Rathenau Instituut

Editing under provision

Dutch citizens' views on new genomic techniques in food crops

Report

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Photography

Cover: visitors to the Hague market (Owen O'Brein/ANP Hollandse Hoogte)

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Preface

A tomato that not only gives you added vitamins, but lowers blood pressure and aids relaxation. An apple that does not discolour when you cut it into wedges. A suite of new genetic techniques have been developed in recent years that make it relatively easy to adjust the properties of crops. They are faster and cheaper than the older genetic modification techniques and, according to proponents, also safer.

But genetically modifying crops is not without controversy. In the 1990s it led to widespread social resistance, forcing the European Commission to develop strict regulation. As a consequence, hardly any genetically modified crops are cultivated in the European Union. The Commission will soon propose a new way to regulate the new techniques. Companies and scientists have clearly expressed their views on this. What citizens think is less prominent. With this report we seek to help change this.

It is often said that you cannot discuss these kinds of complicated subjects with citizens, that it is simply not possible to research people's opinions about issues they know little about. Indeed, a questionnaire with a representative sample of Dutch people will reveal very little of genuine use for policymakers. But our research shows that citizens are capable of forming a well-founded opinion about complicated topics. You approach the issue with care and talk to citizens in small groups, giving them explanations and information and space to develop their views and perspectives. This empowers them to work out what they think in conversation with each other. Through these dialogues with different groups, you gain insight into what society may think about a subject about which there is currently little discussion, but about which it may soon crackle.

We discussed the different viewpoints on the new genomic techniques in six focus groups with citizens from diverse backgrounds in the context of food and the food system. Although most citizens are not necessarily against these techniques, they doubt whether they will contribute to solving major social problems as the world food problem. Unanimously, they are not in favor of excluding these techniques from regulation.

This report therefore calls on national and European policymakers for a new way of developing governance and regulation, that includes open and honest dialogue with citizens and that ensures that governance is aligned with what citizens find important. This is necessary not only to gain broad societal support for the policy, but especially because it concerns the future of food for all of us.

Prof. dr. ir. Eefje Cuppen
Director Rathenau Instituut

Summary

Our global food system is in need of a transition towards one that is sustainable, fair, and healthy. With the Farm to Fork Strategy, the EU aims to accelerate this transition and ensure a competitive European agriculture. But what constitutes such a system? And which role can technology play? These are relevant questions, and pertinent to the current debate on what role new genomic techniques (NGT) should play in the European plant breeding sector.

The European Commission (EC) is preparing a policy initiative for plants (and food and feed derived from these plants) obtained by new genomic techniques (NGTs). These are techniques capable of changing the DNA of an organism, developed after 2001, when the existing GMO legislation was adopted. Currently, food crops developed with NGTs are subject to the EU Directive on the deliberate release into the environment of genetically modified organisms (GMOs). A study by the EC concluded that there are strong indications that this legislation is not fit for purpose for some NGTs and their products.

Two policy options for the EU dominate the debate on the use of NGTs plant breeding. One option is to exempt NGT crops from the GMO Directive, if and only if there is no foreign DNA present in the end product. The other policy option is to uphold the GMO Directive for NGT crops. Both options come with societal consequences and challenges. A third policy option is increasingly receiving attention. This option attempts to unify the benefits of both options and entails a less elaborate risk assessment for NGT crops with lower anticipated risks than currently is the case. Moreover, the use of NGTs would be allowed only under specific conditions, depending on the level of genetic intervention and on broader social and ethical considerations.

Currently, the debate on using NGTs in plant breeding is held almost exclusively among scientists, scientific and industry organisations, and companies in the agri-food field, as well as a small number of NGOs. However, in shaping a new policy on NGTs, it is important to include the voice of citizens, not only because biotechnologies have the power to redesign life, but also because they offer the potential to reshape the practice of agriculture and the future of our food (system). The way we produce food involves questions of how we want to live on this planet and how we want to relate to other species. For purposes of democracy, citizens need to have a say on which public values are incorporated in a new policy for NGTs.

Aim of the study

In this study, we have engaged with Dutch citizens from several layers of society in open, constructive dialogue using focus group discussions to explore their views on the use of NGTs and older genetic modification (GM) techniques in crops, the factors shaping these views, and the conditions they deem necessary to introduce NGT crops onto the European market, if introduced at all. For this, we employed an anticipatory method, to explore how concerns and responses emerge in structured interaction. The six focus groups were made up of five to eight participants, each professionally recruited. To ensure a diversity of perspectives, and provide a reflection of Dutch society, we selected individuals representing broadly the Dutch public in terms of age, educational background, socio-economic class, and gender. Our findings provide an insight into how the Dutch public is likely to respond when the proposal of the EC for a new regulatory framework for NGTs in plants becomes a public issue. This study therefore provides policymakers with a unique opportunity to understand and address public sensibilities towards the use of NGTs in crops, and to help develop democratic governance for NGTs in agricultural practice.

Findings

The attitudes of citizens in our focus groups towards the use of NGTs in crops diverge. Some believed these techniques will be necessary for dealing with current predicaments, like climate change, while others viewed the introduction of these techniques in practice as likely to aggravate current problems in agriculture and the food system. However, in general, citizens views converged towards reservation and hesitation about the use of NGTs and genetic modification in crops. Citizens raised doubts mainly about the plausibility that these crops will contribute meaningfully to the solving of our current societal challenges in the food system, and whether they are indeed the right approach for dealing with these challenges. They wondered if alternative solutions may be better, and how these may come with less unforeseen, long-term risks for human health and ecosystems. However, some participants expressed doubts whether alternatives are realistic, such as for example, in the fight against food shortage, eating less meat as a strategy to make agricultural land available for food instead of feed. Moreover, the citizens in our study questioned whether companies will in practice develop valuable varieties for society, as the logics of the corporate world tend to be focused on capital accumulation and on making profits.

Citizens in our study were unanimous in their view that regulation of NGT crops is necessary for diverse reasons: to prevent harms to the environment and human health, to give consumers freedom of choice, to guard against the potential of the technology to increase inequalities, and to ensure that the technology is directed towards contributing to solutions to societal problems. The latter is viewed as an important pre-condition for the introduction of NGT products onto the marketplace.

According to citizens, NGTs should not be developed purely for commercial motives driven by the logic of the market. There needs to be a clear societal purpose for their introduction. In terms of policy, this would necessitate a case-by-case assessment of NGT crops for broader considerations such as purpose, and value to society.

Values underlying citizen's views

The views of citizens are shaped by underlying values that include those of safety, naturalness, justice, well-being, and feelings of unease about the pursuit of perfection and efficiency in our food system. Besides these underlying values, the context of the climate crisis, the corona crisis, and the nitrogen crisis also are formative of opinions. For citizens, there remains an underlying concern that the application of the technology is likely to exacerbate certain ongoing and unwelcome trends and developments in society, such as the increasingly unequal global food system and the concentration of power in large corporations. Economic and commercial purposes are by many dismissed as sufficient justification for introducing NGTs in plant breeding practices.

Recommendations for public engagement

The key message that emerges from our research is that it is essential for the European Commission and national governments to increase their efforts to engage in regular and continuous open constructive dialogue with citizens about the upcoming EC policy initiative, and in subsequent discussions on the use of NGTs in crops and on alternatives.

The reasons for this are fourfold. First, changes to regulation are of public importance because biotechnologies have the potential to impact society, redesign life, and reshape the practice of agriculture and the future of our food system. Citizens therefore have a key interest to be involved in decision-making processes. Second, when citizens are involved in the development of a new policy, and public values are taken onboard, the chance of broad societal support becomes higher. Third, we have learned from our research that the views of Dutch citizens converge on the need for regulation of NGTs in agriculture, and that these views stand in direct contrast with the current dominant frame in the debate. Fourth, we have learned that Dutch citizens in our study emphasize the importance of transparency and of the governments duty to inform the public.

Based on our findings and building on previous research carried out by the Rathenau Instituut and by co-author Phil Macnaghten, we provide policymakers with three recommendations on public engagement.

Recommendation 1

Take into account cultural, ethical, and socio-economic considerations in policy discussions on the use of NGTs in crops. Investigate with all relevant parties, including the public, what broader concerns and interests merit a place on the public agenda.

To develop a new democratic policy on NGT crops, and to gain public trust in the process, it is important to avoid strategies that seek to convince the public of their importance or necessity. Citizens should be included in decision-making, not merely informed about upcoming technologies. It is important to provide space for citizens for deliberation on the dominant framings of the technology, and engagement with the broader considerations and the underlying values seen as important to citizens. When discussing NGTs in food and an upcoming change in regulation, citizens in our focus groups express concern about safety, increased corporate control, increased inequality in the food system, and a loss of consumer choice. These wider citizen considerations need to be taken seriously; citizens' concerns need to be embraced in decision-making processes.

Recommendation 2

Build a relationship of trust with citizens by being open about the uncertain impacts of NGTs on society, both positive and negative. Discuss the alternatives available as well as the possible unfair distribution of benefits among parties in the agrifood system.

Trust in institutions is critical for the acceptance of a technology. Fully informing and entering into dialogue with citizens, including on matters of context, uncertainties, challenges, and alternative options for policy, are the most effective ways to respond to distrust. For NGTs specifically, this entails policymakers and scientists to be open about (the potential of) the technology to solve as well to aggravate current societal challenges, including issues associated with the patentability of NGT crops. This also means that scientists and policymakers avoid the exceptionalism that commonly attaches to discussions on NGTs by acknowledging that a sustainable agriculture system can be achieved by alternative methods. But more important than the practical reason of gaining societal support, is the prerogative that the regulation of technologies is democratically formed. This is only possible when all stakeholders, including citizens, are viewed as serious discussion partners.

Recommendation 3

Communicate openly the scientific uncertainties on the use of NGTs in crops in public engagement initiatives.

The need for honest communication extends to the communication of current uncertainties and gaps in scientific knowledge. The scope and significance of the current state of scientific uncertainties is sometimes downplayed to prevent unrest. However, this tactic may prove counter-productive, especially in cases where long-term safety is impossible to prove, as is currently the case for gene editing. Being open and communicating scientific uncertainties allows citizens to formulate a well-balanced informed opinion and is more likely to instill trust.

Recommendations for policy options

We also provide policymakers with four recommendations on ways to translate the views and underlying values of citizens towards gene editing in crops into a new policy approach for NGTs in food.

Recommendation 1

Avoid the proposal of exempting NGTs from the current GMO Directive, but instead develop a differentiated, or level-based, policy approach.

Similar to other studies, citizens in our focus groups are unanimous in their view that NGTs needs to be regulated. Even with a formal risk assessment, the citizens we have spoken with are not keen on the introduction of NGT foods to the market. If the EC were to exempt NGTs from the GMO Directive, they would also be exempt from an environmental risk assessment and monitoring obligations, which assess the immediate and long-term effects of a GM crop on public health and the environment. Citizens in our study are unanimous in their view that an assessment for risks to human health and the environment should be a requirement prior for market approval.

In a previous report, we offered a way forward to modernize the current biotechnology policy with a level-based, or differentiated, approval policy. Such an approach would offer different levels of intensity or strictness of regulation with various levels of risk assessment. This approach would take into account the differences in expected risks associated with different ways in which the new genomic techniques can be used *in practice*. The assumed risks would determine the strictness and speed of the risk assessment procedure. Most citizens in our focus groups are open to such differentiation in risk assessment between crops altered with older genetic modification techniques and NGTs.

Recommendation 2

Move from a consumer-oriented to a society-oriented governance regime that incorporates ethical, cultural and socio-economic considerations into the market authorisation process.

Citizens in our focus groups expressed the view that assessing the goal of a specific innovation, its contribution to societal challenges, and the desirability of using the technology as a solution to these challenges, were important considerations for governance. Only within a broader assessment framework can these be taken into account. It is therefore important that policymakers think beyond a consideration of risks and economic benefits, seen as important for *consumers*, towards a focus on the ethical, cultural, and socio-economic aspects that *citizens* find important. By means of a case-by-case assessment of ethical, cultural and socio-economic considerations, public values can be brought into the design and selection of NGT crops for market authorisation. A policy initiative should thus combine a differentiation in risks assessment with an assessment of broader considerations, on a case-by-case basis.

Recommendation 3

Ensure that the ethical, cultural, and socio-economic aspects of NGT crops are assessed by an independent EU body.

An independent committee could be established with the dual tasks of developing broader democratic assessment criteria, and with assessing on a case-by-case basis market approvals of crops modified with NGTs. Such an authority could be founded in the European Union, or on a national level. In the latter scenario, member states can identify their own relevant cultural, ethical and societal considerations. Citizens in our study indicate that they would trust the formal assessment of risks and of broader considerations if they are performed by independent institutes. Nevertheless, outstanding questions remain on who decides what is ethical and valuable to society and what it entails for a crop to be sustainable.

Recommendation 4

Preserve the freedom of choice of citizens by maintaining the requirement to label GM food, including NGT food.

The citizens we spoke with in our focus group discussions emphasize the need for freedom of choice for citizens, and conclude that the labelling of NGT products is

required. If the EC were to exempt NGTs from the GMO Directive, citizens would not be given the freedom of choice not to buy NGT foods, nor would there be a free market, as citizens cannot express their preferences through purchasing behavior.

Concluding remark

The EU is currently looking for ways to transition towards a sustainable food system. NGTs are seen as having the potential to contribute to this transition. Citizens, however, are cautious, mainly because they seem to assess the new technology not by its potential power, but instead by the circumstances seen as likely to determine how the technology emerges and the interests shaping its use. Moreover, citizens are interested in alternative approaches and opportunity costs, and consider justice and fairness in the food system to be important guiding criteria. Citizens demonstrate an awareness of the entanglement of technologies with politics and the food system. We believe that the political debate on the role of NGTs and the upcoming regulatory change would benefit if policymakers make this entanglement explicit. This is necessary to help ensure a mature discussion on what role we want technology to play in a future agricultural and food system.

Contents

Introduction

Currently our global food system is in need of a transition towards a sustainable, fair, and healthy system. Effective interventions are urgently needed, especially as growing wealth, globalization, and a rapidly growing population are contributing to the further deterioration of natural resources as well as providing challenges for food security and nutrition worldwide.[1] Dealing with a multitude of factors which include the depletion of fish stocks, decreases in biodiversity, land degradation, and greenhouse gas emissions that contribute to climate change, constitutes one of our most pressing grand societal challenges.[2] For the European Union, the Farm to Fork Strategy lies at the heart of the European Green Deal. It aims to accelerate the transition to a sustainable, resilient, and competitive European agriculture.[3]

But what constitutes as a sustainable, healthy, and fair food system? And which role does technology play in this transition? The agri-food sector petitions European policymakers to make necessary legislative changes and to give financial support to enable innovation to drive the targets of the Farm-to-Fork strategy. In their view innovations, like smart technologies, digital transformation, but also biotechnologies like new genomic techniques (NGT) and genetic improvement of farmed animals, are key to the sustainable transition outlined by the Farm to Fork Strategy.[4] Others believe the EU should focus foremost on a transition from industrial agriculture to diversified agro-ecological systems, [5] including nature-inclusive circular agriculture.

These different views as what constitutes a sustainable food system and what role technologies can play, are also important in the current debate in Europe on what role new genomic techniques (NGT) should play in the plant breeding sector in Europe. According to the European Commission (EC), plants modified with NGTs have the potential to contribute to a more resilient and sustainable agri-food system. The EC is in the process of preparing a policy initiative for plants (and food and feed derived from these plants) obtained by new genomic techniques, in particular by targeted mutagenesis and cisgenesis.[6] Currently, these plants are

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[1] The Food and Agriculture Organization (FAO) (2018). *Sustainable food systems Concept and framework*. Brief.

[2] UNEP (2016). *Food Systems and Natural Resources*. A Report of the Working Group on Food Systems of the International Resource Panel. Westhoek, H. *et al*.

[3] https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en

[4] https://fefana.org/info-centre/press-releases/farm-to-fork-strategy-how-to-reach-targets/

[5] International Panel of Experts on Sustainable Food Systems (IPES-Food) (2016). From uniformity to diversity: A paradigm shift from industrial agriculture to diversified agroecological systems.

[6] Ares(2020)1117880 – 21/02/2020; https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13119-Legislation-for-plants-produced-by-certain-new-genomic-techniques_en: "*In targeted mutagenesis, mutation(s) are induced in selected target locations of the genome without insertion of genetic material. In cisgenesis, genetic material (e.g. a gene) is inserted into a recipient organism from a donor organism with which the recipient is sexually compatible (crossable) in nature, e.g. a gene from a wild potato indo a domesticated potato*"

subject to the Directive on the deliberate release into the environment of GMOs (Directive 2001/18/EC) (see Appendix 1 for a brief explanation of the current regulation for new plant varieties developed with traditional breeding techniques and developed with genetic modification techniques).

In a previous report, we examined the debate in the EU on the future regulation of crops obtained by NGTs.[7] We found that two opposing policy options dominate the debate. Some stakeholders, such as environmental NGOs, the organic sector, and several scientists argue that the EU Directive should not be amended, and therefore that the NGTs should be regulated in the equivalent manner as the older genetic modification techniques. [8] Others, mainly agrochemical and plant-breeding companies, biotech companies, interest groups, and some research institutes, argue for an exemption of NGTs from the GMO Directive as is currently already the case for classical mutagenesis, a genetic modification technique that uses radiation to induce genetic changes in crops (see Appendix 2). A third option, less prominent in the debate, advocates a level-based policy approach for all genetically modified organisms, including crops developed using NGTs. This policy option takes into account a diversity in risks as well as broader societal and ethical considerations. The assumed risks dictate the strictness and speed of the risk assessment procedure. Several levels of risks assessments exists.

Public engagement is lacking in the development of new regulation for NGTs

At the moment, the debate on using NGTs in crop breeding is held almost exclusively among scientists, organisational actors, and companies in the agri-food field, as well as a small number of NGOs. Numerous stakeholder engagements have taken place in the last several years,[9] however, very few public engagement opportunities were provided for citizens (see Appendix 3). When shaping a new policy on NGTs, it is important to include the voice of citizens, because biotechnologies not only redesign life, but they can also reshape the practice of agriculture and the future of our food (system). The mechanization of agriculture in the past, has for example led to the takeover of small-scale farmers by large

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[7] Habets, M., L. van Hove and R. van Est (2019). *Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations*. The Hague: Rathenau Instituut

[8] ENSSER (2017). *Statement on New Genetic Modification Techniques. Products of new genetic modification techniques should be strictly regulated as GMOs*.

[9] https://food.ec.europa.eu/plants/genetically-modified-organisms/new-techniques-biotechnology/ec-study-new-genomic-techniques/stakeholders-consultation_en#about-the-consultations; Panel for the Future of Science and Technology (STOA). (2021) *Regulating genome editing: Societal hopes and fears*. Brussels, European Union; Bureau KLB (2017) *De stand van de gedachtewisseling over modernisering van het biotechnologiebeleid*; several stakeholders meetings have been organized by the Dutch Ministry of Infrastructure and Water management between 2017 and 2022; there is a council group Biotechnology consisting of stakeholders that have been meeting for several years, organized by the Ministry of Infrastructure and Watermanagement. Moreover, organisation like the COGEM, EPSO, and Plantum, as well as academic groups, have organized stakeholder events in the Netherlands.

farming businesses, while the development of biotechnologies such as genetically modified seeds and biotech enzymes have contributed to the transfer of power and control from farmers to other actors, like suppliers, processors and distributors.[10]

(Bio)technologies are intrinsically political, and how they are regulated and under what conditions they can enter the market place, requires more than mere scientific knowledge on the technology. Considering that the outcome of the debate will be formative in shaping our future agricultural and food system, the Rathenau Instituut believes that a broader societal debate is crucial in order to develop democratic policy. Citizens should have a voice, not to legitimize the introduction of technologies, but to assist policymakers in developing regulation that influence the future of our food system. Therefore, we have engaged with Dutch citizens from several layers of society in open, constructive dialogues on this topic.

Aim of this study

The aim of the project is to examine the views of Dutch citizens on the use of NGTs and older genetic modification techniques in food crops, to investigate what factors shape these views, and explore their views on the conditions they deem necessary to introduce NGT crops on the European market, if introduced at all. We employed an anticipatory focus method designed to examine how views on a new technology, not being used yet in societal practice, emerge and how these become elaborated in structured social interaction.

This study was not designed to inform or influence the public, or to examine people's perceptions as *consumers*; rather, it is their role as citizens that shapes this particular study. This is important, as we would like to provide policymakers with knowledge on the shared commitments and concern of citizens. Identifying citizens as consumers, is simplifying and reducing the complex and diverse identities of citizens.[11]

Rationale of this study

Engaging in open constructive conversations with citizens is important because it gives the public a voice in how we shape the future of agriculture and of our food production. Views on the way we produce food involves questions of how we want to live on this planet and how we want to relate to other species. Moreover, technological innovation in our current knowledge economy has significant power in influencing the development of norms and social relationships. As Sheila Jasanoff

[10] Ruivenkamp, G. en J. Jongerden (2013). From Prescription to Reconstruction: Opportunities for Subpolitical Choices in Biotechnological and Genomics Research. In: Derkx, P. and Kunneman, H. (eds) *Genomics and Democracy: Towards a Lingua Democratica for the Public Debate on Genomics*. Rodopi.

[11] Kan, S. (2022). *More than consumers: Post-Neoliveral identities and Economic Governance*. Roosevelt Institute.

aptly states: "*Our inventions change the world, and the reinvented world changes us."* [12] Genetically modified crops have indeed transformed agricultural systems. It is therefore necessary to examine how citizens can have a say in which public values will be incorporated into a new regulation for NGTs.

The results of this study will give an insight in how the Dutch public may respond when the proposal of the EC for a new regulatory framework for NGTs in plants becomes a public issue. The EC will publish its new regulatory proposal in the second quartile of 2023. This study provides policy makers with the opportunity to understand and address public sensibilities towards the use of gene editing in crops, and to help them develop democratic governance for NGTs in agricultural practice.

Central questions in the project

The report will answer the following questions.

- What are current attitudes of Dutch citizens towards crops modified by the older genetic modification techniques.
- Do Dutch citizens view crops modified by gene editing techniques as substantially different from those modified by the older genetic modification techniques?
- What are citizens' concerns and hopes on gene edited crops and food, and what factors underpin these?
- What governance does the public see fit for gene edited crops?

Reader's guide

In Chapter 1, we give the background and an overview of the current EU debate on the future regulation of crops modified with NGTs. We also underline the importance of including citizens in developing new policy on NGTs. And we briefly describe previous studies in the Netherlands that have engaged with citizens. In Chapter 2, we describe the design and set up of the method of focus groups. Chapter 3 describes the main findings of the discussions among citizens. Chapter 4 interprets these findings, and provides answers to the research questions. In the concluding chapter 5, we draw out some implications of our findings to provide recommendations for further public engagement and communication, and to provide recommendations for the EC to draw up a new regulatory framework for NGTs.

[12] Jasanoff, S. (2017). *The Ethics of Invention: Technology and the Human Future.* Norton: New York, page 1.

1 Background

The proposed introduction of genetically modified (GM) crops and foods in the late 1990s precipitated acute scientific and public controversy across Europe. Concerns centered on risks to human health and the environment, doubts about its value for society, objections to tampering with nature, and disquiet about the concentration of power in large, global agrochemical and plant breeding companies.

To mitigate public concerns, exercise precaution on potential risks to public health and the environment, and harmonize the legislation of member states, the European Union introduced several directives and regulatory measures designed to control the import and cultivation of genetically modified organisms (GMO) (see Appendix 1). From 2001, GM crops subjected to these regulations were now required to be assessed for direct, indirect and cumulative (immediate and long-term) effects on public health and the environment. In addition, GM food and feed needed to be monitored, traceable and labelled, with the aim of informing consumers and other actors.

A consequence of the European policy is that applying for a license to cultivate GM crops has become both time-consuming and expensive for breeding companies. Indeed, while worldwide there has been steady growth in the area covered by GM crops, there are only two EU countries where GM crops are grown, Portugal and Spain. In this context, various companies, scientists, and their respective associations have been active in advocating for a revision of current regulations. During the last two decades, this push to amend the GMO regulation has become stronger, precipitated in recent years by the development of new genomic techniques (NGTs), and more specifically following the development of CRISPR-Cas9.

The European Commission (EC) refers to NGTs as “techniques capable to change the genetic material of an organism and that have emerged or have been developed since 2001, when the existing GMO legislation was adopted”.[13] These technologies have accelerated developments in the genetic modification of plants, especially because NGTs (among which CRISPR-Cas9) offer the capacity to change the genome in ways that in the laboratory are faster, more accurate and less expensive. More so than ever, there is currently the fear expressed chiefly by corporate and scientific actors that Europe will lag behind and lose its competitive

[13] EC. COMMISSION STAFF WORKING DOCUMENT (2021). Study on the status of new genomic techniques under Union law and in light of the Court of Justice ruling in Case C-528/16.

edge in the plant breeding (research and development) field due to the restrictive policy in Europe on GMOs. There has therefore been a strong push to exempt these NGTs from the European GMO Directive.

1.1 Ruling of the European Court of Justice

Most arguments for an exemption of NGTs from the GMO Directive rest on the claim that these techniques are able to make small, targeted changes to the genome of plants in the laboratory (also referred to as targeted mutagenesis). In principle, these mutations could have been achieved by conventional breeding or classical mutagenesis[14], and the changes in the plants' genome do not have to contain any foreign DNA – although these techniques still can be used to introduce foreign DNA in the genome of plants. Many scientists and breeding companies therefore see these techniques as fundamentally different from the class of older genetic modification techniques that were designed to introduce foreign DNA into the genome of cells. Moreover, advocates of NGTs argue that the risks of some of these new genomic techniques are similar to traditional breeding and smaller than those of classical mutagenesis methods.[15] The European Food and Safety Authority (EFSA) concluded that *in some cases*, plants produced by gene editing do not pose new hazards compared to plants produced with classical mutagenesis or conventional breeding techniques.[16] Because the latter are exempt from the GMO Directive, the new genomic techniques should also be exempt when they do not introduce foreign DNA into the genome of plants, in the view of many stakeholders. However, in 2018, the European Court of Justice ruled that only classical mutagenesis methods that have been used for several decades without creating identified risks for the environment or health, are exempt (Appendix 1). For this reason, the court clarified that all NGT-products (irrespective of the presence of foreign DNA) are subject to the GMO Directive. Although this clarification settled the discussion on the current legal status of these new techniques, it has not settled the debate.

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[14] Classical mutagenesis is a method that uses physical radiation or chemical means to induce spontaneous genetic variation in plants to develop new crop varieties.

[15] Euroseeds (2019). position paper. *Plant Breeding Innovation Applying the latest Plant Breeding Methods for the benefit of sustainable Agriculture, Consumers and Society*; EPSO (2021). Statement. *EC roadmap regarding the legislation for plants produced by new genomic techniques (NGTs)*; Plantum (2019). Notitie. *Plantum-visie genome editing*; EuropaBio (2021). *EuropaBio response to the inception impact assessment for legislation for plants produced from certain new genomic techniques*; EU-SAGE (2021). The European Sustainable Agriculture through Genome Editing (EU-SAGE) network, representing scientists at 134 European Plant Science Centres welcomes the study of the European Commission on new genomic techniques. https://eu-sage.eu/sites/default/ files/2021-05/EU-SAGE_response_EU_study.pdf

[16] EFSA Panel on Genetically Modified Organisms (2022). Criteria for risk assessment of plants produced by targeted mutagenesis, cisgenesis and intragenesis. *EFSA Journal*, 10, e07618.

1.2 Amending the European GMO legislation

In light of the court's judgement, the European Council asked the European Commission to undertake a study concerning the status of NGTs under Union law. The Commission was also requested by the European Council, if it was deemed appropriate in view of the outcome of this study, to prepare a policy initiative for plants (and food and feed derived from these plants) obtained by targeted mutagenesis and cisgenesis, accompanied by an impact assessment.[17] Cisgenesis refers to a particular kind of genetic modification, where only genes from closely related species are introduced (Box 1).

Box 1 **Targeted mutagenesis, cisgenesis and transgenesis**

Targeted mutagenesis, cisgenesis and transgenesis do not refer to specific techniques but to the kind of genetic change introduced in the genome of a plant.

- Targeted mutagenesis is an umbrella term and refers to modifying the genetic material of an organisms by specific mutation(s) in selected (target) locations of the genome. No foreign DNA is inserted in the genome. Targeted mutagenesis (or gene editing) can only be achieved by NGTs. CRISPR-Cas is a NGT.
- Cisgenesis refers to modifying the genetic material of an organism with DNA from the same, or a closely related, species.
- Transgenesis refers to modifying the genetic material of an organism with unrelated DNA.

The term cisgenesis had been introduced to distinguish genetic modification using genes of the modified species itself from genetic modification where foreign genes are introduced (transgenesis).[18] In our study, we focus solely on targeted mutagenesis, which we will also refer to as "gene editing", because we used the term gene editing in our engagement with citizens. The concepts "gene editing"

[17] Ares(2020)1117880 – 21/02/2020; https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13119-Legislation-for-plants-produced-by-certain-new-genomic-techniques_en: "*In targeted mutagenesis, mutation(s) are induced in selected target locations of the genome without insertion of genetic material. In cisgenesis, genetic material (e.g. a gene) is inserted into a recipient organism from a donor organism with which the recipient is sexually compatible (crossable) in nature, e.g. a gene from a wild potato into a domesticated potato*"

[18] Schouten, H. (2022). The Origin of Cisgenesis, and Its Evolving Definition. In: A. Chaurasia and C. Kole *Cisgenic Crops: Potential and Prospects*. Springer Nature.

and “targeted mutagenesis” are used interchangeable in the debate: they refer to a kind of genetic change (and thus not to a specific technique) in the genome of an organism, namely, a change where no foreign DNA is inserted in the genome (see Box 1 and 2).

Box 2 **The use of concepts in the societal and political debate**

In contrast to older genetic modification techniques (recombinant-DNA techniques), it is possible for CRISPR-Cas9 to make small, targeted changes to the genome in the laboratory without inserting foreign DNA in the genome. Therefore, this technique was initially referred to as “gene editing” or (interchangeable) “genome editing” as the process is similar to substituting letters in a word of a large text.[19]

As often happens when new technologies are introduced, the new concept emphasizes the innovative nature of the technology, and distinguishes it from the older recombinant-DNA technology. Earlier developed engineered nucleases, such as TALENS and Zinc-Fingers, were retrospectively also referred to as (first-generation) gene-editing techniques. However, opponents often highlight the risks and uncertainties of innovative technologies, upon which supporters react by downplaying the novelty of the new technique and highlighting the similarities of the new techniques with existing ones.[20]

A similar change was seen in the discussion on gene editing. Some proponents have reacted by calling gene editing techniques, New Breeding Techniques, to emphasize their similarity with traditional breeding. After the clarification of the European Court of Justice ruling that gene editing techniques are genetic modification techniques, proponents started referring to these techniques as targeted mutagenesis, emphasizing their similarity to mutagenesis, a conventional genetic modification technique that is exempt from the GMO-Directive. This “older” form of mutagenesis is now called classical mutagenesis or random mutagenesis.

The EC study confirmed that the current regulatory system poses implementation and enforcement challenges in the EU relating to NGT-products.[21] The European

[19] Engineered nucleases, such as TALENS and Zinc-Fingers, which were developed earlier than CRISPR-Cas9, were referred to as first-generation gene-editing retrospectively.
[20] Swierstra, T. and A. Rip (2007). Nano-ethics as NEST-ethics: Patterns of Moral Argumentation About New and Emerging Science and Technology. *Nanoethics* 1, 3-20.
[22] Ref. Ares(2021)5835503 - 24/09/2021

Commission also concluded that plants modified with NGTs have the potential to contribute to a more resilient and sustainable agri-food system by, for example, developing plants resistant to diseases, plants adapted to changing environmental conditions, plants with a reduced need for agricultural inputs or plants with 'improved' nutritional traits. The European Commission is thus in the process of preparing a policy initiative. A new policy will aim at "an appropriate regulatory oversight for the concerned plant products, ensuring a high level of protection of human and animal health and the environment, and enabling innovation and the contribution of safe NGTs to the objectives of the European Green Deal and the Farm to Fork Strategy".[22] The objectives of this initiative are to ensure that NGTs plants are placed on the market provided they are safe for health and the environment; to ensure that legislation takes into account whether the plants and their products contribute to sustainability; to enhance the competitiveness of the Agri-food sector; and to ensure the effective functioning of the internal market. The policy initiative will be supported with an assessment of likely economic impacts, likely social and environmental impacts, fundamental rights (e.g. how it will influence freedom to conduct business for the organic sector), and likely impacts on simplification and/or administrative burden (e.g. reduce current costs and administrative burden).

Exempting NGTs from the GMO regulation

Changing the regulatory framework by exempting NGTs from the EU GMO Directive would be in line with the wishes of many scientists, agrochemical and breeding companies (and their associations), as well as biotech companies (and their associations).[23] These actors have been arguing that applying for a license to cultivate NGT derived crops in Europe is now both time-consuming and expensive. They claim that due to the current restrictive policy, Europe will lag behind and lose its competitive edge in the plant breeding (research and development) field.[24] At the moment, the EU is still a world leader in seed trade.[25] Organisations including the

[22] Ref. Ares(2021)5835503 - 24/09/2021

[23] Euroseeds (2019). position paper. *Plant Breeding Innovation Applying the latest Plant Breeding Methods for the benefit of sustainable Agriculture, Consumers and Society*; EPSO (2021). *Statement. EC roadmap regarding the legislation for plants produced by new genomic techniques (NGTs)*; Plantum (2019). *Notitie. Plantum-visie genome editing*; EuropaBio (2021) *EuropaBio response to the inception impact assessment for legislation for plants produced from certain new genomic techniques*; EU-SAGE (2021). The European Sustainable Agriculture through Genome Editing (EU-SAGE) network, representing scientists at 134 European Plant Science Centres welcomes the study of the European Commission on new genomic techniques. https://eu-sage.eu/sites/default/ files/2021-05/EU-SAGE_response_EU_study.pdf; HollandBio. (2022) *Position paper rondetafelgesprek CRISPR-Cas*; https://euroseeds.eu/app/uploads/2022/11/22.0786-final-joint-Letter-NGTs-14-11-2022.pdf

[24] Michalopoulos. S. (2018). Industry shocked by EU Court decision to put gene editing technique under GM law. Euractiv. https://www.euractiv.com/section/agriculture-food/news/industry-shocked-by-eu-court-decision-to-put-gene-editing-technique-under-gm-law/

[25] https://euroseeds.eu/subjects/seed-trade/#:~:text=The%20European%20seed%20sector%20is,for%20commercial%20and%20research%20purposes.

COGEM and the Health Council of the Netherlands consider it a possibility that commercial and research activities will disappear from Europe if the EC does not amend the directive.[26] Moreover, it is the costly and burdensome licensing procedure and market authorisation in Europe which is in part responsible for the concentration of biotechnology amongst a small group of large multinational companies, according to proponents of an exemption.[27] Due to the lower costs, and the simplicity of use of these technologies, especially CRISPR-Cas, start-ups and small- and medium-sized enterprises (SME) would also have the opportunity to develop and distribute new plant varieties, but only if the GMO regulation is changed. Changing the regulation will thus facilitate in the view of certain actors the availability of NGT to small players, which they refer to as “democratization” of agricultural biotechnologies.[28]

Proponents of NGTs also argue that only if NGTs are exempt from the GMO regulation, will Europe be able to use NGTs to improve plants and crops to contribute to a more resilient and sustainable agri-food system, as well as contributing to the growing demand for food globally. They therefore have been pleading for an exemption of NGT-plants from the GMO regulatory framework.

Opposing an exemption for NGTs

Various civil society organisations, scientists, NGOs and organic farmers have been developing the position that NGTs are not the solution to current societal challenges such as climate change, biodiversity loss and food security.[29] In order to transition to a more resilient, sustainable, fair food system, agricultural *practices* need changing to various nature-inclusive, ecologically, and economically sustainable agricultural practices, in their view. They argue that biotechnology will mainly be

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[26] COGEM and Health Council of the Netherlands. (2016). *Trendanalyse biotechnologie 2016, Regelgeving ontregeld.* Bilthoven.

[27] Bain, C., Lindberg, S. and S. Theresa (2020). Emerging sociotechnical imaginaries for gene edited crops for foods in the United States: implications for governance. *Agriculture and Human Values*, 37, 265-279.10.1007/s10460-019-09980-9; although this concentration of biotech among a few multinationals has taken place outside of Europe, and thus outside of the burdensome licensing procedure.

[28] Bain, C., Lindberg, S. and S. Theresa (2020). Emerging sociotechnical imaginaries for gene edited crops for foods in the United States: implications for governance. *Agriculture and Human Values*, 37, 1-15. 10.1007/s10460-019-09980-9

[29] *Open letter to the Commission on new genetic engineering methods* (2015). http://www.greenpeace.org/euunit/Global/eu-unit/reportsbriefings/2015/20150127%20Open%20Letter%20on%20new%20GM%20technologies.pdf; 1 ENSSER (2017). *Statement on New Genetic Modification Techniques. Products of new genetic modification techniques should be strictly regulated as GMOs*. https://ensser.org/topics/increasing-public-information/ngmtstatement/; IFOAM Organics International (2016). *Genetic Engineering and Genetically Modified Organisms. Position paper*; https://www.saveourseeds.org/en.html; TestBiotech. (2021). *New GE and food plants: The disruptive impact of patents on breeders, food production and society*; The Greens/EFA (2022). *Public consultation on new genetic modification technique. Greens/efa response to the commission;* Greenpeace (2021). *Danger Ahead. Why gene editing is not the answer to the EU’s environmental challenges*; https://www.gmwatch.org/en/

used to sustain the older, non-sustainable system of maximizing yield at lowest costs.[30]

Moreover, these parties claim that the long-term safety of NGT plants for public health and the environment has not (yet) been demonstrated as these techniques have only been used in the laboratory for a couple of years and have hardly been used in cultivation. In addition, they argue that NGTs are able to produce a broad range of novel traits that have not been possible using conventional breeding techniques so far.[31]

Parties opposing an exemption of NGTs from the GMO Directive, therefore appeal to the precautionary principle, which ensures that policy makers can adopt decisions in situations of scientific uncertainty. In EU regulatory practice, the precautionary principle should ensure a high level of proactive protection of human health and the environment. In the view of opponents of an exemption, application of the precautionary principle necessitates an ongoing programme of assessment of NGT products for risks to human health and the environment. Whereas, if NGTs are exempted from the GMO Directive this would have the effect that these new plant varieties would no longer be required to be submitted to a risk assessment, as is currently also the case for crops produced with traditional breeding methods or random mutagenesis (see Appendix 1). Nor would there be a freedom of choice for farmers or consumers to avoid buying NGT products.[32]

These actors further fear an increase in the concentration of power in global agrochemical and plant breeding companies. The use of NGTs in agricultural crops on a wider scale are seen as likely to result in a larger number of patent-protected crops.[33] In patent law, the inventors have exclusive rights to exploit the crops. Others may be allowed to use a patent-protected variety as the basis for further breeding, if they buy an (expensive) license. This is in contrast to the current non-GMO varieties that are protected by plant breeders' rights (also called plant varieties rights). They give the holder the exclusive right to trade seed and propagation material, but allow other breeders and farmers to use this new variety for further breeding. This is referred to as the breeders' exemption. Actors opposing an exemption, warn against a rise of patented NGT crops, as it will lead to a decrease in crops with plant breeders' rights. Farmers and small breeders in low

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[30] IUCN-NL Natuur en milieufederatie Noord-Holland (MNH) Natuur & Milieu (2022). *Biotechnologie in breder perspectief. Een inventarisatie van de posities van Nederlandse natuur- en milieuorganisaties ten aanzien van biotechnologie.*

[31] Kawall, K., Cotter, J. and C. Then (2020). Broadening the GMO risk assessment in the EU for genome editing technologies in agriculture. *Environ Sci Eur,* 32, 106. https://doi.org/10.1186/s12302-020-00361-2

[32] https://beyond-gm.org/gene-editing-just-label-it/

[33] Panel for the Future of Science and Technology (STOA) (2022*). Genome-edited crops and 21st century food system challenges*. Brussels, European Union

income countries will therefore be confronted with a decrease in number of crops that can be used for further adaptation to local needs. Moreover, some are worried that “money will seep away from farmers and consumers in poor countries and converge with investment funds in Europe and the US. It is biotechnological neo-colonialism.”[34] The first few NGTs on the market are indeed patent-protected (see Box 3).

Box 3 **First products developed with NGTs on the market**

The Japanese company Sanatech Seed sells a variety of tomatoes containing high amounts of gamma aminobutyric acid (GABA), the first CRISPR edited crop on the market- although due to patent issues, this tomato is sold only to Japan’s home gardeners and not (yet) to big farms or companies. According to the company, eating these tomatoes may help reduce blood pressure and promote relaxation, although there is no scientific evidence for it so far.

Another NGT product on the market is the Arctic apple, which is genetically modified to prevent the flesh of the apple from browning when exposed to air. The company OSF owns an exclusive worldwide license for this enzymatic browning technology to use in tree fruits. This apple is sold only in slices in plastic bags. The apple is produced by a process called RNA-interference (iRNA): the enzyme that drives oxidation was genetically modified by inserting a suppression gene sequence into the DNA.

The first commercial gene edited crop on the market (modified with TALEN) is a high-oleic soybean variety produced by the United States-based company Calyxt. In this soybean, two genes involved in fatty-acid synthesis are targeted, leading to oil with a reduced content of fatty acids. This patented soybean is cultivated in the United States and sold in the U.S. and Canada.

A third policy option

Some Dutch nature and environmental organisations oppose any amendment to the GMO Directive, while others are in favor of a new, differentiated policy. Such a differentiated policy would uphold a risk assessment for NGTs, albeit less strict, and would be accompanied by a broader societal assessment of potential positive and

[34] Engelsman, V. and M. Haring. *Knippen in DNA van planten maakt de problemen alleen maar groter*. In: Trouw, 18 februari 2023.

negative impacts.[35] As consumer choice remains important to these actors, labelling should be guaranteed.[36]

Other organisations, for example farmer organisations, like the Netherlands Agricultural and Horticultural Association (LTO) and the Dutch Agrarian Youth Contact (NAJK) are advocating for less strict regulation than is currently the case, but also believe some preconditions must be guaranteed. Freedom of choice should be guaranteed for both farmers and consumers. Varieties should therefore be traceable throughout the entire food supply chain. In addition, NGTs should in their view not be used at the expense of making production processes more sustainable, and products of NGTs should not be patentable.[37]

Although the struggle over whether or not to amend the current GMO Directive has reinforced established positions of opponents and proponents of the genetic modification of organisms, some organisations, like farmer organisations and some nature organisations, are thus converging towards a less strict regulatory regime.

1.3 Including citizens in developing new policy

When shaping new policy, it is important to include the voice of citizens, not only because society should have a voice in how we shape the future of agriculture and our food (system), but also because the exchange of multiple viewpoints can lead to more effective governance. Moreover, social science literature has attributed the restricted scope for public involvement in the regulation of GM crops as one factor that contributed to the unrest and social resistance to GM food in Europe in the 1990s.[38] Involving citizens therefore also has an instrumental goal: to ensure that policy has broad social support.

Earlier research has demonstrated the wishes of Dutch and other European citizens to be informed and have a say in regulatory decisions concerning biotechnology.[39] For example, the report on the broad societal debate on biotechnology in food in

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[35] IUCN-NL Natuur en milieufederatie Noord-Holland (MNH) Natuur & Milieu (2022). *Biotechnologie in breder perspectief. Een inventarisatie van de posities van Nederlandse natuur- en milieuorganisaties ten aanzien van biotechnologie.*

[36] Ibid.

[37] Moderne veredelingstechnieken - LTO

[38] Grove-White R. *et al*. (2000). Wising up: the public and new technologies. Centre for the Study of Environmental Change. Lancaster; Macnaghten, P. and S. Carro-Ripalda, (Eds.) (2015). *Governing agricultural sustainability: Global lessons from GM crops*. London: Routledge; ; Macnaghten. P. and M.G.J.L. Habets (2020). Breaking the impasse: Towards a forward-looking governance framework for gene editing with plants. *Plants, People, Planet*, 2, 353-365.

[39] Tijdelijke commissie biotechnologie en voedsel (2002). *Eten en Genen. Een publiek debat over biotechnologie en voedsel.* Den Haag

the Netherlands at the turn of the 21st century advised the Dutch Government to develop better tools to engage with the public early in the development of applications in the area of life sciences to help assure public support for the introduction of new technologies.[40] According to the report, citizens need to be able to form an opinion of the conditions they find necessary to allow the introduction of applications based on "objective, balanced and understandable information".[41] In this context, it is noticeable that in the debate on NGTs, there has been to date restricted scope in the Netherlands for meaningful public involvement.

The EC held a consultation process in 2022 (see Box 4) with the aim of informing citizens and stakeholders about the legislative initiative on plants produced by certain NGTs, and asking for feedback. Overall, there was more support for regulation of NGTs, albeit less strict, than for exempting NGTs from the GMO-Directive, which can be concluded from the higher percentage of respondents preferring a risk assessment and preferring labelling of NGT crops. Although the EC provided citizens with the opportunity to comment on their plans, a limitation is that the use of the survey method restricts the scope of questions (to those seen as relevant by the Commission), and that the questionnaire is likely to have been completed mainly by stakeholders, and citizens with prior knowledge about the debate and the upcoming regulatory change. Indeed, one had to be aware of the existence of this public consultation to participate: these voices are therefore likely to have been already heard in the debate.

1.4 The situation in the Netherlands

The Dutch government has been at the forefront of EU member states actively arguing the need for a revision of the EU GMO Directive to exempt NGTs, both for economic and for wider societal motives. In economic terms, this may not be surprising as the Netherlands has been estimated to have a 34% share in the European export seed market in 2017 (estimated at €7.8 billion). At the European level, the Dutch Ministry of Infrastructure and the Environment presented a proposal in 2017 to amend the GMO Directive to include NGTs in the exemption.[42] Not surprisingly therefore, the Netherlands welcomed the initiative of the EC to propose

[40] Ibid.
[41] Ibid.
[42] Parliamentary papers II 2017/2018, 27 428, no. 346; Appendix to Parliamentary papers II 2017/2018, 27 428, no. 346; The proposal was to amend the exemption (Annex 1B) of the GMO Directive: the words 'they do not involve the use of recombinant nucleic acid molecules or genetically modified organisms' would be replaced by 'recombinant nucleic acid molecules or genetically modified organisms are no longer present in the product'.

a legislative change.[43] In wider societal terms, the Dutch government sees a potential contribution of NGTs in making cropping systems more resilient to pests, diseases and climate change.

In their reaction to the EC impact assessment, the Dutch government also wrote that the provision of "good objective information to the public, appropriate labelling, and *consultations of the public*",[44] is crucial (italics added). Since 2017, there have been several efforts to engage with the Dutch public on the issue of NGTs (Appendix 3), one commissioned by the Ministry of Infrastructure and Water Management and the Ministry of Agriculture, Nature and Food Quality. In 2017, 150 citizens were extensively questioned for four weeks in an online community to gain an understanding of their views and values towards biotechnology across different domains (including agriculture), as well as the factors influencing these views.[45] In 2019, a public survey was undertaken with 1,031 Dutch people, preceded by four focus groups that provided a first qualitative picture of the associations with and perceptions of various techniques to change the genome in plants and in the medical field. [46] And in 2021 a citizen jury was conducted in The Netherlands by Wageningen University.[47]

This limited number of studies on the public perceptions of Dutch citizens found that citizens typically do not express enthusiasm about a change to the regulatory framework for NGTs. They desire that NGT crops are assessed for risks and that they are labelled. Citizens also express the worry that the take-up of NGTs will lead to the further concentration of power in large multinational companies.[48]

Although these previous studies provide some insight on the perception of the Dutch public on application of NGTs in food production, an in-depth investigation into how views are formed, is, so far, lacking. By using an anticipatory focus group methodology, we explore how concerns and responses emerge in structured

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[43] Parliamentary papers II, 2021/2022, 28 8264. Appendix https://www.rijksoverheid.nl/documenten/rapporten/2021/10/29/bijlage-1-reactie-op-inception-impact-assessment. The letter of the Dutch government diverges from the text from the EFSA: "The Netherlands agrees that plants (and their products) derived from cisgenesis and targeted mutagenesis are equally safe as plants produced with classical mutagenesis or conventional breeding techniques." However, the impact assessment of the EC reads: "The EFSA concluded that plants obtained by targeted mutagenesis and cisgenesis can have the same risk profile as plants produced by conventional breeding".

[44] https://www.rijksoverheid.nl/documenten/rapporten/2021/10/29/bijlage-1-reactie-op-inception-impact-assessment.

[45] InSites Consulting (2017). *De burger aan het woord: publieksopvattingen over moderne biotechnologie Onderzoeksrapport.*

[46] COGEM (2019). *Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning*. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM.

[47] Nair, A. *et.al*. (2022). 'Would you eat a genome-edited crop?' Citizens juries in the Netherlands and United Kingdom say yes to new plant breeding techniques. *Agriculture and Human Values*. Submitted; Hanssen, L. (2022) *De Publieke Stem. Publiekspercepties van Nieuwe Biotechnologische Technieken in de Agro- en Industriesector en Mogelijkheden voor een Effectievere Publieksparticipatie bij de Ontwikkeling van Nieuw Biotechnologiebeleid* Commissioned by the Ministery of Infrastructure and Water management.

[48] De Publieke Stem | Rapport | Rijksoverheid.nl

interaction (see chapter 2). We will complement the previous findings of others with important information on how Dutch citizens think about using NGTs to genetically alter crops, as well as the factors that shape their responses. Learning about and understanding underlying values and beliefs that shape people's attitude is important when developing new policy, as it enables policy makers to understand and address these public sensibilities, and to develop democratic governance.

Box 4 **Consultation process of the EC** [49]

The European Commission initiated a public engagement activity in 2022, which consisted of a questionnaire comprising of 18 questions, available during 12 weeks on the Commission's "Have Your Say" portal, between 29 April to 22 July 2022. 2,196 individual contributions were analyzed. Most respondents (67.9%) self-identified as EU citizens. Other contributions came from stakeholders, such as academic research institutions and businesses (together 30.2%), other (0.2%) and non-EU citizens (1.7%). A factual summary (and raw data) is available[50] whereas the full analysis will be published with the Impact Assessment, due in the second quartile of 2023.

Concerning the perceived need for a risk assessment: 40% of respondents expressed the belief that a risk assessment is not necessary for plants produced by cisgenesis and targeted mutagenesis, either at all, or if the plants could have been produced through conventional plant breeding or traditional mutagenesis (mostly selected by trade unions & company representatives), whereas 56% favored either an adapted risk assessment regime or continuation of current GMO regulations (mostly selected by EU-citizens, representatives of pubic authorities, research institutions, environmental and consumers organisations). Furthermore, 41% of respondents expressed the belief that sustainability provisions were not necessary, versus 51% who believed these should be included in the new policy initiative. Lastly, 67% of respondents favored the need for transparency for consumers and operators through the requirement of labelling, whereas 22% believed this was not necessary if plants could have been produced through conventional plant breeding or traditional mutagenesis.

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[49] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/13119-Legislation-for-plants-produced-by-certain-new-genomic-techniques/public-consultation_en;
[50] Ibid.

2 Methodology

The aim of the project is to examine the views of Dutch citizens on the use of genetic modification techniques, in particular NGTs, for crop breeding and to investigate what factors shape these views. For this, we used focus groups as an anticipatory method. In this chapter, we describe the scope of our study, the specific design of the focus groups, and our desk study. The desk research took place at various moments, informing the design of the focus groups and the description of the current debate.

2.1 The scope of our study

Although the expected policy initiative of the EC will apply to plants (and food and feed derived from these plants) obtained by targeted mutagenesis *and* cisgenesis,[51] we have chosen to restrict our study to targeted mutagenesis (or gene editing, see Box 2). This was a practical decision, made because of time constraints in our focus group discussions. Due to the time necessary to explain to participants plant breeding techniques, current and possible future regulation, and the scope of arguments in the debate, we choose not to further complicate the discussions by including cisgenesis. Although additional information on how citizens view cisgenesis is important, we choose to focus solely on targeted mutagenesis (or interchangeable gene editing), because the current political debate has focused mostly on this kind of genetic modifications, and because these modifications are only possible by NGTs (for an explanation of concepts, see Box 1 and 2 and Appendix 2).

Although gene editing techniques are genetic modification techniques developed after 2001, when the existing GMO legislation was adopted (see Appendix 2), we contrast gene editing techniques with genetic modification techniques (by which we refer to older recombinant-DNA techniques, developed before 2001) in this report. The choice to distinguish gene editing from genetic modification is in line with the current literature. It is also practical: one of our research questions examines whether citizens view gene editing (targeted mutagenesis) as substantially different from genetic modification (represented by transgenesis in our focus group discussions).

[51] Ares(2020)1117880 – 21/02/2020

2.2 Focus groups as anticipatory method

To examine the views of Dutch citizens, we used the methodology of the focus group. Focus group discussions are small, structured conversations with a limited number of participants, typically between 6 and 8.[52] Focus groups give an insight into the thoughts, perspectives, and feelings of participants on a given topic. They also allow for an exploration of the values underlying particular arguments and narratives.

The six focus groups we employed each lasted between 2,5 and 3 hours and took place in Amsterdam (n=5) and Amersfoort (n=1). The discussions were structured using a topic guide (see Appendix 4). The format was such that participants could express their ideas in an open discussion, where differences and commonalities were explored in a deliberative and permissive atmosphere. As moderators we emphasized to participants that there was no need to reach consensus of any kind and that each view was valid in its own way. Participants were asked to share and develop freely their thoughts, feelings and ideas regarding the topic.

In this research, we employed an anticipatory focus group methodology, as developed by Macnaghten, to explore how concerns and responses emerge in structured interaction.[53] An anticipatory approach is particularly useful and insightful when technologies and their impact are not yet visible in the public domain and when publics have not yet developed their own views and attitudes. With an anticipatory approach, societal responses to emerging technologies can be projected in terms of its likely unfolding in real world circumstances. The focus groups were designed to anticipate the kinds of issues that gene editing in plants would bring into being. A feature of the methodology lies in how citizens can negotiate the meanings, concerns and priorities associated with gene editing. An anticipatory approach consists of five design criteria:

1. context;
2. framing;
3. moderation;
4. sampling; and
5. analysis and interpretation.

[52] Kitzinger, J. (1994). 'The methodology of focus groups: the importance of interaction between research participants', *Sociology of Health & Illness*, 16, 103-121.

[53] Macnaghten, P. (2021). 'Towards an anticipatory public engagement methodology: deliberative experiments in the assembly of possible worlds using focus groups', *Qualitative Research*, 21, 3–19.

We briefly elaborate on these design criteria.[54]

Context

An important first step in the anticipatory public engagement focus group methodology is to explore contextual dynamics. Given that, by definition, people are unfamiliar with an emerging technology such as gene editing and with the social and ethical issues that may arise from its deployment, it is necessary to explore the context out of which public responses are likely to emerge.[55] More significantly, if contextual factors are not explored prior to explicit deliberation on the technological innovation, participants are likely to develop responses using definitions and narratives that have been pre-defined exogenously, typically by scientific and policy elites. The question remains: what contextual factors are likely to be significant in the structuring of subsequent responses? In response, based on conversations amongst the project team and analysis of the literature, we projected that responses to gene edited foods and crops are likely to depend principally on people's views and relationships with food, their ideas on food production and their views on the role of technology herein. For our research, we started each focus group by exploring the participants' relationship with food, and their views on the food system. Participants deliberated on the importance of food in daily life, on how foods and the food system had changed, on preferences in food systems and on the appropriate role of technologies in food and agriculture. This provided a basis on which to initiate the conversation on genetic modification and gene editing, and the regulation thereof.

Framing

Our conceptual approach is one in which technologies are represented as inevitably framed in particular ways by particular actors and for particular purposes: there is no such thing as a value-free representation of a technology. As classically defined by Entman,[56] framing involves the selection of 'some aspects of a perceived reality [to] make them more salient in a communicating text, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described'. Within the literature, there are two broad approaches to framing: frames as cognitive representations stored in people's heads and frames as what people construct in social interactions.[57] For our purposes, we argue for an alternative approach that examines how public attitudes

[54] For a detailed description, see: Macnaghten, P. (2021). 'Towards an anticipatory public engagement methodology: deliberative experiments in the assembly of possible worlds using focus groups', *Qualitative Research,* 21, 3–19.

[55] Ibid.

[56] Entman, R.M. (1993). Framing: Toward Clarification of a Fractured Paradigm. *Journal of Communication*, 43, 51-58.

[57] Dewulf, A. *et al.* (2009). Disentangling approaches to framing in conflict and negotiation research: a meta-paradigmatic perspective. *Public Administration and Policy*, 62, 155-193.

are formed in social interaction in relation to the interplay of existing frames (embedded in wider cultural narratives) about science and technology.[58] Embedding this concept into our focus group design, the imperative for the methodology was to facilitate a process where participants develop their own views by making them aware of the full range of extant framings, and to introduce gene editing explicitly and systematically through arguments as they are being articulated (or framed) by stakeholders present in the debate. Crucially, this involves attending to both current and future imagined uses of the technology and its societal impacts.

Accordingly, we need not simply to be aware of the range of these framings, but to introduce the new technologies to participants in the focus groups using the range of frames as they are being articulated by stakeholders in the debate.

Prior to the focus groups, we conducted a desk study (see 2.3) to help determine the different ways in which current and prospective uses of gene editing technologies are framed in the political and societal debate. We presented these different frames in the form of arguments to the participants in the focus groups using two concept boards (see Appendix 5, board 6 and 7). Special attention was given to the different ways in which stakeholders, such as NGOs, scientists, governmental institutions and biotech companies frame gene editing. By offering participants different frames (written and illustrated on concept boards) we made sure that not one frame would be dominant from the onset of the focus group, as this would also have an influence on the way participants shape their own opinion on gene editing. The concept boards had been carefully drafted to be even-handed and impartial. The moderator made sure to present all frames in a neutral way, so as not to steer the conversation in one direction or frame.

Besides representing various framings to participants, the concept boards also included a few examples of new varieties made with various methods, to provide participants with more than only theoretical information on breeding. For traditional breeding, we used the example of broccoli, kohlrabi, Brussels sprouts and red cabbage, that all derived from an original cabbage; for classical mutagenesis, we used the example of the red grapefruit, which acquired its colour and became seedless using this technology; for genetic modification (transgenesis)[59], we presented the example of the Bt-brinjal eggplant, which had been made resistant to the eggplant moth by inserting a gene from a soil bacterium. When the gene editing technology was introduced to participants later in the focus group discussions, we presented the example of the GABA-tomato, modified to contain a higher concentration of gamma-aminobutyric acid GABA, which may lead to health

[58] Macnaghten, P., Davies, S. and M. Kearnes (2019). 'Understanding public responses to emerging technologies: a narrative approach', *Journal of Environmental Planning and Policy,* 21, 504-518.

[59] We did not provide specific information on cisgenesis, as it is out of scope of this study.

benefits such as lower blood pressure. This example was chosen because it was the first CRISPR-Cas product on the market. The other examples (Bt-brinjal eggplant, red grapefruit and cabbages) were provided by designer Mies Loogman, and originated from the Future Food exhibition *From Cabbage to Super-cabbage*, displayed in Nemo Science Museum.[60]

Moderation

A focus group is more than a group interview or the aggregation of individual opinions and preferences. It is a space in which a group identity and discourse can emerge, where the collective is empowered to articulate the issue at hand in its own terms through conversation. The moderator has a large responsibility in focus group research, encouraging the movement between argument and counter-argument, and at understanding not merely what people say, but elaborating on why they say what they say. Facilitating a group dynamic and identity is an important accomplishment as the group has to formulate shared understandings of issues that had been unfamiliar prior to the group discussion. For this reason, a senior and experienced member of the research team moderated the focus groups. The role of the moderator is, principally:

- to keep the group on topic (using a well-formulated topic guide, see Appendix 4);
- to raise topics, to listen empathetically and accurately to each participant's stories;
- to engage in nondirective moderation where participants can express their views with minimal interference;
- to ensure a diversity of voice independent of background or experience;
- to probe difference and convergence between group members;
- to move from one topic to the next only when the full range of arguments appears exhausted;
- to require participants not necessarily to arrive at a common output or consensus but, nevertheless, to articulate shared issue definitions (when present) facilitating a collective or shared group discourse aimed at increasing awareness and mutual understanding of participants' viewpoints.

To ensure that discussions are not framed by expert discourses and norms, the focus groups avoided the inclusion of technical experts, as the presence of experts (unless they are very well trained and integrated into the research) can induce deference to prior framings amongst lay participants.[61] Nevertheless, codified information on what the technology is, how it works and what it means, was

[60] https://www.enlightens.nl/assignment/future-food-at-nemo-science-museum/; *From Cabbage to Super-cabbage* was a collaboration between Enlightens (Mies Loogman) and Wageningen University and Research

[61] Wynne, B. (2006). 'Public engagement as a means of restoring public trust in science: Hitting the notes, but missing the music?' *Community Genetics*, 9, 211–220.

communicated by the moderator through the use of concept boards (Appendix 5), but where the practical meaning of the technology, for the participants, is derived through group discussion and deliberation. Through abiding with some general rules of good focus group moderation – that there are no right or wrong answers, that this is not a test, that all opinions matter and should be respected, that you, as the moderator, are showing due empathy to participants' views and experience – participants proved themselves as able and competent to enter into the current and future worlds of gene editing in crops and foods.

Sampling

The focus groups were made up of five to eight participants and were professionally recruited by the market research agency Norstat. Participants were selected based on age, socio-economic background, and education level, but also on particular interests that might provide distinctive perspectives on technology in food. Participants received a financial incentive for participation. The focus groups were 'topic blind', meaning that the participants were not informed on the specific topic of the focus group prior to participation. We did not invite participants that may have a priori stakes in the debate. We excluded experts and participants such as scientists or farmers, that were deemed likely to already have a predisposed position. Inviting uninformed participants allows for them to develop their own opinion in dialogue and in a safe space. According to the method, the participants' own local and tacit knowledge and lines of questioning are not viewed as in any manner less legitimate than that of experts.

To ensure a diversity of perspectives, and provide a reflection of Dutch society, we selected individuals representing broadly the Dutch public in terms of age, educational background, socio-economic class, and gender. Although the focus group discussions took place in Amsterdam and Amersfoort, Norstat sampled from a wider area than just these two cities. For an overview of the participants, see Table 1.

To create groups with different perspectives, Norstat selected participants also based on characteristics that reflect a certain perspective on food, technology, nature, sustainability, and institutions. We called these 'topic groups'. The five chosen topic-specific characteristics were chosen to provide distinctive perspectives on food and technology. The first topic group consisted of participants who either loved food and cooking or who were vegetarian (foodies and vegetarians) intended to represent people that are passionate about food, health and possibly animal health. For the second group, we invited people who were enthusiastic about technology (technophiles) intended to represent citizens who are more future-oriented and have a progressive attitude towards scientific developments. For the third and fourth focus group, we invited participants who

were fond of outdoor activities, gardening, or who strived to live sustainably (outdoorsy people), designed to represent people interested by and involved with nature and sustainability. The fifth group consisted of public sector professionals with a keen interest in global affairs, representing citizens who can view themes from different standpoints, including the point of view of legislation and regulation, and from a global perspective (public sector professionals). For the last, and sixth focus group, we invited participants who shared a certain distrust for institutions, politics, and government representing citizens that may have a more conservative and questioning attitude toward scientific progress and expertise (less trust in institutions).

To create the conditions for an open discussion and an atmosphere where everyone felt comfortable to speak freely and where collective views can emerge, we grouped participants into groups that shared similar age, educational levels, and similar perspectives towards among other food, technology, nature and institutions (see below). We did so since we have learned from previous experience that more academically educated people tend to speak in more complex and abstract language, whereas those with a practical education are more likely to speak in concrete and hands-on terms.[62] By grouping individuals according to similar educational background and age, this created a 'level playing field' of people predisposed to develop a group dynamic. A shared experience or characteristic allows for a favorable setting for discussing an unfamiliar topic.[63] For an overview of the participants, see Table 1.

2.2.1 Analyses and interpretation

With consent, all focus groups were recorded and transcribed ad verbatim afterwards. Using Atlas.Ti9, we coded the full transcripts. Codes and themes were formed in the process of analyzing. Special attention was given to analyzing the underpinning values and assumptions that shaped participants' responses to gene editing technologies. We looked for convergences and divergences between and across groups.

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[62] Habets, M., L van Hove and R. van Est (2019). *Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations*. The Hague: Rathenau Instituut

[63] Macnaghten, P. and G. Myers (2004). 'Focus Groups: The Moderator's View and the Analyst's View', in G. Gobo *et al*. (eds.) *Qualitative Research Practice*. London: Sage; Morgan, D. (1988). *Focus Groups as Qualitative Research*. London: Sage.

Table 1. Composition and characteristics of the different focus groups

	Age range	Nr of partici-pants	Gender	Educational background	Location	Language	Topic specific group
1	25-40	8	4M/4F	Theoretical education	Amsterdam	English	Foodies & vegetarians
2	35-50	7	3M/4F	Theoretical education	Amsterdam	Dutch	Technophiles
3	40-55	5	2M/3F	Practical education	Amersfoort	Dutch	Outdoorsy
4	40-55	7	4M/3F	Practical education	Amsterdam	Dutch	Outdoorsy
5	45-60	8	3M/5F	Theoretical education	Amsterdam	Dutch	Public sector professionals
6	30-45	6	2M/4F	Practical education	Amsterdam	Dutch	Less trust in institutions

2.3 Desk study

We conducted a desk study to help determine the different ways in which gene editing technologies are framed in the scientific, political and societal debate, and which arguments are used in favor and against the use of gene editing in food crops.
In a previous project, the Rathenau Instituut studied the significance of genome-editing technologies for agriculture; specifically, its significance in the debate on the regulation of biotechnology in plant breeding in Europe.[64] We found that two policy options for the EU dominate the debate on genome editing in plants and crops. One option is to uphold the GMO Directive, the other is to exempt genome-editing techniques from the GMO Directive if and only if there is no foreign DNA present in the end-product. In this report, we also address the various arguments of stakeholders for both policy options as well as the societal consequences and challenges.

These previous findings were complemented with additional literature, especially papers published after 2019, and/or papers that documented the narratives and framing in the debate on NGTs. We looked for literature on the historical context of

[64] Habets, M., L. van Hove and R. van Est (2019). *Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations*. The Hague: Rathenau Instituut

genetically modified organisms (GMOs) and NGTs, and the way the debate evolved in the following years.[65] In addition, we searched for studies on public attitudes of GMOs and NGTs.[66]

From the literature we identified five frames (and counter frames). These frames provided different key arguments either in favor or against exempting NGTs from the GMO Directive. The arguments in favor of exemption related to:

- the naturalness of GE by referring to the end product that would be indistinguishable from plants altered with traditional breeding techniques;
- the need for GE for food security;
- the importance of innovation for the competitive advantage of Europe; and
- the potential of gene editing to democratize genome editing.

Counter frames provided arguments against exempting gene editing techniques from the regulation by drawing attention to:

- the process used to create new crops, a process which does not occur in nature;
- the current food system which has caused food security problems that will not be solved by the introduction of GE;
- the uncertainty surrounding the technique that warrants a precautionary approach;
- the possibility to patent GE processes thereby not democratizing but facilitating further monopolization of large companies;
- the need for consumer choice, that would be lost if gene editing crops would be exempt from the GMO Directive.

These arguments were introduced to focus group participants by attributed quotes from scientists, NGOs, governmental organisations, or industry.

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[65] Helliwell, R., Hartley, S., and W. Pearce (2019). NGO perspectives on the social and ethical dimensions of plant genome-editing. *Agriculture and Human Values*, 36, 779-791; Siebert, R., Herzig, C., and M. Birringer (2022). Strategic framing of genome editing in agriculture: an analysis of the debate in Germany in the run-up to the European Court of Justice ruling. *Agriculture and Human Values*, 39, 617-632; Bain, C., Lindberg, S. and T. Selfa (2020). Emerging sociotechnical imaginaries for gene edited crops for foods in the United States: implications for governance. *Agriculture and Human Values*, 37, 265-279; Bonny, S. (2003). Why are most Europeans opposed to GMOs?: Factors explaining rejection in France and Europe. *Electronic journal of biotechnology*, 6, 7-8; Marris, C. (2001). Public views on GMOs: deconstructing the myths. *EMBO reports*, 2, 545-548.

[66] Busch, G *et al*. (2021). Citizen views on genome editing: effects of species and purpose. *Agriculture and Human Values*, 39, 1-14; IPSOS Mori (2021) *Consumer perceptions of genome edited food*. https://www.food.gov.uk/sites/default/files/media/document/consumer-perceptions-of-genome-edited-food.pdf.; McFadden, B. R. *et al*. (2021). Gene editing isn't just about food: comments from US focus groups. *GM Crops & Food*, 12, 616-626; Norwegian Biotechnology Advisory Board and GENEinnovate (2020) *Norwegian consumers' attitudes toward gene editing in Norwegian agriculture and aquaculture*; Van der Berg, J. P. *et al*. (2021). Future-Proofing EU Legislation for Genome-Edited Plants: Dutch Stakeholders' Views on Possible Ways Forward. *Agronomy*, 11, 1331; Frewer, L. J. *et al.* (2013). Public perceptions of agri-food applications of genetic modification–a systematic review and meta-analysis. *Trends in Food Science & Technology*, 30, 142-152.

Based on the information of the desk study, our previous report, and a pilot study with students at a high school, we developed eight concept boards to guide the conversation. These boards allowed us to present participants with necessary information to discuss the topic, the various frames from the viewpoint of the various stakeholders, and examples of varieties produced with different breeding methods. All boards contained images and either information, or quotes attributed to scientists, NGOs, governmental organisations or industry. The boards were on:

1. Several approaches to agriculture;
2. Ways to modify crops;
3. Arguments in the GMO controversy of the 1990s;
4. Current situation in Europe;
5. A new technology: CRISPR-Cas9;
6. Arguments in favor of GMO regulation revision;
7. Arguments against GMO regulation revision; and
8. A new level-based approach.

Appendix 5 provides an overview of the concept boards.

2.4 Advisory committee

We set up an advisory committee with three experts to help ensure quality control of this research project. The advisory committee gave advice and support to members of the project team of the Rathenau Instituut and Wageningen University regarding the structure, methods, and content of the project, as well as the structure and line of argumentation of this report. The content of this report is, however, the sole responsibility of the project team. See Appendix 6 for an overview of the advisory committee.

3 Findings

In this chapter, we describe the main findings of six focus group discussions with Dutch citizens. The findings are structured into four sections. In the first section, we discuss participants' attitudes towards food and the food system, their views on changes in the food system, the future of food, and their perspective on the use of technology in agriculture and food production. In the second section, we describe the attitudes of participants towards genetic modification (GM). Their attitudes towards gene editing (GE) technologies, and the underlying factors underpinning their responses, are discussed in the third section. The last section describes the views of participants on the governance of GE in crops. To begin, we first describe some general observations of the focus group discussions.

Participants agreed it was not easy to form an opinion on genetic modification in crops, not least because they were quite unfamiliar with the topic and with the myriad debates and views of different actors. However, as the focus group discussions progressed, we observed that participants had engaged in a genuine effort to understand and reflect upon the information provided, and across all groups a meaningful and insightful conversation took place which shaped the attitudes of participants. Participants enjoyed the conversation and found it an interesting topic. Despite differences in group composition, as regards age, socio-economic background and educational level, similar concerns, hopes, and conditions were voiced, and fairly comparable attitudes to genetic modification and gene editing emerged, which is not to say that no individual differences in opinions existed within groups.

We noticed a slight difference between groups in which issues were emphasized when participants talked about the (future of) food. Whereas participants from a higher socio-economic background with a theoretical education where inclined to talk about food and the food system in a global context (e.g. fairness, effect on the environment), participants from a lower socio-economic background with a practical education tended to focus more on price and taste –although global issues were also discussed. Another difference was the underlying tone in which genetic modification was talked about initially, irrespective of socio-economic background or education. Some groups seem more positive than others, but the more information participants received and discussed, the more groups converged towards the view that we need to be cautious with introducing this technology.

In brief, citizens in our focus groups raise doubts about the plausibility that genetically modified crops and gene edited crops will contribute meaningfully to

solving current challenges in the food system, like food waste, the nitrogen crisis, and food shortage. They were doubtful whether these biotechnologies are the right approach to deal with the current challenges in agriculture and the food system, for two reasons. First, these technologies do not solve the underlying causes of the problems, and second, there are alternatives that do, in their view. As the introduction of technologies in society often comes with unforeseen negative consequences, citizens expressed concerns about the long-term safety of these techniques for human health and the environment. Moreover, these citizens voiced doubts whether the interests of companies developing gene edited crops would be aligned with what is important for society, nature, and the environment. Whether in practice, social valuable products would be developed is far from a foregone conclusion, in their view.

In general, citizens converged during the discussion towards the view that the European Union should take a precautionary approach. Participants with initial stronger negative feelings adapted a “no, unless…” attitude, whereas the initially more positive participants, ended up with a “yes, provided that…” attitude. *If* the technology of genetic modification and gene editing would be able to bring necessary, socially valuable, and sustainable solutions to current challenges in our food system, *then* citizens would not be opposed to their use in crops. But commercial motives were not sufficient reason. Furthermore, there was a unanimous call for regulation. All participants wanted risks to be assessed before products will come on the market, and freedom of choice should be guaranteed by compulsory labelling. A part of the conversation in focus group 1 is representative of conversations that took place in all groups.

Part of a conversation in focus group 1:

F1: […] I want it [my food] to be pure and organic and in my ideal situation, I grow my own food. […] It [genetic modification] sounds a bit creepy to me, like, playing with nature, and we don't know the long-term effects.

M1: I think if you kind of take away Australia, the US and Spain, a lot of the countries [cultivating GM crops) are basically the Global South where this is happening. A huge amount of people are actually farmers, like way more than in the Western world, and are still living on rural lands, and are farming themselves. And for them, it's (GM) a huge sense of security, because maybe before, with a certain virus or an infestation, it could have destroyed their whole yield and the security for farmers would have been gone. And now, they know that at least, they are protected to a higher level.

M2: Yes, if they get the technology to use themselves locally, and it's not just the big Brazilian corporations… Like, I don't know that much about Brazil, but I do know, that things are not fairly distributed over there.

M1: No, yeah, good point.
F1: And also, what is it worth when it's not healthy food?
F2: We don't know that, that's the question, I think.
M1: Well, if you have to choose between food or no food. In many parts of the world, there is still a hunger crisis. So, I think when you can, when the food security can be improved like significantly by this and people can get food, then it's a good thing.
M3: But would you then suggest the kind of system where you have different legislations, for instance for third world countries or you name it?
M1: Yeah, I think it's good if it's legislated and the fact that it's traceable and monitored and labelled. For me, that suggests that at least you know wherever it's coming from and is traceable. So then, it's arranged in a fair, well, reasonable way, that reassures me as consumer. Yeah, that is a good thing.

3.1 Attitudes towards food and the food system

We initiated the conversation by asking participants about their current relationship towards food. Lines of questioning included whether participants enjoy preparing and cooking food, what healthy food means for them, and what is important for them in the way food is produced. Eating healthy, nutritious, tasty and varied meals was important for most participants. Multiple participants also mentioned they attach great value to the social component of having dinner together with friends and family. Food is tastier when it is prepared with care and attention and in social gatherings. Many participants take pleasure in cooking (either alone or together with their partner, family or friends) and prefer to prepare their meals with fresh ingredients that are free of conservatives or additives, even if some mentioned (almost apologetically) they buy prefabricated food when time is limited as this is easy and quick. Price was also an important criterion for people, especially in lower socio-economic demographics. Organic food was viewed as healthy, and many respondents claimed their preference for it, although not everyone’s budget allowed them to act on this preference. Some respondents found it important to buy “responsible” products: products developed in a fair manner, with regard for the environment and animal welfare, and a fair price for the labor of farmers.

Part of a conversation in focus group 1:

F1: I watch a lot of documentaries because I find it very important to know where the food is from and also how it's been grown, if there’s a lot of pesticides used, these kind of things.

Mod:[67] *So that's important to you. How about the rest of you?*
M1: Yeah. Also seasonal, that you eat food that grows here this season, that you're gonna eat what grows in spring, in spring. I try to be aware what I eat and what time of the year I eat it.
F2: Yeah, me too. I also eat other things. But I prefer when it's organic.
M2: I try to make that choice a lot, but I live in the Centre [of town] and I see that not a lot of like specialty kind of shops are left there, like most of the big supermarkets have taken over when it comes to groceries there.

Part of a conversation in focus group 6:

Mod: Are there more things that are important to you with regards to food?
F1: Healthy, I often find that important.
F2: Yes.
F3: For me, if I can manage financially, also organic. Apart from the ethics side of it, I also find the taste a lot better, fuller.

3.1.1 Our changing relationship to food

When asked about changes in the way we eat food nowadays, participants mentioned the trend of moving from the traditional Dutch cuisine of 'vegetables, meat and potatoes' to more diverse, exciting and international cuisines. Most participants were happy with this change and enjoyed the increased pallet of food and flavours. Participants viewed this increase in variety of fruits and vegetables nowadays, including the fact that there are no longer restricted seasons for fruits and vegetables, as both a positive and a negative development. They enjoyed the opportunity this provides to eat what they want when they want, but also questioned the unlimited, year-round availability of many products from all over the world. Eating locally grown and seasonal foods was viewed by many participants as more sustainable, and arguably as healthier and tastier as well.

Across all the focus groups, participants remarked on the apparent need for food to be (at least on the outside) perfect in appearance. We will elaborate on this particular issue below in Section 3.3. Participants also saw a shift towards greater convenience for consumers achieved by such innovations as precut vegetables and meal boxes (*verspakketten*), various take-away and food delivery options, and fast food restaurants. They also expressed unease with the commercialization of the food sector. Groups talked about the impact of cooking shows, numerous fads and diets, and the role that food plays in social media.

[67] Mod = moderator

Part of a conversation in focus group 4:

M1: What bothers me personally is that food is gaining a prominent place in every festivity, or at least it is marketed as such by the industry. Everything centers around food. For Easter an Easter brunch, Easter dinner…. Everything should turn into a food-fest, if you believe the commercials.
M2: It is all becoming very commercial.
F1: Yes, first the Christmas cake and then the Easter cake.
M1: No one should be alone you know, at Christmas. But you have to have at least forty different snacks on the table at such parties.
M2: And strawberries for Valentine's day, dipped in chocolate, with champagne…
F1: Yes, and all these magazines filled with beautifully set tables…
Mod: So everything centers around consumption?
[participants express agreement]

Some respondents remarked on the current increase in awareness among citizens of sustainability issues in food production and the interdependence of stakeholders in the food system. They mentioned for example that the war in Ukraine has exposed how dependent we are on particular countries for particular food products. The increased awareness in society of sustainability issues in food production was seen by citizens as a result of the problems caused by the current system, such as the commercialization of food, food waste, food imported from various parts of the world with consequences for CO2 production, and concerns on animal unfriendly livestock farming. Participants viewed this awareness as a positive development. This has, according to some, resulted in an increased demand for organic and locally produced food, as well an increase in the consumption of vegan and vegetarian food.

3.1.2 The future of food

Respondents saw a number of challenges and some reasons for hope for the future of food production. Food scarcity and the current Dutch problem of high nitrogen emissions were mentioned as challenges in almost all groups.[68] Most participants considered the food system to be unfair. They saw an unfair distribution of food in the world and an unfair distribution of economic benefits in the food production chain, with only a small minority reaping the economic benefits of food production, whereas many farmers, for example, were having to work hard for meagre wages.

[68] The Netherlands has been struggling with high nitrogen emissions caused by livestock, industry and transport, which is threatening nature and biodiversity. The high emissions lead to acid rain, deterioratian of soil and groundwater polution. To deal with this problem and comply with European legislation, the Dutch government has proposed to reduce significantly the number of livestock in the Netherlands. This has led to unease among the farming community and to major farmer protests in 2022.

This unfairness was also seen at the level of the consumer: participants mentioned that healthy (organic) food is more expensive, and not everyone can therefore afford to eat healthily. Because of the (at the time) current increases in food prices, participants wondered whether healthy food will still be affordable in future for “the average person”, or whether eating healthily will become increasingly “elitist”. Underlying these sentiments are values of justice, health and naturalness. Indeed, there was an undertone among the participants that “healthy” is synonymous with “natural”. Natural, unprocessed, and organic food were viewed as better than food grown with fertilizers in more intensive agricultural systems and food with additives.

Part of a conversation in focus group 4:

M1: Yes, I do worry … If you look at the price nowadays. If you want to eat healthily, […] If you just eat your portion of meat or vegetables or rice or potatoes or whatever, the healthier you want to eat, the more expensive that is compared to... So, it does seem sometimes, especially for people with less money to spend, that you're just pushed in a certain direction of: you don't have a lot to spend so you can’t buy healthier food, and you get fatter or you get other health problems.

M2: Well, that is true. People with less income have no choice. They can't choose to buy organic. I see it very often in my work. People with a minimum income, they want to live healthier but it's just not possible. It's just not possible. And that is actually the government's fault, I think.

Part of a conversation in focus group 5:

F: But look at the price of organic products. Not all people can afford that. Okay, you are poor, you eat average produce. And you're rich, you eat organic. But this is my big concern that you really get a big difference between people. Now a lot of people say: yes I want organic, I want natural food. But how to think about the people, a lot of people cannot afford those prices.

A similar sentiment of preference for more natural food was expressed when participants discussed the phenomenon of larger, perfect looking vegetables. Participants often saw a trade-off between the better tasting (traditional) fruit and vegetables, often still prevalent in southern countries, and those in Dutch supermarkets, which were larger and prettier but which in reality just contained more water in their view. The trope of the larger, perfect vegetable reoccurred throughout the discussion across most focus groups (see also Section 3.3.3).

Other issues that concerned participants about the future of food include those of climate change, epidemics in livestock (at the time linked to and underpinned by the

COVID-19 crisis and the bird flu), the increased economic interdependencies of countries in matters of food supply (including the current increase in food prices due to the Russian invasion in the Ukraine), overfishing, soil exhaustion, food waste, and overproduction. Some participants were hopeful that the increased awareness of citizens about problems in the food system would generate solutions. The implication seemed to be that citizens as consumers could change the food system if they acted on this awareness.

3.1.3 Ambivalence to technology in food

When asked about the role of technology in farming, citizens displayed a nuanced view about the use of technology in agriculture in general. They acknowledged that technology can provide many advantages and that it can in principle help to solve some of our current challenges, such as those of climate change, a fast growing world population, and the high emissions of nitrogen from agriculture. For some, the use of technologies in agriculture or food production was therefore seen as an inevitable necessity in our collective capacity to be able to deal with societal challenges. Others saw the introduction of new technologies as inevitable (for good and ill) using a more determinist argument: because technologies are like ships that have already set sail, whose course either cannot be altered (because these developments take place at an international level) or should not be altered because of the need to “keep up” with other countries.

In contrast to those who viewed technology as solutions, other participants were more critical: they wondered whether in practice technology will really be used to solve societal challenges – even if this would theoretically be possible. Indeed, participants discussed that it is not the technology itself that is important, but *how the technology is used*. Participants across all the groups further emphasized not only that technologies have the potential to create new problems, but that these problems are hard for us to predict a priori because we only have access to current knowledge, and “thinking outside the box is difficult”. Because of these unpredictable, unintended negative consequences, participants felt it important to introduce new technologies with care and caution.

3.2 Attitudes towards genetic modification in plants

Following a more general discussion on the use of technology in agriculture, we introduced the topic of genetically modified (GM) crops and foods, by asking for spontaneous associations with the term “genetic modification”. Participants expressed both positive and negative associations. Clear negative associations

included those of: Monsanto, creepy, playing with nature, disconnection from nature, playing God a little bit, scary, not for our (consumer) benefit, arrogance, and dangerous. Positive association included: ability to adapt to local conditions, resisting diseases, efficiency, taking charge of mutations, higher yield. Most participants had heard about the topic of genetically modified organisms (GMOs), especially the older participants who also expressed some familiarity with the controversy surrounding GMOs. Yet, participants generally possessed little knowledge on what exactly genetic modification is, and were unsure whether farmers currently cultivate GM crops in the Netherlands, and whether supermarkets currently sell genetically GM food or not. In general, not many participants were aware of the current practices of plant breeding, including traditional breeding.

3.2.1 Views on plant breeding

To discuss genetic modification in more detail, we introduced participants to three breeding techniques: traditional breeding, classical mutagenesis and genetic modification (transgenesis) (see Appendix 5). Overall, participants expressed their preference for crops modified by traditional breeding techniques. Similar to a study by COGEM in 2019, we found that participants voiced worries about classical mutagenesis because of the radiation used, and the apparent randomness of the induced mutations. Participants also expressed doubts about the (long-term) safety of these products. In addition to informing participants about these three different technologies to modify the genome of crops, we also introduced them to some of the arguments in the 1990s debate on GMOs from both sides of the debate (see Appendix 5, board 3). This is important so as not to narrow down the conversation by one narrative, but rather to open it up.

In most groups, one or two participants were against the use of genetic modification technologies to breed new variants because they preferred “pure” food, because they did not trust that GM crops were safe, or because they had doubts about the nutritional value of GM food. On the other hand, there were also participants who believed the world needed these technological solutions, either because of climate change or other current challenges in agriculture and food. For example, some participants had a positive view on the introduction of the Bt-brinjal eggplant in Bangladesh, which we used as an example of a GM crop (Appendix 5, board 2). In this eggplant, a gene from the soil bacterium Bacillus thuringiensis has been introduced to make the plant resistant to the eggplant moth in Bangladesh to support the livelihood of farmers and to make sure that the population had enough food. Others expressed doubts about the long-term safety record for humans, and the effect on the ecosystem of this eggplant.

As can be seen in the exchange below, participants believing that the necessity of new technologies tended to view society's current societal problems as having been in part created by current agricultural practices.

Part of a conversation in focus group 2:

F1: We just have to go along with it if we want to keep ourselves alive.
M1: Unless we can reverse climate change by reducing the scale of livestock farming.
F1: But I think we've already passed that station.
M1: Yes, I'm afraid so, yes.
F1: And I'm pessimistic about that.
M1: Yeah, it's a circle in that sense. It [introducing GM technology) is necessary, because of way we are currently doing it – agriculture, livestock farming – leads to the climate problem.

Apart from a few participants who were either in favor or against the use of genetic modification in agriculture, the majority of participants expressed reserved views towards genetic modification of crops and foods. This was partly due to their concerns about safety. In particular, participants raised questions about the long-term safety of GM foods for human health, their effect on our DNA, and the impact of GM crops on the equilibrium on nature and ecosystems. But participants were also reserved because of their doubts about the intention behind introducing genetically modified food: What is behind it? Why is it done? Who is doing it? The reserved feelings should also be viewed in light of the preference participants have for pure and unprocessed food. Genetic modification seems to be viewed as a step towards more "unnatural food". Moreover, there are questions about how far society will go in its pursuit of perfection and making the world convenient for humans. Where is the limit?

Furthermore, participants had many questions about genetic modification in plants and wanted to be informed about such matters as: what the technique would be used for and why, who benefits, whether there would be choice, and whether GM crops were already commonplace in (European) agriculture.

3.2.2 Is genetic modification the answer to societal challenges?

In general, the majority of participants did not oppose the introduction of GM crops, but only saw room for it under the condition that these had been proven to be safe, and that they would be used in practice to solve some of our current global societal challenges, such as food security. However, they simultaneously questioned

whether these technologies would indeed be used as a solution to our societal challenges, not least because many of these challenges had been exacerbated by the use of technologies in agriculture in the first place.

Participants provided three main reasons as to why GM technology may not be a (socially robust) response to (global) societal challenges. First, the use of GM crops was not seen as responding to the root problems of the societal challenges in the food system, such as the unfair distribution of food, corruption in developing countries, and the intensive livestock industry. Second, participants often expressed a preference for alternative non-technical solutions, for example, using land more efficiently for food instead of animal feed and more generally, changing consumption patterns including the consumption of less meat. And third, participants questioned whether *in practice* the technology would indeed be used to solve these societal challenges, suggesting that in practice the technology would be driven by the need to generate profits for corporations, and by superficial consumer desires such as convenience and better-looking fruit and vegetables.

3.3 Attitudes to gene editing in plants

We introduced the concept of gene editing (GE) to participants through a short presentation of CRISPR-Cas9, a gene editing technique, by briefly explaining the technology and presenting the first CRISPR-edited vegetable on the market, the GABA-enhanced tomato (see Box 5 and Appendix 5). The conversation on GE was initiated by asking participants whether they viewed gene editing techniques as similar to traditional breeding techniques, or as similar to genetic modification techniques.

Participants responded in several ways. According to them, the technique of gene editing may be claimed to be faster, cheaper, and more accurate, but you are still “tinkering” in the DNA of the plant and therefore still modifying DNA. Although the end product *may also occur* in nature this was viewed as less relevant to participants, because the gene edited plant *did not occur* in nature, but rather was created by scientists. Sometimes, participants explicitly mentioned that this supposed distinction between gene editing and genetic modification appeared as a semantic discussion in their eyes, or possibly as a ploy for advocates of the technology to try to rid gene editing of a bad connotation. Presenting gene editing as similar to traditional breeding was framed as a marketing tactic, as reflected in the exchange below.

Part of a conversation in focus group 2:

F1: Maybe it's just marketing and it's just genetic modification…
M1: Yes, that's why.
M2: Yes.
F1: … but it is called differently. Yes, and it sounds nicer. Editing.
M3: And you have fewer hoops to go through to get it to market.
F2: Yes.
F1: Yes, maybe.

In general, most participants expressed the view that the issues and questions they had voiced with gene edited crops and foods were similar in kind to the questions they had expressed when discussing genetic modification. For them, gene editing and genetic modification are similar interventions. And those questions were seen as more important than the question of how to call the new technique. The more substantial questions associated with the technique remained: for what purposes is the technology being developed? For whom? Will gene edited crops be used to help solve our societal challenges? Or will it be used merely for short-term commercial motives, for the profits of the companies involved?

Part of a conversation in focus group 4:

M1: Whether it's bad, that's another [question].
F1: Well, what are you going to change? What do you want with it?
F2: Yeah, exactly, that's the thing.
F1: I think that's the most important thing to know.

The fact that participants view gene editing as a genetic modification technique, does not mean that they believe a distinction between genetic modification techniques cannot be made. They are e.g. open to the idea that some GM techniques may come with more risks than others, and that a differentiated risk assessment procedure may be in order (see 3.4).

To further explore public views on gene editing, we introduced participants to arguments from actors who both support and who oppose amending the EU regulatory framework for gene edited plants (see Appendix 5). Participants used these arguments to discuss the merits of each and through these discussions to clarify and develop their own attitudes towards GE food. Here, we first describe participants' hesitation on whether gene edited products are safe. Next, we discuss which questions and goals are relevant for participants to adjudicate their views on acceptability: would gene editing be driven by commercial motives, would it be

governed for the public interest, does it constitute an appropriate approach to deal with current predicaments or would it be used primarily for aesthetic reasons?

3.3.1 Safety and nutritional value of gene edited crops

Not surprisingly, the safety and nutritional value of gene edited crops were viewed as important considerations in determining whether they find gene editing an acceptable way to 'alter' food crops. Participants expressed questions and doubts about the safety of gene edited crops and foods for humans and the environment: the fact that gene editing only introduces small changes in the genome did not imply that the impact will similarly be negligible. Specifically, participants affirmed the need to scrutinize the long-term safety of gene edited foods on human health, including, whether the foods will impact human DNA, a question according to participants that may not be known until many years later. Participants also worried about the nutritional value of GE foods and their effect on human health. Will GE foods be as nutritious as "natural" food? For participants, "naturalness" seems to be equated with good or healthy food, and appears an important value, with suggestions that GE may threaten this naturalness, and even that we may not be being told the full facts:

Part of a conversation in focus group 2:

M1: Well, I always think: what's the catch with things like that? What are they not telling us? And I often worry about that…Because I don't know that much about it. So, what's the part they are not telling us?
M2: Or what do they not know yet?
F1: Yes, exactly. Indeed.
M1: Yeah, well, I suppose that is more likely.
F1: Yes. That something like this doesn't also have an effect on our DNA...
M1: Exactly, yes.
F1: … that we will …
M3: Also [have a] shiny skin.

Besides concerns about human health, participants also expressed concern about the impacts that GE crops may have on the ecosystem. In some groups, participants returned to the example of the Bt Bringal eggplant we had introduced earlier (see Appendix 5). Others discuss the effect new GE-plant varieties could have on the ecosystem in general. For example, will certain resistant species lead to negative effects later in the natural food chain? Will certain species displace others in ecosystems?

Part of a conversation in focus group 2:

F1: What immediately came to my mind is indeed the impact on the whole ecosystem, of the pollination of fruits, vegetables and fruits. So, what is the effect on that? And won't it also push out other species? Or will they cross with them too? And what would that signify?
M1: Yes.
F1: Yes. And what is the effect on our health?
M2: Or for animals, those worms. Maybe they'll all die and then we'll have another problem.
F1: Yes, exactly. And maybe all the bees. Yes.
M3: Yes, fish. Which then come to the surface.
M2: Yes. Yes, by dead trees.
M2: Yes.
M1: You just don't know what it's going to do to the whole chain. That's what it comes down to.
F2: No, so you actually get a bit of nature out of it.
M1: So that needs to be examined
F2: Yes.

People commonly drew on a narrative of the precarious balance that exists in ecosystems, and of how this could be threatened by well-meaning but poorly considered technological interventions. Analogies were drawn in some groups with current problems in Dutch gardens. For example, an analogy was drawn with the Japanese knotweed, an introduced species which is proliferating in Dutch gardens, disrupting biodiversity. Another analogy drawn was the boxwood moth, which has caused great damage to boxwood plants in the Netherlands. Participants seem to draw from their current experience, as well from an awareness of the decline in biodiversity in general, leading to the shared view that care and foresight needs to be taken to guard against an unintended imbalance in ecosystems.

Given that the long-term safety of gene edited crops has not yet been proven according to some stakeholders, caution with introducing the gene editing technology was seen to be warranted. Even though societal problems are seen as in need of urgent attention, nevertheless this does not imply that this technology should be implemented with the same urgency and at all costs. The technology might be suitable and it might help us combat societal challenges in the coming years, but participants warn that we need to make sure we are not creating “a bigger monster than we are dealing with now”. Safety is an important value that underlined many of the responses of people to gene edited food.

3.3.2 The purpose of introducing gene editing in crops

Most participants were cautiously positive about the potential of using gene editing to contribute to a more sustainable world and to helping solve food scarcity. They found the arguments of dealing with climate change, reducing the use of pesticides and nitrogen fertilizer, food security, and environmental sustainability *in principle* important reasons to introduce this new technology if really necessary. However, they were doubtful as to whether the technology would indeed be used to solve the current problems in agriculture and food, and they doubted whether corporations would turn their efforts towards developing such products that are valuable to society and the environment instead of products with primarily commercial value. We will describe both arguments below.

Is gene editing a solution to current challenges?
One reason participants were hesitant about the use of gene edited crops and foods was due to doubt as to whether this was the right solution to the right problem. For participants, our current problems in agriculture and the food system were primarily associated with the intensification of agriculture that had become embedded in current practices of intensive livestock farming, food waste and in food being shipped all over the world. Participants argued that previous technologies had been complicit in creating many of these problems, and that we should therefore be careful to seek the solution in yet more technology. Conversation centered on whether we should first try alternative solutions that aim to transform the food system into a more sustainable system through responding to underlying systemic and behavioral problems, for example, through eating less meat or engaging in degrowth.[69] Simultaneously, participants acknowledged that behavioral change is never easy to accomplish. Although there was a tendency for some participants to favor traditional agriculture and organic agriculture, others believed this to be an utopia. Technology is probably necessary, according to participants, but it is important to find the right balance. These views on the use of gene editing in crops, are similar to the views on the use of genetic modification in crops (see Section 3.2.2.)

[69] Degrowth is a political and environmental movement that emphasizes that current consumerism cannot continue to exist

Will gene editing be driven by commercial motives?
Mistrust in the motives and capacity of corporations to respond to societal challenges was a widespread and commonplace theme across all the focus groups. Research that may be intended benignly to provide societal benefits would inevitably be used by corporations for short-term commercial benefits, inescapably driven by the logics of capital and the market, and generating change that would poorly be aligned with societal or environmental goals. For these reasons, participant raised doubt that gene edited crops and foods would be developed as a solution for current problems in the food system.

Part of a conversation in focus group 6:

F1: I think if they don't harm anyone with it [developing GE technology], we should continue doing it. But the danger [is] that using food, which is important to all of us […] very large companies make a lot of money. Then the balance is lost. And I think that's very worrying. Just like [what happened] with healthcare, you know, that it is privatized, [and] that the misbalance between rich and poor is actually strengthened as a result. That undermines food security. Because then you can say food security, but if...
F2: For whom.
F1: Half of them can no longer pay it….

Raising such doubts, participants asked repeatedly: who is promoting this technology, and why? Answering this question themselves, participants responded that the motives behind using gene editing in food were money and profit, and that these motives would trump other motives, such as societal usefulness and sustainability. The dynamic of this transformation, including the slippery slope of worthy societal goals inevitably being reconfigured by commercial imperative, is expressed below.

Part of a conversation in focus group 6:

F1: […] I genuinely believe that in the beginning, they [corporations] will do it purely for what it is intended to do. So, going to add extra vitamins or [develop] plants to deplete the soil less, because then, I don't know […]
M1: Needs less water.
F1: Yeah, you know. So, I do believe that. But then what happens as time goes by and we get a little lazier and we get a little less observant. What then? Then there may be someone who says: "oh yes, then we can clone by the way, right?"
F2: We have already cloned animals. Horses are cloned.

F1: No, I know, cloning also happens, but I just want to say something about allowing (or releasing) something [technology]. […] , I have the feeling that eventually an abusive position will arise.
F2: When the floodgates are opened, that's it eventually.
F1: Yes, in the beginning you [the corporation] act like, hey, big brother is watching you, everyone is watching you, so of course you are going to act according to the rules. And at some point, they [corporations] will be "but, you know, we can change this little rule because it doesn't work well. And then in our interest we're going to do it that way."

Participants assumed that gene editing technologies would in future be used for commercial reasons, and it is exactly those commercial reasons that participants did not view as appropriate to develop the technology for. Even if these commercial reasons are in line with consumer wishes, and gene editing would be used for aesthetic reasons and convenience, it was still rejected by most participants.

3.3.3 Aesthetic motives, convenience and striving for perfection

Most groups discussed the phenomenon of fruits without seed, now prevalent in grapes and grapefruit, as a signifier: some saw these as useful and convenient innovations, while others saw these as unnecessary and as a sign of our collective desire for indulgence, or as a superficial "need" created by the food industry. Related examples were bigger and better-looking fruit and vegetables ostensibly made to be more attractive for consumers. Participants did not have a positive view of larger vegetables: they were believed to contain more water and less flavor and were referred to as e.g. "waterbombs", "vegetables kilo bangers" (*kiloknallers*), and "less for more".[70] They were often contrasted with the smaller, and sometimes misshapen vegetables and fruits from Southern-Europe, which were viewed as tastier.

In general, participants felt uneasy about this trend towards a pursuit of perfection in society. Surprisingly, in all groups the "misfits" (*Buitenbeentjes*) from Albert Hein, a Dutch supermarket chain were discussed. "Misfits" are fruits that have bruises, or otherwise are not perfect looking. They were seen as a symptom for our desire for perfection, and as an indication how perfect our food already is: if it is differently shaped than perfect, we call it a misfit. There was a common sense that this pursuit of perfection is a step too far. Why do we want everything to be perfect? And why do we want to adapt the world to our human needs? Will we in the future breed square tomatoes because they fit better in the trucks that need to transport them, or

[70] In the Netherlands, kiloknallers usually refers to meat sold for a very small prize, with the undertone that the animals were not treated well.

better in our fridge? This strive for perfection was seen as an indication of our dissatisfaction with the world, of how we struggle to make peace with the world not being perfect, of making the world “makeable”. Not surprisingly, this trend of pursuing perfection was sometimes pitted against valuing nature as it is, a common sentiment in the groups that nature is good.

> *I don't think it's [GE crop] “improved”. Also, I question whether the nutritional value is still the same. And the further away you go from nature, I think it's not an improvement.*
> (Focus group 1)

> *Because the more that happens to it [vegetables], the more natural properties are lost, I think. And, yes, what is naturally in it, is precisely why it is so good.*
> (Focus group 3)

> *A tomato just needs to stay a tomato.*
> (Focus group 5)

> *That story about tomatoes and cutting is still nice. But those words, synthetic and genetic, don't actually go very well with that green tomato. And we don't want that with our vegetables and with our things. You actually merge nature with technology. That's what this is... but do we want that?*
> (Focus group 4)

This line of argument was also deployed using other examples including in the biofortification of crops. Genetically increasing vitamin content in certain vegetables was viewed by some participants as a sign of our indulgence, and our striving to create the world according to our wants: “we prefer not to eat carrots, so will add those vitamins to our tomatoes”. Other participants saw benefits of increasing the nutritional value of fruits and vegetables as they may contribute to human health. Vitamin-rich vegetables could for example be valuable at a time when climate change would prevent crops from growing in certain places. And possibly, it is already useful for low-income countries where certain vitamin deficiencies persist. In contrast, the example of the GABA-enriched tomato, the first crop genetically modified with CRISPR-Cas, was mostly met with skepticism (see Box 5).

Box 5 **The first CRISPR-edited food on the market: GABA-tomato**

When introducing the genome-editing technology (CRISPR–Cas9 in our case), we presented the GABA-enriched tomato to participants. These are the first gene-edited product on the market. These tomatoes are genetically edited to contain high amounts of γ-aminobutyric acid (GABA). The company (Sanatech Seed) sells directly to consumers with the claim that oral intake of GABA can help support lower blood pressure and promote relaxation.

In a few groups this led to suspicion as to why this “relax-tomato” was marketed. Who decides to market a calming tomato? Is it done to make money? It is done because people are too stressed out? It is done to keep people quiet and mellow, and to make sure they do not protest? Some groups see it as behavioral manipulation. In other groups, it is seen as a luxury item, and therefore unnecessary. Some participants see advantages though as it may lead to the development of “medicinal” vegetables that help cure people. Or as a step towards vegetables that are more nutritious. Groups in general do not view the development of the GABA tomato as a positive development.

3.4 Attitudes towards regulation of gene editing

None of our participants were aware of the current regulatory regime of GMOs in Europe. When we explained the regulation, many were pleasantly surprised by the fact that Europe already has in place strict regulations. They felt reassured that GM crops are assessed for risks, and that they are monitored and labeled. As participants did not see a substantial difference between genetic modification and gene editing, it is not surprisingly therefore, that none of the participants were in favor of exempting gene editing technologies from the regulation; they want GE food to be assessed for risks to human health, animal health and the environment. For participants, there needs to be oversight because you are introducing new technologically-altered crops in the food system and environment, especially since these may come with unintended consequences for human health or the environment that may not be visible for years. So participants stressed again that caution is important, not haste.

Part of a conversation in focus group 1:

M1: So, what I'm trying to understand, if gene editing is more or less, let's say, in an efficient way, superior form of GMO, then the essential argument of whether or not it should be regulated does not change. It's just more efficient. But the idea why you have the regulation in the first place is because it's genetically modified, with all the benefits and risks that come with that, but that all of a sudden being more efficient, does it make it less dangerous?
F: Yeah, exactly.
M2: Yeah, I agree. I don't see why you wouldn't take the risk assessment and the labelling mandate just to maybe bring it [the gene edited crop] to the market a few years earlier when it can go through the process and make sure that it's in a very good way with those checks.

3.4.1 Innovation versus precaution

Even though the concept boards had been carefully drafted to be even-handed and impartial, participants were more drawn to arguments from NGOs and from nature and environmental organisations. In general, our research showed that participants rarely if ever found the arguments (see Appendix 5) for the deregulation of gene edited foods and crops persuasive. We have already described that most participants were not convinced of the argument that gene editing was necessary for sustainability, neither did they believe that in practice it would be used for that purpose. A further argument commonplace in the discourse of proponents of deregulation is the innovation and competitiveness argument. In the focus group discussions we asked participants to deliberate on this argument: because it is time-consuming and expensive to apply for a license for GM and GE crops in Europe, innovation is hampered, and if Europe does not change its restrictive policy, companies and research institutions will fall behind, and even leave the EU. For participants, we found that the imperative for innovation and for remaining economically competitive was not as important as the imperative for precaution. For some participants the very notion of competition was seen as in tension with the ethos of solving societal challenges, which required collaboration, of scientists and innovators working together and not competing, as expressed below.

From focus group 5:

F: I think if you are talking about creating food security so everyone at least goes to bed with a full belly, and your next argument is 'because of competitiveness', you're basically wiping the first argument immediately off

the table. […]. *If it is about food security, shouldn't they [companies and scientists] work together?*

Another participant (focus group 6) points out that competitiveness may lead to similar issues as we have in our Dutch privatized healthcare, where everyone is searching for the cheapest and most efficient care. But is this the best care?

Proponents of deregulation deploy another argument, namely that because the gene editing technology is easier to use and cheaper than genetic modification, small companies and research institutions also are able to develop and market gene edited products, but only if gene editing is exempted from the current GMO regulation. Otherwise, only large corporations can introduce GE crops on the market, since the market authorisation procedure is too expensive and onerous for small companies. Exemption could therefore reduce the scope of influence and control of large multinational corporations over our food system. In response, the Dutch citizens in our focus groups expressed unease of the idea of enabling increased numbers of scientists and companies the power to develop and market increased quantities of gene edited fruits and vegetables. In three of the groups in particular, the notion that deregulation would increase access for new actors to develop and commercialize the technology (what some proponents have termed 'democratization') was seen as troublesome and even dangerous.

Part of a conversation in focus group 2:

M1: What do they mean? I think that is a particular sentence: "Modifying genes has been democratized."
M2: You and I can start tinkering too. That is democratization?
M1: Is that democratizing?
M2: Yes.
M1: That you just… That anyone can tinker.
M2: Yes
M3: Yes. That is how I understand it too.
F1: Yes, that it will be available to everyone.
F2: And that any madman can get [it] to work.

Participants came to the collective view that governance and oversight is necessary and important because of potential risks to human health and the environment, because of unease about companies having too much power, and because they do not trust (small or large) companies to behave in the public interest and to develop sustainable products. Regulation is seen as one way for governments to exercise control and maintain the public interest. "So if you want to have confidence in the

products you eat, it seems crucial to me that we at least have some kind of assessment." (focus group 2, M)

Participants therefore would prefer strict oversight of large corporations, as precautionary viewpoints weigh heavier than those promoting innovation or competitiveness. More so, because there are seen to be better and alternative ways to make agriculture more sustainable. Simultaneously, not everyone was convinced that in practice, it would be possible to transition to a more fair and sustainable food system without using biotechnologies. Changing behavior, necessary for some alternatives like eating less meat, would be hard to achieve. According to participants, society will desire a risk assessment to take place, for gene edited products to be labelled, and for the power of multinational companies to be limited.

3.4.2 Labelling and choice

Besides the importance of assessing and monitoring the risks of gene edited crops and foods, participants also expressed the view that the application of gene editing techniques in agriculture needs to be regulated because they believe the labelling of gene edited food to be important. With one exception, all our participants agreed that consumers should be able to choose, with solely one person (FG 4) responding that it was not important for him personally whether gene edited food was labelled, but only *if* there was a guarantee that the product was similar to (and as safe as) an organic product. He continued that he had doubts whether that reassurance could be given at the moment. It was expressed that one could only speak of a real choice if the label would be big enough to notice. Some participants quoted research that shows consumers do not pay attention to labels on foods, that there has been an increase in all kinds of front-of-pack food labels, and that they are not always trustworthy. Simultaneously, some participants disclosed that it was likely that they would rarely if ever check whether a product is a labelled as genetically modified or gene edited. In one group, it was emphasized that a real choice would only exist if gene edited food would be similarly priced as conventional food. If it would be cheaper, one can hardly speak of a choice as people with a lower income will not have the option to buy more expensive, and in the view of participants "less healthy food".

Transparency
Participants commonly expressed their surprise that they were not aware of the current status of GM-crop cultivation in the EU, and of current developments in gene editing and possible legislative changes. Especially those that tend to keep up with current affairs expressed surprise.

Part of conversation from focus group 5:

F *"There are really things in here that I didn't know at all, even though I thought I knew. And [I] also keep track of the information. And that gives a feeling of discomfort. Like, huh, what are they doing? I am paying attention, aren't I?"*

Participants in group 6 drew a comparison between the manner in which the Dutch government is not informing citizens about gene editing developments and the scarce information that had been accompanied with the COVID-19 vaccines. In both cases the government had not exercised transparency in their view. Transparency was a topic of conversation across all groups, and an important value to all participants. Participants clearly expected the government to provide citizens with information about the current and prospective legislative procedures of the EU.

In general, we found an issue of trust with the Dutch government. Various participants express mistrust in the government to behave in the public interest. This diminished trust in government is viewed by participants as having been brought about by publicized abuses and wrongdoings of government and ministries in recent years, and where citizens had been kept in the dark (such as the Benefits affair or Toeslagen-affaire). For participants in focus group 6, they saw a (too close) alliance between government and corporations, where politicians too commonly become CEO's in large corporations, and where politicians prioritize the interests of corporations above the wider interest of the country and its citizens. Participants also mentioned the large influence that pharmaceutical companies have on governments. In general, experiences during the COVID pandemic, including the introduction of the mRNA vaccines (with possible side effects), appear to have led to diminished trust in government.

3.4.3 Alternative regulation

Towards the end of the focus group discussions, we introduced participants to a third alternative, a new option, to regulate novel gene edited products. This alternative policy option is based on a Norwegian proposal, described in a Rathenau Instituut report from 2019.[71] In this proposal, there are several levels of risk assessments. Based on the level of genetic intervention (i.e. introducing a gene of another species or changing some letters in the DNA of a gene) a certain level of risk assessment would be applicable. This would allow gene edited crops (with anticipated low risks to humans and the environment) to undergo a less strict and less burdensome risk assessment procedure than GM crops. Simultaneously, all

[71] Habets, M., L. van Hove and R. van Est (2019). Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations. The Hague: Rathenau Instituut

products would be assessed for broader criteria, such as sustainability, ethical aspects and societal benefits.

Following deliberation, many participants expressed the view that they are not knowledgeable enough to know whether the current regulation is too strict or not. Therefore, they found it hard to develop an informed opinion to a new form of regulation with a lighter risk assessment regime for gene edited food than for genetically modified food. If there are indeed less risks associated with gene edited foods, they could imagine that the rules may well have to be adapted. They could live with less strict regulation for gene editing techniques, but the option of not regulating at all was seen as a bad idea.

In general, participants liked the idea of assessing gene edited products using broader societal and ethical criteria. Indeed, throughout the discussion in all the groups, there remained the over-riding view that gene editing and genetic modification should only be used when there is a good reason to do so (commercial reasons being insufficient in themselves). When confronted with this Norwegian model, however, participants were doubtful about its practicality and feasibility. Who decides whether something is useful? Or sustainable? Or ethical? And what indeed is ethical? And how should the criteria be weighed and compared?

Part of a conversation from focus group 1:

M1: Who is in the committee?
Mod: Who is in the committee?
M1: How do you… are you able to quantify and compare it? Okay. Yeah, this is how do you have apply, okay, the score is really high on [the] sustainability [scale], but how does it compare to, I don't know something else that could be used as an argument against it? So, I mean, if maybe there's some thought behind it already, I mean on a positive note, it's, to me this looks like sensible, but yeah, like who's going to assess the whole thing and how are you going to get to compare certain indicators? That's, it's not quite complicating to.
Mod: Some practical of might be really difficult.
M1: Yeah. It might be very difficult to execute this thing.

According to participants it was important that a committee set up to evaluate on a case-by-case basis, the value and usefulness of GE crops, would need to be independent. The process would need to be robust, reliable and independent. Moreover, participants expressed the view that the risk assessment should not be influenced by a positive assessment of broader aspects. If a certain crop would contribute to sustainability, for example, this should not compromise or restructure

the conduct of the risk assessment. Risk assessment and broader assessment should be independent processes. Safety was seen as too important to be overruled by a societal benefit.

At the end of the session, we asked citizens to briefly tell us what resonated most with them or what they thought overall about gene editing. In box 6, we give an overview of some of the answers participants gave.

Box 6 **Views of participants summarized by short quotes on their overall view on gene editing at the end of the focus group**

- “Shady but worth exploring.”
- “Excited about the benefits, but no unnecessary risks should be taken unless the real social and sustainable effects have been proven.”
- “I think we can use the money and time to look for other solutions.”
- “Still many questions.”
- “It can be useful but it needs to be used well.”
- “I can see the pros, but I have questions and objections.”
- “It is exciting to see what useful and maybe fun tasty new things will be marketed in future.”
- “I think it is really smart to think well about this.”
- “Is this necessary?”
- “It seems like we are in a hurry. What is the reason behind it?”
- “Not everything you can do, you should do.”
- “Smart, but I cannot see the consequences yet, so maybe wait a bit”.
- “I like innovation.”
- “Europe is strict and it should stay that way.”
- “I would like some control for me and my family.”

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4 Discussion

In this study, we have engaged with Dutch citizens from several layers of society in open, constructive dialogues using focus group discussions to explore their views on gene editing in food crops, the factors shaping their perceptions, and the conditions they deem necessary to introduce gene-edited crops into the European market. In this chapter, we answer the four research questions we set out to examine.

1. What are current attitudes of Dutch citizens towards crops modified by the older genetic modification techniques?
2. Do Dutch citizens view crops modified by gene editing techniques as substantially different from those modified by the older genetic modification techniques?
3. What are citizens' concerns and hopes on gene edited crops and food, and what factors underpin these?
4. What governance does the public see fit for gene edited crops?

In the conclusion (Chapter 5), we discuss the implications of our findings and give recommendations for the development of a new policy initiative for NGTs. We also provide recommendations for how to engage the public in the continuing debate on how to reform current regulation.

4.1 Attitudes towards genetic modification in food

In this section, based on our findings, we answer the first research question.

> What are current attitudes of Dutch citizens towards crops modified by the older genetic modification techniques.

Our findings confirm the findings of previous studies that Dutch citizens have reservations towards the use of genetic modification in crops.[72] Although the

[72] InSites Consulting (2017) *De burger aan het woord: publieksopvattingen over moderne biotechnologie* Onderzoeksrapport; De Publieke Stem | Rapport | Rijksoverheid.nl; COGEM (2019). Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM.
Gaskell, G. *et al*. (2010). *Europeans and biotechnology in 2010. Winds of change?* A report to the European Commission's Directorate-General for Research*; Eten en Genen. Een publiek debat over biotechnologie en voedsel* Verslag van de Tijdelijke commissie biotechnologie en voedsel, onder voorzitterschap van dr. J.C. Terlouw. 2001

citizens we spoke with believe that GM crops may deliver benefits, especially with regards to sustainability and food security, they have doubts whether in practice the application of the technology would lead to socially beneficial crops. Instead, they expect that companies would prioritize the development of commercially interesting crops. Moreover, they express doubts whether the technology is the right answer to our current societal challenges. They propose that alternative solutions, like a more fair distribution of food in the world to solve the current food shortage, would be more efficient and arguably better. Furthermore, such alternatives would not be accompanied by unforeseen, long-term risks for human health and for ecosystems, as has been the case with the introduction of biotechnologies, according the citizens.

Do these views differ from the views and perspectives of Dutch citizens on genetic modification in crops in the late 1990s and early 2000s? Although our study is not comparative, some parallels came to the fore between the findings of our study and the findings of the broad public debate that took place in 2001 in the Netherlands (*Eten en Genen*). Citizens then and now express doubts about the usefulness or purpose of GM crops, inquire about alternatives, and question the safety of these crops.[73] Such worries are also observed in other studies in Europe.[74] Indeed, of the many objections voiced by citizens in the Dutch public debate in 2001, most were based on utilitarian considerations (i.e. on the consequences of using GM). Only a limited number of people objected to genetic modification using principal or deontological ethical arguments (i.e. that GM constitutes an infringement of the integrity of a species).[75]

In our study, we found also only a few participants who rejected GM crops on principal grounds. But many participants did express an unsettling feeling (see 4.3.1) which needed to be overcome prior to approval or acceptance: in our case, only a genuine need for the technology for societal purposes would offer the participants reason to overcome their hesitation. Mere economic benefits were

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[73] *Eten en Genen. Een publiek debat over biotechnologie en voedsel* Verslag van de Tijdelijke commissie biotechnologie en voedsel, onder voorzitterschap van dr. J.C. Terlouw. 2001

[74] Special Eurobarometer 52.1 The Europeans and biotechnology. 2000; Special barometer. Europeans and Biotechnology in 2005: Patterns and Trends; Special barometer. 73.1 Biotechnology 2010; Eurobarometer 58.0. Europeans and Biotechnology in 2002; Grove-White *et al.* (1997) *Uncertain World. Genetically Modified Organisms, Food and Public Attitutes in Britain.* A report by the Centre for the Study of Environmental Change in association with Unilever, and with help from the Green Alliance and a variety of other environmental and consumer NGOs. Lancaster University.

[75] *Eten en Genen. Een publiek debat over biotechnologie en voedsel.* Verslag van de Tijdelijke commissie biotechnologie en voedsel, onder voorzitterschap van dr. J.C. Terlouw. 2001, p. 19; These findings seem to contrast the findings of the Eurobarometer of 2000, which found that European citizens believed GM crops to be morally unacceptable. (Eurobarometer 52.1 The Europeans and Biotechnology. 2000 p. 31) We do not have an explanation for this discrepancy. Perhaps, Dutch citizens have always had fewer moral objections than citizens of (some) other European countries, or citizens can be more nuanced in a focus group discussion then in a survey.

insufficient to legitimize the development and introduction of GM crops to the market, in the eyes of citizens we spoke with. In the organized debates in 2001 (one part of the broad public dialogue in the Netherlands), 75% of citizens expressed the view that they could accept further development of biotechnology in food under several conditions. These were:

- that the usefulness and necessity must be demonstrated;
- that strict rules and surveillance were in place for food safety;
- that consumers would have freedom of choice; and
- that risks to the environment were minimized.[76]

These findings of research conducted in the Netherlands in 2001 are very similar to our own, and to others.[77] Simultaneously, we observed that participants in our focus groups assess technologies not by their potential power, but instead on the circumstances in which they emerge. In addition to concerns about impacts on health and the environment, they reflect on the wider ramifications of the technology, alternative approaches, and considerations of justice and fairness in the food system. Citizens demonstrate an awareness of the entanglement of technologies with politics and the food system.

4.2 Views on gene editing compared to genetic modification

In this section, based on our findings, we answer the second research question.

> Do Dutch citizens view crops modified by gene editing techniques as substantially different from those modified by the older genetic modification techniques?

This question needs careful answering: our findings show that citizens do not view the technique of gene editing as substantially different from genetic modification, however, for regulatory purposes, citizens we spoke with are open to a differentiation in risk assessment between genetic modification and gene editing in crops. Similar to a previous study commissioned by COGEM, we found that citizens

[76] In other sub studies of the broad debate on Biotechnology and food, 43% of respondents did not want any market authorisation for GM-food.

[77] InSites Consulting (2017). *De burger aan het woord: publieksopvattingen over moderne biotechnologie* Onderzoeksrapport; COGEM (2019*). Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning.* Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM; Nair, A. *et al*. (2022). 'Would you eat a genome-edited crop?' Citizens juries in the Netherlands and United Kingdom say yes to new plant breeding techniques. Agriculture and Human Values. Submitted; Hanssen, L. (2022) *De Publieke Stem. Publiekspercepties van Nieuwe Biotechnologische Technieken in de Agro- en Industriesector en Mogelijkheden voor een Effectievere Publieksparticipatie bij de Ontwikkeling van Nieuw Biotechnologiebeleid.*

make a clear distinction between plant varieties created by traditional breeding on the one hand, and genetic techniques, including classical mutagenesis, gene editing, and genetic modification, on the other hand.[78] In our study, citizens express a preference for traditional breeding.

This finding stands in contrast to one of the key narratives used by proponents for the exemption of GE crops from the GMO Directive. Proponents emphasize that plants modified by gene editing technologies are biologically equivalent to plant varieties of traditional plant breeding methods and (traditional) mutagenesis. The argument for equating gene edited crops with traditionally bred crops is that the product (the crop) could be genetically similar, even though the process is different. The citizens in our focus group discussions, however, argue rather that the fact that certain mutations could have also happened in classical breeding, or in nature, is irrelevant, because they *did not* happen through classical breeding or in nature. Instead, scientists modified the genome in the laboratory according to their desires to introduce new traits. The process (and intention) of gene editing is relevant for citizens in our study.

In the academic literature, biologically equating gene editing with traditional breeding is sometimes viewed as a strategically chosen narrative, as the products from traditional plant breeding and mutagenesis are not regulated (as in traditional breeding) or exempt from regulation (as in mutagenesis).[79]

The citizens in our study reflect on the fact that equating gene editing with traditional breeding can be done for political or marketing reasons, to rid gene editing of a bad connotation. They mentioned that the term ‘gene editing’ sounded “nicer” than the term genetic modification. Perhaps the new term was meant to make it sound friendlier.

However, the fact that citizens do not view gene editing as substantially different from genetic modification does not imply that citizens are categorically opposed to the idea of a less strict risk assessment option for gene edited crops. This indicates that they can see how various way to modify genes in crops can have different risk profiles.

We can conclude that for citizens crops that result from gene editing are not seen as substantially different from those that result from genetic modification. Gene

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[78] COGEM (2019). *Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning*. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM.

[79] Bain, C., Lindberg, S. and T. Selfa (2020). Emerging sociotechnical imaginaries for gene edited crops for foods in the United States: implications for governance. *Agriculture and Human Values,* 37, 1-15. 10.1007/s10460-019-09980-9.

editing is seen as a form of genetic modification. However, for regulatory purposes, differentiation among different forms of genetic modification techniques may be possible according to many participants, although experts would need to assess this.

4.3 Citizens' views on gene editing

In this section, based on our findings, we answer the third research question.

> What are citizens' concerns and hopes on gene edited crops and food, and what factors underpin these?

Our study demonstrates that the citizens we spoke with have reservations about introducing gene editing techniques in plant breeding practice in Europe. Broadly, they give three (underlying) reasons for this. First, they have doubts about the likelihood that gene edited crops will deliver on the promises that are currently being made. Second, they are aware of the fact that the introduction of technologies often comes with unforeseen and unintended consequences. Third, several cultural ideas underlie the attitude these citizens take towards gene editing in crops (see 4.3.1). The EU should therefore take precaution when introducing gene editing in agriculture.

In general, the citizens we spoke to were open to the idea that gene editing can provide solutions for specific problems in agriculture, like infections and plagues. They can foresee a future with gene edited crops made resistant to diseases that threaten harvests, or crops developed to grow in dryer climates. Some citizens hope that with this new technology crops can be developed that are more nutritious because of increased levels of vitamins, or that can be borne by people with food intolerances and allergies, like gluten-free wheat. Most participants also agree that if there is strong evidence that gene edited crops are necessary in low income countries to deal with specific and local societal challenges, the introduction of those crops should be possible under well-defined conditions. Indeed, if gene edited crops would deliver on some of their promises, many citizens we spoke with would view them in a positive light. This result was also found in 2001, during the broad debate on Biotechnology in Food in the Netherlands. Dutch citizens expressed views to accept genetic modification in crops if the positive effect on the environment is large *and* proven.[80] But citizens then and now question whether GM and GE crops will deliver on their promises for two reasons.

[80] *Eten en Genen. Een publiek debat over biotechnologie en voedsel* Verslag van de Tijdelijke commissie biotechnologie en voedsel, onder voorzitterschap van dr. J.C. Terlouw. 2001, p. 13

First, the citizens we spoke with question the plausibility that societal interests would prevail over commercial interests if decisions are left primarily to the market. It is seen as more likely that commercial motives would shape the development of the technology in the real world. And it is precisely the prevalence of commercial motives that citizens reject as sufficient justification for the development of gene edited crops, partly due to reasons of unnaturalness and unfairness (see 4.3.1).

Citizens worry that gene edited plants are unlikely to contribute meaningfully to solving current challenges such as the nitrogen crisis, the climate crisis or food security, because these challenges are caused by multidimensional, complex factors. Moreover, it is the unjust food system that needs repairing. They doubt whether gene edited crops will provide solutions as they do not see how these would solve underlying causes of our current predicaments.

Second, the reserved attitude among citizens is also caused by the awareness of unintended and unforeseen negative consequences that often accompany the introduction of technologies. Citizens in our focus groups view the intensification of agriculture, and the technologies necessary for this intensification, as having caused many or our current problems, like nitrogen disposition, decreased biodiversity, impoverished soil, and climate change. Solving these problems with yet another new technology, is seen as a temporary solution that is likely to generate unintended and unforeseen side effects in the long-term.

For these reasons, citizens express the view that we should take a precautionary approach, just as Europe has done so far with genetically modified crops, rather than to rush to introduce this technology in society. Possible negative consequences that were discussed in the focus group discussions were a further concentration of the power of large companies in the food system, risks (and uncertainties) to human health, and risks to the precarious balance in natural ecosystems (including agricultural ecosystems). They substantiate these risks with their experience of the concentration of power of big tech companies in recent years, and with their experience of exotic species driving endemic species to extinction. But citizens also address the unknown unknowns: harms that may occur that cannot be predicted beforehand. These possible negative consequences were also mentioned by citizens in public perception studies of 2017 and 2019.[81] The (special) Eurobarometer surveys also find perceptions of high risk among European citizens towards GM food.[82]

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[81] COGEM (2019). *Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning*. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM; InSites Consulting (2017). *De Burger aan het Woord: Publieksopvattingen over Moderne Biotechnologie*. Onderzoeksrapport in opdracht van het Ministerie van IenW.

[82] Special Barometer. Europeans and Biotechnology in 2005: Patterns and Trends. p.17-18; Special barometer. 73.1 Biotechnology 2010; Eurobarometer 58.0. Europeans and Biotechnology in 2002

Although proponents of deregulation depict the introduction of gene editing technologies in the plant breeding practice in Europe as a development in the best interest of society, and leading to a more sustainable agriculture, citizens in our focus groups are critical of this view.

The third underlying reason why citizens are hesitant to embrace the use of gene editing technologies in plant breeding are underlying cultural ideas, which we will address below.

4.3.1 Values underpinning the views of citizens: naturalness, the pursuit of perfection, and justice

Several cultural ideas, or narratives, are formative in the attitudes citizens take towards the use of gene editing in crops. Here, we will discuss the three dominant ones.

The importance of naturalness

Many citizens in our focus groups express a preference for “pure” or organic food. We believe that the concept of “naturalness” of this food underlies this preference. Indeed, what is natural is often equated with what is good or healthy. [83] In our focus group discussions, this concept was sometimes expressed explicitly (see 3.3.3). Sometimes it was implicit in the discussion, for example when someone mentioned that you just have to let things grow in their own time (and thus not manipulate the ripening process of fruits and vegetables).

Other studies too, have shown a strong preference for natural and organic food in high-income countries.[84] Naturalness, freshness, and minimal processing are the most desirable food attributes, according to a survey held in 60 countries among more than 30.000 respondents.[85] Studies have shown that when it comes to determining the naturalness of an entity, the process is more important than the content for Western citizens:[86] “The absence of human processing” or “the absence

[83] Nuffield Council on Bioethics. (2015). *(Un)natural. Ideas about naturalness in public and political debates about science, technology and medicine.*

[84] Roman S, Sanchez-Siles LM and Siegrist M. (2017). The importance of food naturalness for consumers: results of a systematic review. *Trends Food Sci. Technol*., 67, 44–57; Rozin P., Fischler C. and C. Shields-Argeles (2012) European and American perspectives on the meaning of natural. *Appetite* 59, 448–55; Rozin P. *et al*. 2004. Preference for natural: instrumental and ideational/moral motivations, and the contrast between foods and medicines. *Appetite*, 43, 147–54

[85] Nielsen Co. (2015). *We Are What We Eat: Healthy Eating Trends Around the World*. New York: Nielsen Company.

[86] Scott. S.E. *et al.* (2018). An Overview of Attitudes Toward Genetically Engineered Food. *Annu. Rev. Nutr.*, 38, 459–79.

of additives" is the most common definition of naturalness given by Western Europeans and Americans in one study.[87]

It may therefore not come as a surprise that gene editing and genetic modification are seen as a move away from nature, a move away from their natural purpose, perhaps even a threat to the idea of natural, which may partly explain the hesitation among citizens to embrace this technology.[88] Gene editing is a process of targeted, intentional modification of the genome of a plant in the lab. One participant (Focus group 4) called the gene edited GABA tomato "a merging between technology and nature".

Scott and colleagues suggest that perceptions of naturalness can be influenced by even minimal contact between a natural food and an unnatural entity, such as a scientist or a piece of foreign DNA.[89] This may explain why in our study, and in a previous study, Dutch citizens distinguish traditional breeding from all genetic modification techniques (including transgenesis, cisgenesis, classical mutagenesis and gene editing).[90] Although we did not extensively address views on traditional breeding, it is possible that because this has been done for thousands of years, and can be done by farmers and not only scientists in the lab, it is seen as dissimilar to genetic modification techniques. However, the general discomfort in all groups with the increased availability of perfectly formed and large vegetables, are an indication that citizens in our focus groups are hesitant about the purpose of introducing new varieties in general, regardless of which process is used.

In pursuit of perfection

The hesitation to move away from what is viewed as an intrinsically "good" nature may be a factor in two other attitudes we observed in our study. First of all, the sentiment of GE crops being undesirable as a move away from nature, may underlie the emphasis of citizens that the purpose of introducing gene editing in plant breeding should not be primarily commercial. Our society is viewed by our citizens as moving problematically towards ever more intensive forms of "making" the world "perfect" or "improved", and especially more convenient for satisfying human desires. Citizens are at best ambivalent about this. "Tinkering" in the genetic material of plants is seen as a move towards the making of plants as instrumental objects, modified for human convenience and for commercial purposes, like the making of square tomatoes because they fit better into trucks or in our fridges.

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[87] Rozin P., Fischler C. and C. Shields-Argeles (2012). European and American perspectives on the meaning of ` natural. *Appetite*, 59, 448–55.

[88] Macnaghten, P. (2004). Animals in their nature. A case study on public attitudes to animals, genetic modification and nature. *Sociology*, 38, 533–551.

[89] Scott. S.E. *et al.* (2018). An Overview of Attitudes Toward Genetically Engineered Food. *Annu. Rev. Nutr.*, 38, 459–79.

[90] COGEM (2019). *Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning*. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM

Moving away from nature was thus seen as bringing nature (plants) ever more into the sphere of human control for purposes of efficiency. The citizens we spoke with seem cautious about this move. Why can we not be content with nature and accept our place in the world? Why can we not adjust our agricultural practices to become nature-inclusive, instead of adjusting crops to conform with (ever-more technologized) agricultural practices? Moving away from nature seems to be viewed as coinciding with a move towards a makeable world or a "perfect" world: a world where we have adapted nature for our convenience in line with commercial and instrumental motives. And if we are striving for perfection, which is already a questionable issue for some participants, then it should not be done for commercial motives.

Second, tinkering or messing with nature is also seen as posing new risks. The new gene editing technology can put nature out of balance. Nature is in this case seen as in equilibrium, and we need to tread carefully not to intervene and disturb this balance. Citizens worry that gene edited crops, like exotic species, are likely to spread in Europe and perform in unexpected ways, threatening native species, altering the landscape and generating unexpected harms.

This trend towards more efficiency and perfection when combined with the use of gene editing technology is also seen as problematic because it may lead to a slippery slope, according to some of the participants in our focus groups. The sentiment "it starts with plants and ends with animals and humans" (FG 6, M), was heard across many of our focus group discussions.

Justice

Besides implicit and explicit views on naturalness, we also found that views on "justice" play a role in the formation of attitudes towards the use of gene editing in plant applications. Justice, fairness and equality are commonly mentioned concepts. Citizens discuss:

- the unjust distribution of food globally (availability and price);
- the unjust or unequal access to healthy food nationally (due to price);
- the unjust distribution of economic benefits in the food system (e.g. with international supermarket chains making large profits and farmers working hard for low incomes); and
- the unfair and disrespectful treatment of animals in our current agricultural system.

Across a few of our focus group discussions, citizens came to the view that if market authorisation of gene edited crops was facilitated by changing the regulatory framework, that this will lead to growing inequality in the food system. These participants fear that the divide between citizens from a high socio-economic

background and those from a lower socio-economic background was seen as likely to grow, because citizens from a lower socio-economic background would have no choice but to eat gene edited food (as opposed to more expensive healthy and organic foods), once such foods had become the common and least expensive choice in the EU. Moreover, given that the introduction of gene edited crops was viewed as most likely to be behest of large producers, wealth inequality in the food system was also seen as likely to increase giving multinational companies would gain more power and increase their profits.

Given the prevalence of the views that gene edited food was less natural, probably less healthy, cheaper, and that it would most likely lead to increases in inequality – it is not surprising that the citizens in our focus groups reject gene editing technologies for commercial purposes, and would like conditions for the introduction of gene edited crops in the EU to assure socially beneficial outcomes. We discuss this is the next section.

4.4 Democratic governance

In this section, based on our findings, we answer the fourth research question.

> What governance does the public see fit for gene edited crops?

The citizens in our focus groups differed in their views on genetic modification and gene editing, but when it came to regulation, they all opposed an exemption of gene editing technologies from the GMO regulation. Following deliberation, citizens arrived at the view that Europe has got it right in regulating GM technology strictly, and that Europe should exercise precaution with this new gene editing technology too.

Regulation is necessary for citizens for three reasons. First, citizens are concerned about risks and want these to be assessed before gene edited crops come on the market to prevent harm to human health and the environment. Second, they believe freedom of choice is an important democratic right and value and therefore, gene edited products must be labeled. Third, citizens in our focus groups advocate the need for regulation since they do not want gene edited crops to be developed purely for commercial motives driven by the logic of the market. They do not trust that companies, in a deregulated environment, are motivated to develop socially useful products. Regulation is useful to shape conditions for public interest market authorisation, possibly prevent growing inequalities in the system due to a power concentration.

When presented with a concise version of the Norwegian model (see Appendix 5, board 8), as discussed in our Rathenau 2019 report on genome editing in plants and crops,[91] citizens expressed positive views on the principle of adding broader socio-economic and ethical aspects in an assessment for market authorisation for gene edited crops. Nevertheless, citizens still expressed doubts about the practicality and feasibility of such a proposal. Who would decide on what is sustainability? Who would judge what is ethical? And how would ratings be compared?

A number of conditions were discussed by participants as necessary if the EU would introduce a framework like the Norwegian framework. First, the risk assessment element should not be influenced by a positive assessment of broader aspects. Rather, the risk assessment and broader assessment should be separate processes. Second, according to participants it was important that the committee set up to evaluate the value and usefulness of GE crops, on a case by case basis, would need to be independent with no a priori stake or interest in the issue. Third, in their view the evaluation process would need to be robust, reliable and independent.

4.5 Limitations of our study

How people develop an opinion on and give meaning to a new technology is dependent on contextual factors, the way that a new technology will influence these factors in everyday life, and the way this new technology is framed. When a new technology is introduced in society, citizens will be exposed to different framings of the technology, presented by different actors. In the design of our focus groups, we incorporate these aspects by two important methodological design criteria: framing and context.

We introduced our participants to the customary framings (or representations) of the technology currently present in the scientific, political and (albeit narrow) societal debate. It is highly likely that these are the frames that citizens will be exposed to in real life when this topic becomes a public issue. In the focus group discussions, participants interpreted and discussed the presented frames based on their own experiences, earlier discussions on what we termed contextual factors, and the interaction with other participants: both in what they said, and in their non-verbal cues. However, the choices made undoubtedly influenced how citizens interpreted the technology and the influenced meaning-making processes of

[91] Habets, M., L. van Hove and R. van Est (2019). Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations. The Hague: Rathenau Instituut

participants. By focusing on a certain context – in our case citizen's relation to food, their ideas on food production and their view on the role of technology – we also have influenced the flow of conversation. Although, this can be seen as a limitation of our study, it is simultaneously a limitation that will always be present in any public engagement. Moreover, we believe in the robustness of our choice, namely, that people's view on gene editing in food will be shaped principally by their broader views on food and the food system.

Another limitation was the short amount of time available to discuss this complex issue with citizens, and that the conversations necessarily were based on a limited amount of information, albeit bringing the essence of various perspectives and explaining the key aspects of the technologies. However, it should be noted that a limited amount of information will most likely be available to citizens when they will form an opinion on the matter in the real world. Moreover, studies have shown that for individuals, factual information does not enhance the strength of a particular frame.[92] That fact that we cannot provide participants with extended factual information is, although of course preferable, thus less problematic as it may seem at first sight.

Finally, another important aspect of our methodology is the grouping of individuals according to similar educational background and shared characteristics. This was done to create a 'level playing field' and because a shared experience or characteristic allows for a favorable setting for discussing an unfamiliar topic.[93] Simultaneously, it is possible that due to the shared characteristics among participants in a group, their representation or interpretation of the information provided during the focus group, is similar. In that case, participants would not be exposed to various other possible interpretations of the issue from citizens with different viewpoints. The discourse between participants would in that case be limited, influencing the group process of meaning-making. However, if this were the case, we would find differences between groups, which we did not. Moreover, within groups views on gene editing in crops did differ, however, views converged when it concerned regulation.

Although the number (6) and size (6-8 participants) of the focus groups may seem limited, we saw the same themes, views and arguments emerging from the focus groups. There was no new thematic content, new insights, or new views after four

[92] Druckman, J. and Bolsen. T. (2011). Framing, Motivated Reasoning, and Opinions About Emergent Technologies. *Journal of Communication*, 61, 659-688; Nisbet, M. C. and C. Mooney (2007). Framing science. *Science*, 316, 56; although facts can have an equivalent effect as frames without facts.

[93] Macnaghten, P. and G. Myers (2004) 'Focus Groups: The Moderator's View and the Analyst's View', in G. Gobo, J. *et al*. (eds.) *Qualitative Research Practice*. London: Sage p. 65–79.; Morgan, D. (1988) *Focus Groups as Qualitative Research*. London: Sage.

focus groups, which tells us that we have been able to gather the wide range of different perspectives concerning the use and regulation of NGTs. Moreover, when it concerned regulation, participants were unanimous in their views. Our findings are similar to those of other studies.

4.6 Further reflections

In this section we reflect briefly on some findings in our study that may seem paradoxical.

One observation is the central role that citizens in our focus group reserve for the role of government in the regulation of NGTs. National surveys, and our findings, show that trust in Dutch politics is at a historical low.[94] Why would citizens want oversight from a government they do not trust? One way to explain this divergence is that citizens distinguish between the role of government in general and the current cabinet. Whilst many citizens have little trust in the proper functioning of the current Dutch cabinet, they still support the role and functioning of governments in principle to develop and carry out policies in the public interest. In our focus groups, citizens foresee a role for government in developing regulation and expressed their preference for independent committees (those without an already expressed interest in the outcome) to assess the risks to human health and the environment, as well as the broader impacts of gene editing crops. A 2010 Eurobarometer on biotechnology found that 85% of Dutch respondents believed that the government should take responsibility to ensure that new technologies should benefit everyone.[95] Citizens do not want the government to reduce its tasks, instead, they want the government to perform better at its tasks.

Another paradoxical observation in our focus groups is that citizens are very critical of commercial motives, and the wider neoliberal system, that incentivizes corporations to produce at scale more, cheaper and ever more perfect-looking products. While, at the same time, many citizens opt in supermarkets for these inexpensive and perfect-looking products that this system produces. One way to explain these differences is to distinguish the dual identities of our participants as *consumers* and as *citizens.* Choice, quality, and costs are important consumer values, however, citizens have concerns and commitments outside their market relationships.[96] Indeed, participants as citizens, prioritize a different set of values that include integrity, care for the world (and the future), compassion, and respect

[94] https://nos.nl/collectie/13915/artikel/2445243-enquete-vertrouwen-in-de-politiek-is-enorm-laag
[95] https://europa.eu/eurobarometer/surveys/detail/755 (Factsheet the Netherlands)
[96] Kan, S. (2022). *More than consumers: Post-Neoliberal identities and Economic Governance*. Roosevelt Institute

for other species. Another explanation is that some citizens simply do not have the financial means to opt for anything but the inexpensive option. Moreover, although consumers have freedom to choose between products on offer in the market, they have little direct influence on the supply.[97]

4.7 Summary

The attitudes of citizens towards the use of genetic modification and gene editing in crops diverge. Some believe these techniques will be necessary for dealing with current predicaments, like climate change, while others view an introduction of these techniques in practice as likely to aggravate current problems in agriculture and the food system. These views are formed by underlying values that include those of safety, naturalness, justice, well-being, and feelings of unease about the pursuit of perfection in our society. Welfare does not play an important role in the discussions, and economic and commercial purposes are by many dismissed as insufficient justification for introducing gene editing techniques in plant breeding practices. Besides these underlying values, the context of the climate crisis, the COVID-19 crisis, and the nitrogen crisis also are formative of opinions. And there is the underlying unease that the application of the technology will exacerbate certain ongoing and unwelcome trends and developments in society, such the increasingly unequal global food system and the concentration of power in large corporations.

Notwithstanding diverging views on the use of gene editing in crops, citizens agree that regulation is necessary to prevent harms to the environment and human health, to give consumers freedom of choice, to guard against the potential of the technology to increase inequalities, and to ensure that the technology is directed towards the solving of societal problems.

We conclude that citizens assess technologies not by their potential power, but instead focus on the circumstances in which they emerge. This approach leaves room for a consideration of alternative approaches, opportunity costs, and considerations of justice and fairness in the food system. When citizens talk about gene editing in crops they demonstrate an awareness of the entanglement of technologies with politics and the food system.

[97] Van Woerkum, C., N. Aarts and H. Padmos (2006). Wat burgers zeggen en consumenten doen: analyse van een schijntegenstelling. In: *Bestuurswetenschappen,* 60, 25 - 41.

5 Conclusion

The EC is preparing a policy initiative that aims at developing an appropriate regulatory framework for food crops and other plant products developed using NGTs, ensuring that these products are placed on the market under the condition that they are safe for health and the environment, and helping to achieve the objectives of the European Green Deal and the Farm to Fork Strategy.[98] Numerous stakeholder engagements on this new regulation have taken place in the last several years, however, very few public engagement opportunities were provided for citizens.

The key message that emerges from our research is that it is essential for the European Commission and national governments to increase their efforts to engage in regular and continuous open constructive dialogue with citizens about the upcoming EC policy initiative, and in subsequent discussions on the use of NGTs in crops and on alternatives.

There are four main reasons for this. First of all, the potential regulatory changes are of public importance because the introduction of new biotechnologies, like NGTs, can create significant benefits and harms at a public level.[99] Biotechnologies have the potential to influence society, redesign life, and reshape the practice of agriculture and the future of our food system.[100] Citizens should have a voice in how we shape the future of our agriculture and our food, as this involves questions of how we want to live on this planet and how we relate to nature. Therefore, it is important to take a democratic approach in developing new regulation. This entails including citizens in the societal debate and taking into account public values when developing new regulation. Second, when citizens are involved in the development of a new policy, and public values are taken aboard, the chance of a broad societal support of introducing gene-edited crops on the market is higher. Policymakers should not only consult with stakeholders such as scientists and corporations on a regular basis, but also with the end users of the products developed with the technology, which includes citizens, to learn about their wishes and concerns regarding the upcoming regulatory change.

[98] Document Ares(2021)5835503 Proposal for a Regulation of the European Parliament and of the Council on the deliberate release, including placing of the market, of plants, and food and feed plant products, obtained by targeted mutagenesis or cisgenesis

[99] Nuffield Council on Bioethics (2012) *Emerging biotechnologies: technology, choice and the public good*

[100] Ruivenkamp, G. and J. Jongerden (2013). From Prescription to Reconstruction: Opportunities for Subpolitical Choices in Biotechnological and Genomics Research. In: Derkx,P. and H. Kunneman (eds) *Genomics and Democracy: Towards a Lingua Democratica for the Public Debate on Genomics.* Rodopi

Third, we have learned from our research that the views of Dutch citizens converge on the need for the regulation of NGTs in agriculture. These views contrast with the dominant frame in the current societal debate, and therefore also with the view of the Dutch government, which favors an exemption from the GMO regulation. Fourth, we have learned that Dutch citizens emphasize the importance of transparency and of the governments duty to inform the public. Many of the citizens in our focus groups questioned the perceived lack of transparency and available information as none of them had as yet heard of the upcoming regulatory change. Continuous public engagement is therefore viewed as necessary.

5.1 Recommendations on public engagement

Based on our findings and building on previous research of the Rathenau Instituut and of co-author Phil Macnaghten, we will provide policymakers with three recommendations that are important when engaging with the public.

Recommendation 1

Take into account cultural, ethical, and socio-economic considerations in policy discussions on the use of NGTs in crops. Investigate with all relevant parties, including the public, what broader concerns and interests merit a place on the public agenda.

To democratically develop a new policy on NGT crops, and to gain public trust in this process, it is important not to try to convince the public of its importance or necessity, but rather to give participants the time and resource required to deliberate critically on the dominant framings of the technology, to provide space for critical reflection, and engage with the broader considerations, and the underlying values, important to citizens.[101] Public dialogue should focus on the full range of values and reflections important to citizens, which entail question such as “what entails a positive impact” on society and “what is important for human welfare”. In our focus group discussions of NGTs in food and the upcoming possible change in regulation, citizens express concerns about safety, increased corporate control, increased inequality in the food system, and a loss of consumer choice. These wider considerations of citizens need to be taking seriously; citizens should be included in decision-making, not merely informed about upcoming technologies.

[101] Stilgoe, J. and T. Cohen (2021). Rejecting acceptance: learning from public dialogue on self-driving vehicles. *Science and Public Policy*, 46, 849–859.

Often, public engagement is still seen as a way to raise public awareness, public acceptance, and ultimately public adoption of a technology.[102] Especially when faced with public resistance, it is tempting to resort to providing citizens with information, and to increase communication efforts to convince the public of the benefits of technologies "on trial". However, history shows that this rarely leads to changes in attitudes, but instead can make people view a technology in a more negative way.[103] Previous research demonstrates that for genetic modification in crops, the provision of information on biotechnology in food is not a sufficient condition for public acceptability.[104] In our research, we did not see an increase in acceptance during the focus groups either. Moreover, a lack of including broader considerations in the societal debate of technologies, can lead to science itself becoming contested. [105] This can happen when citizens feel that they are not heard nor taken seriously, which commonly leads to distrust.

Recommendation 2

Build a relationship of trust with citizens by being open about the uncertain impacts of NGTs on society, both positive and negative. Discuss the alternatives available as well as the possible unfair distribution of benefits among parties in the agrifood system.

Trust in institutions is a predictor of attitudes of the public towards biotechnology: "If laypeople feel that they know little about gene technology, they may rely on other institutions to manage risks. If those institutions are trusted, the technology is considered less risky."[106] Fully informing citizens, including context, uncertainties and alternative options for policy or dealing with challenges, are the most effective ways to instill trust. For NGTs specifically, this entails policymakers and scientists to be open about (the potential of) the technology to solve as well to aggravate current

[102] Stilgoe, J. and T. Cohen (2021). Rejecting acceptance: learning from public dialogue on self-driving vehicles. *Science and Public Policy*, 46, 849–859; For example, at the CRISPRCON 2019 in Wageningen, conversation took place on how to ensure "the general public can pass a thoughtful judgment on the application of the modern biotechnology". The chairman of the board of Wageningen University & Research said "it would be good for the acceptance of Crispr-cas to look for a few applications that really make a difference to people." Hoe verder met crispr-cas? (2019) WAGENINGENWORLD 3, 22-25.

[103] Blankesteijn M., G. Munnichs and L. van Drooge (2014). *Contested science - Public controversies about science and policy.* The Hague, Rathenau Instituut; Frewer L.J. *et al.* (1999). Reactions to information about genetic engineering: impact of source characteristics, perceived personal relevance, and persuasiveness. *Public Underst. S*ci., 8,35–50; Scholderer J., and L.J. Frewer (2003). The biotechnology communication paradox: experimental evidence and the need for a new strategy. *J. Consum. Policy*, 26,125–57.

[104] Scott *et al.* (2018). An Overview of Attitudes Toward Genetically Engineered Food. *Annu. Rev. Nutr.,* 38, 459-479; Hanssen, L. (2022). *De Publieke Stem. Publiekspercepties van Nieuwe Biotechnologische Technieken in de Agro- en Industriesector en Mogelijkheden voor een Effectievere Publieksparticipatie bij de Ontwikkeling van Nieuw Biotechnologiebeleid*

[105] Blankesteijn M., G. Munnichs and L. van Drooge (2014). Contested science - Public controversies about science and policy. The Hague, Rathenau Instituut; Macnaghten, P. and S. Carro-Ripalda (2015). *Governing agricultural sustainability. Global lessons from GM crops.* Routledge, Oxon.

[106] Scott *et al.* (2018). An Overview of Attitudes Toward Genetically Engineered Food. *Annu. Rev. Nutr.,* 38, 459-479.

societal challenges. This means to avoid the exceptionalism that commonly attaches to gene editing technologies by acknowledging that a sustainable agriculture system can be achieved by alternative methods. Such honesty implies acknowledging that the current gene edited products on the market are not making meaningful contributions to any societal issues. Which leaves open the possibility that in the future NGT crops can assist in solving societal problems. Instead of trying to find possible acceptable uses of NGTs in crops to citizens, scientists and policymakers should invite citizens to reflect with them which uses are seen as relevant and important to society. This is especially important because we find that citizens already doubt the plausibility of these commonly pronounced promissory assumptions in the debate.

Recommendation 3

Communicate openly the scientific uncertainties on the use of NGTs in crops in public engagement initiatives.

This honesty also extends to communicating uncertainties in scientific knowledge. Indeed, the handling of uncertainties involved in scientific risk estimation can be a cause for science itself to become contested. The scope and significance of these uncertainties is sometimes downplayed to prevent unrest, however, this may prove counter-productive, especially in cases where long-term safety is impossible to prove, as is currently the case for gene editing. Calling for more scientific research from academia and institutions has proven to be insufficient to address public unrest, even though scientific evidence may be needed to answer some of the difficult questions posed by citizens. But science does not serve as an independent arbitrator in contested areas like genetic modification, shale gas test drilling, and HPV-vaccination.[107] Trust has been proven to be more important in contested areas of science and technology than scientific information itself.[108] Being open and communicate scientific uncertainties are more likely to instill trust.[109]

5.2 Recommendations on policy options

Our findings can be viewed as an initial indication of a public response, a sneak preview as it were, because we mimic the real world in our focus groups: we

[107] Blankesteijn M., G. Munnichs and L. van Drooge (2014). *Contested science - Public controversies about science and policy.* The Hague, Rathenau Instituut; Sarewitz, D. (2004) How science makes environmental controversies worse. *Environmental. Science & Policy*, 7, 385-403.

[108] Blankesteijn M., G. Munnichs and L. van Drooge (2014*). Contested science - Public controversies about science and policy.* The Hague, Rathenau Instituut.

[109] Van de Bles, A.M. *et al*. (2020). The effects of communicating uncertainty on public trust in facts and numbers. *PNAS*, 117, 7672-7683.

expose our participants to various frames, arguments, facts and value judgements that citizens will most likely be exposed to when the upcoming regulatory change will become a public issue. Similar to what could happen then, citizens in our focus groups have engaged in an opinion formation process building on their prior experience and these information and frames. Based on the results of the focus group research, other public engagement studies, and previous research of the Rathenau Instituut, we provide policymakers with four reflections on ways to translate the views, and underlying values, of citizens towards gene editing in crops into a new policy approach for NGTs in food.

Recommendation 1

Avoid the proposal of exempting NGTs from the current GMO Directive, but instead develop a differentiated, or level-based, policy approach.

Similar to other studies, citizens in our focus groups are unanimous in their view that gene editing needs to be regulated.[110] Even with a risk assessment, citizens we have spoken with are not keen on the introduction of NGT foods on the market. Citizens in our focus groups are concerned about safety, increased corporate control, increased inequality in the food system, and a loss of consumer choice if gene edited crops are introduced in the EU. The context in which citizens have developed this attitude towards gene editing in food includes, amongst others, the nitrogen crisis in the Netherlands, related farmers protests, the COVID-19 crisis, and the climate crisis. Citizens also feel unease about the pursuit of perfection in society (with regards to food as well as wider aspects), the injustices in the global food system, the power concentration of large corporations, and the drift away from natural foods for purposes of efficiency. Collectively, these contribute to a diffuse underlying sense of unease with societal developments and to a lack of trust in politics and corporations to respond to societal challenges, and in the capacity of the free market to bring valuable products for society.

If the EC were to exempt NGTs from the GMO Directive, they would also be exempt from environmental risk assessment and monitoring obligations, which assess the direct, indirect and cumulative (immediate and long-term) effects of the GM crop on public health and the environment. Citizens in our study are unanimous in their view that an assessment for risks to human health and the environment is a requirement for market approval.

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[110] InSites Consulting (2017). De burger aan het woord: publieksopvattingen over moderne biotechnologie Onderzoeksrapport; COGEM (2019). *Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning*. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM; Nair, A. *et al*. (2022). 'Would you eat a genome-edited crop?' Citizens juries in the Netherlands and United Kingdom say yes to new plant breeding techniques. Submitted.

In a previous report, we offered a way forward to modernize the current biotechnology policy with a level-based approval policy. Such an approach would offer different levels of intensity or strictness of regulation and includes various levels of risk assessment. This approach would take into account the differences in expected risks associated with different ways in which NGTs can be used in practice. The assumed risks can dictate the strictness and speed of the risk assessment procedure. Such a differentiated policy already exists for working with GMOs in closed spaces, such as in a laboratory or in greenhouses.

A level-based approach can serve to satisfy in part both the arguments of parties favoring an exemption of NGTs from the GMO Directive as well as parties against an exemption. Some nature organisations also advocate such a level-based approach.[111] This current study reaffirms the importance of a level-based approval system. Citizens are open to a differentiation in risks assessment between crops altered with older genetic modification techniques and NGTs. Although citizens indicate they do not have the knowledge to make this judgment, they trust that independently financed scientists, are able to exercise judgement to make assessments on this issue.

Recommendation 2

Move from a consumer-oriented to a society-oriented governance regime that incorporates ethical, cultural and socio-economic considerations into the market authorisation process.

An exemption from the GMO Directive would also remove NGT products from an assessment of the broader ethical, cultural, and socio-economic considerations important to citizens. An amendment to the GMO Directive in 2015 gave individual member states the right to exclude GM crops on the basis of, among other things, societal, cultural and ethical aspects, such as, sustainability or landscape value.[112] This gave legal status to broader societal aspects that play a role in the debate on GMOs in agriculture.[113] Exempting NGTs from the GMO directive entails excluding NGTs from safety assessment and from this broader assessment, which the Rathenau Instituut does not view desirable.

[111] IUCN-NL Natuur en milieufederatie Noord-Holland (MNH) Natuur & Milieu. (2022) *Biotechnologie in breder perspectief. Een inventarisatie van de posities van Nederlandse natuur- en milieuorganisaties ten aanzien van biotechnologie.*

[112] Directive (EU) 2015/412 of the European Parliament and the Council.

[113] Habets, M., L. van Hove and R. van Est (2019). Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations. The Hague: Rathenau Instituut

Citizens in our focus groups expressed the view that assessing the goal of a specific innovation, its contribution to societal challenges, and the desirability of using the technology as a solution to these challenges, were important considerations. Only within a broader assessment framework can these be taken into account. It is therefore important that policymakers think beyond considerations of risks and economic benefits, seen as important for *consumers*, towards a focus on the ethical, cultural, and socio-economic aspects that *citizens* find important. This can for example be issues like access to certain plants, ownership of seed, and the distribution of power, that all relate to sustainability as well as social justice. Citizens need to be viewed as citizens, not as just consumers. By considering a case-by-case assessment of ethical, cultural and socio-economic considerations, public values can be brought into the design and selection of NGT crops for market authorisation.

Article 26 of the Cartagena Protocol on Biosafety establishes the right of parties to take into account socio-economic considerations arising from the impact of living GMOs on the conservation and sustainable use of biodiversity. Austria and France considered socioeconomic aspects in GMO decision making and/or having socio-economic considerations included in their national legislation even before 2015, as do several non-EU countries.[114] Norway has also implemented a broader impact assessment framework for market approval of GM crops in its Gene Technology Act of 1993.[115] This framework includes socio-economic criteria like sustainability, benefit to society and ethics. The Norwegian Biotechnology Advisory Board has established guidance documents for the societal utility criterion and for the sustainability criteria.[116] Relevant questions in an assessment of societal benefits include whether there is a need for the product and whether the product will solve or possibly contribute to solving a societal problem. As public engagement studies, including ours, demonstrate the importance of these questions to citizens, the Norwegian Act and the guiding documents on the broader assessment can serve as starting point for policymakers in the EU to discuss and develop such a broader assessment framework.

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[114] Spök, A. (2010). *Assessing socio-economic impacts of GMOs. Issues to consider for policy development*. Commissioned by the German Federal Ministry of Health; Federal Ministry for Agriculture, Forestry, Environment, and Water Management.

[115] Gene Technology Act. Act of 2 April 1993 No. 38 Relating to the Production and Use of Genetically Modified Organisms. https://www.regjeringen.no/en/dokumenter/gene-technology-act/id173031/

[116] Norwegian Biotechnology Advisory Board (2009) *Sustainability, Benefit to the Community, and Ethics*. https://www.bioteknologiradet.no/filarkiv/2010/07/2009_11_18_diskusjonsnotat_baerekraft_engelsk.pdf Norwegian Biotechnology Advisory Board (2014) *Herbicide-resistant genetically modified plants and sustainability*. https://www.bioteknologiradet.no/filarkiv/2014/09/Herbicide-resistant_genetically_modified_plants_and_sustainability_NBAB.pdf; Norwegian Biotechnology Advisory Board (2018) *Societal Benefits and Genetically Modified Organisms*. https://www.bioteknologiradet.no/filarkiv/2018/10/2018-10-18-Rapport_Samfunnsnytte_Eng_lesevennlig-versjon.pdf

Recommendation 3

Ensure that ethical, cultural, and socio-economic aspects of NGT crops are assessed by an independent EU body.

A draft theoretical framework necessary for a level-based assessment including socio-economic and sustainability criteria for market approval of NGTs in the EU, should be discussed and further developed with relevant stakeholder and with EU citizens. An independent committee could be established both assigned with the task to democratically develop broader assessment criteria, as well as assigned with the task to assess NGT and GM crops based on these criteria.
Citizens in our study indicate that they would trust the assessment of risks as well as the assessment of broader considerations, if they are performed by independent institutes. Whereas the European Food Safety Authority (EFSA) provides independent scientific advice on food-related risks, there is no EU authority for assessing for broader considerations. Such an authority could be founded in the European Union, or on a national level. In the latter scenario, member states can identify their own relevant cultural, ethical and societal considerations. This approach would allow member states to take into account country-specific cultural values as well as the socio-economic situation of the specific member state.[117] This authority or these committees would assess broader considerations, on a case-by-case basis, to justify market approval of NGT crops. This would be in line with the wishes of citizens, who do not see commercial reasons as an appropriate or sufficient justification for introducing NGT crops on the market; only if NGT-products contribute towards solving current challenges in agriculture and food production, citizens support their introduction.

Recommendation 4

Preserve the freedom of choice of citizens by maintaining the requirement to label GM food, including NGT food.

The citizens we spoke with in our focus group discussions emphasize the need for freedom of choice for farmers and the public, and conclude that the labelling of NGT products is required. If the EC were to exempt NGTs from the GMO Directive, citizens would not be given freedom of choice to not buy these NGT crops, nor would there be a free market as consumers are not able to express their preferences through purchasing behavior. Simultaneously, some citizens remark that a real choice is only present when there is no price difference between NGT-products and non-NGT products. Some citizens worry that NGT-food will be less

[117] Poort, L.M. and F. Coman-Kund (2022). *The EU GM Regulatory Framework on Green Biotechnology under Revision.*

expensive, forcing citizens of lower socio-economic status to buy these products. It is important that policymakers take these worries into consideration.

Final remarks

The EU is currently looking for ways to transition towards a sustainable, fair, and healthy food system. NGTs are seen as having the potential to contribute to this transition. Citizens, however, are cautious, mainly because they seem to assess the new technology not by its potential power, but instead on the circumstances seen as likely to determine how the technology emerges and the interests shaping its use. Moreover, citizens are interested in alternative approaches and opportunity costs, and consider justice and fairness in the food system to be important guiding criteria. Citizens demonstrate an awareness of the entanglement of technologies with politics and the food system. We believe that the political debate on the role of NGTs and the upcoming policy initiative would benefit if policymakers make this entanglement explicit.

A democratic approach to developing new policy allows for a greater alignment with public values. These values, as expressed by citizens in our focus groups, are justice, equality, sustainability, and safety. These values should steer NGT development, NGT crop development, and the regulation of NGT food crops.

Independent of the development of a new policy for NGTs, the EC, and member states, need to collectively think about how NGT crops fit in a future sustainable, healthy, and fair agriculture.

Summary in Dutch

De Europese Commissie werkt aan nieuw beleid voor voedselgewassen die verkregen zijn met behulp van nieuwe genomische technieken. Dit beleid zal ook gelden voor de levensmiddelen en diervoeders die met deze gewassen zijn gemaakt.

Nieuwe genomische technieken (ngt's) zijn gentechnieken waarmee het dna van een organisme kan worden veranderd. Ze zijn ontwikkeld na 2001 toen de EU-richtlijn voor genetisch gemodificeerde organismen (ggo's) werd aangenomen. Momenteel vallen ngt-voedselgewassen onder deze Europese ggo-wetgeving, maar hierin komt wellicht verandering.

Twee beleidsopties voor de EU domineren het debat over het gebruik van ngt's in de plantenveredeling. De ene optie is om ngt-gewassen vrij te stellen van de ggo-richtlijn als er geen vreemd dna in het eindproduct aanwezig is. De andere optie is handhaving van de ggo-richtlijn voor ngt-gewassen. Beide opties hebben maatschappelijke consequenties en uitdagingen.

Een derde beleidsoptie, die steeds meer aandacht krijgt, tracht de voordelen van de beide andere opties te verenigen. Hierbij is de risicobeoordeling voor ngt-gewassen minder uitgebreid dan voor voedselgewassen die gemodificeerd zijn met oudere technieken. Tegelijkertijd wordt gekeken naar bredere sociale en ethische overwegingen. Zo is de toelating van een nieuw gewas tot de markt alleen mogelijk als dat maatschappelijke nut heeft en bijdraagt aan een duurzame landbouw.

Op dit moment wordt het debat over het gebruik van ngt's in de plantenveredeling bijna uitsluitend gevoerd door wetenschappers, bedrijven in de agrarische sector, biotechbedrijven, hun belangenbehartigers en een klein aantal ngo's. Maar bij de vormgeving van een nieuw ngt-beleid is het ook belangrijk om burgers te betrekken, omdat biotechnologieën een grote invloed kunnen hebben op de landbouwpraktijk en op hoe ons voedsel geproduceerd wordt. Hoe mensen daarover denken, hangt vaak nauw samen met hoe ze willen leven en zich verhouden tot andere soorten. Door burgers inspraak te geven, kunnen beleidsmakers waarden die burgers belangrijk vinden, een plek geven in de nieuwe regelgeving.

Doel van de studie
In dit onderzoek hebben we met Nederlandse burgers met verschillende achtergronden open en constructief gesproken over het gebruik van ngt's en oudere genetische modificatietechnieken in gewassen. In zes focusgroepen

onderzochten we hun opvattingen hierover, de waarden die hieraan ten grondslag liggen, en de voorwaarden die zij nodig achten om ngt-gewassen op de Europese markt toe te laten, als die al geïntroduceerd mogen worden. Hierbij gebruikten we een anticiperende methode, die inzicht geeft in hoe zorgen en opvattingen ontstaan in een gestructureerd gesprek. De focusgroepen bestonden uit vijf tot acht deelnemers die door een gespecialiseerd bureau geselecteerd waren op leeftijd, opleiding, sociaaleconomische klasse en geslacht, zodat ze een afspiegeling vormden van de Nederlandse samenleving en verschillende perspectieven vertegenwoordigen.

Onze bevindingen geven inzicht in hoe het Nederlandse publiek zou kunnen reageren wanneer het voorstel van de Europese Commissie voor nieuw beleid voor ngt's in planten een publieke kwestie wordt. Op dit moment zijn de meeste burgers zich namelijk niet bewust van de aankomende verandering van de regelgeving. Deze studie biedt beleidsmakers tevens de mogelijkheid om de overwegingen van burgers mee te nemen bij het vormgeven van nieuw, democratisch beleid voor ngt's in de landbouwpraktijk.

Bevindingen
De meningen van burgers in onze studie over het gebruik van ngt's in gewassen lopen uiteen. Sommigen denken dat deze technieken noodzakelijk zullen zijn om problemen zoals klimaatverandering aan te pakken. Anderen daarentegen vermoeden dat de invoering ervan de problemen in de landbouw en het voedselsysteem juist zullen verergeren. In het algemeen zijn ze terughoudend en aarzelend over het gebruik van ngt's en genetische modificatie bij gewassen. Ze twijfelen er vooral aan of deze gewassen daadwerkelijk een zinvolle bijdrage gaan leveren aan de oplossing van de huidige maatschappelijke uitdagingen in het voedselsysteem.

Ook betwijfelen ze of nieuwe technieken de juiste manier zijn om deze uitdagingen aan te gaan. Zij vragen zich af of alternatieve oplossingen misschien beter zijn omdat ze de oorzaken van de problemen kunnen aanpakken en minder onvoorziene langetermijnrisico’s met zich meebrengen voor de gezondheid van mens en ecosysteem. Wel is er twijfel of alternatieven, zoals bijvoorbeeld het eten van minder vlees om landbouwgrond beschikbaar te maken in de strijd tegen voedselschaarste, realistisch zijn. Burgers in onze studie vragen zich ook af of bedrijven daadwerkelijk waardevolle nieuwe plantenrassen zullen ontwikkelen voor de samenleving. Zij ervaren dat het bedrijfsleven vooral gericht is op het maken van winst.

De deelnemers aan de focusgroepen vinden unaniem dat regulering van ngt-gewassen noodzakelijk is. Als redenen daarvoor noemen ze: schade voorkomen

aan het milieu en de volksgezondheid, keuzevrijheid voor consumenten, voorkomen dat technologie de maatschappelijke ongelijkheid vergroot, en ervoor zorgen dat technologie bijdraagt aan het oplossen van maatschappelijke problemen. Dat laatste vinden de burgers die wij spraken een belangrijke voorwaarde voor het op de markt brengen van ngt-producten. Volgens hen moet er een maatschappelijk doel zijn en mogen ngt-gewassen niet louter uit commerciële motieven worden ontwikkeld. Voor nieuw beleid zou dit betekenen dat ngt-gewassen per geval moeten worden beoordeeld op bredere overwegingen zoals het doel dat met het nieuwe gewas bereikt kan worden en de waarde ervan voor de samenleving.

Waarden die aan opvattingen ten grondslag liggen
Opvattingen van burgers worden gevormd door onderliggende waarden zoals veiligheid, natuurlijkheid, rechtvaardigheid, welzijn en onbehagen over het streven naar perfectie en efficiëntie in ons voedselsysteem. De burgers die wij spraken, leken hun opvattingen te vormen in de context van de klimaatcrisis, de coronacrisis en de stikstofcrisis. Een van hun onderliggende zorgen was dat de technologieën ongewenste maatschappelijke trends en ontwikkelingen zullen verergeren, zoals bijvoorbeeld de concentratie van macht bij grote bedrijven. Economische en commerciële doeleinden vinden velen geen voldoende rechtvaardiging voor de invoering van ngt's in de plantenveredeling.

Aanbevelingen voor een maatschappelijke dialoog
De belangrijkste boodschap die uit ons onderzoek naar voren komt, is dat de Europese Commissie en de nationale regeringen van de EU-landen regelmatig open en constructieve dialogen met burgers moeten aangaan over het aankomende beleidsinitiatief van de EC.

Er zijn vier belangrijke redenen om burgers meer bij de besluitvorming te betrekken. Ten eerste beïnvloeden biotechnologieën onze samenleving, kunnen ze leven opnieuw vormgeven en ons landbouw- en voedselsysteem veranderen. Aanpassingen in de regelgeving zijn daarom van algemeen belang. Ten tweede zal er een breder draagvlak ontstaan wanneer burgers bij de ontwikkeling van nieuw beleid worden betrokken en er rekening wordt gehouden met hun waarden. Ten derde, zo blijkt uit dit en eerder onderzoek, staan de opvattingen van Nederlandse burgers haaks op de visie die overheerst in het beperkte maatschappelijke debat dat momenteel gevoerd wordt en op de koers die de Nederlandse overheid heeft gekozen. Ten vierde geven burgers in onze studie aan dat zij transparantie hoog in het vaandel hebben staan. Ze vinden dat de overheid de plicht heeft burgers over dit soort zaken te informeren.

Op basis van onze bevindingen geven wij beleidsmakers drie aanbevelingen voor de dialoog met de samenleving. Hierbij bouwen we voort op eerder eigen onderzoek en dat van coauteur Phil Macnaghten.

Aanbeveling 1

Houd bij de discussie over het beleid voor ngt's in gewassen rekening met culturele, ethische en maatschappelijk overwegingen. Onderzoek met alle relevante partijen, waaronder de burgers, welke bredere zorgen en belangen een plaats verdienen in het debat.

Om nieuw beleid voor ngt-gewassen te ontwikkelen dat recht doet aan alle betrokken partijen en om vertrouwen in het proces te verkrijgen, is het belangrijk dat beleidsmakers niet kiezen voor een strategie die zich richt op het overtuigen van burgers. Beleidsmakers dienen burgers niet alleen informatie te geven, maar ook te betrekken bij de besluitvorming over het nieuwe beleid. Het is belangrijk om hen ruimte te bieden voor overleg over de dominante narratieven in het debat, over bredere overwegingen en onderliggende waarden die zij belangrijk vinden. Bij de gesprekken in de focusgroepen over het gebruik van ngt's in voedsel en de aankomende verandering van de regelgeving, uitten burgers zorgen over veiligheid, toegenomen controle door bedrijven, grotere ongelijkheid in het voedselsysteem en een verlies aan keuze voor consumenten. Beleidsmakers dienen dit mee te nemen in het besluitvormingsproces.

Aanbeveling 2

Bouw een vertrouwensrelatie met burgers op door open te zijn over de onzekere positieve en negatieve gevolgen van ngt's voor de samenleving. Bespreek de beschikbare alternatieven en de mogelijke oneerlijke verdeling van de voordelen van deze technieken voor partijen in het agro-voedselsysteem.

Vertrouwen in de overheid en overheidsinstellingen is cruciaal voor de acceptatie van een technologie. De dialoog aangaan en het volledig informeren van burgers, ook over zaken als de context, onzekerheden, alternatieve oplossingen, alternatieve beleidsopties en hoe om te gaan met uitdagingen, zijn de meest effectieve manieren om wantrouwen te voorkomen en erop te reageren. Voor ngt's betekent dit dat beleidsmakers en wetenschappers open moeten zijn over de potentie ervan om maatschappelijke uitdagingen op te lossen of juist te verergeren. Het is namelijk ook mogelijk dat ze worden ingezet om de huidige intensieve landbouw in stand te houden. Aangezien ngt-gewassen gepatenteerd kunnen worden, kunnen ze ook zorgen voor machtsverschuivingen. Een gesprek over hun

octrooieerbaarheid en de invloed hiervan op de landbouwpraktijk is dus belangrijk. Verder is het raadzaam te erkennen dat een duurzaam landbouwsysteem ook kan worden bereikt met alternatieve methoden. Maar belangrijker nog dan het creëren van maatschappelijke draagvlak, is ervoor te zorgen dat bij de regulering van technologieën alle belanghebbenden, inclusief burgers, als serieuze gesprekspartners worden beschouwd.

Aanbeveling 3

Communiceer open over de wetenschappelijke onzekerheden bij het gebruik van ngt's in gewassen.

De noodzaak van eerlijke communicatie strekt zich ook uit tot de communicatie over de huidige onzekerheden en lacunes in wetenschappelijke kennis. De omvang en het belang van wetenschappelijke onzekerheden worden in maatschappelijke dialogen soms gebagatelliseerd om onrust te voorkomen. Dit kan contraproductief werken, vooral waar de veiligheid op lange termijn onmogelijk kan worden aangetoond, zoals momenteel het geval is voor ngt's. Openheid en communicatie over wetenschappelijke onzekerheden stellen burgers in staat een evenwichtige mening te vormen en wekken vertrouwen.

Aanbevelingen voor beleidsopties
We geven beleidsmakers vier aanbevelingen over hoe ze de opvattingen en onderliggende waarden van burgers ten aanzien van ngt's in gewassen kunnen meenemen bij het maken van beleid.

Aanbeveling 1

Kies niet voor het uitzonderen van ngt's van de huidige ggo-richtlijn, maar ontwikkel beleid waarbij onderscheid wordt gemaakt in risicobeoordeling.

De burgers in onze focusgroepen zijn unaniem van mening dat ngt's gereguleerd moeten zijn. Ook in andere studies wordt dit gevonden. Zelfs met een formele risicobeoordeling staan de burgers met wie wij spraken niet te springen om ngt-voedsel op de markt te brengen. Als de Europese Commissie ngt's zou vrijstellen van de ggo-richtlijn, vindt er geen risicobeoordeling meer plaats voor de volksgezondheid en het milieu. De burgers in ons onderzoek vinden dat zo'n beoordeling vereist is voor goedkeuring op de markt.
In een vorig rapport hebben wij een manier voorgesteld om het huidige biotechnologiebeleid te moderniseren door middel van een gedifferentieerd beleid voor marktgoedkeuring. Hierbij zijn er verschillende niveaus van strengheid en intensiteit in de risicobeoordeling. Afhankelijk van de verwachte risico's, wordt een

bepaald niveau van risicoanalyse gebruikt. De veronderstelde risico's bepalen de striktheid en de snelheid van de beoordelingsprocedure. Die risico's hangen af van de manier waarop de ngt's zijn gebruikt en de eigenschap die veranderd is. De meeste burgers in onze focusgroepen staan open voor een dergelijk onderscheid in risicobeoordeling. Bovendien komt zo'n aanpak grotendeels tegemoet aan de argumenten van voor- en tegenstanders van een vrijstelling van ngt's van de ggo-richtlijn.

Aanbeveling 2

Ga van een consumentgerichte naar een maatschappijgerichte besturing van het markttoelatingsproces met aandacht voor ethische, culturele en maatschappelijke overwegingen.

Burgers in onze focusgroepen vinden dat het doel van een specifieke innovatie een belangrijke overweging is. Daarbij gaat het om de bijdrage ervan aan maatschappelijke uitdagingen en de wenselijkheid om die innovatie hiervoor te gebruiken. Het is dan ook belangrijk dat beleidsmakers bij het maken van nieuw beleid niet alleen kijken naar risico's en economische voordelen (belangrijk voor consumenten), maar ook naar de ethische, culturele en maatschappelijke aspecten die burgers belangrijk vinden. Door deze aspecten per geval te beoordelen, kunnen publieke waarden een rol spelen bij de toelating van ngt-gewassen tot de markt. Het nieuwe beleid zou een gedifferentieerde risicobeoordeling dan ook moeten kunnen combineren met een beoordeling van de bredere overwegingen.

Aanbeveling 3

Zorg ervoor dat een onafhankelijke EU-commissie de ethische, culturele en maatschappelijke aspecten beoordeelt.

Er kan een onafhankelijke EU-commissie worden opgericht met als taak om bredere beoordelingscriteria te ontwikkelen én de afzonderlijk marktgoedkeuringen voor ngt-gewassen te beoordelen. Ook kan de EC ervoor kiezen om deze bredere beoordeling op nationaal niveau te laten uitvoeren. In dit scenario kunnen lidstaten hun eigen relevante culturele, ethische en maatschappelijke overwegingen identificeren.

De burgers in ons onderzoek geven aan dat zij vertrouwen zouden hebben in de beoordeling van risico's en van bredere overwegingen, indien deze door onafhankelijke instellingen worden uitgevoerd. Wel vragen ze zich af wie er bepaalt wat ethisch en waardevol is voor de samenleving. En wat het bijvoorbeeld betekent als een gewas duurzaam is?

Aanbeveling 4

Behoud de keuzevrijheid van burgers door verplichte etikettering van genetisch gemodificeerd voedsel, inclusief ngt-voedsel.

De burgers die wij spraken, benadrukken de noodzaak van keuzevrijheid voor consumenten en concluderen dat etikettering van ngt-producten daarvoor noodzakelijk is. Als de Europese Commissie ngt's van de ggo-richtlijn zou vrijstellen, zouden burgers er niet voor kunnen kiezen om voedsel te kopen zonder ngt-toepassingen. Omdat burgers dan hun voorkeur niet kunnen tonen, kan ook de vrije markt haar werk niet doen.

Slotopmerking

De Europese Unie zoekt momenteel naar manieren om over te schakelen naar een duurzaam, gezond en eerlijk voedselsysteem. Verschillende partijen wijzen erop dat ngt's aan deze overgang kunnen bijdragen. De burgers in ons onderzoek zijn echter terughoudend, vooral omdat zij de nieuwe technieken niet lijken te beoordelen op hun potentiële kracht, maar op de omstandigheden die waarschijnlijk bepalen hoe de technologie in de maatschappij gaat landen, en de belangen die hier meespelen. Bovendien zijn burgers geïnteresseerd in alternatieve benaderingen en beschouwen zij rechtvaardigheid en eerlijkheid als belangrijke leidende criteria voor het voedselsysteem. Burgers zijn zich bewust van de verwevenheid van technologieën met politiek en (dominante actoren in) het voedselsysteem. Het politieke debat over de rol van ngt's en de komende wijziging van de regelgeving is erbij gebaat als beleidsmakers deze verstrengeling ook expliciet maken. Dit is nodig voor een volwassen discussie over welke rol de samenleving ziet weggelegd voor het gebruik van deze nieuwe technieken in een toekomstig landbouw- en voedselsysteem.

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Appendix 1. Current regulation of new plant varieties in the Netherlands

Current regulation of traditional breeding methods
If a plant breeding company wants to market a new plant variety produced with traditional breeding methods, the variety has to be registered in the National Variety Register. To enter the Register, the Netherlands Inspection Service for Horticulture (Naktuinbouw), carries out several tests to determine whether the new variety is distinguishable from existing varieties (distinct), whether the variety is uniform (uniform), and whether the variety remains stable during propagation (stable) (so called DUS-testing). To enable varieties to be listed, the variety is required to have an accepted name. The Board for Plant Varieties then decides whether to accept the new variety.

Agricultural varieties (in contrast to ornamentals and vegetables) are also subject to the Value for Cultivation and Use test (VCU). A new variety requires a significant improvement to any variety already registered, according to Directive 2002/53/EG, 'whether for cultivation or for valorisation of the harvest or of the products obtained from it'.

In order to protect ownership of a plant variety, a breeder can also apply for plant breeders' rights. Plant breeders' rights give the holder the exclusive right to trade the seed and propagation material. Other breeders may, however, use this new variety for further selective breeding. This is significantly different from patent rights. A patent is an exclusive right. Others may only do further selective breeding if they purchase a – possibly expensive – licence.

Current regulation of genetic modification in crops
The European GMO Directive 2001/18/EC regulates the release of genetically modified (GM) crops into the environment. Crops subjected to the GMO directive require an environmental risk assessment (ERA). The ERA studies the direct, indirect and cumulative (immediate and long-term) effects of the GM crop on public health and the environment. Furthermore, these organisms have to be monitored. Under Regulation (EC) no. 1830/2003, traceability and labelling is ensured, with the aim of informing consumers. In addition, EU Regulation (EC) no. 1829/2003 sets down rules with respect to licences, risk management and labelling for food and animal feed containing GMO ingredients.

An amendment to the GMO Directive in 2015 (Directive (EU) 2015/412) makes it possible for individual member states to restrict or ban cultivation of GMO crops based on, among other things, societal, cultural and ethical aspects, provided there is a sufficient legal basis in the member state's national legislation, after a licence has been granted to cultivate a GMO crop in Europe.

Crops exempt from the GMO Directive are thus exempted from a risk assessment, traceability, monitoring, labelling, and the possibility of member states to restrict or ban cultivation based on broader aspects.

Based on: Habets, M., L. van Hove and R. van Est (2019). Genome editing in plants and crops – Towards a modern biotechnology policy focused on differences in risks and broader considerations. The Hague: Rathenau Instituut

Appendix 2. Explanation of concepts

<table>
<tr><th colspan="2">Concepts used for these technologies</th><th>Scientific term</th><th></th></tr>
<tr><td rowspan="2">Genetic modification techniques

Genetic modification refers to the artificial insertion of DNA from one living thing into the DNA of another living thing, introducing a new or different characteristic.

Since the new term gene editing has arrived, genetic modification techniques are used by proponents to only refer to changes that could not be achieved by conventional breeding. However, this is in some ways artificial, because gene editing techniques can also be used to introduce foreign genetic material which cannot be achieved by conventional breeding.[118] All new genomic techniques are genetic modification techniques.</td><td>Cisgenesis</td><td rowspan="2">Recombinant-DNA</td><td>When new genes from the same or sexually compatible species are inserted into a host plant.</td></tr>
<tr><td>Transgenesis</td><td>The genetic modification of a recipient plant with one or more genes from any non-plant organism, or from a donor plant that is sexually incompatible with the recipient plant.</td></tr>
</table>

[118] Whether one can say that no foreign DNA is inserted is a semantic discussion to some extend. To make a comparison. If a student says she wrote the paper herself, the answer is still true if she has copied it from someone elses paper. As long as she did not copy-paste in Word, but written the words herself, she has written it herself. In a similar way, when using gene editing the new piece of DNA is not inserted, but the cell makes a copy of the foreign strand of DNA using its own nucleotides. Below the explanation:

Gene editing techniques cut DNA in a certain place (sequence) and the cell itself repairs the DNA subsequently. The cell can do this is two ways: in one way, the cel randomly and quicky fixes the DNA. In this case it is true that no foreign DNA is added. However, the other way, the cell uses another piece of DNA as template when it repairs the DNA (and thus copies the DNA). In nature, the cell uses it's paired homologous strand for copying. This way the DNA is repaired using the correct sequence. However, scientists use this technique to insert a foreign strand of DNA. This foreign piece of DNA is not inserted, however, the cell makes a copy of the DNA using its own nucleotides**.** Although this new piece of DNA is therefore not foreign, the DNA sequence is nonetheless foreign. It would be best to make a distinction between these two forms of gene editing.

Genetic modification techniques	New genomic techniques/gene editing techniques	TALENs Zinc-fingers CRISPR-Cas Meganucleases	These new techniques can make intentional small mutations, which is referred to as targeted mutagenesis or (site) directed mutagenesis. This is contrasted with random (or conventional) mutagenesis methods: radiation or chemical mutagenesis. Mutagenesis is the introduction of small genetic changes into DNA of cells. These genetic changes can bring about phenotypic changes in the plant).

Appendix 3. Prior research of public perceptions and public debates

InSites Consulting was commissioned by the Ministry of Infrastructure and Water management in 2017 to explore public perceptions of modern biotechnology, in order to better engage the public and societal values when balancing the risks and benefits of biotechnological applications.[119] In this study, an online community of 150 citizens were extensively questioned for four weeks to gain an understanding of the views, values towards biotechnology in different domains (a.o. agriculture), as well as the aspects influencing these views. The investigation concluded that limited knowledge exists among citizens on biotechnology. During discussions on particular applications, researchers found diverging opinions. Participants of the online community discussed various benefits and drawbacks. Mitigating uncertainty was seen as important, as was the purpose or benefit of the technology. Participants expected strict supervision for biotechnologies.

In 2019, the Dutch Committee on Genetic Modification (COGEM) commissioned a study to examine public perceptions towards genetic modification in agriculture and the medical field.[120] Four focus groups were conducted to provide a first qualitative picture of the associations with and perceptions of genetic modification. These results were then used to draw up a 12- minute questionnaire for a public survey in which 1,031 Dutch people participated.

Regarding GM in agriculture, this study found that citizens wish for all applications of biotechnologies, including the new techniques, to be subject to slightly stricter safety requirements than traditional breeding. Moreover, citizens also wanted mutagenesis to be subject to slightly stricter safety measures than traditional breeding (at this moment this is not the case). Citizens in this study make a clear distinction between conventional breeding and genetic modification techniques, among which they group mutagenesis. Although citizens saw opportunities for genetic technologies regarding quality of life, food, and environment, they also mentioned threats, like a concentration of power of companies, unforeseen consequences, and upsetting nature's balance often.

[119] InSites Consulting (2017) De burger aan het woord: publieksopvattingen over moderne biotechnologie Onderzoeksrapport

[120] COGEM (2019). *Percepties van burgers over genetische modificatie Een kwalitatieve en kwantitatieve verkenning*. Onderzoeksrapport CGM 2019-02. Bilthoven: COGEM.

In 2021, two citizen juries were conducted by Wageningen University and Research in both the Netherlands and the UK.[121] In the Netherlands, in four half days, 11 jury members were informed about the possibilities of gene editing by plant scientists followed by a critical reflection on the technology by social scientists. In the setup, strong proponents and opponents of GM were not invited to give information, as this may stall the discussions among jury members.

The Dutch citizen jury is mostly in favor of using new genomic techniques in plants, however, strict conditions should apply: NGT-plants need to be as safe and nutritious as older techniques; they need to have a societal purpose like heat or drought resistance; they need to be monitored (and traced) for their environmental impact and an ethical review is necessary by independent organisations.

[121] Nair, A. *et al*. (2022). 'Would you eat a genome-edited crop?' Citizens juries in the Netherlands and United Kingdom say yes to new plant breeding techniques. Agriculture and Human Values. Submitted; Hanssen, L. (2022) *De Publieke Stem. Publiekspercepties van Nieuwe Biotechnologische Technieken in de Agro- en Industriesector en Mogelijkheden voor een Effectievere Publieksparticipatie bij de Ontwikkeling van Nieuw Biotechnologiebeleid* Commissioned by the Ministery of Infrastructure and Water management.

Appendix 4. Topic guide for focus group discussions

I. Welcome

- Introductions
- Explain we would like to discuss food, agriculture, food production and future food
- Explain moderators are social scientists working for the Rathenau Instituut and Wageningen University and Research
- Request to speak freely, as we are interested in your opinion and underlying arguments for it – feel free to disagree. In the end, we don't have to come to a shared opinion or consensus.
- The conversations are recorded to describe afterwards what was said. We do not mention who says what. Anonymity is guaranteed.
- Are there any questions?

II. Introduction; food in everyday life

- Introduce yourself by telling us your name, profession and favourite food?
- Is having a meal an important part of your day, or more of a necessity?
- Do you put little or a lot of time in preparing your food? Do you enjoy preparing it?

III. Food production system

- What ingredients do you use? Where do you buy them?
- What is important regarding the way food is produced for you?
- Have there been changes in the way we eat food nowadays (compared to 20 or 30 years ago)?
- Are there changes in the food system?
- What concerns you about food and why?
- What are the big issues about/surrounding food?

IV. Approaches to agriculture / food (production) systems

Board 1: showing different forms of production systems

- Do you have any questions about this?
- Do you recognize these farming systems?
- What are your views on these farming systems? Do you have specific hopes or concerns regarding these approaches?
- Do you see a future for (one of) these approaches to agriculture? Why?

V. Use of technology in food production

- How do you think we should use technologies in food production?
- What are the advantages and possible challenges of using technologies in agriculture?

We would like to talk about a certain kind of technology in agriculture, namely the genetic modification of crops.

- Have you heard about this?
- What comes to mind when you hear about it?

Board 2: conventional breeding techniques and Genetic modification explanation

- Do you have any questions on these techniques?
- Do you have specific hopes or concerns regarding the use of GM in agriculture?
- Are you aware of the societal debate in the nineties about GM?

VI. Controversy surrounding GMO in the nineties

Board 3: arguments in the GM controversy of the nineties

- Do any of the arguments resonate with you? And why?
- Do you think these arguments are still relevant today?

VII. Current situation in the Europe

Board 4: explaining the current situation in Europe/Netherlands

- Do you have any questions about this board?
- If you look at the map, what does this say to you? What questions arise?

BREAK

VIII. Views on GE in agriculture

We would now like to focus on a new technique that can change the genetic material.

Board 5: a new technology: CRISPR-cas9

- Are there any questions about this board?
- What do you think of this technique?
- What do you think about the claims that are made?
- How do you think gene editing should be seen?

IX. Revision of GMO regulation

The European Union is thinking about changing the legislation for these new techniques. There are two ways people tend to think about changing the legislation.
Board 6: arguments of proponents of revising the current regulation
Board 7: arguments of proponent of keeping the status quo.

- What are your first thoughts?
- What do you think about the arguments in the debate? Are you leaning towards one or the other? And why?
- Which arguments used by either groups do you find important?

From arguments to regulation

- Which type of policy regulation do you prefer? And why? Which elements of either policy option is important to you?
- Is the goal or use of the techniques and (who benefits) important to you?
- Are there specific goals you think GE should or should not be used for?

X. New policy regulation

Board 8: a new policy option that takes serious arguments of both sides?

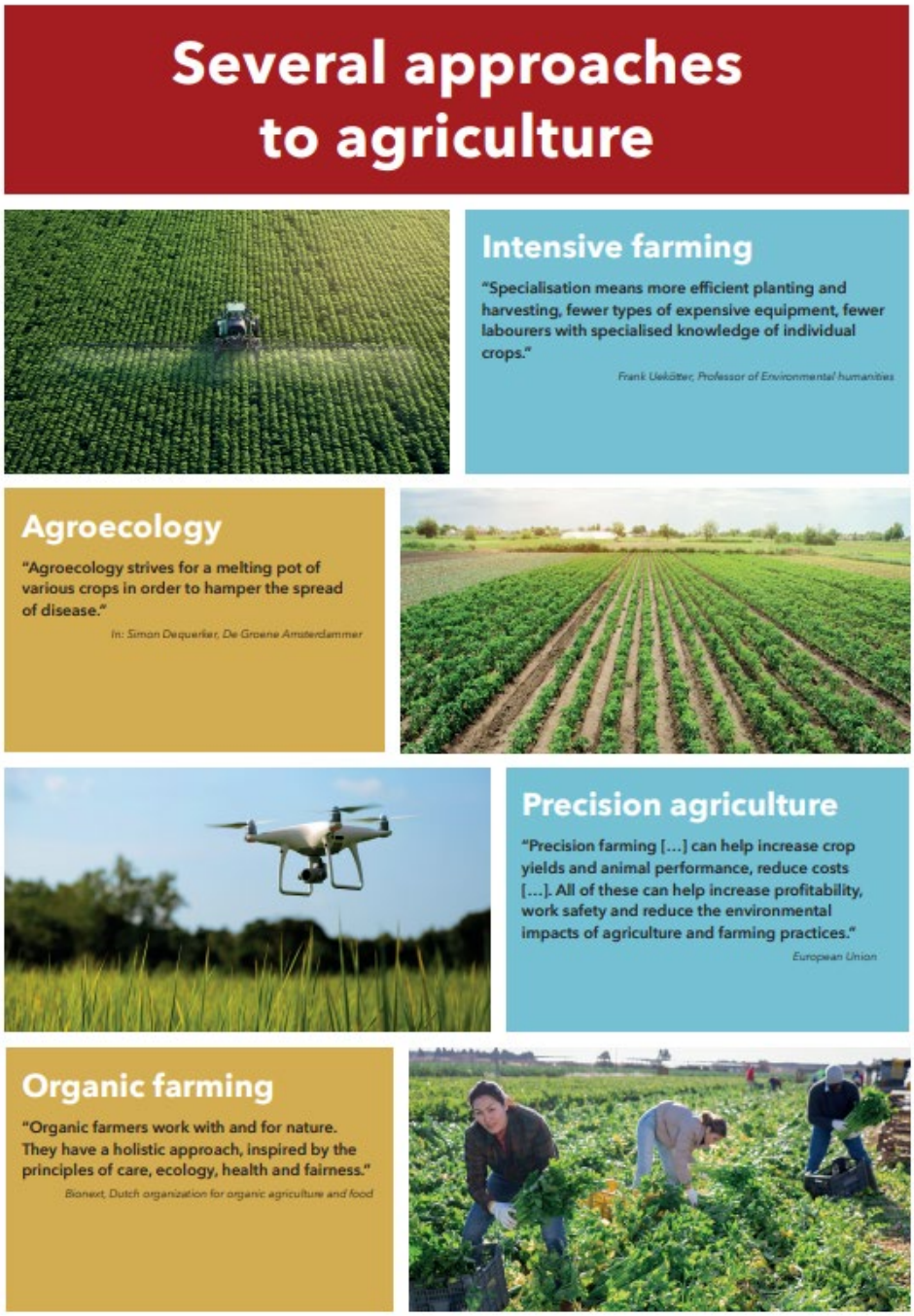
- Do you have any questions about this board?
- What do you think of these new policy option?

XI. Concluding remarks

- What resonated most with you about what we have discussed this evening?
- Wrapping up/ thanks/ explanation what will happen with this input

Appendix 5. Boards used during focus group discussion

Board 1



Board 2

Ways to modify crops

Classic Breeding

Since 10.000 ago

Cross-breeding plants of the same species to combine favourable qualities in the next generation

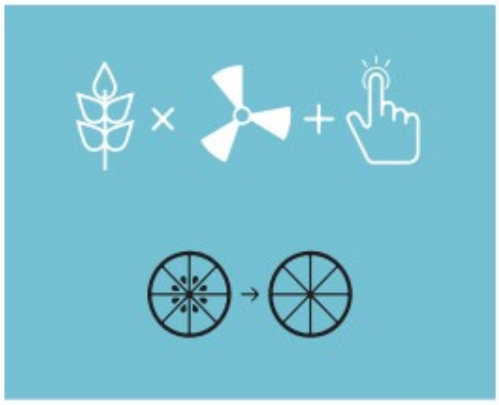
Example
The original cabbage gave rise to new varieties such as broccoli, kohlrabi, Brussels sprouts and red cabbage.

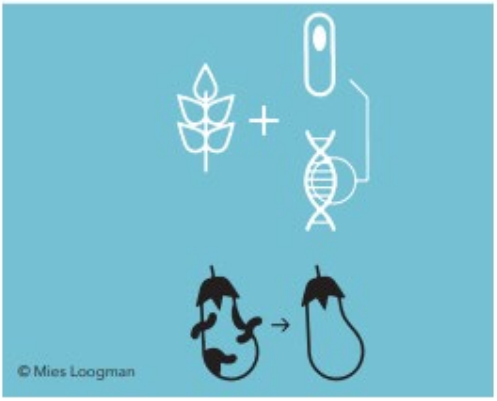
Mutagenesis

Since the first half of the 20th century

Mutations can be induced by processes such as radiation resulting in spontaneous changes to genes which may lead to desired as well as undesired modification in the genes.

Example
This is how red grapefruit acquired its colour and became seedless.





Genetic modification (Transgenesis)

Since the 1970s

A desired gene from an unrelated species is inserted into the DNA of a plant.

Example
A gene from a soil bacterium is inserted into the Bt-brinjal eggplant to make the crop resistant to the eggplant moth in Bangladesh.

Board 3

Arguments in the GMO controversy of the 1990s

Food security

"There doesn't seem to be any other way of creating the next green revolution without GMOs."

Edward Wilson, Professor of Entomology

Competitive advantage

"Genetic modifications techniques will help to maintain the competitiveness of the biotech and seed industry in the country."

In: Sylvie Bonny, Electronic Journal of Biotechnology

No need for GMO

"There is plenty of natural, normal good food in the world to nourish the double of humanity. There is absolutely no justification to produce genetically modified food except the profit motive and the domination of the multinational corporations."

Jean Ziegler, special rapporteur for the UN on the 'Right to food'

Corporate control

"This is likely to be a technique that will deliver for large scale monocultures and farming systems that undermine farmers' ability to control what they grow ..."

In: Richard Hellwel and others, Journal for Agriculture and Human Values

Crossing natural barriers

"Genetic manipulation breaks through natural barriers, it combines characteristics of organisms in a way that could never be possible in nature."

ASEED EUROPE (NGO targeting the causes of environmental destruction and social injustice)

Board 4

Current situation in Europe

efsa
European Food Safety Authority

Regulation in Europe

GM crops are subject to strict regulations.
GM crops need to:

- be assessed for risks;
- be monitored;
- be traceable;
- be labeled.

Cultivation of GM-crops worldwide

GM crops worldwide

"Today, genetically modified (GM) crops are mainly grown in North and South America. In the US and Brazil, around 95% of soybean, maize and rapeseed are genetically engineered."

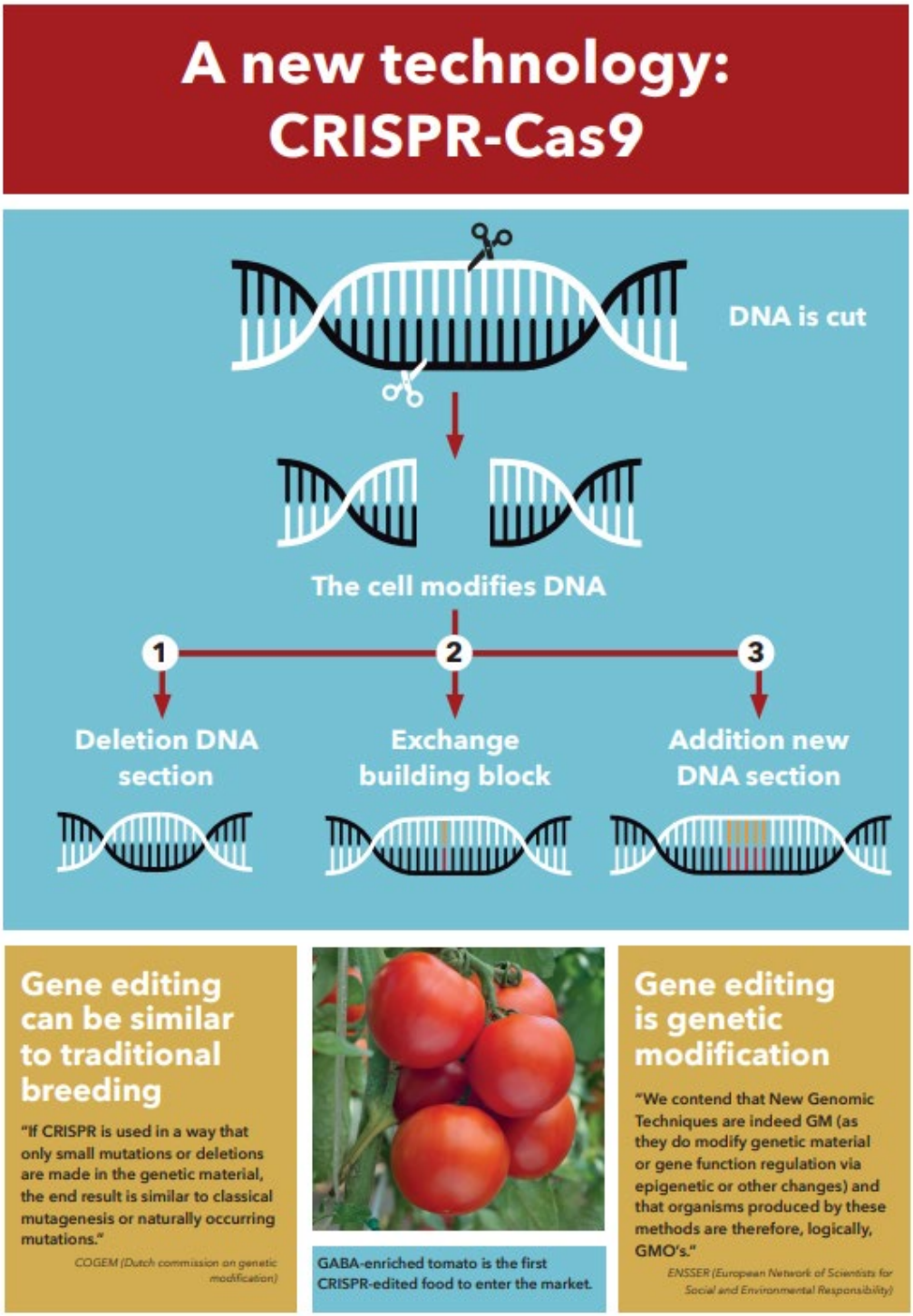
Greenpeace (Global environmental organisation)

The three most common traits in GMO crops

- Resistance to certain damaging insects
- Tolerance of certain herbicides
- Resistance to certain plant viruses

U.S. Food and Drug Administration (FDA) (Federal agency of the Department of Health and Human Services)

Board 5


A new technology:
CRISPR-Cas9
DNA is cut
The cell modifies DNA
1
2
3
Deletion DNA section
Exchange building block
Addition new DNA section
Gene editing can be similar to traditional breeding
"If CRISPR is used in a way that only small mutations or deletions are made in the genetic material, the end result is similar to classical mutagenesis or naturally occurring mutations."
COGEM (Dutch commission on genetic modification)
GABA-enriched tomato is the first CRISPR-edited food to enter the market.
Gene editing is genetic modification
"We contend that New Genomic Techniques are indeed GM (as they do modify genetic material or gene function regulation via epigenetic or other changes) and that organisms produced by these methods are therefore, logically, GMO's."
ENSSER (European Network of Scientists for Social and Environmental Responsibility)

Board 6


GMO regulation should be revised
Innovation
"[...] to boost the EU's competitiveness and innovation, and reach environmental and climate commitments, we call for a change in the EU regulatory framework."
EuropaBio (Representative organisation of biotech companies)
Societal challenges
"If we think about the pace of change: climate change, the need to reduce nitrogen fertilizer, need to use less pesticides; the faster we get the genetic changes we need, the faster we are able to adapt to all of that changing world around us."
KWS, plant-breeding firm
Accessible technology
"This technology has democratized genome editing so that it's no longer something that only highly experienced individuals can implement."
Samuel Sternberg, assistant professor biochemistry and molecular biofysics

Board 7

GMO regulation should not be revised

Safety

"Since genome editing is a very recent development with very little experience in practical application, these new genetic engineering techniques and the plants and animals they can create should be carefully risk assessed in each case before any decisions are made on using them in agriculture, or releasing them into the environment."

Testbiotech (Institute for the Independent Impact Assessment of Biotechnology)

False promises

"[...] wild promises are being made about the alleged benefits of crops and animals which are made using genome editing techniques, to convince the public of their value. Similar promises were also made for GMOs in the past, but never proved true."

Corporate Europe Observatory (Research and campaign group focused on lobby practices in the EU)

Corporate control

"The claim that gene editing, in particular through CRISPR/Cas, will make agricultural innovation accessible to publicly funded breeding programmes is disproven by the fact that the technology is already owned and controlled by very few large corporations."

The Greens/EFA (Parliamentary group of the European parliament)

Consumer choice

"Consumers could not avoid buying GM food, since the EU's GMO labelling rules would no longer apply. EU governments could not impose national bans on the cultivation of GM crops. The companies could turn our landscapes into a massive field trial with unknown consequences for our food and ecosystems."

Greenpeace (Global environmental organisation)

Board 8

A new level-based approach

Genetic changes

LEVEL 0
Temporal genetic changes

LEVEL 1
- Point mutations
- Substitution of gene variant/allele similar to crossing (new DNA)

LEVEL 2
- Large/several deletions
- Extra gene copies or non-targeted DNA from same/closely related species

LEVEL 3
DNA from different species or synthetic DNA

Risk assessment

LEVEL 1
Obligation to notify

LEVEL 2
Expedited assessment and approval

LEVEL 3
Standard assessment and approval

Assessment of broader considerations

LEVEL 1,2 & 3
- Societal benefit
- Sustainability
- Ethics

Appendix 6. Members of the advisory committee

- Prof. dr. Noelle Aarts, professor Socio-Ecological Interactions and Director of the Institute for Science in Society, Radboud University.
- Dr. Bert Lotz, Team leader Applied Ecology. Wageningen University and Research.
- Prof. dr. Tsjalling Swierstra, Professor of Philosophy, Maastricht University.

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