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CropBooster-P

Deliverable No. 3.2

Title: Report on the Dutch and British Citizens' Juries

Start date of the project: **November 1st, 2018** / Duration: **36 months**
Planned delivery date: M20 (October 2021)
Actual submission date: February 2022
Work package: WP3 / Task: 3.2

Work package leader: JKI
Deliverable leader: A. R. H. Fischer
Version: Final
Date of version: February 2022

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Dissemination level	Public

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EXECUTIVE SUMMARY

CropBooster-P aims to create a roadmap to future-proof European crops to meet a growing population's future food demands given the ever-increasing climate change impacts, changing labour dynamics, and limited agricultural land.

We engaged two citizens' juries, one with the Dutch and the other with the British, to assess the social desirability of using new plant breeding techniques (NPBTs) for future-proofing crops. The current report presents the results of the Dutch and British juries composed of eleven and ten citizens (or jurors), respectively. The juries were held online and lasted four days. Over the first three days, the jurors heard presentations from CropBooster-P experts and key expert witness testimonies to be informed and educated about NPBTs. Jurors were allowed to deliberate, ask questions and cross-examine the experts. We also welcomed their views and opinions. The fourth day of the jury was the verdict formulation. We organised knowledge structuring sessions for the jurors to map the most critical factors that they felt would decide whether they would support or reject NPBTs and to help them to formulate the reasons behind their judgment and the conditions that need to be met if any.

Both juries passed the verdict supporting NPBTs, with the Dutch jury passing a unanimous verdict in favour of NPBTs under certain conditions. The British jury gave the verdict in support of NPBTs under certain conditions, with a small majority supporting NPBTs without any conditions and a small undecided minority.

The main reasons behind their support, as stated by jurors, included increasing food production to ensure food security and decreasing world hunger, reducing the environmental footprint of agriculture and helping to mitigate climate change, and increasing the food sector's resilience to economic shocks and climate change impacts.
The most prominent conditions required for the jurors' support towards NPBTs were:

- The use of the technology must comply with appropriate **transparency** and ethical **accessibility**.
- The **technology's governance and regulation must be adequate** to ensure **safety** and **crop quality**.
- The **carbon footprint** of improved crops must be equal to or lower than that of existing crops.

Overall, the verdicts of the citizens' juries showed that using NPBTs for future-proofing crops in Europe was perceived as being socially desirable to ensure food security and contribute to mitigating climate change, under the conditions that their implementation is safe, well-regulated and contributes to making the world more equitable.

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1. Introduction

Food security in the face of climate change, a growing population (expected to reach 9.7 billion people by 2050) and increasing food demand are some of the most significant challenges facing humankind. Food security must be delivered while society transitions from a fossil fuel-based economy towards a bioeconomy to minimise global climate change. This transition will require a doubling of global crop productivity to achieve food and nutrition security and meet a future bioeconomy's demands. Projections from the current crop yield rates suggest that we will fall 40-70% short of future demand without agricultural innovations to increase crop production. Increasing crop production must be achieved while maintaining crop nutritional quality and ensuring sustainability of the food sector. This will require crops that combine the efficient use of scarce resources (e.g., water and minerals) and cultivation schemes and practices that preserve Earth's biodiversity. The crops must also have good yield stability with high resilience to adverse climate and volatile weather conditions.

The CropBooster-P project is a Consultation and Support Action within the EU H2020 research programme that aims to address these challenges by identifying opportunities to adapt and boost productivity in a background of environmental and societal changes. The objective of CropBooster-P is the development of a roadmap for future-proofing our food system and the European economy, with a specific focus on making crop production more sustainable, resilient, and responsible while at the same time guaranteeing nutritional food quality. Taking a responsible research and innovation approach, CropBooster-P involves vital stakeholders, such as scientists, businesses, farmers, consumers/citizens, and policymakers, to couple the process and its outcomes with society's values, needs, and expectations. In a series of work packages, we consider technologies and stakeholder responses, leading to a roadmap for future-proofing Europe's agri-food sector. The first work package (WP1) identified several techniques and strategies for crop improvement. These strategies were later refined in work package 2 (WP2), and their (potential) impacts were assessed. In work package 3 (WP3), we couple crop improvement outcomes from WP1 and WP2 with society's values, needs, and expectations to assess the social desirability of future-proofing crops.

WP3 aims to i) analyse societal needs, acceptability and expectations for crop improvement associated with novel plant breeding technologies (NPBTs) (Task 3.1A), ii) investigate the social desirability of crop improvement using NPBTs (Task 3.1B), and iii) elaborate on an appropriate strategies to increase public awareness and trust in these novel technologies in the medium term (Task 3.2). To do so, it takes a mixed stakeholder-and citizen-focused approach, building on results from WP1 and WP2 (illustrated in Figure 1). This deliverable reports on the second public engagement (Task 3.1B) on the social desirability of future-proofing crops via NPBTs, which took the form of two citizens' juries. Section 2 presents the methodological approach undertaken for the citizens' juries.

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Figure 1. *Overview of Work Package Three.*

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2. Methods

This deliverable provides qualitative data on the discussions and deliberations leading to the judgements passed on future-proofing crops from two online citizens' juries. Each jury was four days long, with sessions lasting between 3 hr and 5 hr and 30 min each day. We video-recorded the sessions to capture the full extent of participants' interactions, discussions, and deliberations. All jurors were informed about GDPR protection laws and asked for their signed consent before the event started.

2.1. Design of the citizens' juries

Citizens' juries have developed as a form of participatory research seeking to reduce conflict in planning and decision-making and promote the creation of more citizen-centred policymaking, which increases the democratic legitimacy of policies (Devaney et al., 2020; Kythreotis et al., 2019). They have become a popular method for engaging citizens in deliberation and decision-making about complex public policy issues such as climate change, health or food (Thompson et al., 2021). Citizens' juries are composed of an inclusive group of citizens, generally between 10 and 12 people (Wells et al., 2021), who receive expert information on a particular issue, cross-examine experts and deliberate with each other to come up with informed recommendations on how to deal with that issue (Goodin & Dryzek, 2006; Smith & Wales, 2000).

In this study, we held two online citizens' juries to assess the social desirability of future-proofing crops via NPBTs – one with Dutch participants, the other with British participants. The motivation for engaging these citizens' juries was to ascertain the reasons and conditions that led to supporting or rejecting future-proofing crops using NPBTs. The verdict from these juries set a precedent for future research and development on NPBTs. The citizens' juries were held online over a period of four days. We sought to have citizens who represent different ages and education levels while being geneder balanced to play the role of jurors. To have this stratified group we approached recruitment agencies in the Netherlands and the United Kingdom. The Dutch jury took place in August 2021 and had eleven jurors from the Netherlands, while the British jury was held in November 2021 with ten jurors.

2.2. Protocol of the citizens' juries

We developed a detailed citizen's jury protocol based on literature review, expert consultations, and our prior experience in developing online deliberative sessions (Menary et al., 2021). The entire protocol can be found in the Annex. We began the citizens' juries by giving the jurors a broad introduction to the CropBooster-P project. We told them that the purpose of forming the citizens' juries was to have them pass a reasoned judgement and verdict on the social desirability of future-proofing crops via NPBTs. We stated that we aimed to inform and educate them about the developments in the fields of future-proofing crops and

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NPBTs in a way that could be understood and grasped easily by a lay audience to help them to reach an informed decision at the end of the jury. We also mentioned that key expert witness testimonies would complement these presentations and that the jurors would have the opportunity to ask questions and deliberate with each other. The welcome note was followed by an ice-breaking session and a 15-minute keynote presentation introducing the jurors to plant breeding and future-proofing plants.

Days 1-3 of the citizens' juries were organised as 'knowledge sharing and learning sessions', where the jurors, after having heard presentations from CropBooster-P experts and key expert witnesses, questioned and deliberated on the outcomes of Crop-Booster-P and the witnesses' testimonies. During day one, the jurors were introduced to NPBTs, the current state of the art on the techniques, and how they are used to improve crops. Then, they heard testimonies from witnesses who breed crops using NPBTs. Similarly, on day two, a CropBooster-P expert introduced the jurors to the impact NPBTs have on society, the economy and the environment. This was followed by a talk from an expert witness working on the ethical dimension of NPBTs for the Dutch jury and by an academic with experience on the technical, natural and human dimensions of crop improvement and NPBTs for the British jury. On day three, a CropBooster-P expert introduced the jurors to the views, values and expatiations of key stakeholders and consumers vis-à-vis crop improvement via NPBTs, followed by the testimony from an expert working on the social dimensions of NPBTs for the Dutch jury and from an economist working on NPBTs for the British jury. The key expert witnesses had a minimum of 15 years of work experience on NPBTs.

The jurors had the opportunity to ask questions after each talk/presentation. In addition, we organised unmoderated deliberation sessions, during which we broke up jurors into two groups to brainstorm, identify problems, and develop specific questions for the key experts. We provided a Mural to help them formulate questions. Figure 2 illustrates the Mural template that was used to help the jurors brainstorm and prepare questions. The last session of days 1-3 was reserved for an additional Q&A between the jurors and the experts to ensure that all jurors had the opportunity to ask questions, ask for clarifications they may need or share their thoughts with the rest of the group. These activities were designed to help the jury to gain a better understanding and insight into NPBTs and crop improvement.

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Figure 2. *Mural template used to help the jurors to brainstorm and prepare questions.*

During day four, the jurors were asked to pass their reasoned judgement on using NPBTs for future-proofing crops and formulate a verdict statement. We started the day with a 'knowledge structuring session', during which we divided the jurors into two groups. We developed a Mural to help them to identify strengths and weaknesses internal to NPBTs and external opportunities and threats that may potentially affect the development and implementation of NPBTs. We asked the jurors to prioritise the most critical factors that would influence their decision on NPBTs and to reflect on the following three questions:

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- Do the risks of NPBTs outweigh the benefits or do the benefits outweigh the risks?
- What are the most crucial issues that have led you to support or oppose NPBTs for crop improvement?
- What would need to happen to change your mind about supporting or rejecting NPBTs for crop improvement?

At the end of this session, a preliminary vote was held asking the jurors whether they were in favour of using NPBTs, against NPBTs, in favour of NPBTs but with conditions or undecided towards NPBTs. The 'knowledge structuring session' was moderated by two CropBooster-P researchers. Figure 3 presents the Mural template that was used during this session.

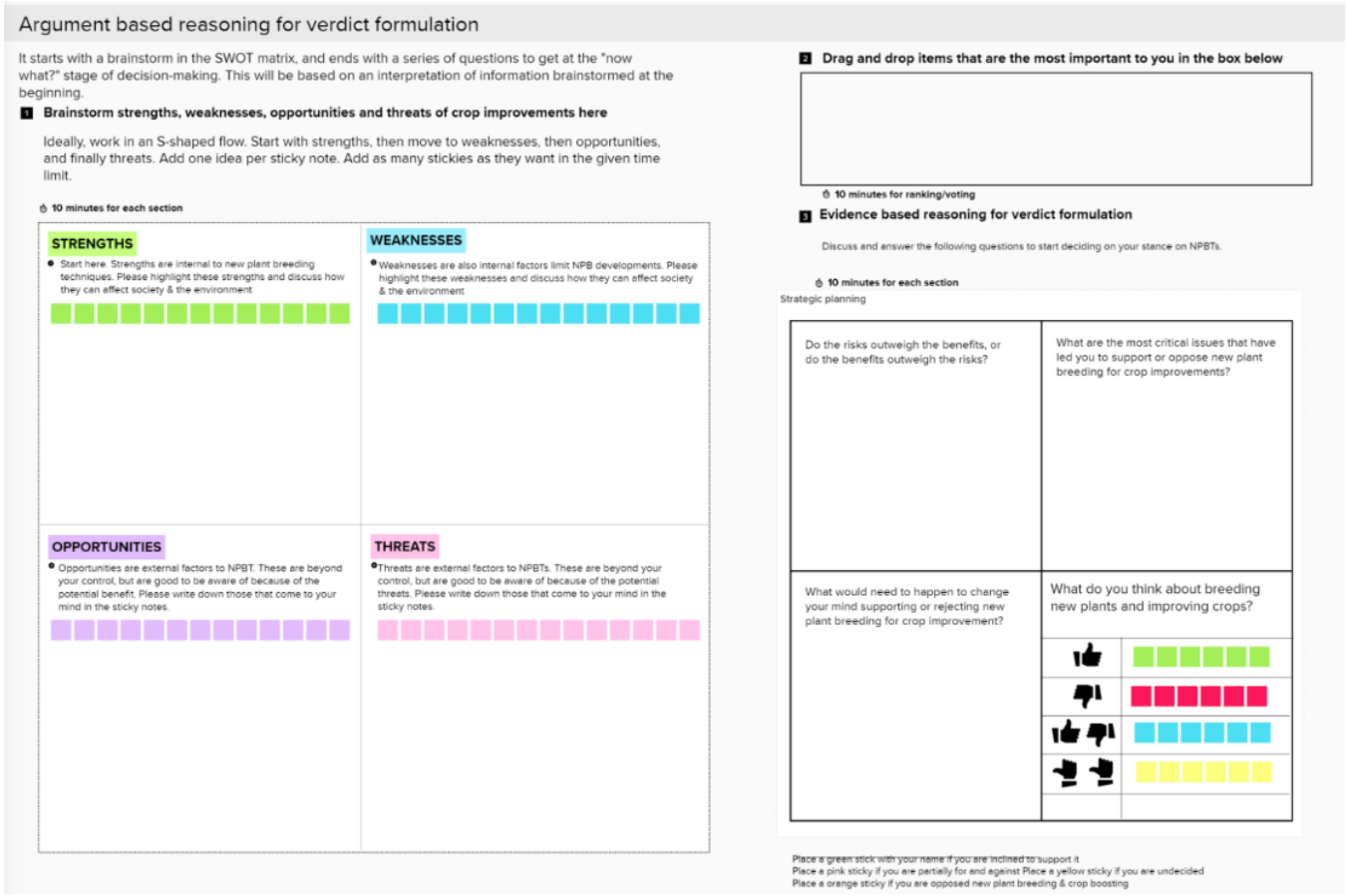

Figure 3. *Mural template used in day four's 'knowledge structuring session'.*

In the following session, we brought all the jurors together and polled them on current and future imaginaries of NPBTs (Figure 4, polls one to three) based on extreme scenarios of NPBTs futures developed within the CropBooster-P project (Cornelissen et al., 2021) and summarised in Figure 5. We then polled the jurors on whether they were inclined to support or reject NPBTs (Figure 4, poll four). Following this poll, we allowed the jurors to debate and convince those with differing opinions to change their minds. We polled the jurors again (Figure 4, poll five) to observe whether their stand in supporting or rejecting NPBTs had changed after the debate.

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These polls helped to analyse the impact of deliberations and voting patterns on jurors' views (Henderson et al., 2013).

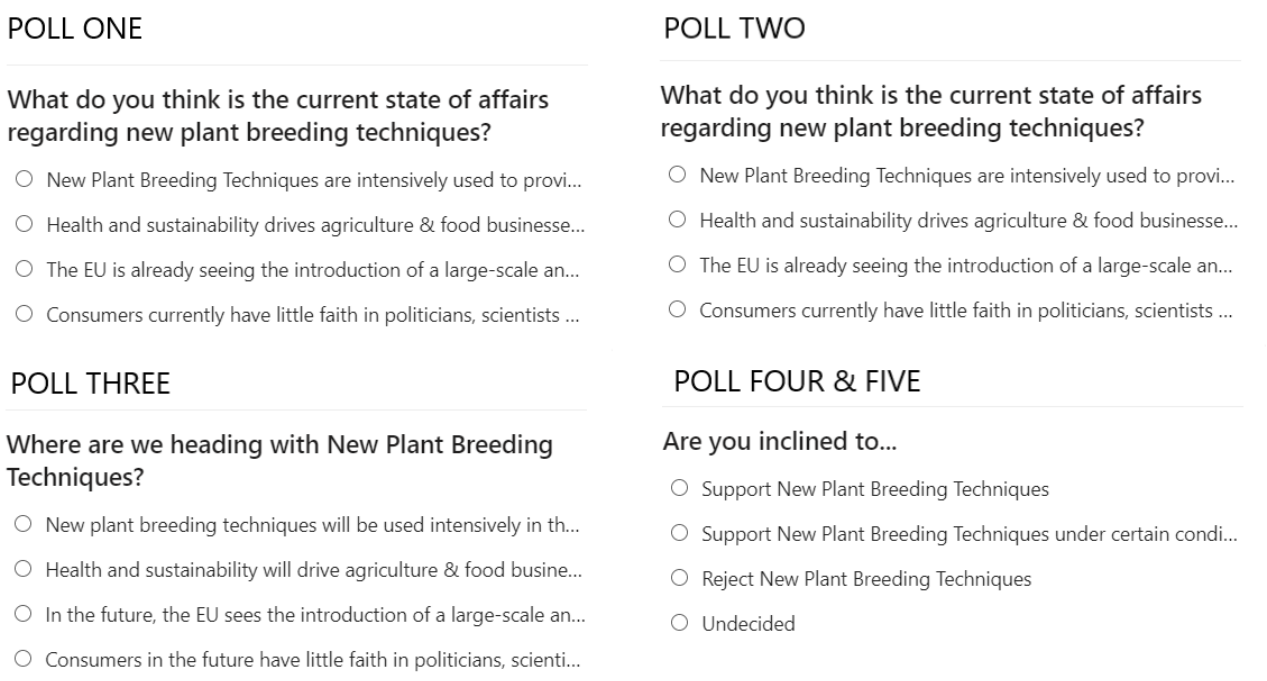

Figure 4. *Polls on current and future imaginaries of NPBTs (polls two to four) and their desirability (polls one and five).*

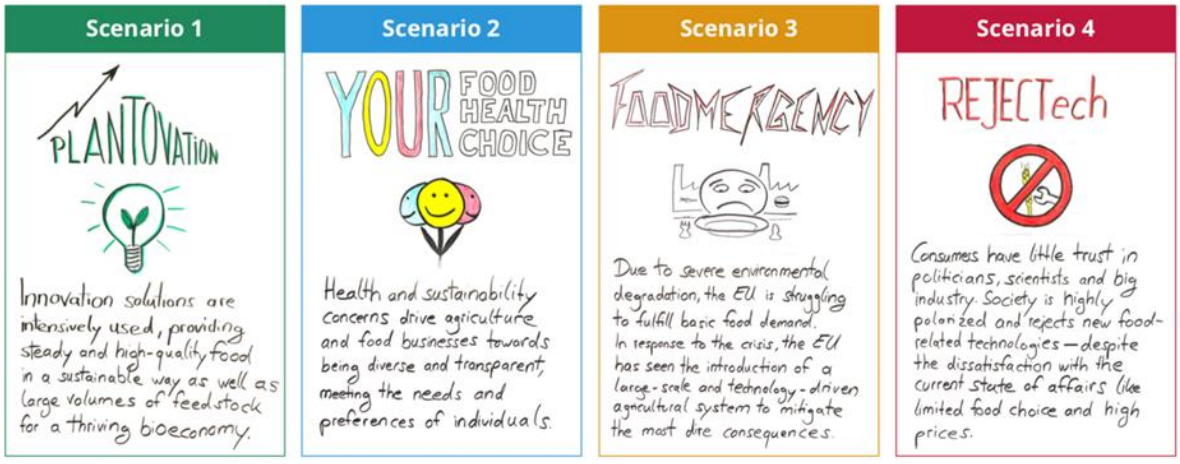

Figure 5. *Future imaginaries of NPBTs as four learning scenarios for agriculture in the EU in 2050. Source: (Cornelissen et al., 2021)*.

In the final session, the jurors gave their judgement on the use of NPBTs for future-proofing crops. During this session, we displayed the results of poll five to know whether the jurors were in a:

- unanimous majority,

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- supermajority and a small minority,
- small majority and a large minority, or
- hung jury.

in supporting or rejecting NPBTs, implying that the majorities can be either for or against NPBTs. Based on the poll results, we asked jurors to give us the main reasons for their decision and conditions, if any. We used the Mural shown in Figure 6 to help the jurors to reason their verdict and conditions.

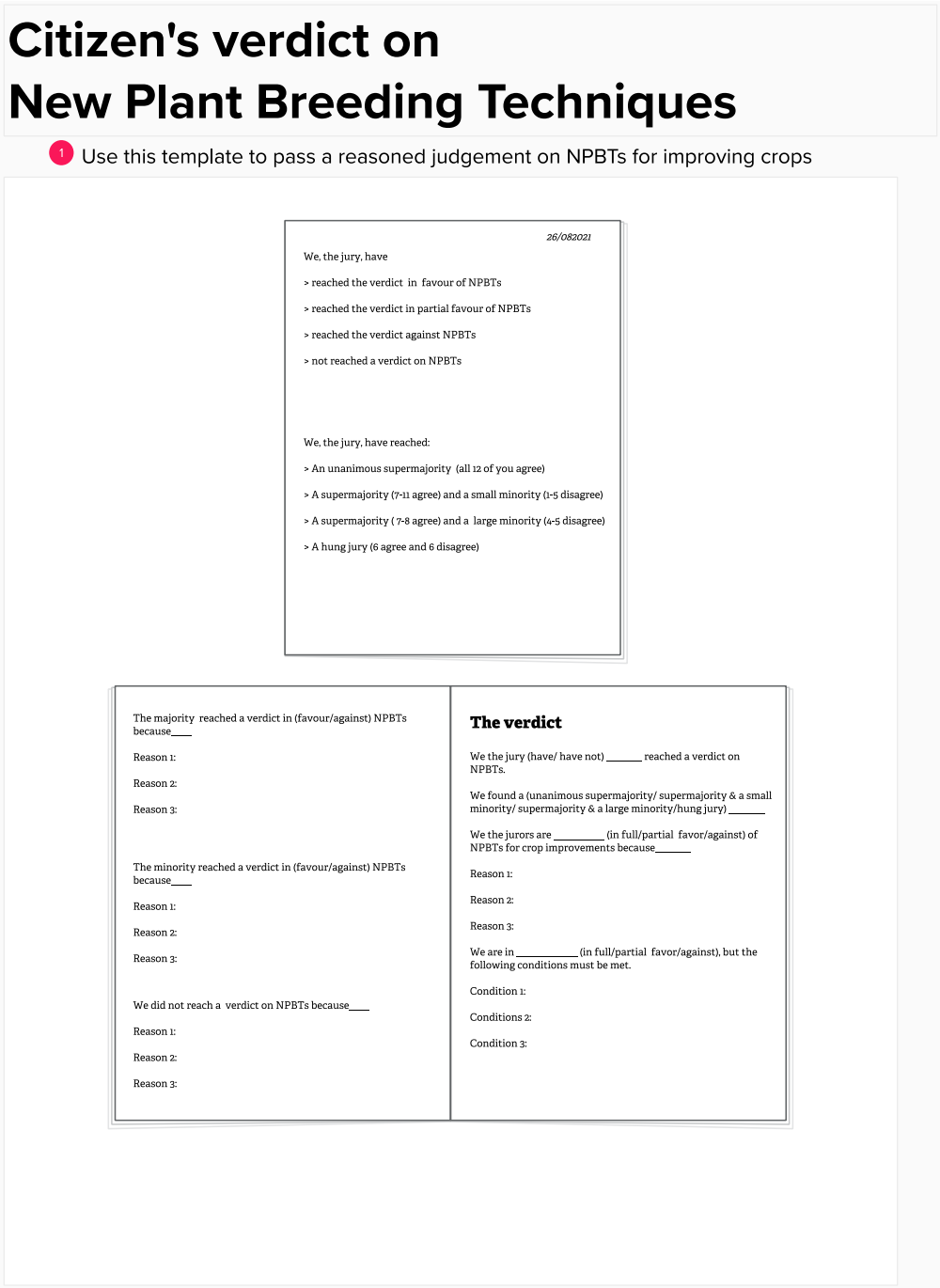

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Figure 6. *Verdict template.*

2.3. Materials

Citizens' juries were held on Microsoft Teams. We used the Teams breakout-room function during the question formulation and group deliberation sessions to facilitate the discussion between jurors. We also used the Teams poll function to run the different polls on day four. The chat function on Teams proved helpful for some jurors to formulate their questions for the experts during the presentations.

For each question formulation session, we provided the jurors with a premade MURAL interface as additional help to get the discussion started (Figure 2). The MURAL displayed a whiteboard divided into three sections – 1) What intrigued you about the topic? 2) What concerns do you have? and 3) Any questions that you have for us? – on which jurors could add sticky notes to answer the different questions asked to them. Below these three sections, the whiteboard also allowed the jurors to write down the five most important questions they wanted answering.

For day four's 'knowledge structuring session', we developed a MURAL template to help jurors to identify aspects that are critical to NPBTs and strategically plan whether they were inclined to support or reject NPBTs (Figure 3). It consisted of three sections – one on brainstorming the strengths, weaknesses, opportunities and threats vis-à-vis NPBTs, one for picking the most important SWOT items, and one where the jurors were asked three further questions about NPBTs and their preliminary positions towards NPBTs (see section 2.2). The moderators facilitating the session filled in the jurors' views and opinions based on the deliberations.

The last MURAL interface (Figure 6) was created and screen-shared during the final session to help the jurors to formally write their verdict. This verdict template was composed of three sections: the first section served to write down the verdict (specifying the outcomes of the consensus), the second section was dedicated to the main reasons behind the decisions (e.g., the reasons why a minority was undecided towards NPBTs), and the last section provided room for potential conditions to be added to the verdict.

2.4. Analysis framework

A GDPR-compliant company transcribed the video recordings of both juries. Transcripts were checked for errors and anonymised. Transcripts from the Dutch jury were translated into English for analysis and publication purposes. A thematic analysis of the transcripts was carried out (Menon & Stafinski, 2008; Timotijevic & Raats, 2007; Wells et al., 2021) using NVivo, a qualitative data analysis software. We assigned two researchers to code the transcripts in NVivo, which involved manually identifying key sections and categorising them into emerging themes and sub-themes.

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3. Results

3.1. The Dutch citizens' jury

3.1.1. Citizens' jury days 1-3: deliberations and discussions

Throughout days 1-3, the jurors questioned the use of NPBTs and expressed their concerns and opinions about NPBTs, their acceptability and the strategies for ending global food challenges during the deliberation and Q&A sessions. Their discussions and questions to the experts were about the effects of NPBTs on the environment, taste, and nutritional profile. They wanted to hear examples of NPBTs being used and to learn more about the possibilities and risks associated with their use. They suggested that terms such as "manipulated" and "modified crops" would make it difficult for a consumer to accept improved crops via NPBTs. The jurors were also concerned that NPBTs could create monopolies in the agri-food sector and increase costs for the consumer and farmers. They were also keen on understanding the companies and actors involved in NPBTs and their governance and regulation in the Dutch and broader European context. These discussions led to questioning whether the risks and benefits of NPBTs were communicated to a large audience.

> *"I'm just afraid that if you're going to adjust a lot, right, or you are going to change something in a gene that you're going to taste. Of course, there will be a higher yield, but keeping certain flavours and things like that is also important. So does it retain its nutritional value?" – Dutch juror.*

> *"I read that you said that there is the possibility to apply CRISPR-Cas in Europe, but I also read that it is not yet allowed in Europe. So how does it have to do with regulations?" – Dutch juror.*

On day two, the jurors discussed the possible effects of mainstreaming NPBTs, those who stood to benefit and their political motives. These discussions took them back to discussing global food challenges and those responsible for solving them. They discussed the need to have the right balance of strategies to solve global food challenges. They also deliberated several possible solutions such as the need to reduce consumption, food waste, change diets, vertical farming, industrial greenhouse farms, and NPBTs' role in addressing these challenges. They suggested actively communicating NPBTs' role to the larger audience to inform, instil confidence and gain consumer support.

> *"Investigation is done by an independent organisation, what is independent about the organisation, and who pays for that organisation? …consumer confidence is everything. In recent years, the consumer has often been cheated by the food industry, let's face it, I think that this is not a positive." – Dutch juror.*

> *"So, it is best at some point to have a [TV] programme where you are going to discuss genetically modified food. I have tried to find a neutral article, and it is almost*

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impossible because everyone has a position, so you must have a programme both, the sides are of course well. I think that it is tough, but it can reduce polarisation." – Dutch juror.

During the third day, jurors mainly discussed whether NPBTs were indeed a good strategy for addressing global food challenges. They also weighed the pros and cons of having limitarian policies mainstreaming NBPTs for addressing (international) food challenges.

"I do think that politics should give support [to the adoption NPBTs] under conditions, if necessary, but that support is so important." – Dutch juror.

"I think you have to change things very carefully and that people ultimately are willing to make choices that are not necessarily in their favour. I fear that the kind of things have to be subtly imposed from above because if you leave it to the individual, you will get chaos." – Dutch juror.

3.1.2. Citizens' jury day 4: knowledge structuring deliberations

On day four, we asked the jurors to deliberate on the strengths and weaknesses internal to and the opportunities and threats external to NPBTs. The jurors felt that the most important aspects of NPBTs were that they could help to i) reduce the Netherlands' food dependency, ii) increase nutritional security, iii) increase crop resilience, and iv) increase the monopolisation of food and shift the balance of power from farmers to businesses. Politicians and the lack of policy guidance were also important threats identified by the jurors.

"…that is [food] independence Europe. We can have more species to be less dependent, should things go wrong in the other regions. And the threat is that it is possible to develop these crops in Europe, because of the [consumer] acceptance." – Dutch juror.

"… policy too… the slow, lack, inadequate regulation, and also the lack of political guidance...for the consumer and the farmers, or for the breeders." – Dutch juror.

3.1.3. Citizens' perspectives on future imaginaries

Results from the first poll suggest that most jurors think that we are currently heading towards rejecting the use of NPBTs (Figure 7). Results from the second poll show that the jurors were split (Figure 7): they felt that we could either fully adopt NPBTs and that science and society would flourish or that people did not trust the government and rejected NPBTs entirely. The results of the third poll suggest that the majority of jurors felt that the most desirable way forward would be to adopt NPBTs and that society would flourish along with science, while others felt that it should be assumed only in response to the climate emergency (Figure 7).

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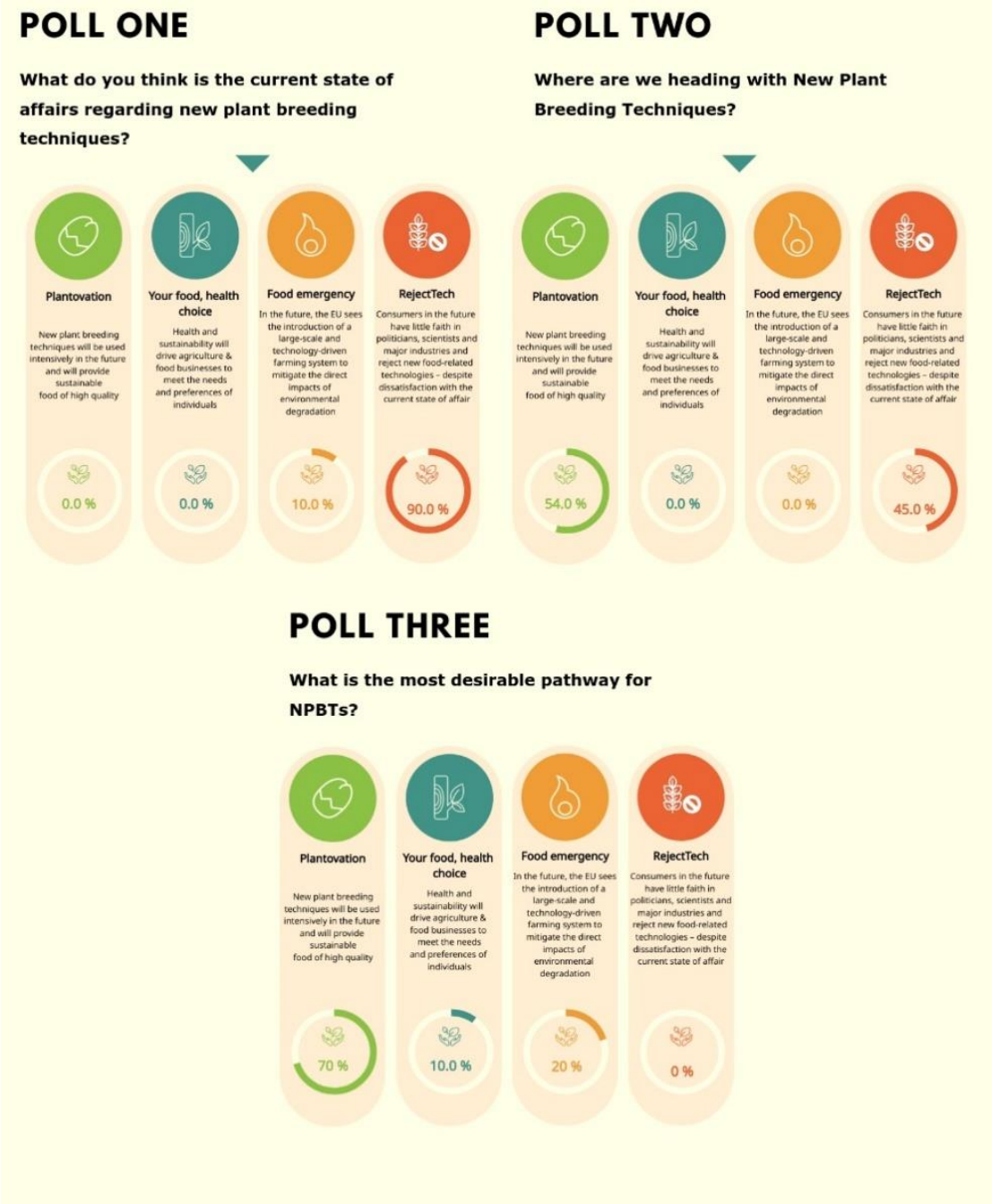

Figure 7. *The Dutch jury's current and future trajectories for NPBTs based on future imaginaries.*

Results from the fourth poll show that 93% of the jurors supported the use of NPBTs for future-proofing crops under certain conditions, while 7% supported it without conditions (Figure 8). Since the jury passed a unanimous verdict in support of NPBTs, most of the discussions that followed focused on the governance and regulation of NPBTs and their impact on sustainability. The jurors felt that NPBTs should be adopted to take into account consumers' food preferences and health choices. We polled them again to see if their views had changed, but their final judgment remained the same (Figure 8).

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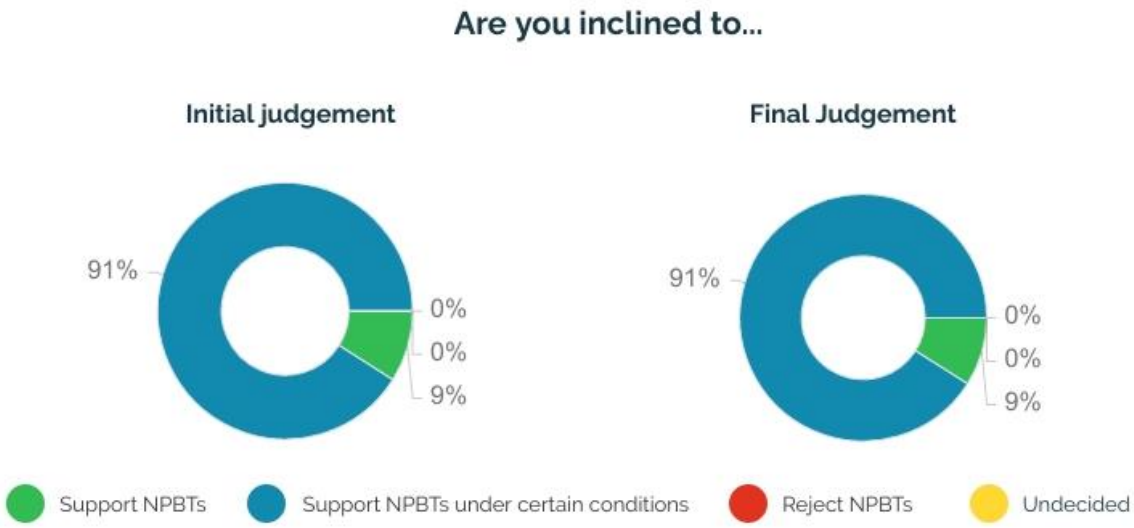

Figure 8. *Results of the poll on whether the Dutch jurors were inclined to support or reject NPBTs.*

3.1.4. Jury verdict

Figure 9 illustrates the verdict of the Dutch jury (translated to English). In summary, the jurors supported the use of NPBTs for future-proofing crops with a unanimous majority, but under certain conditions. Their reasons for supporting NPBTs were that it could i) increase food production, ii) contribute to climate change mitigation and adaptation, iii) develop crop varieties leading to higher food quality worldwide, which can, in turn, contribute to improving people's food well-being and, thus, prevent global unrest. However, their conditions for supporting NPBTs were that food produced using these techniques should be safe and nutritious (condition 1). The jurors mentioned that the application of NPBTs must also be accessible and ethical (conditions 2-3). They also mentioned that the technology should be used if it has the same or a lesser climate impact than conventional breeding techniques (condition 4). Finally, there must be options to revert to previous genetic material to have a safety net in case of unforeseen and detrimental effects (condition 5).

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The Dutch Citizen's jury verdict on New Plant Breeding Techniques for future-proofing crops

We, as a group, have reached a judgment about new plant breeding techniques

We are unanimously in favour of the development of these technologies.

We, as a group, are in favour of new plant distribution techniques for crop improvements because_

Reason 1: There is a need for [increasing] food production, and there do not seem to be sufficient, sustainable alternatives that can completely solve the shortage of food production.

Reason 2: These techniques can contribute to dealing with climate change and contribute to controlling climate change.

Reason 3: These techniques can lead to better availability of higher quality food throughout the world through more and better food production. This can contribute to people's food well-being; and thus prevent (global) unrest.

We are in favour, but the following conditions must be met.

Condition 1: The food made with these techniques must be as safe and nutritious as current, comparable products.

Condition 2: The application of these techniques must serve a social interest and be accessible [to farmers and developing countries].

Condition 3: Short, medium and long term monitoring of the environment and ethical impacts by independent regional/global organizations is essential

Condition 4: This technology must have the same or less climate impact per product (weight) than current, comparable products.

Condition 5: There must remain the possibility to go back to previous alternatives to have a safety net in case of problems.

Figure 9. *The Dutch jury's written verdict on NPBTs.*

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3.2. The British citizens' jury

3.2.1. Citizens' jury days 1-3: deliberations and discussions

Throughout days 1-3, jurors expressed their concerns and opinions towards NPBTs during the deliberation and Q&A sessions. Their discussions and questions to the experts first intended to understand better how the technology presented to them worked. The jurors were interested in the rationale behind using NPBTs, their aims and applications (e.g., which species of crops would be improved and how), what is feasible and what is not with the technology.

> *"A lot of it is a relatively advanced science, and genetics is extremely complicated, especially gene splicing, which is what they're talking about, cutting up genes and sticking them back together, in the simplest terms." – British juror.*

> *"It sounds like, well, it's excellent because you could adjust crops to any climate, you know, they talked about flood-resistant crops or whatever it is. So, then it just makes me think: if that's the case, how many different varieties of one crop can you make?" – British juror.*

Jurors also enquired about the potential impacts of the NPBTs, whether these impacts were positive or negative, and how they were monitored by the scientific teams in charge of developing improved crops and would be considered by regulatory bodies. Three main fields were mentioned over the three days for which participants expected impacts to represent a risk: human health, the environment and the economy.

Another worry of the participants related to barriers that may impede the development and implementation of NPBTs. These barriers were perceived obstacles that jurors believed might need to be addressed to allow for NPBTs to be used in Europe (e.g., the overall negative public opinion towards genetic modification in Europe, a lack of communication to and education of the general public on genetic modification, and the current regulations on genetic modification being too constraining). They also corresponded to jurors' own opinions, which could be representative of more general doubts from the public sphere towards NPBTs (e.g., the feeling that NPBTs are a solution for a problem – food insecurity – that is not yet present in Europe, the fear that NPBTs could be weaponised, and the uncertainty on whether farmers would be able and willing to cope with the required changes in agricultural practices needed to accommodate NPBTs).

> *"Is it dangerous to use new ways too quickly, [...] when we don't have the long-term data and effects on human beings? [...] To do something that would usually happen in nature actually over millions of years?" – British juror.*

Furthermore, we observed a shift in focus in the jurors' deliberations and questions formulation over the three days. At the beginning of the exercise, jurors mainly were concerned with the potential direct risks of NPBTs. They asked questions relating to the negative impacts their use

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might have on the environment, particularly on biodiversity (e.g., by contributing to decimating insect populations or by disrupting ecosystems) and on soil quality (e.g., by depleting the soil from its nutrients), and on socio-economic aspects, such as on human health (e.g., by creating new allergies or being carcinogenic), on farmers and rural communities (e.g., by requiring important changes in farming practices or by having negative effects on jobs and incomes), and on low-and-middle-income countries (e.g., by disrupting trade). Jurors also formulated questions to understand the eventual side-effects of their application more in detail. They enquired on how side-effects were controlled and monitored, how strong the evidence was to back up scientific claims that the technology did not present any risks, and whether there were examples of improved crops already implemented and grown in other countries outside of Europe. Moreover, there were sentiments of distrust towards science, the government and the EU as an organisation. Our bias was questioned, as we were seen as advocating in favour of NPBTs and pursuing the EU's agenda.

> *"I know we're planting things, but how does that react with the soil of the earth? [...] Or, you know, the biodiversity? [...] That worries me, but then I think the whole world is artificial in many ways. It's the way it seems to be going, and I'm not sure there's a way to slow that down." – British juror.*

However, as the days went by and jurors were exposed to the talks from the CropBooster-P experts and heard key experts' witness testimonies, their worries moved to broader questions of governance, regulation and applications of NPBTs. The technology in itself was not at the core of their preoccupations anymore; several jurors, having heard the presentations and debated with the expert witnesses, felt that they trusted that the scientific evidence and knowledge behind NPBTs was thorough enough as to not present so much of a risk as they initially thought. Instead, how NPBTs will be governed (e.g., who will have access to improved crops or how the profits will be shared), and the risks of a downward slide after their use has been mainstreamed became more of their central point for debate. More specifically, jurors expressed concern relating to the possibility for genetic modification to be weaponised and used on humans, an eventual lack of transparency (especially relating to potential side-effects being disclosed to the general public), and the hazard of the technology spiralling out of control, mainly in the form of some modified crop species becoming loose in the environment and leading to knock-on effects on other species.

> *"So there already are these sorts of 'do it yourself warehouses' where, you know, [...] they're not purposely trying to make viruses and pathogens, but it is a concern in the scientific community that one of them might make something that was unintended, that could basically kill us all. And there's not much regulation in the space." – British juror.*

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3.2.2. Citizens' jury day 4: knowledge structuring deliberations

Deliberations from the knowledge structuring exercise highlighted that the jurors considered the benefits brought by the use of NPBTs, mainly increased productivity, with higher and more stable yields, increased crop resistance to environmental factors, increased crop quality and increased sustainability of farming practices, and the strong safety standards regulating the development of improved crops to be the main strengths of NPBTs. They also believed that reducing world hunger and food insecurity, improving quality of life, reducing the impacts of agriculture on the environment, increasing resilience to climate change and creating economically profitable solutions to world hunger were the principal opportunities that the use of NPBTs could realise.

> *"I know that the most important opportunity is really to reduce deforestation and the impacts of agriculture on flora and fauna, [...] because without, [...] we are truly screwed. I don't think everyone realises how much we need those systems, which we are destroying, to be working properly." – British juror.*

Conversely, jurors believed that the main weaknesses of NPBTs were due to the potential risks linked to the technology, primarily negative impacts on health, the environment and prices of foodstuffs, and the slow and lengthy implementation process of the technology. Negative public opinion about genetic modification, slow bureaucracy coupled with strict regulations, and the possibility of a downward slide (weaponisation, use on humans, improved crops running out of control) constituted the significant threats that could affect NPBTs.

> *"If you make a mistake in giving open sharing of the technology and they make crops that interact with everything else around […], we could create some sort of unintended, unforeseen effect, [...], there could be some form of unforeseen, unintended human annihilation." – British juror.*

3.2.3. Citizens' perspectives on future imaginaries

Results from poll one show that most jurors think that we are currently rejecting NPBTs, while a small minority of jurors think that NPBTs are being used within Europe (Figure 10). Results from the second poll suggest that most jurors felt NPBTs could be fully adopted, and that science and society would flourish (Figure 10). A small minority felt that NPBTs would be adopted to mitigate the effects of climate change. Results from poll three suggest that most jurors believed that the most desirable way forward would be to adopt this technology and that society would flourish along with science, considering sustainability and consumers' health needs (Figure 10). In contrast, a small minority felt that the technology would be adopted only as a response to the climate emergency.

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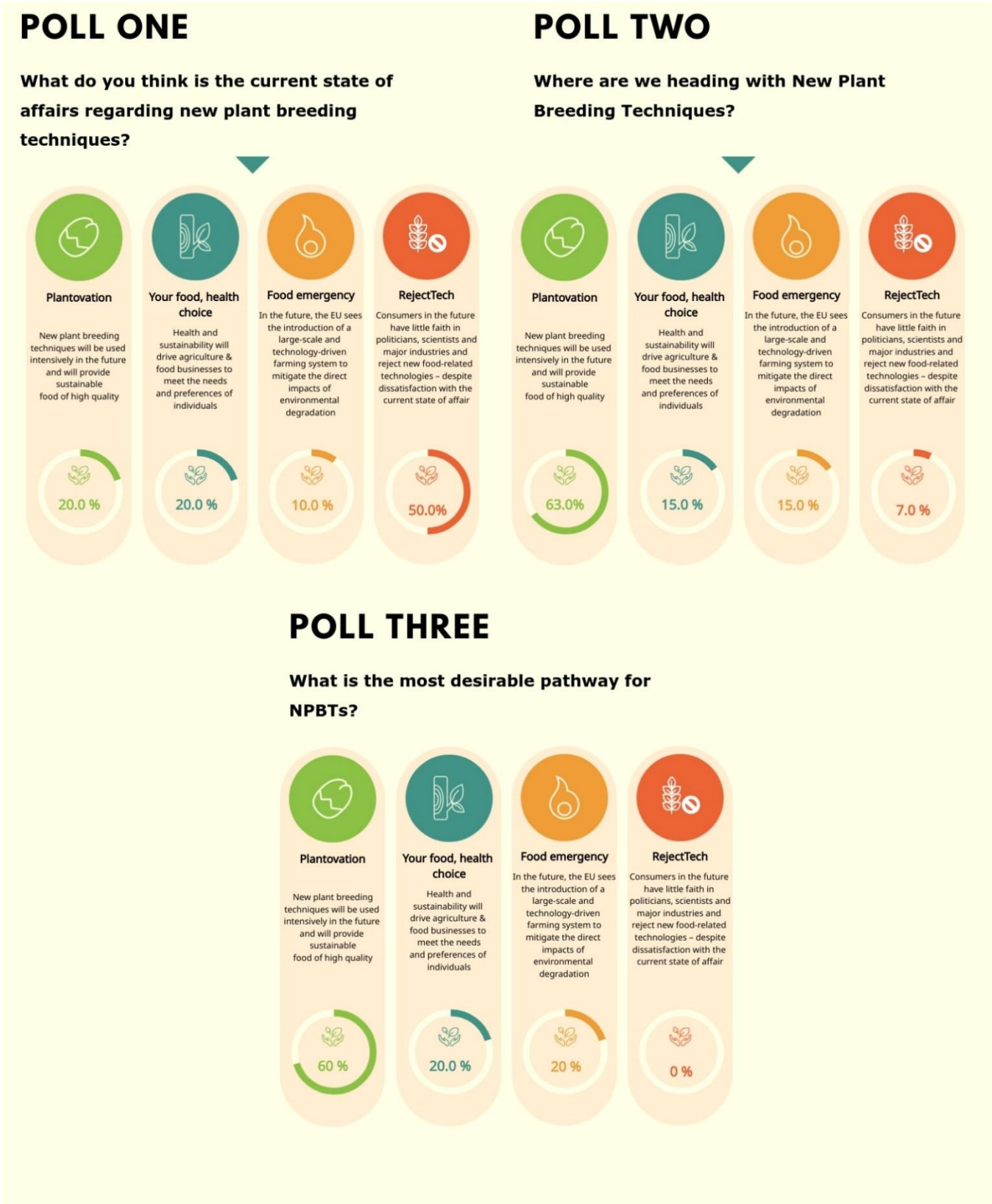

Figure 10. *The British jury's current and future trajectories for NPBTs based on future imaginaries.*

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Results from poll four show that 70% supported NPBTs for future-proofing crops under certain conditions, while 20% supported it without conditions, and 10% were undecided (Figure 11). Following this poll, jurors were asked to attempt to convince each other to reconsider their vote to reach a verdict. The debate was heated, with the undecided jurors questioning whether those who voted for NPBTs would eat a genetically modified crop. Most jurors stated that they would eat genetically modified crops given all they had heard and their deliberations.

After this debate, we polled them again to see if their views had changed. Results from poll five suggest that 30% supported NPBTs without conditions, while 60% supported NPBTs under certain conditions, and 10% remained undecided (Figure 11). In the final judgment, jurors who supported NPBTs under certain conditions moved towards supporting NPBTs without any conditions, while those who were undecided did not change their view and would support NPBTs only if other alternatives could not solve future food challenges.

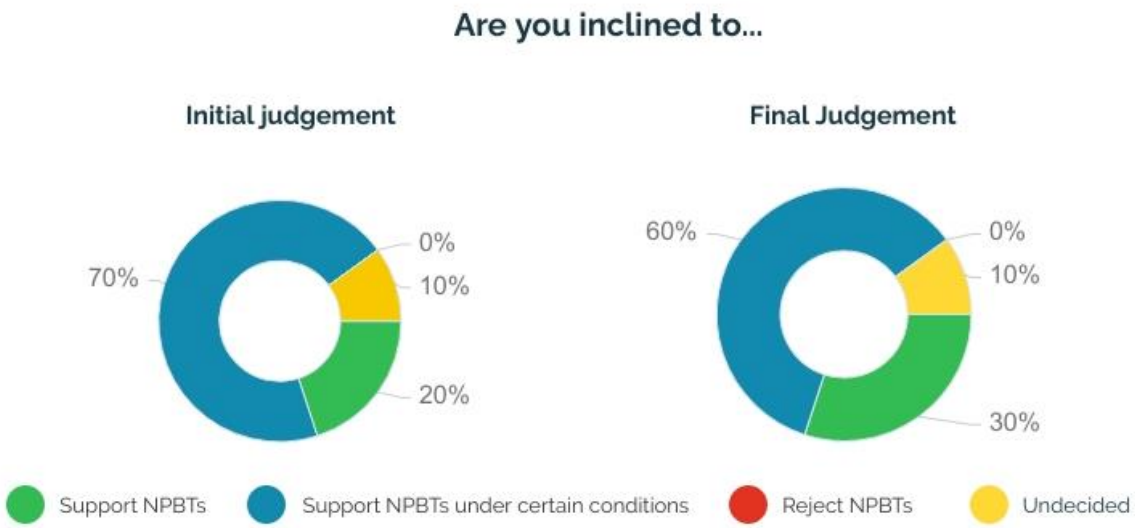

Figure 11. *Results of the poll on whether the British jurors were inclined to support or reject NPBTs.*

3.2.4. Jury verdict

The verdict of the UK jury is presented in Figure 12. In summary, the jurors supported NPBTs, with a supermajority supporting NPBTs and under specific conditions (60%), the large majority supporting NPBTs for future-proofing crops without any conditions (30%) and a small undecided minority (10%). They decided to support the implementation of NPBTs since they saw NPBTs as a holistic response to the current social, economic and environmental issues faced by humankind at the global level. They believed that NPBTs represented an effective and efficient solution to world hunger and food insecurity, could improve the resilience of countries and communities to economic shocks and climate change impacts, and could participate in reducing the ecological footprint of the agricultural and food sectors on the planet. However, the jurors also conditioned their support to NPBTs to the appropriate transparency and ethical accessibility of the technology

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(conditions 1-3), the adequate governance and regulation of the technology (conditions 4 and 6), and the maximising of financial opportunities at the government level from pursuing the development and implementation of the technology (condition 5). The small minority (10%) of jurors that were undecided towards the use of NPBTs argued that, though they understood the advantages of NPBTs, they were convinced that alternatives to NPBTs could be more effective at solving the problems at stake and should be investigated more thoroughly before settling on NPBTs.

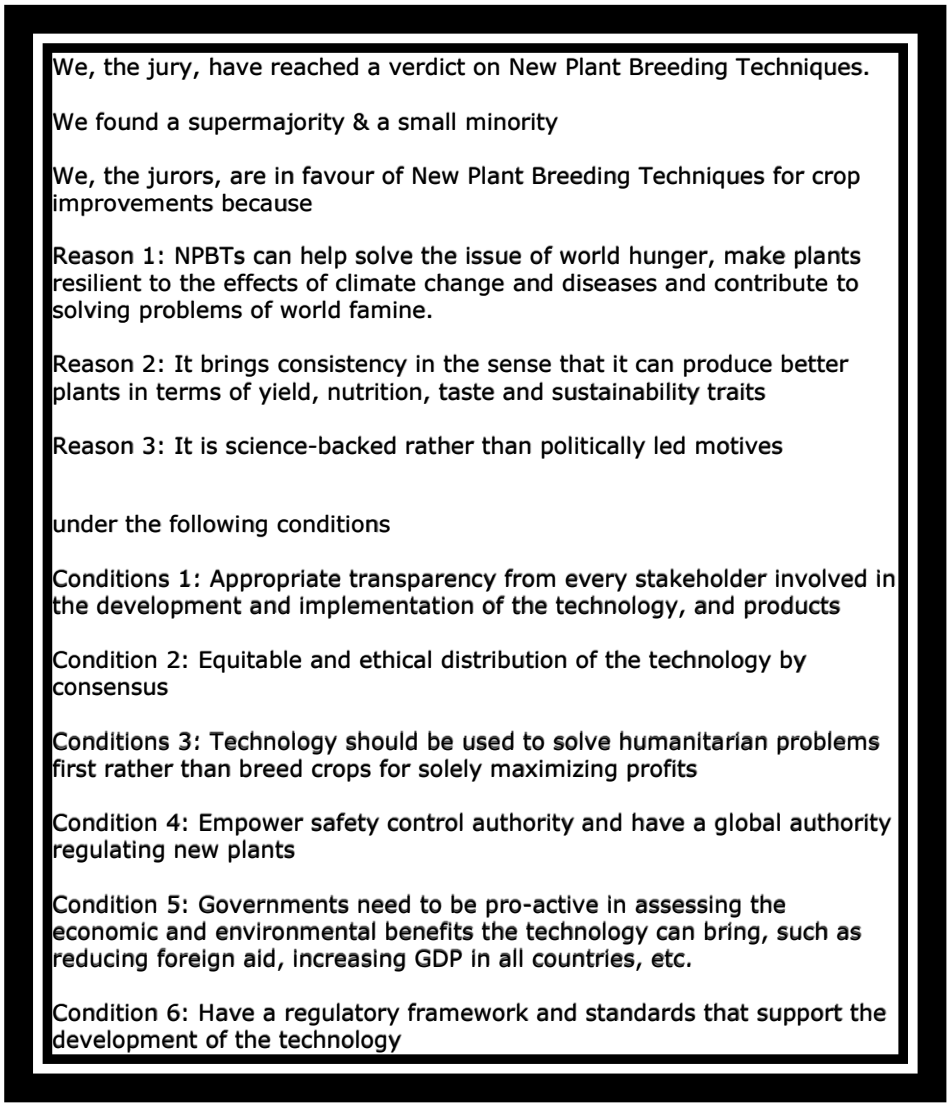

Figure 12. *The British jury's written verdict on NPBTs.*

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4. Conclusion

The citizens' juries shed light on the social desirability of improving crops using NPBTs. Both the Dutch and British juries conditionally supported the development of NPBTs for crop improvements. The main reasons behind this support, as stated by participants, included increasing food production to ensure food security and decrease world hunger, reducing the ecological footprint of agriculture on the environment and helping to mitigate climate change, and increasing the food sector's resilience to economic shocks and climate change impacts. However, the jurors' support towards NPBTs was subject to a series of conditions:

- The use of the technology must comply with appropriate **transparency** and ethical **accessibility**.
- The **technology's governance and regulation must be adequate** to ensure **safety** and **crop quality**.
- The **carbon footprint** of improved crops must be equal to or lower than that of existing crops.

These conditions were at the core of both the Dutch and British verdicts. However, there were also some differences in terms of conditions between the two juries. A condition that was crucial only for the Dutch jurors was the possibility to revert to previous alternatives (i.e. current breeding techniques) as a **safety net** if NPBTs were to engender unforeseen problems. A condition that was especially important for the British jurors was that governments must seek to maximise the **financial opportunities** resulting from the development and implementation of NPBTs. A minority of British jurors, though in favour of NPBTs, second-guessed their effectiveness at reaching climate and food security goals and advocated investing in more effective **alternatives** instead of NPBTs.

Overall, the verdicts of the citizens' juries showed that using NPBTs for future-proofing crops in Europe is perceived as being socially desirable to ensure food security and participate in mitigating climate change, under the conditions that their implementation is safe, well-regulated and contributes to making the world more equitable.

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ANNEX

Citizens jury protocol	***Details***	We intend on orchestrating two online citizen's juries, and each jury will take place over four days
		
		1. *Netherland's citizen's jury*
		   ○ *Day 1: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 2: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 3: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 4: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		
		2. *United Kingdom's citizen's jury [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 1: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 2: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 3: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		   ○ *Day 4: [xx:xx-xx:xx CET – dd.mm.yyyy]*
		
		We intend on having 8-10 participants at each citizen's jury. We will present the scientific assessments, expert views, and societal expectations vis-à-vis crop improvement plans and strategies in each jury. After these presentations, we will have question formulation sessions for the public to brainstorm, identify problems, and develop questions that need answering. A panel session will then engage a CropBooster-P and a critical external expert to discuss critical issues on crop improvements and new plant breeding, which a Q&A session will follow. These activities will help the public gain a better understanding and insight into crop boosting and its techniques. These activities will happen in the first three days, with each day having a session on the followed by the and question formulation discussion followed by a panel discussion and a Q&As round.
		
		On the fourth (final) day of the citizen's jury we will break participants into smaller groups to deliberate whether they are for or against new plant

		breeding for crop boosting. Since a hung jury is foreseeable, we will present four pathways for new plant breeding for crop boosting in the deliberative session. We will ask the public to deliberate these option as select one pathway that is the most desirable. We will also have a session to synthesise the individual group deliberations to assess public social desirability.

	Materials	Make sure:
		• You have sent the PIS to all participants by email at least 24 hours before the online workshop; preferable attached to the invitation email.
		• You have created the event as a Teams meeting (this is mandatory for video recording)
		• You have created a backup meeting in Webex
		• You have a draft email to all participants with a backup Webex link ready to be sent in case of any issues with Teams
		• You have sent a follow-up email that details the **time**, Teams **link** and **agenda** for the meeting
		• Make sure:
		  ○ You have **screen capture software** set up or a **voice recorder to record audio via laptop/tablet speakers (this is back up in case Teams doesn't record correctly)**
		  ○ You know how to use the voice recorder
		  ○ You have checked that the voice recorders work (**battery**)
		  ○ You have provided participants with a link to the consent form
		  ○ You have checked in advance that all participants have filled in the online consent form

		▪ Have links to consent forms ready in case anyone has not yet done it/wants to remind themselves of what was in it ○ You have links to option card materials and are comfortable using them ○ You have a **notepad** ○ **You have the printed out notetaking sheet** ○ **You have two pens** ○ List of (expected) attendees • The partner organisation is either A. attending to give a short presentation, B. sending a prepared video which you have ready, or C. not attending, and you have added a thank you slide to the presentation • You have a spare computer already switched on, with the links for the Teams and Webex calls ready to act if need be • You have a LAN to connect to the internet directly • You have a set of headphones (preferably with a microphone) - unless you are using the dictaphone as a backup, in which case check that your audio quality is acceptable • You know who is attending and who is missing
	Before starting	Ensure that you: • Greet people as they arrive and make them feel welcome • Chat with them, try not to leave anyone out • You explain to participants that you will be recording the event • Check everyone's microphone and video connections individually • We have a designated backup moderator ready to help out **[SEND OUT A LINK TO CONSENT FORMS IN ADVANCE OF THE MEETING]**

Protocol: Day 1

Welcome presentation	**5 MINS (t=5)**	• The hosting partner can give a quick introduction (1-2 minutes) or provide a video
		• Explain briefly the CropBooster-Project
		• Explain ground rules
		  ○ There are no wrong answers
		  ○ We are video/audio recording so we do not miss anything and your responses will be kept anonymous
		  ○ Online meetings are not as fluid as in-person meetings, so please be patient with each other and I'll try to make sure everyone gets a turn speaking.
		  ○ Glitches usually resolve quickly – here is how we will deal with them
		  ○ If you have issues with audio during the call, please use the chat function to alert the moderator
		  ○ If the moderator drops out of the call and does not return within 5 minutes, please 1) check your email to see if we have sent you anything and if not, 2) contact the emergency moderator (put the emergency moderator's email in the chat)
		
		[REMIND EVERYONE THAT THEY NEED TO SIGN THE CONSENT FORM IF THEY HAVEN'T DONE SO]

Introduction	**10 MINS (t=15)**	**[START TEAMS RECORDING AND VOICE RECORDER/SCREEN CAPTURE SOFTWARE]** In this session, participants will introduce themselves, give us a bit about their lives, occupations and why they chose to participate as a jury member. 1. Can you tell us your first name and a little about your occupation?

		2. Can you tell us why did you choose to be a part of this citizen's jury or 3. Does the topic of food production and crop improvements intrigue you? **[MAKE A NOTE OF PEOPLE'S NAMES]**
Ice-breaking session	**30 MINS (t=45)**	In this session, we will break participants into smaller groups (three groups of four) and shuffle them every 10 mins. The motivation is to get the participants to feel comfortable around each other and speak their minds openly. 1. If you could only pick three foods to eat for a month, what would you choose? 2. Would you eat insects to protect the planet? 3. Superfood vs organics choose one and why? 4. A perfectly shaped apple or misshaped tomato? 5. Soy vs beef for life, choose one and why? 6. Soy vs quinoa for life, choose one and why? [NB: These questions implicitly aims to extract more information regarding participant bais]
Break	**15 mins (t=60)**	Grab a drink – coffee tea or whatever you like.
Keynote address	**15 MINS (t=75)**	**[RENE's PRESENTATION: "WHAT IS A THE FUSS ABOUT – In Dutch & English]**
Presentation: WP1 results	**30 MINS (t=105)**	**[ALEXANDRA's PRESENTATION: "STATE OF THE ART IN NEW PLANT BREEDING: TECHNIQUES AVAILABLE AND ACHIEVEMENTS UNLOCKED" – In Dutch & English]**

Question formulation session *(revolving moderator: no explicit moderation)*	**45 MINS (t=150)**	**[SHIFT PARTICIPANT INTO TWO BREAKOUT ROOMS]** **[PROVIDE SEPARATE LINKS TO THE QUESTION FORMULATION GUIDE]** **[ASK PARTICIPANTS TO USE THE MURAL TO FOLLOW THE TEMPLATE TO FORMULATE QUESTIONS THAT NEEDS ANSWERING]** **[MODERATOR: MOVE TO NEXT ROOM]** 1. What aspects of the topic intrigued you? • Please list down the various concepts in the first column in the question formulation guide and discuss why. 2. Was there anything that concerned you? • Please list down the various concepts in the second column in the question formulation guide and discuss why. 3. What issue would you like to know more about? 4. Is there something that you would like clarity on? 5. What is a view that you would like to share us? **[INFORM PARTICIPANT TO BREAK FOR LUNCH AND JOIN US AGAIN IN AN HOUR BY CLICKING THE INVITATION LINK]** **[INFORM THEM THE MODERATED TALK WILL START AT XX: XX TIME AND NOT TO BE LATE]**
LUNCH BREAK	**60 mins (t=210)**	
Moderated talk: *Organic vs GM vs Genome editing*	**30 MINS (t=240)**	**[ONCE ALL PARTICIPANT HAVE RETURNED, INVITE THE CRITICAL EXTERNAL EXPERT TO VOICE THEIR OPINION REGARDING THE RISKS AND BENEFITS OF CROP IMPROVEMENT – 15 MINS]**

		[NB: IF CITIZEN'S RAISE THEIR HANDS OR WANT TO ASK QUESTIONS, ASK THEM TO RAISE THEIR HANDS] **MODERATOR PROMPT:** 1. Do you agree with the issues raised by the critical external expert? **[CROPBOOSTER EXPERT INPUT – MAX 5 MINS]** **[CRITICAL EXTERNAL EXPERT's REBUTTLE OR ADDITION – MAX 5 MINS]** 2. What other opportunities or threats do you see? **[CROPBOOSTER EXPERT OPINION – MAX 5 MINS]** **[CRITICAL EXTERNAL EXPERT's REBUTTLE OR ADDITION – MAX 5 MINS]** 3. How can these risks be managed? **[CROPBOOSTER EXPERT OPINION – MAX 5 MINS]** **[CRITICAL EXTERNAL EXPERT's REBUTTLE OR ADDITION – MAX 5 MINS]** 4. How would you chart the future? **[CRITICAL EXTERNAL EXPERT's OPINION – MAX 10 MINS]**
Questions & Answers	**30 MINS (t=270)**	• Ask participant what they felt about the presentations • Ask them if they have specific questions that they like answered, which they formulated during the "Question formulation session." • Ask them if they will share their thoughts regarding crop boosting.

Debrief	**10-15 MIN (t=285)**	• Inform participants that you have now reached the end of today's session • Ask if they have any remaining questions. • Tell them we are looking forward to having them tomorrow • Thank participants for their time **[END RECORDING]**

Protocol: Day 2

Welcome	**5-15 MINS (t=15)**	1. Thank participant for joining Day Two of the citizen's jury 2. Tell them the agenda for the day 3. Briefly mention the ground rules again **[START RECORDING]**
Presentation: WP2 results	**30 MINS (t=45)**	**[JESS's & ARNOUT's PRESENTATION: "IMPACTS OF CROP BOOSTING AND EXPERTS OPINION, VIEWS AND EXPECTATIONS" – In English & Dutch]**
Question formulation	**45 MINS (t=90)**	**[FOLLOW DAY 1 PROTOCOL]**
Break	**15 mins (t=105)**	Grab a drink (I had one recently with a small task – put on nice music while doing so). That worked rather well setting your mind in something else

Moderated talk: *Future of food, feed and bio-economy: Plant breeding vs food systems interventions*	**30 MINS (t=135)**	**[ONCE ALL PARTICIPANT HAVE RETURNED, INVITE THE CRITICAL EXTERNAL EXPERT TO VOICE THEIR OPINION ON WHETHER INTERVENTIONS FOR FUTURE-PROOFING SHOULD FOCUS AT CROP OR FOOD SYSTEM LEVEL – 15 MINS]** **[NB: IF CITIZEN'S RAISE THEIR HANDS OR WANT TO ASK QUESTIONS, ASK THEM TO RAISE THEIR HANDS]** **MODERATOR PROMPT:** 1. Do you agree with the issues raised by the critical external expert? **[CROPBOOSTER EXPERT OPINION – MAX 5 MINS]** **[CRITICAL EXTERNAL EXPERT's REBUTTLE OR ADDITION – MAX 5 MINS]** 2. How can crop improvements create food system changes? **[CRITICAL EXTERNAL EXPERT'S OPINION – MAX 10 MINS]** **[CROPBOOSTER EXPERT'S OPINION – MAX 5 MINS]** 3. How can crop improvement support the feed and bio-economy? **[CRITICAL EXTERNAL EXPERT'S OPINION – MAX 10 MINS]** **[CROPBOOSTER EXPERT'S OPINION – MAX 5 MINS]**
Questions & Answers	**30 MINS (t=165)**	**[FOLLOW DAY 1 PROTOCOL]**
Debrief	**15 MIN (t=180)**	**[FOLLOW DAY 1 PROTOCOL]**

Protocol: Day 3

Welcome	**5-10 MINS (t=15)**	1. Thank participant for joining Day Three of the citizen's jury 2. Tell them the agenda for the day 3. Briefly mention the ground rules again **[START RECORDING]**
Presentation: WP3 results	**30 MINS (t=45)**	**[ARNOUT's PRESENTATION: "SOCIETAL ACCEPTABILITY OF NEW PLANT BREEDING AND VIEWS AND EXPECTATIONS"]**
Question formulation	**45 MINS (t=90)**	**[FOLLOW DAY 1 PROTOCOL]**
Break	**15 mins (t=105)**	Grab a drink (I had one recently with a small task – put on nice music while doing so). That worked rather well setting your mind in something else

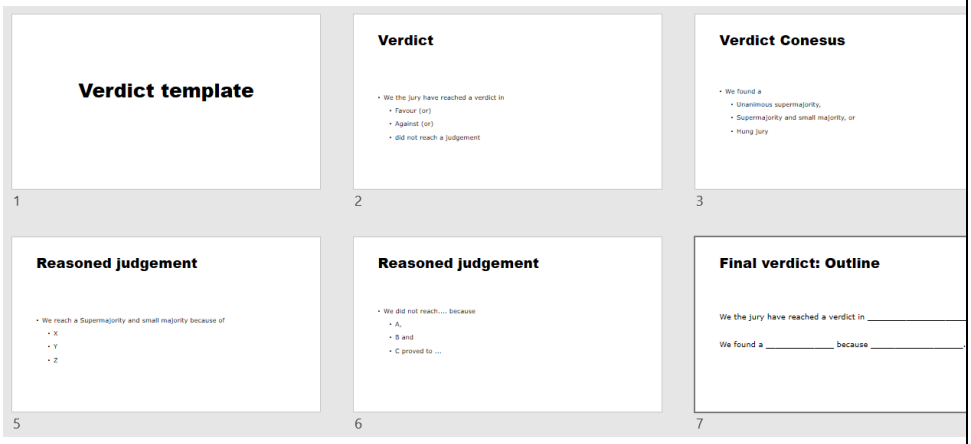
Moderated talk: *Regulation, when why and by how much?*	**30 MINS (t=135)**	**[ONCE ALL PARTICIPANT HAVE RETURNED, INVITE THE CRITICAL EXTERNAL EXPERT TO VOICE THEIR OPINION ON WHETHER THERE IS ENOUGH INFORMATION TO ACT AND CAN REGULATORS HELP REDUCE UNCERTAINTY IN DECISION MAKING – 15 MINS]** **[NB: IF CITIZEN'S RAISE THEIR HANDS OR WANT TO ASK QUESTIONS, ASK THEM TO RAISE THEIR HANDS]** **MODERATOR PROMPT:** 1. Do you agree with the issues raised by the critical external expert? **[CROPBOOSTER EXPERT OPINION – MAX 5 MINS]** **[CRITICAL EXTERNAL EXPERT's REBUTTLE OR ADDITION – MAX 5 MINS]** 2. How strong is decision making, and how can it be improved? **[CRITICAL EXTERNAL EXPERT'S OPINION – MAX 10 MINS]** **[CROPBOOSTER EXPERT'S OPINION – MAX 5 MINS]** 3. Who are the most important players, and how can they help improve or hinder decision-making? **[CRITICAL EXTERNAL EXPERT'S OPINION – MAX 10 MINS]** **[CROPBOOSTER EXPERT'S OPINION – MAX 5 MINS]**
Questions & Answers	**30 MINS (t=165)**	**[FOLLOW DAY 1 PROTOCOL]**

Debrief	**15 MIN (t=180)**	• Inform participants that they will need mention their stand on whether they are for or against crop boosting and new plant breeding techniques and WHY? • And that they must voice their stand in tomorrow's group discussions • Each participant will have five minutes to give us your stand • Inform participants that you have now reached the end of today's session • Ask if they have any remaining questions. • Tell them we are looking forward to having them tomorrow • Thank participants for their time **[END RECORDING]**

Protocol: Day 4

Welcome (9:00)	**5-15 MINS (t=15)**	1. Thank participant for joining Day Three of the citizen's jury 2. Tell them the agenda for the day 3. Briefly mention the ground rules again **[START RECORDING]**
Group (9:15) deliberations *(Moderated)*	**60 MINS (t=75)**	**[SPLIT THE PARTICIPANTS INTO TWO ONLINE BREAKOUT ROOMS]** **[PROVIDE EACH GROUP WITH THE LINK TO THE DELIBERATION GUIDE]** **[TELL THEM HOW TO USE THE DELIBERATION GUIDE]** **MODERATOR PROMPTS:** 1. Which outweighs the other? • Do the risks outweigh the benefits, or do the benefits outweigh the risks? 2. What are the most critical issues that have led you to support or oppose new plant breeding for crop improvements? 3. What would need to happen to change your mind supporting or rejecting new plant breeding for crop improvement?
Break	**15 MINS (t=90)**	**Grab a drink**
Synthesising deliberations (10:30) *(Moderated)* ***PART I**: Where are we at and where do*	**30 MINS (t=225)**	**[BRING ALL THE PARTICIPANTS INTO THE MAIN MEETING ROOM]** **[USE MODERATOR'S NOTE TAKING TEMPLATE]** **[POLL THE CITIZENS: PROVIDE A POLL AND DISPLAY RESULTS REGARDING THE DESIRABILITY OF NEW PLANT BREEDING]** **[FLASH THE FOUR SCENARIO CARDS]**

we want to go?		 **[POLL THE CITIZENS: REGARDING THE MOST DESIRABLE PATH FORWARD]** **[POLL THE CITIZENS: REGARDING THE PATH THAT THEY THINK THE WORLD IS CURRENTLY ON]**
Synthesising deliberations *(Moderated)* ***PART II:*** *Convince your peers on what you want and why!* ***LUNCHBREAK***	**90 MINS (t=315)**	1. Ask participants to raise their virtual hands (moderator need to make note of this) in MS TEAMS if they are 1.1. Undecided **[ASK EACH PARTICIPANT TO PROVIDE AT LEAST ONE IMPORTANT REASON FOR THEIR INDECISION]** **[ASK THESE PARTICIPANTS TO CONVINCE EVERYONE ELSE TO JOIN THEIR SIDE]** 1.2. Partially for and against crop improvement **[ASK EACH PARTICIPANT TO PROVIDE AT LEAST ONE IMPORTANT REASON FOR THEIR STAND]** **[ASK THESE PARTICIPANTS TO CONVINCE EVERYONE ELSE TO JOIN THEIR SIDE]** 1.3. Completely for new plant breeding and crop improvement **[ASK EACH PARTICIPANT TO PROVIDE AT LEAST ONE IMPORTANT REASON FOR THEIR SUPPORT OF NEW PLANT BREEDING TECHNIQUES]** **[ASK THESE PARTICIPANTS TO CONVINCE EVERYONE ELSE TO JOIN THEIR SIDE]** 1.4. Against new plant breeding for crop improvement

		[ASK EACH PARTICIPANT TO PROVIDE AT LEAST ONE IMPORTANT REASON FOR THEIR OPPOSITION] **[ASK THESE PARTICIPANTS TO CONVINCE EVERYONE ELSE TO JOIN THEIR SIDE]**
Synthesising writing *(Moderated)* ***PART III:*** *Pass the verdict*	**30 MINS (t=345)**	**[VERDICT STATEMENT]** 
Debrief	**15 mins (t=400)**	• Inform participants that you have now reached the end of the citizen's jury • Ask if they have any remaining questions • Thank them for the time that they spent **[END RECORDING]**