Journal of Cleaner Production 390 (2023) 136136

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Is less more? Investigating citizen and consumer preferences for the future direction of livestock farming policy

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ARTICLE INFO

Handling Editor: Kathleen Aviso

Keywords:
Sustainable livestock sector
Livestock numbers
Transformation
Future workshop
Scenario
Latent profile analysis

ABSTRACT

The sustainable transition of livestock farming has moved on the agenda of international and national policy regulations aimed at the mounting sustainability challenges. Until now, the political debate has been focused on how to change production and management practices to enhance animal welfare or reduce greenhouse gas (GHG) emissions. The question about the number of livestock, however, has been neglected so far. In particular, this is true for the question of what a socially accepted development of livestock numbers could look like. Thus, the objective of this study was to investigate citizen preferences for a sustainable transition of livestock farming regarding the number of livestock, and whether citizen preferences align with consumer preferences. The sample consisted of 1030 German participants who were surveyed online in January and February 2021. A latent profile analysis (LPA) identified two sub-groups within the population labelled "status-quo proponents" (49.0%) and "proponents of a sustainable transition" (51.0%) that differed in their perception of the development of future livestock numbers. "Status-quo proponents" were aware of the sustainability challenges in livestock production but less interested in supporting the transition with their consumption behavior of animal-based products. For "proponents of a sustainable transition", a reduction of livestock numbers was a viable pathway for the livestock sector. They were willing to adapt their consumption behavior accordingly. To reach a socially accepted transition of livestock farming, including a reduction of animal numbers, the transition should be supported by a combination of political push and pull measures, such as financial support for farmers, as well as information provision, nudging, and taxes on the market side.

1. Introduction

The major sustainability challenges the world currently faces can only be overcome through comprehensive transformation processes, as the United Nations foresees in its 2030 Agenda (United Nations, 2015a). One sector that is particularly affected by this is the agri-food sector, which accounts for 35% of global total anthropogenic greenhouse gas (GHG) emissions.

With 57%, the livestock sector, and thus the production of animal-based food, is responsible for a significant share of the climate impact of this sector. In contrast, plant-based foods account for only 29% of the total GHG emissions from the production of food (Xu et al., 2021).

Moreover, ethical and moral questions about animal rights, animal welfare, and animal protection are also increasing (Ortega and Wolf, 2018). Especially in north-west European countries, the public debate about the future development of livestock production and the consumption of animal-based foods, such as meat, has been intensifying for years (Eurobarometer, 2016). This has led to increasing political discussions about what the future development of livestock farming could look like to address the rising concerns regarding sustainability. Until now, the political and scientific debate has been focused on how to change production and management practices to enhance animal welfare or reduce GHG emissions (Clark et al., 2017; Ortega and Wolf, 2018). The question about the number of livestock, however, has been neglected so far. In particular, this is true for the question of what a socially accepted development of livestock numbers could look like.

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https://doi.org/10.1016/j.jclepro.2023.136136
Received 17 January 2022; Received in revised form 11 January 2023; Accepted 19 January 2023
Available online 26 January 2023

On a global, European, as well as country level, several policy regulations have already been introduced to foster more sustainable livestock farming. For instance, on a global scale, the Paris Agreement (United Nations, 2015b) as well as the 2030 Agenda for Sustainable Development (United Nations, 2015a), both initiated by the United Nations, were signed. Although these agreements are not solely intended to pursue a transformation in the livestock sector, GHG reduction goals inevitably force the sector to consider the direction that a sustainable transition of livestock farming could take. On a European scale, the common agricultural policy in combination with the European Green Deal envisions a more sustainable agriculture by environmental protection and reduction of GHG emissions (European Commission, 2019). On a national scale, several European countries have additionally initiated policy regulations to enhance animal welfare. The strong economic relevance of the sector has led to ambitious political discussions in Germany. As such, the German Federal Minister of Food, Agriculture and Consumer Protection has initiated several expert networks to develop practical recommendations for the future livestock sector. Farmers, consumers, companies, as well as researchers and non-governmental organizations (NGOs) are involved in different commissions. Overall, they recommend enhancing the level of animal welfare, tackling environmental challenges, and better addressing public concerns to maintain the sector's "license to produce" (ZKL, 2021; Sonntag et al., 2019). In some European countries, the political debate goes even further and focuses on a reduction of livestock numbers (Kotkamp, 2021). For example, in the Netherlands, the ongoing political attempts to make livestock production more sustainable already include a plan to reduce the number of livestock by a third within 10 years. The attempts were incorporated into the new coalition agreement published on December 15, 2021 (Coalition Agreement 2021–2025, 2021; Levitt, 2021). Several policy measures, such as buy-back schemes, subsidies for extensive land-use practices, as well as economic incentives to reduce nitrogen emissions and enhance biodiversity, are planned for implementation (Tiktak et al., 2021).

To avoid a further reduction in public acceptance of livestock farming and to maintain the sector's license to operate and thus avoid negative economic consequences for the industry, future developments in the livestock industry should take citizens' concern more strongly into account (Ritter et al., 2022). However, taking citizens' preferences into account and coordinating and aligning them with consumer preferences creates a complex challenge because an individual's behavior as a consumer often differs from the person's choices as a citizen, which in turn leads to a divergence in voting outcomes and market shares (Paul et al., 2019). For example, since 2016, most European citizens have claimed to be concerned about how animals are treated in modern livestock production (Eurobarometer, 2016). In contrast, meat with higher animal welfare standards has remained a niche product on the European market in 2022, indicating that people would vote for stricter livestock legislation but are not willing to pay the price premium for such products (Clark et al., 2017). The same applies to citizens who voted for an abandonment of caged eggs and at the same time purchase caged eggs in their role as consumers (Paul et al., 2019). This specific example of conflicting interests is known as "vote-buy gap". The "vote-buy gap" describes the divergence between an individual's voting behavior as a citizen interested in public goods (e.g., voting for legislation aiming to increase animal welfare) and an individual's consumption behavior as a consumer focusing on personal interests (e.g., not buying animal welfare products) (Norwood et al., 2019). Regarding the future development of livestock farming, citizen pressure could lead to livestock regulations that tackle a reduction of livestock numbers, while consumers are not ready to reduce their consumption level of animal-based products. This in turn would lead to uncertainty among other key stakeholders, such as farmers and politicians (Norwood et al., 2019), and thus hamper a successful transition of livestock farming.

In consumer research, a similar phenomenon that describes the discrepancies between consumer behavior and consumer attitude is observed and called the "attitude-behavior gap". Sometimes this phenomenon is also described as the consumer-citizen gap. However, Paul et al. (2019) argued that differences in decision making between a citizen and a consumer rather explain differences in individuals' voting vs. behavior and thus recommend not to use both phenomena synonymously. This inconsistency in consumer behavior was found in various areas of sustainable consumption, such as grocery shopping, personal care, and clothing (Jacobs et al., 2018). However, discrepancies also exist between other psychographic factors (e.g., values, intentions) and consumer behavior, resulting in "value-action gaps" or "intention-behavior gaps". Thus, Jacobs et al. (2018) proposed using the term "behavioral gap" as an umbrella term to describe the variety of discrepancies in consumer behavior. Although the "vote-buy gap" also describes a discrepancy in consumer behavior, special emphasis is given to what an individual does in the role of a citizen and what the same individual does as a consumer. As a citizen, an individual is part of the political process and opinion formation. This involves voting or participating in local meetings to prevent the building of a farm, for example. In contrast, when food shopping, the same individual acts as a consumer (Grunert, 2006). The perception of the future development of livestock farming is of special interest for citizens. Thus, this study focuses on the vote-buy gap to investigate what future scenario of livestock farming is preferred by citizens and whether this aligns with the intended consumption behavior as consumers.

So far, the future orientation of livestock policy with a special focus on the development of livestock numbers has been neglected in scientific studies. The discussion of reducing livestock numbers is still in its infancy, and scientific results on expedient livestock numbers as well as consequences for the environment are missing. However, livestock production is undoubtedly responsible for 57% of the food sector's GHG emissions (Xu et al., 2021). More, livestock production has widespread impacts on land-use changes, water use, and pollution (Swain et al., 2018), and previous findings have already pointed out the urgent need to change dietary patterns towards less animal-based products to reduce negative consequences for human health (Blaurock et al., 2021). So far, scientific results on what a socially accepted transition towards a reduction of livestock numbers could look like are missing. However, to derive policy recommendations that help to reduce the impact livestock production on the climate, environment, and animal welfare and that help to maintain the sectors' license to operate, citizens' concerns need to be taken more strongly into account.

This study fills this research gap by exploring citizen preferences for possible pathways in livestock policy with a special focus on the development of livestock numbers. As the alignment of individual choices as citizens (e.g., voting behavior) and choices as consumers (e.g., shopping behavior) is crucial to reduce the gap between market shares and voting outcomes, and thus prevent negative economic consequences for the industry, this study placed special emphasis on exploring individuals' roles as citizens and whether this aligns with their intended behavior as consumers. As the occurrence of the "vote-buy gap" differs between individuals (Norwood et al., 2019), this study used a segmentation approach to investigate differences between individuals (Brunsø et al., 2021).

2. Methodology

2.1. Development of possible pathways with stakeholders

This work is based on previous results from a transdisciplinary dialogue that invited key stakeholders from the livestock sector to develop possible pathways for a sustainable transition of livestock farming in Germany. The following describes the development of the scenarios used in more detail.

First, the authors invited more than 60 researchers, industry partners and NGOs to nominate key stakeholders to discuss the future development of livestock farming. Subsequently, the nominees were contacted,

and 20 individuals from 11 interest organizations associated with environmental protection, animal welfare, conventional and alternative farming, conventional processing of agricultural products, and vegan farming agreed to participate in discussing the future development of livestock farming in Germany. The subsequent dialogue was structured according to the "future workshop approach" (Jungk and Müllert, 1997). By offering a structured guidance to exchange ideas and foster shared problem solving, the "future workshop method" is helpful in reaching an envisioned future collectively (Schrot et al., 2021).

As proposed by Jungk and Müllert (1997), the future workshop started with a "critique phase" in spring 2020, where problems were identified and structured. In the end, the participants agreed on the importance of considering the overall quantity of animals in livestock farming. During the subsequent "fantasy phase" in autumn 2020, desirable future scenarios of what livestock farming could look like were identified. The scenarios developed in this phase were utopian in the sense that they were not meant to be immediately realizable. The challenge of implementation was not part of the "future workshop". The future scenarios were analyzed by using the following criteria to implement the scenario: timeframe, motives of change, animal farming approach, overall size of animal farming, associated diets, and suggested instruments. Seven final scenarios were identified and confirmed by one-on-one interviews and in a feedback workshop with participants (see Table 1 for an overview of the scenarios). To reduce biases, the workshops were moderated by professionals. An overview of the procedure is shown in Fig. 1.

Table 1
Scenarios.

No.	Livestock number	Scenario name	Scenario description
1	Increasing	Increased	We should keep more animals in Germany in the future. This is the only way for the agricultural sector to stay competitive. But you cannot say something like that out loud without being criticized by others.
2	Conserving	Restrained	The number of animals in Germany should not change. There are important aspects besides all these sustainability issues (e.g., environmental protection, climate protection, animal welfare) when it comes to how livestock production should develop in the future.
3		Innovation-driven	We should not change anything about the number of animals. If we promote modern technology and innovative ideas in livestock production, we can still do enough for environmental protection, nature conservation, and animal welfare.
4	Reducing	Restrained	We should make livestock production more sustainable. The most important factors here are climate protection, environmental protection, and improved animal welfare. This will inevitably mean that we have to keep fewer animals.
5		Explicit	Abolishing livestock production in the near future is unrealistic. But we should drastically reduce the number of animals in order to protect the environment, nature, and animals as much as possible. We should only keep as many animals as we can produce feed for in Germany.
6	Abolishing	Restrained	We should drastically reduce the number of animals. We should only keep animals for the production of food if the animals do not have to be killed for their purpose (e.g., milk, eggs). Keeping a few animals is important for nature conservation. Cows and sheep on the pasture are, e.g., important for landscape conservation.
7		Explicit	We should completely abolish livestock production in Germany. This is the only way to protect the environment and nature as well as the animals. We should not use animals for human consumption.

2.2. Data collection and sample of survey with citizens

Subsequently, an online survey was conducted from January 27, 2021, to February 5, 2021. Data collection was supported by an online access panel provider (Respondi AG, Cologne, Germany). To ensure high data quality, two quality checks were included (e.g., *To control for your continued attention, please select "somewhat agree"*). Respondents who incorrectly answered those questions were directly excluded from the survey (n = 126). Furthermore, 66 respondents were eliminated due to a rapid response behavior (faster than ½ of the median). In the end, 1030 participants remained and were included in the subsequent analysis. The sample resembles the German population in terms of gender, age, origin, and income. Detailed sociodemographic sample characteristics are shown in Table 2.

2.3. Questionnaire content and measures

The questionnaire consisted of five parts. First, respondents were asked to provide sociodemographic data. Second, their past and future intended consumption behavior of meat as well as vegan/vegetarian meals was measured. Past consumption behavior of meat was assessed by asking respondents about their actual consumption of beef, pork, poultry, and sausage on a 5-point Likert scale ranging from *1 = never* to *5 = (almost) daily*. Future intended consumption behavior of meat was measured on a 5-point Likert scale ranging from *1 = no more at all* to *5 = much more than before.*

Third, an information treatment was provided and apprised participants of the actual livestock numbers in Germany as well as the current housing conditions, the economic importance of livestock production for farmers, the consequences of modern livestock production for the environment and climate, as well as the international trade of livestock products. A detailed overview of the provided information is shown in Appendix A. The information treatment was discussed among experts in the field of livestock production in Germany to ensure that the most relevant information was chosen. In addition, participants were asked to indicate whether they already knew about the information (*I already knew/I did not know yet*). However, these data were not intended to be part of the subsequent data analysis and were solely used to ensure participants' attention while reading the information.

Fourth, each participant was then confronted with seven scenarios describing the future of livestock numbers. Scenarios were shown in a randomized order. To measure participants' attitudes towards the scenarios, participants were asked to rate each scenario on a 5-point semantic differential (*bad/good*; *something I am against/something I am in favor of*; *not meaningful/meaningful*; *not viable/viable*). Items were inspired by Mørk et al. (2017) and were complemented to fit in this study context.

Finally, we measured the perceptions of policy instruments to reduce the number of livestock. The three items for price sensitivity were based on Laroche et al. (2001) but were adapted to fit this study context (e.g., *I would be willing to spend an additional €10 a week for milk/meat if livestock numbers were reduced in Germany*). Items for perception of state interventions were newly developed for this study to reflect on the recent developments in the Netherlands (Tiktak et al., 2021). The 5-point Likert scale ranged from *1 = totally disagree* to *5 = totally agree*.

2.4. Statistical approach

The principal component analysis (PCA) with varimax rotation showed that for each scenario, the items measuring participants' attitudes (*bad/good*; *something I am against/something I am in favor of*; *not meaningful/meaningful*; *not viable/viable*) added up to one component.

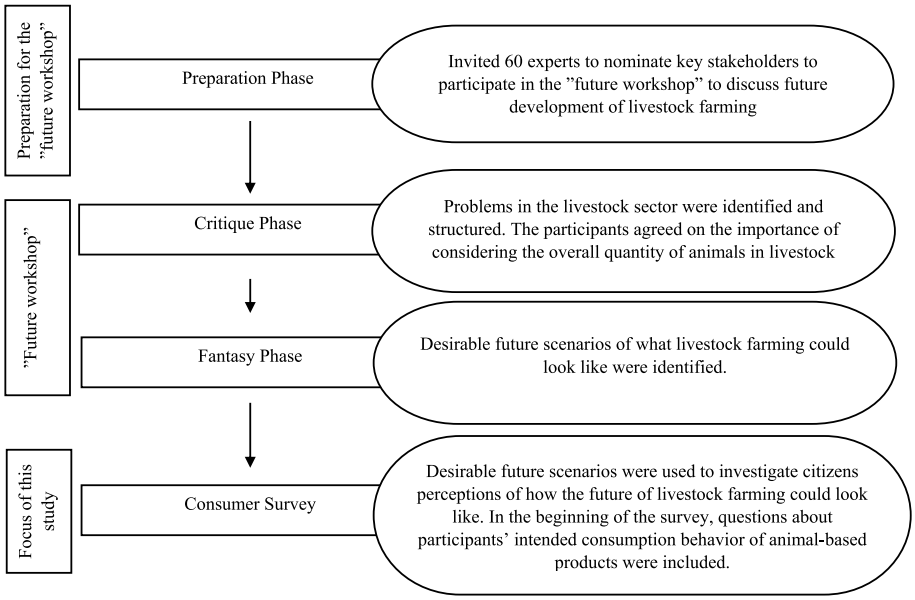

Fig. 1. Overview of the methodological approach.

Table 2
Sample description.

	Total sample n = 1030 (%)	German population (%)
Gender		
Male	49.8	49.0
Female	50.0	51.0
Other	0.2	–
Age		
18–24 years	8.5	9.1
25–39 years	19.5	22.7
40–59 years	34.4	34.8
60 years and older	37.5	33.3
Place of residence		
South	28.7	29.1
East	20.5	19.6
North	16.3	16.1
West	34.5	35.3
Household income		
Less than €1300	24.3	26.3
€1300 – €2599	40.7	39.6
€2600 – €4999	27.7	27.1
€5000 and over	7.4	6.5

Own calculations and German population data according to Federal Statistical Office (2016, 2019).

Subsequently, for each scenario, an index was calculated by using the mean of the four items. The newly generated variable was called "perceived future viability" and used in the further analysis. Repeated measurement ANOVA was used to investigate differences between the scenarios shown.

To identify sub-groups within the sample, a latent profile analysis (LPA) was used. LPA is a form of latent class analysis when using continuous variables to form a latent categorial variable. This approach outperforms conventional segmentation approaches, such as K-means clustering. Compared to traditional approaches, LPA uses individual probabilities to classify profiles (see Spurk et al. (2020) for a detailed overview). Subsequently, the identified profiles were further described by using an independent sample *t*-test. For the analysis, we used Stata 16 and IBM SPSS Statistics 26.

3. Results

The descriptive analysis showed that perceived future viability varied between the investigated scenarios (Table 3). Participants showed the highest preference for the two scenarios that described a reduction of livestock numbers. Most participants showed approval for a restrained reduction (4) ($M = 3.92$, $SD = 1.08$) and explicit reduction (5) ($M = 3.60$, $SD = 1.19$) as viable for the future, followed by innovation-driven conserving (2) ($M = 2.92$, $SD = 1.21$) and restrained abolishing (5) ($M = 2.76$, $SD = 1.24$). Increasing the quantity of livestock (1) ($M = 2.08$, $SD = 1.14$) and explicit abolishing (7) ($M = 2.00$, $SD = 1.13$) were perceived as the least viable pathway for the future development of livestock numbers. Repeated measurement ANOVA showed significant differences between the scenarios. However, no significant difference was found between explicit abolishing (7) and increasing the number of livestock (3).

Subsequently, an LPA was used to identify sub-groups within the sample. The model fit was evaluated using the Bayesian Information Criterion (BIC), Akaike Information Criterion (AIC), and entropy value. Smaller AIC and BIC values in combination with a higher value of entropy indicate a better model fit (Nylund et al., 2007). However, the entropy value should be greater than 0.8 (Tein et al., 2013). The two-profile solution was evaluated as superior and used for further

Table 3
Frequencies and mean comparisons of perceived future viability of scenarios (n = 1030).

No.	Livestock number	Scenario	$M^1(SD)$
1	Increasing	Increased	2.08^{c} (1.14)
2	Conserving	Restrained	2.48^{b} (1.18)
3		Innovation-driven	2.92^{a} (1.21)
4	Reducing	Restrained	3.92^{d} (1.08)
5		Explicit	3.60^{e} (1.19)
6	Abolishing	Restrained	2.76^{a} (1.24)
7		Explicit	2.00^{cf} (1.13)

[1] Originally measured on a five-point semantic differential from *1 = bad* to *5 = good* (*something I am against/something I am in favor of*; *not meaningful/meaningful*; *not viable/viable*, respectively); mean comparison using repeated measurement ANOVA with Greenhouse-Geisser correction, F(*p*-value) = 400.792 (<0.001), pairwise comparison: different letters indicate a significant ($p < 0.05$) difference between groups according to post-hoc tests using the Bonferroni correction.

Table 4
Model fit indices for the latent profile analysis.

Profile solution	LL_m	AIC	BIC	Entropy
1	−11334.95	22697.9	22767.02	–
2[1]	−10675.49	21394.98	21503.6	0.80
3	−10531.04	21122.09	21270.21	0.87
4	−10314.57	20705.13	20892.75	0.90

[1]The best-fitting model; LL*m:* $Loglikelihood_{model}$; AIC: Akaike Information Criteria; BIC: Bayesian information criterion.

analysis. Model fit indices for 1 to 4 profile solutions are presented in Table 4.

Two profiles were derived that differed in their perceived future viability of the scenarios shown. The profiles were similar in size. As such, 505 participants (49.0%) were assigned to profile 1, and 525 participants (51.0%) were assigned to profile 2. Individuals assigned to profile 1 perceived scenario 3 (innovation-driven conserving) as the most viable scenario for the future, followed by scenario 4 (restrained reducing) and scenario 4 (restrained conserving). Scenario 7 (explicit abolishing) was perceived as the least viable. Accordingly, profile 1 was labelled "status-quo proponents". In contrast, individuals assigned to profile 2 preferred a reduction of overall livestock numbers. As such, scenario 4 (restrained reducing) was perceived as the most viable scenario for the future, followed by scenario 5 (explicit reducing). Scenario 6 (restrained abolishing) was perceived as somewhat viable, while the remaining scenarios were not preferred. Accordingly, profile 2 was labelled "proponents of a sustainable transformation". The indicator means are presented in Table 5. An independent sample *t*-test revealed that the profiles differed significantly regarding the perceived future viability of the investigated scenarios.

Moreover, the perception of policy instruments to reduce the number of livestock differed significantly between status-quo proponents (profile 1) and proponents of a sustainable transformation (profile 2) (Table 6). As such, status-quo proponents (profile 1) were more skeptical about state interventions than proponents of a sustainable transformation (profile 2). However, financial support for farmers to keep fewer livestock received moderate approval from status-quo proponents (profile 1) and approval from proponents of a sustainable transformation (profile 2).

Moreover, status-quo proponents (profile 1) were less willing to pay more for livestock products as a consequence for a sustainable transformation of livestock production. Individuals assigned to this group showed moderate approval to pay more (10% or €10 per week) for livestock products, while they refused to pay more taxes to reduce the number of livestock in Germany. In contrast, proponents of a sustainable transformation (profile 2) were willing to pay more for a reduction of livestock in Germany. As such, they agreed to pay more (10% or €10 per week) for livestock products and showed moderate approval for paying

Table 5
Means comparison of profile indicators in the 2-profile solution using an independent sample *t*-test.

No.	Livestock number	Scenario	Profile 1	Profile 2		Whole sample
			Status-quo proponents	Proponents of a sustainable transformation		
			$n = 505$ (49.0%)	$n = 525$ (51%)		$n = 1030$
			M (*SD*)	*M* (*SD*)	**T** (*p*-values)	*M* (*SD*)
1	Increasing	Increased	2.86 (1.03)	1.33 (0.61)	28.626 (<0.001)	2.08 (1.14)
2	Conserving	Restrained	3.29 (0.92)	1.70 (0.82)	29.253 (<0.001)	2.48 (1.17)
3		Innovation-driven	3.66 (0.94)	2.21 (1.00)	23.765 (<0.001)	2.92 (1.21)
4	Reducing	Restrained	3.28 (1.05)	4.54 (0.67)	22.947 (<0.001)	3.92 (1.08)
5		Explicit	2.95 (1.13)	4.24 (0.86)	20.479 (<0.001)	3.60 (1.19)
6	Abolishing	Restrained	2.37 (1.13)	3.15 (1.23)	10.596 (<0.001)	2.77 (1.24)
7		Explicit	1.79 (1.01)	2.21 (1.21)	5.940 (<0.001)	2.00 (1.14)

Mean values for perceived future viability measured by four semantic differential items ranging from *1 = bad* to *5 = good* (respectively, *something I am against/something I am in favor of*; *not meaningful/meaningful; not viable/viable*).

Table 6
Differences in perception of policy instruments to reduce the number of livestock using an independent sample *t*-test.

	Profile 1	Profile 2		Whole sample
	Status-quo proponents	Proponents of a sustainable transformation		
	M (*SD*)	*M* (*SD*)	T (*p*-values)	*M* (*SD*)
Perception of state intervention to reduce number of livestock [1] (α = .648)	2.51 (0.70)	3.21 (0.72)	15.99 (<0.001)	2.87 (0.79)
The state should not interfere with the number of livestock in Germany.	3.05 (1.07)	2.20 (1.03)	12.997 (<0.001)	2.62 (1.13)
The state should financially support farmers to keep fewer livestock.	2.76 (1.12)	3.60 (1.09)	12.350 (<0.001)	3.19 (1.18)
Farms that are particularly odorous should receive money for the abolition of livestock production.	2.29 (0.97)	2.66 (1.11)	5.690 (<0.001)	2.48 (1.06)
Farmers should pay a penalty if they do not reduce their livestock numbers.	2.07 (1.05)	2.76 (1.15)	10.092 (<0.001)	2.42 (1.16)
Willingness to pay [1] (α = .824)	2.52 (1.03)	3.55 (1.01)	16.191 (<0.001)	3.04 (1.14)
I would accept paying 10% more taxes if we kept fewer farm animals in Germany in return.	2.32 (1.13)	3.18 (1.27)	11.574 (<0.001)	2.76 (1.28)
It is okay for me to pay 10% more money for animal products (e.g., milk, meat) if we keep fewer farm animals in Germany.	2.90 (1.22)	4.03 (1.02)	15.306 (<0.001)	3.48 (1.25)
I would be willing to pay €10 more per week for animal products (e.g., milk, meat) if fewer farm animals were kept in Germany in return.	2.62 (1.18)	3.73 (1.14)	15.306 (<0.001)	3.19 (1.28)

Items listed in bold are mean index values with α = Cronbach's alpha. Items listed in italics were reverse-coded for reliability analysis and mean index calculation.
[1]Measured on a 5-point Likert scale from *1 = strongly disagree* to *5 = strongly agree*.

Table 7
Differences in meat consumption behavior using an independent sample *t*-test.

	Profile 1	Profile 2		Whole sample
	Status-quo proponents	Proponents of a sustainable transformation		
	M (*SD*)	*M* (*SD*)	T (*p*-values)	*M* (*SD*)
Actual meat consumption behavior[1] (α = .83)	3.44 (0.69)	2.91 (0.96)	10.172 (<0.001)	3.17 (0.88)
Beef	3.11 (0.83)	2.68 (0.96)	7.758 (<0.001)	2.89 (0.92)
Pork	3.22 (1.00)	2.69 (1.07)	8.264 (<0.001)	2.95 (1.07)
Poultry	3.46 (0.77)	3.06 (1.02)	7.023 (<0.001)	3.25 (0.93)
Sausage	3.79 (0.94)	3.12 (1.24)	9.703 (<0.001)	3.45 (1.12)
Intended future meat consumption behavior[2](α = .85)	2.78 (0.41)	2.39 (0.65)	11.463 (<0.001)	2.58 (0.58)
Beef	2.83 (0.55)	2.45 (0.77)	9.144 (<0.001)	2.63 (0.69)
Pork	2.60 (0.67)	2.17 (0.77)	9.617 (<0.001)	2.38 (0.75)
Poultry	2.94 (0.48)	2.60 (0.76)	8.640 (<0.001)	2.77 (0.66)
Sausage	2.74 (0.52)	2.35 (0.74)	9.940 (<0.001)	2.54 (0.67)

Items listed in bold are mean index values with α = Cronbach's alpha. [1] Measured on a 5-point Likert scale from *1 = never* to *5 = (almost) daily*. [2] Measured on a 5-point Likert scale from *1 = no longer at all* to *5 = much more than before*.

10% more taxes to reduce the number of livestock in Germany.

More, the groups differed in terms of their meat consumption behavior (Table 7). As such, innovation-driven conservers (profile 1) showed a significantly higher actual consumption behavior of meat compared with restrained reducers (profile 2). Depending on the product type (beef, pork, poultry, sausage), status-quo proponents (profile 1) stated to consume meat sometimes or regularly. In contrast, proponents of a sustainable transformation stated to consume all types of meat sometimes. Unsurprisingly, status-quo proponents (profile 1) were less motivated to reduce their meat consumption in the near future. Overall, they claimed they would maintain their meat consumption behavior, while proponents of a sustainable transformation (profile 2) stated they would reduce their meat consumption behavior in the near future.

Overall, both profiles showed similar sociodemographic characteristics (see Appendix B). However, slight differences can be detected: Profile 1 contained slightly more male individuals (56.4%), while profile 2 showed slightly more female individuals (56.4%). Individuals assigned to profile 1 were older, while individuals in profile 2 were more often younger. The proportion of lower educated participants was higher in profile 1. Household income did not differ significantly between profiles.

4. Discussion

This study investigated citizens' preferences for the future development of the overall number of livestock in Germany and whether they align with consumer preferences.

The political discussion about reducing the number of livestock has just begun (Government of the Netherlands, 2021; Kotkamp, 2021). So far, scientific studies have neglected the question of what a socially accepted transition pathway regarding the total number of livestock could look like and whether individuals in their role as consumers are willing to adjust their consumption behavior of animal-based products accordingly. This study took a first attempt to fill this research gap.

Results of this study showed a strong citizen preference for a sustainable transformation of livestock farming and provided evidence that, from a citizen perspective, a reduction in livestock numbers is considered an acceptable pathway. Economic advantages of livestock production, including in the scenario describing an increase of livestock numbers, were less preferred. This is in line with results from Sonntag et al. (2019) showing that, from a citizen perspective, ethical aspects are valued more than economic reasons. The same aversion is observed for completely abolishing livestock production. From a citizen perspective, this result might be based on cultural values and habits, making it difficult for citizens to imagine a world without livestock farming (Tienhaara et al., 2015). The results of this study highlight the public's awareness of the current sustainability challenges in livestock farming and that citizens' preferences are in line with current international and national policy goals aimed at more sustainable food systems (European Commission, 2019; United Nations, 2015a&b). Even recent local policy proposals (Kotkamp, 2021) that focus on reducing the number of livestock were supported.

However, as highlighted previously (Kazbare et al., 2010), there were differences between citizens' perceptions of future livestock policy approaches. The LPA revealed two citizen segments, labelled "status--quo proponents" and "proponents of a sustainable transformation", each accounting for half of the sample. Previous segmentation studies that investigated citizen perceptions of animal welfare found more than two groups (Sonntag et al., 2019). This discrepancy can be explained as follows: Sustainable transition of livestock farming is complex, and animal welfare is only one part of it. In contrast, the scenarios used in this study included more information than the number of livestock alone. Our results highlight that, regarding the direction that a sustainable transition could take, citizen preferences are more aligned compared to more specific challenges in modern livestock production (e.g., animal welfare).

Status-quo proponents were aware of sustainability challenges in livestock farming but rarely interested in supporting the transition. They were neither motivated to adjust their consumption behavior nor did they support state interventions aiming to reduce the number of livestock. Previous studies showed that less radical interventions, such as information provision and nudging, are widely accepted in climate protection policy (Lemken et al., 2018) to encourage individuals to consume less meat. Thus, to encourage status-quo proponents to further increase their interest in sustainability challenges as citizens and to adapt their consumption behavior as consumers accordingly, more moderate policy interventions should be implemented.

The other half of the participants, namely proponents of a sustainable transition, was open to a sustainable transition of livestock farming, including a reduction of livestock numbers. Proponents of a sustainable transition were willing to support the sustainable transition by adapting their consumption patterns accordingly. More, in their role as consumers, these individuals also show the willingness to pay for the change in form of higher consumer prices and increased taxes.

Thus, the results of this study indicate that for this segment, the individual's role as a citizen (e.g., voting for a sustainable transition of livestock farming) overlaps with the individual's role as a consumer (e.g., intending to consume fewer animal-based products), and thus the vote-buy gap is less present for individuals in this segment.

Similar results were also found by Tienhaara et al. (2015), who investigated both consumer and citizen roles when implementing a conservation program for agricultural farming practices. In their study, they stated that a clear distinction between an individual's behavior as a citizen and as a consumer is artificial, and that an individual's behavior as a citizen overlaps with their behavior as a consumer.

Also, in the past, citizen preferences were not always in line with

consumer preferences when it came to food decisions and led to uncertainty among farmers, the industry, and politicians (Norwood et al., 2019). Looking at current consumption levels of animal-based products, it is difficult to imagine that consumer preferences for a meat-reduced diet will increase soon. Meat is still an important part of everyday food choices, although recent studies showed enormous potential for meat-reduced dietary styles. As such, the number of vegetarians and vegans is rising. Among the younger generational cohort, the share of individuals following a meat-reduced diet is even higher (Jürkenbeck et al., 2021). Regarding these recent developments and according to the results of this study, political efforts to reduce livestock numbers come at just the right time and meet citizen and consumer preferences for what the future of livestock farming could look like. In the past, public pressure has already led to drastic changes in livestock policy (e.g., abandonment of caged eggs). If the initial request to reduce livestock numbers grows, the sector will be forced to reduce livestock numbers in the future to maintain the sectors' license to operate. The future livestock policy plays an important part in the human and environmental health of the planet (Mehrabi et al., 2020). In the long run, a reduction of livestock numbers would result in a reduction of feed production and processing, which currently accounts for 45% of the whole sector's GHG emissions. This would include a reduction of GHG emissions from land use changes, manufacturing and use of fertilizers and pesticides, manure excreted and applied to fields, feed processing, and transport (Graça et al., 2019). Also, emissions from enteric fermentations, which currently accounts for 39% and processing and transportation of animal products which currently accounts for 6% of the sector's emissions, would be reduced (Gerber et al., 2013). Additionally, environmental challenges, such as intensive use of ground water, water pollution, and loss in biodiversity, could be alleviated. Transitioning to a diet rich in plant-based foods would additionally solve health problems, such as coronary heart disease, cancer, stroke, and diabetes, which are diseases associated with the overconsumption of red meat and diets low in plant-based foods (Springmann et al., 2016).

In contrast to animal-based products, their plant-based counterparts also have the potential to minimize the environmental impact (Detzel et al., 2022). However, livestock production in Germany cannot be seen separately. Global commodity flows create a tight net within the world's economy, which lead to the urge of multilateral agreements on the demand and supply side to foster a sustainable transition of the livestock sector (Mehrabi et al., 2020).

5. Conclusions

Bearing in mind that livestock production is responsible for 57% of the food sector's GHG emissions, has wwidespread impacts on land-use changes, water use, and pollution (Swain et al., 2018) and that current meat consumption patterns in Western countries have negative consequences for human health (Blaurock et al., 2021), a reduction of livestock numbers and thus a reduced consumption of animal-based products seems appropriate to face current sustainability challenges.

Pressured by the ambitious sustainability goals aiming to protect the climate and the environment, the question about the number of livestock recently already appeared on the political agenda. Combining both the question of how to improve animal housing and handling conditions and the question of the number of livestock allows a more comprehensive view and opens a wider range of possible scenarios for the future of livestock farming.

This study showed social support for the existing yet rarely considered option of reducing the total livestock numbers to lower GHG emissions and to protect the environment (Kotkamp, 2021). A remarkable group of consumers is already motivated to align its consumption behavior to its voting behavior as citizens. This provides even more evidence for the approval of a sustainable transition, including a reduction of livestock numbers. To effectively address current sustainability challenges, the gap between citizens' and consumers' preferences needs to be closed as much as possible.

From a public perspective, a transition cannot solely be financed by higher consumer prices. According to our results, the transition process should be supported by a combination of political push and pull measures, such as taxes or financial support for farmers, and appropriate labelling and the associated product differentiation on the market. The adjustments should be implemented carefully and in moderate steps to achieve broad acceptance in society.

Consequences of a transition towards a reduction of livestock numbers touch farmers, consumers, citizens, and politicians equally. To avoid a private solution and to work out a holistic approach of transforming the livestock sector, timely political involvement is necessary.

6. Limitations and directions for future work

Reducing livestock numbers is only one possible approach to minimize the negative impact of livestock production on the climate and environment. Another discussed approach is the intensification of livestock production, which aims to increase livestock yields without exacerbating the negative consequences for the climate and environment (Cassman and Grassini, 2020). However, conflicting perceptions regarding the potential contribution of extensification and intensification of livestock production exist (van Grinsven et al., 2015). This research made a first attempt to identify socially accepted future pathways and found that reducing livestock numbers, and thus the extensification of livestock production, is preferred by German consumers. However, there are still open questions, such as the optimal number of livestock, that need to be answered by future research. Further studies also need to investigate whether the small gap between voting and buying behavior, as found in this study, remains as close when analyzing real purchase and consumption data.

It should be noted that the scenarios were carefully developed in accordance with the perception of key stakeholders in the livestock sector in Germany. However, the development phase of the scenarios allowed for a discussion of utopian ideas. A subsequent discourse about how to implement the scenarios was not part of our study. This question needs to be addressed in further studies. More, the scenarios include several dimensions, such as animal welfare and environmental and economic consequences of changes in livestock numbers. This study cannot identify the main drivers of these public preferences. Further studies should investigate which dimensions are the most important to consider by using more controlled studies, such as experiments. Moreover, this study looked at citizen and consumer preferences. Consumer preferences are solely measured based on self-reported consumption levels. The implementation of a discrete-choice experiment could have revealed more specific consumer preferences. Even more evidence could be provided with real-world data to investigate the vote-buy gap. In addition, this research is based on a study with German consumers. In 2020, Germany had the third largest livestock population and was, with 5.1 million tons of pig meat, the main pig meat producer among the EU Member States (Eurostat, 2021). This study therefore examined an important producer of animal-based products. However, as the development of livestock numbers as well as the future demand for livestock production is a holistic challenge, future studies should also take citizens' perceptions in other countries into account. These results are needed to find a socially accepted pathway of the future development of livestock production on a global scale.

Funding

The project is supported by funds from the Federal Ministry of Food and Agriculture (BMEL) based on a decision of the Parliament of the Federal Republic of Germany via the Federal Office for Agriculture and Food (BLE) under the innovation support program.

CRediT authorship contribution statement

Maureen Schulze: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing, Visualization. **Winnie Sonntag:** Conceptualization, Methodology, Data curation, Writing – review & editing, Supervision, Project administration, Funding acquisition. **Marie von Meyer-Höfer:** Conceptualization, Methodology, Formal analysis, Data curation, Writing – review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Information treatment

Information treatment		Source
Original (German)	Translation	
In Deutschland werden zurzeit ca. 25 Millionen Schweine, ca. 11Millionen Kühe und ca. 173 Millionen Hühner, Enten und Gänse für die Produktion von Fleisch, Milch & Eiern gehalten. Das heißt, pro 1000 Einwohner werden ca. 307 Schweine, ca. 137 Kühe und ca. 2096 Hühner, Enten und Gänse gehalten.	In Germany, about 25 million pigs, about 11 million cows and about 173 million chickens, ducks and geese are currently kept for the production of meat, milk, and eggs. This means that per 1000 inhabitants, approx. 307 pigs, approx. 137 cows and approx. 2096 chickens, ducks and geese are kept.	BMEL (2020)
Die Tierhaltung ist für ca. 7% der ausgestoßenen Treibhausgase in Deutschland verantwortlich.	Animal husbandry is responsible for about 7% of the greenhouse gases emitted in Germany.	UBA (2022)
Durch die Ausscheidungen der Tiere kommt es zu Nitratbelastungen des Grundwassers und zur Bedrohung der biologischen Vielfalt.	The excretions of animals lead to groundwater nitrate contamination and are a threat to biodiversity.	IPCC et al. (2014); WBA/WBW (2016)
Die Tiere werden vorrangig in Ställen gehalten und haben i. d. R. keinen Zugang nach draußen und zu einer Weide. Dadurch ist das Ausleben natürlicher Verhaltensweisen teilweise eingeschränkt.	The animals are primarily kept in stables and usually have no access to the outdoors or to pastures. This partially restricts their natural behaviors.	BMEL (2020)
Die meisten Landwirte (ca. 70%) halten Tiere und generieren damit mehr als die Hälfte der landwirtschaftlichen Verkaufserlöse. Das ist wichtig für die deutsche Lebensmittelindustrie und die deutschen Bauern. Das führt dazu, dass der Lebensmittelpreis für tierische Erzeugnisse (wie Fleisch und Milch) in Deutschland sehr günstig ist.	Most farmers (about 70%) keep animals, generating more than half of agricultural sales revenues. This is important for the German food industry and German farmers. As a result, the food price for animal products (such as meat and milk) in Germany is very inexpensive.	BMEL (2020)
Um alle Tiere zu füttern importieren wir Futter aus anderen Ländern (z. B. Soja aus USA/Brasilien). Die Fleisch- und Milchprodukte, die wir in Deutschland nicht essen, exportieren wir in andere Länder, innerhalb und außerhalb der EU (z. B. Niederlande, China, Afrika). Aber wir importieren auch Fleisch- und Milchprodukte aus anderen Ländern, z. B. Geflügelfleisch aus Thailand, Rumpsteak aus Argentinien.	To feed all animals, we import feed from other countries (e.g., soy from the USA/Brazil). The meat and dairy products that we do not eat in Germany we export to other countries, both inside and outside the EU (e.g., Netherlands, China, Africa). But we also import meat and dairy products from other countries, e.g., poultry from Thailand and rump steak from Argentina.	BMEL (2020)

Appendix B. Means comparison of demographical group-specific inhibitors using cross tabulation

	Profile 1	Profile 2	Whole sample	
	Status-quo Proponents	Proponents of a sustainable transformation		
	n (%)	n (%)	χ^2 (*p*-values)	n (%)
Age			15.937 (0.001)	
18–24	27 (5.3)	61 (11.6)		88 (8.5)
25–39	93 (18.4)	108 (20.6)		201 (19.5)
40–59	191 (37.8)	164 (31.2)		355 (34.5)
60 and older	194 (38.4)	192 (36.6)		386 37.5)
Gender			17.464 (<0.001)	
Female	219 (43.4)	269 (56.4)		515 (50.0)
Male	285 (56.4)	228 (43.4)		513 (49.8)
Other	1 (0.2)	1 (0.2)		2 (0.2)
Place of residence				
South	155 (30.7)	141 (26.9)		296 (28.7)
East	110 (21.8)	101 (19.2)		211 (20.5)
North	74 (14.7)	94 (17.9)		168 (16.3)
West	166 (32.9)	189 (36.0)		355 (34.5)
Education			18.966 (<0.001)	
No graduation (yet)	3 (0.6)	3 (0.6)		6 (0.6)
Secondary school	298 (59.0)	240 (45.7)		538 (52.3)
High school	95 (18.8)	141 (26.9)		236 (23.0)
University degree	108 (21.4)	140 (26.7)		248 (24.1)
Household income			n.s.	
Less than €1300	123 (24.4)	127 (24.2)		250 (24.3)
€1300 – €2599	199 (39.4)	220 (41.9)		419 (40.7)
€2600 – €4999	145 (28.7)	140 (26.7)		285 (27.7)
€5000 and over	38 (7.5)	38 (7.2)		76 (7.4)

n.s. = not significant.

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