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Article

Consumer acceptance and willingness to pay for cow housing systems in eight European countries

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Abstract

Free walk housing systems aim to address major animal health issues for dairy cows and support higher animal welfare. The purpose of this study is to estimate consumer acceptance of different housing systems and willingness to pay (WTP) for milk from tie-stall, cubicle, compost-bedded, and artificial floor housing systems in addition to attitudes toward animal welfare. Focus groups were held to identify the pertinent concepts for an online quantitative survey conducted in eight European countries. A discrete choice experiment was included for estimating WTP. Consumers are found to care about animal welfare and grazing. Results indicate consumers like the compost-bedded system the best followed by the artificial floor system; however, no positive WTP for these systems was found. Consumers seem to find the current labeling rules regarding organic production and grazing sufficiently informative. The results can help producers make more informed investment and marketing decisions regarding cow husbandry.

Keywords: Animal welfare, Willingness to pay, Dairy cow housing systems, Consumers, Milk
JEL codes: Q01, Q18, D12

1 Introduction

Consumers are increasingly concerned about the well-being of livestock animals. Ninety-four percent of European Union (EU) citizens believe that it is important to protect the welfare of farmed animals (European Commission 2016). While this has generally increased the demand for foods with higher animal welfare standards, countries vary in their willingness to pay (WTP) for these products and in their outlook toward increasing animal protection. For instance, slightly over half of those surveyed in the Netherlands and Italy believe there is already a sufficient choice of high animal welfare food products, whereas those in Germany and Sweden disagreed with such statements (European Commission

2016). As of 2018, the milk sector is the biggest agricultural sector in terms of output value in the EU, representing 13.2 percent of the estimated 434.3 billion euro value of the entire EU agricultural industry (Eurostat 2019). Milk is produced in all EU countries, but dairy farms vary greatly in terms of system types, farm size, and yields (Augère-Granier 2018). Currently, there are only general guidelines at the EU level for cow welfare, but many countries have more specific regulations (European Commission 2017).

Husbandry systems for dairy production range from mountain- and pasture-raised cows to those kept indoors either partially or year-round. The most common types of indoor housing are the tie-stall and the cubicle (also known as free stall) (Compassion in world farming 2012; Bewley *et al.* 2017). In 2010, 27 percent of cattle in the EU were raised in tie-stall housing system, 63 percent in loose housing systems (defined as housing systems in which the animals can move freely, including cubicle housing), and 11 percent in other types of housing systems (Eurostat 2013). Cow housing systems have been found to impact animal health and welfare (European Food Safety Authority 2009; Bewley *et al.* 2017; Blanco-Penedo *et al.* 2020). For example, the risk of lameness, which is one of the three major reasons for early culling, is related to cubicles and flooring (Weigele *et al.* 2018). The FreeWalk project is a collaboration between eight European countries (Austria, Germany, Italy, the Netherlands, Norway, Slovakia, Slovenia, and Sweden) to develop and evaluate innovative cow housing systems to improve animal welfare (Galama *et al.* 2020). There is some evidence that free walk housing systems (i.e. compost-bedded and artificial floor systems) increase cow welfare by offering more space to the animals and allowing them to rest without being restrained by cubicle separators like those found in tie-stall and cubicle housing systems (Bewley *et al.* 2017; Blanco-Penedo *et al.* 2020; Galama *et al.* 2020; Leso *et al.* 2020). The overall use of these free walk systems is relatively low compared with the tie-stall and cubicle, but its adoption has grown in the past decade in Europe. The artificial floor is a newer development and as of this study few farms have been able to adopt it. Results reported in Barberg *et al.* (2007) on US compost-bedded pack dairy barns showed that lameness was greatly reduced (8 percent compared with about 25 percent in cubicle systems). Furthermore, the compost material from the compost-bedded housing floor could be re-used for other purposes such as energy or growing produce, potentially increasing the system's sustainability. However, while previous research has evaluated these different housing systems from an animal welfare and management point of view, little work has evaluated consumer perception of these newer cow housing systems. The positive impact of the new housing systems can be measured in terms of better animal welfare, high consumer acceptance, and eventually higher willingness to pay for products differentiated along the housing dimension. As illustrated by the Wissenschaftlicher Beirat für Agrarpolitik's (German Scientific Advisory Board for Agricultural Policy) 2015 report in Germany, animal welfare policies across Europe differ in how far they stress a regulatory rationale (e.g. Sweden with strict legal requirements) or a market segmentation approach (Spiller *et al.* 2015). Due to the high consumer concern regarding animal welfare issues in food production, it is important to understand how consumers view these systems, whether they perceive them as an improvement and acceptable, and thus have evidence of societal acceptance before continuing further developments, including farmers' investments. Therefore, the purpose of this study is to estimate consumer acceptance of and willingness to pay for milk from tie-stall, cubicle, compost-bedded, and artificial floor housing systems. The perception of organic production and grazing is also examined. Moreover, consumer attitudes toward animal welfare and re-using compost from the compost-bedded system are assessed.

There is extensive literature on how consumers view farm animal welfare and their WTP for animal-friendly products (e.g. meta-analysis and systematic literature reviews from Lagerkvist and Hess 2011; Clark *et al.* 2016, 2017; Janssen *et al.* 2016). Typically, WTP has been found to be positive for farm animal welfare, but there is variability between species. For instance, according to the meta-analysis by Clark *et al.* (2017), pigs have the lowest

average WTP estimates for increased animal welfare products, whereas the highest estimates were found for beef cattle and dairy cows. Moreover, there is some evidence of a citizen–consumer gap, which means that while as a member of the public an individual may state they are concerned about animal welfare, as a consumer they choose not to purchase higher animal welfare products (Vanhonacker *et al.* 2010). Many studies have also found that there is heterogeneity in consumer preferences toward animal welfare products (Vanhonacker *et al.* 2007; de Jonge *et al.* 2015; Heise and Theuvsen 2017). In addition, there are a few studies about consumer attitudes and their WTP for cow husbandry practices and welfare in dairy production in Europe and most also find evidence of differing consumer groups. For instance, Weinrich *et al.* (2014) and Markova-Nenova and Wätzold (2018) found different consumer segments for attitudes and the WTP for dairy housing and production systems in Germany for milk. Overall, in both studies consumers preferred milk that came from pasture-raised cows. De Graaf *et al.* (2016a,b) assessed the consumer purchase intentions for animal-friendly milk and identified six market segments with a high degree of differentiation in Belgium. They identified access to pasture, freedom of movement, and health as the main marketing criteria. In another study, Kühl *et al.* (2017) identified four consumer groups in Germany that had various degrees of WTP and perceptions of different tiers of pasture-raised labeled milk. Kühl *et al.* (2019) compared the public acceptance of four types of dairy husbandry systems related to cubicle housing and varying levels of fresh air and outdoor access using a picture-based approach in Germany and found participants had a negative reaction to an indoor system that had less air and outdoor access mainly due to the lack of natural conditions. In sum, previous literature shows consumers generally value outdoor access and the ability to graze in dairy production; however, there exists strong evidence of preference heterogeneity indicating there are groups that place emphasis on other criteria.

Many animal welfare and dairy-related consumer studies have focused on one country. Our study adds to this literature by comparing animal welfare attitudes in general and with respect to dairy production across multiple European countries. In addition, to our knowledge, this is one of the first studies to explicitly compare four specific cow housing systems (tie-stall, cubicle, compost-bedded, and artificial floor) and assess the free walk systems from a consumer perspective. We used a mixed methods approach with focus groups in three countries (Germany, Austria, and Slovenia) and an online survey in the eight European Free-Walk project countries. The online questionnaire included a discrete choice experiment to estimate consumer preferences and the WTP for the housing systems in addition to organic production and grazing. A latent class logit analysis of the choice experiment data is used to account for consumer heterogeneity and examine consumer groups. Our study results give deeper insights into European consumer perception of animal welfare and dairy production.

2 Methods

A combination of qualitative and quantitative methods was used for the study. First, focus groups were conducted to get a better grasp of consumer understanding of the issues at stake. Afterward, a questionnaire with closed questions, including a choice experiment, was prepared and implemented in an online survey.

2.1 Focus groups

Focus groups were conducted in October 2018 in Vienna (Austria), Munich (Germany), and Ljubljana (Slovenia) to identify important perceptions and concepts for the quantitative survey. Countries were chosen to represent different consumer WTP and animal welfare attitudes based on the Eurobarometer 442 survey results (European Commission 2016). According to this survey, Slovenia represents a low WTP and a medium need for better animal welfare, Austria a medium WTP and a low need for better animal welfare protection,

and Germany a high WTP and a strong need for better animal welfare protection. Two sessions averaging around 90 min each of seven to ten people were held in each location. Participants were screened to not be vegans and soft quotas were in place for age, gender, and education level. They also received monetary compensation for their time. Each focus group followed a discussion guide that was developed prior to the first session and all moderators received focus group training from a seasoned qualitative researcher. After introductions, participants were asked a series of questions to stimulate conversations regarding their food choices, animal welfare (in general and specifically for cows), cow housing systems (tie-stall, cubicle, compost-bedded, artificial floor), grazing, and products made using compost material from the compost-bedded system. Each session ended with concluding remarks and thanking the participants for their time. For the cow housing system section, two pictures of each system were provided to help participants visualize and understand what was meant by each housing system because many consumers are not familiar with the details of cow husbandry. After initially asking participants for ideas regarding the compost, pictures were also provided as examples of different compost-related products. All focus group sessions were transcribed using the video and audio recordings and translated into English. First, detailed notes of each session were taken for every discussion topic and common themes and categories were determined. Summaries of the analysis were completed to describe each country for each topic and overall.

2.2 Survey instrument

Following the focus group analysis, a quantitative survey was developed and conducted online through a market research firm in Austria, Germany, Italy, the Netherlands, Norway, Slovakia, Slovenia, and Sweden in spring 2019. The countries surveyed represent a wide range of diversity of European consumers. Around 400–600 participants per country (total $n = 3693$) were quota sampled to be nationally representative for age and gender. Soft quotas were also used for the region of residence, education, and income. Participants were screened to be non-vegan, milk consumers, responsible for at least some of the household food purchases, and not currently living on a farm with livestock. Additional socio-demographics and food and milk purchase behavior information were also collected. Topics measured in the survey included the perception of animal welfare, housing system preferences, and attitudes toward re-using the compost from the compost-bedded housing system. Participants were asked to estimate their knowledge about animal husbandry systems on a 5-point scale (1 = 'very low', 5 = 'very high'). They were also asked how satisfied they are overall with the food system and current animal welfare standards in general, for dairy cows, and beef cattle in their country on a 10-point scale (1 = 'completely unsatisfied', 10 = 'completely satisfied') in addition to indicating ways they believe would be effective in improving animal welfare. Participants then selected the three factors related to dairy cow welfare they are concerned about most and least out of eleven options. They could also indicate they are not concerned about the welfare of dairy cows. Concernment about cow housing conditions specifically was measured on a 10-point scale (1 = 'not concerned at all', 10 = 'very concerned') and participants were asked whether they would like to see a labeling system on dairy and beef products that indicates the type of housing used for the cows during production. A 9-point hedonic scale (1 = 'dislike extremely', 9 = 'like extremely') was used to determine the level of consumer acceptance of each housing system. Participants were asked to choose which housing system they believe to be best for specific characteristics related to animal welfare: hygiene, health, happiness, preventing injury, space for the cow, and comfort. They also selected which system(s) they find acceptable to use when the cows are and are not allowed to graze. At the end of the survey, participants rated how worried they are about the safety of the food they eat on a 10-point scale (1 = 'not worried at all', 10 = 'very worried'), how safe they feel consuming food products that

are grown using the compost-bedded system compost (1 = 'not safe at all', 10 = 'fully safe'), and what they thought about re-using the compost. A brief description about the compost material from the compost-bedded system was given before the compost-related questions.

2.3 Discrete choice experiment

2.3.1 *Design*

A discrete choice experiment using 1 L of milk as a representative product was included in the quantitative survey for estimating the preference for attributes and WTP. The choice experiment was presented to participants prior to any purchase behavior, animal welfare, and specific cow housing-related questions. There were four attributes in the experimental design: price (four levels per country), grazing (yes/no), housing type (tie-stall, cubicle, compost-bedded, artificial floor), and production type (organic and conventional). Grazing and production type were added as attributes based on results from the focus groups. Prices for each country were provided by the FreeWalk project partners and confirmed via an internet search of milk offered by major grocery retailers in each country. The prices were in the local currency and covered the market retail prices for conventional and organic milk at the time of the study in the corresponding country (for prices by country see Appendix 2, Table A1, in the Supplementary Material). Organic was constrained to always have grazing to comply with organic EU regulations regarding outdoor access in addition to being above the lowest price level in the choice set to resemble current market price conditions more closely. The design was optimized on NGENE software using an efficiency design. A total of twenty-four choice sets were split into two blocks so that each participant answered twelve choice sets. Each choice set consisted of two alternatives and a 'None—I would not choose either of these' option. Definitions for all attributes, including an example picture of each housing type, were provided prior to the first choice set (see Appendix 1 in the Supplementary Material). Information and pictures regarding the housing systems were selected to be neutral and comparable as much as possible across systems regarding the environment (e.g. light, cow positioning) in addition to depicting the varying stocking density typical for each housing system. Participants were instructed to assume all other milk characteristics (e.g. fat content, packaging type) met their personal standards. Instructions and a cheap talk script (see Appendix 1 in the Supplementary Material) were also included in order to reduce hypothetical bias (Cummings and Taylor 1999; Lusk 2003).

2.3.2 *Model specification:*

Choice model specification starts with the Lancaster (1966) theory that states utilities for products can be broken down into separate utilities based on their attributes. The random utility theory (McFadden 1974) takes this further and proposes that individuals choose the product for which they will receive the highest utility. Combining these theories, we can model the utility function for consumer i facing j product alternatives in choice set t as

$$U_{ijt} = V_{ijt} + \varepsilon_{ijt} \tag{1}$$

where V_{ijt} is the deterministic component of the utility and ε_{ijt} is the random utility error. The deterministic component can then be defined as the linear combination of the product's attributes ($\beta_i X_{jt}$). For the discrete choice experiment used in this study, we can define the following utility model:

$$\begin{aligned} U_{ijt} = {} & \beta_0 * \text{price}_{jt} + \beta_1 * \text{ASC\_none}_{jt} + \beta_2 * \text{organic}_{jt} + \beta_3 * \text{grazing}_{jt} + \beta_4 * \text{tiestall}_{jt} \\ & + \beta_5 * \text{compostbedded}_{jt} + \beta_6 * \text{artificialfloor}_{jt} + \varepsilon_{ijt} \end{aligned} \tag{2}$$

where β_i are parameters to be estimated and ASC_none_{jt} is the alternative-specific constant for the none option. All attribute levels except price were coded as dummy variables. The

cubicle housing system was used as the reference in the analysis because it is the reference used for comparison with the case farms in the FreeWalk project. In addition, prices for Norway and Sweden were converted from the local currencies used in the survey to euros.

Latent class logit analysis was used to analyze the pooled data from the choice experiment to account for consumer heterogeneity and determine consumer groups. Pooled data were used for the analysis instead of data at country level because no previous evidence exists showing purchasing behavior for milk is strictly divided by country lines. Furthermore, the estimation efficiency is improved and more holistic insights can be found. Latent class models offer the advantage of determining distinct classes to further investigate the composition of different consumer groups compared with using a random parameters logit model that does not identify the source of the heterogeneity. Class segment placement is determined by the respondents' choice behavior from the discrete choice experiment. This means the analysis does not include further consumer characteristics to predict class membership because there is no evidence to lead us to specific hypotheses on the influencing variables. Consumer preferences are presumed homogeneous within each class but differ between classes.

The latent class specification follows Greene and Hensher (2003) and Greene (2012). N consumers are divided into S class segments that have class-specific parameters β_s for the alternative-specific characteristics X_{jt}. The probability that consumer i belongs to class s is the conditional choice probability:

$$P_{i\,jt|s} = \frac{\exp\left(\beta_s X_{i\,jt}\right)}{\sum_{j=1}^{J} \exp\left(\beta_s X_{i\,jt}\right)}. \tag{3}$$

The variable y_{it} denotes the choice of alternative j made by consumer i in choice set t. For the given class s, the joint probability of all the choices for consumer i is

$$(P_{i|s}) = \prod_{t=1}^{T_i} prob(y_{it} = j|s). \tag{4}$$

In addition, the class membership is unknown and the prior probability for class s can be estimated with the model parameters using a multinomial logit form:

$$\pi_s = \frac{\exp(\theta_s)}{\sum_{s=1}^{S} \exp(\theta_s)}, \quad \theta_S = 0 \text{ and } \sum_s \pi_s = 1. \tag{5}$$

The last θ is normalized to zero for identification because only $S-1$ parameters are needed to specify the S probabilities. The unconditional likelihood for consumer i is the expectation over classes:

$$P_i = \sum_{s=1}^{S} \pi_s P_{i|s}. \tag{6}$$

Putting it all together, the log-likelihood function for the N consumers becomes

$$\ln L = \sum_{i=1}^{N} \ln P_i = \sum_{i=1}^{N} \ln \sum_{s=1}^{S} \pi_s P_{i|s}. \tag{7}$$

Parameters are estimated using the expectation–maximization (EM) algorithm for latent class logit analysis in Stata 15 as outlined by Pacifico and Yoo (2013). The EM algorithm starts with a random split of individuals into classes. The classes are then updated based on an improvement criterion and reclassified until the best classification of individuals is found. The number of classes was pre-determined by examining the Bayesian information

criterion (BIC) and the consistent Akaike information criterion (CAIC) in addition to calculation feasibility, stability, and interpretability.

Willingness to pay estimates for the milk attributes for each class were calculated as follows:

$$\mathrm{WTP}_{js} = -\frac{\beta_{js}}{\beta_{0s}}, \tag{8}$$

where β_{0s} is the price coefficient estimate and β_{js} is the estimated attribute parameter within each class. Confidence intervals were estimated using the Krinsky Robb parametric bootstrap method with 10,000 repetitions. Lastly, participants were assigned to the class to which they had the highest posterior probability of belonging. The classes were characterized in terms of socio-demographics, food habits, animal husbandry, and cow housing variables to further learn more about the consumer groups using descriptive statistics by class.

3 Results and discussion

3.1 Focus groups

The focus groups largely agreed that the tie-stall is the worst system overall, the cubicle system is slightly better, and the compost bedded and artificial floor are the best systems. None of the groups saw grazing as a major cause for environmental concern and felt it is important for milk and meat quality. The amount of available space, slaughter conditions, type of transport, and personal care (e.g. naming, being gentle) were associated with animal welfare across the board and the majority stated animal welfare as being important. Austria and Germany also agreed on many points: lowering meat consumption, increasing meat prices, more regulations and subsidies, and increasing education about animal welfare. All sessions mentioned that there were too many labels and that they can be difficult to discern, although many still claimed to purchase animal products with organic or other certification labels and want more information about husbandry and welfare practices. Additionally, distrust and skepticism of labels and production systems (including organic) were expressed in all sessions. Purchasing local and directly from the farmer or butcher were also associated with better quality and animal welfare. Austria and Germany also had some concerns regarding re-using the compost for produce, whereas in Slovenia everyone generally approved. There was some concern in particular for produce that is normally uncooked (e.g. lettuce, cucumbers). Out of those who expressed feeling wary about re-using the compost for growing edible items, many mentioned the effect of feed and possible antibiotic use on the compost quality as reasons. Austria and Germany were also generally unsure whether a hypothetical cow housing system label would affect the product quality and their product choice. Those in Slovenia thought a cow housing label might affect their purchase decisions, but the product would need to meet their overall quality expectations.

As already stated, the goal of the focus groups was to help determine concepts for the wider quantitative survey. Themes from the focus groups helped determine the attributes used for the discrete choice experiment in addition to directing question topics and response options. For instance, a question about what could be effective ways to improve animal welfare was added with responses coming directly from the discussions (e.g. government subsidies). Furthermore, it helped guide answer choices when asking about their thoughts regarding re-using the compost. While a choice experiment is hypothetical, it is important not to exclude attributes that are thought to be important for the product so that the choices can be put in context with real market product selection. Many groups discussed the importance of organic in their food purchasing decisions and organic is also a common option for milk. Grazing was also emphasized in the discussion of cow animal welfare and the connection to product quality. Therefore, organic and grazing were included as

Table 1. Summary statistics of socio-demographic variables ($n = 3693$).

Variable	Frequency (%)
Gender	
Male	50.56
Female	49.23
Age	
18–24	11.32
25–34	17.76
35–44	18.60
45–54	20.31
55–64	16.33
65+	15.68
Education	
No degree	3.25
High school	35.85
Trade/vocational	31.98
University	27.08
Ph.D.	1.84
Area	
Rural	27.92
Suburban	23.77
Urban	48.31
Household size	2.73 (mean)

Notes: The sample totals by country are Austria ($n = 415$), Germany ($n = 633$), Italy ($n = 592$), the Netherlands ($n = 423$), Norway ($n = 401$), Slovakia ($n = 410$), Slovenia ($n = 397$), and Sweden ($n = 422$). See Table A2 in Appendix 2 in the Supplementary Material for country-level summary statistics.

attributes in the discrete choice experimental design next to the cow housing types that were of main interest in this study.

3.2 Quantitative survey

3.2.1 *Sample*

Summary statistics for demographic variables are presented in Table 1 for the entire sample. There are almost an equal number of males and females in the sample and the average age is forty-five. Around a third of participants have at least a high school degree, almost half live in an urban area, and the average household size is 2.73. Furthermore, around 95 percent of participants consume meat and other animal products. The remaining participants identify as either pescatarians, vegetarians, or lacto vegetarians. The sample contained heavy milk users with around 90 percent stating they consume milk at least once a week or daily. Nearly all participants shop at supermarkets, 17 percent go to farmers' markets, and 11 percent to organic markets. Almost one in ten participants indicates they exclusively purchase organic dairy products. Half of the participants feel they have average knowledge about animal systems and around a third estimated they have low levels of knowledge.

3.2.2 *Animal welfare*

Consumers are generally satisfied with the overall food system (see Table 2). Norway has the significantly highest mean satisfaction and Slovakia the significantly lowest mean satisfaction. For current animal welfare standards in general, mean satisfaction scores are lower than for the overall food system and there are slightly more differences between countries. Norway still has the highest satisfaction but does not differ significantly from Slovenia, while Slovakia and Germany have the lowest satisfaction scores. Mean scores for animal welfare standards for dairy cows and beef cattle (see Appendix 2, Table A3, in the Supplementary Material) follow a similar pattern as the general animal welfare standards mean scores with

Table 2. Mean scores and standard deviations for satisfaction with the overall food system and current animal welfare standards in total and by country.

	Overall food system		Animal welfare standards	
Country	Mean	Standard deviation	Mean	Standard deviation
Austria	6.95cd	2.27	5.78cd	1.99
Germany	6.67d	2.18	5.08e	2.22
Italy	7.01bcd	1.84	5.74d	2.01
Netherlands	7.04bcd	1.69	6.31b	1.80
Norway	7.88a	1.89	7.02a	1.89
Slovakia	5.44e	2.07	5.10e	1.80
Slovenia	7.40b	2.19	6.60ab	2.43
Sweden	7.10bc	1.94	6.20bc	2.08
Total	6.92	2.11	5.91	2.14

Notes: Different letters within each mean column indicate significant differences between countries as evaluated by Tukey's HSD ($P < 0.05$). Questions measured on a 10-point satisfaction scale (1 = 'completely unsatisfied', 10 = 'completely satisfied').

a total mean satisfaction of 6.04 for dairy cows and 5.83 for beef cattle. Furthermore, there is a medium–large Pearson correlation of around 0.60 between the general food system satisfaction and the animal welfare standards satisfaction questions (the overall food system satisfaction question was asked prior to the animal welfare standards satisfaction questions). The animal welfare standard satisfaction questions are also highly correlated with each other ($r \geq 0.86$). This indicates that consumers factor in animal welfare to some degree when thinking about the entire food system in their country. Moreover, they do not fully differentiate their satisfaction levels for animal standards in general and specifically for dairy cows and beef cattle. Although consumers are not completely dissatisfied with the animal welfare standards in their country, the majority of consumers indicated that animal welfare could be improved. Almost 60 percent of participants believe more farm inspections could be an effective way to improve animal welfare. Between 41 and 48 percent believe more consumer transparency, government subsidies for farmers with better animal welfare, and increased education for the public and farmers would also improve animal welfare.

In terms of specific aspects of animal welfare for dairy cows, antibiotic usage, hygiene, and slaughtering conditions are the top three factors of concern for participants, corroborating the focus group discussions about animal welfare. Milking by machine, the ability of the cows to socialize, and floor type are the bottom three factors of concern. It should be noted that 19 percent of participants are not concerned about the welfare of dairy cows. The total mean score for cow housing concernment is 6.35 and most countries have a mean score of around 6 illustrating consumers are only slightly concerned about cow housing systems (see Appendix 2, Table A4, in the Supplementary Material). However, Slovenia and Italy are significantly higher than all other countries with mean scores of 7.36 and 6.80, respectively, showing that this is a potentially more important topic in these countries.

3.2.3 *Housing systems*

A hedonic liking score type question was used to capture the respondents' assessment of cow housing systems. Interestingly, the same pattern emerged across all countries for the hedonic liking results: all systems are significantly different from each other and the compost-bedded housing system is the most liked, followed by the artificial floor, cubicle, and the tie-stall (see Fig. 1). Mean scores for each housing system appear to be similar across countries and there are only a few significant differences between countries (see Appendix 2, Fig. A1, in the Supplementary Material). The favorable mean scores for compost bedded and artificial floor indicate that consumers would be open to products from farms that

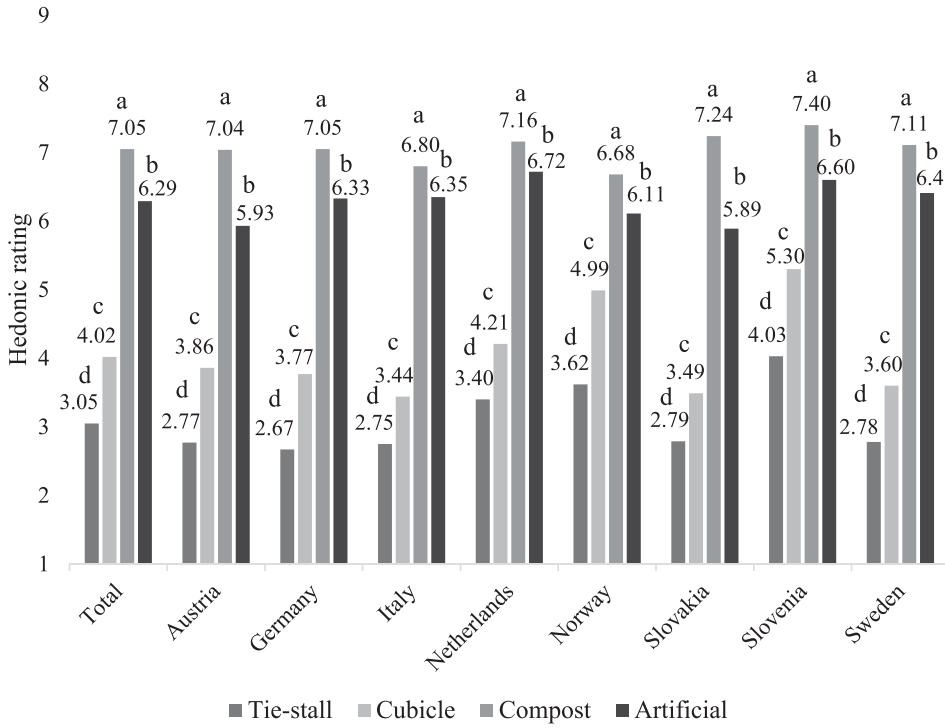

Figure 1. Hedonic mean scores for each housing system in total and by country.
Note: Different letters within total and each country indicate significant differences between housing systems as evaluated by Tukey's HSD ($P < 0.05$).

Table 3. Percentage of participants who chose each housing system to be the best for animal welfare-related characteristics ($n = 3693$).

		Characteristics				
Housing system	Hygiene	Health	Happiness	Preventing injury	Space for the cow	Comfort
Tie-stall	12.05d	6.93c	5.69c	12.00c	5.96d	5.25c
Cubicle	17.14c	20.17b	17.3 3b	20.77b	15.52c	17.55b
Compost bedded	37.42a	52.56a	58.35a	46.79a	53.78a	57.41a
Artificial floor	33.39b	20.34b	18.63b	20.44b	24.75b	19.79b

Note: Different letters within each column indicate significant differences between housing systems as evaluated by Tukey's HSD ($P < 0.05$).

choose to adopt these emerging housing systems. In addition, the majority (70.4 percent) stated they would be interested in a housing labeling system on dairy and beef products. Around 20 percent indicated they do not know whether they would like a housing label. Out of those who would not like to see a housing labeling system, the most cited reason was not being interested in knowing more about the housing system before purchasing dairy or beef products followed by thinking that there are already too many labels on dairy and beef products.

Results for how consumers view the housing systems for different animal welfare characteristics are shown in Table 3. The compost-bedded system is rated to be significantly higher than the other systems for all characteristics with over half of the participants thinking

Table 4. Percentage of participants who think the housing system is acceptable to use for cows with grazing compared with no grazing ($n = 3693$).

Housing system	% with grazing	% without grazing	%-point change
Tie-stall	14.30	10.37	3.93***
Cubicle	33.50	18.41	15.09***
Compost bedded	67.24	71.87	−4.63***
Artificial floor	41.81	34.88	6.93***

Note: ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels.

compost bedded is the best for health, happiness, space, and comfort. Since compost bedded is the most liked system, it may be that consumers like the compost bedded overall because they associate the system with higher cow welfare. In contrast, the tie-stall was chosen significantly less often for all characteristics, indicating consumers generally do not think the tie-stall offers the best conditions for cows. The artificial floor was only chosen significantly more than the cubicle for hygiene and space. Despite the artificial floor and the compost bedded both having open areas, the artificial floor is chosen significantly less often than the compost bedded for all characteristics. Consumers may view the compost-bedded floor as more closely resembling the outside because of the soft compost material, therefore giving the illusion that the cow is in a more 'natural' environment. Being outside has been cited as an important factor to cow welfare (Miele *et al.* 2011; Weinrich *et al.* 2014; Markova-Nenova and Wätzold 2018); hence, this could give the impression that the cows are better off in the compost-bedded system, especially in terms of health, happiness, and comfort.

Grazing is also found to affect how consumers view the different housing systems (see Table 4). The majority of participants think that the compost bedded is acceptable whether the cows are allowed to graze or not. Furthermore, there is a negative significant difference between 'with grazing' and 'without grazing', indicating some consumers may not find the compost-bedded housing as necessary when cows are able to graze. The artificial floor was the second most selected followed by the cubicle and tie-stall for both cases, but the differences were positive between 'with grazing' and 'without grazing' for these systems. The largest significant increase was for the cubicle housing: consumers chose the cubicle system when it was stated cows were allowed to graze 15 percentage points more consumers chose the cubicle system when it was stated cows were allowed to graze than when they were not allowed to graze, tie-stall and the artificial floor are selected significantly more by 3.93 and 6.93 percent points, respectively. Therefore, consumers appear to value cows having the ability to graze or being in an environment that mimics the outdoors.

A potential added benefit of the compost-bedded system is the ability to re-use the compost floor material for other purposes. While participants indicated to be somewhat worried about the safety of the food they eat, participants generally feel safe consuming food products grown in the compost (see Appendix 2, Table A5, in the Supplementary Material). Nevertheless, more participants think the compost should be used for non-edible products than edible products (see Fig. 2). Moreover, more participants think that the compost can be used for produce that is usually cooked rather than uncooked and only a quarter think that the compost can be used for raising animals. Some consumers may feel some hesitancy toward eating food that was grown with the compost despite having indicated feeling safe. Considering this potential trepidation and that almost two in ten participants chose they need more information or it should not be re-used, information will need to be disseminated explaining the compost itself and its guaranteed safeness before it can start to be commercialized, particularly for food-related products. Lastly, around a third think that re-using the compost can make the housing system more sustainable and improve farmers' income.

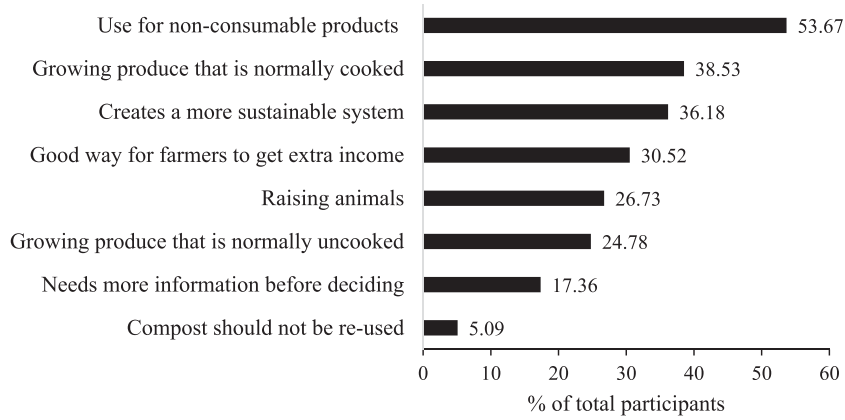

Figure 2. Participant opinion on re-using the compost from the compost-bedded system.

Table 5. Latent class logit analysis results for the choice experiment. Standard errors are shown in parentheses.

	Class 1 (49.4%)	Class 2 (40.4%)	Class 3 (10.2%)
Price	−0.20***	−0.27***	−0.78***
	(0.04)	(0.04)	(0.15)
None option	−3.03***	−0.10	1.14***
	(0.09)	(0.07)	(0.20)
Organic	0.07***	0.09***	−0.16
	(0.02)	(0.03)	(0.13)
Grazing	0.04	0.08***	0.22**
	(0.02)	(0.03)	(0.11)
Tie-stall	0.07**	−0.02	−0.32**
	(0.03)	(0.04)	(0.15)
Compost bedded	−0.02	−0.07**	−0.43***
	(0.03)	(0.03)	(0.14)
Artificial floor	−0.05*	−0.11***	−0.43***
	(0.03)	(0.03)	(0.13)

Notes: ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels. Cubicle housing is used as the reference housing system.

3.3 Choice experiment

Latent class models were estimated for one to twelve classes. Although five classes had the absolute lowest CAIC and BIC values, one of the classes was very small (around 4 percent) and parameter estimates could not be identified consistently. The four class models displayed the same issues. Model estimates from the three class models were found to be stable and produce the same results after testing multiple starting values and convergence criteria. In addition, the BIC and CAIC values were not much larger than the ones for four and five classes. Therefore, three consumer classes were chosen for the final model due to estimate reliability and interpretability.

Results from the latent class analysis are found in Table 5. Class 1 (49.4 percent) has a preference for organic, Class 2 (40.4 percent) has a preference for organic and grazing, and Class 3 (10.2 percent) has a preference only for grazing. All classes prefer lower prices and Class 3 has a higher likelihood to choose the none option, meaning consumers in this group would rather purchase a type of milk that is not found in the choice set. For all groups, compost-bedded and artificial housing systems do not increase milk product choice compared with the cubicle system due to either being insignificant or having significant

Table 6. Mean WTP estimates for milk attributes for each class (in Euro).

	Class 1 (49.4%)	Class 2 (40.4%)	Class 3 (10.2%)
Organic	0.34***	0.32***	−0.21
Grazing	0.18	0.30***	0.29**
Tie-stall	0.34**	−0.08	−0.41**
Compost bedded	−0.11	−0.28**	−0.55***
Artificial floor	−0.24*	−0.40***	−0.55***

Notes: ***, **, and * indicate significance at the 1 percent, 5 percent, and 10 percent levels. Cubicle housing is used as the reference housing system.

negative parameter estimates; however, consumers in Class 1 are more inclined to choose the tie-stall system.

As can be seen in Table 6, the mean WTP estimates follow the same pattern as the latent class logit results. Classes 1 and 2 have a higher WTP for organic with Class 2 having an additional WTP for grazing of 0.30 €. Class 3 only has a WTP for grazing. There are no positive WTP estimates for the compost-bedded and artificial housing systems compared with the cubicle. Previous research has shown that consumers associate organic with animal welfare (Harper and Makatouni 2002; Hughner *et al.* 2007; Christoph-Schulz *et al.* 2015). Studies have also shown that consumers value grazing in dairy production and connect it to higher cow welfare (Miele *et al.* 2011; Tempesta and Vecchiato 2013; Cardoso *et al.* 2016; Kühl *et al.* 2017, 2019). Organic and grazing may be seen as strong enough signals of welfare or other factors of concern to consumers compared with individual housing systems. Therefore, consumers are willing to pay more for these attributes irrespective of the type of housing system used for the dairy cows. Furthermore, the free walk systems are not widespread in Europe. Although they may like the compost-bedded and artificial floor systems after receiving information about them, consumers may not be inclined to pay more for these systems over the more common cubicle system yet, especially when the milk has been produced organically or with grazing. Furthermore, there could also be an attitude–behavior gap for the free walk housing systems: consumers state they like and accept the concept but when faced with a purchase situation do not choose the product with these attributes. Instead, they opt for the more recognizable organic or grazing options.

A profile of the classes was conducted to better understand the different consumer groups. Table 7 shows class segment characteristics for socio-demographic variables. Class 1 has significantly more males, 18–34-year-olds, and those with children than Classes 2 and 3. Furthermore, significantly more consumers in the lowest income bracket and not currently employed or on a pension were in Class 3 (see Appendix 2, Table A6, in the Supplementary Material). Table 7 also shows that Classes 1 and 2 also have a significantly higher percentage of participants with a university degree or higher than those in Class 3. Moreover, the classes are not divided along nationality, indicating milk preferences are not defined by country lines. Class 1 has a significantly higher percentage of Norwegians and Slovenians than the other classes and more Slovakians than Class 2. Class 2 consists of significantly more Germans overall in addition to having more Austrians and Swedes than Class 1. Lastly, Class 3 is made up of significantly more Italians. There are no significant differences among Dutch participants between the classes. These slight country variations may partly account for the milk preference differences between the classes. For example, Tempesta and Vecchiato (2013) show that Italians value regionality and pasture husbandry for milk and Class 3 prefers to have a milk type that was not presented in the choice set due to having a higher probability of choosing the none option (regionality was not included) while also preferring grazing. However, it becomes clear that an analysis of milk choice by country is not warranted as we would have expected stronger differences in the composition by nationality in the classes.

Table 7. Class segment profiles for socio-demographic variables.

Variable	Class 1 (47.85%)	Class 2 (42.57%)	Class 3 (9.59%)
Gender			
Female	46.86b	53.63a	55.37a
Male	52.97a	46.18b	44.07b
Other	0.17a	0.19a	0.56a
Age			
18–24	13.02a	10.31b	7.34b
25–34	20.37a	15.65b	14.12b
35–44	18.79a	18.32a	18.93a
45–54	19.35a	21.56a	19.49a
55–64	14.20b	18.13a	18.93ab
65+	14.26b	16.03ab	21.19a
Education			
No degree	3.40b	2.48b	5.93a
High school	36.39a	35.31a	35.59a
Trade	29.49b	33.78a	36.44a
University/M.S./Ph.D.	30.73a	28.44a	22.03b
Children (% yes)	41.31a	29.26b	25.42b
Country			
Austria	9.85b	12.40a	12.99ab
Germany	14.32b	20.87a	14.69b
Italy	13.07c	17.62b	23.73a
Netherlands	11.32a	10.94a	14.41a
Norway	15.05a	6.49b	9.32b
Slovakia	12.39a	9.99b	9.60ab
Slovenia	13.70a	8.65b	5.37c
Sweden	10.30b	13.04a	9.89ab

Notes: The class segment percentages have slightly changed due to the use of the posterior probabilities for each participant belonging to a class. Significant differences determined using cross-tabulations with Chi-square *z*-tests across columns.

Class segment profiles for food habits in addition to animal husbandry and cow housing variables are found in Table 8. Interestingly, there are significantly more vegetarians in Class 3 and they also consume milk less often than those in the other classes. More consumers in Class 1 shop at butchers and health food stores. Furthermore, they shop at specialized food retailers and organic supermarkets more than those in Class 3, but not Class 2. This makes sense considering Classes 1 and 2 both preferred organic milk. Class 1 has a significantly higher number of consumers who believe they have very high levels of knowledge about animal husbandry systems, while more of those in Class 3 think they have very low levels of knowledge. Moreover, Class 1 is more satisfied with animal welfare standards in general and specifically for dairy cows. There are no differences between the classes in terms of concern for the housing conditions of cows. Although the tie-stall was found to be the least liked system overall, a higher percentage of those who had a higher acceptance are in Class 1 (Norwegians and Slovenians), which could partially explain the increase in probability to choose milk that has used tie-stall in its production. Consumers in this class may be more familiar with tie-stalls and associate it with a traditional system. Tie-stalls today are also used more in smaller operations and in mountain regions such as the Alps, which could be associated with positive milk characteristics for those in Class 1 (Zuliani *et al.* 2018; Wallenbeck *et al.* 2019). They also have a higher hedonic mean score for the cubicle system. Those in Class 3 like the compost-bedded and artificial floor systems the least, which also corresponds to the latent class estimates. Class 1 would like to see a cow housing product label the most and has the least number of consumers who do not know about wanting a

Table 8. Class segment profiles for food habits, animal husbandry, and cow housing variables.

Variable	Class 1 (47.85%)	Class 2 (42.57%)	Class 3 (9.59%)
Diet			
Vegetarian[a]	4.19c	6.11b	9.89a
Milk consumption			
Daily	50.82a	48.22a	50.28a
>1× per week	39.67a	39.82a	32.77b
<2–3× per month	9.51c	11.96b	16.95a
Grocery store type			
Supermarket	91.45a	93.00a	90.11a
Discounter	46.12a	44.47a	43.22a
Butcher	33.16a	27.10b	23.45b
Specialized food retailers	17.43a	15.97ab	11.86b
Farmers market	18.00a	17.68a	16.38a
Organic supermarket	12.45a	10.43ab	7.63b
Health food store	9.62a	6.49b	5.08b
Directly from the farmer	13.47a	14.50a	16.95a
Internet	3.57a	3.69a	2.82a
Knowledge about animal husbandry			
Very low	7.64b	7.95b	11.58a
Low	28.35a	30.98a	31.07a
Average	45.90b	50.76a	47.18ab
High	10.24a	8.84a	7.34a
Very high	7.87a	1.46b	2.82b
Overall animal welfare standards mean satisfaction	6.36a	5.51b	5.45b
Dairy cow animal welfare standards mean satisfaction	6.47a	5.68b	5.53b
Cow housing conditions mean concernment	6.44a	6.27a	6.29a
Cow housing hedonic mean scores			
Tie-stall	3.45a	2.61c	2.90b
Cubicle	4.42a	3.72b	3.42b
Compost	7.15a	7.09a	6.38b
Artificial	6.49a	6.25b	5.53c
Cow housing label on products			
Yes	74.36a	68.89b	57.63c
No	9.96ab	8.65b	12.15a
Do not know	15.68c	22.46b	30.23a

Notes: The class segment percentages have slightly changed due to the use of the posterior probabilities for each participant belonging to a class. Significant differences determined using cross-tabulations with Chi-square *z*-tests across columns or ANOVA and Tukey's HSD for mean scores ($P < 0.05$).

[a] Vegetarian is defined as those who are either pescatarian, vegetarian, or lacto vegetarian.

label, whereas Class 3 has the least number of consumers who want to see a cow housing label on dairy and beef products and the most who do not know.

4 Conclusion

This study helps to gain a better understanding of how European consumers value animal welfare and different cow housing systems. The majority of consumers believe animal welfare can be improved and are concerned with aspects of cow welfare. The compost-bedded system is liked best in all countries and has an association with better animal welfare. Moreover, there is an overall positive attitude toward re-using the compost from the compost-bedded housing system. Our results from the choice experiment using latent class analysis show further evidence of consumer heterogeneity for milk product preferences with almost half of consumers preferring organic milk and a tie-stall housing system, 40 percent preferring organic milk and grazing, and 10 percent only preferring grazing. Consumer

groups varied in terms of socio-demographics, food purchasing habits, animal welfare standards satisfaction, and outlook toward cow housing. Although consumers like the free walk systems (compost bedded and artificial floor), it does not translate into a higher WTP across all consumer groups. Consumers appear to prefer milk produced organically and/or with grazing over conventional production with the free walk systems. Organic and/or grazing may assure a sufficient level of animal welfare for consumers. Consumers also may have a more vivid picture in their mind of 'happy' cows grazing and connect that to organic as well. However, the pictures shown in the context of the survey were to visualize the specific housing setup, which may lead to less intense emotions compared with those of cows in a meadow and hence only have a limited impact on product choice. Furthermore, there could have been an ordering effect regarding the placement of the choice experiment prior to the specific questions about the cow housing systems and animal welfare. Consumers were able to answer the choice experiment without deeper reflection upon being prompted for their housing preferences overall and in terms of animal welfare. There may also be a gap between the stated preference and purchasing behavior in relation to housing systems. While consumers indicate they are interested in a cow housing label, in the end the housing system may not actually matter to consumers when other production methods are also stated. In addition, the results may display the conflicting sentiments discussed in the focus groups regarding animal husbandry and welfare-related labels on products. While many wanted to be more informed about animal husbandry practices and welfare, they expressed feeling confused by and were skeptical of the labels already on animal products.

Considering the favorable reaction to the free walk systems, especially the compost-bedded housing system, dairy farmers and producers may still be able to advertise the use of these systems for their products as marketing material but should be cautious about expecting to receive an extra price premium for using these systems based on our results. Our results seem to suggest that there is only a limited potential for improving animal welfare through a market segmentation approach, at least not with very detailed aspects of the husbandry system; therefore, we would not recommend an additional cow housing-specific label for milk products. In addition, these results can help farmers make a more informed decision on whether to invest in a free walk system. While there are many aspects that factor into this decision, including location, labor, cost, and cow welfare, it is important for farmers to be aware of the consumer perception of these systems in order to gauge whether it could hurt their reputation and net profit.

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Supplementary Data

Supplementary data are available at *QOPEN* online.

Data availability statement

The data underlying this article are available in the data repository of the Technical University at Munich at https://mediatum.ub.tum.de/1592043?show_id=1592042, and can be accessed with doi:10.14459/2021mp1592042.

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