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RESEARCH ARTICLE

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The societal roles and responsibilities of plant scientists in the context of genome-edited crops

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Societal Impact Statement

The societal debate on the use of genome-edited crops has been polarised from the start. While policymakers struggle to democratically resolve this dilemma, plant scientists have been criticised for taking up advocative roles and thereby risking further polarisation. This study demonstrates how plant scientists themselves perceive their roles and responsibilities. Indeed, those scientists active in the debate were found to fulfil advocative roles, and there seems to be an underlying, persistent—and very traditional—view on roles and responsibilities of scientists within the community. Critical reflection on this view is required for better democratic dialogue and decision-making. More interdisciplinary interaction could facilitate this reflection.

Summary

- In this paper, we examine how plant scientists from Wageningen University and Research (WUR) demarcate their roles and responsibilities in relation to the societal impact of their research, in response to calls for public legitimacy of their research, and within the societal debate on the governance of genome-edited crops (GE crops) in Europe.
- We analysed 16 semi-structured interviews, 5-day journals, and (social) media contributions of plant scientists at WUR.
- Our study demonstrates that the perceived roles and responsibilities of the interviewees were aligned with the ideal of the scientist as value-free, as separate from society, and as producing knowledge that leads to unproblematic societal benefits through industry. When confronted with the polarised debate on the governance of genome editing (GE) technology, the reflexivity that our respondents had demonstrated in general, tended to be dispersed. Respondents rarely considered the GE crop debate, or their own position, to be value-based. Those respondents active in the debate were found to fulfil advocative roles, and they struggled to recognise the validity of viewpoints other than their own.
- We hypothesise that this decreased reflexive capacity is a product of the long-term polarisation of the GM/GE debate, mediated by both their conceptual alignment with the linear model of innovation and their limited interactions outside of

their field. In order to better align the perspectives of social and natural scientists on the topic of science-responsibility, and to constructively contribute to the debate on GE crops, we argue for more interaction between the these two communities.

KEYWORDS
biotechnology, communication, genome-edited (GE) crops, inclusion, linear model of innovation, new genomic techniques (NGTs), responsibility, responsible research and innovation (RRI)

1 | INTRODUCTION

The roles and responsibilities of scientists are an increasingly prominent topic of societal discussion. Public attention is sparked by renewed reflections on past innovations, development of new innovations, and news-worthy actions of scientists. Evoking the past, the recent movie *Oppenheimer* reflects on the roles and responsibilities of scientists that developed the nuclear bomb in Los Alamos in 1945 (Nolan, 2023). In addition, the rapid development of new innovations, such as artificial intelligence, incites questions such as: what responsibility do computer scientists bear for the impact of artificial intelligence innovation or, more specifically, for the real-world implications of Large Language Models (LLMs) or self-driving cars? And what roles should they adopt to ensure positive societal outcomes of their work? Besides these reflections, contemporary public activities of scientists have drawn attention to their roles and responsibilities. For instance, in the Netherlands, climate scientists are blocking highways side-by-side with climate activists (Hilhorst & Landsman, 2023), ecologists and environmental scientists are calling for political action to reduce nitrogen pollution (Olff & de Vries, 2022), and plant scientists are advocating against the strict European rules on new genomic techniques (van der Ham et al., 2023). Are these scientists crossing a line, or is it their role and responsibility to speak up?

The intersection of innovation, policy, and society provides a complicated playing field for scientists. Funding agencies require scientists to work in transdisciplinary teams to address complex societal challenges. Politicians and policymakers expect scientists to provide scientific input for political debates and policy on science and technology and, more broadly, to inform various public policies at the local, national, and international level. Scientists are expected to be independent and disinterested when informing these policies. Scientific advice is supposed to be free of values as well as social, political, and cultural assumptions, even though social scientists have long emphasised that value-free knowledge does not exist as it cannot be viewed separately from society (Fleck, 2009; Jasanoff, 2004). Within this complicated playing field, it is not straightforward to determine desirable and fitting roles for scientists, and it is an even greater challenge to distribute responsibilities.

Traditionally, conceptions of the roles and responsibilities of scientists were guided by the idealised representation of basic research (or 'pure science') and the linear model of innovation (Douglas, 2014; Pielke, 2007). This linear model postulates that the knowledge creation and application process starts with basic research, which then leads to applied research and development, culminating in applications as a means for furthering the well-being of humans. The ideal of science is represented as a privileged site of knowledge production, separate from society (Polanyi, 1962). Correspondingly, it is the role and responsibility of scientists to conduct 'good science' and to safeguard the integrity and autonomy of science. Reflecting on the future use and governance of applications in development or on the market was not seen as the responsibility for scientists. Indeed, science and innovation itself were perceived as neutral instruments for humankind; how technologies would be deployed would determine whether it would be beneficial or detrimental to society. With 'the empirical turn', it instead became transparent that society influences technology development as well (Pinch & Bijker, 1984). Simultaneously, the very design of technologies was observed to potentially have an impact on society, by, for example, influencing our relationships, our social practices, and production methods. If the design of innovations has a constitutive role in shaping our future society, and some relevant social groups have more influence on the design process, then one has to recognise that science and innovations are intrinsically political (Winner, 1980).

In this context, it matters very much what roles scientists play. For example, by facilitating processes of reflection, societal engagement, and inclusion, scientists are able to incorporate values and interests important for society into their research practices and into the design of technological innovation. The dismissal of any responsibility for the impact of science on society can have the opposite effect (Pielke, 2007; Stilgoe et al., 2013; Turnhout et al., 2013). The artificial separation of the scientific community from society can result not only in a lack of public legitimacy for science but also in the development of public polarisation and mistrust (Pellizzoni, 2004; Pielke, 2007). Moreover, within the political realm, dissociated one-way communication and the linear supply of information are mostly insufficient to inform, settle, or democratise value-centred debates about science. Inclusion and two-way dialogue are invaluable for democratic decision-making, and the scientific community is deemed to essentially limit the democratic process by playing a 'traditional' role (Douglas, 2003; Pellizzoni, 2004; Pielke, 2007). Thus, although it is difficult, it is critical to reflect properly on the roles and responsibilities of scientists in today's complex society.

In response to these discussions, social scientists and policymakers have proposed new models to conceptualise the roles and

responsibilities of scientists. These models aim to democratically and prospectively govern science and innovation, rather than retrospectively mitigate risk and public polarisation. According to the European Commission, the goal is to develop an approach 'that anticipates and assesses potential implications and societal expectations with regard to research and innovation, with the aim of fostering the design of inclusive and sustainable research and innovation…', implying that 'societal actors 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, 2014, pp. 1–2). Thus, science should not be divorced from society, but conducted with and for society (Owen et al., 2012). In this process, scientists are encouraged to take up responsibility not only for the scientific validity of their research but also for anticipating its societal outcomes and for ensuring its public legitimacy (Douglas, 2003; Stilgoe et al., 2013). Correspondingly, it can be considered that the role of scientists as a community is to reflect on their own interests and values as well as on the potential outcomes of their research, to engage in genuine dialogue about these outcomes with a variety of actors, and to include the views and values of these actors into their work (Pielke, 2007; Stilgoe et al., 2013; Turnhout et al., 2013).

1.1 | A common language?

Although such dialogical models of science and society relations have been taken up in science policy and funding institutions to some extent (Owen et al., 2021; Owen et al., 2021)—embedded most recently in the science policy language of responsible (research and) innovation (RRI)—recent research has shown that their practical implementation is hampered by competing logics between these policies and deeply embedded cultures of practice within the scientific community. For example, Glerup et al. (2017) explored how scientists in nanotechnology and synthetic biology in the United States, the United Kingdom, and Denmark perceived and practiced responsibility. They showed that while scientists articulated and practiced a range of 'bottom-up' responsibilities that included the conduct of sound science, taking care of employees, creating 'impact', and carrying out publicly legitimate science, they viewed policy discourses such as RRI as largely unfamiliar to them, and even as alienating and irrelevant. Åm et al. (2020) also demonstrated a lack of conceptual alignment between policymakers and scientists reflecting different logics in science policy. They found a marked difference between the representation of scientists, or the 'imagined scientist', of bio- and nanotechnologists and the 'imagined scientist' as assumed within policy documents of the Research Council of Norway (RCN) that aimed to implement the policy imperatives of RRI. Whereas scientists framed usefulness in terms of industrial justifications of worth and of working on societal and sustainability challenges, they found little sensitivity or appetite to anticipate potentially negative aspects of their work, a foundational ambition of RRI in its constitutive dimension of 'anticipation' (Stilgoe et al., 2013) and embedded in the policy documents of the RCN. Similarly, Sigl et al. (2020) reported that complex models of science-society relationships have not gained much acceptance amongst life scientists in Vienna. Indeed, their study demonstrated that scientists found it difficult to imagine or integrate practices to address broader societal concerns within their roles and responsibilities. And finally, a study by Owen et al. (2021) sought to explain the limited uptake of RRI in funding and research institutions by an analysis of competing institutional logics, responsibility norms, and epistemic practices. Collectively, these studies point to the complexities involved in embedding a prospective notion of responsibility into the daily practice of scientists, as well as to the prevailing mismatch between the perspective of scientists and new models of science-society relationships. Glerup et al. (2017) concluded that there is a need for the development of a 'common language' on responsibility by grounding the discussion in existing experiences of scientists.

1.2 | Public controversy, genome editing (GE), and the responsibility of plant scientists

Most empirical studies on the imaginaries of scientists have focused on relatively unpolarised fields of technology development. In this study, we extend this literature by investigating the perceived roles and responsibilities of scientists in a contested science area within a highly polarised societal debate: those of plant scientists within the societal debate on genome-edited crops (GE crops; Box 1). How is responsibility configured in an epistemic community that prides itself as being at the forefront of the development of a publicly controversial technology? Our motivation is twofold: we anticipate the controversy to have had a notable impact on the attitudes of scientists (of what kind we are less sure), and we believe these general attitudes may have had a role in perpetuating, even reproducing, the societal controversy and impasse (see also Macnaghten & Habets, 2020).

GE technology is a key example of a controversial technology that has provoked discussions on the roles and responsibilities of scientists. Scientists have been criticised for adopting roles that induce polarisation (Stone, 2017) by 'pushing' their vision onto other actors without engaging in two-way conversation (Svingen & Jahren, 2023). In April 2023, the Dutch investigative science programme Zembla criticised Dutch plant scientists for having lobbied for their own cause of exempting GE products from the strict European rules that govern GM crops (van der Ham et al., 2023). Taken together, the long-term polarised status of the GM/GE debate and the public criticism on the actions of plant scientists render the context of GE crops a valuable case for investigating scientists' perspectives on their own roles and responsibilities. Moreover, as the technology is still largely to be developed into marketable products, and the European Union is in the process of developing new legislation, it is an opportune moment to open up a conversation with scientists to understand better why and how the self-perceived responsibilities of scientists are expressed into their roles in practice, as well as to facilitate reflection of the scientific community on their (self-perceived) responsibilities.

Box 1 The debate on NGTs and GE crops in the EU.

New genomic techniques (NGTs) have evolved rapidly in the last 20 years, and have revolutionised genome editing (GE), particularly since 2012, with the invention and uptake of the CRISPR-Cas9 system. NGTs have made modifying DNA in the laboratory faster, easier, less expensive, and more accurate compared to older genetic modification (GM) techniques, and are widely expected to play a prominent role in innovations across the plant breeding sector. However, in the European Union (EU), this role is expected to be limited unless the current Directive, 2001/18/EC for the deliberate release of genetically modified organisms (GMOs) into the environment is revised. Directive, 2001/18/EC was issued by the EU in 1990—and revised in 2001—to protect public health and the environment, and harmonise the legislation of its member states concerning GM-crops, partly by introducing a requirement for an environmental risk assessment before the release of these crops. Directive, 2001/18/EC defines a GMO as an organism, with the exception of human beings, whose genetic material has been altered *in a way* that does not occur naturally by mating and/or natural recombination (*our italics*). With the development of GE technology, some stakeholders were of the opinion that GE crops did not fit this definition, as the genetic material found in an NGT plant could have occurred naturally. In contrast, other stakeholders believed that the phrase 'in a way' refers to the method. As CRISPR-Cas9 and other NGTs do not cut genetic material in plants naturally, it is thus not a natural occurring process and therefore GE crops are GMOs. In 2018, the Court of Justice of the European Union clarified that all organisms obtained by mutagenesis including those modified with NGTs are GMOs within the meaning of the GMO Directive and hence subject to the Directive. The Court also clarified that only GM crops obtained through certain methods of genetic modification that had *conventionally been used in a number of applications and had a long safety record* are exempt. As NGTs do not have a long safety record, GE crops do not qualify for exemption from the provisions of the directive. Yet this has done little to settle the political and societal debate on whether they should be exempted (Dahm, 2023; Habets et al., 2019).

Within the debate, agrochemical and plant breeding companies, as well as many research institutes, argue for the need to amend the current GMO Directive in order to more easily introduce GE technology in EU crop breeding and cultivation. These actors commonly argue that GE technology will enhance the competitiveness of the EU agri-food sector and increase the speed of plant breeding to an extent necessary for achieving the sustainability objectives of the European Green Deal and the Farm to Fork and Biodiversity strategies. In contrast, environmental organisations, the organic sector, and other scientists claim that to achieve the aims of the European Green Deal, what is required is not the introduction of GE crops, but rather a transition to a sustainable food system based on resilient and nature-inclusive circular agriculture. According to them, the current GMO Directive should not be revised to exempt GE crops because GE crops do not have a demonstrated long term safety record, and may have a negative impact on (local) socio-economic systems, as well as on power balance, access to knowledge, fair distribution of food, sovereignty of farmers and countries, and freedom of choice (IUCN-NL et al., 2022). The arguments on either side of the political debate are echoes from the earlier, similar polarised debate on the desirability of GM in European agriculture.

Following the clarification of the Court of Justice, the EU Council requested the European Commission to provide a study on NGTs in November 2019, in which the Commission concluded that the current rules—mainly the existing GMO legislation—lag behind scientific and technological progress and do not sufficiently facilitate the development and placing on the market of innovative GE products (2021). Therefore, the European Commission published a proposal for a new Regulation on plants obtained by certain NGTs and their food and feed in July 2023. In developing this new regulation, the European Commission relied on EU-level scientific advisory bodies, as well as on wider scientific expertise and stakeholder opinions, amongst which the seed industry and their interest groups.

The aim of this research was to investigate how a particular epistemic community of plant scientists at Wageningen University and Research (WUR) demarcate their roles and responsibilities. WUR is a globally recognised leader in the fields of agriculture and life sciences (Times Higher Education, 2022), and present at the forefront of debates on both GE crops and science-responsibility. Institutionally, GE technology has been represented as necessary in developing robust responses to societal challenges, such as how to feed a growing population and respond to changing consumption patterns (Macnaghten et al., 2021). We examined how plant scientists perceive and practice their role as scientists (RQ1); whether and how they reflect on their responsibility for the societal impacts of research (RQ2); to what extent they respond to the calls for wider public legitimacy of their research (RQ3); and how these general views extend to their perspective on their role and responsibility in relation to the specific political debate on the governance of GE crops (RQ4). By presenting the motivations and perspective of plant scientists, we aspire to contribute constructively to the societal debate on GE technology, and to

advance the broader discussions on the roles and responsibilities of scientists.

2 | MATERIALS AND METHODS

The analysis draws on 16 qualitative semi-structured interviews with plant scientists from WUR (i.e., scientists employed by WUR to conduct research that could contribute to the development or use of GE crops) conducted between April and May 2022. The sampling of WUR plant scientists was undertaken strategically, designed to cover a diversity of chair groups, career stages, locations/universities of education, gender, degree of social media presence (Twitter and LinkedIn), and assumed roles and perspectives of the scientist, continuing until we had reached saturation in the perceived roles. The final sample included six women and ten men, with positions ranging from PhD candidate to chair holder, and with varying degrees of social media activity (Table 1).

Similar interview guides were used across the interviews (Method S1), although specific examples and sub-questions were added based on what the interviewer had found in online data about the interviewee. Audio recordings of the interviews were transcribed using Happy Scribe (happyscribe.com, machine generated) and manually corrected. The transcripts were both literally and interpretatively analysed using Atlas.ti. For each research question, codes were dynamically developed during analysis (Table S1). After coding, Google Jamboard (jamboard.google.com) was used to obtain an overview of the different arguments, opinions, and considerations per topic (Figure S1). Additionally, after each interview, interviewees were asked whether they would be willing to fill in a journal for five working days (Method S2). These were used to obtain a more systematic overview of their daily activities, interactions, and communications. In the end, 10 of 16 interviewees filled in the journal and forwarded their entries. To further investigate the roles of the plant scientists, within the timeframe of the project (1 July 2021–1 April 2022), we attended events, and analysed interviewees' online videos, blogposts, news articles, podcasts, social media posts, and radio recordings, paying attention to the ways and extent to which scientists communicate via these various platforms and to their intended audience. The journal entries and outcomes of the media analysis were compiled in a Microsoft Excel table, summarising the observed and self-reported activities, interactions, and communications per interviewee. This table and the created interview Jamboard sheets were used to plan and structure the results section.

3 | RESEARCH FINDINGS

3.1 | Motivation for research driven by fascination and curiosity

To initiate the interviews, we asked each scientist to explain the motivation for their career choice. Shared across all interviewees was their justification to become a plant scientist, not because of a desire to create 'super plants' with GE technology or to become wealthy, but rather because of a simple fascination for plants. Indeed, curiosity and fascination proved to be *the* powerful motivators for a career in plant science. One interviewee explained that they had always been fascinated by how adaptive specific processes within a plant can be. Although self-locomoting organisms (such as animals) can move to find a more suitable place to live or try to escape dangerous predators, plants can only *grow* in a certain direction. The interviewee was fascinated by the processes within the plant tissue that seem to attempt to compensate for the inconvenience of sessility. For example, the light-antennas of the photosynthesis machinery can grow or shrink depending on the availability of light:

> It's like playing, most of the time. So, for me, the research part is not really like work because it's just trying to figure out how things work. And yeah, it satisfies my curiosity, basically. In that sense the… I mean, of course, I like if my work has an application, but what drives me is more figuring out how things work. Doing puzzles, basically, but not like Sudoku. I don't like Sudoku.

For our respondents, the attempt to solve the interesting puzzle of how plant processes work, using tools and knowledge from the fields of biology, chemistry, and physics, made science both challenging and fun. Similarly, for another interviewee, it was curiosity that constituted their primary motivation to choose a career in science:

TABLE 1 Overview of the diversity within the interviewed sample of plant scientists from Wageningen University and Research (WUR). Senior positions include all permanent senior research positions, such as assistant professor, full professor or group leader. For this table, we considered scientists to be 'active' on social media if they regularly posted or liked content on either Twitter or LinkedIn between 1 July 2021 and 1 April 2022. The plant scientists were interviewed about their perceived roles and responsibilities (Method S1), they were requested to fill in a journal (Method S2), and their online media activities were analysed.

	Men	Women	PhD candidates	Postdocs	Senior positions	Active on social media	Native Dutch speaker	Received (part of) higher education in the Netherlands
Number of interviewees	10	6	4	2	10	8	9	12

> I think that people pay me to do research because they expect it to enhance crop production ultimately… It's not necessarily what I'm interested in. So, I'm really interested in the fundamental biology, the thing that gets me out of bed in the morning. Just a curiosity.

Although fascination seemed to be the core motivation for our respondents, the development and progress of the scientific field were inherently important motivators for the pursuit of knowledge as well. And, in this regard, the scientists adopted a wide range of roles and responsibilities related to the process and organisation of research.

3.2 | Responsibility for the process and organisation of research

Our interviewees dedicated most of their time to activities that served the production and dissemination of knowledge within the scientific community, such as working on experiments, preparing and giving lectures, participating in scientific meetings, applying for funding, investing in collaboration, and supervising students. In line with these roles, safeguarding the quality of knowledge production and its dissemination was generally seen as the primary responsibility of scientists. Similarly, when defining what constitutes 'good science', the scientists collectively claimed that it should be reliable, reproducible, robust, properly designed and carried out, peer reviewed, transparently communicated, and ideally open access. In addition, several interviewees articulated the view that 'good science' is accomplished when it is conducted with the right purpose in mind: to discover new knowledge for its own sake, not for the sake of prestige or career.

> Good science is science done properly, which means well documented, which means inspired by [something] that goes beyond the need for citations or publications or whatever. […] So it's done in good faith and it's done with this idea that you really want to make progress.

It was evident that the interviewees' definitions of 'good science' concerned mostly the way in which science is conducted, motivated, and scientifically communicated; rather than a consideration for its consequences or societal relevance. One PhD candidate explained their conscious choice for this demarcation:

> [When defining 'good science',] my first instinct is on it being well done, I mean, proper. And not really focus on the application. […] Because everyone will have their own vision of what is good and what is bad. So, it's difficult to objectively talk about good science, thinking about the impact. Yeah. I will stay focused on the methods.

In general, these findings align with those of Glerup et al. (2017) in demonstrating a strong perceived social responsibility amongst scientists for supporting the process and organisation of research, in addition to their alignment with traditional norms for 'good science'. Additionally, our scientists seemed to agree with those interviewed by Sigl et al. (2020) that distancing oneself from the societal relevance of a research topic can be seen as 'good science' because it is perceived as more 'objective'.

3.3 | Limited responsibility for the impact of science

Although several scientists indicated that their research is in part motivated by the possibility of contributing to potential societal applications, 11 out of 16 interviewees argued that it is not the responsibility of scientists to ensure beneficial outcomes nor to prevent 'bad' ones. The responsibility of scientists was to conduct good science and not to judge or govern its so-called 'subjective' consequences. Although most interviewees (13 of 16) agreed that scientists should think about the potential consequences of their research, taking responsibility for outcomes was often seen as a step too far. To support this notion, many interviewees argued that there is neither a necessity nor a capacity for individual scientists to influence the societal outcomes of their work. Justifying this perceived lack of necessity, interviewees often intuitively expected science to have positive, unproblematic outcomes, and as such, they reflected little on potential negative consequences.

> I think when somebody thinks of a project, you only think about how it will help. […] I don't think we think so much about: will my research actually make it worse? [When you apply for a grant] I think there is [always a section]: how will it help, [or] how will it be applied for society? And negative [aspects that are inquired about are] mostly: it's a high risk project or… how is the feasibility of the project? [Those are the] negative aspects, […] I could be wrong here, [but I don't think] there is like this part that says: what if you create a Frankenstein, or something.

Even those interviewees who did foresee the possibility of certain negative consequences resulting from their scientific work were optimistic that these consequences would be prevented or overcome. For example, one respondent remarked: 'Yeah, you never can look into the future, but still, I think you can take the risk and then see how you solve the next challenge as well'. Conveying a lack of personal capacity, the interviewees stated that, as the societal outcomes of their research were perceived as highly uncertain and beyond their control, ensuring positive outcomes of their research was not within their sphere of influence. To illustrate this point, one interviewee related that while all science should (ideally) be open; this is unrealistic in a commercial world:

> I would prefer that there are no patents and people can do what they want, because [a patent] also rises prices and things like that. But yeah… in a commercial world, I think you cannot hold it back, I think, completely… Yeah. You cannot change that much.

This sense of limited perceived responsibility for the implications of science seemed persistent within the plant science community: even those few interviewees (2 of 16) who expressed some perceived responsibility *and* influence for steering outcomes were hesitant to advocate such a broadening of responsibility to all scientists as a community. It was chiefly seen as the role and responsibility of the government and industry to govern the consequences of their research on society. In line with what Åm et al. (2020) found, our study indicated that the possibility of unanticipated negative research impacts emerging is neither experienced as a pressing problem nor as within the imagined scientist's sphere of influence. Clearly, this perspective aligns with the deeply-rooted linear model of innovation, raising an imaginary boundary between science and society, as was also found for scientists interviewed by Sigl et al. (2020). Furthermore, the previous two quotes indicate a lack of institutionalised encouragement and incentive to reflect upon and anticipate the consequences of research, and a feeling of powerlessness to ensure positive societal outcomes 'in a commercial world'. In this regard, our findings resonate with the studies of both Glerup et al. (2017) and Sigl et al. (2020) in signalling a strong dependency of the roles and perceived responsibilities of scientists on their institutional embedding.

3.4 | Limited responsibility for public legitimacy

Although most of our interviewees agreed that the public legitimacy of science was, in principle, a necessary and desirable goal, we found limited evidence to indicate that they felt a significant responsibility or capacity to actively improve the public legitimacy of their research. As indicated in the introduction, two common practices that aim to improve public legitimacy are citizen involvement (or inclusion) and science communication (including dialogue). Regarding citizen involvement, some interviewees expressed the belief that because citizens pay for public research, they should in some way be involved in decision-making processes. Inspired by the increased focus of funding institutions on front-end citizen involvement, one interviewee was even very enthusiastic about this idea, although they admitted to finding the concept itself hard to grasp.

> Interviewee: 'It's not informing the public, but it's to bring them also in somehow, in the decision, which is difficult for us, this interaction… […] But this is really now discussed a lot. You see it in all the meetings from the EU, from the Commission, that you should bring [in] the public.'
>
> Interviewer: 'Okay. What do you think could help [in making this less difficult]?'
>
> Interviewee: 'Maybe also in projects to really have more with social scientists? […] I've been to the matching day of NWO for this proposal. They are very [heavy] on the social sciences […]: it's as important as the technology. So, they really mentioned it a thousand times. [And I was talking to someone who is] working together with a philosopher [laughs]. He was explaining to me… [that] the idea was to bring, in fact, values [into the project] … and I found it so nice.'

However, most respondents displayed little motivation to either involve citizens at the front-end of research or to adapt their research design to public views and values (10 of 16 interviewees). More generally, the inclusion of actors outside of natural science and industry was found to be limited. While some respondents acknowledged the value of involving citizens in more applied research settings, most respondents did not intuitively consider the involvement of citizens in the conduct of research as potentially beneficial.

> In principle, every research starts with a research question. If your research question is that you just want to know about [a] particular process, so gaining knowledge on the biology […], then I do not think that it's useful to have citizens involved. If you would like to […] develop a particular technology, then I can imagine that it would be interesting to involve a broader public. […] Because technology […] should be applied. And if there is something that prevents the application, that could be a public view on a new technology, then, of course, that will hamper the application of the technology. And that will also affect why you're doing that particular research. So, in that case, technology development that might be applicable for, let's say, [a] more general public, or for [the] production of something that will be used by the public; there I can see that it's important [to involve citizens].

Reasons why it was not deemed beneficial or why it was difficult to include citizens in fundamental, curiosity-driven research included the following: non-experts are not well-equipped to discuss technical matters; expert knowledge is necessary to make informed decisions in domains such as funding allocation and prioritisation; and citizens can be fickle and change their minds as a result of ill-considered views or short-term interests. In general, we found that the interviewees tended to frame citizens as consumers, rather than as citizens with rights and responsibilities as members of a democratic community. Within this limited representation, the public was seen as entitled to express preferences in a product's practical use, including whether they would or would not buy it, but they were not seen as entitled to articulate broader opinions or to be involved in the research process. This framing of the public as consumers was further mediated by the

extent to which companies had been involved in the research. As one professor explained, once companies are involved, researchers are more inclined to demarcate responsibilities for societal engagement to corporate actors.

> So, I think we probably think that the companies know what products are wanted or what traits are wanted, and they're going to deal with the outreach, right? If it's like, what's the new thing on the market going to be. We as researchers are not… We trust… And I guess we're getting information via the companies like, oh, yeah, these are the traits that make it hard to grow, or this is what consumers don't like. […] Yeah, that's true. It's 100% coming from the companies. They are a filter telling us what traits they're breeding for because they know what consumers want.

Moving from citizen involvement to communication, science communication was almost exclusively interpreted and practiced as a one-way communication from the scientists to the public; it was not typically understood as a two-way dialogue from which all partakers can learn and by which science can be democratised and legitimised. In practice, amongst those scientists who were found to publicly communicate about (their) science (14 of 16 interviewees), including on social media, 13 were found to frame their messages in an uncritical or 'promotional' manner, expressing enthusiasm about science, about scientific progress, and about innovation in general. Both on social media and in citizen-targeting news media, scientific findings of projects tended to be linked to potential and beneficial societal applications. By contrast, only one interviewee was found to present both pros and cons of potential applications that may be generated by their scientific findings and referred to any alternative solutions to the challenges the potential application would address. Possibly stimulating this promotional form of communication, the official Twitter and LinkedIn accounts of WUR were found to communicate in an even more uncritical and promotional manner. During the interviews, the interviewees gave two main reasons for engaging in science communication: to inform citizens what public money had been spent on, and as a mechanism to demonstrate the importance and trustworthiness of science, as expressed by a PhD candidate:

> I've always said this, that sometimes if there's a trust issue between the public and the scientists, why isn't there [between] a doctor and a patient? And if a doctor comes and tells you, 'I have a new experimental drug and you need to take it', you are much more perceptive and open to that than someone saying, 'I have a genome-edited plant, would you eat it?' And that's also because I think we are not very much in contact about our work with the people. And that's also coming back to your first question, why talk about it? Why involve citizens? It's because you develop trust. […] You're open, you're transparent. And then they see we're just, in our case, like young people working in the lab just doing experiments, and we are not creating nuclear weapons or something. So really to make it normal.

Even with these motivations in mind, however, communication with the public was not seen as an integral part of science nor part of the duties of scientists. The research of some interviewees was seen as very fundamental, and therefore as too marginal for the public interest to warrant communication with society. For others, there was insufficient reward, recognition, and time for public communication activities. For one interviewee, the issue was framed as follows:

> I know for my own work that we are extremely busy. We have to teach. We have to do research as well. We have to publish. Those are the main things that we get credits for and money for. If we don't do that, I don't have a job. So, in my spare time, I still need to inform the public and talk with the government and with the farmers. So, I don't receive any credits for that. Internally, they don't ask me for this. And there are plenty of other tasks that I need to do to […] be a scientist. […] Of course, we strengthen each other to say that we have to communicate, but [it is] also really dependent on your personal belief that it's important.

To summarise, our respondents expressed the view that scientists have limited responsibility for safeguarding the public legitimacy of science or for improving science-society relations. Most did not intuitively recognise any need for citizen involvement besides their role as consumers for product development. Furthermore, because the opinion of citizens was not necessarily seen as valuable or helpful, science communication was understood and practiced in a unidirectional manner, with the goal to provide information and promote science. When asked about the importance of public legitimacy directly, respondents did recognise its value, but for many interviewees, any potential lack of public legitimacy was ascribed to the faulty attitude or flawed ideas of citizens rather than to the view of science as being undemocratic. Remarkably, the interviewees' frustration with the low trust in—and esteem of—plant scientists in society was a recurring topic throughout these conversations. Specifically, when discussing the topic of citizen engagement in research, it was found that some interviewees believed that (plant) science is insufficiently trusted and appreciated by the public and that the role of the scientists is to persuade the public otherwise.

> [you just] have to trust us as scientists… also because science is not watching a football game, which everybody has an opinion about. I mean, it's an art. It comes [with] a lot of knowledge behind it. People should also realize that they don't have that knowledge. Science is not just… it's not an opinion.

3.5 | The case of genome-edited crops

Moving from a general discussion on the role and responsibility of scientists, we examined respondents' views on the specific case of GE crops. Before we address how scientists configure their own roles and responsibilities in this polarised field, we address their views on GE and on the current regulation of GE crops.

3.5.1 | Views on genome editing and the current regulation

We found that respondents envision and frame GE technology as prototypical of an innovation that conforms with the linear model of innovation. The respondents unanimously agreed that GE is a very useful tool for research, with most agreeing that the technique has the potential to speed up the current breeding process and contribute to 'solving societal problems', such as by improving sustainability in agriculture or food security. Although the scientists acknowledged the possibility of negative consequences emerging from GE applications, they tended to attribute these to the context of the application and not to the technology itself. The interviewees stressed that the challenges and disadvantages associated with the application of GE technology in agriculture are actually shortcomings of the current (agricultural) system and of the way in which the technology would be applied, rather than something inherent in the technology. Concerns over safety, and even those of IP and ownership, were therefore also viewed as manageable through appropriate oversight and regulation. Despite this general positivity about the possibility of GE to contribute to solving our current societal predicaments, our scientists had varying thoughts on the actual likelihood of this possibility and on the urgency of applying GE technology in plant breeding. According to some respondents, we urgently need to accelerate the development of 'improved' crops because 'we are facing an enormous problem in feeding the world', and because currently, GE is the only source to provide an appropriate acceleration in plant breeding. In contrast, other respondents expressed some doubt about the claimed urgency of applying GE technology, as one explains:

> It looks like a very neat tool to assist [...] in plant breeding. Whether it's a really essential thing, I am not sure. I think it can speed up breeding, but I'm not sure if the advantages are so huge. It can be useful. Can we do without? Yes, probably. Can we do without GM? Yes, for a long time, depending on what the challenges are.

Analogous views were voiced by another interviewee, who saw the potential of GE in speeding up the current breeding process but had doubts about whether this is the right way to solve our current societal challenges in general. A third respondent even voiced concerns about scientists overselling GE as a solution to certain problems. Possibly, these more nuanced views on the possibility of GE to solve current societal predicaments can be partially attributed to the fact that these interviewees are amongst the few who reportedly engaged in conversations with social scientists and other types of stakeholders.

As expected, given their shared general view on the potential benefits of GE technology, almost all respondents voiced concern with the current EU GMO Directive and its role in impeding the development of GE crops in Europe. Although a detailed understanding of the GMO Directive was limited, nearly all our respondents expressed exasperation about the perceived strictness and inconsistency of the Directive, particularly concerning GE. According to them, GE crops can have similar mutations as crops modified with conventional mutagenesis or traditionally bred crops. And, because the latter are not regulated, nor should GE:

> Interviewee: 'There is no problem. They are the same thing. There is no problem.'
> Interviewer: 'What do you mean?'
> Interviewee: 'So like with genetically edited crops, they're exactly the same as a traditionally bred crop or a traditionally mutagenized crop. There is no difference. [...] I mean, you shouldn't need stating that things that are the same are the same, but that's what scientists maybe do need to do at some point. I don't know.'

Even scientists who were only mildly enthusiastic about the potential benefits of GE crops expressed their frustration with this perceived inconsistency. Besides the inconsistency, scientists expressed the belief that the current regulation will not prevent the spread of GE crops in the EU, because other countries will develop them, and the subsequent spread of genetic material is unavoidable. In addition, several scientists stressed the socio-economic disadvantages of the current strict regulation.

3.5.2 | Misinformation as a cause for the debate, and loss of nuance amongst the scientists

Interestingly, the explanation for the anomaly in EU regulations, as expressed above, was believed to have been exacerbated by the spread of misinformation and by uninformed policymakers and citizens. For example, 'citizens do not seem to know how agriculture and breeding currently work', 'how important plant science is', that 'everything is already manipulated and processed', that we are 'already importing [a lot of GM products]', that 'farmers already have to buy their seeds', and that science is not just 'an opinion'. Furthermore, our respondents explained that the views of the misinformed public had been influenced by misinformation on the risks and benefits of GE crops spread by other influential actors in the debate, including environmental NGOs, organic farmer communities, and conspiracy theorists. Lastly, some interviewees believed that current negative attitudes may have been influenced by the strictness of current regulations and by the fact that there is a public discussion on this

topic in the first place, with both the strict regulations and discussions expectedly sparking public suspicion regarding GE crops.

In summary, we found that most interviewees expressed the view that there is no valid reason to support the controversy surrounding GMOs or GEs, and that the current regulation of GE technology under the GMO Directive arose as a result of a misplaced misunderstanding rather than an articulation of legitimate societal values. Taking these views one step further, several respondents expressed the view that increased knowledge about GE crops will naturally change the opinion of citizens on the desirability of GE crops. As expressed by one interviewee, respondents believed that fully informed citizens will understand that there are no 'rational' arguments against the use of GE technology for agriculture:

> Interviewer: 'So if you give this presentation [about genome-edited crops], what do you try to [convey] to people?'
>
> Interviewee: 'I try to make them think about it. And also not… Well, base their opinion… and whether it's pro or against, that's their choice, right? But they should base it on solid arguments.'
>
> Interviewer: 'Right. But do you think, reasoning from this angle, [that people could] even be against, if [they] base it on solid arguments?'
>
> Interviewee: 'I think no. No. And that's why I'm so frustrated, or I can be so angry, especially when policymakers have these strong opinions against, or Greenpeace, that can really make me mad.'

Although most interviewees did not view the provision of scientific data alone as sufficient for policymaking when talking about science and regulation in general, this view changed when talking about the regulation for GE crops. For example, one interviewee explained that while they believed it was logical to take 'human emotion' into account when deciding how to deal with the COVID-19 pandemic (for example, on whether or not to go into lockdown), these social factors were viewed as simply less relevant when making decisions related to agriculture. Such a shift in response and tone was notable across the interviews when the interviewer introduced the topic of GE technology. Whereas many scientists had been relatively nuanced in expressing their opinions on the responsibility of scientists for the outcomes of their own research, this nuance rarely extended to the topic of the GE crop debate. While reflection on the potential negative societal consequences of their own research, albeit limited, could still be stimulated by the interviewer, any view on potential negative consequences of GE technology was often denied with force.

3.5.3 | Implications for the role and responsibility of scientists

Having outlined the views of respondents on GE and the GMO Directive, we now explore the implications of these views for how scientists configured their own roles and responsibilities in the debate. In line with their views on social responsibility in general, our respondents articulated the view that responsibility for ensuring positive outcomes of GE crops lies principally with politicians, in collaboration with independent institutes and industry. As they also held the view that the benefits of GE technology are insufficiently recognised and that the strictness of the current GMO Directive has been triggered by ignorance, we expected them to apportion some responsibility for scientists to educate policymakers and the public to ensure that these benefits could be realised. However, only a few scientists in our research had played any role in the public GE crop debates. Several reasons were mentioned for this lack of engagement: some scientists did not feel motivated because current regulations were not limiting their research, while many other expressed the view that they did not feel comfortable in taking part. For example, one interviewee explained that the debate around GE crops is a 'nasty' debate and that it is impossible to emerge from it in a positive way:

> If people don't want to listen because it doesn't fit their ideas, then it becomes a very frustrating thing. And then you can only get out of that if you put an awful lot of time in it and that I don't want to. […] It's all about image and how you put things. And I think a lot of the NGOs are very good at that. That's how they make their money. And we don't. We try to convince governments to sponsor us, and it goes indirectly through the general public. But these NGOs, they need to get money from people directly.

Similarly, many scientists mentioned that they do not feel equipped to enter the debate or that entering into the debate would provide a difficult situation for them as scientists. Some interviewees explained that they would not feel comfortable in making strong statements, for example, about the expected benefits of GE technology, but felt that this was necessary if they were to be taken seriously in an already heated debate. Interviewees with a more nuanced view were less intrinsically motivated to participate in the debate. Perhaps it is therefore not surprising that we observed that the interviewees who were more vocal on this issue in the media are the ones who feel most strongly about the potential benefits and urgency of applying GE crops in agriculture.

Correspondingly, the form of communication of those respondents who were already involved in public discussions on GE technology was typically advocative. Specifically, several respondents tended to argue for the desirability of using GE technology using arguments on its relative safety and precision and by stating that 'mutations also occur by natural processes'. These arguments were presented by scientists as 'objective fact', rather than as arguments in a value-based debate. This does not mean that respondents did not use value judgements in their communication. For example, some interviewees advocate for GE crops by arguing that we need them to 'increase food production to feed the growing population'. They thus assume that

increasing food production is the right way to address food security and that the application of GE for crop breeding is the right way to achieve increasing food production. Thus, our findings regarding this specific subset of interviewees align with previous observations on the roles of scientists in this particular debate (Stone, 2017; Svingen & Jahren, 2023; van der Ham et al., 2023).

4 | DISCUSSION

The aims of this study were, first, to explore how a particular epistemic community at WUR demarcates their roles and responsibilities as plant scientists; second, how they reflect on their responsibility for the societal outcomes of research; third, how they respond to calls for wider societal engagement and public legitimacy in the research process; and fourth, how these views are expressed and translated in the context of the highly polarised area of genome-edited crops (GE crops). We now summarise our findings before attending to their wider implications.

The perceived roles and responsibilities of our interviewees as scientists in general were very much aligned with those of natural scientists as reported in prior research (Åm et al., 2020; Glerup et al., 2017; Sigl et al., 2020). We found a strong prevalence of the ideal of the scientist as independent and value-free, driven by curiosity and the pursuit of knowledge, and with a strong perceived social responsibility for supporting the process and organisation of research. In their view, the institution of science is an objective process, with objective outcomes, rather than a tool or service that is influenced by, and influencing, the political environment. Overall, scientists did not view themselves as responsible for ensuring that science would have a positive impact on society nor equipped to govern any outcome outside of the laboratory. Science and innovation were expected to bring benefits to society, with possible negative consequences viewed as manageable with the right judicious oversight. The views of our scientists thus aligned with the conventional governance perspective embedded in the linear model of innovation, conveying that science is separate from society and that it leads to unproblematic societal benefits through industry. Indeed, only a few respondents envisioned a legitimate role for societal engagement at the front-end of research, or expressed a willingness to adapt their research design to public views and values. Communication with the public tended to take place in a one-way, promotional, and uncritical manner. In our study, we thus too find a misalignment between the internal conceptual framework of scientists and current prospective models that advocate for the broadening of the social responsibilities and reflective capacities of scientists (Åm et al., 2020; Sigl et al., 2020).

There are two parallel but overlapping ways of explaining the persistence of this misalignment. On the one hand, there is a cultural explanation. The traditional culture of research, predicated on the linear model of innovation, appears to remain dominant within the plant science community. This dominant culture, reproduced and reinforced through literature and education, likely mitigates the scientists' perceived responsibility to critically reflect on the outcomes of their research and engage with the public. On the other hand, there is the structural explanation. This relates to the institutionalised ways in which research is evaluated, recognised, and rewarded. Despite efforts to broaden the evaluation of scientists, such as the Dutch Recognition and Rewards programme (VSNU et al., 2019), our interviewees articulated that they experience little reward nor recognition for engaging in two-way conversations with the public or designing research that critically anticipates societal impact. It is an open question how these cultural and structural dynamics unfold in the coming years, but we hope our recommendations (Section 4.2) can assist their productive development.

4.1 | The reflexivity of plant scientists in the context of genome-edited crops

A key question for the research was to examine how the roles and responsibilities of our respondents as scientists in general translated within the particular controversial context of the debate on GE technology (or NGTs). Most interviewees articulated a clear *political* position to deregulate GE crops, and we found that some respondents lost a degree of reflexivity in their responses when the topic of GE crops was introduced. This tendency to lose nuance and to choose a political allegiance appeared to be more pronounced than was found in analogous studies on scientists' perceived responsibilities in other policy contexts, such as medical biotechnology, nanotechnology, or bioenergy (Åm et al., 2020; McCarthy & Kelty, 2010; Saarela, 2019). The few scientists in our study who were taking part in the debate were found to be forceful advocates of the use of GE technology in agriculture.

We hypothesise that our findings on the plant scientists' decreased reflexive capacity, and their outwardly political role, is a product of the long-term polarisation of the GM/GE debate, mediated by both their conceptual alignment with the linear model of innovation and their limited interactions outside of their field. Addressing their conceptual alignment, we found the interviewees' view of science as objective, value-free, separate from society, and leading to positive outcomes, in this polarised area, seems to extend to their views and expectations regarding GE technology, its governance, and the societal debate. Indeed, respondents stressed that the challenges and disadvantages associated with the application of GE technology in agriculture are actually downsides of the current (agricultural) system, or of the way in which the technology would be applied, rather than that of the technology itself. As the scientists themselves expect GE crops to have a positive effect on society, they deem this the 'logical' expectation, perceive their own position as objective, and consider the current GMO Directive as neither objective nor value-free, but rather as a product of misinformation and of (scientifically) uninformed policymakers and citizens. Perhaps not surprisingly, our respondents did not consider the GE crop debate to be value-based and failed to recognise the validity or legitimacy of viewpoints other than their own. Further intensifying this trend, the

traditionally limited interaction of plant scientists with social scientists and other actors restricts the broadening of their perspective. For a long time, plants scientists can be viewed as having been in a kind of echo chamber, broadly insulated from societal actors and wider perspectives, reflecting and reinforcing each other's opinions on the usefulness of GM/GE technology, the inconsistency of the EU regulations, and the, in their eyes, unjustifiably low societal trust in plant science. Given the perceived extent of ignorance in the current public and policy debate, there is little incentive to change this situation, and the key interactive role for the scientific community is seen as one of education: to assist understanding that the scientists' view on the necessity of GE crops is the right one. Considering that plant scientists outside of WUR have been observed to fulfil roles as advocates for GE technology as well (Stone, 2017; Svingen & Jahren, 2023; van der Ham et al., 2023), and given that the internalisation of the linear model appears a common trait amongst scientists across disciplinary boundaries (Åm et al., 2020; Sigl et al., 2020), our hypothesis is likely to be applicable to the broader plant science community.

The observed advocative role of the plant science community may have implications for the political and societal debate on the use of GE technology in agriculture. Namely, if strongly opinionated plant scientists do not see the debate as value-based, and plant scientists with nuanced views are hesitant to partake, other actors, including citizens, will mostly be exposed to strong advocates of GE technology who are not open to alternative perspectives. In this way, the plant science community may unwittingly intensify the polarisation within the GE debate by disregarding and discrediting alternative views and opinions. Given this observed role of plant scientists, an important question is whether policies based solely on scientific knowledge are desirable. The corona crisis demonstrated both the importance of scientific knowledge to inform policy and its limitations (Aarts et al., 2022). Epidemiologists can tell us how a virus will spread and how to counter it. However, a government cannot rely on this knowledge alone, as there are values important in society besides health, including economic values, but also social values, such as the need of teenagers to interact with peers and the feelings of loneliness of the elderly. Therefore, multiple perspectives need to be delineated and taken into account in the shaping of public policy. And it is precisely this weighing up of perspectives that is abandoned if we were to adhere solely to the views of our respondents. Policymakers need to include assessments of the socio-economic and ethical effects of the technology and need to hear multiple voices. Questions such as 'how are these GE crops going to contribute to the livelihoods of smallholder farmers?' and 'how are they going to change the landscape?' are legitimate questions. And when undermining the legitimacy of such questions and their answers, other actors will feel (rightfully) unheard and under-represented, which risks to only increase the polemic. Scientists that participate in the public debate can show their enthusiasm for the new techniques, but when aiming for democratic decision-making, trust, and depolarisation, we would recommend against narrowing the discussion to risks or calling the European regulations anti-scientific.

4.2 | A way forward

From our findings, we conclude that the apparent role of the plant science community within the GE crop debate, and their views on science-responsibility and science-society relations stem from a range of internalised understandings and structural factors that are persistent within the community. Based on this conclusion, and in line with authors before us, we argue that adapting structural factors is needed but likely insufficient in isolation (Åm et al., 2020). Namely, there is a need for more active dialogue between the natural and social sciences to facilitate the cultural reconfiguration of dominant science-responsibility models. During our interviews, we noticed that plant scientists who commonly and closely interact with social scientists were more nuanced in expressing their views, also when the conversation moved to the more controversial area of GE crops. Interdisciplinary dialogue and interaction offer the potential to open up the perspectives of plant scientists and possibly to better align them with prospective models of science-responsibility. More generally, interdisciplinary interactions that assist reflection on roles and responsibilities might benefit not only the plant science community but various other natural science communities as well. Vice versa, interaction with natural scientists could help social scientists to embed and develop these prospective frameworks within the specific day-to-day context of natural science communities. Reflexivity, in other words, cuts both ways. Indeed, the RRI framework has often been criticised for its vagueness regarding practical application (Schuijff & Dijkstra, 2020). Being embedded in a natural science context will help social scientists to develop such frameworks to be more specific and context-dependent and will therefore hopefully lead to more practically defined steps. Finally, and specifically within this polarised context, we found most of our interviewees to be reluctant to enter the GE crop debate because they did not see how to do so in a nuanced and, importantly, personally safe way. We believe that open interaction and collaboration with social scientists could specifically provide a way forward in such polarised contexts.

We propose three ways to instigate mutual learning between social scientists and communities of natural scientists. First, there are opportunities for knowledge institutes to facilitate the interaction and collaboration of their social and natural science departments by providing an encouraging institutional setting. At WUR, for example, there is currently a clear physical barrier in the housing of the social scientists and the campus that embraces the natural science chair groups and adjacent business communities. Moving the social science community closer physically, for example, by organising events and rewarding collaborations, would provide opportunities to facilitate better communication and mutual learning. Second, there are opportunities for funding agencies to facilitate innovative funding consortia. There is already a promising tendency, particularly pronounced in the Netherlands, to involve social scientists at an early stage of research projects via interdisciplinary consortia. For example, CropXR is a recent, partly nationally funded Dutch initiative in which plant scientists, computer scientists and social scientists collaboratively aim to drive innovation for sustainable agriculture (NWO, 2023). Social

scientists working alongside natural scientists can encourage reflexivity, while also practically developing the implementation and evaluation of prospective science-society models in context. Third, individual scientists and their departments have the agency to reach out and develop new initiatives for collaboration and mutual learning. Natural scientists can actively contact social scientists and vice versa. We advise social scientists involved in innovation governance to 'practice what they preach' and enter into conversation with natural scientists. This way, in dialogue, the roles and responsibilities of the scientific community might be reconfigured in an inclusive way.

AUTHOR CONTRIBUTIONS

Phil Macnaghten and Aisha M. So jointly planned the research, with support of Christa Testerink and Michelle G.J.L. Habets. Aisha M. So executed the data collection and analysis and took the lead in writing the paper. Phil Macnaghten, Michelle G.J.L. Habets and Christa Testerink substantially revised the paper.

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CONFLICT OF INTEREST STATEMENT

The authors declare no competing interest.

DATA AVAILABILITY STATEMENT

The textual data that support the findings of this study are available in anonymized form from the corresponding author upon specific request. Full transcript data can be shared only with informed consent of the interviewees. The data are not publicly available due to privacy or ethical restrictions.

ETHICS STATEMENT

The research took place following the Wageningen Code of Conduct for Research Integrity. The research sought informed consent from the interviewees with assurances of anonymity on the purposes of the study and on how the data would be used in practice.

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SUPPORTING INFORMATION

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