Attitudes towards genome editing in farmed animals: An interview study

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Abstract

The ethical debate about genome editing in animal breeding lacks disciplinary diversity and public engagement. This paper aims to address both issues by presenting 23 interviews with stakeholders from animal breeding, animal advocacy, and animal farming, which covered human-animal relations, breeding technologies, and the future of farming. Six distinct patterns of argumentation were identified: technology is neutral, an already-existing issue, a dystopian future, consumer capitalism, playing God, and a technological fix. Distinguishing between these six lines of argumentation improves the understanding of the diversity of views in the public debate on the use of CRISPR Cas9 in animal breeding. This is an essential step for further research into public attitudes and public dialogue on novel techniques in animal breeding.

Keywords: CRISPR Cas9, genome editing, livestock, narrative, semi-structured interviews

Introduction

As has been reported in the literature, the use of genome editing in animal breeding results in ethical questions (de Graeff *et al*., 2019; Eriksson *et al*., 2018; NCOB, 2021). This literature shows that the main societal and ethical themes include question and concerns related to efficiency, human health, potential risks, public acceptability, environmental impacts, animal welfare, and animal dignity (cf. de Graeff *et al*., 2019). Being part of a Horizon 2020 project on genetic innovations in pig and poultry breeding, this study starts in the existing literature, but focuses on stakeholder views with regard to genome editing in livestock breeding. This has added value because the current debate is lacking disciplinary diversity and a proper inclusion of the public, not taking the animals sufficiently into account, and for lacking systematic comparisons (de Graeff *et al*., 2019: p. 9; Middelveld *et al*., 2022).

This research aims to address these shortcomings by investigating the perception of genome editing among representatives of animal breeding, animal advocacy, and animal farming. Breeders and geneticists are relevant as they are involved in the development and application of the technologies. Similarly, farmers work with the modified animals and depend on the public acceptance of the end-product. Finally, animal advocates represent the interests of animals, who are directly affected by genome editing. Aside from broadening the debate by adding animal advocates' perspectives, this research investigates the perception of different applications of genome editing, but also human-animal relations, the way they are influenced by technologies, and possible future visions of animal farming.

Methods

This research draws on critical empirical ethics, which builds on an iteration of empirical and normative processes (Rehmann-Sutter *et al*., 2012). While the interview guide was informed by philosophical theory, such as Ihde's (1990) postphenomenology, pragmatism and democratic principles require to

consider different prevalent perspectives. Furthermore, the interviews are analyzed in the form of narratives, which follows the methodology of a Dutch study about the public perception of genome editing in farmed animals (Middelveld *et al*., 2022).

Participants

Between June and September 2022, 23 participants were interviewed. They were recruited via convenience sampling starting in the network of the consortium partners of the related Horizon 2020 project. 12 participants were associated with the breeding sector, 6 with animal advocacy/protection, 4 with animal farming, and one participant with neuroscience. There were 13 males and 10 females, whose age ranged from 22-66 years with a median of 33 years. 9 German, 6 French, 3 Dutch, 1 Italian, 1 Danish, 1 British, 1 US-American, and 1 Canadian/US-American respondent participated in total.

Materials and procedure

Respondents were invited via e-mail or personal approach to participate in the interview. Before conducting the interviews, they received a letter of information and signed an informed consent form. All interviews were conducted in German or English by LB, a native speaker of German, and, if applicable, translated into English. The interview guide consisted of six parts, including demographics, introductory questions, human-animal relations, breeding technologies, the future of animal farming, and a round-up sessions. As these were semi-structured interviews, the researcher occasionally asked follow-up questions.

The introductory questions covered the participant's motivation for their work and what they liked or disliked about it and were designed to engage them. Subsequently, human-animal relations were discussed, and participants indicated how they perceived animals in general. The questions on breeding technologies covered the extent of familiarity with and attitudes towards breeding-related technologies, and an evaluation of animal farming. Moreover, two questions referred to the influence of technologies on human-animal relations and breeding goals. The focus of this section was the evaluation of genome editing for the breeding goals of allergen-free food, disease resistance, welfare improvements by making amputation redundant, feed efficiency, and productivity. The questions on the ideal future of animal farming invited the participants to assess five different scenarios based on previous qualitative research (Middelveld *et al*., 2022). Ways to close the gap between ideal future and the status quo were discussed. Finally, participants were asked to add important ideas not covered in the interview.

Data analysis

Audio data from the 7 in-person interviews and video data from the 16 online interviews were recorded. 2 respondents disagreed with recording the interview but still wanted to participate. In these cases, interview data were generated by the researcher taking notes while interviewing. Most interviews lasted between 60 and 90 minutes. All interviews were analyzed based on manual transcripts, which were digitalized and completed based on the recordings. Subsequently, they were coded and placed into existing narratives, which they resemble. To anonymize the interviews, the participants were ascribed codes consisting of the sector (B for breeder, A for animal advocate, F for farmer, and O for other) and the number of the interview conducted. Thus, the first interview with a breeder was coded as B1.

Results

The answers given by the interviewees resemble six reoccurring narratives regarding the ethical implications of genome editing in farm animals.

The neutrality hypothesis: Technology is just a tool

The first narrative was that genome editing is inherently neutral and its normative implications only lie in its application or in other words: "The technology is neutral, but the context can be good" (B2). The same thought was formulated more negatively by another respondent: "The tool is not the problem, the people are" (B5). Many interviewees stated that they regard genome editing in an instrumental way and the purpose makes the technology ethical or unethical (B2, B5, B6, B7, B8, B9, B12, A6, F1). Three breeders (B4, B7, B8) compared genome editing with nuclear energy, which could be used as a sustainable source of energy, but also for bombs (B4). Thus, genome editing as well can and should be used for good purposes, but there is the danger of abuse. As one respondent put it: "It is problematic to use the technology only for your own profit. It should only be used for the benefit of the animals like in castration (to make it redundant)" (B2). Especially breeders were theoretically in favor of applying genome editing to increase animal welfare if done carefully (B2, B3, B4, B5, B6, B7, B8, B9, B11, B12), but more stakeholder expressed this view (A2, A3, A5, A6, F1, F2, F3, F4). Still, some respondents criticized the neutrality hypothesis. When interacting with genetic data tables, a breeder stated that "many people forget that the number is an animal" (B8). This refers to an objectification inherent in the technology regardless of how it is used and contradicts the idea of technology being neutral. Another breeder provided a similar argument against precision farming: "the animal is seen as a production unit but not as a living being. We are losing the link between humans and animals" (B3).

The ethical issue ascribed to genome editing issue already exists

As a second narrative, several interviewees reported that the ethical issues associated with genome editing are not new but in line with previous technology. An animal advocate said that "there is no big difference between genome editing and selective breeding" (A1). Similarly, a farmer stated that "genome editing is not new: it improves, accelerates, and refines existing technologies. The moral questions are not different than before" (F1). Although the farmer suggests that the moral questions remain the same, it does not mean that there are no moral questions. As an expert in animal genetics put it: "the relation between human and animal is not different from before. Still, we are harming the integrity of animals. Is it the right thing to do? However, we already crossed the line by domesticating animals. We decided that it is acceptable to use this tool" (B9). Simultaneously, the same respondent observed that "people are reluctant to reevaluate previous decisions. New technologies open up these decisions. (…) There is a fear of an open ethical discussion" (B9).

Genome editing paves the way to a dystopian future

A third narrative is that genome editing paves the way to a dystopian future, which took the form of slippery slope arguments or a reference to Pandora's box. Some respondents referred to Huxley's "Brave New World" (B9, F1). Pessimists might interpret the previous arguments that genome editing is not new or that "we already crossed the line" (B9) as indices that Pandora's box is already opened. This idea was related to the danger of abuse. As one participant warned: "You can do what whatever you want and also things you don't know can occur, so it's like opening Pandora's box from (…) and letting companies and profits driv(e) this is not a good solution. (…W)e cannot totally allow this technology for everything" (B6).

A slippery slope argument concerned the possible use of genome editing in humans: "At one point, the daughter will ask her parents: why do I have brown eyes instead of blue eyes?" (B1). Similarly, a farmer posed the question of "What if humans apply it at themselves? What is possible in pigs is also possible in humans" (F1). When asked about the moral difference between genetically modifying humans or animals, he responded that "the human has another rank than the animal. We must not blur the line

between humans and animals. Usually this leads to a devaluation of humans rather than an elevation of animals" (F1). An animal advocate asked the same question but emphasized the arbitrariness he perceives in the distinction between humans and animals: "why is it unethical in humans but not in animals? This is pretty revealing as it shows us how humans perceive animals. (...) Why don't we create humans eating grass? This would be considered unethical, but why can we then create animals?" (A4). Finally, another slippery slope mentioned was the idea of creating non-sentient animals (A5).

Consumer capitalism: Greed is good

A fourth narrative is consumer capitalism, which refers to incentives provided by the economic system. This idea recurred in the discussion of the distribution of risks and benefits from the technology, but also in the topic of farming itself. When discussing ethical issues in the context of animal farming, many interviewees criticized the price pressure and the lack of willingness of consumers to pay higher prices for higher welfare or quality (B1, B2, B5, B6, B7, B10, B11, F1, F2, F3, F4). Simultaneously, some breeders mentioned that there are consumers, especially in the nonwestern world, who simply cannot afford more expensive products (B7, B10).

The industry's aims for low prices, while generating profit were regarded skeptically. A breeder stated: "The extreme focus on gain in money bothers me. Therefore, I am happy not to work in production" (B4). Also, animal advocates criticized the entanglement of economic purposes and animals: "I think it's horrific that beings are used for monetary value. I think it should not be possible that pain or suffering can have a certain worth expressed in euros. I don't think that's okay at all. So I think that any product that can experience pain is not something that can be used for commercial purposes." (A1). What the animal advocate suggests is that farm animals are not respected as individuals but regarded as products. Instrumentalization and objectification were named as ethical issues in the context of breeding and farming by various participants (B2, B4, B8, B11, A2, F2). A breeder stated that "animals are regarded as products or as kilos of meat rather than as an individual" (B4). A farmer made similar experiences during her vocational education. When asked about whether selecting bulls from a catalogue influences her relationship with animals, she reported that "It is like shopping: the animal seems like a product, but I never saw it that way. I think about the calves. My former boss regarded bulls as a product. You could see it in his language: he described the cow as a tool or as a performance product" (F2). Therefore, it was said that regulation is necessary as otherwise only prices matter (B5). Another breeder warned: "Don't let it be done for profit" (B6).

In line with this idea, most participants opposed improvements merely serving economic purposes. Concerning the increase of productivity, a breeder stated: "It is unethical because it benefits us at the cost of animals" (B2). Similarly, a farmer stated that "increasing efficiency leads to strange outcomes" referring to animal health issues (F1), while another one highlighted that breeding for productivity or allergen-free food should only be done if there are no side-effects and no animals are harmed through experiments in the research and development phase (F2). Most participants, especially breeders and animal advocates regarded the efforts to make animal products allergen-free as disproportional since consumers could eat other products.

Playing God, dominating nature, and side effects

Another narrative was that humans should not play God or dominate nature. A breeder argued that genome editing is morally problematic as "we are losing respect for nature and evolution" (B1) and "we think that we can do everything" (B1). Another breeder stated that she was "not a big fan of high tech. It is unnatural. We should not be altering nature. It is okay to change with things you already have in nature (...) Respect of nature is important" (B10). A similar argument was given by an animal advocate:

"humans think they rule over nature. Why do we need that many technologies? I need to think about that quote from Jurassic Park: 'just because we can doesn't mean we should'" (A4). Finally, another argument related to nature is the lack of traceability of what has been done (B3, B4). One breeder said about genome editing: "should we not leave any trace? It is difficult to distinguish the artificial from the natural then. If we cannot prove it was made by humans, it should not be patented" (B3).

While such arguments relate to a specific attitude towards technology or nature, and resemble a sort of hybris, the concerns are often related to unforeseen side effects. To quote a breeder: "nature as it is offers enough. Side-effects are unforeseeable. We will never fully understand nature and should be humbler" (B1). When asked about using genome editing to make milk or eggs allergen free, a breeder mentioned that certain genes might have important unknown functions. "(...) there might be unknown side effects as the gene responsible for making the food allergic might have some important function in the animal that we don't know yet. Therefore, we should be careful" (B2). With regards to potential side-effects, an animal advocate drew an analogy with genetically modified corn: "A farmer told me that GMO corn is good as it does not require pesticides and fungicides, but what does GMO corn cause in us? We don't know. People are only concerned with benefits. Then, farmers apply it, but they know the least about such technologies" (A4). The animal advocate reasoned in the same manner against genome editing. He raised questions such as "what happens with the animal's body when altering such genes?" or "what does it do to humans to eat such cows?" (A4).

Therefore, some participants proposed to only apply genome editing to create breeds that already exist to reduce side effects: "polled cattle already exist in nature. We can use genome editing for cases already present. For new mutations, we have a strong responsibility and have to care for side effects" (B3). In contrast, a breeder argued that genome editing is redundant if such animals can also be bred using other techniques. "We have other possibilities. Genome editing is expensive and inefficient. People want to make money with it. Theoretically, it is an interesting field, but take the example of cows: the polled gene is known for 15 years. We don't need genome editing anymore. The gene is even dominant" (B1). Another side effect mentioned was that microorganisms change and adapt faster than the corresponding animal when increasing resistance towards diseases (B1, B5, B7, B8, B9, F3). Moreover, the respondents mentioned the dangers of rebound effects when increasing the feed efficiency or productivity of animals. As a farmer put it: "Increasing feed efficiency is interesting, but difficult. Ultimately, it might lead to even more animals in stables. I would only accept it if there were enough welfare regulations" (F2). After being confronted with potential rebound effects, two respondents changed their initially positive opinion about increasing productivity (A3, O1).

The technological fix

Finally, respondents provided answers that link to a technological fix narrative, which refers to the danger of maintaining or sustaining an unjust system by fixing parts of the problem with a technology. Such arguments were provided by animal advocates, farmers, and breeders, although the ultimate goals of the respective groups differed (B1, B4, B5, B6, B9, B10, B11, B12, A1, A2, A3, A4, F2). A breeder said that he wants to "eat meat without feeling guilty" (B6), while animal advocates, but also some breeders advocated a world without slaughter (B8) or entirely without animal farming (B12, A1, A2, A3, A4, A5, A6, O1).

Regarding polled cattle, a breeder argued that "we should keep animals in conditions where this is not a problem. Breeding such animals removes the symptoms but not the problem" (B11). Another breeder mentioned the conflict between moral standards and economic feasibility in such questions: "From a production perspective I would say yes (to polled cattle), but from an animal's perspective, I would say: no! Change the system!" (B4). Instead of pursuing technological fixes, arguments were made for

changing the conditions under which animals live: "disease resistance can better be achieved via housing, vaccines, management, and feeding" (B1). However, some animal advocates were concerned that welfare improvements justify and maintain animal farming, which causes more harm to animals in the long run than abolishing it earlier without such welfare improvements (A1, A2, A3).

Discussion

In this study, we scrutinized professional breeders', farmers' and animal advocates' perception of genome editing in farmed animals. Six different narratives were identified in the responses given by the participants, namely the neutrality hypothesis, the existing issue, the dystopian future, consumer capitalism, playing God, and the technological fix. The technological fix, consumer capitalism, and playing God replicate findings of previous research (Middelveld *et al*., 2022). Overall, most participants were open towards applying genome editing for animal welfare, while productivity or allergen-free animal products were mostly opposed. Moreover, the participants raised concerns about side effects, abuse due to economic powers, humans overestimating themselves, and the inhibition of potentially more desirable future scenarios.

A strength of this study was the theoretically informed methodology that allowed the inclusion of contextual factors, such as human-animal relations and future scenarios of animal farming, which helped figure out the ultimate goals of different stakeholders that influence their view on gene editing. However, limited recruitment resources caused a lack of diversity in stakeholders, for example, all farmers were Germans. Second, the future scenarios lacked specificity as the vision without animal farming contained cultivated meat which makes use of animal cells and was rejected even by some animal advocates (A1, A3). Also, there was no vision about insect farming, although this was mentioned in some interviews (F1, O1). Based on this research, two recommendations for future research emerge. First, after consulting experts and animal advocates, the general public should be involved as well given the current lack of public engagement (de Graeff *et al*., 2019, p.9), which is an important constituent of a democratically legitimated decision-making process. Second, cultural dimensions might play an important role. Especially the French respondents (B3, B10) linked food and culture.

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