)	(0.267)
Biodiversity: high improvement	0.182	−0.273	0.266*	−0.458	0.299**	−0.541	0.317**	−0.480
	(0.125)	(0.469)	(0.139)	(0.372)	(0.138)	(0.343)	(0.137)	(0.332)
Feed self-sufficiency	0.002	−0.025	0.001	−0.018	0.001	−0.017	0.000	−0.014
	(0.004)	(0.021)	(0.005)	(0.016)	(0.005)	(0.014)	(0.005)	(0.013)
Milk yield reduction	−0.054***	−0.058**	−0.053***	−0.054**	−0.052***	−0.056***	−0.051***	−0.054***
	(0.007)	(0.026)	(0.007)	(0.022)	(0.007)	(0.019)	(0.008)	(0.018)
Class membership function								
_cons	−2.300		−2.019		−3.013		−1.971	
	(5.967)		(6.225)		(6.432)		(6.590)	
Attitude			0.545***				0.460***	
			(0.127)				(0.132)	
Environmental identity					0.436**		0.351	
					(0.215)		(0.222)	
Social identity					0.784***		0.712***	
					(0.251)		(0.265)	
Economic identity					−0.132		−0.147	
					(0.293)		(0.301)	
Age	−0.034		−0.032		−0.041*		−0.038	
	(0.021)		(0.022)		(0.023)		(0.023)	
Gender	−0.108		−0.077		0.340		0.555	
	(0.371)		(0.391)		(0.380)		(0.398)	
Education	0.498		0.729*		−0.259		−0.147	
	(0.370)		(0.386)		(0.393)		(0.413)	
Dairy_experience	0.013		0.009		−0.002		−0.002	
	(0.019)		(0.020)		(0.021)		(0.021)	

(Continues)

TABLE 4 (Continued)

	Standard LCM		Hybrid LCM					
	Model 1		Model 2		Model 3		Model 4	
	LC 1	LC 2	LC 1	LC 2	LC 1	LC 2	LC 1	LC 2
Training	−0.443		−0.651*		−0.614*		−0.679*	
	(0.332)		(0.339)		(0.350)		(0.353)	
Conventional_system	−0.796**		−0.001		−0.001		−0.001	
	(0.365)		(0.002)		(0.002)		(0.002)	
Grazing_area	0.000		−0.613		−0.001		−0.000	
	(0.002)		(0.377)		(0.001)		(0.001)	
Dairy_herd_size	−0.001		−0.000		−0.371		−0.197	
	(0.001)		(0.001)		(0.382)		(0.386)	
Milk_yield	0.591		0.926		1.205		1.332*	
	(0.652)		(0.682)		(0.754)		(0.764)	
Diary_income_share	0.004		0.004		0.005		0.004	
	(0.005)		(0.005)		(0.005)		(0.005)	
N	6750		6750		6750		6750	
Log-likelihood	−1961.487		−1951.852		−1949.702		−1943.393	
AIC	3980.975		3963.704		3963.403		3952.787	
BIC	4178.676		4168.223		4178.676		4177.758	

Note: ***, **, and * denote variables significant at the 1%, 5%, and 10% levels, respectively. The standard errors are reported in parentheses.

(Table 4). Notably, the estimated coefficient of attitude towards more grass-based feeds is positive and statistically significant at the 1% level. This implies that dairy farmers with positive attitudes towards grass-based feeds are more likely to belong to LC1 than LC2. In other words, farmers with more positive attitudes towards grass-based feeds are more likely to be interested in environmental and social identities. The estimated coefficients of identities in Table 4 (Model 3) indicate that farmers with stronger pro-environmental and prosocial identities are more likely to be in LC1. Therefore, beyond the theoretical assumption that feed choices reflect farmers' underlying identities, the results indicate that environmental and social identities are empirically related to farmer preference heterogeneity. However, when accounting for farmer attitudes, the observed effect of environmental identity was attenuated (Table 4, Model 4). This suggests that the effect of environmental identity is largely reflected through farmer attitudes, whereas social identity appears to be only partially reflected through farmer attitudes. Farmer and farm characteristics did not significantly explain the latent class membership or feed choices of farmers, except for milk yield and training, which are marginally statistically significant. The estimated coefficients suggest that dairy farmers whose farms have higher milk yields are more likely to belong to LC1. Surprisingly, farmers who participated in feed-related training are less likely to belong to LC1.

Overall, farmer underlying attitudes, and environmental and social identities explain the observed heterogeneous feed choices more strongly than the observable farm(er) characteristics, which supports the role of behavioural factors in farmer decisions (Schaub et al., 2023; Wuepper et al., 2023). Additionally, the consideration of attitude and identity linkages provides additional insights into how behavioural factors explain heterogeneous feed choices. This aligns with the literature that argues that identity and attitude are correlated in explaining behaviour (e.g., Abu Hatab et al., 2022; Hallajow, 2018; Nash & Wakefield, 2022).

Table 5 presents results on how dairy farmers trade off utilities in their feed choices by latent class. In both classes, dairy farmers are willing to accept some milk yield reduction per cow for an increase in feed costs reduction but the tradeoff is larger on average for LC2. This result and the marginal utility estimates (Table 4) indicating that LC2 cares only about milk yield and feed cost reduction collectively suggest that LC2 farmers are more sensitive to utility from profit in their feed choices than LC1 farmers. While LC1 farmers are willing to trade milk yield per cow for reductions in GHG emissions, low or high improvements in animal welfare, and high improvement in biodiversity, LC2 farmers are not. Notably, LC1 farmers are willing to forgo an average of 19% milk yield per cow for high improvement in animal welfare. This suggests that LC1 farmers attach more value to animal welfare improvement in feed choices, which aligns with recent findings regarding farmer interest in animal welfare-improving practices. For example, Owusu-Sekyere et al. (2022) revealed that a segment of Swedish dairy farmers is willing to pay €142 on average per square metre of alley and waiting area floor space to change hard floors to soft floors for improvement in animal welfare. Similarly, Läpple and Osawe (2023) demonstrated that Irish dairy farmers categorised as prosocial were willing to pay approximately €7 per cow for animal welfare improvement through sexed semen lab establishment. Additionally, LC1 farmers are willing to sacrifice approximately 6% and 0.5% of milk yield per cow for a high improvement in biodiversity and a 1% reduction in GHG emissions, respectively. This indicates LC1 farmers' stronger interest in contributing to Swedish environmental goals regarding net-zero GHG emissions and biodiversity improvement.

Unexpectedly, both classes are unwilling to trade milk yield for an increase in feed self-sufficiency, despite emerging public interest in feed self-sufficiency in Sweden (Krizsan et al., 2021), especially amidst recent disruptions in global grain supply. In summary, while LC2 is more interested in maximising profits, LC1 seeks to balance profit maximisation with environmental and social concerns, which strongly relates to differences in farmer identities. This is consistent with the results of Howley and Ocean (2021), who applied an identity-based utility framework in the UK and found that maintaining both identity considerations and

TABLE 5 Tradeoffs (% milk yield reduction per cow).

	LC 1	LC 2
	Mean	**Mean**
GHG emissions reduction	0.542	NS
	(0.371, 0.778)	
Animal welfare: low improvement	16.779	NS
	(13.245, 22.184)	
Animal welfare: high improvement	19.839	NS
	(11.770, 34.596)	
Feed cost reduction	0.719	0.914
	(0.524, 1.027)	(0.415, 2.578)
Biodiversity: low improvement	−5.989	NS
	(−9.656, −2.379)	
Biodiversity: high improvement	6.209	NS
	(0.739, 15.289)	
Feed self-sufficiency	NS	NS

Note: Tradeoffs were estimated based on the coefficients in Table 4 (Model 4) and 95% confidence intervals are reported in parentheses. Tradeoff values are not reported for insignificant coefficients, as indicated by 'NS'.

financial returns matters to some farmers in their decisions regarding conservation farming practices.

4.3 | Robustness checks

The results of our robustness checks are presented in Tables A4–A7. The utility estimates accounting for respondent sequences of feed choices without the latent class membership covariates in Table A4 are qualitatively similar to the estimates in Table 4. Additionally, the sources of heterogeneous preferences, which were inferred indirectly by comparing the means of attitude and identity indicators and observable farm(er) characteristics between LC1 and LC2 in Table A5, produced similar inferences to those derived from Table 4. However, the class membership probabilities differed slightly. In general, our results are robust to potential biases associated with the misspecification of the class membership function.

The descriptive information on self-reported ANA in Table A6 indicates that approximately 17% of dairy farmers ignored at least one attribute in their sequence of feed choices, which lends credence to the estimation of the ANA-corrected models (Caputo et al., 2018). Table A7 presents the estimates of the hybrid LCM controlling for ANA. The utility and class membership estimates of the conventional ANA model are qualitatively similar to the estimates in Table 4, except for the non-significance of training in the ANA model and marginal changes in latent class membership probabilities. Additionally, the estimates of the validation ANA model support the respondent ANA responses, except for feed self-sufficiency. Overall, our results are robust against potential ANA bias.

5 | CONCLUSIONS AND POLICY IMPLICATIONS

We investigated dairy farmers' preferences for feeding system attributes using more grass-based feeding systems as an example of a more sustainable agricultural practice. The attributes were designed to reflect the utilities from the environmental, social and economic sustainability dimensions of feeding systems. We developed an identity-based utility framework drawing on research by Akerlof and Kranton (2000, 2005, 2010), and applied it using a hybrid LCM and data from a sample of Swedish dairy farmers.

Our findings demonstrate that in addition to economic sustainability attributes, many dairy farmers consider environmental and social sustainability attributes in their feed choices, suggesting that their decisions are not solely driven by pecuniary motives. This is consistent with the findings of recent studies on the pecuniary and non-pecuniary drivers of farmer adoption decisions (Cullen et al., 2020; Dessart et al., 2019; Owusu-Sekyere et al., 2022). Furthermore, our findings reveal substantial heterogeneity in feed choices. Notably, we identified two distinct clusters of dairy farmers with different feed choice patterns that are related to differences in their underlying identities. The first cluster (*strong proponents of sustainability-enhancing feed rations*) is utility maximising in the three dimensions of sustainability associated with dairy feeds, whereas the second cluster (*weak proponents of sustainability-enhancing feed rations*) is mainly utility maximising in the economic dimension. Our findings demonstrate that dairy farmers are willing to trade some milk yield per cow for sustainability utilities other than feed self-sufficiency; however, the tradeoffs differ between clusters. In a broader ecosystem service valuation of grass resources, where tradeoffs exist between marketable and non-marketable ecosystem services, as reported by Huber et al. (2022), the tradeoffs we identified suggest that some farmers are willing to bear certain costs (i.e., forgo some milk yield) to achieve a favourable balance of food production with environmental and social sustainability considerations.

Our findings reveal that dairy farmers' underlying environmental and social identities and attitudes are the main drivers of observed heterogeneous feed choices and trade-offs, and that observable farm(er) characteristics play a limited role. This indicates that overly focusing on farm(er) characteristics in explaining preferences while excluding behavioural factors would produce limited insights for policies. Furthermore, our findings demonstrate that the effects of farmers' identities on feed choices are partly reflected through their attitudes. This suggests that future research interested in modelling farmers' adoption decisions should consider the role of behavioural factors beyond observable characteristics and the links between factors to capture the complexities of farmer decision-making.

We provide important policy implications. First, our findings imply that environmental and social identity-enhancing interventions are potential low-cost complementary policy instruments to financial incentives in encouraging the uptake of sustainability-enhancing feeds. Reflecting on these mechanisms, we draw on the social psychology literature that posits that values are adjustable to changes in the social environment of decision-makers (Parks & Guay, 2009; Sagiv & Schwartz, 2022) and play a crucial role in shaping identity (Bouman et al., 2021; Ruepert et al., 2016). Therefore, it seems reasonable to target value changes in farmers through behavioural interventions that can potentially strengthen their pro-environmental and prosocial identities. Second, the design of future feed-related policies should consider differential strategies for those who are strong versus weak proponents of sustainability-enhancing feed rations as a way of accounting for how farmers balance utilities in feed choices. For example, it may be more cost effective to target higher (lower) feed-related incentives for farmers who are less (more) likely to apply grass-based feeding systems without such incentives. Although this is sensible and can prevent crowding out the intrinsic motivation for the uptake of grass-based feeding systems, it could also raise equity concerns if farmers are treated unequally, especially in relation to financial instruments within the EU's CAP. Therefore, it is reasonable to leverage identity-enhancing interventions in the context of differential feed policies. This topic is open to further research on how different farmer segments can be better targeted using variants of identity-related interventions. Third, given the pronounced sensitivity of farmers to milk yield losses, policy programmes specifically tailored to more grass-based dairy feeding, as applied in Switzerland, where dairy farmers receive compensation for applying feed rations containing 70% to 85% grass (Bystricky et al., 2023), could be relevant in Sweden and similar settings. However, this would require a rigorous *ex-ante* evaluation to inform the design of such programmes.

Finally, our findings provide policy-relevant insights into how dairy farmers' interests (mis) align with national goals related to net-zero GHG emissions and biodiversity conservation, and regional goals related to the EU's bioeconomy and farm-to-fork strategies. This sheds light on specific feed-related sustainability aspects that farmers appear indifferent to (e.g., feed self-sufficiency), which may require urgent policy interventions to spur dairy farmers' interests in contributing to sustainability goals through their feed choices.

FUNDING INFORMATION

This study was supported by Mistra (The Swedish Foundation for Strategic Environmental Research) (grant number DIA 2018/24 #8).

CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Oyinbo, O. & Hansson, H. (2024) Understanding dairy farmers' trade-offs between environmental, social and economic sustainability attributes in feeding systems: The role of farmers' identities. *Journal of Agricultural Economics*, 75, 869–888. Available from: https://doi.org/10.1111/1477-9552.12588