Is it just about grazing? UK citizens have diverse preferences for how dairy cows should be managed

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ABSTRACT

Conflicting views between the dairy industry and the public about how dairy cows should be managed, together with an increase in the availability of alternatives to dairy foods, challenge future markets for milk producers. Members of the public value animal welfare as well as naturalness and grazing, but neither the relative importance of specific aspects of management nor the diversity of views underlying these preferences have been established. To better understand these issues, 2,054 UK citizens recruited through a research panel took part in an online survey. They were asked to rank 17 attributes relating to dairy cow management and milk production through the novel application of best–worst scaling, a discrete choice methodology that allows a trade-off between items. Hierarchical Bayesian analysis of the results revealed 3 attributes of equal top importance: (1) access to grazing, (2) cow health and welfare, and (3) cow comfort. Alongside this overarching ranking, underlying differences in preferences were identified in 6 approximately equally sized citizen groups within the sample, which were identified through latent class analysis. Each latent class expressed significantly different priorities from the other, and each had different indicative sociodemographic, attitudinal, experiential, and value-oriented characteristics, as established through a multinomial logistic model. If the diversity of preference between the citizen groups found in the sample is reflected within wider populations, there may be opportunities for the dairy industry to improve communication about positive practices, develop new dairy product markets, and consider changes to dairy farming systems to better meet different citizens' needs. Furthermore, the defining characteristics and priorities of each group raise the question of whether grazing in particular, but also other attributes presented within

the study, is understood in different ways by different subgroups of citizens.

Key words: dairy, public opinion, milk, grazing, best–worst scaling

INTRODUCTION

Farm animal production methods adopted in the United Kingdom (UK) and beyond since World War II have led to more efficient farming that uses less labor and fewer resources and produces an abundance of safe, affordable, and accessible food (Capper et al., 2009; Godfray et al., 2010; FAO, 2017). However, this evolution has raised concerns about an increase in factory farming, a term used more than 50 yr ago (Harrison, 1964) and still used today to refer to livestock managed intensively with perceived or actual negative outcomes in terms of society, the environment, or animal welfare (Fraser, 2001; Lusk et al., 2007).

The way in which the global dairy industry manages its cows amid growing economic and environmental sustainability pressures (Peters et al., 2016; Röös et al., 2017), and reconciles these with social sustainability concerns (von Keyserlingk et al., 2013; Britt et al., 2018), is the topic of much debate, not least because of the lack of consensus around what constitutes good management. It has been well documented that 2 key stakeholder groups—farmers and the public—often hold conflicting perspectives, particularly on animal welfare. For example, Vanhonacker et al. (2008) reported differences in opinion between citizens and farmers about whether farm animals were able to engage in natural behavior. The beef and pig farmers questioned in Spooner et al. (2012, 2014a) prioritized biological health and protection from natural hazards for their animals, whereas the citizens in Spooner et al. (2014b) wanted farm animals to have a natural life. A similar disconnect between farmers or agricultural advisors and lay citizens was identified by Cardoso et al. (2019) regarding expectations for dairy farming standards: the farmers and advisors interviewed placed the most importance on biological functioning, and lay

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citizens instead referred to affective states and naturalness. Survey findings show that European citizens have clear expectations that farm animal welfare should be protected (European Union, 2016), and it was the opinion of Britt et al. (2018) that societal preferences will continue to affect food—including dairy—production as future generations become increasingly displaced from ancestral connections with farming. This phenomenon, coupled with a growing range of alternatives to dairy foods (Graham, 2019), portends new threats to the economic viability of dairy products.

The case for taking action to address both the image and the underlying practices of dairy farming as well as the market focus of its products may be evident (Duffy et al., 2005; Ellis et al., 2009), but exactly which aspects are most important to the public, and therefore priorities for the industry to tackle, remain unclear. In many studies, the public expresses broad and sometimes vague concepts of good farm animal management, such as animal welfare and naturalness or natural behaviors (Lusk and Briggeman, 2009; Bazzani et al., 2016). Other studies have determined support for specific features, such as outdoor access (Lusk et al., 2007; Mulder and Zomer, 2017), reduced stocking density (Liljenstolpe, 2008; Vanhonacker et al., 2008), and improved bedding or flooring (Hall and Sandilands, 2007; Krystallis et al., 2009). Specifically regarding dairy production, Ellis et al. (2009) concluded that the general public aligns good dairy cow welfare most closely with aspects such as appropriate feeding, good stockmanship, cleanliness, and plenty of space or freedom to roam, whereas von Keyserlingk and Weary (2016), referring to Cardoso et al. (2016) and Schuppli et al. (2014), maintained that the public was unanimous in its expectation that cows should have access to pasture. These studies reported their results based on the mean of their participants' responses. Other studies have identified subgroups with heterogeneous preferences regarding, for example, meat production (Meuwissen et al., 2007; de Jonge and van Trijp, 2013), cow-calf separation in dairy cows (Busch et al., 2017), and pasture-based milk production (Weinrich et al., 2014; Kühl et al., 2017). These differing preferences have been explained by a range of factors, including sociodemographics, experiences, and knowledge (Kendall et al., 2006; Cornish et al., 2016); belief in an animal mind (Knight and Barnett, 2008); and wider values (Boogaard et al., 2011). However, to our knowledge, the relative importance that individuals place on various features of a dairy cow's environment or management has not previously been examined, nor has their heterogeneity of preference or the characteristics that might affect any differences.

In attempting such an exercise, Likert-type scoring, which is common in determining preferences, has the

potential to be limited by lack of score differentiation and social desirability bias (Cohen and Neira, 2003; Bertram, 2006). An alternative method is best-worst scaling (BWS), which repeatedly presents differently ordered subsets of the items to participants and asks them to select only the best and worst (or most and least) options, compelling them to trade off items against each other. This method has been found to improve predictability (Adamsen et al., 2013) and has been used in a range of fields, including consumer behavior (Jaeger et al., 2008; Mueller and Rungie, 2009), health care (Najafzadeh et al., 2012), food safety (Erdem et al., 2012), food labeling (Ellison et al., 2017), and dairy farmer preferences (Hansson and Lagerkvist, 2016), but has not previously been used for this subject with citizens. Therefore, this study set out to present several attributes relating to dairy cow management through the novel application of the BWS method in an online survey of UK citizens. The aim was to obtain a relative ranking of cow management attributes according to their importance in the eyes of citizens and to determine whether heterogeneity of preference exists as well as an explanation of any differences.

MATERIALS AND METHODS

Data Collection and Sample

Between April 6 and 13, 2018, a consumer marketing research company (Made In Surveys, Lille, France; <https://en.misgroup.io/>) with 1 million panel members globally and 160,000 in the UK invited its UK members to participate in an online survey on behalf of the University of Nottingham School of Veterinary Medicine and Science. It aimed to recruit sociodemographically diverse citizens aged 16 yr and older from across the UK to participate, with those completing the survey receiving points toward vouchers as a standard incentive practice used by this marketing research company. Although many surveys set age parameters at 18 yr and older, 16- and 17-yr-olds were included due to emerging generational differences in attitudes toward food and animal ethics (Bennett et al., 2017). The sample was balanced by gender, age, geographical region, dietary preference, and rurality of area. To secure a representative sample of rural citizens with a precision of $\pm 2\%$ and confidence level of 95% (385) from an adult population of 35 million in the UK, of which less than 20% are likely to be rural (estimated from a rural population of 17% in England; DEFRA, 2017), a total sample of 1,418 respondents was required. After adjusting for nonresponse or nonparticipation, the sample size was increased to 2,000. The survey was created in Sawtooth Software Lighthouse Studio version 9 (Sawtooth Soft-

ware Inc., 2008) and received ethical approval from the University of Nottingham School of Veterinary Medicine and Science's Research Ethics Committee. Compliance with General Data Protection Regulation 2016/679 was explained to participants in the survey introduction.

BWS

Best–worst scaling was the discrete choice methodology used to present a range of cow management attributes to participants. Introduced in the early 1990s (Louviere and Woodworth, 1991; Finn and Louviere, 1992), BWS forces a trade-off by requiring participants to choose the 2 items that are best and worst, or most and least, from a subset of (most commonly) 4 or 5 items presented to them repeatedly in different combinations. The approach produces both a rank and an interval scaling of the items indicating their relative importance for both individual participants and the sample as a whole.

Using Sawtooth Software Lighthouse Studio version 9 (Sawtooth Software Inc., 2008), a partially balanced incomplete block design was created for the BWS exercise according to methods previously described by Sharma (2000). Subsets of the attributes identified for inclusion were presented in repeated tests that were balanced in (1) factor frequency, (2) positional frequency, and (3) orthogonality to satisfy optimal design characteristics, following an approach defined by Orme (2009). This means that the attributes were presented an equal number of times in different combinations and orders across a total of 12 tests, with 5 attributes in each test (Orme, 2005; for an example of a test, see Supplemental Table S1, <https://doi.org/10.3168/jds.2019-17111>). Given the anticipated range of experiences and knowledge of dairy farming among the participants, it was important to anchor them in an environment to which they could all relate equally. Therefore, a supermarket aisle was selected as the setting, although steps were taken in the framing of the question to eliminate bias due to diet, purchasing habits, and concerns over the accuracy of the information provided. Respondents were asked to select the most and least important attributes in each set when asked the following:

“You are in a grocery shop, walking through the aisle for milk, dairy and plant-based alternatives. More information than usual has been provided about the different types of cow milk on display. This has been supplied by a trusted food assurance scheme. Irrespective of whether you are buying any milk on this occasion, you have time to spare, so you read the information provided. You will now see a series of questions. Each includes

5 pieces of information about the cow milk on display. Which feature is the MOST important and LEAST important TO YOU in each set of 5, if price is not an issue? There are 12 questions in total.”

Attributes

Thirteen themes related to farm animal or dairy cow management identified from scientific literature and other available reports were judged to be relevant to the research and were therefore included as attributes in the BWS exercise. These were (1) outdoor access including fresh air, daylight, and sun (Vanhonacker et al., 2008; Bergstra et al., 2017); (2) choice of environment and activity (Schuppli et al., 2014; Spooner et al., 2014b); (3) grazing or access to pasture (Spooner et al., 2014b; Cardoso et al., 2019); (4) length of access to grazing, usually in days per year (Kühl et al., 2017; Darwent and Leaver, 2018); (5) scale and corporatization of the farm (Lassen et al., 2006; Lusk et al., 2007); (6) individual care and avoidance of commoditization of the animal (Vanhonacker et al., 2010; Cardoso et al., 2019); (7) space allowance or restriction and confinement when inside (Harper and Henson, 2001; Te Velde et al., 2002); (8) nutrition and diet (Ellis et al., 2009; Schuppli et al., 2014); (9) comfort, especially when lying (Vanhonacker et al., 2010; Cardoso et al., 2019); (10) health and welfare (Schuppli et al., 2014; European Union, 2016); (11) mother–offspring separation (Ventura et al., 2013; Hötzel et al., 2017); (12) mechanization and technology (Boogaard et al., 2008; Cardoso et al., 2019); and (13) behavioral enrichment and ability to investigate surroundings (Vanhonacker et al., 2010; Bergstra et al., 2017). The term “naturalness” was excluded because it has a more complex range of definitions that are more open to interpretation than the chosen themes (Nuffield Council on Bioethics, 2015). Other qualitative methods should be used to explore the use of this term.

Previous studies have indicated that some participants are more interested in eating quality or environmental and social impact of food than the welfare of the animals. As a result, 4 additional noncow attributes were added to provide alternatives for participants for whom cow management or welfare were of less interest. These were (1) locally produced milk (Wolf et al., 2011), (2) the taste of milk (Meuwissen and Van Der Lans, 2004), (3) a fair price paid to the farmer for the milk (Ellis et al., 2009), and (4) the milk's carbon footprint (Vanclay et al., 2011). The price of milk as an end product was deliberately excluded to avoid implying that this was a willingness-to-pay exercise; however, this aspect was controlled for in the framing of the question by asking

which feature was most and least important if price was not an issue. All attributes were phrased in a consistent form in an attempt to mitigate any criticism of terms being presented positively or negatively and were phrased succinctly to fit within the BWS structure.

Values, Attitudes, and Experiences

The extent to which respondents believed dairy cows have awareness, can recognize cause and effect, and experience emotions, thoughts, or feelings was explored. This was based on a set of 6 questions taken from Busch et al. (2017), which was in turn adapted from Hills (1995; see Supplemental Table S2, <https://doi.org/10.3168/jds.2019-17111>). Other questions included how rural or urban the areas in which the respondent had lived were; their connection with farming or the dairy industry; whether they had visited farms and, if so, how long ago; experience of keeping pets or animals; dietary preferences; and type of milk or alternative they consumed at typical milk consumption opportunities (Lusk et al., 2007; Ellis et al., 2009). An indication of pre-existing knowledge of dairy farming was ascertained through 3 multiple-choice questions relating to dairy cows based on Vanhonacker et al. (2007) and Ventura et al. (2016). The respondents were also asked to rate their own knowledge of dairy farming compared with the average UK citizen on a sliding scale of -5 to $+5$.

Following observations from Boogaard et al. (2011) about the role of values in acceptance of modern farming practices, an indication of participants' value orientations was obtained using the Schwartz Portrait Value Questionnaire (Schwartz, 2003b), validated internationally and through its use in the European Social Survey (Davidov et al., 2008). The Schwartz Portrait Value Questionnaire presents 21 short descriptions of a person's behavior and asks respondents to state for each, on a 6-point Likert-type scale, how like that person the description is, ranging from "not like me at all" to "very much like me." The 21 descriptions relate to 10 values identified by Schwartz. Centered scores for a respondent's own values are computed by taking the mean scores for the items that index each value and then deducting the mean score obtained across all 21 questions (Schwartz, 2003a, 2012).

Statistical Analysis

The BWS responses were analyzed using a hierarchical Bayes framework, a random utility theory approach that is based on the method of paired comparisons (Thurstone, 1927) and commonly used for discrete choice experiments. The underlying hypothesis is that the utility or worth of option 1 over option 2 is indi-

cated by how often option 1 is selected in preference to option 2. The more times option 1 is selected at the expense of option 2, the stronger the preference for option 1 compared with option 2, which results in not just a ranking but also a scale of importance, which Thurstone (1927) called a "distance" between 2 alternatives. A choice is assumed to have an underlying value, or utility, to respondents. When applying this to a set of options, it is assumed that individuals have an underlying subjective scale behind their choices and that the utility allocated to each item represents where each item is on that scale (Louviere et al., 2013). This can be expressed as

$$U_{xn} = V_{xn} + \varepsilon_{xn},$$

where U_{xn} is the unidentified utility that individual n associates with choice option or item x ; V_{xn} is the observable component of utility that can be estimated from behavioral data; and ε_{xn} is the random error component that follows a Gumbel distribution (Louviere et al., 2002).

As described in Shortall et al. (2017), the probability (P) that a person will choose item i as the most important from a set of K items can be expressed as

$$P_i = e^{U_i} / \sum e^{U_K},$$

where e^{U_i} is the antilog for the utility for item i , and e^{U_K} is the antilog of the utility scores for each item in the set of K items. Conversely, the probability of choosing item j as the least important in the set of K items can be expressed as

$$P_j = e^{-U_j} / \sum e^{-U_K},$$

where e^{-U_j} is the antilog for the negative utility for item j , and e^{-U_K} is the antilog of the negative utility scores for each item in the set of K items. Finally, the probability that a person will choose items i and j as most and least important, respectively, is the probability that the difference in utility between i and j is greater than the difference in utility between any other pair in a set of K items. This probability (P) can be expressed in conditional logit form (i is chosen best and j is chosen worst) as follows:

$$P_j = \frac{e^{U_i - U_j}}{\sum_{m=1}^K \sum_{l=1}^K e^{U_m - U_l} - K},$$

where m is the most important choice and l is the least important choice.

Hierarchical Bayesian Analysis

A hierarchical Bayesian (HB) estimation within the MaxDiff program was used to calculate individual scores under the logit rule (Sawtooth Software Inc., 2008). Using this approach, HB analysis gave an overall ranked and scaled score for each attribute across the whole sample.

Latent Class Analysis

To identify underlying groups that ranked the attributes in a similar way within the overall sample, latent class analysis was conducted (Sawtooth Software Inc., 2008). Latent class analysis is a measurement model through which individuals can be classified into groupings, or latent classes, based on their pattern of answers from a set of categorical variables—in this case, their ranked and scaled attributes from the BWS exercise. This analysis identified underlying groups of participants who expressed preferences similar to each other but different from other groups and estimated utility scores (with logit scaling) for each group (Orme, 2009). Between 2 and 7 latent class grouping options were considered. Although positive but diminishing gains in a Bayesian information criterion goodness-of-fit test indicated that 5 or 6 latent class groups both presented optimal solutions, 6 classes gave a better differentiation of preferences between groups. Therefore, a class membership, or group allocation, from the 6-class latent class solution was allocated to each respondent based on the maximum probability of their membership in that class.

Multinomial Logistic Modeling

Multinomial logistic modeling in Stata 15.1 (Stata-Corp, College Station, TX) was used to build a model in a forward stepwise approach, expressing relative risk ratios (RRR) of an individual belonging to latent classes 2, 3, 4, 5, or 6 against that individual belonging to latent class 1. The model was intended to draw out maximum differences between the 6 latent class groups in terms of related sociodemographic, attitudinal, experiential, and value-oriented characteristics. The moderate nature of latent class 1's relationship with most of these characteristics, as opposed to the more extreme relationships exhibited by some of the other classes, provided an informative baseline against which more subtle differences between the groups could emerge. Therefore, when testing for results from the model, using latent class 1 rather than any of the other classes as a reference provided the most insight into

the characteristics of the individuals allocated to the different groups.

The multinomial logistic model can be described as

$$\log \left[\frac{\pi_i^{(s)}}{\pi_i^{(t)}} \right] = \beta_0^{(s)} + \beta_1^{(s)} x_i, s = 1, \dots, t-1,$$

where the probability of the i th respondent being in class s rather than class t is estimated by contrasting each of the response categories with its reference category. In this, the parameter $\beta_1^{(s)}$ is interpreted as the additive effect of a 1-unit increase in x on the log-odds of being in category s rather than category t .

RESULTS

Respondent Characteristics

A total of 2,054 completed survey responses were received over the 1-wk period. Although this was a convenience sample recruited from a panel database, quotas had been set to reflect UK distributions for age, gender, region, dietary preference, and the rurality of the area in which the participant had lived. The sociodemographic breakdown of respondents is described in Table 1.

Ranking the Attributes by Relative Importance

The mean fit statistic for the whole sample was 0.490, indicating that the BWS MaxDiff exercise had been completed to a good level of internal consistency within the sample as a whole. The mean preference scores for each attribute, calculated from the HB analysis of the sample responses to the BWS exercise and scaled for relative importance, are presented in the second column of Table 2 and in Figure 1 in order of ranked importance (see Table 3 for a list of attributes and their abbreviations). Three attributes were of equal top importance, with no significant difference between the highest-scored attribute “This milk comes from cows that graze outdoors most of the year” and the second highest-scored attribute “This milk comes from farms ranked top in the UK for health and welfare” ($P = 0.72$); neither was there a significant difference between “This milk comes from farms ranked top in the UK for health and welfare” and the third highest-scored attribute “This milk comes from farms that prioritize the comfort of their cows above everything” ($P = 0.57$). The scores for these 3 attributes were significantly higher (by almost 20%) than the next nearest attribute, “This milk guarantees a fair price to the farmer.”

Table 1. Sociodemographic breakdown of the respondents completing the online survey (n = 2,054)

Variable	Sample results
Age	Mean, 45.94 yr; range, 16–86 yr Percentage in each age category ¹ : 16–24 yr, 10.91% (13.47%); 25–34 yr, 21.03% (16.74%); 35–44 yr, 16.71% (15.58%); 45–54 yr, 18.62% (17.27%); 55–64 yr, 14.30% (15.54%); 65–74 yr, 14.69% (12.30%); 75+ yr, 3.73% (10.10%)
Gender	Male, 43%; female, 56%; other, <1%; prefer not to say, <1%
Region	Northwest, 13%; Northeast/Yorkshire, 13%; East Midlands, 9%; West Midlands, 11%; East/East Anglia, 9%; Southeast/London, 23%; Southwest, 9%; Wales, 5%; Scotland, 7%; Northern Ireland, 2%
Children	Responsibility for children: no, 41%; yes—now, 30%; yes—used to, 29%; other, <1%
Area	Main residence: urban, 38%; suburban, 34%; rural, 16%; mix of places but not rural, 2%; mix of places including rural, 9%; other, <1%
Income	Annual household take-home income: <£20,000, 29%; £20,000–40,000, 35%; £40,000–£60,000, 16%; £60,000–£100,000, 8%; >£100,000, 2%; prefer not to say, 10%
Education	Highest achieved: school, 28%; college diploma, 16%; degree, 32%; postgraduate, 13%; vocational/skilled, 9%; other, 1%; prefer not to say, 1%
Ethnicity	White, 90%; mixed, 2%; Asian, 5%; black, 2%; other, <1%; prefer not to say, 1%

¹ONS (2017) statistics given in parentheses.

Attributes relating to the behavioral enrichment of the cow and use of technology (“This milk comes from cows given brushes and toys so they can express their natural curiosity” and “This milk comes from farms which use the latest technology and automation,” respectively) emerged as the least important attributes. Next lowest—although twice as important as the previous 2 items according to the scaled scores—was “This milk has a lower carbon footprint than other milk and plant-based alternatives.” Attributes relating to the size of the farm and the individual level of attention

given to the cow (“This milk comes from small farms where just the family manages the cows” and “This milk comes from farms where the farmer knows each cow’s history and character,” respectively) scored next lowest for importance.

Latent Class Groups

The 6 groups identified through latent class analysis of the whole sample’s individual HB scores all prioritized different attributes (Table 2), with the exception

Table 2. Overall ranking and hierarchical Bayesian (HB) scores for the 17 attributes alongside individual HB scores for each underlying latent class¹

Item	Attribute abbreviation	HB ²	Class ³					
			1 (welfare)	2 (grazing)	3 (taste)	4 (farm price)	5 (cow comfort)	6 (no preference)
Class size, % of sample			18.3	15.6	15.2	18.9	14.8	17.2
Overall ranking								
1	GrazeM	10.70	9.56	16.83	10.44	10.59	10.45	6.18
2	H&W	10.64	17.76	5.28	13.43	9.30	9.91	7.34
3	Comfort	10.61	15.02	11.12	7.24	8.44	15.97	6.60
4	Price	8.85	12.43	5.00	11.98	15.29	2.05	5.71
5	Yards	7.63	7.40	11.48	5.58	4.91	10.16	6.49
6	Calves	7.12	7.53	8.85	3.73	5.66	11.02	5.59
7	Graze2	6.35	5.71	10.63	6.39	5.36	4.92	5.72
8	Choice	5.92	5.67	7.94	1.76	2.43	12.43	5.77
9	Diet	5.18	5.78	4.11	6.60	3.09	5.24	6.35
10	Local	5.07	1.60	1.93	4.08	13.63	0.93	5.34
11	Taste	4.39	1.05	2.97	14.67	2.07	0.66	5.69
12	Roam	4.29	3.64	5.71	3.90	3.14	4.99	6.24
13	Family	3.82	1.91	3.05	2.56	8.21	2.47	5.07
14	Individual	3.63	1.85	2.76	1.76	4.93	3.75	5.63
15	Carbon	2.99	2.19	1.25	3.94	1.80	1.28	5.85
16	Toys	1.47	0.52	0.41	0.41	0.44	3.50	4.77
17	Tech	1.34	0.39	0.69	1.53	0.72	0.29	5.65

¹The most important attribute in each class is identified in bold.

²Hierarchical Bayesian score indicating scaled ranking by importance.

³Each class name is in parentheses.

Figure 1. The 17 attributes in order of declining ranked importance after hierarchical Bayesian analysis (n = 2,054). See Table 3 for abbreviation definitions.

of latent class 1 and latent class 6, which both selected health and welfare as most important. The groups were relatively evenly distributed within the sample, with the numerically largest (latent class 4) comprising 18.9% of the sample and the smallest (latent class 5) comprising 14.8%.

Multinomial Logistic Regression Model

The multinomial logistic model identified 13 sociodemographic, attitudinal, experiential, and value-oriented characteristics that were significant predictors of class membership and therefore, potentially, dairy cow man-

Table 3. The 17 attributes tested in the best-worst scaling exercise¹

"This milk..."	Abbreviation
is from cows managed indoors that can walk into open outdoor yards at any time	Yards
is from cows that choose their own timetable and habitat, inside and out	Choice
comes from cows that graze outdoors most of the year ²	GrazeM
comes from cows that graze outdoors for at least a couple of months each year ²	Graze2
comes from small farms where just the family manages the cows	Family
is from farms where the farmer knows each cow's individual history and character	Individual
comes from farms where cows roam freely when indoors	Roam
is from cows fed a diet designed to meet their individual nutritional needs	Diet
is from farms that prioritize the comfort of their cows above everything	Comfort
is from farms ranked top in the United Kingdom for health and welfare	H&W
comes from cows that keep their calves beside them for several months	Calves
is from farms that use the latest technology and automation	Tech
is from cows given brushes and toys so they can express their natural curiosity	Toys
comes from farms local to your area	Local
tastes better than other cows' milk	Taste
guarantees a fair price to the farmer	Price
has a lower carbon footprint than other milk and plant-based alternatives	Carbon

¹Attributes were presented in subsets of 5 within 12 differently ordered combinations.

²These attributes were prohibited from appearing together.

agement or milk production priorities. These were age; gender; education; experience with pets or animals; a previous visit to a farm; knowledge of dairy farming; dietary choice; milk consumption choice; the level of belief in “a dairy cow’s mind”; self-rated knowledge of dairy farming; and the 3 values of achievement, universalism, and tradition. Only 3 of the 10 values in the Schwartz Portrait Value Questionnaire were included due to multicollinearity (Schwartz, 2003a). The RRR showing the relative likelihood of an individual in latent class 2, 3, 4, 5, or 6 having certain characteristics compared with latent class 1 are summarized in Table 4.

Characterizing the Latent Classes

With each latent class selecting a different attribute as its most important, the classes were named after their most important attribute. The exception was latent class 6. As with latent class 1, its members identified health and welfare as the most important attribute, but unlike latent class 1, all of the scores awarded to each attribute were much closer together and showed no significant prioritization. For this reason, latent class 6 was named the “no preference” group, and latent class 1 (the reference class against which the predominant characteristics of the other 5 classes were estimated) was named the “welfare” group.

Because all other classes had a lower RRR than the welfare group for the value of universalism (i.e., wanting to make the world a better place), members of the welfare group had the highest probability of including respondents that were oriented toward universalism. Equally, they were low in their orientation toward achievement. They were very likely to have visited a farm at some point, the most likely to eat an unrestricted (likely omnivorous) diet, and the most likely to have a university education.

By contrast, latent class 2, which was labeled the “grazing” group after its members’ highest-prioritized attribute, included individuals least likely to have lived in rural areas. This group was one-third less likely to live in rural areas ($RRR = 0.7$) than the welfare group and was the most urban and suburban group in the sample. The grazing group was also the joint oldest group, particularly with people over 45 yr of age, who were between 3.4 and 4.9 times more likely to be in the grazing group than the welfare group.

Members of latent class 3, named the “taste” group because the taste of milk was their most important attribute, were half as likely to believe in a dairy cow’s mind ($RRR = 0.5$) as those in the welfare group. They were 1.8 times more likely to be male and half

as likely to be oriented toward universalism ($RRR = 0.5$). They scored joint highest for dairy knowledge and were around 1.8 times more likely to have gotten all 3 multiple-choice questions correct (i.e., they were more knowledgeable about dairy farming than those in the welfare group).

Latent class 4, which was named the “farm price” group because of its highest ranked attribute, was similar to the grazing group in that it generally included older members; people over 45 yr of age were between 2.4 and 5.1 times more likely to be in this group than in the welfare group. They were also the most likely to be traditional (with higher scores for traditionalism; $RRR = 1.2$), and they had the joint highest level of dairy knowledge alongside the taste group ($RRR = 1.8$). They were almost one-third less likely ($RRR = 0.7$) to have a university education than the welfare group and much less likely ($RRR = 0.6$) to have had a pet or other animal at any point.

Latent class 5, named the “cow comfort” group after its top-ranked attribute, was characterized by being most likely to have members with a strong belief in a dairy cow’s mind. In fact, out of the whole sample, those with a strong belief in a dairy cow’s mind were more than 2.5 times more likely to be a member of the cow comfort group than the welfare group. However, they were half as likely to consume cow milk as those in the welfare group ($RRR = 0.5$) and two-thirds less likely to have an unrestricted diet ($RRR = 0.3$), meaning that this group contained the highest proportion of vegans and vegetarians. They also had the lowest likelihood of having a university education ($RRR = 0.62$ compared with the welfare group, which had the greatest likelihood of a university education).

As noted earlier, the final class (latent class 6) was named the “no preference” group because its members showed very little contrast in preference between the 17 attributes. The difference in scores between their most and least important attributes was just 2.57 compared with the other groups, which had scores ranging from 14.26 (taste group) to 17.24 (welfare group). Those in the no preference group were less than half as likely to believe in a dairy cow’s mind as the welfare group ($RRR = 0.4$). They had the lowest experience with pets or animals ($RRR = 0.4$), rated their dairy knowledge as the highest of all groups ($RRR = 1.3$), were more than twice as likely to be male than the welfare group ($RRR = 2.2$), and were more likely than the welfare group to have never visited a farm ($RRR = 2.0$). As with the taste group, they were strong on achievement ($RRR = 1.26$) and were almost two-thirds less likely to be universally minded than the welfare group ($RRR = 0.4$).

Table 4. Relative risk ratio (RRR) of belonging to class 2, 3, 4, 5, or 6 against belonging to class 1 for variables included in the multinomial logistic model¹

Item	Class 2 (grazing)		Class 3 (taste)		Class 4 (farm price)		Class 5 (cow comfort)		Class 6 (no preference)	
	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI	RRR	95% CI
Age, yr (compared with being 16–24 yr in class 1)										
25–34	1.28	0.62–2.62	1.15	0.63–2.08	1.55	0.81–2.95	0.64	0.35–1.16	1.16	0.66–2.05
35–44	1.94	0.94–4.00	1.06	0.56–2.00	1.51	0.77–2.96	1.07	0.58–1.94	1.04	0.56–1.91
45–54	3.40***	1.67–6.91	1.29	0.68–2.47	2.42**	1.25–4.71	1.28	0.70–2.33	0.82	0.43–1.56
55–64	3.60***	1.73–7.48	1.38	0.70–2.71	2.77**	1.41–5.45	0.69	0.35–1.35	0.58	0.28–1.19
65–74	4.87***	2.34–10.16	1.90	0.97–3.74	3.11***	1.56–6.17	0.67	0.33–1.36	0.26**	0.11–0.63
75+	4.70**	1.62–13.66	2.79*	1.01–7.68	5.12***	1.95–13.48	0.88	0.26–3.00	0.51	0.14–1.90
Belief in a dairy cow's mind	0.94	0.74–1.20	0.49***	0.38–0.64	0.72**	0.57–0.91	2.57***	1.99–3.32	0.45***	0.34–0.58
Dairy cow knowledge (referent: fewer than 3/3 correct answers)	1.05	0.65–1.69	1.85*	1.15–2.98	1.84**	1.20–2.83	1.05	0.62–1.77	0.86	0.48–1.55
Rurality (referent: has not lived in rural areas)	0.66*	0.45–0.96	0.73	0.49–1.08	1.38	0.98–1.94	0.89	0.60–1.31	0.73	0.47–1.13
Type of milk consumed (referent: does not mainly drink cow milk)	1.41	0.68–2.92	1.19	0.60–2.34	1.76	0.83–3.71	0.46**	0.26–0.82	0.67	0.36–1.24
Dietary preference (referent: restricted diet, e.g., vegetarian)	0.69	0.41–1.14	0.77	0.44–1.34	0.82	0.49–1.37	0.33***	0.21–0.52	0.62	0.36–1.07
Education (referent: not university educated)	0.76	0.54–1.06	0.90	0.65–1.27	0.70*	0.51–0.97	0.62**	0.44–0.89	0.75	0.53–1.07
Experience with animals (referent: has no experience)	0.70	0.42–1.15	0.50**	0.31–0.80	0.60*	0.37–0.96	1.10	0.62–1.94	0.38***	0.24–0.62
Self-rated dairy cow knowledge	1.06	0.98–1.14	0.99	0.92–1.07	1.08*	1.00–1.16	1.02	0.94–1.10	1.30***	1.20–1.41
Gender (referent: female)	1.30	0.94–1.81	1.77***	1.27–2.49	1.07	0.78–1.47	0.84	0.59–1.21	2.21***	1.55–3.16
Farm visit experience (referent: has visited a farm in the past)	1.13	0.77–1.66	1.15	0.78–1.69	1.04	0.71–1.52	1.25	0.83–1.89	1.98***	1.33–2.94
Achievement	1.12	0.91–1.37	1.28*	1.05–1.58	1.01	0.84–1.23	1.11	0.90–1.37	1.26*	1.01–1.56
Tradition	1.16	0.95–1.40	1.04	0.85–1.27	1.23*	1.02–1.48	1.07	0.88–1.30	0.93	0.76–1.15
Universalism	0.65***	0.51–0.84	0.52***	0.40–0.67	0.62***	0.49–0.79	0.88	0.68–1.14	0.36***	0.28–0.48

¹The referent class used was class 1 (welfare). All RRR figures are expressed relative to class 1.* $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

DISCUSSION

The novel application of BWS means that this is the first study, to our knowledge, to have identified a relative ranking of importance among citizens for specific aspects of dairy cow management and milk production. Furthermore, it is the first to determine heterogeneity of preference in underlying latent classes, or citizen groups, and the indicative characteristics of members of these groups.

Somewhat unexpectedly, grazing outdoors most of the year, cow comfort, and health and welfare were all ranked as being of equal top importance in this study. Dairy cows' access to grazing is already a well-established priority for the public, expressed both in research (e.g., Ellis et al., 2009; Ventura et al., 2016; von Keyserlingk and Weary, 2016) and in campaign group literature (e.g., Ispos MORI, 2010; CIWF, 2011; Darwent and Leaver, 2015), and is often cited alongside a belief that it improves cow welfare. This raises questions about the direction of UK dairy farming because despite indications that more than 90% of UK dairy farms include grazing as part of their feeding and management regimen, grazing is thought to be decreasing (March et al., 2014). Although concepts of health and welfare (e.g., Lusk and Briggeman, 2009; Kühl et al., 2019) and animal comfort (Vanhonacker et al., 2008; Cardoso et al., 2019) have also received support from the public in previous research, their equal standing with grazing in this study was unexpected, especially given the strength of preference for grazing and pasture access expressed in the aforementioned research. The additional finding that only 1 of the 6 underlying citizen groups awarded top importance to grazing means that, for this sample of UK citizens at least, preferences for dairy cow management are certainly not all about grazing.

Other attributes of relatively high importance included the ability for cows to have outside access even though they live indoors, to choose their own timetable and habitat inside and out, and to keep calves with them for several months. These findings are consistent with previous research: the public in both Spooner et al. (2014b) and Schuppli et al. (2014) supported cows being able to have their feet on pasture or earth, with Schuppli et al. (2014) further establishing that both lay citizens and those affiliated with the dairy industry wanted cows to access fresh air and sunshine and to choose their environment, inside and out. Concerns around the timing of cow-calf separation have also been well established (Ventura et al., 2013; Busch et al., 2017; Hötzel et al., 2017).

However, attributes identified as less important were revealing too. The low relative importance placed on

milk being from small family farms did not reflect concerns from the public that larger dairy farms negatively affect cow health and welfare, the quality of milk, and the naturalness of the animals' circumstances found in Miele (2010) and Cardoso et al. (2016). Nor were concerns evident over the level of personalized care an animal receives (Miele, 2010); farms where the farmer knows each cow individually also ranked relatively low in importance.

Of the 4 noncow attributes explored in this research (i.e., a fair price paid to the farmer, carbon footprint of the milk, taste of the milk, and locally produced milk), milk that guarantees a fair price to the farmer was most important and placed fourth overall. The reasons for its prioritization are not immediately clear. Boogaard et al. (2011) found that Dutch consumers would be willing to pay more for milk to support a higher quality product, and in Benard and de Cock Buning (2013), both farmers and citizens acknowledged that the ability to provide better welfare was linked to the income farmers received. In our study, 3 of the underlying citizen groups identified through latent class analysis (the welfare, taste, and price groups) placed a high relative importance on a fair price to farmers. The priorities and characteristics associated with these groups may imply that motivations are linked to a notion of fairness not only for the cows but also for the farmer working with the cows, or to enabling the farmer to produce better milk, or to supporting rural communities and traditional ideals. It would be helpful to use further methods to unpack the notion of fairness in particular. An alternative explanation is that the price paid to farmers was at the forefront of participants' minds because of publicity surrounding farmgate milk price in the media, although this issue peaked in prominence 2 yr before the survey took place (BBC News, 2015).

The scaled rankings identified for each of the underlying citizen groups provide further insight into the importance of the different attributes in relation to each other and the differences in priorities. For example, the welfare group rated health and welfare as being almost twice as important as grazing outdoors most of the year, but the grazing group rated grazing most of the year as being more than 3 times as important than health and welfare. These quantitative differences in preference between the groups illustrate that the top priorities for the whole sample were formed not from homogeneous views but rather from a combination of strong and differing preferences expressed by individuals within the underlying citizen groups.

The characteristics found through the multinomial model to be the strongest indicators of membership in a particular citizen group were coherent with previous research and with each group's priorities. Belief in

an animal mind, as described by Knight and Barnett (2008) and Busch et al. (2017), was strongly exhibited in the cow comfort group, which prioritized attributes that could be connected with a cow's behavioral well-being, such as choice about her environment or staying with her calf. As suggested by Boogaard et al. (2011), personal values were also significant. For example, the welfare, grazing, and cow comfort groups, which prioritized cow-related attributes, scored highest for universalism, indicating an interest in fairness and making the world a better place for others (including animals). The taste and no preference groups, which did not prioritize cow attributes, scored highest for achievement, which suggests more self-interest. The sociodemographic and experiential characteristics identified as significant indicators were consistent with reviews conducted by Kendall et al. (2006) and Cornish et al. (2016)—namely, age, gender, education, dietary and milk consumption choices, pet ownership, experience or knowledge of farming, and rurality were all linked to attitudes toward animal welfare.

Although the use of BWS was successful in establishing ranked preferences and identifying the underlying heterogeneity in the sample, the necessary brevity of the attribute descriptions gives rise to speculation about how participants interpreted and understood each attribute or how the presentation and wording of the attribute influenced prioritization or trade-offs. Some attributes could have been assumed to be givens (i.e., already delivered under a farmer's duty of care to his or her animals) and therefore were traded off in favor of attributes seen as currently unmet needs. Miele (2010) observed that for the vast majority of focus group participants in her study, issues such as hunger and thirst were considered very important but were also problems that "should not exist anymore in a 'civilized' Europe." Visits to farms reported in Boogaard et al. (2008) and Ventura et al. (2016) satisfied some participants' concerns but raised other concerns in areas they had previously assumed to be satisfactory. Hence, in this study, it is possible that participants inadvertently downgraded attributes that nonetheless hold great importance for them. Furthermore, some attributes could have been seen as proxies or enablers of others. For example, some may believe that grazing delivers improved health and welfare, better cow comfort, or a more suitable diet and therefore that prioritizing grazing will prioritize some associated attributes by default. Despite this, the identification of latent classes linking different rankings with specific characteristics such as dairy knowledge, rural experiences, and values gives some indication of the possible frames through which these attributes may have been interpreted. More research to clarify the

reasons behind the choices made by different groups of participants would be worthwhile.

Given evidence of a disconnect between the priorities of the dairy industry and other stakeholders (Vanhonacker et al., 2008; Cardoso et al., 2019), this research suggests several priorities the industry could seek to address. These could include better communication of how the industry is meeting cows' needs and public expectations around these aspects (e.g., delivering cow comfort or cow health and welfare), targeted product marketing based on key attributes of importance (e.g., grazing or a fair price for farmers), or adaption of current farming practices to address aspects of most concern (e.g., outdoor access for cows that otherwise remain indoors). However, questions remain as to what meanings people have constructed around these attributes and what practice and process interventions on-farm would deliver the anticipated outcomes; we intend to investigate these subjects in a following study. At a minimum, the benefits of this study come from improved understanding and better "anticipating societal debates" (Vanhonacker et al., 2008).

Several limitations to this study are acknowledged. The data were collected online through a marketing research panel whose members are paid by survey irrespective of how accurately they complete the exercise. This raised the potential for bias in the survey sample toward people who are more disposed to take part in online research panels, but also for inaccuracy if there is no incentive to complete the survey with care. Although the sample was broadly representative of the population with a few minor exceptions, there was low overall representation of ethnic groups. Media or marketing could have had effects beyond those already discussed. However, stories over the past decade almost exclusively focus on whether dairy cows graze (e.g., Webster, 2015; Blythman, 2017), and claims on milk packaging relate mainly to grazing (Darwent and Leaver, 2015; Rodionova, 2017). Hence, these external influences could explain heightened support for grazing and not for the equal priority placed on health and welfare and cow comfort or the different priorities of the 5 other citizen groups. The use of UK citizens in the study could affect its relevance elsewhere. However, the attitudes, concerns, and preferences and the demographic groups expressing them are broadly consistent with previous research from several other countries, and Schwartz's values are validated across cultures (Spini, 2003; Davidov et al., 2008). This suggests that countries with similarly developed dairy sectors and consumer affluence may find comparable heterogeneity of preference within their populations. Finally, although BWS was novel to this area and pivotal in

obtaining the scaled rankings central to our results, it can only indicate relative importance. Therefore, the top- and bottom-ranked attributes were only most and least important relative to the 17 attributes offered, and their wider importance or unimportance in relation to other attributes cannot be construed from the results. As previously discussed, the necessarily concise attribute descriptions within the BWS exercise were a key limitation of using a quantitative approach. Thus, further studies should attempt to more fully understand, through qualitative methods, what participants may have believed when they selected the attributes they did as most or least important.

CONCLUSIONS

The novel methodologies used in this study to examine citizens' rankings of importance for different aspects of milk and dairy cow management revealed a wide range of preferences and a clear order of priority. Six underlying citizen groups within the sample, which were approximately equally sized, each expressed significantly different priorities from each other and had different indicative sociodemographic, attitudinal, experiential, and value-oriented characteristics. If the diversity of preference and characteristics in this sample is representative of wider populations, it suggests that the dairy industry has an opportunity to address the current disconnect between dairy farming and its different publics through improved communication, marketing, or changes to farming systems. Building on the findings of this study through qualitative research should reveal more about the understandings that different citizens have of the features or benefits inherent in some of the attributes presented.

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REFERENCES

- Adamsen, J. M., S. Rundle-Thiele, and J. A. Whitty. 2013. Best-worst scaling... Reflections on presentation, analysis, and lessons learnt from case 3 BWS experiments. *Market Soc. Res.* 21:9–27.
- Bazzani, C., G. W. Gustavsen, R. M. J. Nayga, and K. Rickertsen. 2016. Are consumers' preferences for food values in the U.S. and Norway similar? A best-worst scaling approach. Paper no. 235844 in *Proc. Ann. Mtg. Agric. Appl. Econ. Assoc.*, Boston, MA.
- BBC News. 2015. Cows taken to Asda in Stafford for milk price protest. Accessed Mar. 3, 2019. <https://www.bbc.co.uk/news/uk-england-stoke-staffordshire-33840815>.
- Benard, M., and T. de Cock Buning. 2013. Exploring the potential of Dutch pig farmers and urban-citizens to learn through frame reflection. *J. Agric. Environ. Ethics* 26:1015–1036. <https://doi.org/10.1007/s10806-013-9438-y>.
- Bennett, M. M., T. A. Beehr, and L. V. Ivanitskaya. 2017. Work-family conflict: Differences across generations and life cycles. *J. Manag. Psychol.* 32:314–332. <https://doi.org/10.1108/JMP-06-2016-0192>.
- Bergstra, T. J., H. Hogeveen, and E. N. Stassen. 2017. Attitudes of different stakeholders toward pig husbandry: A study to determine conflicting and matching attitudes toward animals, humans and the environment. *Agric. Human Values* 34:393–405. <https://doi.org/10.1007/s10460-016-9721-4>.
- Bertram, D. 2006. Likert scales: CPSC 681—Topic report. Accessed Mar. 21, 2019. https://www.researchgate.net/profile/Farhad_Waseel/post/How_can_one_help_people_create_simple_scales_from_Likert-scored_items/attachment/5c9e2e9acf4a7299499df34/AS%3A741800755068929%401553870490367/download/topic-dane-likert.pdf.
- Blythman, J. 2017. If you believe that cows belong in fields, “free range” milk will give you hope. Accessed Feb. 16, 2019. <https://www.theguardian.com/commentisfree/2017/feb/28/free-range-milk-asda-dairy-farming-cows-in-fields-pasture-promise>.
- Boogaard, B. K., B. B. Bock, S. J. Oosting, J. S. C. Wiskerke, and A. J. van der Zijpp. 2011. Social acceptance of dairy farming: The ambivalence between the two faces of modernity. *J. Agric. Environ. Ethics* 24:259–282. <https://doi.org/10.1007/s10806-010-9256-4>.
- Boogaard, B. K., S. J. Oosting, and B. B. Bock. 2008. Defining sustainability as a socio-cultural concept: Citizen panels visiting dairy farms in the Netherlands. *Livest. Sci.* 117:24–33. <https://doi.org/10.1016/j.livsci.2007.11.004>.
- Britt, J. H., R. A. Cushman, C. D. Dechow, H. Dobson, P. Humblot, M. F. Hutjens, G. A. Jones, P. S. Ruegg, I. M. Sheldon, and J. S. Stevenson. 2018. Invited review: Learning from the future—A vision for dairy farms and cows in 2067. *J. Dairy Sci.* 101:3722–3741. <https://doi.org/10.3168/jds.2017-14025>.
- Busch, G., D. M. Weary, A. Spiller, and M. A. G. von Keyserlingk. 2017. American and German attitudes towards cow-calf separation on dairy farms. *PLoS One* 12:e0174013. <https://doi.org/10.1371/journal.pone.0174013>.
- Capper, J. L., R. A. Cady, and D. E. Bauman. 2009. The environmental impact of dairy production: 1944 compared with 2007. *J. Anim. Sci.* 87:2160–2167. <https://doi.org/10.2527/jas.2009-1781>.
- Cardoso, C. S., M. J. Hötzel, D. M. Weary, J. A. Robbins, and M. A. G. von Keyserlingk. 2016. Imagining the ideal dairy farm. *J. Dairy Sci.* 99:1663–1671. <https://doi.org/10.3168/jds.2015-9925>.
- Cardoso, C. S., M. G. von Keyserlingk, and M. J. Hötzel. 2019. Views of dairy farmers, agricultural advisors, and lay citizens on the ideal dairy farm. *J. Dairy Sci.* 102:1811–1821. <https://doi.org/10.3168/jds.2018-14688>.
- CIWF. 2011. Consumer perception regarding milk. Accessed Jan. 13, 2019. <https://www.compassioninfoodbusiness.com/resources/dairy/consumer-perception-regarding-milk/>.
- Cohen, S., and L. Neira. 2003. Measuring Preference for Product Benefits Across Countries: Overcoming Scale Usage Bias with Maximum Difference Scaling. *World Association of Research Professionals*, Amsterdam, the Netherlands.
- Cornish, A., D. Raubenheimer, and P. McGreevy. 2016. What we know about the public's level of concern for farm animal welfare in food production in developed countries. *Animals (Basel)* 6:E74. <https://doi.org/10.3390/ani6110074>.
- Darwent, N., and C. Leaver. 2015. UK's first free range milk launched today. Accessed Mar. 10, 2019. <http://www.freerangedairy.org/2015/07/uks-first-free-range-milk-launched-today/>.
- Darwent, N., and C. Leaver. 2018. Grazing days. Accessed Jun. 10, 2019. <http://www.freerangedairy.org/2018/01/press-release-grazing-days/>.
- Davidov, E., P. Schmidt, and S. H. Schwartz. 2008. Bringing values back in: The adequacy of the European social survey to measure values in 20 countries. *Public Opin. Q.* 72:420–445. <https://doi.org/10.1093/poq/nfn035>.

- de Jonge, J., and H. C. M. van Trijp. 2013. Meeting heterogeneity in consumer demand for animal welfare: A reflection on existing knowledge and implications for the meat sector. *J. Agric. Environ. Ethics* 26:629–661. <https://doi.org/10.1007/s10806-012-9426-7>.
- DEFRA (Department for Environment, Food and Rural Affairs). 2017. Rural population 2014/15. Accessed Feb. 22, 2018. <https://www.gov.uk/government/publications/rural-population-and-migration/rural-population-201415>.
- Duffy, R., A. Fearn, and V. Healing. 2005. Reconnection in the UK food chain: Bridging the communication gap between food producers and consumers. *Br. Food J.* 107:17–33. <https://doi.org/10.1108/00070700510573177>.
- Ellis, K. A., K. Billington, B. McNeil, and D. E. F. McKeegan. 2009. Public opinion on UK milk marketing and dairy cow welfare. *Anim. Welf.* 18:267–282.
- Ellison, B., K. Brooks, and T. Mieno. 2017. Which livestock production claims matter most to consumers. *Agric. Human Values* 34:819–831. <https://doi.org/10.1007/s10460-017-9777-9>.
- Erdem, S., D. Rigby, and A. Wossink. 2012. Using best–worst scaling to explore perceptions of relative responsibility for ensuring food safety. *Food Policy* 37:661–670. <https://doi.org/10.1016/j.foodpol.2012.07.010>.
- European Union. 2016. Attitudes of Europeans Towards Animal Welfare: Special Eurobarometer 442. Accessed Dec. 20, 2019. <https://op.europa.eu/en/publication-detail/-/publication/9bc3a0b7-ec17-11e5-8a81-01aa75ed71a1/language-en>.
- FAO (Food and Agriculture Organization of the United Nations). 2017. The Future of Food and Agriculture: Trends and Challenges. FAO, Rome, Italy.
- Finn, A., and J. J. Louviere. 1992. Determining the appropriate response to evidence of public concern: The case of food safety. *J. Public Policy Mark.* 11:12–25. <https://doi.org/10.1177/074391569201100202>.
- Fraser, D. 2001. Farm animal production: Changing agriculture in a changing culture. *J. Appl. Anim. Welf. Sci.* 4:175–190. https://doi.org/10.1207/S15327604JAWS0403_02.
- Godfray, H. C. J., J. R. Beddington, I. R. Crute, L. Haddad, D. Lawrence, J. F. Muir, J. Pretty, S. Robinson, S. M. Thomas, and C. Toulmin. 2010. Food security: The challenge of feeding 9 billion people. *Science* 327:812–818. <https://doi.org/10.1126/science.1185383>.
- Graham, R. 2019. Plant-based power list: Who's driving the meat-free revolution? Accessed Dec. 20, 2019. <https://www.thegrocer.co.uk/power-list/plant-based-power-list-whos-driving-the-meat-free-revolution/593700.article>.
- Hall, C., and V. Sandilands. 2007. Public attitudes to the welfare of broiler chickens. Land Economy Research Group, Scottish Agricultural College, Edinburgh, Scotland.
- Hansson, H., and C. J. Lagerkvist. 2016. Dairy farmers' use and non-use values in animal welfare: Determining the empirical content and structure with anchored best-worst scaling. *J. Dairy Sci.* 99:579–592. <https://doi.org/10.3168/jds.2015-9755>.
- Harper, G., and S. Henson. 2001. Consumer concerns about animal welfare and the impact on food choice. EU FAIR CT98-3678. Final Report. The University of Reading, Reading, UK.
- Harrison, R. 1964. Animal Machines. Vincent Stuart Ltd., London, UK.
- Hills, A. M. 1995. Empathy and belief in the mental experience of animals. *Anthrozoös* 8:132–142.
- Hötzel, M. J., C. S. Cardoso, A. Roslindo, and M. A. G. von Keyserlingk. 2017. Citizens' views on the practices of zero-grazing and cow-calf separation in the dairy industry: Does providing information increase acceptability? *J. Dairy Sci.* 100:4150–4160. <https://doi.org/10.3168/jds.2016-11933>.
- Ipsos MORI. 2010. Three in five milk buyers say they would never buy milk produced in large indoor dairies. Accessed Jan. 27, 2019. <https://www.ipsos.com/ipsos-mori/en-uk/three-five-milk-buyers-say-they-would-never-buy-milk-produced-large-indoor-dairies>.
- Jaeger, S. R., A. S. Jørgensen, M. D. Aaslyng, and W. L. P. Bredie. 2008. Best-worst scaling: An introduction and initial comparison with monadic rating for preference elicitation with food products. *Food Qual. Prefer.* 19:579–588. <https://doi.org/10.1016/j.foodqual.2008.03.002>.
- Kendall, H. A., L. M. Lobao, and J. S. Sharp. 2006. Public concerns with animal well-being: Place, social structural location, and individual experience. *Rural Sociol.* 71:399–428. <https://doi.org/10.1526/003601106778070617>.
- Knight, S., and L. Barnett. 2008. Justifying attitudes toward animal use: A qualitative study of people's views and beliefs. *Anthrozoös* 21:31–42.
- Krystallis, A., M. D. de Barcellos, J. O. Kügler, W. Verbeke, and K. G. Grunert. 2009. Attitudes of European citizens towards pig production systems. *Livest. Sci.* 126:46–56. <https://doi.org/10.1016/j.livsci.2009.05.016>.
- Kühl, S., S. Gauly, and A. Spiller. 2019. Analysing public acceptance of four common husbandry systems for dairy cattle using a picture-based approach. *Livest. Sci.* 220:196–204. <https://doi.org/10.1016/j.livsci.2018.12.022>.
- Kühl, S., L. Schlüterbusch, and A. Spiller. 2017. Trust in ag-related marketing claims: A segmentation with German consumers. *Br. Food J.* 119:1999–2012. <https://doi.org/10.1108/BFJ-09-2016-0412>.
- Lassen, J., P. Sandøe, and B. Forkman. 2006. Happy pigs are dirty! – Conflicting perspectives on animal welfare. *Livest. Sci.* 103:221–230. <https://doi.org/10.1016/j.livsci.2006.05.008>.
- Liljenstolpe, C. 2008. Valuing animal welfare with choice experiments: An application to Swedish pig production. 11th Congress of the European Association of Agricultural Economists, Copenhagen, Denmark. *Agribusiness* 21:67–84.
- Louviere, J., I. Lings, T. Islam, S. Gudergan, and T. Flynn. 2013. An introduction to the application of (case 1) best-worst scaling in marketing research. *Int. J. Res. Market.* 30:292–303. <https://doi.org/10.1016/j.ijresmar.2012.10.002>.
- Louviere, J., D. J. Street, R. Carson, A. Ainslie, J. R. Deshazo, T. Cameron, D. Hensher, R. Kohn, and T. Marley. 2002. Dissecting the random component of utility. *Market. Lett.* 13:177–193. <https://doi.org/10.1023/A:1020258402210>.
- Louviere, J., and G. Woodworth. 1991. Best-worst scaling: A model for the largest difference judgments. Working Paper. Faculty of Business, University of Alberta, Edmonton, Canada.
- Lusk, J. L., and B. C. Briggeman. 2009. Food values. *Am. J. Agric. Econ.* 91:184–196. <https://doi.org/10.1111/j.1467-8276.2008.01175.x>.
- Lusk, J. L., F. B. Norwood, and R. W. Prickett. 2007. Consumer Preferences for Farm Animal Welfare: Results of a Nationwide Telephone Survey. Department of Agricultural Economics, Oklahoma State University, Stillwater, OK.
- March, M. D., M. J. Haskell, M. G. G. Chagunda, F. M. Langford, and D. J. Roberts. 2014. Current trends in British dairy management regimens. *J. Dairy Sci.* 97:7985–7994. <https://doi.org/10.3168/jds.2014-8265>.
- Meuwissen, M. P. M., and I. A. Van Der Lans. 2004. Trade-offs between consumer concerns: An application for pork supply chains. *Acta Agric. Scand. C Food Economics* 2:27–34.
- Meuwissen, M. P. M., I. A. Van Der Lans, and R. B. M. Huirne. 2007. Consumer preferences for pork supply chain attributes. *Wageningen J. Life Sci.* 54:293–312.
- Miele, M. 2010. Report concerning consumer perceptions and attitudes towards farm animal welfare. EU Platform on Animal Welfare. European Union, Brussels, Belgium.
- Mueller, S., and C. Rungie. 2009. Is there more information in best-worst choice data? *Int. J. Wine Bus. Res.* 21:24–40. <https://doi.org/10.1108/17511060910948017>.
- Mulder, M., and S. Zomer. 2017. Dutch consumers' willingness to pay for broiler welfare. *J. Appl. Anim. Welf. Sci.* 20:137–154. <https://doi.org/10.1080/10888705.2017.1281134>.
- Najafzadeh, M., L. D. Lynd, J. C. Davis, S. Bryan, A. Anis, M. Marra, and C. A. Marra. 2012. Barriers to integrating personalized medicine into clinical practice: A best-worst scaling choice experiment. *Genet. Med.* 14:520–526. <https://doi.org/10.1038/gim.2011.26>.
- Nuffield Council on Bioethics. 2015. Ideas about naturalness in public and political debates about science, technology and medicine:

- Review of research on public perspectives. Accessed Dec. 20, 2019. <https://nuffieldbioethics.org/assets/pdfs/Naturalness-analysis-paper.pdf>.
- ONS (Office for National Statistics). 2017. Overview of the UK population. Accessed Feb. 22, 2019. <https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/articles/overviewoftheukpopulation/july2017>.
- Orme, B. 2005. Accuracy of HB Estimation in MaxDiff Experiments. Sawtooth Software, Sequim, WA.
- Orme, B. 2009. Sawtooth Software MaxDiff Analysis: Simple Counting, Individual-Level Logit, and HB. Sawtooth Software Inc., Sequim, WA.
- Peters, C. J., J. Picardy, A. F. Darrouzet-Nardi, J. L. Wilkins, T. S. Griffin, and G. W. Fick. 2016. Carrying capacity of U.S. agricultural land: Ten diet scenarios. *Elementa* 4:000116. <https://doi.org/10.12952/journal.elementa.000116>.
- Rodionova, Z. 2017. Asda to become the first major UK retailer to sell "free-range milk." Accessed Jan. 10, 2019. <https://www.independent.co.uk/news/business/news/asda-free-range-milk-uk-supermarket-chain-pasture-promos-a7603141.html>.
- Röös, E., B. Bajželj, P. Smith, M. Patel, D. Little, and T. Garnett. 2017. Greedy or needy? Land use and climate impacts of food in 2050 under different livestock futures. *Glob. Environ. Change* 47:1–12. <https://doi.org/10.1016/j.gloenvcha.2017.09.001>.
- Sawtooth Software Inc. 2008. The MaxDiff system. Technical Paper Series. Sawtooth Software Inc., Orem, UT.
- Schuppli, C. A., M. A. G. von Keyserlingk, and D. M. Weary. 2014. Access to pasture for dairy cows: Responses from an online engagement. *J. Anim. Sci.* 92:5185–5192. <https://doi.org/10.2527/jas.2014-7725>.
- Schwartz, S. H. 2003a. Computing scores for the 10 human values. *European Social Survey*. Accessed May 15, 2018. https://www.europeansocialsurvey.org/docs/methodology/ESS_computing_human_values_scale.pdf.
- Schwartz, S. H. 2003b. A proposal for measuring value orientations across nations. Pages 259–319 in *Questionnaire Development Package of the European Social Survey*. https://www.europeansocialsurvey.org/docs/methodology/core_ess_questionnaire/ESS_core_questionnaire_human_values.pdf.
- Schwartz, S. H. 2012. An overview of the Schwartz theory of basic values. *Online Read. Psychol. Cult.* 2:1–20. <https://doi.org/10.9707/2307-0919.1116>.
- Sharma, V. K. 2000. Partially Balanced Incomplete Block Designs. Centre of Advanced Studies in Agricultural Statistics and Computer Applications, New Delhi, India.
- Shortall, O., M. Green, M. Brennan, W. Wapenaar, and J. Kaler. 2017. Exploring expert opinion on the practicality and effectiveness of biosecurity measures on dairy farms in the United Kingdom using choice modeling. *J. Dairy Sci.* 100:2225–2239. <https://doi.org/10.3168/jds.2016-11435>.
- Spini, D. 2003. Measurement equivalence of 10 value types from the Schwartz value survey across 21 countries. *J. Cross Cult. Psychol.* 34:3–23. <https://doi.org/10.1177/0022022102239152>.
- Spooner, J. M., C. A. Schuppli, and D. Fraser. 2012. Attitudes of Canadian beef producers toward animal welfare. *Anim. Welf.* 21:273–283. <https://doi.org/10.7120/09627286.21.2.273>.
- Spooner, J. M., C. A. Schuppli, and D. Fraser. 2014a. Attitudes of Canadian pig producers toward animal welfare. *J. Agric. Environ. Ethics* 27:569–589. <https://doi.org/10.1007/s10806-013-9477-4>.
- Spooner, J. M., C. A. Schuppli, and D. Fraser. 2014b. Attitudes of Canadian citizens toward farm animal welfare: A qualitative study. *Livest. Sci.* 163:150–158. <https://doi.org/10.1016/j.livsci.2014.02.011>.
- Te Velde, H., N. Aarts, and C. Van Woerkum. 2002. Dealing with ambivalence: Farmers' and consumers' perceptions of animal welfare in livestock breeding. *J. Agric. Environ. Ethics* 16:21–36–43.
- Thurstone, L. L. 1927. The method of paired comparisons for social value. *J. Abnorm. Soc. Psychol.* 21:384–400. <https://doi.org/10.1037/h0065439>.
- Vanclay, J. K., J. Shortiss, S. Aulsebrook, A. M. Gillespie, B. C. Howell, R. Johanni, M. J. Maher, K. M. Mitchell, M. D. Stewart, and J. Yates. 2011. Customer response to carbon labelling of groceries. *J. Consum. Policy* 34:153–160. <https://doi.org/10.1007/s10603-010-9140-7>.
- Vanhonacker, F., E. van Poucke, F. Tuytens, and W. Verbeke. 2010. Citizens' views on farm animal welfare and related information provision: Exploratory insights from Flanders, Belgium. *J. Agric. Environ. Ethics* 23:551–569. <https://doi.org/10.1007/s10806-010-9235-9>.
- Vanhonacker, F., W. Verbeke, E. Van Poucke, and F. A. M. Tuytens. 2007. Segmentation based on consumers' perceived importance and attitude toward farm animal welfare. *Int. J. Sociol. Agric. Food* 15:84–100.
- Vanhonacker, F., W. Verbeke, E. Van Poucke, and F. A. M. Tuytens. 2008. Do citizens and farmers interpret the concept of farm animal welfare differently? *Livest. Sci.* 116:126–136. <https://doi.org/10.1016/j.livsci.2007.09.017>.
- Ventura, B. A., M. A. G. von Keyserlingk, C. A. Schuppli, and D. M. Weary. 2013. Views on contentious practices in dairy farming: The case of early cow-calf separation. *J. Dairy Sci.* 96:6105–6116. <https://doi.org/10.3168/jds.2012-6040>.
- Ventura, B. A., M. A. G. von Keyserlingk, H. Wittman, and D. M. Weary. 2016. What difference does a visit make? Changes in animal welfare perceptions after interested citizens tour a dairy farm. *PLoS One* 11:e0154733. <https://doi.org/10.1371/journal.pone.0154733>.
- von Keyserlingk, M. A. G., N. P. Martin, E. Kebreab, K. F. Knowlton, R. J. Grant, M. Stephenson, C. J. Sniffen, J. P. Harner III, A. D. Wright, and S. I. Smith. 2013. Invited review: Sustainability of the US dairy industry. *J. Dairy Sci.* 96:5405–5425. <https://doi.org/10.3168/jds.2012-6354>.
- von Keyserlingk, M. A. G., and D. M. Weary. 2016. Stakeholder views, including the public, on expectations for dairy cattle welfare. *WCDS Adv. Dairy Technol.* 28:147–158.
- Webster, B. 2015. Thousands of cows never see the sun. Accessed Dec. 30, 2019. <https://www.thetimes.co.uk/article/thousands-of-cows-never-see-the-sun-tvlhrckt3xl>.
- Weinrich, R., S. Kühn, A. Zühlendorf, and A. Spiller. 2014. Consumer attitudes in Germany towards different dairy housing systems and implications for the marketing of pasture raised milk. *Int. Food Agribus. Market. Rev.* 17:205–222.
- Wolf, C. A., G. T. Tonsor, N. J. Olynk, S. Journal, R. Economics, and N. August. 2011. Understanding U.S. consumer demand for milk production attributes. *J. Agric. Resour. Econ.* 36:326–342.

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