Track 6 - CRISPR for responsible animal breeding: implications for social acceptance and animal welfare?

(Anne Ingeborg Myhr, NORCE; Bjørn K. Myskja, NTNU)

Thursday 29th 8:30-10:30 – Chair: Anne Ingeborg Myhr, NORCE, Tromsø, Norway

Abstracts

The responsibility of experts in the public debate about genome editing

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In June 2023 the Norwegian Gene Technology Committee submitted its report "Genetic technology in a sustainable future" (NOU 2023:18) to the Norwegian Ministry of Climate and Environment. The NOU marks a milestone in a timely and necessary renewal of the Norwegian gene technology regulation and is a response to the recent technological advances within gene technology. CRISPR and other genome editing methods are more precise and less costly than previous gene modification methods, and thus more accessible for the research communities. Both in Norway and in other countries the use of new genomic techniques has become crucial tools within both basic and applied research.

The work by the Norwegian Gene Technology Committee is divided in its opinion on the need for new regulation. The majority of the committee argues for a deregulation of genome edited animals, plants and microorganism, while the minority wants a modernization of the current Act. In the EU a committee has presented a suggestion for a new Directive for genome edited plants,recommending less stringent requirement for risk assessment of plants with edited changes not involving any novel genetic material from non-crossable plants. Both the Norwegian and the European proposals has created debate among representatives from governmental agencies, research and education societies, farmers, consumer organisations, and lay people. One important question concerns what should be considered sufficient scientific evidence for the safety of genome edited products, including whether a small change in a genome in itself represents low risk. This is associated with thethe question ofsimilarity in risk between genome editing and conventional breeding. Farmers, consumer groups, other NGOs and members of the public are in addition concerned with questions related to the future of food production, about market accept and the need for ensuring consumer choice.

The majority of the Norwegian committee has engaged in a one-way public debate after submitting the report, presenting strong arguments for the importance of deregulation for Norwegian research communities and industries “to avoid lagging behind the rest of the world”, “science is absolute about safety”, and it is “unethical not to use genome editing”. Here we aim to elaborate on the implications of this one-way dialogue and especially about

the "unethical" argument. Research has shown that people's opinions about the use of new technologies include expressions of value systems, and these opinions are important contributions to how we want to organize our society around new technologies. This research stands in opposition to the so-called «knowledge-deficit-model», where it is assumed that lay people's skepticism to new technology is primarily based in their lack of knowledge. We will argue that the public debate contributions of the majority representatives express a knowledge-deficit approach to technology communication. If the objective is to develop a broad and value-based knowledge basis for responsible regulation of genome editing, the contributions from representatives of different parts of our society as well as lay people are necessary addition to the experts' viewpoints.

Animal breeding projects anticipating who and what is at stake using an SDG-based sustainability assessment

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Genome editing such as CRISPR allows novel development in animal breeding, including sterile or lice resistant salmon. A small tool has widened the horizon beyond previous innovations. The availability of the tool and the pace of its application stresses the need for research projects to pre-assess – anticipate, the potential effects of their proposed solution, affected parties and stakeholders, possible alternative solutions (Ravetz 1997, Stilgoe et al. 2013). In order to approach the need for research projects to assess the potential impacts of research results, I suggest using an SDG-based sustainability assessment. This assessment can be implemented as a step of anticipation in biotech projects on GE in animals. In a previous publication we have suggested a frame for a sustainability assessment framework (Blix and Myhr 2023). In this publication, we used genome-edited salmon as a case study, but the framework can be modified to other organisms and industries. Using data from stakeholder interviews and focus groups with participants from the Norwegian public and a document analysis, this framework was built on the 17 UN SDGs and Stockholm Resilience Centre Wedding cake-model. The assessment consists of 15 different topics categorized according to environment, society or economy, with respective control questions to assess the sustainability of genome-edited salmon.

Applying such a framework early in a planning process of CRISPR-projects for animal breeding can help scientist identify future challenges and stakeholders, align projects accordingly and help operationalize scientists' co-responsibility in science and innovation. According to Eberling and Langkau (2023) such SDG-based assessments have been used in various different contexts, and if all SDGs are included it is possible to achieve "holistic" assessments. This implies taking all sustainability pillars into consideration and aligning with global understanding and expectation of what sustainability is and how it is operationalized. Further, building on the assessment should thus be both available and the topics familiar to researchers. I use two different Norwegian CRISPR-projects targeting salmon breeding to show how identification of stakeholders, challenges, could actually aid the objective of the project (Güralp et al. 2020, Robinson et al. 2023). I also show how the assessment can be applied in practice through RRI activities. Finally, I return to RRI as a concept and argue that the suggested framework for sustainability assessment is actually overlapping well with several of the original "Lines of questioning on responsible

innovation" suggested by Stilgoe et al. (2013), which is considered a main understanding of RRI. Conducting the assessment should thus provide the projects applying the assessment with a solid foundation for further dissemination of results and development.

References:

Blix, T. B., & Myhr, A. I. (2023). A sustainability assessment framework for genome-edited salmon. Aquaculture, 562, 738803. https://doi.org/10.1016/j.aquaculture.2022.738803

Eberling, E., & Langkau, S. (2023). Utilizing SDGs in sustainability assessments of innovations: Deriving methodological recommendations from existing approaches. Journal of Cleaner Production, 140383. https://doi.org/https://doi.org/10.1016/j.jclepro.2023.140383

Güralp, H., Skaftnesmo, K. O., Kjærner-Semb, E., Straume, A. H., Kleppe, L., Schulz, R. W., Edvardsen, R. B., & Wargelius, A. (2020). Rescue of germ cells in dnd crispant embryos opens the possibility to produce inherited sterility in Atlantic salmon. Scientific Reports, 10(1), 18042. https://doi.org/10.1038/s41598-020-74876-2

Ravetz, J. R. (1997). The science of 'what-if?'. Futures, 29(6), 533-539. https://doi.org/https://doi.org/10.1016/S0016-3287(97)00026-8

Robinson, N. A., Østbye, T.-K. K., Kettunen, A. H., Coates, A., Barrett, L. T., Robledo, D., & Dempster, T. (2023). A guide to assess the use of gene editing in aquaculture. Reviews in Aquaculture, n/a(n/a). https://doi.org/https://doi.org/10.1111/raq.12866

Stilgoe, J., Owen, R., & Macnaghten, P. (2013). Developing a framework for responsible innovation. Research Policy, 42(9), 1568-1580. https://doi.org/https://doi.org/10.1016/j.respol.2013.05.008

RRI in genome editing projects: Use of the Research Ethics cards to promote societal and ethical awareness

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Genome editing methods as CRISPR has paved its way into agriculture and aquaculture research. Within animal and plant breeding it is expected to impact how we produce feed and food. There is genome edited plants available at the market in some countries which are nutritional enhanced, disease resistant and providing high yield. Japan has approved genome edited fishes with enhanced meat production and USA climate adapted cattle.

How to regulate genome editing is debated around the world, both in Norway and Europe has suggestions for deregulation been submitted to political decisionmakers. The use of genome editing has, especially, connected to our food systems created debates engaging scientists, food producers, consumer, and environmental organisations as well as citizens. Important issues are market access, consumers rights, risks to environment and human and animal welfare, and impacts on food production systems. Other uses of genome editing, as for production of non-food products as materials etc. have not yet played a role in the debates, possibly because these uses do not raise the same questions and aspects.

Here we will report from a project where we use genome editing in micro-algae for production of natural photonics. Current production of photonic crystals are costly and not environmentally friendly. These crystals are key components of photonic technologies facilitating light manipulation. The objective of the projects is to combine genome editing technologies and nanophotonics to develop bio-based photonic crystals for use in biosensing and photocatalytic platforms. To foster discussions and reflection about the effects and potential impacts of the research the Research of Ethics cards has been considered to represent a usable RRI tool. The Research of Ethics cards are developed to help researchers, managers and research participants to identify, explore and reflect on their ethical responsibilities in research and innovation (Millar et al. 2022).

The Research of Ethics cards are designed to raise discussion and ask questions about a wide range of values, aspects, and assumptions underlying research and innovation, and the cards come in 14 categories that includes implications for society, environment and economy, values and principles, participants and stakeholders, as well as with regard to the research process from planning to dissemination. We will here present our experience with using these cards in technology projects, and discuss the value of using these card with regard to the overall aim of RRI in terms of its key dimensions: anticipatory, inclusive, reflective and responsive processes (Stilgoe et al. 2013; RCN, 2023). A special focus will be on how these cards can be of use in projects that aims to use new technology in projects which of nature are more based in basic research or for industrial applications beyond health and food.

References:

Millar, K M, Hyde R, Craigon PJ (2022). Constructing ethics for the 'Ethics in Research' Card-Based tool: Concepts and Categories. EURSAFE, scientific presentation.

RCN (2023). Responsible research and innovation at the Research Council. https://www.forskningsradet.no/en/research-policy-strategy/rri/

Stilgoe, J., Owen, R. and Macnaghten, P. (2013). Developing a framework for responsible innovation. Research Policy 42: 1568-1580

Making sense, lacking agency: Public perceptions on the use and regulation of CRISPR in agriculture in Norway

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This paper investigates the Norwegian public's perceptions of novel gene editing technology and shed light on how they see their own role in the governance of the technology. Since the development of CRISPR in 2012, research efforts have been put towards understanding the conditions for social acceptance and the need for governance of new forms of gene editing technology (see for instance Middelveld et al., 2023, Nawaz and Kandlikar, 2021, Nelson et al., 2021). The multitude of ethical questions and the severity of the consequences relating to this technology is thought to require a broad and democratic approach, giving members of the public a larger role to play in the governance of this technology, as: "(…) it [the human

genome] belongs equally to every member of our species, and decisions about how far we should go in tinkering with it have to be accountable to humanity as a whole" (Hurlbut, Saha & Jasanoff, 2015). The technology and its potential consequences evidently need careful consideration, but regulating this is not simple: As a new and "enabling" technology, it raises issues both because it is complex and uncertain, and because it is loaded with moral questions. Daniel Sarewitz (2015) argues that science alone cannot capture the complexity of the issues posed by CRISPR, and that the decisions that traditionally are settled scientifically, for instance by risk assessment, must be handled more democratically – by the population and with an emphasis on issues of value. Simultaneously, inclusion and upstream public engagement are a central part of the Responsible research and innovation (RRI) concept (see for instance Stilgoe et al. 2013), which implies that 'social actors (researchers, citizens, policy makers, business, third sector organisations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society' (European Commission n.d.). This means that questions concerning the broader social and economic goals that emerging technologies should serve should be opened to wider public discussion.. As "reliable witnesses" the public as consumers are considered important producers of knowledge about the effects of the technology in the lives of "most people" (Kjeldaas et al. 2022, Funtowicz and Ravetz 1993). Thus, understanding the ways members of the public tackle gene editing technology in different ways is essential in order to regulate the technology effectively.

Against this backdrop, this paper addresses the following questions: What views on regulation and steering of gene editing technology are produced by the public themselves, and what could this mean for the regulation of CRISPR? Through qualitative interviews with members of the public the paper traces how the public makes sense of gene editing technology and the implications of its use. The merging of values, interest, knowledges, and ideologies produce distinct co-productions (Jasanoff 2004) of the technology and exemplifies the multitude of "publics" that exist. Not only do they produce different discourses on what the technology is and the implications of its use, but also give important insight into how the public view their own legitimate role in the governance of new technologies.

References:

European Commission n.d. "Responsible Research & Innovation." https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

Hurlbut, K. J., Saha, B. and Jasanoff, S. (2015). CRISPR Democracy: Gene Editing and the Need for Inclusive Deliberation. Issues in Science and Technology 32: pp 266–271

Middelveld, S., Macnaghten, P., & Meijboom, F. (2023). Imagined futures for livestock gene editing: Public engagement in the Netherlands. Public Understanding of Science, 32(2), pp 143–158. https://doi.org/10.1177/09636625221111900

Nawaz, S. and Kandlikar, M., (2021). Drawing Lines in the Sand? Paths Forward for Triggering Regulation of Gene-Edited Crops, Science and Public Policy, Volume 48, Issue 2, April 2021, Pages 246–256, https://doi.org/10.1093/scipol/scab014

Nelson, J.P., Selin, C.L. & Scott, C.T. (2021) Toward anticipatory governance of human genome editing: a critical review of scholarly governance discourse, Journal of Responsible Innovation, 8:3, pp 382- 420, DOI: 10.1080/23299460.2021.1957579

Sarewitz, D. (2015). CRISPR: Science can't solve it. Nature, 522, pp 413-4.

Stilgoe, J., Owen,R. and Macnaghten, P. (2013). Developing a Framework for Responsible Innovation. Research Policy, 42, pp 1568–80.

Enhancing upstream engagement through understanding of Australian public attitudes about gene editing in livestock production

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The recent turn to gene editing as a potential solution to a range of animal welfare, productivity, sustainability and other issues associated with animal production processes presents significant challenges from a responsible research and innovation (RRI) perspective, particularly as applications of this technology raise important social and ethical questions. Little is known about community attitudes toward gene editing (separate from older forms of genetic modification) and its prospective use in livestock (with exception of Middelveld et al. 2022). RRI calls for upstream stakeholder and public engagement on novel technologies (Bruce & Bruce 2019), guided by the principles of anticipation, reflexivity, inclusion, and responsiveness (Stilgoe et al. 2013). This approach thus requires consideration of the broader (and often complex) socio-cultural context that informs why people think certain things about the technology. Understanding community opinions is crucial when considering how to develop proactive strategies to support engagement and alignment between different actors such as scientists, policymakers, regulators and the community with regard to whether or how a technology should be used. Despite optimism about the use of gene editing amongst the scientific community, few attempts have been made to date to engage members of the public in accordance with the RRI principles.

In this paper, we present the results of a qualitative empirical study of Australian community attitudes toward the use of gene editing in the red meat industry that aimed to develop a rich account that could inform both the science and public engagement around the development of gene editing applications. We describe our empirical research that aimed to provide a rigorous exploration of community values and viewpoints with focus on the results obtained from the use of online, asynchronous focus groups. Presentation of scenarios describing different applications of gene editing that have been developed or are likely were the centrepiece of the research allowed us to identify key questions that participants viewed as central to their conditions about the ethical acceptability of use of gene editing in sheep and cattle. Using the generic inductive qualitative analysis method, we found that participants' attitudes towards gene editing technology are closely connected to the nature and context of the proposed applications. Contrary to prior studies on related topics which report acceptability separately from perceived risks and benefits, we found that perceived risks, benefits, and acceptability were closely linked. Our study's participants assessed the application of gene editing technology according to the perceived validity of

the problem it proposed to address and whether the problem was considered 'genuine' (e.g., if there was a perceived alternative solution that did not require use of gene technologies). Our findings emphasise that more upstream engagement is required to involve different publics in defining the 'problems' to be considered when exploring social and ethical acceptability of biotechnologies, and specifically to identify what potential applications of gene editing (if any) may be acceptable for use in the livestock production sector.