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Assessing citizens' views on the importance of animal welfare and other sustainability aspects in livestock farming using best–worst scaling

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In recent years, farm animal welfare has become an important issue from both an animal science and a societal perspective. Moreover, livestock production is increasingly associated with negative consequences for human health, the environment, and the climate. Thus, there is clear evidence that a more sustainable focus in animal husbandry is needed. However, this is a complex and challenging task, as different stakeholders and emerging trade-offs regarding sustainability need to be considered. For example, outdoor climate housing systems may be socially valued and bring benefits to animal welfare, but at the same time may be detrimental to the environment, the climate, human health, or even animal health. With regard to a sustainable, future-oriented transformation of animal husbandry, it is crucial to identify potential trade-offs and to evaluate them from not only a scientific perspective, but also a societal perspective. Therefore, the aim of this study is to find out how citizens assess the importance of various aspects of livestock production from different goal categories (e.g., ensuring animal welfare vs. environmental or climate protection), as well as within the category “ensuring animal welfare” (e.g., good housing conditions vs. good health conditions). A total of 2,000 participants were recruited via an online panel provider using quota and split sampling. We used the best–worst scaling (BWS) approach to measure the importance of the different aspects for four different farm animal species (dairy cows: $n = 503$; fattening pigs: $n = 500$; broilers: $n = 499$; and laying hens: $n = 498$). The results show that, regardless of animal species, in a trade-off situation, citizens prioritize animal welfare and human health over other sustainability aspects and, in particular, over product attributes (i.e., product price and taste). In terms of animal welfare, the provision of good housing conditions was found to be the most important sub-aspect for all animal species, but good feeding and animal health were also ranked highly. We consider our results valuable for the development of policy frameworks aimed at a sustainable and socially accepted transformation of current animal husbandry.

KEYWORDS

livestock production, transformation, sustainability, trade-offs, animal welfare, best–worst scaling

1 Introduction

Current prevailing livestock production systems are in serious need of improvement from both an animal science and a societal perspective, and thus have been the focus of public criticism for years (Clark et al., 2016; Dawkins, 2016; Mkwanazi et al., 2019; Alonso et al., 2020). Several international studies demonstrate the public desire for more natural and species-appropriate housing systems that provide better farm animal welfare (Boogaard et al., 2011; Spooner et al., 2014; Clark et al., 2016; Bergstra et al., 2017; Sonntag et al., 2019b; Alonso et al., 2020; Schütz et al., 2023). There is evidence that citizens' concerns about the welfare of farm animals is not a short-term effect but a growing megatrend (European Commission, 2007; European Commission, 2016; Fernandes et al., 2021). Ignoring this trend may lead to a rising legitimacy problem for commercial animal use and a loss of the "social license to operate", i.e., to keep animals (Fernandes et al., 2021).

At the same time, livestock farming affects the environment and human health (Post et al., 2020). It is one of the most polluting human activities (Tabassum-Abbasi et al., 2016) and contributes to global warming and water consumption (Rotz, 2020). Furthermore, it is associated with the occurrence of zoonotic infections in humans (Tomley and Shirley, 2009). All of these negative impacts have led to an increased demand for a more sustainable orientation of livestock production (Post et al., 2020). Sustainable livestock production is characterized by being environmentally friendly, profitable for farmers, acceptable to society, and suitable for animal welfare (Lebacqz et al., 2013). Moreover, its impacts should be acceptable not only in the present but also in the future, especially in terms of the availability of resources, consequences of operation, and ethics of activities (Broom et al., 2013). As animal welfare is only one pillar among many within sustainable livestock management (Velarde et al., 2015), its improvement is might be problematic and leads to what is known as a "wicked problem", requiring a complex solution that addresses several stakeholders (Alonso et al., 2020). In discussions about the development of sustainable livestock production, which is considered necessary, citizens make demands that give rise to various trade-offs.

In general, a trade-off can be defined as an at least partial incompatibility of two or more goals that need to be prioritized during decision-making (Sieben and Schildbach, 1975). With regard to livestock farming, trade-offs can occur not only between different goal categories (e.g., ensuring animal welfare, environmental or climate protection, human health, and economic efficiency), but also within a specific goal category (e.g., animal welfare) (Meuwissen and Van Der Lans, 2005). In recent years, trade-offs between different sustainability aspects in particular are increasingly being discussed. An example in this context would be farming systems with outdoor climate access, which on the one hand may be beneficial for animal welfare, but on the other hand may be detrimental to the environment, climate, human health, or even animal health (Siegford et al., 2008; Dawkins, 2016; Delsart et al., 2020; Wolf et al., 2022). In terms of a sustainable, future-oriented transformation of livestock farming, it is crucial to identify potential trade-offs and to evaluate them not only from a scientific perspective but also from a societal perspective.

However, measuring citizens' sustainability preferences is particularly challenging as it is likely that they will rate all aspects as important. To force changes toward more sustainable husbandry systems, it is crucial to find out which aspects are more important than others. Until now, few studies have analyzed citizens' preferences for different sustainability aspects in trade-off situations, and these were often limited to only one animal species, included different aspects, or used different methods. Schmiess and Lusk (2022) showed, using the example of beef production, that consumers are willing to pay more for animal welfare aspects than for environmental efficiencies in a trade-off situation. Furthermore, Sonntag et al. (2019a) found that animal welfare arguments in pig production, such as space, fresh air, daylight, or acting out natural behaviors, outweigh economic, technical, hygienic, or even animal health arguments. Both studies are in line with other studies demonstrating that confronting citizens with trade-offs leads to feelings of helplessness and overwhelm. When in doubt, citizens opted for improved animal welfare (Meuwissen and Van Der Lans, 2005; Ryan et al., 2015). This is also reflected by the findings of a recently published study where animal welfare was ranked above other sustainability aspects or price in a trade-off situation involving different pig housing systems (Schütz et al., 2023).

Against this background, the aim of this study is to find out how citizens rate the importance of different sustainability aspects in livestock production in trade-off situations using the best-worst scaling (BWS) approach. We applied two separate BWSs to four different farm animal species (i.e., dairy cows, fattening pigs, broilers, and laying hens) in order to find out (1) how citizens rate aspects from different goal categories (e.g., ensuring animal welfare vs. environmental or climate protection) and (2) how citizens evaluate aspects within the goal category "ensuring animal welfare" (e.g., good housing conditions vs. good health conditions).

The BWS approach was originated by Louviere and Woodworth (1990) and overcomes the limitations that exist when applying other approaches such as rating scales or ranking (Mühlbacher et al., 2016; Parvin, 2016). It is an approach for measuring preferences where respondents are able to choose only the best or most important and worst or least important aspect out of at least three aspects instead of rating each offered item separately (Mühlbacher et al., 2016). This makes the task easier for participants, especially as the number of items increases, and prevents them from rating all items at a similar importance level (Cohen, 2009; Nakano and Tsuge, 2019). For our study, we used the so-called BWS object case approach, as it seemed particularly suitable for two reasons. First, the aspects we wanted to be evaluated are issues that matter a lot in today's society, and, therefore, hold the risk that participants will rate given aspects on a similarly high level. Second, in our study, we wanted to find out how different aspects are evaluated in a trade-off situation, meaning that participants had to weigh up how important different aspects were to them relative to each other instead of evaluating each aspect separately. This type of BWS has been applied in numerous previous studies, especially those related to citizens' food behavior

(e.g. Cohen, 2009; Hristov and Kuhar, 2015; Liu et al., 2018; Yeh, 2020), healthcare (e.g. Gallego et al., 2012; Marti, 2012; Hauber et al., 2014; Ross et al., 2015), and agricultural policy (Glenk et al., 2014; Caputo and Lusk, 2020; Nong et al., 2020; Muunda et al., 2021).

The wicked problems mentioned above need complex consideration to improve animal welfare in current housing systems. Based on the results, recommendations for action can be given to decision-makers in politics, trade, and business on how husbandry conditions and animal welfare can be improved in the interests of citizens.

2 Materials and methods

2.1 Data collection and sample

Data were collected in Germany between May and June 2021. Participants were recruited by an online panel provider using quota sampling in order to obtain a sample whose composition corresponds to the German population in terms of some sociodemographic characteristics. Participants were split over four subsamples representing one type of farm animal each, namely dairy cows, fattening pigs, broilers, and laying hens. Sex, age, regional affiliation, household income, education level, current employment status, and eating habits were set as quota control criteria according to the distribution in the German population for each subsample. Out of 2,203 respondents, 203 were removed from the final dataset because of inappropriate response behavior according to the ISO 20252 standard (i.e., conspicuous answers to open questions, too fast response time, and straight-lining behavior). Specifically, 151 participants were removed because of conspicuous answers to open questions, 64 were identified as “speeders” (i.e., their response time was faster than the average), and 87 were removed because they showed no variance in response behavior (i.e., were identified as “straight-liners”). Many respondents were removed for more than one of these reasons. For example, 66 out of the 151 respondents, who were removed because of inappropriate answers to open questions, were also identified as speeders and/or straight-liners. The final sample size comprised 2,000 respondents (dairy cows: $n = 503$; fattening pigs: $n = 500$; broilers: $n = 499$; and laying hens: $n = 498$).

2.2 Study design

Data for the present study were obtained from a comprehensive online survey conducted within the framework of a joint project assessing citizens' perceptions and attitudes toward several issues relating to different types of livestock farming. In the first and last part of the questionnaire, some questions about sociodemographic characteristics and personal data were asked. The main part then included questions on the social perception and acceptance of livestock farming and on how citizens deal with emerging trade-offs, questions on dietary behaviour and information behaviour

when shopping, and questions on media use and media reporting. The present study focuses on the social perception of livestock farming and how citizens deal with emerging trade-offs only.

The overall aim of the study was to find out how important different aspects of livestock farming (e.g., ensuring animal welfare or environmental and climate protection) are to citizens, especially in trade-off situations. Against this background, we decided to select aspects that are currently relevant in livestock farming and that allow us to simulate two separate trade-off situations. To assess which aspects were more or less important to participants relative to each other, we applied the BWS approach (Louviere and Woodworth, 1990; Mühlbacher et al., 2016). In total, we selected seven aspects from different goal categories and seven aspects from the goal category “ensuring animal welfare”, which were evaluated in two separate BWSs [i.e., BWS (1) and BWS (2)]. Selected aspects were the same for all four subsamples, and only the examples given to illustrate the aspects were adapted to the respective farm animal type. A list of all 14 aspects used can be found in Tables 1, 2. Aspects from different goal categories were selected based on existing literature as well as expert discussions, which were carried out by one of our project partners. With regard to the goal category “ensuring animal welfare”, aspects were selected based on the criteria developed by the Welfare Quality® project (Blokhuis et al., 2013). Overall, the finally selected aspects cover different areas (e.g., different sustainability aspects), are particularly relevant to livestock farming, and can be applied to all four types of farm animals in the same manner.

2.3 BWS survey design

After choosing aspects (items) to be evaluated, the next step in applying the BWS approach is the construction of choice sets by selecting the most appropriate statistical design out of numerous existing options (Louviere et al., 2013; Parvin, 2016). One design, frequently applied when it comes to BWS surveys, is the balanced incomplete block design (BIBD) (Flynn and Marley, 2014; Liu et al., 2018). According to this design, items (objects) are sorted into choice sets in which a single item appears a predetermined number of times with other items (Louviere et al., 2013). Moreover, a balanced incomplete block design with v items (i.e., aspects) has the following parameters: b , r , k , and λ . The parameter b represents the number of choice sets in the design, r tells us how often it appears per level, k tells us how many aspects we have in each choice set, and λ provides information on how many times each individual aspect occurs with each other aspect across all choice sets (Cohen, 2009). The number of choice sets depends on the number of items (i.e., aspects) to be used. Although participants can usually handle up to 20 choice sets, it is assumed that boredom has already set in after 10–12 choice sets (Cohen, 2009). Consequently, we tried to keep the number of aspects and thus the number of choice sets at a level that is still easy to handle for participants, especially given the length of the entire questionnaire, in which we had to fit both BWSs. Thus, we finally decided to use a 7,4,4,2 design (Table 3) with seven

TABLE 1 Aspects from different goal categories used for the BWS (1) approach.

No.	Aspects	Examples given to illustrate each aspect
1	Ensuring animal welfare	Good housing conditions, good health condition
2	Nature and species protection	Avoidance of the use of pesticides in fodder cultivation, planting flower strips for bees and insects
3	Securing the world's food supply	Avoiding dumping exports of farm animal products ¹ in developing countries, feeding an increasing world population through the sustainable use of resources
4	Environmental and climate protection	Avoiding the release of greenhouse gases or the entry of pollutants into the soil and water through keeping farm animals ²
5	Protection of people working in livestock farming ³	Good income, occupational health, and safety
6	Protection of human health	Avoiding the transmission of pathogens from farm animals ² to humans or of antibiotic residues <i>via</i> the respective products ¹
7	Consumer protection	Products that are cheap or taste good ¹

¹Pork/dairy/chicken/egg products.

²Fattening pigs/dairy cows/broilers/laying hens.

³Pig fattening/dairy farming/broiler farming/laying hen farming.

TABLE 2 Aspects within the goal category "ensuring animal welfare" used for the BWS (2) approach.

No.	Aspects	Examples given to illustrate each aspect
1	No painful management measures	Shortening curly tails, ² dehorning, ¹ shortening beaks ^{3,4}
2	Opportunity to express natural behavior patterns	Exploratory behavior such as rooting, ² licking, ¹ scratching, ^{3,4} social behavior ^{1,2,3,4}
3	Good housing conditions	Enough space, comfortable and clean resting place
4	Good health condition	No risk of illness or injury
5	Positive emotional state	Happy, relaxed
6	Good supply of food and water	Sufficient quantity, good quality
7	Good human-animal relationship	Good handling of animals, ^{1,2,3,4} no fear of humans

¹Dairy cows. ²Fattening pigs. ³Broilers. ⁴Laying hens.

aspects per BIBD. As our study had two different types of aspects with a total of 14 aspects (see Tables 1, 2) to query, we applied the 7,4,4,2 design twice. In this design with seven aspects, there are seven choice sets. Each choice set consists of four aspects, and each aspect appears four times across the entire design (i.e., across all choice sets) and twice together with each other aspect.

TABLE 3 Balanced incomplete block design (BIBD) used for the BWS (1) and (2) approaches.

Choice set	Design 7, 4, 4, 2			
I	1	2	3	6
II	2	3	4	7
III	3	4	5	1
IV	4	5	6	2
V	5	6	7	3
VI	6	7	1	4
VII	7	1	2	5

The first choice set in both BWSs was preceded by a brief instruction that read as follows: "In the following we would like to know how important individual aspects regarding fattening pig/dairy/broiler/laying hens farming are to you. When making your evaluation, bear in mind that in reality it is often difficult to consider all these aspects at the same time or to the same extent. There may be trade-offs that arise between these different aspects. From the following choice sets please select only ONE aspect that is least important to you and ONE that is most important to you." An example of what the choice sets looked like in our study can be found in Table 4.

2.4 Data analysis

Data were analyzed using IBM SPSS Statistics version 26 (IBM Corporation, Armonk, NY, USA) and Microsoft Excel[®] 2019 (Microsoft Corporation, Redmond, WA, USA). In order to analyze obtained data from both BWSs, we applied a counting approach in which the number of times one aspect was selected as most important and the number of times one aspect was selected as least important was counted (see Ola and Menapace, 2020). For this purpose, two

TABLE 4 Example of the BWS (1) approach for fattening pigs: choice set III.

Least important	Aspect	Most important
<input type="checkbox"/>	Securing the world's food supply (e.g., avoiding the dumping exports of pork products in developing countries, feeding an increasing world population through sustainable use of resources)	<input type="checkbox"/>
<input type="checkbox"/>	Environmental and climate protection (e.g., avoiding the release of greenhouse gases or the entry of pollutants into the soil and water through keeping fattening pigs)	<input type="checkbox"/>
<input type="checkbox"/>	Protection of people working in fattening pigs (e.g., good income, occupational health conditions, and safety)	<input type="checkbox"/>
<input type="checkbox"/>	Ensuring animal welfare (e.g., good housing conditions, good health)	<input type="checkbox"/>

new variables were calculated for each participant and aspect, i.e., “total best” (B) and “total worst” (W). Variable B consisted of four variables each, since an aspect appeared a total of four times over the seven choice sets and could therefore be selected a maximum of four times as most important by each participant. Accordingly, variable W also consisted of four variables each, since each aspect could be selected as least important a maximum of four times. Consequently, at the end of our two BWSs with seven aspects each, we obtained 14 B and 14 W variables.

Subsequently, we calculated the B–W score as well as the average B–W score for each aspect. The B–W score was determined by subtracting the sum of times a particular aspect was chosen as least important (W) from the sum of times the same aspect was chosen as most important (B). Values for each aspect and participant were ranked between +4 and –4, with a positive value indicating that the given aspect was selected more often as most important than least important, and a negative value meaning that the given aspect was selected more often as least important than most important. A value of zero means that an aspect was either selected as most important and least important the same number of times or that the aspect was not selected as either most important or least important even once across the seven choice sets. By dividing the value of the B–W score by the number of participants in the respective subsample and the total number of times the aspect appears in all choice sets of the design (i.e., four), the average or standardized B–W score was determined (see Cohen, 2009; Parvin, 2016).

To obtain a deeper insight into the importance of particular aspects, we determined the relative importance of each aspect (see Cohen, 2009). First, the square root (SQRT) of the ratio of B and W for each aspect was calculated. The aspect that had the highest value in this calculation (i.e., that was marked as the most important) was used as a benchmark and received a relative value of 100. The relative importance of the other aspects was then calculated with respect to this benchmark. The relative importance can be interpreted as the probability (expressed as a percentage) of a given aspect being selected as most important.

3 Results

3.1 Sample description

Table 5 shows the distribution of the sociodemographic characteristics set as quota control criteria in the subsamples and

in the German population. There was only a little deviation from the German population in all four subsamples.

3.2 BWS (1)—evaluation of aspects from different goal categories

Table 6 presents participants' rankings of the importance of aspects from different goal categories evaluated in the BWS (1), showing total best (B) and total worst (W) values, B–W scores, average B–W scores, the square root of the ratio of B and W [SQRT (B/W)], and the relative importance for all four subsamples. For a better overview, average B–W scores and relative importance values are also plotted in Figures 1, 2.

With regard to the B–W score and average B–W score, results show that for dairy cows and broilers, participants evaluated the aspect “ensuring animal welfare” as most important and the aspect “protection of human health” as the second-most important (Table 6; Figure 1). For fattening pigs and laying hens, “protection of human health” was assigned the highest importance, whereas “ensuring animal welfare” was assigned second-highest importance. For the remaining five aspects, the ranking order was the same for all four types of farm animals: in third place was “nature and species protection”, followed by “environmental and climate protection”, then “securing the world's food supply”, then “protection of people working in dairy/pig fattening/broiler/laying hen farming”, and then “consumer protection” was ranked last.

Looking at the relative importance, the ranking order was the same for all four subsamples, with “ensuring animal welfare” being the most important aspect and assigned a relative importance of 100, serving as a benchmark (Table 6; Figure 2). The second-most important aspect was “protection of human health” with a value of 66.8 for dairy cows, 93.1 for fattening pigs, 87.1 for broilers, and 88.5 for laying hens. The aspect “environmental and climate protection” was in the middle of the rankings, with 50.3 for dairy cows, 52.9 for fattening pigs, 59.7 for broilers, and 53.2 for laying hens, which means that this aspect was considered to be approximately half as important as “ensuring animal welfare”. In other words, the probability of “environmental and climate protection” being selected was half that of “ensuring animal welfare” being selected. The aspect rated as least important was “consumer protection”, with a probability of being selected of 15.4 for dairy cows, 16.2 for fattening pigs, 19.5 for broilers, and 15.3 for laying hens.

TABLE 5 Sociodemographic characteristics of the subsamples and the German population.

Specification	Dairy cows (n = 503), %	Fattening pigs (n = 500), %	Broilers (n = 499), %	Laying hens (n = 498), %	German population, ^a %
Sex					
Female	50.1	49.0	49.9	48.2	49.3
Male	49.9	50.8	49.7	51.6	50.7
Other	0.0	0.2	0.4	0.2	–
Age groups (years)					
18–29	10.5	11.8	13.2	12.0	16.3
30–39	17.5	14.2	18.2	15.3	15.5
40–49	17.7	18.8	16.6	16.7	14.7
50–59	22.5	23.2	20.8	21.9	19.4
60+	31.8	32.0	31.1	34.1	34.2
Region					
North ¹	18.7	13.8	17.6	16.9	16.1
South ²	30.8	32.2	26.5	27.5	29.4
West ³	32.4	34.6	38.7	33.7	35.4
East ⁴	18.1	19.4	17.2	21.9	19.2
Household income per month					
Up to 1,499 EUR	23.1	23.6	24.2	23.3	25.7
1,500–2,599 EUR	30.4	32.2	29.3	30.5	31.1
2,600–3,199 EUR	14.5	15.2	15.0	16.9	11.7
3,200–4,499 EUR	21.1	17.6	16.6	16.3	16.6
4,500 EUR or more	10.9	11.4	14.8	13.1	14.9
Education					
Low-level education ⁵	22.5	22.0	23.0	20.9	26–37 ⁸
Middle-level education ⁶	36.6	35.6	32.3	36.3	29–34 ⁸
High-level education ⁷	41.0	42.4	44.7	42.8	32–40 ⁸
Current employment status					
Employed	64.0	60.2	61.9	64.9	59–70 ⁸
Not employed	36.0	39.8	38.1	35.1	29–35 ⁸
Eating habits					
Vegetarian/vegan	7.6	6.4	6.0	8.4	5–6
Omnivorous	92.4	93.6	94.0	91.6	94–95

¹Bremen, Hamburg, Lower-Saxony, Schleswig-Holstein.²Bavaria, Baden-Wuerttemberg.³Hessia, North Rhine-Westphalia, Rhineland-Palatinate, Saarland.⁴Brandenburg, Berlin, Saxony, Saxony-Anhalt, Thuringia, Mecklenburg-Western Pomerania.⁵No secondary education completed (yet); graduated from general or lower-level secondary school (German: Hauptschul-/Volksschulabschluss).⁶Graduated from a polytechnical college or middle-level secondary school (German: Polytechnische Oberschule; Realschulabschluss/Mittlere Reife).⁷Graduated from higher-level secondary school (German: Abitur).⁸As we do not have official population data for the age range included in our study for this criterion, we estimated intervals for the quotas.^aStatistisches Bundesamt, GENESIS-Datenbank 2019.

Eur, euro.

TABLE 6 Importance of aspects from different goal categories [BWS (1) approach].

Aspects	Total best	Total worst	B–W score	Average B–W score	SQRT (B/W)	Relative importance
Dairy cows (n = 503)						
Ensuring animal welfare	755	135	620	0.308	2.365	100.0
Protection of human health	747	299	448	0.223	1.581	66.84
Nature and species protection	679	294	385	0.191	1.520	64.26
Environmental and climate protection	529	374	155	0.077	1.189	50.29
Securing the world's food supply	443	631	–188	–0.093	0.838	35.43
Protection of people working in dairy farming	214	621	–407	–0.202	0.587	24.82
Consumer protection	154	1,167	–1,013	–0.503	0.363	15.36
Fattening pigs (n = 500)						
Ensuring animal welfare	740	153	587	0.294	2.199	100.0
Protection of human health	880	210	670	0.335	2.047	93.08
Nature and species protection	596	317	279	0.140	1.371	62.35
Environmental and climate protection	517	382	135	0.067	1.163	52.90
Securing the world's food supply	454	571	–117	–0.059	0.892	40.55
Protection of people working in pig fattening farming	169	734	–565	–0.283	0.480	21.82
Consumer protection	144	1,133	–989	–0.495	0.357	16.21
Broilers (n = 499)						
Ensuring animal welfare	744	170	574	0.288	2.092	100.0
Protection of human health	780	235	545	0.273	1.822	87.09
Nature and species protection	615	318	297	0.149	1.391	66.48
Environmental and climate protection	516	331	185	0.093	1.249	59.68
Securing the world's food supply	490	609	–119	–0.060	0.897	42.88
Protection of people working in broiler farming	174	781	–607	–0.304	0.472	22.56
Consumer protection	174	1,049	–875	–0.438	0.407	19.47
Laying hens (n = 498)						
Ensuring animal welfare	756	148	608	0.305	2.260	100.0
Protection of human health	828	207	621	0.312	2.000	88.49
Nature and species protection	662	295	367	0.184	1.498	66.28
Environmental and climate protection	518	358	160	0.080	1.203	53.22
Securing the world's food supply	391	656	–265	–0.133	0.772	34.16
Protection of people working in laying hen farming	194	680	–486	–0.244	0.534	23.63
Consumer protection	137	1,142	–1,005	–0.505	0.346	15.32

Aspects listed according to 'relative importance'.

SQRT, square root.

3.3 BWS (2)—evaluation of aspects within the goal category “ensuring animal welfare”

Table 7 presents participants' rankings of the importance of aspects within the goal category “ensuring animal welfare” evaluated in the BWS (2), showing total best (B) and total worst

(W) values, B–W scores, average B–W scores, the square root of the ratio of B and W [SQRT(B/W)], and the relative importance for all four subsamples. For a better overview, average B–W scores and relative importance values are additionally plotted in Figures 3, 4.

Examining the B–W score and average B–W score, it becomes clear that “good housing conditions” was considered the most important aspect, followed by “good supply of food and water”

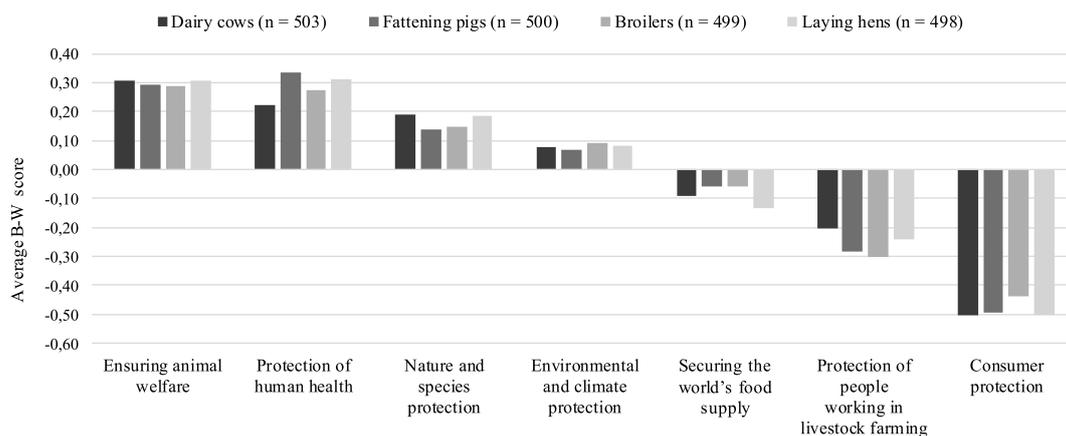


FIGURE 1
Average B–W scores for aspects evaluated in the BWS (1) approach.

and “good health conditions” in all four subsamples (Table 7; Figure 3). The fourth-most important aspect for dairy cow and fattening pig husbandry was “opportunity to express natural behavior patterns” and in broiler and laying hen husbandry it was “no painful management measures”. The fifth-most important aspect was “positive emotional state” for dairy cows, “no painful management measures” for fattening pigs, and “opportunity to express natural behavior patterns” for broilers and laying hens. The aspect “no painful management measures” was ranked sixth in order of importance for dairy cows, as was “positive emotional state” for the other three species. “Good human–animal relationship” was ranked as the least important aspect for all animal species.

Looking at the relative importance levels, in contrast to BWS (1), the order in which aspects were rated as important was not the same for all four subsamples, although only few aspects were rated differently for most of the given aspects. “Good supply of food and water” was the most important aspect for dairy cows, fattening pigs,

and laying hens, whereas for broilers it was “good housing conditions”. This was reversed for the next-most important aspect, meaning that “good housing conditions” was rated as the second-most important aspect for dairy cows (91.6), fattening pigs (94.1), and laying hens (97.8), whereas for broilers it was “good supply of food and water” (96.6). However, third place was assigned without exception to “good health conditions”, with a relative importance of 67.2 for dairy cows, 74.9 for fattening pigs, 78.3 for broilers, and 80.1 for laying hens. In last place was “good human–animal relationship” in all subsamples, with a relative importance of 19.1 for dairy cows, 15.1 for fattening pigs, 14.9 for broilers, and 14.7 for laying hens. The variation in ranking order among subsamples was strongest for the aspects ranked from fourth to sixth, mainly because the aspect “no painful management measures” was rated quite differently among subsamples. Thus, in relation to the benchmark, the probability of selecting this aspect as most important was 25.6 for dairy cows (rank 6), 34.3 for fattening pigs (rank 5), 50.2 for broilers and 56.3 for laying hens (both rank 4).

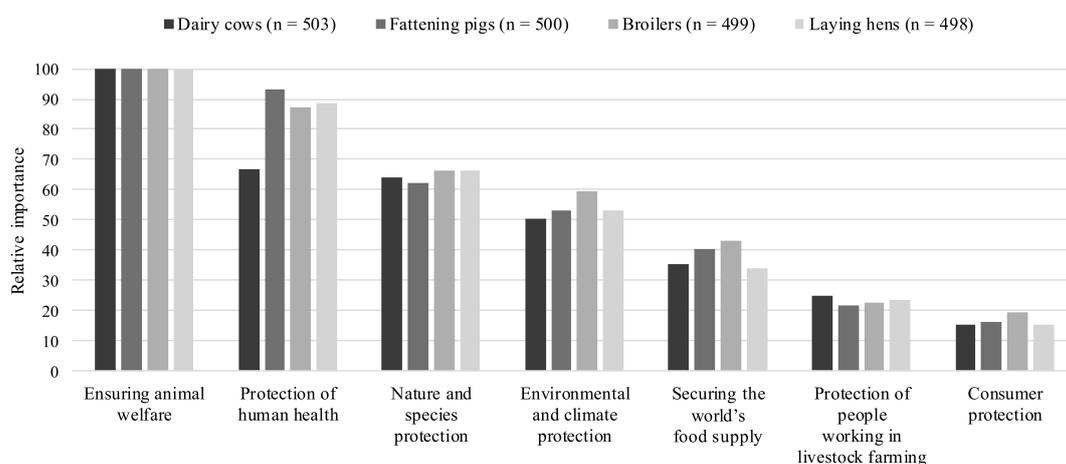


FIGURE 2
Relative importance of aspects evaluated in the BWS (1) approach.

TABLE 7 Importance of aspects within the goal category “ensuring animal welfare” [BWS (2) approach].

Aspects	Total best	Total worst	B–W score	Average B–W score	SQRT (B/W)	Relative importance
Dairy cows (n = 503)						
Good supply of food and water	797	116	681	0.338	2.620	100.0
Good housing conditions	869	143	726	0.361	2.460	91.60
Good health conditions	526	169	357	0.177	1.760	67.17
Opportunity to express natural behavior patterns	433	740	307	–0.153	0.760	29.00
Positive emotional state	335	688	–353	–0.175	0.690	25.65
No painful management measures	321	712	–391	–0.194	0.670	25.57
Good human–animal relationship	240	953	–713	–0.354	0.500	19.08
Fattening pigs (n = 500)						
Good supply of food and water	687	120	567	0.284	2.390	100.0
Good housing conditions	825	163	662	0.331	2.250	94.14
Good health conditions	583	181	402	0.201	1.790	74.89
Opportunity to express natural behavior patterns	497	583	–86	–0.043	0.920	38.49
No painful management measures	420	622	–202	–0.101	0.820	34.30
Positive emotional state	332	657	–325	–0.163	0.710	29.70
Good human–animal relationship	156	1,174	–1,018	–0.509	0.360	15.06
Broilers (n = 499)						
Good housing conditions	865	156	709	0.355	2.350	100.0
Good supply of food and water	678	131	547	0.274	2.270	96.59
Good health conditions	519	152	367	0.184	1.840	78.29
No painful management measures	587	421	166	0.083	1.180	50.21
Opportunity to express natural behavior patterns	459	633	–174	–0.087	0.850	36.17
Positive emotional state	232	765	–533	–0.267	0.550	23.40
Good human–animal relationship	153	1,235	–1,082	–0.542	0.350	14.89
Laying hens (n = 498)						
Good supply of food and water	672	125	547	0.275	2.310	100.0
Good housing conditions	838	163	675	0.339	2.260	97.83
Good health conditions	564	164	400	0.201	1.850	80.08
No painful management measures	628	366	262	0.132	1.300	56.27
Opportunity to express natural behavior patterns	423	627	–204	–0.102	0.820	35.49
Positive emotional state	217	807	–590	–0.296	0.510	22.07
Good human–animal relationship	144	1,234	–1,090	–0.547	0.340	14.71

Aspects listed according to ‘relative importance’.
SQRT, square root.

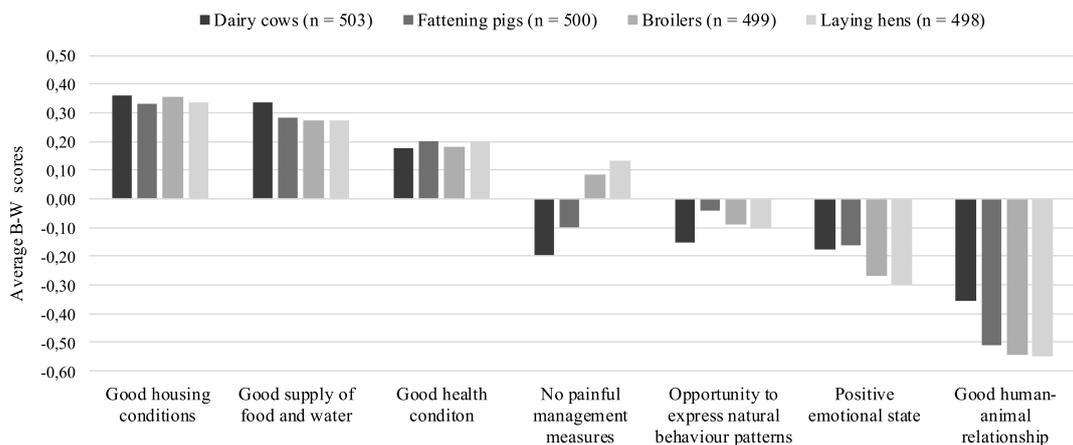


FIGURE 3 Average B–W scores for aspects evaluated in the BWS (2) approach.

4 Discussion

The aim of this study was to find out how citizens rate the importance of different sustainability aspects that are relevant to livestock production (i.e., to dairy farming, pig fattening, and broiler and laying hen production) not only from a scientific perspective but also from a societal perspective. As the simultaneous consideration of these aspects gives rise to numerous trade-offs, especially regarding animal welfare, we chose the best–worst scaling approach (BWS) to measure citizens’ preferences. We consider our results to make a valuable contribution to the field, as previous research differs from our study in several respects: the selection of the aspects investigated, the context in which aspects were evaluated, the methods used to measure importance levels, and the animal species considered (Lusk et al., 2007; Vanhonacker et al., 2007; Sackett et al., 2013; Spooner et al., 2014; Tuytens et al., 2014; Caracciolo et al., 2016; Cummins et al., 2016; Vanhonacker et al., 2016; Ventura et al., 2016; Verain et al., 2016; Ellison et al., 2017; Grunert et al., 2018; Heise and Theuvsen, 2018; Sonntag et al.,

2019a; Faucitano et al., 2022; Schmiess and Lusk, 2022; Schütz et al., 2023). A comparison of the importance levels of the aspects we investigated with previous studies is therefore only possible to a limited extent, which should be kept in mind in the following discussion of the results.

4.1 BWS (1)—evaluation of aspects from different goal categories

Within the first research question we aimed to find out how citizens rate the importance of several aspects of livestock production from different goal categories (e.g., ensuring animal welfare vs. environmental or climate protection) in a trade-off situation. Looking at absolute importance indicators (i.e., B–W score or average B–W score), it becomes clear that the most important aspects are “ensuring animal welfare” (in first place for dairy cows and broilers and second place for fattening pigs and laying hens) and “protection of human health” (in first place for

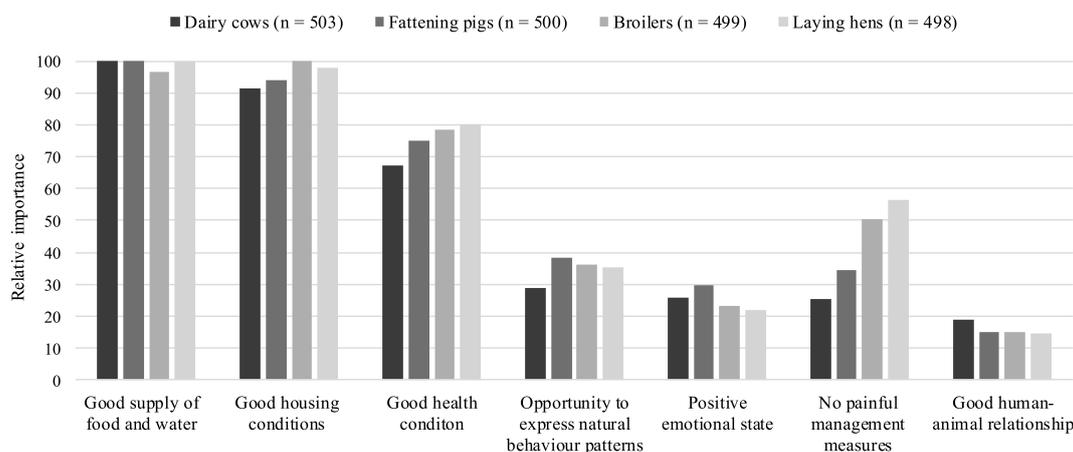


FIGURE 4 Relative importance of aspects evaluated in the BWS (2) approach.

fattening pigs and laying hens and second place for dairy cows and broilers). The next most important aspect for all animal species is “nature and species protection”, then “environmental and climate protection”, then “securing the world’s food supply”, then “protection of people working in dairy/pig fattening/broiler/laying hen farming”, and then “consumer protection” in last place.

In recent years a large number of studies have dealt with citizens’ or consumers’ attitudes toward farm animal welfare, demonstrating increasing concern in Western society (Thorslund et al., 2017; Clark et al., 2019; Alonso et al., 2020). For example, for more than 9 out of 10 EU citizens, the protection of animal welfare is important, and approximately 80% believe that the welfare of farmed animals should be better protected. Furthermore, consumers’ preferences for animal welfare are also reflected by their interest in animal-friendly products and their willingness to pay a price premium for such products (European Commission, 2007; Napolitano et al., 2010; European Commission, 2016; Clark et al., 2017; Yang and Renwick, 2019). For example, more than 50% of European consumers claim to be willing to pay more for products from more animal-friendly husbandry systems or to change their shopping behavior in favor of animal welfare (European Commission, 2007; European Commission, 2016). However, public concern about animal welfare is no longer limited to high-income states; it is also gaining importance in developing countries and is therefore likely to become a universal human value rather than a passing trend (Estévez-Moreno et al., 2021; Estévez-Moreno et al., 2022). Against this background it is not surprising that animal welfare was also rated as highly important in our study (i.e., in relation to different farm animal species). Nevertheless, given our study design, this result becomes remarkable, as participants had to trade off animal welfare against other sustainability aspects.

However, participants also rated the issue of human health as of similar importance to animal welfare. This could be due the fact that citizens often associate animal welfare (i.e., animal health) with human health, which may have been further reinforced by the specific examples we gave in brackets (i.e., the transmission of pathogens from animals to humans and antibiotic residues in the products). According to Clark et al. (2019), citizens consider infectious diseases in animals to be a risk not only to animals but also to human health and food safety. In particular, citizens are critical toward the use of antibiotics, or rather the generation of antibiotic resistance and residues, because they consider it both an indicator for poor animal welfare and a risk to human health and food security (Clark et al., 2019; Busch et al., 2020; Denver et al., 2021). Citizens’ concerns about this issue are justified, as public health scholars, medical scientists, and the World Health Organization (Shallcross et al., 2015; Monger et al., 2021) all consider antibiotic use, or rather its consequences, as a major threat to human health. Furthermore, the similarly high importance assigned to animal protection and human health protection in our study also corresponds to the public’s increased awareness about the relationship between these aspects in the sense of the One Health approach due to the COVID-19 pandemic (Rhouma et al., 2021). However, it is also conceivable that the

respondents perceived and evaluated these aspects independently and considered only their own wellbeing.

With regard to “environment and climate protection”, participants in our study ranked this aspect in the middle and, in relative terms, considered it approximately only half as important as “ensuring animal welfare”. Given the highly intense public debate on environmental and, in particular, climate protection, and the strong impact livestock production has on both (Steinfeld et al., 2006; Nijdam et al., 2012; Tullo et al., 2019; Marquardt, 2020), this rating may appear a little unexpected at first. However, results from previous studies match and help to explain our findings. According to the review of Hartmann and Siegrist (2017), many consumers are not aware of the ecological consequences of livestock farming and consequently underestimate them. Furthermore, Sanchez-Sabate and Sabaté (2019) show in their review that for the general Western population, ecological reasons only play a minor role in decisions to reduce or avoid meat consumption—animal welfare and health concerns are much stronger motives in this context. Thus, even for vegans/vegetarians, ecological concerns appear to be merely another reason with which to legitimize their diet, rather than the original motive for abstaining from animal products. It is therefore conceivable that the participants’ rating in our study is due not only to a relatively lower prioritization of this aspect, but also to a lack of knowledge about the environmental and climate impact of livestock production. Nevertheless, given the heterogeneous results from previous studies, it remains unclear how effective the provision of information on the environmental impact of meat is in increasing awareness of the issue and willingness to reduce meat consumption.

Furthermore, previous studies dealing with citizens’ views on the importance of different aspects of husbandry systems have already demonstrated the comparatively high preference for animal welfare. Taking farrowing crates for sows and outdoor access for pigs as an example, Sonntag et al. (2019a) found that in a trade-off situation, the animal welfare argument (i.e., improved housing conditions) was more convincing than, e.g., economic, technological, or hygienic arguments. In addition, in a recent study by Schütz et al. (2023) where different pig housing systems had to be evaluated against the background of emerging trade-offs, citizens were more likely to trade off animal welfare (i.e., housing conditions) against animal or human health than against climate protection or a lower product price.

However, studies that focus on preferences for different animal product and production attributes from a consumer perspective (especially when making buying decisions) demonstrate that attributes providing individual rather than animal welfare or societal benefits are often favored (Vanhonacker et al., 2007; Cummins et al., 2016; Verain et al., 2016; Ellison et al., 2017; Grunert et al., 2018). This is in contrast to our findings, as the aspect rated as least important in our study was “consumer protection” (i.e., products that are cheap or taste good). For example, Grunert et al. (2018) found that, in general, consumers desired food safety or health-related production attributes (i.e., less antibiotics, GMO-free feed, traceability, or no microbial contamination) more than

attributes related to animal welfare or the environment, to the extent that production with a zero-carbon footprint was selected the least often by a considerable margin. Results from a subsequent choice experiment, where product attributes were also included, showed that origin, fat content, color, and price were ultimately the most important attributes and had the highest impact on food choice. Moreover, according to Verain et al. (2016), taste, price, and healthiness were rated as more important food choice motives than different sustainability-related aspects (e.g., animal or environmental friendliness). Nevertheless, when it comes to trade-offs between animal welfare and environmental production attributes, Schmiess and Lusk (2022) demonstrated that consumers clearly prefer increased animal welfare over lower levels of environmental impact, which matches our findings.

However, in contrast to the studies mentioned above, participants in our study were asked to rate the given aspects in a more general context (e.g., the importance of aspects in the general context of livestock production) rather than in a specific buying situation, and were therefore addressed in their role as a citizen rather than as a consumer. It is widely known that attitudes people hold as citizens do not necessarily match what is ultimately important to them as consumers and do not necessarily reflect their actual (purchasing) behavior. This phenomenon is called the attitude–behavior gap (Carrington et al., 2010; Aschemann-Witzel and Niebuhr Aagaard, 2014; Busch and Spiller, 2020). Attitudes related to animal welfare are a prime example of this, as it has been shown that such concerns often do not automatically lead to the purchase of products advertising improved animal welfare (Miele, 2010; Aschemann-Witzel and Niebuhr Aagaard, 2014; Alonso et al., 2020). This is evident in the low market shares of such products (Vermeir and Verbeke, 2006; Miele, 2010; Vigors, 2018; Busch and Spiller, 2020) and can be caused by multiple reasons, including consumers having to make various compromises in a buying situation, insufficient credibility, a lack of transparency or availability of information about ethical production attributes, or the unavailability of corresponding products, as well as high prices (Carrington et al., 2010; Miele, 2010; Grunert, 2011; Aschemann-Witzel and Niebuhr Aagaard, 2014; Grunert et al., 2014; Alonso et al., 2020).

4.2 BWS (2)—evaluation of aspects within the goal category “ensuring animal welfare”

The second research aim was to investigate how citizens rate the importance of selected aspects of animal husbandry within the goal category “ensuring animal welfare” (e.g. “good supply of food and water” vs. “opportunity to express natural behavior patterns”) in a trade-off situation.

As already discussed in the previous section, animal welfare is an issue of major importance in the public debate about livestock production. However, the question is how to understand the concept of animal welfare. Research has clearly shown that it is not just about animal health and high levels of productivity (Ventura et al., 2021), but that it is a multifaceted concept that

encompasses many aspects, which makes its evaluation challenging (Miele et al., 2011). For this study, we selected seven aspects from the European Welfare Quality® project (Blokhuis et al., 2013) in order to comprehensively cover the concept of animal welfare.

The absolute importance indicators (i.e., B–W score and average B–W score) showed that the most important aspect for all four animal species studied was “good husbandry conditions”, followed by “good supply of feed and water”, and then “good health conditions”. The ranks 4–6 are shared, with the order depending on animal species, by the aspects “opportunity to express natural behavior patterns”, “no painful management measures”, and “positive emotional state”. A good human–animal relationship was ranked as the least important aspect for all animal species.

One reason why “good husbandry conditions” was rated as most important among all seven animal welfare aspects might be that from a citizen/ consumer perspective it most comprehensively reflects animal welfare. Our results are in line with previous studies, although a direct comparison is limited owing to various reasons (see above). Heise and Theuvsen (2018) examined the importance of five animal welfare aspects (i.e., animal performance, animal behavior, animal health, management practices, and husbandry system) and found that German citizens rated the husbandry system as the most important aspect in an open-question format and as the second-most important aspect in a closed-question format. In a qualitative study by Ventura et al. (2016), aspects related to housing conditions, such as pasture and/or outdoor access or space and freedom to exhibit behaviors, were also considered highly important (i.e., just after fresh food and water). A study conducted among European consumers showed that among several aspects (e.g., outdoor access, sufficient space, and exhibiting natural behavior), the largest percentage of respondents rated sufficient space as the most important aspect (Faucitano et al., 2022). Similarly, Sato et al. (2017) found that the majority of consumers considered sufficient freedom of movement as a key aspect of an ideal pig husbandry system.

A good supply of food and water was rated as almost as important as good housing conditions in our study. In the aforementioned study by Heise and Theuvsen (2018), the supply of feed and water as a sub-aspect of management practices was ranked second in importance in the open-ended question. Similarly, Canadian citizens most frequently named fresh food and water as necessary for good dairy cattle life (Ventura et al., 2016). Vanhonacker et al. (2016) demonstrated that both producers and consumers consider “good feeding” as one of the least problematic aspects of animal welfare. Thus, a good supply of feed and water seems to be quite an important part of ensuring animal welfare, although its implementation has already reached a satisfactory level in Western countries. The third-most important aspect in our study was “good health conditions”, which has been found to be the most important in some recent studies (e.g., Tuytens et al., 2014; Heise and Theuvsen, 2018).

It is important to note that the respondents consider the aspects ranked fourth to seventh (i.e., “opportunity to express natural behavior patterns”, “positive emotional state”, “no painful management measures”, and “good human–animal relationship”) to be clearly less important than the three highest-ranked aspects

(i.e., “good supply of feed and water”, “good housing conditions”, and “good health conditions”), especially for dairy cows and fattening pigs. This can be explained by the fact that the respondents probably believed that if the three highest-ranked aspects are fulfilled, the other aspects will also be at a satisfactory level. However, the opportunity to express natural behavior was the most frequently mentioned aspect of animal welfare in the qualitative study by [Spooner et al. \(2014\)](#) and was also considered by respondents to be an important element of the ideal pig stable ([Sato et al., 2017](#)). According to [Vanhonacker et al. \(2016\)](#), Belgian consumers considered good treatment to be the most problematic aspect of broiler welfare. However, the clear ranking of a good human–animal relationship as the least important aspect in our study can be interpreted as the result of a superficial understanding and insufficient knowledge of the nature of this aspect, as a positive human–animal relationship is beneficial for animal welfare in different respects ([Rault et al., 2020](#)).

As previous studies indicate cultural differences with regard to the importance levels of different animal welfare aspects, it would be interesting to examine the aspects included in our study in other countries. For example, [Pejman et al. \(2019\)](#) surveyed people from eight European countries (the United Kingdom, Sweden, Poland, Lithuania, Romania, Italy, Greece, and Spain) and found that, for example, respondents from Mediterranean countries rated the issue of appropriate and natural animal food as more important than those from the other countries. In contrast, people from northern European countries rated aspects such as feeding, pain, and animal health as less important than respondents from other European regions. Furthermore, respondents from Poland, Italy, and Lithuania considered natural living conditions and a clean environment to be the most important aspects of animal welfare.

5 Conclusion and practical implications

The aim of this study was to investigate citizens’ views on the importance of different sustainability aspects of livestock production (i.e., dairy farming, pig fattening, and broiler and laying hen farming) and of several sub-aspects of animal welfare by using the best–worst scaling approach. The results show that, independent of animal species, in a trade-off situation, citizens prioritize ensuring animal welfare and human health over other sustainability aspects and that product attributes (i.e., products that are cheap or taste good) were ranked as least important. With regard to animal welfare, providing good housing conditions turned out to be the most important sub-aspect for all animal species, but good feed and animal health were highly prioritized as well. Other welfare aspects, such as enabling animals to express natural behavior patterns or ensuring a good human–animal relationship, were considered comparatively less important.

In terms of a transformation toward more sustainable and socially accepted livestock production, our results demonstrate that animal welfare should receive a special focus despite the high relevance of other sustainability issues, for example environmental

and climate protection, in the public debate. This is particularly important with regard to situations in which trade-offs may occur and prioritization becomes necessary. In this context, making compromises on animal welfare will negatively affect social acceptance of animal husbandry, and even jeopardize the license to operate and thus to keep farm animals. Ultimately, this may encourage people to follow a vegetarian or vegan diet. For outdoor climate systems, for example, the implementation of which still faces several challenges in Germany, this would imply that to enable animal welfare improvements, the appropriate framework conditions should be established, even if these may entail some drawbacks for, for example, the environment or the climate. However, this does not generally mean that improved animal welfare should be pushed through without any consideration of the negative impacts on other sustainability issues. Rather, it is important to consider the extent to which animal welfare improvements are associated with compromises on, for example, the environment or the climate, and whether or not they are reasonable. In the end, knowing the high priority citizens attach to animal welfare may strengthen efforts to find options that can mitigate or even resolve various trade-offs and therefore find solutions that are not only acceptable with regard to animal welfare from a societal point of view.

Furthermore, our findings clearly demonstrate that, from a citizen’s perspective, not only housing conditions but also animal health conditions are highly important animal welfare criteria. Therefore, in animal welfare measures, for example in the context of animal welfare labeling, the reduction of welfare to simply housing criteria is insufficient not only from an animal science but also from a societal point of view and should therefore be reconsidered in the future.

Together, our results provide valuable insights for the development of political framework conditions that aim at a sustainable and socially accepted transformation of current livestock farming. On the one hand, they help with the general orientation of livestock farming by identifying aspects (e.g., ensuring animal welfare or environmental and climate protection) that are prioritized from a societal perspective. On the other hand, they provide more specific insights for solving “wicked problems” regarding the highly relevant topic of animal welfare by showing which sub-aspects (e.g., animal health or husbandry conditions) are particularly important to citizens and should therefore be given (greater) consideration in the future. The differentiation of animal welfare into sub-aspects and the associated individual evaluation by citizens enables a structured approach to the development of innovative husbandry systems.

6 Limitations

In order to give the participants a better understanding of the aspects evaluated and thus to ensure an equal basis for evaluation, we opted to provide several examples for each aspect. However, although we carefully selected examples that represent the aspects in an appropriate and comprehensive way, it cannot be ruled out that,

for example, the different levels of knowledge or subjective perceptions of the participants influenced their evaluations. In this context it is therefore conceivable that the specific selection of the examples influenced our results to some extent.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethics review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AS, IF, WS, and IC-S: conceptualization. AS and IF: methodology and formal analysis. AS and IF: writing—original draft preparation; WS: contribution to writing individual sections of the manuscript. AS, IF, WS, and IC-S: writing—review and editing. WS and IC-S: funding acquisition. All authors contributed to the article and approved the submitted version.

References

- Alonso, M. E., González-Montaña, J. R., and Lomillos, J. M. (2020). Consumers concerns and perceptions of farm animal welfare. *Animals* 10 (3), 385. doi: 10.3390/ani10030385
- Aschemann-Witzel, J., and Niebuhr Aagaard, E. M. (2014). Elaborating on the attitude–behaviour gap regarding organic products: young Danish consumers and in-store food choice. *Int. J. Consum. Stud.* 38 (5), 550–558. doi: 10.1111/ijcs.12115
- Bergstra, T. J., Hogeveen, H., and Stassen, E. N. (2017). Attitudes of different stakeholders toward pig husbandry: a study to determine conflicting and matching attitudes toward animals, humans and the environment. *Agric. Hum. Values.* 34 (2), 393–405. doi: 10.1007/s10460-016-9721-4
- Blokhuys, H., Miele, M., Veissier, I., and Jones, B. (2013). *Improving farm animal welfare: science and society working together: the welfare quality approach. 1st edn* (Wageningen: Wageningen Academic Publishers).
- Boogaard, B., Boekhorst, L. J. S., Oosting, S., and Sørensen, J. (2011). Sociocultural sustainability of pig production: citizen perceptions in the Netherlands and Denmark. *Livest. Sci.* 140, 189–200. doi: 10.1016/j.livsci.2011.03.028
- Broom, D. M., Galindo, F. A., and Murgueitio, E. (2013). Sustainable, efficient livestock production with high biodiversity and good welfare for animals. *Proc. R. Soc. B.* 280 (1771), 2013–2025. doi: 10.1098/rspb.2013.2025
- Busch, G., Kassas, B., Palma, M. A., and Risius, A. (2020). Perceptions of antibiotic use in livestock farming in Germany, Italy and the United States. *Livest. Sci.* 241, 104251. doi: 10.1016/j.livsci.2020.104251
- Busch, G., and Spiller, A. (2020). *Warum wir eine tierschutzsteuer brauchen - die bürger-Konsumenten-Lücke*. (University of Göttingen: Discussion paper No. 2001. Department of Agricultural Economics and Rural Development).
- Caputo, V., and Lusk, J. L. (2020). What agricultural and food policies do U.S. consumers prefer? a best–worst scaling approach. *Agric. Econ.* 51 (1), 75–93. doi: 10.1111/agec.12542
- Caracciolo, F., Cicia, G., Del Giudice, T., Cembalo, L., Krystallis, A., Grunert, K. G., et al. (2016). Human values and preferences for cleaner livestock production. *J. Clean. Prod.* 112, 121–130. doi: 10.1016/j.jclepro.2015.06.045
- Carrington, M. J., Neville, B. A., and Whitwell, G. J. (2010). Why ethical consumers don't walk their talk: towards a framework for understanding the gap between the ethical purchase intentions and actual buying behaviour of ethically minded consumers. *J. Bus. Ethics.* 97 (1), 139–158. doi: 10.1007/s10551-010-0501-6
- Clark, B., Panzone, L. A., Stewart, G. B., Kyriazakis, I., Niemi, J. K., Latvala, T., et al. (2019). Consumer attitudes towards production diseases in intensive production systems. *PLoS One* 14 (1), e0210432. doi: 10.1371/journal.pone.0210432
- Clark, B., Stewart, G. B., Panzone, L. A., Kyriazakis, I., and Frewer, L. J. (2016). A systematic review of public attitudes, perceptions and behaviours towards production diseases associated with farm animal welfare. *J. Agric. Environ. Ethics.* 29 (3), 455–478. doi: 10.1007/s10806-016-9615-x
- Clark, B. Z., Stewart, G. B., Panzone, L. A., Kyriazakis, I., and Frewer, L. J. (2017). Citizens, consumers and farm animal welfare: a meta-analysis of willingness-to-pay studies. *Food Policy* 68, 112–127. doi: 10.1016/j.foodpol.2017.01.006
- Cohen, E. (2009). Applying best–worst scaling to wine marketing. *Int. J. Wine Bus. Res.* 21 (1), 8–23. doi: 10.1108/17511060910948008
- Cummins, A. M., Widmar, N. J. O., Cronney, C. C., and Fulton, J. R. (2016). Understanding consumer pork attribute preferences. *Theor. Econ. Lett.* 06 (02), 166. doi: 10.4236/tel.2016.62019
- Dawkins, M. S. (2016). Animal welfare and efficient farming: is conflict inevitable? *Anim. Prod. Sci.* 57 (2), 201–208. doi: 10.1071/AN15383
- Delsart, M., Pol, F., Dufour, B., Rose, N., and Fablet, C. (2020). Pig farming in alternative systems: strengths and challenges in terms of animal welfare, biosecurity, animal health and pork safety. *Agriculture* 10 (7), 261. doi: 10.3390/agriculture10070261
- Denver, S., Jensen, J. D., and Christensen, T. (2021). Consumer preferences for reduced antibiotic use in Danish pig production. *Prev. Vet. Med.* 189, 105310. doi: 10.1016/j.prevetmed.2021.105310
- Ellison, B., Brooks, K., and Mieno, T. (2017). Which livestock production claims matter most to consumers? *Agric. Hum. Values.* 34 (4), 819–831. doi: 10.1007/s10460-017-9777-9

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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- Estévez-Moreno, L. X., María, G. A., Sepúlveda, W. S., Villarroel, M., and Miranda-de la Lama, G. C. (2021). Attitudes of meat consumers in Mexico and Spain about farm animal welfare: a cross-cultural study. *Meat. Sci.* 173, 108377. doi: 10.1016/j.meatsci.2020.108377
- Estévez-Moreno, L. X., Miranda-de la Lama, G. C., and Miguel-Pacheco, G. G. (2022). Consumer attitudes towards farm animal welfare in Argentina, Chile, Colombia, Ecuador, Peru and Bolivia: a segmentation-based study. *Meat. Sci.* 187, 108747. doi: 10.1016/j.meatsci.2022.108747
- European Commission. (2007). *Special eurobarometer 270: attitudes of EU citizens towards animal welfare, report* (Brussels, Belgium: European Commission), 82.
- European Commission. (2016). *Special eurobarometer 442: attitudes of Europeans towards animal welfare*. Available at: https://data.europa.eu/euodp/de/data/dataset/S2096_84_4_442_ENG (Accessed November 15, 2017).
- Faucitano, L., Martelli, G., Nannoni, E., and Manteca, X. (2022). "Fundamentals of animal welfare in meat animals and consumer attitudes to animal welfare," in *New aspects of meat quality - from genes to ethics second edition* (Cambridge: Elsevier-Woodhead Publishing), 667–703.
- Fernandes, J. N., Hemsworth, P. H., Coleman, G. J., and Tilbrook, A. J. (2021). Costs and benefits of improving farm animal welfare. *Agriculture* 11 (2), 104. doi: 10.3390/agriculture11020104
- Flynn, T. N., and Marley, A. A. J. (2014) Best-worst scaling: theory and methods. In: *Handbook of choice modelling* (Edward Elgar Publishing). Available at: https://econpapers.repec.org/bookchap/elgeechap/14820_5f8.htm (Accessed March 17, 2023).
- Gallego, G., Bridges, J. F. P., Flynn, T., Blauvelt, B. M., and Niessen, L. W. (2012). Using best-worst scaling in horizon scanning for hepatocellular carcinoma technologies. *Int. J. Technol. Assess. Health Care* 28 (3), 339–346. doi: 10.1017/S026646231200027X
- Glenk, K., Eory, V., Colombo, S., and Barnes, A. (2014). Adoption of greenhouse gas mitigation in agriculture: an analysis of dairy farmers' perceptions and adoption behaviour. *Ecol. Econ.* 108, 49–58. doi: 10.1016/j.ecolecon.2014.09.027
- Grunert, K. G. (2011). Sustainability in the food sector: a consumer behaviour perspective. *Int. J. Food Syst. Dyn.* 2 (3), 207–218. doi: 10.18461/ijfsd.v2i3.232
- Grunert, K. G., Hieke, S., and Wills, J. (2014). Sustainability labels on food products: consumer motivation, understanding and use. *Food Policy* 44, 177–189. doi: 10.1016/j.foodpol.2013.12.001
- Grunert, K. G., Sonntag, W. I., Glanz-Chanos, V., and Forum, S. (2018). Consumer interest in environmental impact, safety, health and animal welfare aspects of modern pig production: results of a cross-national choice experiment. *Meat. Sci.* 137, 123–129. doi: 10.1016/j.meatsci.2017.11.022
- Hartmann, C., and Siegrist, M. (2017). Consumer perception and behaviour regarding sustainable protein consumption: a systematic review. *Trends Food Sci. Technol.* 61, 11–25. doi: 10.1016/j.tifs.2016.12.006
- Hauber, A. B., Mohamed, A. F., Johnson, F. R., Cook, M., Arrighi, H. M., Zhang, J., et al. (2014). Understanding the relative importance of preserving functional abilities in alzheimer's disease in the united states and Germany. *Qual. Life Res.* 23 (6), 1813–1821. doi: 10.1007/s11136-013-0620-5
- Heise, H., and Theuvsen, L. (2018). Citizens' understanding of welfare of animals on the farm: an empirical study. *J. Appl. Anim. Welf. Sci.* 21, 153–169. doi: 10.1080/10888705.2017.1400439
- Hristov, H., and Kuhar, A. (2015). Subjective knowledge as a determinant of young adult consumers wine behaviour. *Br. Food J.* 117 (12), 2930–2946. doi: 10.1108/BFJ-04-2015-0163
- Lebacqz, T., Baret, P., and Stilmant, D. (2013). Sustainability indicators for livestock farming, a review. *Agron. Sustain. Dev.* 33 (2), 311–327. doi: 10.1007/s13593-012-0121-x
- Liu, C., Li, J., Steele, W., and Fang, X. (2018). A study on Chinese consumer preferences for food traceability information using best-worst scaling. *PLoS One* 13 (11), e0206793. doi: 10.1371/journal.pone.0206793
- Louviere, J., Lings, I., Islam, T., Gudergan, S., and Flynn, T. (2013). An introduction to the application of (case 1) best-worst scaling in marketing research. *Int. J. Res. Mark.* 30 (3), 292–303. doi: 10.1016/j.ijresmar.2012.10.002
- Louviere, J., and Woodworth, G. (1990). *Best-worst scaling: a model for the largest difference judgments*. (Working Paper. Faculty of Business: University of Alberta).
- Lusk, J., Norwood, B., and W. Pickett Norwood, R. (2007). *Consumer preferences for farm animal welfare: results of a nationwide telephone survey*. (Department of Agricultural Economics, Oklahoma State University), 19.
- Marley, A. A. J., and Flynn, T. N. (2015) *Best worst scaling: theory and practice* (Elsevier). Available at: <https://linkinghub.elsevier.com/retrieve/pii/B9780080970868431223> (Accessed March 17, 2023).
- Marquardt, J. (2020). Fridays for future's disruptive potential: an inconvenient youth between moderate and radical ideas. *Front. Commun.* 5. doi: 10.3389/fcomm.2020.00048
- Marti, J. (2012). A best-worst scaling survey of adolescents' level of concern for health and non-health consequences of smoking. *Soc. Sci. Med.* 1982 75 (1), 87–97. doi: 10.1016/j.socscimed.2012.02.024
- Meuwissen, M. P. M., and Van Der Lans, I. A. (2005). Trade-offs between consumer concerns: an application for pork supply chains. *Acta Agr. Scand. Section. C - Food Econ.* 2 (1), 27–34. doi: 10.1080/16507540510033442
- Miele, M. (2010). *Report concerning consumer perceptions and attitudes towards farm animal welfare* (Uppsala University). Available at: https://www.academia.edu/1213586/Report_concerning_consumer_perceptions_and_attitudes_towards_farm_animal_welfare (Accessed August, 31, 2022).
- Miele, M., Veissier, I., Evans, A., and Botreau, R. (2011). Animal welfare: establishing a dialogue between science and society. *Anim. Welf.* 20, 103–117. doi: 10.1017/S096272860002475
- Mkwanazi, M. V., Ncobela, C. N., Kanengoni, A. T., and Chimonyo, M. (2019). Effects of environmental enrichment on behaviour, physiology and performance of pigs - a review. *Asian-australas. J. Anim. Sci.* 32 (1), 1–13. doi: 10.5713/ajas.17.0138
- Monger, X. C., Gilbert, A.-A., Saucier, L., and Vincent, A. T. (2021). Antibiotic resistance: from pig to meat. *Antibiot. (Basel. Switzerland)*. 10 (10), 1209. doi: 10.3390/antibiotics10101209
- Mühlbacher, A. C., Zweifel, P., Kaczynski, A., and Johnson, F. R. (2016). Experimental measurement of preferences in health care using best-worst scaling (BWS): theoretical and statistical issues. *Health Econ. Rev.* 6 (1), 5. doi: 10.1186/s13561-015-0077-z
- Muunda, E., Mtimet, N., Schneider, F., Wanyoike, F., Dominguez-Salas, P., and Alonso, S. (2021). Could the new dairy policy affect milk allocation to infants in Kenya? a best-worst scaling approach. *Food Policy* 101, 102043. doi: 10.1016/j.foodpol.2021.102043
- Nakano, M., and Tsuge, T. (2019). Assessing the heterogeneity of consumers' preferences for corporate social responsibility using the best-worst scaling approach. *Sustainability* 11 (10), 2995. doi: 10.3390/su11102995
- Napolitano, F., Girolami, A., and Braghieri, A. (2010). Consumer liking and willingness to pay for high welfare animal-based products. *Trends Food Sci. Technol.* 21 (11), 537–543. doi: 10.1016/j.tifs.2010.07.012
- Nijdam, D., Rood, T., and Westhoek, H. (2012). The price of protein: review of land use and carbon footprints from life cycle assessments of animal food products and their substitutes. *Food Policy* 37 (6), 760–770. doi: 10.1016/j.foodpol.2012.08.002
- Nong, Y., Yin, C., Yi, X., Ren, J., and Chien, H. (2020). Farmers' adoption preferences for sustainable agriculture practices in Northwest China. *Sustainability* 12 (15), 6269. doi: 10.3390/su12156269
- Ola, O., and Menapace, L. (2020). Revisiting constraints to smallholder participation in high-value markets: a best-worst scaling approach. *Agric. Econ.* 51 (4), 595–608. doi: 10.1111/agec.12574
- Parvin, S. (2016). Review of best-worst scaling method: a new method over other scales in marketing research. *J. Bus. Stud.* 37 (1).
- Pejman, N., Kallas, Z., Dalmau, A., and Velarde, A. (2019). Should animal welfare regulations be more restrictive? a case study in eight European union countries. *Animals* 9 (4), 195. doi: 10.3390/ani9040195
- Post, P. M., Hogerwerf, L., Bokkers, E. A., Baumann, B., Fischer, P., Rutledge-Jonker, S., et al. (2020). Effects of Dutch livestock production on human health and the environment. *Sci. Total Environ.* 737, 139702. doi: 10.1016/j.scitotenv.2020.139702
- Rault, J.-L., Waiblinger, S., Boivin, X., and Hemsworth, P. (2020). The power of a positive human-animal relationship for animal welfare. *Front. Vet. Sci.* 7. doi: 10.3389/fvets.2020.590867
- Rhouma, M., Tessier, M., Aenishaenslin, C., Sanders, P., and Carabin, H. (2021). Should the increased awareness of the one health approach brought by the COVID-19 pandemic be used to further tackle the challenge of antimicrobial resistance? *Antibiotics* 10 (4), 464. doi: 10.3390/antibiotics10040464
- Ross, M., Bridges, J. F. P., Ng, X., Wagner, L. D., Frosch, E., Reeves, G., et al. (2015). A best-worst scaling experiment to prioritize caregiver concerns about ADHD medication for children. *Psychiatr. Serv. (Washington. D.C.)* 66 (2), 208–211. doi: 10.1176/appi.ps.201300525
- Rotz, A. (2020). Environmental sustainability of livestock production. *Meat. Muscle Biol.* 4 (2), 11, 1–18. doi: 10.22175/mmb.11103
- Ryan, E. B., Fraser, D., and Weary, D. M. (2015). Public attitudes to housing systems for pregnant pigs. *PLoS One* 10 (11), e0141878. doi: 10.1371/journal.pone.0141878
- Sackett, H. M., Shupp, R., and Tonsor, G. (2013). Consumer perceptions of sustainable farming practices: a best-worst scenario. *Agric. Resour. Econ. Rev.* 42 (2), 275–290. doi: 10.1017/S1068280500004378
- Sanchez-Sabate, R., and Sabaté, J. (2019). Consumer attitudes towards environmental concerns of meat consumption: a systematic review. *Int. J. Environ. Res. Public Health* 16 (7), 1220. doi: 10.3390/ijerph16071220
- Sato, P., Hötzel, M. J., and Von Keyserlingk, M. A. G. (2017). American Citizens' views of an ideal pig farm. *Animals* 7 (8), 64. doi: 10.3390/ani7080064
- Schmiess, J., and Lusk, J. (2022). Trade-off between animal welfare and environmental impacts of beef production: an analysis of presentation effects on consumer choice. *J. Agric. Resour. Econ.* 47 (2), 278–299. doi: 10.22004/ag.econ.310530
- Schütz, A., Busch, G., and Sonntag, W. I. (2023). Systematically analysing the acceptability of pig farming systems with different animal welfare levels when considering intra-sustainability trade-offs: are citizens willing to compromise? *PLoS One* 18 (3), e0282530. doi: 10.1371/journal.pone.0282530
- Shallcross, L. J., Howard, S. J., Fowler, T., and Davies, S. C. (2015). Tackling the threat of antimicrobial resistance: from policy to sustainable action. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* 370 (1670), 20140082. doi: 10.1098/rstb.2014.0082

- Sieben, G., and Schildbach, T. (1975). *Betriebswirtschaftliche entscheidungstheorie* (Düsseldorf: Werner).
- Siegford, J. M., Powers, W., and Grimes-Casey, H. G. (2008). Environmental aspects of ethical animal production. *Poult. Sci.* 87 (2), 380–386. doi: 10.3382/ps.2007-00351
- Sonntag, W. I., Kiehas, M. T., Spiller, A., Kaiser, A., Ludolph, L. M., Grunert, K. G., et al. (2019a). Consumer evaluation of intra-sustainable trade-offs in pig production - a mixed-method approach to analyze different consumer segments. *Livest. Sci.* 224, 102–113. doi: 10.1016/j.livsci.2019.04.010
- Sonntag, W. I., Spiller, A., and von Meyer-Höfer, M. (2019b). Discussing modern poultry farming systems—insights into citizen's lay theories. *Poult. Sci.* 98 (1), 209–216. doi: 10.3382/ps/pey292
- Spooner, J. M., Schuppli, C. A., and Fraser, D. (2014). Attitudes of Canadian citizens toward farm animal welfare: a qualitative study. *Livest. Sci.* 163, 150–158. doi: 10.1016/j.livsci.2014.02.011
- Steinfeld, H., Gerber, P., Wassenaar, T. D., Castel, V., Rosales, M., Rosales, M., et al. (2006). *Livestock's long shadow: environmental issues and options* (Rome: Food and Agriculture Organization of the United Nations).
- Tabassum-Abbasi, Abbasi, T., and Abbasi, S. A. (2016). Reducing the global environmental impact of livestock production: the minilivestock option. *J. Clean. Prod.* 112, 1754–1766. doi: 10.1016/j.jclepro.2015.02.094
- Thorslund, C. A. H., Aaslyng, M. D., and Lassen, J. (2017). Perceived importance and responsibility for market-driven pig welfare: literature review. *Meat. Sci.* 125, 37–45. doi: 10.1016/j.meatsci.2016.11.008
- Tomley, F. M., and Shirley, M. W. (2009). Livestock infectious diseases and zoonoses. *Philos. Trans. R. Soc. Lond. B. Biol. Sci.* 364 (1530), 2637–2642. doi: 10.1098/rstb.2009.0133
- Tullo, E., Finzi, A., and Guarino, M. (2019). Review: environmental impact of livestock farming and precision livestock farming as a mitigation strategy. *Sci. Total. Environ.* 650, 2751–2760. doi: 10.1016/j.scitotenv.2018.10.018
- Tuytens, F., Vanhonacker, F., and Verbeke, W. (2014). Broiler production in Flanders, Belgium: current situation and producers' opinions about animal welfare. *Poult. Sci. J.* 70 (2), 343–354. doi: 10.1017/S004393391400035X
- Vanhonacker, F., Tuytens, F. A. M., and Verbeke, W. (2016). Belgian Citizens' and broiler producers' perceptions of broiler chicken welfare in Belgium versus Brazil. *Poult. Sci.* 95 (7), 1555–1563. doi: 10.3382/ps/pew059
- Vanhonacker, F., Verbeke, W., Poucke, E. V., and Tuytens, F. A. M. (2007). Segmentation based on consumers' perceived importance and attitude toward farm animal welfare. *Int. J. Sociol. Agric. Food* 15 (3), 91–107. doi: 10.48416/ijfaf.v15i3.286
- Velarde, A., Fàbrega, E., Blanco-Penedo, I., and Dalmau, A. (2015). Animal welfare towards sustainability in pork meat production. *Meat. Sci.* 109, 13–17. doi: 10.1016/j.meatsci.2015.05.010
- Ventura, B. A., Keyserlingk, M. A. G., Wittman, H., and Weary, D. M. (2016). What difference does a visit make? changes in animal welfare perceptions after interested citizens tour a dairy farm. *PLoS One* 11 (5), e0154733. doi: 10.1371/journal.pone.0154733
- Ventura, G., Lorenzi, V., Mazza, F., Clemente, G. A., Iacomino, C., Bertocchi, L., et al. (2021). Best farming practices for the welfare of dairy cows, heifers and calves. *Animals* 11 (9), 2645. doi: 10.3390/ani11092645
- Verain, M. C. D., Sijtsma, S. J., and Antonides, G. (2016). Consumer segmentation based on food-category attribute importance: the relation with healthiness and sustainability perceptions. *Food Qual. Prefer.* 48, 99–106. doi: 10.1016/j.foodqual.2015.08.012
- Vermeir, I., and Verbeke, W. (2006). Sustainable food consumption: exploring the consumer "Attitude – behavioral intention". *Gap. J. Agric. Environ. Ethics.* 19 (2), 169–194. doi: 10.1007/s10806-005-5485-3
- Vigors, B. (2018). Reducing the consumer attitude–behaviour gap in animal welfare: the potential role of "Nudges". *Animals* 8 (12), 232. doi: 10.3390/ani8120232
- Wolf, U., Eurich-Menden, B., Dehler, G., Horlacher, D., Smirnov, A., Grimm, E., et al. (2022). *EmiDaT – ergebnisse der emissionsmessungen in mastschweineeställen mit auslauf: 18* (KTBL-Tagung "Aktuelle rechtliche Rahmenbedingungen für die Tierhaltung"). Available at: https://www.ktbl.de/fileadmin/user_upload/Allgemeines/Download/EmiDaT/2022_Rechtliche_Rahmenbedingungen_Darmstadt.pdf.
- Yang, W., and Renwick, A. (2019). Consumer willingness to pay price premiums for credence attributes of livestock products – a meta-analysis. *J. Agric. Econ.* 70 (3), 618–639. doi: 10.1111/1477-9552.12323
- Yeh, C.-H. (2020). What matters when purchasing fresh agri-food for Taiwanese consumers? a best-worst scaling approach. *Open J. Bus. Manage.* 8, 135–155. doi: 10.4236/ojbm.2020.81009