

RESEARCH ARTICLE

Is ignorance bliss? Milk from gene-edited cows and animal welfare considerations

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Abstract

Dairy cows who excel at milk production also grow horns, which are dangerous to other animals and their human handlers. Recent developments in gene editing make it possible to edit a cow's genome so that it does not grow horns. We assess from the consumer's perspective whether the improvements in animal welfare resulting from gene-edited cows outweigh the perceived risks individuals associate with milk from these animals. We find that milk from gene-edited cows and milk from dehorned cows have lower willingness to pay relative to milk that comes from cows without mention of dehorning or gene editing.

Keywords: Clustered regularly interspaced palindromic repeats; milk; animal welfare

Introduction

Dairy cows have been bred for generations to optimize their milk production. It so happens that the cows who excel at milk production also grow horns. In their evolutionary past, horns were advantageous against predators. However, in modern dairy farms, horns are dangerous to other animals and their human handlers (Thompson et al., 2017). Thus, producers use disbudding procedures on calves, which involve labor costs and are painful to the animals as their wounds heal. Scientists have identified the gene that causes horns to grow in dairy cows (Canada, Beef Cattle Research Council, 2023, Thompson et al., 2017). Recent advancements in clustered regularly interspaced palindromic repeats (CRISPR)-Cas9 gene editing¹ allow for the modification of a cow's genome to eliminate horn growth, offering benefits such as reduced animal suffering and lower labor costs (Panko, 2016). Despite these benefits and assurances from scientists, governments, and industry regarding their safety, consumers remain skeptical of new food technologies, such as gene editing (Qaim, 2020; Alston and Pardey, 2021). Therefore, the use of gene editing in dairy cows presents a tradeoff for consumers, weighing the benefits of enhanced animal welfare against the perceived risks associated with consuming milk from gene-edited cows.

¹Gene editing is also called genome editing. There are several forms of gene editing, and the form of gene editing in this study is CRISPR-Cas9.

Previous research consistently demonstrates that consumers are willing to pay price premiums for foods produced enhancing animal welfare. To this point, information on production practices involving the pain that animals might endure, is likely to cause discomfort among consumers. There is limited research on consumers' preferences for avoiding information that could cause discomfort. Given individual's tendency to avoid information that triggers sadness, fear, cognitive dissonance, or uncertainty; one questions whether consumers avoid information concerning productions methods linked to animal welfare.

An objective of this study is to understand how the improvements in animal welfare associated with gene-edited cows are related to consumers' willingness to pay (WTP) for from such animals. Therefore, in this study, when presenting results, any mention of gene-edited hornless cows is specifically related to pain prevention. We employ a discrete choice format to estimate the WTP for a gallon of milk exhibiting three different labels: milk from dehorned cows, milk from gene-edited cows to prevent painful dehorning, and milk without any indication of dehorning or gene editing.

The study includes three information treatments and a control group. The treatments differ in format and content and include excerpts from a *Washington Post* article with a questioning tone, social media posts in X (formerly Twitter), and a 4-minute video on gene editing created by scientists. The aim is to improve the understanding of consumer decision-making by presenting both positive and negative viewpoints on gene editing. Importantly, the excerpts used are authentic, reflecting the genuine tone of gene-editing information from each communication channel.

This study offers insights for the dairy industry and policymakers. By gaining a better understanding of consumers' attitudes and preferences toward gene-edited animals, the industry can make more informed decisions about investing in these technologies. Additionally, these findings can inform regulatory decisions governing gene-edited animals and the products derived from them. It is worth noting that the widespread commercial implementation of gene editing to produce hornless dairy cows has not yet been achieved. As of July 2023, the U.S. Food and Drug Administration has approved the intentional genomic alterations in animals on five instances²; however, gene editing for the hornless dairy cows was not among the approved applications (U.S. Food and Drug Administration, 2023).

As a preview of our findings, we estimate that labeling the characteristic of how cows became hornless (i.e., by dehorning or by gene editing) generally decreases consumers' willingness-to-pay (WTP) for milk. Both milk from gene-edited cows and milk from dehorned cows have lower WTP relative to milk that comes from cows without mention of dehorning or gene editing. The information treatments have differential effects on choices.

Literature review

Gene editing is a breeding technology that consists of identifying specific locations in the DNA sequence and breaks it at specific sites. There are different approaches for gene editing. CRISPR-Cas9 (hereafter CRISPR) is the most popular gene-editing approach due to its ease of use and efficiency (Doudna and Charpentier, 2014). CRISPR applications have the potential to make livestock production more efficient and environmentally sustainable. Besides the potential to improve animal welfare by avoiding horn removal in

²These instances include: AquAdvantage® Salmon, pPL657 rDNA Construct in domestic pigs, Bc2371 rDNA Construct in R69 New Zealand white rabbits, hLAL rDNA Construct in SBC LAL-C chickens, and Bc6 rDNA Construct in GTC 155-92 goats.

calves, CRISPR has been used to enhance animals' resistance to diseases (e.g., pigs that are resistant to porcine respiratory and reproductive syndrome virus), improved animal products quality (e.g., Superfine Merino lambs that produce the highest quality of wool) (Menchaca *et al.*, 2020). CRISPR applications also include treating genetic disorders in animals, expediting livestock breeding, and controlling disease-carrying insects (Barrangou and Doudna, 2016).

Genetic modification and CRISPR offer proven benefits, and there is scientific consensus that the risks from genetically engineered crops and animals to human health, society, and the environment are not greater than the use of conventional breeding. Despite this, consumers remain predominantly skeptical towards these technologies (Qaim, 2020). There is a large body of literature indicating that consumers, in general, are willing to pay to avoid genetically engineered foods (Dannenberg, 2009; Lusk *et al.*, 2014; Dolgoplova and Roosen, 2018; Huffman and McCluskey, 2021). Regarding gene editing, studies on consumers' WTP show that individuals, on average, discount gene-edited foods compared to conventionally bred ones (Shew *et al.*, 2018; Muringai *et al.*, 2020; Yang and Hobbs, 2020; Marette *et al.*, 2021; Kilders and Caputo, 2021; Uddin *et al.*, 2022; Ma *et al.*, 2024). However, when comparing this discount to that of genetically engineered foods, the discount for gene-edited tends to be smaller, albeit with some exceptions (Hu *et al.*, 2022). Consumers' aversion towards any form of genetic engineering, including gene editing, in agri-food production may result in society missing out on the benefits of agri-food research, thereby jeopardizing the ability to sustainably meet the needs of the global population (Lusk *et al.*, 2014; Qaim, 2020; Alston and Pardey, 2021).

Information plays a role in how the public perceives genetic engineering technologies. Rapid scientific progress can lead to confusion among the public regarding scientific terminology and the reconciliation of the scientific theories with prior knowledge and beliefs. This confusion can lead to misconceptions and misunderstandings (Hansen *et al.*, 2003; Krystallis *et al.*, 2012; Bearth and Siegrist, 2016; Siegrist *et al.*, 2016; Lusk *et al.*, 2018; Yang and Hobbs, 2020).

The format and framing of the information transfer and the trust in the information source have an impact on consumers' perceptions and acceptance. Regarding the format and framing of information delivery, narratives stemming from factual and unbiased scientific knowledge have the potential to promote public comprehension and engagement (Yang and Hobbs, 2020). On trusted sources of information, U.S. consumers consider health professionals, university scientists, consumer organizations, industry scientists, the regulator, and the media as trusted sources (Lang and Hallman 2005; Wunderlich and Gatto, 2015).

Traditional news media coverage affects consumer perceptions of new agri-food technologies and demand for such products (McCluskey *et al.*, 2016). Evidence shows that social media also plays a role in food perceptions and choices. However, the dissemination of information, particularly related to breeding technologies, across traditional media and social platforms, often contradicts the scientific consensus (Yang and Hobbs, 2020).

The literature suggests that social media influences vary according to the social media outlet (i.e., Twitter, now called X, versus Facebook) and the extent of public engagement. Using X interactions between experts and their followers on gene editing, Navelski *et al.* (2025) find that followers opposed to gene editing have substantially more influence than those favoring it. Also, using X data, Tabei *et al.* (2020) compare U.S. and Japanese consumers' reactions to gene-edited food and found that the Japanese show an overall negative sentiment compared to Americans.

This study examines consumer reactions to animal welfare and their aversion to animal mistreatment. Previous literature suggests that individuals tend to avoid information they anticipate will cause discomfort. This information avoidance is also called strategic or willful ignorance (Nordström et al., 2020). For example, there is evidence that consumers tend to avoid health-related information in foods, such as calorie content (Thunström et al., 2016; Nordström et al., 2020). Another example is avoiding information about agricultural production practices that may be harmful to the environment or unpleasant. Li et al. (2018) find that their consumer subjects were willing to pay the most for wine without information on whether it was made with grapes irrigated with recycled water. Bell et al. (2017) report that avoidance of guilt triggered that about one-third of survey participants admitted being willfully ignorant regarding pork production methods. Reisch et al. (2021) find that approximately 50% of the survey participants expressed interest in receiving information about foods containing genetically modified organisms and animal welfare concerns related to meat production.

Previous research indicates that consumers are willing to pay more for food products linked to higher standards of animal welfare. Studies by Norwood and Lusk (2011) and Lagerkvist and Hess (2011) find that consumers are willing to pay price premiums for meat or eggs from animals not housed in cages or confined spaces. However, these results are heterogeneous across different population segments, with WTP increasing with income and decreasing with age (Norwood and Lusk, 2011; Lagerkvist and Hess, 2011).

The extent of the dehorning issue is significant from a cost perspective. In 2009, 94% of U.S. dairy cattle producers dehorned cattle routinely (U.S. Department of Agriculture, 2009). Costs for traditional dehorning methods range from \$6 to \$25 per head (Thompson et al., 2017), but dehorned cattle often sell at a premium (Morris, 2022). Research shows no difference in milk yield or composition between cows with horns and dehorned cows (Baars et al., 2019). Dehorning reduces injury risk, aggressive behavior, and improves handler safety, while also optimizing feeding space (Thompson et al., 2017). However, dehorning done after horns are attached to the skull can cause pain, stress, bleeding, fly infestation, and infections. Pain relief methods like anesthetics and analgesics are commonly used (Canada, Beef Cattle Research Council, 2023).

Kilders and Caputo (2021) provide the first analysis of consumers' valuation of milk from gene-edited cows with consideration of the animal welfare benefits. They find that their participants require a discount for milk from gene-edited cows relative to dehorned cows and cows with horns. Their results include that information on animal welfare has the strongest effect on WTP for milk from gene-edited cows. Our study differs from Kilders and Caputo's (2021) by presenting the option of milk from cows where there is no information about whether the cow has been dehorned or the dehorning method.

The primary contribution of this paper lies in whether consumers choose to avoid products that provide information regarding the gene editing and agri-food production methods. Specifically, we consider whether the WTP is the greatest for milk from "unspecified" cows, when no information is provided on dehorning or gene editing. Consumers might feel guilt or judged if they knowingly consume a food that inflicts suffering on animals. Thus, our *ex ante* hypothesis was that many consumers would prefer not to know. The policy implication is that if people are willing to pay for no-information, then policies mandating labeling production methods might not enhance consumer welfare.

Experimental design and data collection

The present study utilized an online survey platform, Qualtrics, to recruit a representative sample of U.S. consumers with the purpose of understanding their preferences for milk from gene-edited cows^{3,4}. The survey screened for individuals older than 18 years old, who are responsible at least for 50% of the grocery shopping in the household, and who have purchased or consumed milk in the past 6 months. A between-subjects design was used with four separate versions of the survey based on information treatments, which are discussed below. Between the four versions, 487, 501, 508, and 520 completed surveys were collected, respectively, for a total of 2,016. The survey was administered in February and March of 2023.

The survey included a set of discrete choice experiment questions to analyze consumers' preference for milk from gene-edited cows. In each choice scenario, respondents were presented with a hypothetical situation in which they were asked to choose to buy from two milk choices or a no-buy option. For each choice scenario, they were presented with a random combination of milk from cows (either traditional dehorned cows, cows that were gene edited to prevent painful dehorning, or unspecified), milk fat (whole and reduced 2%⁵), and the price. We opted to include the fat content of milk because previous literature eliciting WTP for milk from cows undergoing alternative technologies include this attribute (Brooks and Lusk, 2010). The range of prices was chosen based on current market prices for milk. Price levels were \$3.29, \$4.29, \$4.59, and \$4.89 per gallon. Table 1 lists the attributes and attribute levels used, and Figure 1 presents an example of the choice scenario. The participants were also asked about their milk preferences, media habits, attitudes towards animal welfare, knowledge of and policy preferences for gene editing, and sociodemographic questions. To be comparable, the animal welfare questions follow Kilders and Caputo (2021).




Each scenario's random combination of attributes originates from an efficient factorial design. The SAS[®] macro function %MktEx was used to find all possible combinations of attribute levels. This macro uses an optimization algorithm in an iterative process to optimize the D-efficiency. A larger D-efficiency implies smaller standard errors of the parameter estimates. A perfect design is orthogonal (all parameter estimates are uncorrelated), balanced (all the levels within each attribute occur with the same frequency), and has 100% D-efficiency. After all possible combinations were created (3×2×4), the %ChoiceEff macro was used to find the most efficient design for the choice experiment. In an efficient design, the variances of the parameter estimates are minimized, given assumed values for them. Since this study uses no priors, these values were set to zero (SAS Support, 2023). The study's design produced a total of 24 final choice sets, organized

³Under our contract with Qualtrics, the deliverable is a pre-agreed upon number of completed surveys. The details regarding individuals initially contacted but who did not complete the survey are not included in the deliverable. As such, we do not calculate a traditional response rate based on initial contacts. Qualtrics as per contractual agreement guarantees streamliners and bots are eliminated. Plus, we include screening questions at the beginning of the questionnaire and two attention checks to guarantee the control of unwanted survey takers/behavior. The number of individuals in the Qualtrics consumer research panel is large enough that we requested Qualtrics survey quotas based on income, age, and geographical distribution to be as close as possible to the U.S. population as reported by the U.S. Census Bureau in 2022.

⁴The survey questions are provided in the online materials.

⁵U.S. whole milk consumption has declined in recent years to a level that is comparable to reduced fat milk, and 1% and skim milk lag far behind. Further, we acknowledge that some consumers only buy milk with one level of fat content (Wolf *et al* 2020).

Table 1. Attributes and attribute levels used in the experimental design of the discrete choice experiment

Attribute	Attribute level
Milk fat content	Whole
	Reduced 2%
Dehorning information	Unspecified, i.e., no indication of dehorning
	
	From dehorned cows
	
	Gene edited cows to prevent painful dehorning
	
Price (\$/gallon)	\$3.29, \$4.29, \$4.59 and \$4.89

into three blocks, with a D-efficiency of 17.76. Each block comprised eight discrete choice scenarios, which were randomly assigned to respondents.

To mitigate hypothetical bias, this study used two methods. One is “cheap talk,” following Champ et al. (2009). The following script was used: “Please keep in mind that studies have shown that answering a question about a hypothetical purchase decision, as if the purchase is for real, is difficult for many people. Usually, survey respondents are more likely to state that they would buy a product when responding to a survey than when the purchase decision is real, and they have to pay for the product. This happens because respondents might think, ‘Sure, I will buy this product’, but when the decision actually involves digging into their pockets to pay for it, respondents might think instead, ‘Do I really want to spend my money on this product?’ We ask you try to avoid this situation and answer the following questions as you would if were really shopping at the store and paying for a gallon of milk.”

The second method involved employing a certainty scale, which respondents completed after each discrete choice scenario question. This consist of using a certainty

PLEASE KEEP IN MIND THAT

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We ask that you try to avoid this situation and answer the following questions as you would if were really shopping at the store and had to pay for a gallon of milk.

- ☐ I have carefully read the information provided and would like to proceed with the survey.

How much do you know about CRISPR-Cas9 (CRISPR) gene editing and its applications in food production?

- ☐ I am very knowledgeable about gene editing.
- ☐ I know some.
- ☐ I don't know much.
- ☐ I completely ignore what gene editing is.

If you were going to buy a gallon of milk, choose only THE ONE option (either A or B) that you WOULD REALLY BUY. Otherwise, please select Option C to indicate you would not buy option A or B.



	Option A	Option B	Option C							
			Neither							
	Price \$4.29 Milkfat whole	Price \$3.99 Milkfat 2%								
I WOULD CHOOSE	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>							
On a scale of 0 to 10, where 0 = Very Uncertain and 10 = Very Certain, how certain are you of your answer above?										
0	1	2	3	4	5	6	7	8	9	10
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 1. Example of choice experiment.

index that ranged from zero (very uncertain) to ten (extremely certain), where respondents report how certain they are about the choice made in the discrete choice experiment (see Figure 1). In this study, a rank of seven or above is considered as certain. Several studies report that the use of a follow-up certainty scale can be effective at mitigating the difference between actual and hypothetical WTP (Champ *et al.*, 2009; Morrison and Brown, 2009; Hensher *et al.*, 2012; Beck *et al.*, 2013; Rose *et al.*, 2015; Beck *et al.*, 2016).

The survey included other questions related to media habits, preferences for milk characteristics, attitudes towards animal welfare, perceptions of breeding technologies and policies, and sociodemographic information. Additionally, two attention checks we incorporated to ensure respondent engagement and enhance data quality.

Information treatments

Our information treatments aim to understand how different information sources and content influence consumers' choices of milk from gene-edited cows. These treatments

include: (1) no additional information, (2) information from a newspaper article, (3) information from social media, and (4) information from a video made by scientists for a public audience.

As outlined in the introduction section, this study employs authentic excerpts from media and social media to accurately reflect the authentic tone of gene-editing information disseminated across various channels. We acknowledge that this approach does not allow us to control other factors influencing consumer perceptions. These factors encompass, but are not limited to, the authors' names, affiliations (including universities and scientific institutions, including animal scientists), retweet counts, hashtags, mentions/likes, illustrations within the tweet, and the elements included in the video, such as audio, duration, and visual aids. The printed information treatments are included in Appendix B, along with a link to the science video. Respondents were randomly assigned to each treatment group.

Traditional news media coverage affects consumer perceptions of food made with new technology and demand for products. Newspapers often emphasize perceived risks in their coverage of new technology in food (McCluskey et al., 2016). The *Washington Post* article examines how an actual newspaper article affects consumers' choices. The excerpts delve into consumer skepticism and regulatory issues. Using actual news coverage provides insights into consumer responses but considering results with and without consumer skepticism is also valuable.

We are also interested in how social media affects consumer choices. Consumers can follow social media influencers, leading to customized information flows. This may result in less diverse newsfeeds compared to traditional media, as consumers often follow like-minded people and companies. Navelski et al. (2025) found that anti-gene-editing experts had greater influence on Twitter/X than pro-gene editing influencers. Our Twitter/X information treatment includes four actual posts from a graduate student, a professor, a U.S. government employee, and the Alliance for Science.

The science video presents information from a scientist's perspective and is more positive towards gene editing. Further, this video discusses why dehorning is needed, the dehorning processes, and implications for animal welfare. It explains how gene editing can be used in place of traditional dehorning methods. Several other studies, including Kilders and Caputo (2021), use videos to communicate scientific information in an easier-to-digest format. Previous studies have shown that consumers trust from scientists more than the media for information about new technology in food (Huffman et al., 2004). The respondents in this information treatment were not allowed to progress in the survey until after the entire 4-minute and 15-second video was played.

Econometric specification

We estimate survey participants' preferences and WTP for milk attributes including the dehorning method the cows had experienced, by using a generalized multinomial logit model (Fiebig et al., 2010). This model is rooted in the Lancaster's consumer demand theory (Lancaster, 1966), and the random utility theory (McFadden, 1974). This theory assumes consumer's utility is composed of a deterministic component given by the goods attributes and a random component, given by unobserved factors (McFadden, 1974). This utility can be specified as

$$U_{nij} = \alpha_i + \beta_n x_{nij} + \varepsilon_{nij} \quad (1)$$

where U_{nij} is the utility derived by respondent n when choosing alternative i , in scenario j , α_i is the alternative specific constant (ASC) denoting the opt-out option; x_{nij} denotes both

the price attribute and the milk attributes: reduced vs. whole milk fat content, dehorned label, gene-edited to prevent painful dehorning, and no information about dehorning; β_n is a vector of coefficients randomly distributed across respondents and assumed to follow a multivariate normal distribution with density $f(\beta_n|\theta)$, where θ is the true parameter vector of the distribution; and ε_{nij} is an unobserved error term that is assumed to be identically and independently distributed (Train, 2009).

This study estimates the WTP space by applying the Generalized Multinomial Logit Model (G-MNL) specification.⁶ The GMNL model incorporates consumers' preference heterogeneity as follows

$$U_{nij} = [\sigma_n\beta + \gamma\eta_n + (1 - \gamma)\sigma_n\eta_n]x_{nij} + \varepsilon_{nij}$$

$$\beta_n = \sigma_n\beta + [\gamma + (1 - \gamma)\sigma_n]\eta_n \quad (2)$$

where σ_n is the individual-specific scale of the idiosyncratic error term that represents the scale heterogeneity, which follows a log-normal distribution with mean $\bar{\sigma}$ and standard deviation τ . η_n is the vector of individual specific taste that represents the individual's residual preference heterogeneity, γ is a parameter between 0 and 1 that controls how the variance of residual taste heterogeneity η_n varies with the scale heterogeneity σ_n . This study uses the GMNL Type II (GMNL-II) where γ equals zero⁷.

Next, expression (2) can be rewritten, as follows,

$$U_{nij} = ASC_{ni} + \sigma_n \left(-p_{nij} + \beta_{RS,n} Reduced\ Fat_{nij} + \beta_{U,n} Dehorned_{nij} + \beta_{GE,n} Gene\ Edited_{nij} + L\eta_n \right) + \varepsilon_{nij}, \quad (3)$$

where U_{nij} is the utility respondent n derives from choosing alternative i among j alternatives, ASC_{ni} is the coefficient estimate for the alternative specific constant, p_{nij} is a continuous variable denoting price that was normalized to -1. By normalizing the coefficient of price to -1, one can interpret the coefficients of other non-price attributes as the WTP estimates. *Reduced Fat_{nij}* is an indicator variable if the milk has 2% fat content, *Dehorned_{nij}* indicates that the milk was identified as coming from cows who were dehorned using traditional (i.e., not gene edited) methods, *Gene Edited_{nij}* indicates that the milk was identified as being from cows who were "gene edited to prevent painful dehorning," ASC_{ni} is the is the ASC, σ_n is the scale heterogeneity, η_n is the residual taste heterogeneity that follows a standard normal distribution and L is the lower triangular matrix of the Cholesky decomposition (Luckstead et al., 2022). All models were estimated using the "gmnl" package in R 4.0.5 (Sarrias and Daziano, 2017).

To mitigate potential hypothetical bias, this study uses the certainty scale (Champ et al., 2009; Morrison and Brown, 2009; Hensher et al., 2012; Beck et al., 2013; Rose et al., 2015,

⁶The mixed logit econometric specification is used to estimate the WTP in preference space. In this specification, the WTP is estimated by dividing the coefficient estimates for each attribute by the price coefficient estimate. Often, prices are assumed to be nonrandom, implying homogeneous consumers' preferences for the price attribute. Given this restrictive assumption, practitioners assume prices are normally or log-normally distributed, however, the ratio of two probability distributions leads to ambiguous results. Therefore, this study applies the WTP space estimation by using the Generalized Multinomial Logit Model (G-MNL) proposed by Fiebig et al. (2010). We performed the mixed logit model in WTP space and found GMNL fit better the data according to measures of goodness of fit.

⁷The GMNL model is classified based on the values the parameter γ takes. If $\gamma = 1$, the standard deviation of the residual taste heterogeneity is independent of the scale, and we get the GMNL Type I or GMNL-I. If $\gamma = 0$, we get the GMNL Type II or GMNL-II, where the standard deviation of the residual taste heterogeneity is proportional to the scale. We estimated both specifications and opted for presenting the results from the GMNL-II model given the superior goodness-of-fit statistics based on the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and log likelihood function values.

Beck et al., 2016). The certainty scale is introduced in the model in the scale heterogeneity parameter, following the procedure in Kunwar et al. (2020),

$$\sigma_n = \exp(\delta \text{certain}_n + \tau v_n), \quad (4)$$

where δ is the parameter of the observed heterogeneity in the scale term, τ is the coefficient on the unobserved scale heterogeneity, $v_n \sim N(0, 1)$, and certain_n is an indicator variable equal to 1 if the respondent n 's certainty scale is greater or equal to 7 and 0 otherwise. Although the literature offers no conclusive information on the most adequate cutoff point (Hensher et al., 2012), we base our choice of 7 on Champ et al. (2009).

Latent class model

A latent class model was used to identify segments of respondents within our sample, which showed different attitudes towards traditional dehorning and dehorning using CRISPR. The model postulates that respondents can be sorted into a number of latent or unobservable segments based on their responses to questions in the survey. Specifically, questions⁸ about media habits, trusted sources of information on how the food is produced, including mass media and social media, respondents' agreement with statements regarding animal welfare and CRISPR policy, and sociodemographic information. The responses to these questions are the membership function variables. The model assumes that the preferences across these segments are heterogeneous and that preferences within a segment are homogeneous. The probability that respondent n chooses alternative i , given that they are a member of latent class c is:

$$Pr(nij|c) = \frac{\prod_{j=1}^J e^{\theta_c x_{nij}}}{\sum_{i=1}^I e^{\theta_c x_{nij}}} \quad (5)$$

where x_{nij} is the vector of observed attributes associated with alternative i , θ_c is the estimated vector of segment-specific utility parameters, which captures preference heterogeneity among segments, and j indicates the set of choice scenarios available to respondent n . A fractional multinomial logit model is used to estimate the probability that respondent n belongs to group c :

$$Pr(c) = \frac{e^{\theta_c m_n}}{1 + \sum_{c=1}^{C-1} e^{\theta_c m_n}} \quad (6)$$

where m_n is the set of observable individual characteristics that affects the group membership vector θ_c , (the c^{th} parameter vector is normalized to zero to ensure identification of the model). The model estimates the probability of a specific choice for individual n as the expected value, over groups, of the group-specific probabilities. In our choice experiment, each respondent was asked to make choices for eight different scenarios. The observation of repeated choices by the respondents facilitates the examination of how levels of various attributes affect individual utility and the comparison

⁸To select the variables to be included as class membership variables, we retrieved the individual WTP for the attributes dehorning using gene editing, dehorning with no information, and reduced fat, and regressed them using OLS with all the variables coming from all questions in the survey. The variables mentioned in the text (media habits, trusted sources of information on how the food is produced, including mass media and social media, respondents' agreement with statements regarding animal welfare and CRISPR policy, and sociodemographic information) were the ones that resulted statistically significant. The preferences for milk characteristics were not included because they were not statistically significant.

of choice responses across different classes or groups of respondents (Greene and Hensher, 2003).

We follow the criteria explained in Nylund-Gibson and Choi (2018) to identify the optimal number of segments or classes. These authors explain that goodness-of-fit measures should not be used alone. Other criteria including balanced distribution of respondents across segments, interpretability of results, and marginal benefits of adding an additional segments or classes. In this study, the goodness-of-fit measures favor the inclusion of four classes (see Table A1 in Appendix A). However, the number of respondents when using four classes is not balanced distributed (class 1 represents 26% of all respondents, class 2 represents 41%, class 3 represents 29% and class 4 represents 4%) and its interpretation is not straightforward. Therefore, we opted for the model with three classes.

Results and discussion

Discussion of survey responses

We present summary statistics about our respondents in Table 2. About 63% of our survey respondents are female. The overrepresentation of women compared to the U.S. Census (50.9%) is desirable because women are overrepresented in the role of primary shopper of their households (Statista, 2024). For education, our sample underrepresents individuals with less school (some school and high school graduate) and overrepresents individuals with more years in school (some college or Associate degree, Bachelor's degree, and Advanced or Professional degree) (U.S. Census, 2022). Also, compared to the U.S. Census (2023), our sample of respondents overrepresents the urban areas and underrepresents the rural and suburban areas. In terms of age, our sample overrepresents the ages from 25 to 54, and underrepresents other age categories. The distribution of income in the sample is comparable to the U.S. Census (2022). On top, the mean U.S. household income in 2021 was \$69,021 (U.S. Census, 2022), which is contained in the median income category of the respondents. Compared to the U.S. Census, our sample overrepresents white ethnicity, households of four or more people, with children under 18, and who own pets (U.S. Census 2022, Forbes, 2023). We observe no major differences in sociodemographic characteristics among the sub-samples of respondents receiving each information treatments.

Appendix C provides summarized statistics on survey responses, focusing on questions pertinent to the latent class model. Regarding social media use, a minority (6.05%) report abstaining from any platform, with Facebook being the most utilized (51.12%), followed by Instagram (16.91%) and TikTok (10.81%), X has a lower percentage of users, with 7.68% of respondents reporting using it. Trust in information sources reveals friends/family and individual farmers as most trusted, while social media platforms garner lower trust, with YouTube ranking highest (3.02) and TikTok lowest (2.42).

In relation to attitudes towards animal welfare, respondents show consensus in that the food they eat is produced in a way that respects animal rights and does not cause pain to animals. There is also a high level of agreement that increased regulation of the treatment of animals in farming is needed, and that animal agriculture raises serious ethical questions. Respondents are concerned about the potential impact of stress on the quality of meat, milk, eggs, and sub-products. However, there is less agreement about the use of gene editing to reduce the risk of injury or disease in farm animals, with some respondents indicating that it should be forbidden even if it could improve animal welfare. Overall, the

Table 2. Descriptive statistics of survey respondents: Pooled sample, sample in each information treatment, pairwise t-test comparison across treatment samples

Variable	Description	U.S. Census	Pooled sample N=2,016	Respondents' sample in each treatment				Pairwise t-test		
				No add. Information	X (former Twitter)	Newspaper	Science video	X vs. No inf.	Newsp. vs. No inf.	Sci. video vs. No inf.
Gender	Female	0.51 ¹	0.63	0.64	0.61	0.64	0.68	−1.23	−0.16	1.14
	Male	0.49	0.36	0.35	0.38	0.36	0.32	1.18	0.31	−1.00
Education	Some school	0.10 ²	0.03	0.02	0.04	0.03	0.02	1.78*	1.26	0.07
	High school graduate	0.26	0.23	0.23	0.25	0.21	0.23	0.71	−0.89	−0.12
	Some college/assoc.	0.28	0.33	0.34	0.33	0.33	0.34	−0.32	−0.47	−0.15
	Bachelor's degree	0.22	0.26	0.27	0.23	0.27	0.27	−1.65*	−0.05	−0.07
	Adv./prof. degree	0.14	0.15	0.13	0.15	0.16	0.14	0.73	1.16	0.41
Community	Rural area	0.31 ³	0.24	0.24	0.22	0.27	0.22	−0.70	1.00	−0.64
	Suburban	0.55	0.46	0.43	0.48	0.43	0.50	1.57	−0.19	2.25**
	Urban	0.14	0.30	0.33	0.30	0.31	0.28	−1.06	−0.73	−1.85*
Age	18 to 24 years	0.09	0.09	0.09	0.11	0.07	0.09	1.33	−0.89	0.12
	25–34 years	0.14	0.29	0.30	0.27	0.31	0.29	−1.06	0.39	−0.26
	35–44 years	0.13	0.24	0.25	0.23	0.28	0.22	−0.99	0.82	−1.47
	45–54 years	0.12	0.21	0.20	0.23	0.18	0.22	1.40	−0.73	0.95
	55–64 years	0.13	0.06	0.04	0.07	0.05	0.07	2.19**	1.23	2.06**
	65+ years	0.17	0.11	0.13	0.09	0.11	0.12	−1.79*	−0.83	−0.39

(Continued)

Table 2. (Continued)

Variable	Description	U.S. Census	Pooled sample N=2,016	Respondents' sample in each treatment				Pairwise t-test		
				No add. Information	X (former Twitter)	Newspaper	Science video	X vs. No inf.	Newsp. vs. No inf.	Sci. video vs. No inf.
Income	Less than \$25 K/yr	0.16	0.13	0.14	0.12	0.14	0.13	-1.12	-0.08	-0.59
	\$25- \$34.9 K/yr	0.07	0.10	0.12	0.10	0.08	0.12	-0.66	-2.15**	0.01
	\$35 - \$49.9 K/yr	0.11	0.11	0.09	0.11	0.12	0.11	0.99	1.40	0.89
	\$50 - \$74.9 K/yr	0.16	0.21	0.20	0.21	0.24	0.20	0.72	1.65*	0.04
	\$75 - \$99.9 K/yr	0.13	0.13	0.15	0.13	0.11	0.12	-1.01	-1.67*	-1.05
	\$100 - \$149.9 K/yr	0.17	0.18	0.21	0.18	0.16	0.18	-0.94	-1.87*	-1.07
	\$150 - \$200 K/yr	0.09	0.07	0.06	0.08	0.07	0.06	0.99	0.21	-0.53
	Greater than \$200 K	0.12	0.05	0.03	0.04	0.06	0.05	0.43	2.11**	1.51
Race	Amer Indian/Alaskan	0.05	0.02	0.01	0.01	0.01	0.02	-0.33	-0.08	0.60
	Asian, Asian American	0.06	0.04	0.04	0.05	0.02	0.05	0.71	-1.43	0.88
	Black	0.12	0.10	0.12	0.08	0.11	0.09	-2.06**	-0.64	-1.28
	Hispanic, Latino	0.19	0.07	0.07	0.10	0.06	0.05	1.48	-0.56	1.48
	Pacific Islander	0.02	0.00	0.01	0.01	0.00	0.00	-0.04	-1.03	-1.05
	White	0.58	0.74	0.71	0.73	0.77	0.75	0.77	2.21**	1.48
	Mixed race	0.04	0.02	0.03	0.02	0.02	0.03	-0.70	-0.96	0.39
	Other	0.06	0.01	0.01	0.01	0.00	0.00	-1.31	-1.72*	-2.17**

(Continued)

Table 2. (Continued)

Variable	Description	U.S. Census	Pooled sample N=2,016	Respondents' sample in each treatment				Pairwise t-test		
				No add. Information	X (former Twitter)	Newspaper	Science video	X vs. No inf.	Newsp. vs. No inf.	Sci. video vs. No inf.
U.S. Region	Northeast	0.17 ⁴	0.18	0.17	0.17	0.18	0.17	0.05	0.44	−0.06
	South	0.39	0.38	0.38	0.39	0.37	0.38	0.37	−0.12	0.04
	Midwest	0.21	0.21	0.21	0.20	0.21	0.22	−0.23	0.05	0.31
	West	0.24	0.24	0.24	0.24	0.24	0.24	−0.25	−0.30	−0.29
Household size	One person	0.23	0.19	0.18	0.18	0.21	0.18	−0.13	1.19	0.16
	Two people	0.38	0.14	0.32	0.35	0.29	0.38	0.76	−1.06	2.00**
	Three people	0.16	0.18	0.20	0.18	0.17	0.19	−0.86	−1.30	−0.51
	Four or more people	0.24	0.29	0.29	0.30	0.33	0.24	0.06	1.13	−1.84*
Children	House with children	0.29	0.41	0.43	0.38	0.45	0.38	−1.47	0.94	−1.62
Pets	House with pets	0.66 ⁵	0.74	0.74	0.74	0.74	0.73	0.05	0.03	−0.37

¹U.S. Census Bureau (2022). Demographic and Housing Estimates, 18-years and over.
²U.S. Census Bureau (2022). Selected Social Characteristics in the United States. Population 25 years and over.
³Pew Research Center (2018).
⁴U.S. Census Bureau (2023). U.S. and World Population Clock.
⁵Forbes (2023).

data suggest concern about animal welfare and a desire for more ethical and humane treatment of animals in agriculture (Appendix C).

Generalized multinomial logit model (GMNL-II) results

The results of the generalized multinomial logit model GMNL-type II⁹ for each of the four information treatments are presented in Table 3. The base case to which we compare is “unspecified” milk that is not labeled as either coming from dehorned cows or from gene-edited cows to prevent painful dehorning. Note that although the milk that is sold in grocery stores is unspecified in this regard, it almost always comes from dehorned cows. Thus, in this sense, the milk labeled as coming from dehorned cows is no different from the milk that consumers currently buy. Also, the WTP for gene-edited to prevent painful dehorning is lower than dehorned, indicating that even though pain mitigation is involved consumers are still willing to discount for gene-edited cows.

We present WTP results across all information treatments. We acknowledge that given the inclusion of genuine excerpts from media and social media, we cannot attribute the information channel itself as the cause for differences in WTP. It is a composite of factors associated with each channel that is influencing these differences, such as the tone of the narrative used in each channel, the way the information is presented, the individual who posted the tweet, the number of retweets, the use of graphics, and so on. Across all information treatments and compared to the unspecified label, respondents require a discount (negative WTP) for both milk labeled that comes from cows that were dehorned and milk that comes from cows that were gene edited to prevent painful dehorning. The science video and newspaper information treatment results are different from the no information but in opposite directions (see Table 3). We anticipated this, because the science video offers the scientists’ perspective, while the newspaper excerpt displays a questioning and somewhat negative tone towards gene editing, which is typical of traditional media coverage of new technology (McCluskey *et al.*, 2016).¹⁰

The respondents who watched the science video require a discount of -\$0.61 to choose milk from cows that were gene-edited to prevent painful dehorning relative to the unspecified label and a baseline WTP of \$4.29/gallon. For the same attribute, the discount was -\$3.38 for those who received the newspaper treatment, -\$2.53 for those who responded to the control (no additional information), and -\$1.94 for those who received the X post treatment. Similarly, respondents who watch the science video stated a -\$1.05 discount to choose milk from dehorned cows, while those who received the newspaper treatment exhibited a discount of -\$2.82, those who responded to the control discounted -\$2.14 and those who were presented the X post discounted -\$1.83.

Given our experimental design, it is impossible to disentangle the effects of other factors associated with each communication channel, therefore we cannot draw conclusions. However, it is important to highlight that regardless of the information treatment

⁹Several regression models were assessed for fit with the data. First, a multinomial logit model, a random parameters logit model, and generalized multinomial logit model (GMNL) considering the pooled sample and interaction terms of the variables with information treatments. The GMNL type I and type II were tested, and goodness-of-fit statistics favor the GMNL-II. Finally results from an F-test and a likelihood ratio test favor separate regression by in over the pooled sample. Therefore, in this section we report the results from the GMNL-II considering four separate regressions one for each information treatment.

¹⁰McCluskey and Swinnen’s (2004) “bad news hypothesis” argues that media consumers, in general, tend to be more interested in negative news items than in positive news items, *ceteris paribus*. McCluskey *et al.* (2016) argue that this negative news bias, the media is more likely to highlight potential risks associated with new food technologies in their reporting.

Table 3. Generalized multinomial logit model type II estimates by information treatment

Variable	No information		X (former Twitter)		Newspaper		Science video	
	No interaction	With interaction	No interaction	With interaction	No interaction	With interaction	No interaction	With interaction
Mean								
Reduced milkfat vs. whole milkfat	0.12 (0.08)	0.17* ¹ (0.09) ²	0.09 (0.08)	0.04 (0.08)	-0.04 (0.10)	0.00 (0.10)	0.30*** (0.07)	0.28*** (0.07)
Dehorned vs. unspecified	-2.14*** (0.14)	-2.77*** (0.24)	-1.83*** (0.13)	-1.69*** (0.22)	-2.82*** (0.18)	-4.09*** (0.33)	-1.05*** (0.09)	-1.36*** (0.17)
Gene edited to prevent painful dehorning vs. unspecified	-2.53*** (0.16)	-4.43*** (0.34)	-1.94*** (0.14)	-2.55*** (0.25)	-3.38*** (0.21)	-5.40*** (0.36)	-0.61*** (0.09)	-1.27*** (0.20)
Dehorned × Democrat ³	-	0.03 (0.21)	-	-0.23 (0.19)	-	0.80*** (0.20)	-	0.76*** (0.15)
Dehorned × social media user ⁴	-	0.68*** (0.23)	-	-0.11 (0.23)	-	1.24*** (0.27)	-	0.12 (0.16)
Gene edited to prevent painful dehorning × Democrat	-	0.99*** (0.21)	-	0.64*** (0.19)	-	1.79*** (0.21)	-	1.11*** (0.16)
Gene edited to prevent painful dehorning × social media user	-	1.81*** (0.28)	-	0.59*** (0.23)	-	1.74*** (0.26)	-	0.43** (0.19)
Opt-out	-6.98*** (0.18)	-6.92*** (0.18)	-6.48*** (0.15)	-6.57*** (0.16)	-7.24*** (0.18)	-7.12*** (0.18)	-6.91*** (0.18)	-6.88*** (0.18)

(Continued)

Table 3. (Continued)

Variable	No information		X (former Twitter)		Newspaper		Science video	
	No interaction	With interaction	No interaction	With interaction	No interaction	With interaction	No interaction	With interaction
Standard deviation								
Reduced milkfat	2.45*** (0.17)	2.47*** (0.17)	2.39*** (0.16)	2.42*** (0.15)	2.19*** (0.16)	2.24*** (0.16)	1.92*** (0.12)	1.90*** (0.12)
Dehorned ²	1.71*** (0.16)	1.69*** (0.17)	1.83*** (0.17)	1.80*** (0.16)	2.13*** (0.19)	2.15*** (0.19)	1.54*** (0.13)	1.54*** (0.13)
Gene edited to prevent painful dehorning ²	4.21*** (0.26)	4.19*** (0.26)	4.07*** (0.25)	4.04*** (0.25)	4.69*** (0.29)	4.43*** (0.28)	3.30*** (0.19)	3.09*** (0.18)
Opt-out	1.64*** (0.18)	1.52*** (0.21)	1.86*** (0.17)	1.57*** (0.17)	1.87*** (0.19)	1.45*** (0.20)	2.18*** (0.16)	2.12*** (0.16)
Scale heterogeneity (τ)	0.39*** (0.03)	0.41*** (0.03)	0.34*** (0.04)	0.36*** (0.03)	0.50*** (0.03)	0.51*** (0.03)	0.29*** (0.04)	0.28*** (0.04)
Certain	−0.01 (0.03)	0.00 (0.03)	−0.04 (0.03)	−0.03 (0.03)	−0.09*** (0.03)	−0.08*** (0.03)	0.16*** (0.03)	0.17*** (0.03)
N. of respondents	487		501		508		520	
N. of observations	3896		4008		4064		4160	
Log likelihood	−2926.09	−2916.71	−3115.92	−3114.03	−3021.62	−3004.16	−3266.60	−3258.01
AIC	5884.19	5873.43	6263.83	6268.07	6075.24	6048.32	6565.20	6556.01
BIC	5984.47	5998.78	6364.57	6393.99	6176.20	6174.52	6666.53	6682.68

¹Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.

²Standard errors are in parentheses.

³Democratic if the respondent identifies as always Democratic

⁴Regular social media user if the respondent reports using social media at least once per day.

presented, one observes a larger discount for milk from cows that were gene edited to prevent painful dehorning compared to milk from dehorned cows.

Further, we include interaction effects for the attributes dehorned and gene edited to prevent painful dehorning with the variables: *Democrat* (binary variable =1 if the respondent always identifies as a Democrat, and zero otherwise) and *social media user* (binary variable =1 if the respondents use social media at least once per day, and zero otherwise). These interaction effects provide some interesting results. The interactions between *dehorned* and *Democrat* are only statistically significant for the newspaper and science video information treatments. The interactions between *dehorned* and *social media user* are statistically significant for the control treatment and the newspaper treatment. All interactions are statistically significant for gene edited to prevent painful dehorning. All of the statistically significant interactions are positive, which means that they reduce the negative value of the attribute. Still, for all cases except for the science-video information treatment when the respondent is both a *Democrat* and *social media user*, the net WTP for the gene edited to prevent painful dehorning combined with the interactions is still negative relevant to unspecified milk. For all cases, the WTP net of interactions for milk from dehorned cows is negative.

Our results are consistent with Kilders and Caputo (2021), who find that WTP increases for milk from gene-edited cows when scientific or positive information is offered. Their information treatments start with no information (the control), then add facts about gene editing and differences with genetically modified organisms, and then add information about animal welfare benefits that can be achieved with gene editing. In our study, the WTP for milk from cows that were gene edited to prevent painful dehorning increases relative to no-information for the information treatments that used a positive tone. Different from Kilders and Caputo (2021), we also included an actual newspaper information treatment, which had a more skeptical tone and as expected the impact of the newspaper article is negative on the WTP.

In relation to other attributes included in the discrete choice scenarios, across three of the four information treatments, there are no statistically significant differences in the WTP for reduced-fat versus whole-milk fat. Only the respondents in the science video information treatment are willing to pay \$0.30 per gallon more for 2% milk fat compared to whole milk. These results are somewhat different from Brooks and Lusk (2010) where they estimated that individuals in their sample were -on average- willing to discount for whole milk compared to skim milk.

Latent class model results

For the latent class analyses, the study only focuses on the control information treatment (no-additional information), to avoid confounding effects with the information-treatment effects. The latent-class model results are presented in Table 4 and the predictors of class membership, relative to the base case, are presented in Table 5. Class 1 is the baseline group and includes 25.31% of the respondents in the control group. Class-1 members have negative valuations for both milk from dehorned cows (−\$2.44) and from cows who were gene edited to prevent painful dehorning (−\$2.69). This class is the most sensitive to price.

Class 2 respondents constitute 41.91% of the respondents in control treatment group. We call them the “avoiders” because they require the largest discount (i.e., negative WTP) for milk from cows that were gene edited to prevent painful dehorning at −\$5.63, which is greater than the highest price of milk in our choice experiment (\$4.89), and the largest discount for milk from dehorned cows (−\$2.52). They have a positive value for the opt-out

Table 4. Latent class model results

Variable	Class 1 Base case 25.31%	Class 2 Avoiders 41.91%	Class 3 Trust science 32.78%
Price	−1.62*** (0.22)	1.54*** (0.45)	−0.58*** (0.09)
Reduced fat	0.10 (0.15)	−0.94*** (0.26)	0.15*** (0.05)
Dehorned	−2.44*** (0.26)	−2.52*** (0.39)	−0.15** (0.07)
Gene edited to prevent painful dehorning	−2.69*** (0.24)	−5.63*** (0.80)	0.27*** (0.08)
Opt-out	−7.66*** (1.00)	3.23* (1.77)	−4.89*** (0.40)
N. of observations	3896		
Log likelihood	−3104.50		
AIC	6351.00		
BIC	6796.01		

Note: Standard errors are in parentheses. The baseline is Milkfat whole. The baseline is No indication of whether the cow was dehorned. Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.

choice. This segment prefers whole over reduced-fat milk. This group exhibits a positive coefficient estimate for price.

Relative to the base class, the avoiders (class 2) have fewer members who are older than forty years old, female, hold a college degree, have an income above \$75,000, and live in the northeastern United States. The avoiders are more likely to have a pet in their household. They exhibit a larger proportion of individuals who have higher trust in information from newspapers¹¹ and food channels for traditional media and X for social media. They have positive but modest trust in scientists. This group has the lowest trust in information that comes from the government.

The avoiders include a smaller proportion of individuals -compared to the base- who agree with the idea that humans can use animals for any purpose as long as the animals do not suffer pain. This group also contains a smaller proportion of individuals who approve of the use of gene editing to reduce the risk of injury in animals. Conversely, the avoiders include a larger proportion who believe that gene editing should not be allowed for farm animals, even if it could enhance animal welfare and that animal agriculture poses serious ethical questions regarding the treatment of animals. In summary, the avoiders show interest in improving animal welfare but are very against the use of gene editing perhaps relating it to ethical issues.

¹¹Given the tendency of newspapers to emphasize negative news (McCluskey *et al.* 2016), it is reasonable to infer that individuals who generally trust newspapers for information may exhibit a greater aversion to biotechnology.

Table 5. Variables predicting class membership (Class 1, the base case, is omitted)

Share Variables	Class 2-Avoiders 41.91%		Class 3-Trust science 32.78%	
	Coefficient	Std Err	Coefficient	Std Err
Sociodemographic predictors				
Age ≥ 40	-0.56*** ¹	(0.14)	-1.47***	(0.12)
Female	-1.03***	(0.16)	-1.20***	(0.16)
College	-0.40***	(0.14)	-0.64***	(0.12)
Income \geq \$75,000/year	-1.02***	(0.15)	-0.31**	(0.12)
Family size ≥ 3	-0.24*	(0.14)	-0.25**	(0.11)
Pet in household	0.67***	(0.15)	0.33***	(0.12)
Northeast	-0.61***	(0.22)	-0.50***	(0.17)
South	0.10	(0.17)	-0.25*	(0.15)
West	0.11	(0.19)	-0.36**	(0.16)
Media habits predictor				
Frequent social media user (at least daily)	0.02	(0.17)	0.89***	(0.15)
Predictors based on trust of information				
Scientists	0.62***	(0.19)	1.09***	(0.15)
Government	-1.54***	(0.29)	-0.60***	(0.20)
Newspapers	1.33***	(0.27)	0.32	(0.24)
Food channels	0.98***	(0.22)	0.01	(0.18)
Instagram	0.25	(0.45)	1.90***	(0.35)
Pinterest	-1.79***	(0.37)	-0.67**	(0.27)
X (former Twitter)	6.01*	(3.22)	5.00	(3.21)
YouTube	-0.32	(0.37)	-0.43	(0.27)
Predictors based on agreement with statements				
In general, humans have too little respect for the quality of life of animals	0.08	(0.25)	-0.10	(0.12)
Animal agriculture raises serious ethical questions about the treatment of animals	0.35**	(0.15)	0.39***	(0.13)
As long as animals do not suffer pain, humans should be able to use them for any purpose	-0.32*	(0.17)	0.60***	(0.13)
Using gene-editing to reduce a farm animal's risk of injury or disease is acceptable	-0.62**	(0.24)	1.41***	(0.15)
Gene-editing should be forbidden for farm animals even if it increases animal welfare	1.01***	(0.15)	0.18	(0.15)

(Continued)

Table 5. (Continued)

Share Variables	Class 2-Avoiders 41.91%		Class 3-Trust science 32.78%	
	Coefficient	Std Err	Coefficient	Std Err
The stress during animal production could affect the quality of meat, milk, eggs	−0.08	(0.14)	−0.61***	(0.12)
Gene editing can be used in ways that benefit animal welfare/ society	−0.16	(0.15)	1.01***	(0.13)
Laws/policies for gene editing in livestock should be the same as those governing conventional breeding in livestock	0.21	(0.16)	1.03***	(0.13)
Laws/policies should be used to encourage some types of gene editing in livestock	0.10	(0.25)	1.12***	(0.18)
Constant	0.50*	(0.27)	0.26	(0.23)
Observations	3896			
Log Likelihood	−3104.50			
AIC	6351.00			
BIC	6796.01			

¹Single, double, and triple asterisks (*, **, ***) indicate statistical significance at the 10%, 5%, and 1% levels.

Class 3 members constitute 32.78% of the sample of respondents in the control group. We can call this class the “trust science” group. They are the only class who indicate that they are willing to pay a premium for milk from cows that were gene edited to prevent painful dehorning (\$0.27). They also have smallest negative WTP for milk from cows who are dehorned (−\$0.15). They are less sensitive to price relative to Class 1. This segment favors reduced-fat over whole-fat milk, and the options with attributes over opting out.

The trust-science class is somewhat like the avoiders in terms of sociodemographic characteristics with the differences mostly in terms of age, trust science, have considerably less proportion of individuals older than 40. These results are aligned with Uddin *et al.* (2022) who found that males, young and hold a bachelor’s degree were more likely to pay a premium for gene-edited grapes. The predictors for all regional variables are negative and significant, which points to the science-trust class being more likely from the U.S. Midwest region (the omitted category). This group has the largest proportion of respondents who trust science-originated information, in greater magnitude than the avoiders. This is similar to Uddin *et al.* (2022) who found that those willing to pay a price premium for gene-edited grapes were the most trusting in science. Relative to the base case, they have a lower proportion of those who have high trust in information from government but not as extreme as the avoiders (class 2). However, different from the avoiders, the trust-science class has a larger proportion of individuals who have higher trust in information from Instagram.

Like the avoiders, the trust-science class has a larger proportion of individuals who agree that animal agriculture raises serious ethical questions about the treatment of animals. Different from the avoiders, the trust-science class has a larger proportion of individuals who agree that animal agriculture raises ethical questions about the treatment of animals and that animals can be used for various purposes without causing them suffering. This group has a larger proportion of individuals who agree in the use of gene

editing to minimize risk of injury or disease, that gene editing could be used to benefit animal welfare and society, and that policies should encourage the use of gene editing in livestock. However, this group has less proportion of individuals who agree that stress in animals could affect the quality of animal products.

In sum, both avoiders and the trust-science group are concerned with animal ethical treatment, yet they diverge on key issues. The avoiders oppose using animals for any purpose, even if the animals do not suffer, while the trust-science group is in favor. The main point of contention between these two groups lies in their views on gene editing, specifically regarding its role in enhancing animal welfare.

Conclusions and implications

In this study, we investigated consumer responses to information about milk that comes from cows who are dehorned, hornless by gene editing to prevent painful dehorning, or unspecified. We find that consumers' WTP for milk generally decreases with labeling that the cows were dehorned, which is the case for almost all commercially available milk, or that the cows were gene edited to prevent painful dehorning. That is, overall, consumers' WTP is the highest for milk with no indication of coming from either dehorned cows or cows that were gene edited to prevent painful dehorning. We note that the status quo in U.S. milk sales is that it comes from dehorned cows, but the milk is not labeled as such. Thus, we expect that the average consumer is unlikely to know about dehorning. The consumers surveyed in this study, prefer to avoid products with information about whether cows they dehorned or treated with new technologies to prevent painful dehorning.

In addition, we applied information treatments to sub-groups of our respondents. The information treatments included (1) a control with no-additional information, (2) excerpts from a *Washington Post* newspaper article, (3) postings from X, and (4) science video on the topic, which was created by the purposes of the wider study of which this article is a component. We find that the tone of the information treatments has differential effects on the choice of milk from cows that were gene edited to prevent painful dehorning, with the science video having the largest positive impact. The excerpts from the newspaper article had a negative impact.

One limitation of this study is that we considered only either positive or negative perspectives from each type of information source. Ideally, we should have incorporated both positive and negative viewpoints from the same source, and control for the name of the person posting, number of re-tweets, length of the information presented, graphical presentation and so on. By doing so, we could better discern which sources exert a greater influence on specific demographics, independent of the content's tone.

This study has two implications. First, consumers often demand information about their food based on health, nutrition, environmental impact, social, and ethical concerns. This transparency, often required by law, can be a double-edge sword because it could reveal practices that consumers find distressing. This study shows that the sample of respondents preferred the product without information on the treatment of dairy cows. The policy implication is that if consumers show they are willing to pay for no-information, then policies mandating labeling production methods do not enhance consumer welfare.

Second, foods made with new technologies, such as gene editing, may be beneficial to animal welfare, the environment, and/or human health, their potential benefits can only be

fully realized if embraced by consumers. Even if consumers would prefer to avoid uncomfortable information about food production methods, transparency in communicating science is of primal importance. Our results suggest that scientists are trusted for information to a greater degree than other entities. As such, it is important to use creative ways for scientists to promote acceptance of food products made with new technologies. The benefits of these new technologies should be communicated to consumers in formats that they use, especially social media. In a study on social media influencers with X data, Navelski *et al.* (2023) finds that anti-gene-editing influencers have more followers and command more influence. Therefore, there is a need for influencers who can play the role of “science ambassadors”. It follows that science communication to the public should be a required component in publicly funded agricultural research.

Overall, our study suggests that consumers generally view both dehorning cows and the use of gene editing negatively. Dehorning may evoke a sense of guilt and discomfort in consumers over animal suffering. Gene editing, on the other hand, raises concerns due to the risks associated with new breeding technologies. When given a choice, consumers are likely weighing their discomfort with animal suffering against their apprehension about the safety or ethics of gene editing. Further research should delve into the impact of different communication channels and styles to improve consumers’ acceptance of new technologies.

Supplementary material. The supplementary material for this article can be found at <https://doi.org/10.1017/age.2025.14>

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References

- Alston JM and Pardey PG (2021) The economics of agricultural innovation. In Barrett CB and Just DR (eds), *Handbook Agric Econ*, vol. 5, 1st ed. Elsevier.
- Baars T, Jahreis G, Lorkowski S, Rohrer C, Vervoort J and Hettinga K (2019) Short communication: Changes under low ambient temperatures in the milk lipodome and metabolome of mid-lactation cows after dehorning as a calf. *Journal of Dairy Science* **102**(3), 2698–2702.
- Barrangou R and Doudna JA (2016) Applications of CRISPR technologies in research and beyond. *Nature Biotechnology* **34**(9), 933–941.
- Bearth A and Siegrist M (2016) Are risk or benefit perceptions more important for public acceptance of innovative food technologies: A meta-analysis. *Trends in Food Science and Technology* **49**, 14–23.
- Brooks K and Lusk JL (2010) Stated and revealed preferences for organic and cloned milk: combining choice experiment and scanner data. *American Journal of Agricultural Economics* **92**, 1229–1241.
- Beck MJ, Rose JM and Hensher DA (2013) Consistently inconsistent: The role of certainty, acceptability, and scale in choice. *Transportation Research Part E* **56**, 81–93.
- Beck MJ, Fifer S and Rose JM (2016) Can you ever be certain? Reducing hypothetical bias in stated choice experiments via respondent reported choice certainty. *Transportation Research Part B: Methodological* **89**, 149–167.
- Bell E, Norwood FB and Lusk JL (2017) Are consumers willfully ignorant about animal welfare? *Animal Welfare* **26**(4), 399–402. <https://doi.org/10.7120/09627286.26.4.399>

- Canada, Beef Cattle Research Council (2023) Dehorning. Available at <https://www.beefresearch.ca/topics/dehorning/> (accessed 12 December 2023).
- Champ PA, Moore R and Bishop RC (2009) A comparison of approaches to mitigate hypothetical bias. *Agricultural Economics Research Review* 38(2), 166–180.
- Dannenberg A (2009) The dispersion and development of consumer preferences for genetically modified food — A meta-analysis. *Ecological Economics* 68(8–9), 2182–2192.
- Dolgoplova I and Roosen J (2018) Competitive niche in milk pricing: Analyzing price dynamics of GMO-free, organic, and conventional milk in Germany during 2009–2010. *Food Policy* 78, 51–57.
- Doudna JA and Charpentier E (2014) Genome editing. The new frontier of genome engineering with CRISPR-Cas9. *Science*. 346(6213), 1258096.
- Fiebig DG, Keane MP, Louviere J and Wasi N (2010) The generalized multinomial logit model: accounting for scale and coefficient heterogeneity. *Marketing Science* 29(3), 393–421.
- Forbes (2023) *Pet Ownership Statistics*. Available at <https://www.forbes.com/advisor/pet-insurance/pet-ownership-statistics/> (accessed 13 December 2023).
- Greene WH and Hensher DA (2003) A latent class model for discrete choice analysis: contrasts with mixed logit. *Transportation Research Part B: Methodological* 37(8), 681–698.
- Hansen J, Frewer L, Robinson P and Sando P (2003) Beyond the knowledge deficit: recent research into lay and expert attitudes to food risks. *Appetite* 41(2), 111–121.
- Hensher DA, Rose JM and Beck MJ (2012) Are there specific design elements of choice experiments and types of people that influence choice response certainty? *Journal of Choice Modelling* 5(1), 77–97.
- Hu Y, House LA and Gao Z (2022) How do consumer respond to labels for CRISPR (gene editing)? *Food Policy* 112, 102366.
- Huffman WE and McCluskey JJ (2021) *New Technology and Conflicting Information: Assessing Consumers' Willingness to Pay for New Foods*. Hackensack, NJ: World Scientific Publishing.
- Huffman WE, Rousu M, Shogren JF and Tegene A (2004) Who do consumers trust for information: The case of genetically modified foods? *American Journal of Agricultural Economics* 85(6), 1222–1229.
- Kilders V and Caputo V (2021) Is Animal welfare promoting hornless cattle? Assessing consumer's valuation for milk from gene-edited cows under different information regimes. *Journal of Agricultural Economics* 72(3), 735–759.
- Krystallis A, Grunert KG, Barcellos M, Perrea T and Verbeke W, 2012. Consumer attitudes towards sustainability aspects of food production: Insights from three continents. *Journal of Marketing Management* 28, 334–372.
- Kunwar SB, Bohara AK and Thacher J (2020) Public preference for river restoration in the Danda Basin, Nepal: A choice experiment study. *Ecological Economics* 175, 106690.
- Lagerkvist CJ and Hess S (2011) A meta-analysis of consumer willingness to pay for farm animal welfare. *European Review of Agricultural Economics* 38, 55–78.
- Lancaster KJ (1966) A new approach to consumer theory. *Journal of Political Economy* 74(2), 132–157.
- Lang JT and Hallman WK (2005) Who does the public trust? The case of genetically modified food in the United States. *Risk Analysis* 25, 1241–1252.
- Li T, McCluskey JJ and Messer K (2018) Ignorance is bliss? Experimental evidence on wine produced from grapes irrigated with recycled water. *Ecological Economics* 153, 100–110.
- Luckstead J, Snell HA, Nalley LL, Nayga Jr RM and Sarpaning J (2022) A multi-country study on consumers' valuation for child-labor-free chocolate: Implications for child labor in cocoa production. *Applied Economic Perspectives and Policy* 44(2), 1021–1048.
- Lusk JL, McFadden BR and Wilson N (2018) Do consumers care how a genetically engineered food was created or who created it? *Food Policy* 78, 81–90.
- Lusk JL, Roosen J and Bieberstein A (2014) Consumer acceptance of new food technologies: Causes and roots of controversies. *Annual Review of Resource Economics* 6(1), 381–405.
- Ma X, Gallardo RK, Canales E, Atucha A, Zalapa J and Iorizzo M (2024) Would consumers accept CRISPR fruit crops if the benefit has health implications? An application to Cranberry products. *Agricultural and Resource Economics Review* 53(2), 1–23. <https://doi.org/10.1017/age.2023.38>.
- Marette S, Disdier A-C and Beghin JC (2021) A comparison of EU and US consumers' willingness to pay for gene-edited food: Evidence from apples. *Appetite* 159: 105064.

- McFadden D** (1974) Conditional logit analysis of qualitative choice behavior. In Zarembka P (ed), *Frontiers in Econometrics*, New York: Academic Press, pp. 105–142.
- McCluskey JJ, Kalaitzandonakes N and Swinnen JFM** (2016) Media coverage, public perceptions, and consumer behavior: Insights from new food technologies. *Annual Review of Resource Economics* **8**, 467–486. <https://doi.org/10.1146/annurev-resource-100913-012630>.
- McCluskey JJ and Swinnen JFM** (2004) Political economy of the media and consumer perceptions of biotechnology. *American Journal of Agricultural Economics* **86**, 1230–1237.
- Menchaca A, dos Santos-Neto PC, Mulet AP and Crispo M** (2020) CRISPR in livestock: From editing to printing. *Theriogenology* **150**, 247–254.
- Moe WW and Schweidel DA** (2014) *Social Media Intelligence*. Cambridge University Press.
- Morris J** (2022) *Economics of Dehorning Cattle*. University of Missouri Extension Farm Management Minute. Available at <https://muextensionfarmmanagementminute.podbean.com/e/economics-of-dehorning-cattle-farm-management-minute/>
- Morrison M and Brown TC** (2009) Testing the effectiveness of certainty scales, cheap talk, and dissonance-minimization in reducing hypothetical bias in contingent valuation studies. *Environmental and Resource Economics* **44**: 307–326.
- Muringai V, Fan X and Goddard E** Canadian consumer acceptance of gene-edited versus genetically modified potatoes: A choice experiment approach. *Canadian Journal of Agricultural Economics* **68**(1): 47–63.
- Navelski J, Badruddoza S and McCluskey JJ** (2023) The expert effect on network formation: An application to gene editing opinions on Twitter. School of Economic Sciences, Washington State University, Working paper.
- Nordström J, Thunström L, van't Veld K, Shogren JF and Ehmke M** (2020) Strategic ignorance of health risk – Its causes and policy consequences. *Behavioural Public Policy* **7**(1), 1–32.
- Norwood FB and Lusk JL** (2011) *Compassion by the Pound: The Economics of Farm Animal Welfare*. Oxford, UK: Oxford University Press.
- Nylund-Gibson K and Choi AY** (2018) Ten frequently asked questions about latent class analysis. *Translational Issues in Psychological Science* **4**, 440–461.
- Panko B** (2016) Gene-edited cattle produce no horns. New technique could eliminate the need for painful dehorning. *Science* (May 10). Available at <https://www.science.org/content/article/gene-edited-cattle-produce-no-horns>
- Pew Research Center** (2018) Demographic and economic trends in urban, suburban, and rural communities. Available at <https://www.pewresearch.org/social-trends/2018/05/22/demographic-and-economic-trends-in-urban-suburban-and-rural-communities/> (accessed 13 December 2023).
- Qaim M** (2020) Role of new plant breeding technologies for food security and sustainable agricultural development. *Applied Economic Perspectives and Policy* **42**(2): 129–150.
- Reisch LA, Sunstein CR and Kaiser M** (2021) What do people want to know? Information avoidance and food policy implications. *Food Policy* **102**, 102076.
- Rose JM, Beck MJ and Hensher DA** (2015) The joint estimation of respondent-reported certainty and acceptability with choice. *Transportation Research Part A* **71**, 141–152.
- SAS Support**. 2023. SAS Macros for Experimental Design and Choice Modeling. Available at <https://support.sas.com/md/app/macros/>
- Sarrias M and Daziano R** (2017) Multinomial logit models with continuous and discrete individual heterogeneity in R: The GMNL package. *Journal of Statistical Software* **79**(2), 1–46.
- Shew AA, LL Nalley, HA Snell, RM Nayga and BL Dixon** (2018) CRISPR versus GMOs: Public acceptance and valuation. *Global Food Security* **19**, 71–80.
- Siegrist M, Hartmann C and Sütterlin B** (2016) Biased perception about gene technology: How perceived naturalness and affect distort benefit perception. *Appetite* **96**, 509–516.
- Statista** (2024) Co-shopping split of groceries in multi-person households in in the United States in 2023, by gender. Available at <https://www.statista.com/statistics/817500/grocery-shopping-responsibility-share-us-by-gender/>
- Tabei Y, Shimura S, Kuan Y, Itaka S and Fukino N** (2020) Analyzing Twitter conversation on genome-edited foods and their labeling in Japan. *Frontiers in Plant Science* **11**. <https://doi.org/10.3389/fpls.2020.535764>

- Thompson NM, Olynk Widmar N, Shutz MM, Cole JB and Wolf CA** (2017) Economic considerations of breeding for polled dairy cows versus dehorning in the United States. *Journal of Dairy Science* **100**(6), 4941–4952.
- Thunström L, Nordström J, Shogren JE, Ehmke M and van 't Veld K** (2016) Strategic self-ignorance. *Journal of Risk and Uncertainty* **52**(2), 117–136.
- Train K** (2009) *Discrete Choice Methods with Simulation*. Cambridge, UK: Cambridge University Press.
- Uddin A, Gallardo RK, Rickard BJ, Alston JA and Sambucci O** (2022) Consumer acceptance of new plant-breeding technologies: An application to the use of gene editing in fresh table grapes. *PlosOne*. <https://doi.org/10.1371/journal.pone.0270792>
- US Census** (2022) QuickFacts. Retrieved from <https://www.census.gov/quickfacts/fact/table/US/PST045222>
- US Census** (2022) American Community Survey Data. Popular American Community Survey Tables. Available at <https://www.census.gov/programs-surveys/acs/data.html> (accessed 13 December 2023).
- US Census** (2023) U.S. and World Population Clock. United States Regional Population. Available at <https://www.census.gov/popclock/> (accessed 13 December 2023).
- U.S. Department of Agriculture** (2009) Dairy 2007, Part IV: Reference of dairy cattle health and management practices in the United States, USDA, Animals and Plant Health Inspection Service, Fort Collins, CO. #N494.0209 (2007). Available at https://www.aphis.usda.gov/animal_health/nahms/dairy/downloads/dairy07/Dairy07_dr_PartIV.pdf (accessed 12 December 2023).
- US Food and Drug Administration** (2023) Intentional genomic alteration (IGAs) in animals. Available at: <https://www.fda.gov/animal-veterinary/biotechnology-products-cvm-animals-and-animal-food/intentional-genomic-alterations-igas-animals> (accessed 2 April 2024).
- Yang Y and Hobbs JE** (2020) The power of stories: narratives and information framing effects in science communication. *American Journal of Agricultural Economics* **102**(4), 1271–1296.
- Wolf C, T Malone and B McFadden** (2020) Beverage milk consumption patterns in the United States: Who is substituting from dairy to plant-based beverages?, *Journal of Dairy Science* **103**(12), 11209–11217.
- Wunderlich S and Gatto KA** (2015) Consumer perception of genetically modified organisms and sources of information. *Advances in Nutrition* **6**(6), 842–851.

Appendix A.

Table A1. Measures of goodness-of-fit as part of the selection criteria to identify the optimal number of segments in the latent class model

Classes	N. of observations	Likelihood function	AIC	BIC
2	3896	−3243.70	6563.39	6801.56
3	3896	−3104.50	6351.00	6796.01
4	3896	−2951.16	6110.32	6762.16
5	3896	−2855.65	5985.30	6843.98

Appendix B.

Information treatments

- 1) No additional information (control group)
- 2) Traditional media. Excerpt from a *Washington Post* article, “Gene-edited farm animals are coming. Will we eat them?” By Carolyn Y. Johnson December 17, 2018,

“As scientists in labs across the world create virus-resistant pigs, heat-tolerant cattle and fatter, more muscular lambs, a big question looms: Will regulation, safety concerns and public skepticism prevent these advances from becoming anything more than fascinating laboratory experiments, or will the animals transform agriculture and the food supply? So far, gene-editing tools have jump-started research worldwide, creating more than 300 pigs, cattle, sheep and goats. Now, proponents of the field say the United States is at a make-or-break moment, when government action over the next year could determine whether any gene-edited food animals make it to market.”

“[At UC Davis, there] are five bulls and a heifer, the second generation of cattle that have been gene-edited to lack horns, avoiding a grisly procedure in the dairy industry called “disbudding,” when calves’ horns are burned or cut off.”

“Gene-edited plants will soon be in the grocery store, but similar tinkering with the DNA of animals faces a far more uncertain future. The regulatory process for getting animals approved is more complex and treats the edited DNA as a veterinary drug — a difference that animal scientists argue will effectively kill their field by preventing innovations that could make raising livestock more sustainable, more efficient or more humane. Many advocates and ethicists agree that the current oversight system is a poor fit but think that scientists and industry underestimate potential safety concerns.”

“‘We’re at this inflection point in society, where gene editing is really taking off, and now is the time we could have a more sustained public conversation about how we want it used in our world and how we don’t want it to be used,’ said Jennifer Kuzma, co-director of the Genetic Engineering and Society Center at North Carolina State University. ‘All the polls indicate that people are less comfortable with animal biotechnology than plant biotechnology . . . A regulatory system cannot be based 100% on science or scientific risk, and values come into play when setting the standards.’”

“Scientists were re-energized by the invention of new and more precise technologies, the most famous of which is CRISPR, short for clustered regularly interspaced short palindromic repeats. Using CRISPR, scientists can quickly, easily and cheaply make targeted cuts to the genome and make changes or insert new genes. Instead of introducing

the foreign DNA that had triggered public skepticism, they could delete or change a single letter out of billions in an animal's genome. Such changes happen routinely in nature — they are the basis for evolution — so scientists were hopeful that regulators and the public would see these animals differently."

3) Social media. Tweets



4) Science video link <https://youtu.be/ZUG9V9mXStU?si=cbaByti-RpeVcOgf>



Appendix C. Descriptive statistics of responses to other survey questions.

Table C1. Descriptive statistics of survey respondents

Variable	Description	Survey respondents (%)
Donor	Ever donate to animal shelter	50.17
Vegetarian	Vegetarian	7.04
Political	Always Democratic Party	23.85
	More often Democratic Party	21.27
	Equally Likely	21.67
	More often Republican Party	19.29
	Always Republican Party	13.93
Farm	Ever work on a farm or ranch	23.35
Ag. Degree	Degree related to agriculture or food	4.51
Ag/Food work	Ever work in agriculture, food production or food processing	15.82
Traditional media use	Newspaper online	46.60
	Other print	29.60
	News magazine online	23.30
	Newspaper print	21.91
	News magazine print	13.38
Social media use	Facebook	51.12
	Instagram	16.91
	TikTok	10.81
	X (former Twitter)	7.68
	Do not use social media	6.05
	Other social media	4.36
	LinkedIn	3.07
Frequency of social media log in	Never	5.08
	Rarely (monthly or less)	2.38
	Weekly	8.48
	Daily	30.89
	A few times a day	27.27
	Always logged in	25.19

Table C2. Summary statistics on trust by information sources

Source	Mean (1=Strongly do not trust, 5=Strongly trust)	Standard deviation
Community		
Friends, family members	4.11	0.93
Farmer farmers	4.07	0.90
Medical professionals	3.95	1.02
Farmer organizations	3.86	0.95
Scientific associations	3.67	1.03
Organic or sustainable agriculture farmers associations	3.66	0.97
Science journals and blogs	3.63	1.01
Science advocates	3.48	1.02
Universities	3.44	1.03
Consumer organizations	3.41	0.97
Government agencies	3.36	1.21
Food retailers	3.36	1.11
Food manufacturers	3.27	1.18
Activist groups	3.03	1.08
Local government	2.99	1.13
Media		
Food channels	3.63	0.96
Specialized food magazines	3.45	1.00
National TV	3.29	1.14
Radio	3.20	1.00
Newspapers online or print	3.18	1.12
YouTube	3.02	
General magazines	2.96	1.10
Pinterest	2.81	1.17
Blogs	2.78	1.13
Reddit	2.76	1.16
Instagram	2.62	1.21
Facebook	2.57	1.23
X (former Twitter)	2.47	1.22
TikTok	2.42	1.24

Table C3. Attitudes towards animal welfare

Statements	Mean (1=Strongly do not agree, 7=Strongly agree)	Standard deviation
It is important that the food I normally eat has been produced in a way that animals' rights have been respected	5.64	1.37
It is important that the food I normally eat has been produced in a way that animals have not experienced pain	5.56	1.39
Increased regulation of the treatment of animals in farming is needed	5.51	1.47
In general humans have too little respect for the quality of life of animals	5.42	1.53
Animal agriculture raises serious ethical questions about the treatment of animals	5.38	1.47
The stress during animal production could affect the quality of meat, milk, eggs and sub- products	5.33	1.32
The farmer should be economically compensated for spending money to increase animal welfare.	5.22	1.38
Using gene-editing to reduce a farm animal's risk of injury or disease is acceptable	4.50	1.71
As long as animals do not suffer pain, humans should be able to use them for any purpose	4.29	1.74
Gene-editing should be forbidden for farm animals even if it increases animal welfare	4.02	1.74
It is acceptable to use animals to test consumer products such as soaps, cosmetics and household cleaners	3.22	1.87

Table C4. Importance of milk characteristics

Milk characteristic	Mean (1=Totally irrelevant, 5=Crucial)	Standard deviation
Sell-by date	4.23	0.93
Price	3.71	1.00
Package size	3.42	1.03
High protein	3.13	1.24
Fat content	2.97	1.20
Ultra-pasteurized	2.93	1.11
Brand	2.88	1.14

(Continued)

Table C4. (Continued)

Milk characteristic	Mean (1=Totally irrelevant, 5=Crucial)	Standard deviation
Grass-fed cows	2.84	1.29
Reduced sugar content	2.70	1.27
rBGH-free or rBST-free	2.67	1.30
Organic	2.61	1.34
Lactose-reduced	2.30	1.33

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