Food Standards Agency
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Consumer attitudes towards emerging food technologies

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Executive summary

Context and scope

The development of new and emerging food technologies and their applications is a fast growing area. The Food Standard Agency's (FSA) focus on protecting consumer interests in relation to food means it needs to understand and keep up to date with consumers' views towards these technologies.

This report presents the results of a rapid evidence assessment (REA) and a series of public dialogue events in different parts of the UK conducted by Collingwood Environmental Planning (CEP) to update the FSA's existing evidence base (see FSA, 2009). The technologies covered by the REA are genetically modified (GM) foods, nanotechnology applied to foods, functional foods, cultured meat, novel food (in the UK) such as insect foods, food from a cloned animal, 3D printed foods and synthetic biology applied to foods. The public dialogue events further explored the views of members of the public towards 4 of these technologies: GM foods, nanotechnology in foods, food from cloned animals and cultured meat.

Key overall findings[1]

- Across all the technologies examined no single picture emerges of consumer views. This is partly because of the inherent variability of the different technologies and partly because of the lack of systematic studies on consumer views.
- General awareness of food technologies is low, this is the case even for those that have been in the media over the past 20 years such as cloning.
- Key concerns that arise across technologies are perceptions of 'unnaturalness', potential impacts on health, animal welfare, farming and the environment. Lack of trust in the motivations of those promoting these technologies also led to concern.
- Perceived benefits of these technologies include higher yields which are required for a growing population, reduced use of pesticides, extended shelf life, reduced waste and improved quality.
- Attitudes toward a food technology can also vary depending on the type of application and the context.
- Ambivalence in views is common as both positive and negative views are held at the same time.

[1] Unless specified as drawing on the public dialogue research, the key findings by technology are based on the research presented in the 'Detailed findings' section of the separate REA report (see FSA, in press).

- Price has an impact. Consumers were more willing to buy GM food if it were available at a reasonable price and less willing to buy food involving nanotechnology if it were more expensive, even if it had health benefits.

Key overall findings by technology

Genetically modified foods

- The literature suggests that GM food was viewed negatively 10 years ago and continues to be. The reasons for this include ‘unnaturalness’, unknown risks, lack of perceived benefits, the desire to avoid any possible risks the technology could pose, health implications and concerns about the motivations of those promoting the technology.
- Attitudes are more negative towards animal based GM foods than plant based GM foods.
- Research from the pubic dialogues reported mixed views on GM food, with a general increase in positivity once participants had received information, although there were still a number who had concerns around how it was unnatural and long term environmental impacts. Of all the technologies spoken about in the dialogue sessions GM food had the highest level of initial familiarity, and some participants felt it was safer as it had been around a long time. A number of participants wrongly assumed that GM food products were available in the UK.
- There were concerns about unnaturalness, health and safety, trust, and long-term impacts in the environment. However, the public dialogue research appeared to contradict this, with GM foods being rated more positively after workshops, although views varied and some people still had concerns about aspects such as unnaturalness and environmental impacts.

Nanotechnology applied to foods

- Consumers awareness of nanotechnology has been found to be low. The evidence on consumer attitudes is mixed with reports of positive and negative feelings towards it. This compares to 10 years ago when it was largely positive.
- In the public dialogue workshops attitudes appeared to be overall neutral or positive towards nanotechnology applied to foods with many participants saying they would try it. It was perceived by some participants as less intrusive than the other technologies. Potential health benefits such as reductions in salt in the diet were received positively.

Cultured meat

- Survey data in the UK suggests many (42% - 62%) would not eat cultured meat. The key concerns in the literature are around the safety and health impacts.
- Framing of information (how it is described) can affect attitudes towards cultured meat.

- There were a variety of views in the public dialogue sessions; the taste, quality and visual appeal were mentioned as factors that would influence willingness to buy cultured meat. Some found the fact it would be grown in a lab off-putting, and some thought it would be very 'processed' and therefore unsuitable for children. Others thought there could be potentially be a benefit in providing meat with a less negative impact on animal welfare.

Food from a cloned animal

- The literature suggests most consumers are critical towards cloning animals for food mainly due to food safety, ethical, animal welfare, economic and environmental concerns. These views were supported by the public dialogue sessions. Food from cloned animals was perceived negatively and views tended to remain negative at the end of sessions.

Functional foods

- Consumer attitudes towards specific functional food products depend on the perceived necessity of the product, perceived healthiness, and the perceived naturalness of the combination of 'carrier' product and added functional ingredient.

Food from insects

- Familiarity with and acceptance of eating insects is growing rapidly. Health conscious, environmentally aware people are more likely to consume foods produced with insect proteins.

3D printed food

- Consumers tend in general to have low levels of knowledge and familiarity, and negative attitudes towards 3D printed food technology.
- Views towards 3D printed food are influenced by appearance, perceived safety, extent of processing, healthiness/nutrition and tastiness, knowledge and information, perceived 'fun to use', fear of eating new or alien food and of the use of novel technology in food production.

Synthetic biology applied to foods

- There is no clear consensus in the reviewed literature on consumer views towards synthetic biology in food. Attitudes toward synthetic biology are similar to those to GM food with concerns around 'unnaturalness' and 'playing God'. On the other hand, consumers express a sense of hope that synthetic biology could address issues such as food security. This suggests ambivalence about the technology.

Key findings from the public dialogue

- Initial familiarity towards all four technologies (GM food, cultured meat, cloned food and nanotechnology) was low. GM food had the highest initial familiarity, but

still half of participants initially considered themselves to be only ‘slightly familiar’ or ‘not at all familiar’ with this technology.

- Participants views towards the different technologies were mixed and fluid. Nanotechnology was generally viewed fairly positively once the technology was explained, whilst cloning was generally viewed the most negatively.
- Some participants were explicitly indifferent about the food technologies, saying they were not interested in how the foods were made if it was cheap, convenient and tasty.
- After information provision many participants felt they would be willing to try all four technologies discussed.
- For some participants, more information led to negative shifts in views (for example, in relation to food from cloned animals) or to greater confusion.
- Participants expressed a desire to be able to rely on government to verify the safety and quality of food technology and were often distrustful of what they saw as profit-driven industry actors.
- The public dialogue research suggests that changes in attitudes towards emerging food technologies (as least in the short-term) may be influenced by: information provision; discussion with others; increased understanding and familiarity with the technologies in particular in relation to safety and the risk assessment process and the benefits both to individuals and to the wider environment and society; belief that some technologies were becoming or would come to be regarded as ‘normal’; and future sustainability challenges.

Key findings from the public dialogue by technology

Genetically modified foods

- Views ranged on GM food. There tended to be some familiarity but also some confusion with some participants under the impression that GM food was already widely consumed in the UK. There were concerns about unnaturalness, health and safety, trust, and long-term impacts in the environment. There was also some recognition that GM food could help sustain food production for example in areas where there is famine. Generally, after information provision and in the second round of the public dialogue workshops participants were more positive towards GM food, although there was still a range of views, and concern about the impact on the environment.

Nanotechnology applied to foods

- Familiarity with nanotechnology was low. Participants tended to be positive when discussing the potential health benefits, such as increased nutrients in people’s diets or decreased salt. There were still concerns about long term impacts to health, the environment, trust issues related to potential mis-use, and discussion of whether nanotechnology was really necessary. Informed views tended to be

overall more positive towards nanotechnology applied to foods compared with some of the other technologies. For example, it was felt that nanotechnology was less intrusive ('[it's not] messing with DNA') and had less adverse connotations than some of the other technologies.

Cultured meat

- There was an initial lack of understanding around cultured meat. Similar to other technologies, there were concerns around the long-term impact on human health of a new technology and the unnaturalness and ethics of growing meat in a lab. But there was also interest in cultured meat if it meant growing meat harming far fewer animals. There were however still some animal welfare concerns for the animal the cells would be initially taken from, and also concerns about what it would mean for the farming industry. Many participants foresaw environmental benefits of cultured meat (for climate change), others worried about possible negative environmental impacts (for biodiversity) The taste, texture and visual appearance were important factors for some in terms of whether they would be willing to buy it. Some participants said they would not try it and would be put off buying something lab grown, or would always choose traditional meat.

Food from a cloned animal

- There was some knowledge of cloning as a number of participants referenced 'Dolly the Sheep' although familiarity was generally low. The term 'cloned' was off-putting for some. As with some of the other technologies it was seen as unnatural and there were concerns about animal welfare and impact on human health, as well as trust issues (being seen by some as primarily for the producer not the consumer). Although a few participants felt if it was fine as long as it was safe, cloning was not an issue for them. Informed views continued to be largely negative. While the primary benefit was recognised as being better quality meat, it was questioned if was ethical or necessary. There were also concerns about price.

Conclusions

Consumer attitudes towards the technologies examined appeared to be generally little-formed. This makes them open to be influenced in different directions by a variety of drivers. The technologies themselves can be applied in different ways and there is a lack of systematic research on consumer views in relation to specific applications. However, a number of themes related to what shapes consumer views can be drawn out across the technologies: naturalness/unnaturalness; controllability/uncontrollability and the possibility of unforeseen consequences; benefits/risks/attitudinal ambivalence; knowledge; and perceptions of the efficacy of governance of, and trust in the food system. Perceptions of risks and benefits appear to influence attitudes and behavioural

intentions towards emerging food technologies more than demographic characteristics such as gender or age.

Introduction

The development of emerging food technologies and their applications is a fast growing area of science and technology. Innovations over the past decade range from the development of cultured meat[2], grown from stem cells harvested without killing animals, through to the use of synthetic biology techniques, for example producing shrimps from algae, and 3D 'printing' of food. Unsurprisingly, the media tend to focus on the more dramatic aspects of some of these technologies.

Would you eat HUMAN meat grown in a lab? Controversial scientist Richard Dawkins suggests it could 'eradicate the taboo against cannibalism'

Mail Online, July 2019

Millennials 'have no qualms about GM crops' unlike older generation

The Telegraph (online), May 2018

However, it is vital to go beyond the headlines to understand how consumers view these technologies: their hopes and concerns about the technologies and specific applications, in order to have a more nuanced picture of the conditions under which they might be accepted or rejected.

The FSA commissioned CEP to carry out a rapid evidence assessment (REA), which included interviews with experts, along with public dialogue research[3], on emerging food technologies, with a view to updating its evidence base in this area building on the work carried out in 2009 (FSA, 2009). This report presents the overall findings from the REA and the public dialogue research.

[2] Cultured meat is also sometimes referred to as 'lab-grown meat' or 'in vitro meat'.
[3] In this project, 'public dialogue' is used to describe a process of deliberative enquiry during a workshop or meeting, in which members of the public are introduced to information about the topic, including with the participation of experts/decision-makers. Participants are encouraged and helped to interrogate that information and develop their understanding of it and provide views relevant to future policy decisions.

The overall research question addressed in this report is: **What are consumers' views of emerging food technologies, how have these changed over the last decade and what insights might we glean from this to inform future policy?**

To answer this question the research explored several sub-research questions (SRQs):

- What are the public's views on emerging food technologies?
- How do views differ depending on the type of technology?
- What shapes the public's views?
- Do different types of people hold different views?
- How do views affect behaviour such as food choices?
- How have views changed over time?
- What are the gaps in current research?

This report first briefly describes the methodologies used for the REA and the public dialogue. We then present the overall main findings for each research question, and for each of the 8 technologies, drawing on both the REA and public dialogue (with the exception of the last SRQ which was addressed by the REA only). This is followed by key findings from the public dialogue, including participants' views towards GM food, food from a cloned animal, nanotechnology applied to food and cultured meat. Finally we provide some overall conclusions based on the REA and public dialogue research. For brevity the primary evidence source is not stated throughout, rather the reader should assume findings are based on the REA unless otherwise specified as drawing on the public dialogue research.

Annex 1: Public dialogue research provides further details on the public dialogue research including methodology, approach to analysis, and selected results, in particular, those from the quantitative data collected during the workshops.

This report is accompanied by a separate report on the REA which includes overall findings and detailed findings by technology, along with details of the REA methodology including the protocol and search results (see FSA, in press).

Methodology

The project comprised 2 linked research activities:

- A REA of literature published since the FSA's 2009 review on consumer perceptions of emerging food technologies.
- A programme of public dialogue to explore the views of consumers in different parts of the UK on emerging food technologies.

Rapid evidence assessment protocol

A protocol was designed to guide the REA to address the SRQs (see FSA (Annex 1), in press). This describes how the REA was carried out, focussing on the inclusion/exclusion criteria for evidence, search string, sources of evidence and approach to prioritisation of documents. As far as possible we aimed to use the same approach to that used in 2009. We highlighted where there are differences and provided a rationale for any changes. The protocol follows the structure laid out in the Defra/NERC guidance on the production of quick scoping reviews and rapid evidence assessments (Collins et al., 2015).

Overview of literature

Following the methodology set out in the REA protocol (see FSA (Annex 1), in press), a final list of 115 articles was produced to be used in this review. This included literature resulting from a search in Scopus[4], grey literature, and any further additional literature as suggested by expert interviewees that fulfilled the exclusion criteria. The number of articles per emerging food technology varied, reflecting the extent of literature coverage for each. Prioritisation criteria[5] were applied to the lists of literature for each technology and the articles most relevant to the research questions were used in the final analysis. For some of the emerging food technologies more literature was deemed relevant than was ultimately possible to include within the scope of this review – in these cases, the literature considered most relevant were selected using the prioritisation criteria together with expert judgement. Of the final list of literature, 93 documents were reviewed in detail and are included in the findings of this report, as summarised in Table 1. The full list of papers included in the REA is provided in
Annex 2: Reviewed literature.

[4] https://www.elsevier.com/en-gb/solutions/scopus

[5] Each source was assessed as to how relevant it was to the research questions and descried in relation to: whether or not it was peer reviewed, the number of citations, its journal impact factor, the quality/robustness of the conclusions for example, were they backed by good data/findings, and whether or not limitations of data and quality were discussed in the paper. This fed into the expert judgement of team members as to whether or not a paper was of sufficient quality to be part of the review.

Table 1: Summary of final literature reviewed by technology

Technology	Total no. of papers included in review	No. of review papers	No. of empirical papers	No. of other
Cultured meat	23	9	14	0
Food from a cloned animal	9	3	5	Position paper = 1
Functional food	11	3	8	0
GM food	11	3	5	Mixed review and empirical = 3
Nanotechnology	10	5	5	0
Novel food processes	17	4	9	Book chapters = 3 Opinion paper = 1
Synthetic biology	6	3	2	Public dialogue process = 1
3D printed foods	6	0	5	Conference paper = 1
Total included	**93**	**30**	**53**	**10**

The REA provided vital input into the public dialogue process giving clear evidence around the different technologies and helping to focus the dialogue.

Public dialogue research

The aim of the public dialogue was to explore the views of consumers in different parts of the UK on emerging food technologies. The public dialogue focused on 4 of the emerging food technologies covered by the REA as agreed with the FSA: GM food, food from a cloned animal, nanotechnology in food and cultured meat.

The public dialogue was conducted in 2 rounds. Three Round 1 (R1)[6] events were held in Wigston (Leicestershire), Belfast and Swansea, to cover the areas in which FSA operates (i.e. England, Northern Ireland and Wales). These events were one-day workshops, each with 15 participants recruited by purposive sampling to provide a

[6] R1 refers to round 1 of the public dialogue events, likewise R2 refers to the second, final round.

balance of gender, age and educational qualifications in each group[7,8,9]. A total of 45 members of the public participated in the R1 events. The final 'recall' or Round 2 (R2) event was held in London and brought together 15 participants from the regional workshops to enable further elicitation of views during a one-day workshop. Using recall events gives participants time to reflect on discussions in the first workshop and share them with friends and family. This generates fresh questions and insights.

The public dialogue workshops were designed to enable participants to engage with information (and experts) around the food technologies, to enable considered discussion of their attitudes and behaviours, together with the underlying factors affecting those positions. R1 sessions covered:

- Exploration of knowledge and understandings of the four selected emerging food technologies.
- Discussion of the four selected technologies based on factsheets.
- Development of participant narratives about the selected technologies using posters.
- Introduction to contextual issues: 'Emerging food technologies and the food system'.
- Exploration of attitudes and behaviours using two future scenario prompt sheets.

In R2, participants had the opportunity to further discuss issues raised in R1 and to bring up points that they had thought between the two sessions. FSA staff provided information and participated in discussions about how new foods are assessed before they can go on the market.

Each workshop comprised a mix of plenary and small group discussions. Participants were also invited to complete short questionnaire before, after and during each workshop to further gauge their familiarity with and attitudes towards the 4 technologies (see Annex 1: Public dialogue research).

Each plenary and small group session was supported by one facilitator and one recorder. Sessions were also audio-recorded (with consent from the participants). A mini-privacy impact assessment was completed to ensure compliance with data protection laws.

[7] People with academic or public policy research in emerging food technologies were excluded.
[8] Participants received a cash incentive at the end of each workshop.
[9] 'Participants are chosen through a process of purposive sampling, as opposed to random sampling often used in quantitative research. The aim of purposive sampling is to involve a selection of people who might represent the widest possible set of views, values and demographics. The findings therefore cannot be taken to be statistically representative of the general population, but can uncover participants' views and the values, beliefs, experiences, interests and needs that underlie them.' (Sciencewise (undated) *What is public dialogue?* p.24*)* http://sciencewise.org.uk/wp-content/uploads/2018/11/What-is-public-dialogue-FAQ-Report-V6.pdf

The data from the workshop events was analysed thematically using Dedoose[10] to enable clear coding of workshop notes. Themes were developed in line with SRQs to code the data. The questionnaire data was analysed in Excel using descriptive statistics.

The information from the public dialogue workshops was examined in relation to the REA evidence to draw out similarities and differences.

Further details on the public dialogue research methodology and results are presented in Annex 1: Public dialogue research.

Limitations

- A distinction can be made between 'citizens' and 'consumer views': the former related to a proxy or their vision of how they would like the world to be and the latter to be focussed on purchasing decisions. Given this, consumer and citizen views may differ. The research includes both sets of views but does not distinguish between the nature of the views expressed. We note that in relation to emerging food technologies, consumers may be more accurately considered 'potential consumers' as in most cases applications to food are not available on the market.
- The public dialogue workshops included only a small number of experts, participant interaction with a wider range of experts representing different perspectives on the technologies could have enabled more depth in some discussions and for more technical questions to have been answered directly.
- In relation to the quantitative results from the public dialogue research, the sample sizes are small and therefore the findings are not generalisable. The results do nevertheless provide some insights which a larger study could give a clearer view on.
- The reviewed literature was described according to their robustness across a number of factors as part of the analysis and synthesis process11. However, this was not formally analysed and presented as part of the findings and is a limitation as it reduces transparency of the REA process. Rather, it fed into the expert judgement of team members as to whether or not a paper was of sufficient quality to be part of the review. Given that the majority of papers were from peer reviewed journals we are confident of a general level of scholarship for these papers reviewed. For the grey literature where a number of those criteria did not apply, experts used their judgement and generally grey literature was from known and reputable sources or recommended by our expert interviews.

[10] Dedoose is a software that enables qualitative data to be coded and compared systematically.
[11] Each source was described in relation to: whether or not it was peer reviewed, number of citations, journal impact factor, quality/robustness of the conclusions for example, were they backed by good data/findings, and whether or not limitations of data and quality were discussed.

Overall findings

Overall findings by research question

What are the public's views on emerging food technologies?

Members of the public are generally not familiar with emerging food technologies, even ones that have been discussed in the media for twenty years such as food from a cloned animal.

Key themes within public/consumer views on emerging food technologies relate to perceived risks and benefits of the technology, including:

- Concerns over potential health impacts, a perceived unnaturalness, impacts on animal welfare, small farmers and the environment.
- Positive benefits for society and the environment associated with extended shelf life, reduced use of pesticides, higher yield, reduced waste and improved quality.
- Ambivalence, as both negative and positive impacts are perceived.
- Some emerging technologies like GM and nanotechnology have many different applications and that contributes to consumer ambivalence.
- Lack of trust in the motivations of those promoting the technologies tends to increase consumers' concerns about potential risks.

How do views differ depending on the type of technology?

- Attitudes toward a food technology can vary depending on the type of application and the context, including:
- In general, food technology was seen as more acceptable for plant foods compared to animal foods.
- The concerns about different types of food technology tend to be broadly similar – animal welfare, cost, environmental impact and implications for human health were consistent themes.
- Emerging food technologies appear to evoke most positive attitudes when there is a focus on health benefits. This was noted in the literature in relation to functional foods[12] and observed in the public dialogue workshops in relation to nanotechnology.
- Novel food processes such as eating insects or food derived from insects, whilst in some cases creating a disgust reaction, seem to arouse interest and have potential for acceptance.

[12] Functional foods are defined in the REA report as foods that 'may provide health benefits beyond those delivered by traditional nutrients, or that the food has potential in preventing disease or in promoting a better life quality (Griffiths, Abernethy, Schuber, & Williams, 2009).' p.42.

What shapes the public's views?

Key factors that shape views include:

- Contextual factors such as previous societal experience of novel foods, for example GM foods.
- Changing global conditions that might necessitate the use of food technologies, for example to increase yields or to avoid climate change emissions, or to meet the needs of a growing global population.
- Product-related factors for example taste, quality, impact on health/environment.
- Food governance: how the food is regulated, who benefits from the technology and trust in the institutions developing the technologies (all technologies). Public dialogue participants often expressed a desire to be able to rely on government to verify the safety and quality of food technology, and were often distrustful of what they saw as profit-driven industry actors. Consumers tend to distrust corporate motives perceived as 'greedy' (participant from public dialogue workshop).
- Individual characteristics such as knowledge/information, views on animal welfare, religion or other particular world views.
- Risk perceptions such as naturalness, unpredictable environmental/health outcomes (all technologies); controllability of effects (GM foods, nanotechnology, synthetic biology). Uncertainty around the impacts on the environment and human health were prominent themes for all food technologies in the public dialogues.
- Perceptions of benefits.
- Framing of information can affect attitudes towards technologies (for example cultured meat, synthetic biology).
- In the public dialogue some participants were explicitly ambivalent about food technology, saying they would not be interested in how the food was made if it was cheap, convenient and tasty.

Do different types of people hold different views?

There is some evidence that consumers' attitudes can vary in terms of the following factors, however the results cannot be generalised given the small number of studies and the mixed findings:

- Gender: men tend to be more accepting/positive towards cultured meat, food from a cloned animal, nanotechnology, GM food, synthetic biology and 3D printed food.
- Age: younger people have been found to be more accepting of insect eating, cultured meat and food from a cloned animal but age has not been found to influence acceptance of 3D printed food or synthetic biology. Older people are more likely to buy functional foods.
- Education: higher levels of education has some relationship to positive attitudes towards cultured meat, GM foods and food from a cloned animal, synthetic biology and nanotechnology.

- Household structure was found to be related to consumer views: for example, acceptance of functional foods increased with the presence of children in the household whereas the presence of children under 12 years made adults less accepting of food from cloned animals.
- Other factors such as cultures, country of residence, whether one lives in an urban or rural environment and other lifestyle and experience factors also influence consumer views.

How do views affect behaviour such as food choices?

- Perceptions of health benefits and positive attitudes are linked to intentions to buy functional foods.
- Price has an effect, with people more willing to buy GM foods if available at a reasonable price and less willing to buy food involving nanotechnology if it were more expensive, even if it had health benefits.
- In the public dialogue, after information provision many participants said they would be willing to try all 4 food technologies discussed.
- Consumers have been found to be less likely to indicate an intention to buy once they know a food is from a cloned animal. The results of the public dialogue research suggest that views on animal welfare were related to not wanting to try meat from a cloned animal.
- The literature suggests that consumers were also less likely to buy cultured meat burgers than plant based burgers or conventional meat burgers. Views on the environment and animal ethics are related to these decisions. A range of views in the public dialogue were linked to willingness to eat cultured meat including good taste, quality, visual appearance and improved animal welfare. Conversely, preferring traditional meat out of habit or finding growing meat in a lab off-putting was linked with not wanting to eat cultured meat
- Public dialogue participants' willingness to eat food made using nanotechnology was linked to perceptions of possible health benefits such as less salt for the same flavour.
- Having a 'green' healthy lifestyle is linked to willingness to eat insects.
- Consumer preference for labelling of nanotechnology food applications is positively linked to willingness to buy, but this is not the case for GM foods.
- There is little evidence of consumer willingness to incorporate 3D printed food into everyday food choices.

How have views changed over time?

- For some technologies, there is some evidence in the literature that since 2009 consumers' attitudes have not changed (functional food) or have largely remained negative (GM foods, synthetic biology, food from a cloned animal). However, the public dialogue research indicated that after information provision and discussion,

attitudes towards GM food were overall either neutral or somewhat positive, although there was a wide range in views, whereas food from a cloned animal remained somewhat negative.

- For other technologies such as nanotechnology there is some evidence in the literature that views have changed from positive to ambivalence or even reluctance since 2009. However, the findings of the public dialogue research suggest that overall views of nanotechnology tend to be neutral or after information provision positive and that many participants would be willing to try this nanotechnology applied to food.
- For some technologies, there is some evidence that attitudes are now more formed (food from a cloned animal) or more nuanced and context dependent (food applications of synthetic biology) than in 2009. The reason for this is unclear.
- The public dialogue research suggests that changes in attitudes towards emerging food technologies at least in the short-term may be influenced by: information provision; discussion with others; increased understanding and familiarity with the technologies in particular in relation to safety and the risk assessment process and the benefits both to individuals and to the wider environment and society; belief that some technologies were becoming or would come to be regarded as 'normal'; and future sustainability challenges.

What are the gaps in current research?

- Research is needed for most of the food technologies on views towards specific food applications, as opposed to the technologies per se, and the influence of a wider range of factors that may influence consumer attitudes, such as, product characteristics, geographic and cultural regions, socio-demographic factors, media and different types of information.
- There are no existing longitudinal studies for GM foods, cultured meat and 3D printed food.
- There is a need to better understand consumer decision making in relation to how people make trade-offs between risk and benefit perceptions.

Key findings by technology

Genetically modified foods

- Research on GM foods and consumer views has continued over the past decade but is not as active now as it was ten years ago.
- Concerns related to GM foods include: 'unnaturalness', unknown risks, lack of perceived benefits, the desire to avoid any possible risks the technology could pose, health implications and the motivations of those promoting the technology.

- Factors that influence consumer perceptions of GM foods include trust/scepticism, knowledge, information, media reporting, educational qualifications and living environment/culture.
- Attitudes are more negative towards animal based GM foods than plant based GM foods.
- Research findings indicate that GM food is still largely viewed negatively. The findings suggest that GM's initial negative image has not been reduced over time although consumers have more information on benefits as well as risks.
- However, the public dialogue research appeared to contradict this, with GM foods being rated more positively after workshops, although views varied and some people still had concerns about aspects such as unnaturalness and environmental impacts.
- Discussion during the public dialogues revealed linkages between familiarity with GM food, perceptions of safety and acceptance: 'I would go for GM as it is more familiar' and 'GM foods have been around for a long time, which makes it seem safer'.

Nanotechnology applied to foods

- Consumer awareness and understanding of nanotechnologies applied to food continues to be relatively low.
- No consensus exists in the reviewed literature about consumers' views on nanotechnology in food and attitudes towards nanotechnology appear to be mixed, both negative and positive. This suggests some change compared to 2009 when it was reported that views were generally positive.
- The public dialogue research found that overall views tended to be neutral or positive, with many participants willing to try nanotechnology in food.
- Nanotechnology in food was perceived by some participants in the public dialogues as less intrusive than the other technologies
- Some participants in the public dialogues tended to prefer nanotechnology applied to food to other technologies discussed. The benefits to the individual of applications such as using nano-sized salt crystals to reduce the amount of salt in food while keeping the same taste were more obvious and these applications were perceived as less of a fundamental change to the original food.

Functional food

- Consumer attitudes towards specific functional food products depend on the perceived necessity of the product, perceived healthiness, and the perceived naturalness of the combination of 'carrier' product and added functional ingredient.
- Overall there is no evidence to suggest that views have changed since 2009.

Cultured meat

- Survey data in the UK indicates that 16% – 19% of consumers would eat cultured meat, 42% - 62% would not, and 19% - 40% are undecided[13].
- The most pressing concerns about cultured meat for consumers are around food safety and health impacts.
- Framing of information can affect attitudes towards cultured meat. For example, describing cultured meat as a high-tech innovation can lead to lower acceptance compared to framing it as having societal benefits or being very similar to conventional meat.
- In the public dialogue research, participants mentioned taste, quality and visual appearance as factors that would influence their willingness to buy cultured meat. Preferring traditional meat out of habit or finding growing meat in a lab off-putting were mentioned as reasons for not wanting to eat cultured meat.
- During the public dialogues, participants talked about parents' responsibility for feeding their children 'good food'. Cultured meat was perceived to be a kind of processed food by some and was less well understood by others: both of these were given as reasons for it being alright for a parent to eat cultured meat but not for children.

Novel food processes – insects as food

- Familiarity with and acceptance of eating insects is growing rapidly.
- Health conscious, environmentally aware people are more likely to consume foods produced with insect proteins.
- Media attention is acting to increase awareness and promote sector growth.

Food from a cloned animal

- Most consumers are critical towards this technology mainly due to food safety, ethical, animal welfare, economic and environmental concerns, as well as the need for labelling.
- Higher acceptance of food from a cloned animal is seen amongst men, (politically) left-leaning individuals, urban consumers, primary grocery shoppers and families with older children.
- Since 2009, attitudes remain unsupportive and appear to be more formed. This was also seen in the public dialogue workshops, with views about food from a cloned animal remaining somewhat negative at the end of the session.
- During the public dialogue, aspects which were influential in changing attitudes to food from a cloned animal included greater awareness of the benefits, for example, quality. For some, more information lead to negative shifts in views or greater confusion.

[13] The Grocer (2017); Surveygoo (2018); YouGov (2013).

3D printed food

- Consumers tend in general to have low levels of knowledge and familiarity, and negative attitudes towards 3D printed food technology.
- Views towards 3D printed food are influenced by appearance, perceived safety, extent of processing, healthiness/nutrition and tastiness, knowledge and information, perceived 'fun to use', fear of eating new or alien food and of the use of novel technology in food production.
- Informing consumers about 3D printed food technology can impact attitudes in some cases resulting in more positive overall opinions towards 3D printed food.
- Relevant aspects of 3D printed food technology to promote include 'fun to use', convenience, health and personalised nutrition. Consideration should also be given to the sensory qualities and level of processing.

Synthetic biology applied to foods

- There is no clear consensus in the reviewed literature on consumer views towards synthetic biology in food.
- Consumer attitudes are generally more positive towards applications with clear benefits for example medical, energy and environment applications rather than for food.
- Attitudes to synthetic biology vary according to application and whether the type of synthetic biology is making more or less fundamental changes to biological processes.
- Attitudes toward synthetic biology are similar to those to GM food with concerns around 'unnaturalness' and 'playing God'. On the other hand, consumers express a sense of hope that synthetic biology could address issues such as food security. This suggests ambivalence about the technology.
- Since 2009 there have been papers on specific applications of synthetic biology in food and as predicted, views do have some similarities to attitudes towards GM foods. However, there is still a need for longitudinal studies and more systematic studies on specific food applications of synthetic biology.

Public dialogue key findings

This section presents more detail on the key findings of the public dialogue workshops. The public dialogue session focussed on four technologies, GM food, nanotechnology applied to food, cultured meat, and food from cloned animals. We first present a brief overview of initial awareness levels and attitudes of participants. This is followed by more in depth findings on their views towards each of the 4 food technologies. We then present findings on whether views changed during the period of the public dialogue workshops and consider some of the factors that might be affecting changes in attitudes. Finally we present a summary of key findings and reflections from the public dialogue workshops.

Initial awareness levels and attitudes

Overall, we found that initial awareness levels towards the emerging food technologies was low: over half of participants initially considered they were ‘not at all familiar’ with food from cloned animals, nanotechnology in food, and cultured meat. GM food was the most familiar of the 4 technologies, but still half of participants initially considered themselves to be only ‘slightly familiar’ or ‘not at all familiar’ with this technology. Perhaps reflecting this lack of familiarity, overall participants initially generally took a neutral or ambivalent view of the technologies, with exception of food from cloned animals which received a more negative initial reaction.

Genetically modified foods

What were the views on genetically modified foods, and why?

Initial gut reactions towards GM food expressed by participants during the opening sessions of Round 1 (prior to more in depth discussion / information provision), reflected some familiarity and awareness of benefits, but also a lack of understanding of the technology, concerns around trust, (un)naturalness, and health/safety. This included:

- Some familiarity or awareness of GM food: ‘I had watched stuff to do with GM food so was comfortable with it’ (Belfast R1).
- A lack of understanding of the technology, for example, ‘I don’t understand what it means to be GM’ (Wigston R1); this was also reflected in some incorrect assumptions about the prevalence of GM food in our food system: ‘assumed all the chicken in ready meals was already GM – might be eating it anyway’ (Belfast R1), and ‘We are eating a lot of GM crops…Walkers crisps are all GM potatoes’ (Wigston R1).

- Some limited awareness of potential benefits, for example, ‘In US…to improve yield’ (Belfast R1) and ‘to meet food needs of growing population. Resistant to disease’ (Belfast R1); and a sense that it could be a solution to global challenges such as famine: ‘if this stuff will help with famine around the world let’s get on with it’ (Swansea R1).
- For some initial reactions were negative: ‘Don’t like it’ (Belfast R1), ‘Put off by GM’ (Belfast R1), and ‘we should steer clear’ (Belfast R1).
- Concerns were expressed about the (un)naturalness of GM food and the ethics of using the technology to change natural products: ‘GM is not very natural that is concerning’ (Wigston R1) and ‘Soy comes in a natural form. To change it puts me off’ (Belfast R1), and ‘Mucking about with nature’ (Swansea R1).
- Concerns were also expressed about health and safety, the environment and animal welfare: ‘GM is ‘poison’ – avoid’ (Swansea R1); ‘the modifications are for the food industry benefits, not for the chicken. Worried about the chicken, it lives in a small cage’ (Swansea R1); and ‘But we need to be mindful about the environment’ (Swansea R1).
- Initial reactions revealed trust issues (and ambivalence) related to the motivations of the industry and producers: ‘have mixed feelings about it, worried about the motivations of the industry/producers’ (Swansea R1).
- While others expressed confidence in regulators and research to ensure safety: ‘Don’t think people should be too worried. If research is done and it’s verified safe then people shouldn’t be as fearful.’ (Belfast R1), and ‘FSA would regulate and make sure we don’t get anything bad – trust the system.’ (Belfast R1).

More informed views towards GM food which emerged during the Round 2 dialogue:

- Further revealed linkages between familiarity with GM food and acceptance and perceptions of safety: ‘GM is used already; it is out there. I would go for GM as it is more familiar’ (R2) and ‘GM foods have been around for a long time, which makes it seem safer’ (R2).
- For some familiarity and acceptance was the result of direct experience, for example ‘I had GM oats, and it is nice’ (R2). One participant reported how the GM foods they had eaten during a holiday in Canada were bigger, tastier and cheaper than the same food in the UK (R2).
- Weighing up of the perceived risks and benefits – for example, GM food was seen as positive due to the need for new ways of producing food: ‘Positive because they need to find new things’ (R2).
- Concerns remained about the perceived impact on nature: ‘Worry about GM affecting other more traditional strawberries in the environment’ (R2) and ‘prefer GM crops over animals – Animals are living creature – I think that’s weird’ (R2).
- A lack of understanding of the technology remained for some: ‘I understood less about GM although around longer’ (R2).

In general, the findings of the public dialogue indicate that, after information provision and discussion, participants were overall somewhat positive towards GM food and would be willing to try it. It appears that GM food has become more familiar and this can contribute to acceptance. For example, while it is extremely rare to find GM ingredients in food in the UK, some public dialogue participants thought that GM food was more widely available and therefore a 'known quantity': '[We] already have that [GM food], we are aware of it, it's not so scary' (Wigston R1). Nevertheless some participants continued to be ambivalent about GM, still feeling uncertain about the implications of its use despite recognised benefits. After a description of the development of 'golden rice' to provide Vitamin A in countries where a deficiency is a major cause of blindness, one public dialogue participant commented: 'Now I'm conflicted, if it is going to be good for other people ... But [I'm] still worried about things' (Swansea R1).

Attitudes towards different applications of GM food technology

Participants in the public dialogue tended to agree that GM animals were less acceptable than GM plants, and this was largely based on concern for animal welfare.

Attitudes towards GM food vs other technologies

Some participants preferred GM food to food from cloned animals: 'better than cloning' (Belfast R1), ''Modified' is not a problem but I struggle with 'cloned'' (Wigston R1).

How do views towards GM food affect behaviour such as food choices?

In the public dialogue, after information provision many participants said they would be willing to try all 4 food technologies discussed. Price came up as a factor in perceived willingness to buy GM food with some participants willing to buy at the right price.

Discussion in one of the public dialogue scenario sessions around a question of whether people would give their children a packed lunch or a school dinner with GM food, centred on choice. If it was the norm then it was considered more acceptable but if there was some choice some participants would choose to have control over the food and do a packed lunch instead of a GM school meal.

Did views towards GM food change during the public dialogue, and if so, why?

The public dialogue findings indicate that even during a short time scale (i.e. within the course of the dialogue process) following the provision of information and discussion, overall participant familiarity with GM food increased and overall views shifted to become more positive. Aspects related to GM food which were influential in changing attitudes during the public dialogue included: safety; the type of modification (GM animals less acceptable than GM plants); whether it is normalised or commonplace (i.e. in the future): 'if norm is GM etc. then would go along with it' (Belfast R1); being made aware of potential benefits for example, potential to grow in harsher/different environments; and balancing what's good for others with personal concerns. For example, one participant commented 'If I knew that the GM apple wouldn't do me any harm I would eat it' (Swansea R1). Aspects which remained of concern for some participants included biodiversity (for example 'hesitant about GM due the impact it might have on biodiversity' (R2)). For some participants it was a harder technology to explain in discussions with others not involved in the dialogue (after the public dialogue).

Nanotechnology applied to foods

What were the views on nanotechnology applied to foods, and why?

Initial gut reactions towards nanotechnology applied to food expressed by participants during the opening sessions of R1 (prior to more in depth discussion / information provision) reflected:

- A general lack of familiarity and understanding of the technology: 'Nano didn't mean anything' (Swansea R1), 'Don't know what nano process is regarding food' (Belfast R1), 'Didn't know what nanotechnology was..[..] doesn't sound like an intrusive technology.' (Wigston R1).
- Some interest and limited awareness of the potential benefits such as eating less and food lasting longer: 'Nanotechnology sounds interesting and can see benefits' (Wigston R1), 'What are the reasons for nano? Are you trying to make things small so you only have to eat less of it?' (Swansea R1).
- It was recognised that nanotechnology applied to food could be valuable in certain situations: 'Nano would be good for the forces' (Swansea R1), 'and [good for] others who need to store food for a long time' (Swansea R1).
- However, some concerns were also expressed, for example, in relation to use of nanotechnology in packaging and plastic: 'is it plastic infused with the nano? Does the plastic break down?' (Swansea R1).
- Initial responses revealed a preference for more natural foods over nanotechnology applied to food: 'Prefer fresh food made from fresh ingredients' (Wigston R1).

- Responses suggested a desire for information or labelling to know whether food is nano-packaged: ‘How would you know something is a nano packaging?’ (Swansea R1).

More informed views which emerged during the R2 dialogue towards nanotechnology applied to food included:

- Deeper understanding/familiarity of nanotechnology, resulting in parallels being drawn with other more commonplace enhancements to food products: ‘A lot of things have been added to food recently to enhance it’ (R2).
- Many perceived potential benefits were identified - in particular:
  - Potential health benefits to individuals and also to the health service: ‘put less salt in food or sugar and have the same effect, that should be good’ (R2), ‘health benefits of nanotech are massive’ (R2), and ‘..not use so much money on the health service’ (R2).
  - Potential social benefits of enabling cheaper food to be more nutritious: ‘could be useful for the homeless - if cheap food can be fortified with nutrients, this would be good’ (R2).
  - Potential consumer and environmental benefits through reduced food waste: ‘extended shelf life’ (R2).
- Concerns related to health and environment remained, including the emerging nature of the technology and whether it had been tested enough; unknown long-term health risks; the use of ‘chemicals’; and concerns about the biodegradability of nanotechnology in packaging: ‘Long term use health concerns’ (R2), ‘Are nanoparticles biodegradable?’ (R2). Concerns were also raised about the potential for overconsumption of nutrients/additives introduced as nanoparticles in food products: ‘but quantity might be a problem as people might be more exposed to it’ (R2).
- Trust issues were raised such as the potential for the technology to be manipulated or misused for example, ‘you could also add bad things, create addiction, make food go off quicker’ (R2). Others expressed confidence in the regulation process: ‘if it goes through the process, it must be fine’ (R2).
- Interest remained in knowing whether or not nanotechnology is used in food products, for example, through labelling: ‘you would need to know what it actually is’ (R2).
- Some participants questioned whether nanotechnology was actually necessary.

Overall, the findings of the public dialogue indicate that after information provision/discussion views towards nanotechnology were slightly more positive (compared with at the start of the dialogue). Many participants would be willing to try nanotechnology in food. Participants preferred nanotechnology primarily because the benefits to the consumer were clear, and because adding nanoparticles was thought to be less intrusive than ‘messing with DNA’.

Attitudes towards different applications of nanotechnology to food

The complexity of the ways in which nanotechnology might be applied to food made some participants cautious about expressing a definite view: 'I don't fully understand nanotechnology – it seems to depend on the application. If [it involves] putting more dubious things into food then [I am] more uncertain about positive impacts' (Belfast R1). In general, the majority of participants had no issues with nanotechnology applied to food packaging, though several were more concerned about its use in food itself. For example, 'Liked nano-bag as it is the packaging rather than the actual food' (Belfast R1). This may reflect that it was easier for public dialogue participants to visualise applications of nanotechnology in packaging (compared with in food) and recognise their potential benefits in terms of reduced waste, longer shelf life and the ability to see when food has deteriorated rather than relying on a date on the package. Some concerns were expressed about nanotechnology in food packaging, for example about the possibility of harmful components from the packaging leaching into the food.

Attitudes towards nanotechnology applied to food vs other technologies

In comparison with the other 3 technologies discussed in the public dialogue, nanotechnology appeared to be one of the more positively perceived technologies by participants. Participants frequently acknowledged the potential health benefits of nanotechnology applied to food and expressed a feeling that this was less intrusive than other technologies, which were perceived to involve more fundamental changes to the original product. Nanotechnology applied to food was described by one group during R2 as having 'less detrimental connotations than other technologies' (R2). The results of the short attitude questionnaires show that in R1 this was the only technology with a better than neutral score on both willingness to eat and willingness to serve to others (see Annex 1).

How do views towards nanotechnology affect behaviour such as food choices?

After information provision many participants said they would be willing to try all 4 food technologies discussed. Perceptions of health benefits, for example, being able to have the same flavour with less salt or sugar and being labelled were associated with intentions to buy or eat nanotechnology in food. However, it was expressed that some people would still buy the cheapest option in spite of potential health benefits associated with the application of nanotechnology.

Did views towards nanotechnology applied to food change during the public dialogue, and if so, why?

A general observation from the R1 dialogue workshops was that participants felt more positive towards nanotechnology applied to food after discussing the technology. During the scenario session, one participant commented that 'If it is part of what you have always eaten, it would be normal – this may be the situation with nano' (Swansea R1).

Cultured meat

What were the views on cultured meat, and why?

Initial gut reactions expressed by participants during the opening sessions of Round 1 (prior to more in depth discussion / information provision) towards cultured meat included:

- A lack of understanding of what the technology is, for example, '[I] don't understand cultured/lab-grown' (Belfast R1), 'Will it involve an actual animal?' (Swansea R1); and confusion related to the nomenclature, for example, 'Thought it meant chicken from another culture' (Wigston R1).
- Potential benefits for animal welfare for example, 'interested by cultured meat, the idea of growing meat without harming animals' (Wigston R1) and 'I'm veggie but would find lab grown meat more acceptable. Animal welfare and deforestation issues. Would be a solution for many meat eaters.' (Swansea R1).
- Perceived (un)naturalness and ethics of growing food in a laboratory were raised, for example, 'Frankenstein food' (Belfast R1), 'It is crazy to grow food in the lab' (Wigston R1), and 'it just didn't seem right' (Belfast R1).
- Health and safety concerns often related to the newness of the technology and potential for unknown harm, for example, 'hasn't been around long enough to know if it would cause harm' (Wigston R1).
- Questioning of the efficacy of cultured meat given wider concerns related to the sustainability of current food choices and the need for society to eat less meat for example 'Not convinced we should be making meat. We should try to eat less meat.' (Swansea R1).

Views towards cultured meat during the R2 dialogue included:

- Some participants still rejected the technology outright: '[I] still wouldn't touch cultured meat' (R2).
- Lack of familiarity, for example, 'Explaining that cultured meat is similar to Quorn might make it more acceptable' (R2).

- Animal welfare remained important and the considerations raised reflected a more nuanced understanding of the technology, for example: preferences for a plant-based medium and '[making] sure the animal is not in pain when the biopsy is taken' (R2); some weighing up of costs and benefits of an animal-based medium for example, 'killing one animal rather than thousands is a good solution' (R2), 'even the way it is done now, the amount of meat they can produce from stem cells is so much better than from what you need to kill' (R2); and also some mixed views with potential pros and cons identified: 'If cultured meat becomes mainstream, poorly treated animals might be pushed out of the market. Cultured meat could cause animal welfare to increase' (R2); and 'Could force illegal breeding underground. There could be drawbacks in terms of pain for the animal when the biopsy is taken.' (R2).
- Consideration of sustainability issues, for example 'I'm big on the environment and think that [cultured meat] will sort it' (R2), 'I was quite for cultured meat. The state the world is in at the moment – a lot of that comes from the food industry – land use, climate etc. taking the animals out of that is better for the long run' (R2).
- Weighing up of the potential positive impacts for climate change versus potential negative impacts for biodiversity, for example, 'cows have methane emissions, which is bad – but cultured meat might mean loss of breeds' (R2) and the scale of uptake was considered important: 'extent of impact on biodiversity depends on extent of adoption – if all meat becomes cultured, there will be a large impact on biodiversity.' (R2).
- Wider contextual issues including the perceived negative implications for the meat industry and farmers for example 'Farmers could go out of business' (R2).
- Potential societal impacts related to the affordability of traditional meat in a future when cultured meat may be more widespread and cheaper: 'In a [future] context where animal meat is very limited or expensive – cultured meat could be a part of a class divide' (R2).
- Concerns around the potential unknown consequences for health/safety remained for example: 'it might be unsafe in the future' (R2), 'might have unknown consequences in 20 years' (R2), and 'Do they do human testing?' (R2).
- Willingness to try cultured meat reflected importance of taste, visual appearance, texture, for example, 'if [it's] steak that tastes the same but isn't then [I'm] still going to eat it' (R2), 'the texture is important as well' (R2); 'A big consideration is taste, appearance, texture. Not interested personally, but a lot of others were concerned about taste. Uncertain of the taste.' (R2); and also, a preference for natural meat, 'would prefer natural beef if there is a choice' (R2).

Overall views towards cultured meat tended to remain neutral and opinions varied between participants and over the course of the session and reflected a mix of positives and negatives. Whilst many participants foresaw environmental benefits of cultured meat, others worried about possible negative environmental impacts. Some concerns about cultured meat that were echoed across the dialogues included: unknown health

issues, animal welfare issues associated with use of foetal bovine serum as the growth medium, impact on small farmers who keep animals, perceived poor taste and texture making this a 'low quality' meat, potential use of additives to enhance taste and colour. Some participants rejected cultured meat as being unfamiliar or unnatural: 'It wouldn't look appetising, it wouldn't look like what we're used to' (Belfast R1), 'It is an unknown science – don't know if there would be health impacts' (Swansea R1). However, most participants recognised that it had potential benefits such as not requiring animals to be killed once a plant-based growth medium has been developed.

Attitudes towards cultured meat vs other technologies

Cultured meat was frequently compared to food from cloned animals. Many participants preferred meat from a cloned animal, since it was considered fresher if it came from a living animal rather than a lab. However, others rejected meat from cloned animals, but were open to cultured meat mainly because of it was perceived to have a less negative impact on animal welfare. While cultured meat was seen as an opportunity to reduce animal slaughter, meat from a cloned animal was regarded as potentially harming cloned animals. The animals might experience painful defects as a result of the cloning process. This preference appears to depend on the individual's ethical views. For some cultured meat was the least favourite of the 4 technologies due to the artificial nature, for example: 'cultured meat least appealing of the options for me. The laboratory element puts me off.' (R2) and 'it is all artificial, in the lab- not natural' (R2).

How do views towards cultured meat affect behaviour such as food choices?

In the public dialogues, after information provision many participants said they would be willing to try all 4 food technologies discussed. Taste, quality and look of the meat were linked to participants in the public dialogue indicating that they would eat cultured meat. The fact animals wouldn't suffer in making cultured meat[14] was also linked to a preparedness to try the meat. Some participants indicated they would eat cultured meat if it was the same nutritionally. Some people said they would not try cultured meat because they felt it was off putting because it was grown in a lab. Others indicated that if there was a choice between cultured meat and conventional meat they would stick with the traditional meat because it was familiar and part of their normal diets, and they were happy with the current system. Some participants reflected that some conventional meat did not look like meat (for example chicken nuggets) anyway so there was no difference in eating cultured meat. Likewise, some said they did not want

[14] As long as the medium is plant based.

to know where their meat came from and so in that way if they did not know how the cultured meat was made they would probably still eat it. A theme of responsibility for feeding your child good food emerged with cultured meat being perceived as part of 'processed food' by some and less well understood by others, both of which were given as reasons for it being ok for a parent to eat but not for children.

Did views towards cultured meat change during the public dialogue, and if so, why?

The public dialogue research indicated that while familiarity with cultured meat increased during R1 of the public dialogue, overall views remained neutral towards the technology. Notwithstanding this, many participants indicated they would be willing to try cultured meat. Moreover in the final R2 workshop (which comprised a sub-sample of the R1 participants), overall views shifted from neutral to become positive towards cultured meat. During the public dialogues, aspects related to cultured meat which seemed to be influential in changing attitudes included: information/education (for example 'Yes now I know it's not just a foreign chicken' (Wigston R1); greater awareness of the benefits (for example 'first just think about a burger in plastic cup, but when you see benefits it's mind-blowing' (Belfast R1); provenance (i.e. knowing who/where the cultured meat is grown (Swansea R1); if medium is plant based (i.e. animal welfare); taste; nomenclature (cultured and clean sound nice/positive, but potentially also misleading (for example 'I was more for the cultured meat but changed my mind, thought it was something ethical..[…] about different cultures, that is not what cultured meat is - there is a branding issue' (R2).

Food from a cloned animal

What were the views on food from a cloned animal, and why?

Initial gut reactions towards food from a cloned animal expressed by participants during the opening sessions of Round 1 (prior to more in depth discussion / information provision) included:

- Some familiarity related to frequent mentions of 'Dolly the sheep'.
- A lack of opinion or a sense of not being bothered for example: 'don't know how I feel about cloning' (Wigston R1), 'Cloned not that bad…Dolly the sheep' (Belfast R1), and 'cloned doesn't matter' (Swansea R1).
- Lack of understanding or knowledge of the technology and conflation with GM technology, for example, 'the idea of cloned suggest all sorts of GM things that I'm not aware of. Don't know if the milk that I have drunk would be cloned or not. The problem is that you don't know what it is' (Swansea R1).

- General concerns and negative responses to the nomenclature, for example, the word cloned was off-putting: ‘don’t like [the] word ‘cloned’’ (Belfast R1); ‘‘The word puts you off - just means ‘a copy’’ (Wigston R1); ‘worried about cloned things’ (Belfast R1).
- (Un)naturalness and preferences for more natural foods, for example, ‘it sounds like it is all manufactured in the laboratory’ (Swansea R1) and ‘want less technology’ (Belfast R1).
- Animal welfare concerns related to perceived cruelty and short life expectations, for example, ‘Cloning sounds cruel – dolly the sheep lived like 24 hours’ (Wigston R1), ‘Dolly the sheep did not live long. This is concerning’ (Wigston R1).
- Health and safety concerns for example, ‘might cause health issues for people as well as animals’ (Wigston R1) and ‘Cloning doesn’t bother me as long as it’s safe’ (Swansea R1).
- Lack of perceived benefits, for example, ‘Must still have same associated environmental issues as normal livestock’ (Wigston R1).
- Trust issues, for example, ‘Doesn’t have a good reputation’ (Wigston R1).

Views towards food from a cloned animal during R2 of the dialogue remained predominantly negative and included:

- More balanced arguments and more complex reasoning, considering more issues and some recognition of the potential benefits, for example: for example ‘[I have] ethical concerns, it is efficient and might be a good idea, but it is wrong’ (R2); ‘You could produce a superior product – don’t agree with this personally, but could be positive overall’ (R2).
- Identification of alternatives to the technology such as breeding traditionally, ‘Cloning animals to get really good steaks – don’t need to do that to produce more and more. Can breed traditionally’ (R2).
- Naturalness, ethics and animal welfare considerations were still important for example, ‘environmentally not more beneficial, expensive, bad for the animals’ (R2), ‘there are many examples of negatively impacted cloned animals.’ (R2) and ‘There has not been a good success rate – a lot of animals die in the process (R2)’.
- Consideration of sustainability issues such as climate change and biodiversity including perceived pros and cons, for example, the potential dominance of particular breeds but also could help to preserve vulnerable breeds: ‘..only using one breed, but also able to preserve species which might die out’ (R2) and ‘I think cloned animals is going down the wrong route. I think it’s going to make current problems worse’ (R2).
- Costs to the consumer were also discussed – higher potential costs being a barrier ‘the price of cloned meat put me off’ (R2), though views were mixed on the expected cost impact, ‘it is not clear whether food from cloned animals would be

more expensive. Would not pay £2 more' (R2); 'cost benefits?' (R2), and 'Cost could be high because cloned animals are expensive to produce' (R2).

- Whose interests – cloning was seen as for producers rather than consumers: 'just for producers, not for consumers' (R2).
- Taste and quality – taste was noted as an 'important issue' (R2); concerns were raised about the possibility of cloning reducing flavour choice for example 'over time you could get one gene pull and one flavour of goat' (R2).

Overall, the public dialogue research indicates that participants' views towards food from cloned animals tend to be negative. Whilst many participants were aware of Dolly the Sheep when prompted, the majority rated cloning as being 'not at all familiar', suggesting their understanding and frequency of hearing of it was relatively low. The main benefit of food from cloned animals was felt by participants to be the quality of the food, especially meat, which was expected to taste very good and have greater nutritional benefits as it would be leaner. If these benefits were realised and the price were right, some participants said they would eat cloned meat.

Attitudes towards different applications of food from a cloned animal

Some participants in the public dialogue perceived cloning to be more acceptable when applied to plants than to animals.

Attitudes towards food from a cloned animal vs other technologies

Among the 4 technologies discussed, food from a cloned animal was generally perceived the least positively. Several participants noted that cloning was their least preferred food technology, and this was often driven by concerns about cost and animal welfare.

How do views towards food from a cloned animal affect behaviour such as food choices?

Across the public dialogue, animal welfare issues, and thinking it a bit 'off putting' was discussed by those who did not wish to eat cloned meat. There seemed to be greater willingness to try milk from cloned cows which was discussed during the scenario session of the public dialogue where participants were asked if (in a future scenario) they would go to an open day of a dairy with cloned cows. Some would still stay away however.

Did views towards food from a cloned animal change during the public dialogue, and if so, why?

While overall participant familiarity with food from cloned animals increased between the start and end of the R1 public dialogue workshops, overall views remained negative towards food from a cloned animal[15]. Nevertheless, over this short-time frame, individual views towards emerging food technologies did change in response to the information provided and the discussions that surrounded these. For example, during R1 workshop almost one-third of participants became more positive and almost one-third of other participants became more negative towards food from cloned animal[16]. Differences at this level would need greater sample sizes to confirm, but do emphasise that though individuals may vary, detecting population-level trend possibilities over such a short time scale is demanding.

During the public dialogue, aspects which were influential in changing attitudes to food from a cloned animal related to: greater awareness of the benefits for example 'becoming aware of the quality of cloned meat made me more positive towards it' (Belfast R1), 'first thought it was intrusive. But now I understand it is cloning the 'crème de la crème' of animals' (Wigston R1). For some, more information lead to negative shifts in views or greater confusion, for example, 'I now feel more confused than at the beginning' (Swansea R1); 'learnt more on cloning and now feel more against than before' (Wigston R1).

Did views change, and if so, what influenced a change in attitudes?

Overall examining the views at the end of the public dialogue compared with the start, some changes in views were evident, with attitudes at the end largely as follows:

- Food from cloned: overall views remained negative and this was generally perceived the least positively, despite some familiarity, and this was often driven by concerns about cost and animal welfare.
- GM food attitudes overall became more positive, possibly related to higher familiarity and length of time it has been around conveying a sense of perceived safety
- Nanotechnology: views became slightly more positive, which may reflect that discussions frequently acknowledged the potential health benefits and a perception that this was less intrusive of the technologies.

[15] As reflected in the median response scores of attitudinal questions – see Annex 1.
[16] Individual differences in views 'before' and 'after' the workshops were only examined in relation to food from a cloned animal.

- Cultured meat: views remained largely neutral – though this does not reflect individual changes during the day.

The public dialogue research suggests that changes in attitudes towards emerging food technologies (within short timescales) may be influenced by a number of factors including:

- Provision of trusted information for example, ‘Information changes attitudes’ (Belfast R1), ‘Getting people to a more informed place is important’ (R2).
- Discussion with others, including within the public dialogue workshops, and talking with others afterwards for example family, friends, colleagues.
- Increased understanding and familiarity related to the technology for example ‘before today I would have said outright no because didn’t understand the technologies’ (Belfast R1).
- Increased understanding of and perception of the efficacy of the risk assessment process for example ‘I have more confidence in food that is out there’ (R2); how the technology is applied (with plant applications often preferred to animal).
- Awareness and understanding of the benefits both to the individual and the wider environmental and social benefits, for example: ‘becoming aware of the quality of cloned meat made me more positive towards it’ (Belfast R1); ‘You first just think about a burger in plastic cup, but when you see benefits it’s mind-blowing’ (Belfast R1), ‘would initially say no to GM, but when you explain benefits, [for example, a] potato for drought/heavy rain then maybe’ (Belfast R1).
- Whether or not the technologies would become more the norm, for example, like veganism, and the idea that food could even taste nicer in future so that these technologies would set a new norm and traditional food would not be perceived as nice.
- Future sustainability challenges for example ‘my answers to questions in this scenario are completely different to my answers earlier in the day’ (Belfast R1).
- And related to this, a recognised need for change in attitudes, changing scenarios mean there is a need to embrace new modifications, and to move with the times for example ‘You need to move with the technology or you’ll get left behind’ (Wigston R1).

For some, more information led to negative shifts in views or greater confusion, for example, in relation to food from cloned animal: ‘learnt more on cloning and now feel more against than before’ (Wigston R1).

Some aspects remained of concern to participants between R1 and R2, for example, potential impact of GM on biodiversity.

Some participants were motivated to look for further information on the food technologies discussed following R1, drawing on information from TV, google (though

not Wikipedia which was not trusted), and YouTube. It was noted by some participants that the majority of literature/research is from overseas for example for GM food from India and America and seems not as mainstream in UK/Europe.

Summary of public dialogue research findings

Over the course of the public dialogue participants added new layers of complexity to their thinking, through deeper understanding of the technologies themselves, their potential application and thinking about the potential ramifications, positive and negative, for themselves, others, and the wider impacts.

In weighing up the benefits and risks of the technologies, there was recognition of the challenges for food provision and some feeling that eating practices should move with the times (for example, eat less meat or culture meat!), and also that changing conditions in the world such as a growing global population might necessitate or rule out some technologies.

There was concern about the potential significant changes to humans, animals, the natural environment or natural processes ('unnaturalness') these technologies may bring.

Worries were expressed that technologies could be put to bad use, reflecting a lack of trust in companies/producers which were seen by some as greed motivated for example, perceived risk that would companies cut corners. Indeed, many participants in the public dialogue commented that food technologies often appeared to benefit the producers more than the consumers, and some were suspicious of corporations' 'greedy' motives. Expectations were expressed that regulators will prevent misuse – this was particularly strong in the Belfast R1 workshop, and also in R2 after discussing about the regulation process.

Participants expressed different and sometimes conflicting views at different times during the public dialogue.

Participants tended to have broadly similar concerns for GM food, nanotechnology, cultured meat, and cloning – the cost, environmental impact, animal welfare implications and effects on human health were common themes for all technologies.

There was a contrast between views about emerging technologies. There were pragmatic views about the need to accept that change happens and to focus on it being well monitored and managed: 'If research is done and it's verified safe, then people shouldn't be so fearful. I think there are positives of these technologies' (Belfast R1).

Other participants focused on wider risks to the environment and took a precautionary approach, emphasising risk avoidance.

Sometimes participants were unclear about the differences between technologies, and often appeared to conflate certain characteristics of the different technologies.

Details about the food technologies were also considered very relevant in the public dialogues. For example, some participants were enthusiastic about the potential animal welfare benefits of cultured meat, but this was entirely dependent on not using animal-based culture media, suggesting some application-specific drivers of attitudes.

Conclusions

Across all the technologies examined no single picture emerges of consumer views. However, there are number of key themes that seem to underlie the attitudes towards emerging food technologies which will be drawn out here together with key changes since 2009 and gaps in research. The lack of a clear picture is partly because of the inherent variability of the different technologies and the issues their development is aiming to address, partly because of the lack of systematic studies on consumer views especially in relation to specific applications of the technologies, and these conclusions should be read with those caveats in mind.

Key themes across all technologies

The themes that arise across the technologies include views towards the actual technology (how the food is made), the food itself and the potential risks and benefits of the technologies and eating food from those technologies. These themes are discussed in the sections below. Consumer views are related to clusters of these themes or factors, with decisions about foods often linked to existing cognitive models and frameworks. This makes consumer views more nuanced and complex than they might seem at first.

Natural/unnaturalness

As reported in the early part of the review consumers do consider the selected technologies in relation to whether or not they are perceived as natural or not, with a tendency towards greater acceptance of processes and products perceived as being more natural. For example, synthetic biology applications and GM food where the transfer of biological material is closer or the same as that of the host culture (for example plant – plant) are perceived as more natural than those that cross species (for example plant - animal). Naturalness in relation to a synthetic biology application was related to ‘goodness’ in terms of quality of the product. The technology for 3D printed food was seen as being a very artificial and highly processed way of preparing food. For cultured meat, nanotechnology in food, and 3D printed food many consumers felt at a personal level that these technologies are unnatural. Unnaturalness is linked to the idea of scientists ‘playing God’, specifically in the case of synthetic biology ‘bottom-up’ applications.

Evidence from both the REA and the public dialogue indicated that food technology is seen as more acceptable when applied to plant foods compared to animal foods.

Engineering animals is seen as being less ‘natural’ and closer to ‘playing God’ than engineering plants.

In terms of naturalness of products, insect eating, whilst in some cases creating a disgust reaction seem to arouse interest and potential for acceptance, perhaps because the food itself is one that is found naturally occurring, it is rather that in developed countries the tradition of eating insects is novel. 3D printed food was considered by some to be unnatural looking for example slimy, too perfect. Consideration of the naturalness of, for example cultured meat, can lead to interesting discussions and realisations around the production of conventional meat, potentially blurring the boundaries between what might be considered natural or unnatural.

Controllability/uncontrollability and possibility of unforeseen consequences

Linked to the theme of natural/unnaturalness is that of controllability/uncontrollability and the potential for unforeseen consequences of technologies. In the literature, this was particularly linked to 3 of the technologies: GM food, nanotechnology food applications and synthetic biology food applications. Historically, this has been associated with the risks of GM crops, specifically perceptions of potentially unpredictable consequences of DNA modification which may have unseen, unintended and potentially irreversible impacts of genetic manipulation that would not occur naturally. Synthetic biology produces similar concerns as does nanotechnology to some degree. These issues were not evident in research on consumer views relating to food from cloned animals, cultured meat, or 3D printed foods. However, it was a recurring theme for all technologies discussed in the public dialogue, with participants expressing concerns about possible ‘future consequences’ of eating cloned meat and the ‘unknown health issues’ associated with cultured meat (Swansea) as well as about the uncertainties and lack of control over the future impacts of nanotechnology in food and GM.

Benefits/risks/attitudinal ambivalence

Across the technologies there were perceived benefits for some of the technologies, for example health benefits of some functional foods, and the possibility of 3D foods enabling people with swallowing difficulties to be able to eat more easily. Concerns about potential health risks were linked to the uncertainty of effects of technologies and to an extent, perceptions of unnaturalness. Willingness to purchase or eat these technologies was linked to a number of factors, and interestingly where price was important to people it had an impact on whether or not they would buy GM food or

food from a cloned animal. Investigating the relationship between affordability and concerns about risks would be useful further research.

Attitudinal ambivalence, where people hold positive and negative attitudes simultaneously, is a common response to many of the technologies. In some cases, the ambivalence is associated with the different applications of technologies such as GM and nanotechnology: in the public dialogue, many participants considered some applications as acceptable (for example plant-to-plant applications of GM) while rejecting other applications of the same technology. The public are able to appreciate both risks and benefits of scientific progress leading to nuanced attitudes. Developing a better understanding of whether there are key factors that dominate in consideration of acceptance of these technologies would also be useful further work.

Knowledge

There was some evidence that knowledge/information is linked with increased acceptance in some cases (for example cultured meat; insects; GM food), but not others (for example food from a cloned animal). This was borne out to some extent by the changes in overall attitudes during the public dialogue. Acceptance of GM food and nanotechnology in food increased somewhat between the start and end of the process: there was no overall change towards a more positive or negative view of cloned meat or cultured meat. However, these are high level results which do not reflect differences between the places where the public dialogues were held or between participants. This is an aspect that merits further research.

Framing of information has also shown to affect attitudes towards technologies (for example cultured meat, synthetic biology). For the majority of the technologies, participants in the studies reviewed, as in the public dialogue, have low awareness or knowledge of the technologies. Studies (for example synthetic biology dialogue, the project's public dialogue) that do introduce people to more information about the technology reveal that attitudes are more complex than perhaps are initially expressed. This is not to say that increased knowledge leads to acceptance of technologies, but rather that to have a clear idea of how people respond to the newer technologies, having an informed public debate can be very useful.

Governance

Across the technologies the issue of trust, transparency and accountability was important and linked to attitudes towards the technologies. Participants in the public dialogue expressed low levels of trust in the food industry, repeatedly questioning the motivations of private companies for developing new food technologies. Understanding who owns the technologies and who might benefit from them are

aspects that were not explored in the public dialogues and are key factors to be further investigated.

In comparison to the high level of suspicion of industry/producers, the public dialogue revealed much more positive attitudes towards regulators, and the FSA in particular. In R2 participants were provided with information and had the opportunity to interrogate the regulatory process in detail. This appeared to strengthen confidence in the efficacy of the process and suggests that the FSA and other regulators could consider providing more information to members of the public about the process of approving food products made with new or emerging technologies.

Individual factors

The review found some limited evidence of consumers' attitudes varying in terms of:

- Gender: men tend to be more accepting/positive towards some of the technologies: cultured meat, food from a cloned animal, nanotechnology, synthetic biology and 3D printed food. Women attach more importance to the functional component of functional foods.
- Age: younger people tend to be more accepting of insect eating, cultured meat and food from a cloned animal but no effects have been seen for 3D printed food or synthetic biology. Older people are more likely to buy functional foods.
- Education: higher education has some relationship to positive attitudes towards cultured meat, GM foods and food from a cloned animal, synthetic biology and nanotechnology.
- Factors such as presence of children in the household structure, cultures, country of residence, living in an urban or rural location, and other lifestyle and experience factors were found to be associated in different ways with consumer views.

Overall, however, the findings cannot be generalised given the small number of studies and the mixed findings. It does suggest that individual factors seem to be less important than perceptions of the technologies per se.

Key similarities and differences between technologies

Attitudes vary within each technology depending on the type of application and the context:

- Functional foods appear to evoke most positive attitudes especially when there is a focus on health benefits.
- Novel food processes – insect eating, whilst in some cases creating a disgust reaction, seems to arouse interest and potential for acceptance.
- Cultured meat and food from a cloned animal - findings suggest a minority of people would eat them. Preference between these 2 technologies appears to depend on views of animal welfare. However, in the public dialogue, after information provision many participants said they would be willing to try these and the other food technologies discussed (GM foods and nanotechnology in food).
- With respect to nanotechnology, there were mixed views with some research suggesting attitudes were more positive than for GM foods, but others showing that was not the case. In the public dialogue, some participants seemed to prefer nanotechnology because the benefits to the individual were more obvious and because it was perceived as less of a fundamental change to the original food.
- While the literature suggests that GM food is largely viewed negatively, the public dialogue results indicated that people were prepared to look at and weigh up the arguments for and against the technology. However, this is a technology about which participants expressed considerable ambivalence with some saying they felt more confused at the end of the process than at the start. The initial negative image of GM seems to persist and cast a long shadow over any discussion of risks and benefits.
- Attitudes to synthetic biology, in part were similar to those of GM foods but there is much less research and it varies according to application and whether the type of synthetic biology is making more (bottom-up) or less (top-down) fundamental changes to biological processes.
- Attitudes among consumers towards 3D printed food tend to be negative, though this is not universal, and information had been found to improve opinions for some.

Key changes since 2009

- Research into consumer attitudes towards food from cloned animals suggests that they have not changed since 2009 and are still negative, but are now more formed than in 2009 when many people did not have a firm view.

- Attitudes towards synthetic biology as an area of technology (rather than as applied to food) seem to be similar to those for other emerging technologies, and specifically GM technologies, and have not changed since 2009. However, the limited studies on specific food applications of synthetic biology suggest a nuanced and context dependent picture.
- Views of functional food vary depending on the combination of the 'carrier' food and added functional ingredient. This reflects the findings in 2009, as do findings that women and older people are more favourable towards functional foods.
- Research on GM foods and consumer views has continued over the past decade, but is not as active as in the decade before the 2009 review. While the research reviewed indicated that views are still negative in general, the experience of the public dialogue suggested a shifting picture with many participants interested in examining the pros and cons and some moving to a more positive position, at least within the context of the public dialogue.
- Views of nanotechnology appear to be mixed, both negative and positive which suggests some change compared to 2009 where it was reported that awareness was low but views were generally positive. The public dialogue tended to support the idea that people are able to see positive elements of nanotechnology, but are likely to weigh these up against what are seen as the technology's more negative aspects.

Areas for future research

Key areas for future research across all the technologies:

- More systematic research into consumer views of specific food applications of the technologies.
- A focus on understanding how perceptions of benefits and risks associated with the technologies are changed by using different techniques for providing information and to what extent these perceptions are maintained or change in the long-term following the intervention.
- Understanding how people weigh up those risks and benefits in different scenarios would also be a useful further research focus, to understand for example, how decisions are made on what to buy or eat.
- Projects that look at actual purchasing or eating behaviours would also be useful as current work is all hypothetical in terms of behaviours. This could also usefully investigate the relationship between affordability and concerns about risks, for example to health.
- Longitudinal research on consumer views across most of these areas to understand change over time and the impact of familiarity/context.

- Finally, understanding how people see the relationships between these technologies would be useful as that could help understand how new technologies with similar characteristics might be viewed in the future. It may be useful to consider the use of scenario development in this context.

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Annex 1: public dialogue research

This annex provides further information about the public dialogue research, including objective and research questions, method and quantitative results.

Objective and research questions

The key objective of the public dialogue was: **To explore the views of consumers in different parts of the UK on emerging food technologies.**

The specific questions explored[17] were:

- What are the participants' views on emerging food technologies?
- How do their views differ depending on the type of technology?
  - What is the acceptability of different emerging technologies?
  - Would the participants be willing to try to the new food?
  - Would they serve it to others?
- What shapes participants' views?
- How do views affect their behaviour such as food choices? What other factors drive behaviour towards emerging foods?
- How have views changed over time?

Method

Public dialogue is a methodology that has been used to enable conversations between members of the public, decision-makers and experts on complex and/or controversial topics (Sciencewise, undated). Our approach is based on the guiding principles for public dialogue established by Sciencewise (2019).

The method involved a process of deliberative enquiry in which participants were introduced to information about a sample of emerging food technologies. Participants were encouraged and helped to interrogate that information and develop understandings about the technologies. Alongside this, the public dialogue enabled exploration of views on the safety and acceptability of the technologies, the benefits they could provide and risks associated with them.

[17] These are some of the questions from the REA.

The method was based on the following key elements:

- Creating an atmosphere of trust where participants felt comfortable asking questions and expressing their views
- Providing enough information for participants to be able to understand the different technologies, what they offer and their actual or potential application to food. For example, short one-page factsheets were prepared for each of the 4 technologies to summarise key points, using neutral language and drawing on the REA, as well as additional google searches to identify suitable images. They were then reviewed by FSA. The factsheets included:
  - What is the technology?
  - What raw materials does it use? Where do the raw materials come from?
  - What process is used in the application of the technology to food?
  - What food products use the technology in their production, distribution, packaging or monitoring?

The public dialogue was conducted in 2 rounds. Three Round 1 (R1) events were held in the following locations: Wigston (Leicestershire), Belfast and Swansea, to cover the areas in which FSA operates (i.e. England, Northern Ireland and Wales. These events were one-day workshops, each with up to 15 participants (recruited by purposive sampling to provide a balance of gender, age and educational qualifications), plus a facilitation team including an expert researcher and one FSA representative in a mainly observation role.

The R1 workshops each comprised 7 sessions, plus a final round and next steps (the sessions are explained in more detail in Table A2):

- Welcome and introductions.
- Ice-breaker - emerging foods cafeteria.
- What are emerging food technologies?
- Feedback on the emerging food technologies discussed.
- Emerging foods and our food system.
- Thinking about food and the future.
- Attitudes and behaviours.

A recall event (R2) was held in London and brought together 15 participants from the regional workshops to enable further elicitation of views in a one-day workshop. There was no expectation that all the R1 participants would be able to participate. The main objective of the R2 event was to further explore the views of consumers in different parts of the UK on emerging food technologies. In addition to the regional participants, and facilitation team, the event was attended by an expert researcher and 4 FSA representatives.

The recall session was held two weeks after the third R1 session, giving all participants the opportunity to reflect on the topics discussed at the R1 events. The R2 workshop comprised the following 8 sessions (the sessions are explained in more detail in Table A3):

- Welcome and Introductions.
- Ice-breaker and evolution of participant opinions since R1.
- How FSA approves and regulates food made using emerging technologies.
- Exploring views on the food risk analysis process for emerging foods.
- Considering ethical and sustainability issues in food risk analysis.
- Comparison of ethical and sustainability issues in selected emerging food technologies.
- Communicating messages about emerging food technologies.
- Round up of public dialogue process.

Public dialogue activities and materials used

A range of materials were developed for use in the public dialogue workshops. Table A1 lists the key printed materials used. Several of the R1 materials were also used in R2, for example, the emerging food technologies chart and the fact sheets. The programme of activities explains how each of the materials was used during the R1 and R2 workshops (see Table A2 and Table A3).

Table A1: Overview of materials used in public dialogue workshops

Name of material	Brief description
Round 1	
Attitude / knowledge questionnaire	Short questionnaire to be completed in 5 minutes at the beginning and end of the dialogue event. 2 x A4 Sheet for scoring each of the EFTs in relation to the following statements, using Likert scale from 1 to 5: • How familiar are you with each of the following food technologies? (1=not at all familiar, 5=extremely familiar) • How positively or negatively do you feel towards each of the following food technologies? (1=very negative, 5=very positive)
Emerging Foods Cafeteria Meal Cards	10 cards each with a different food option, reflecting the 4 EFTs to be covered in the dialogue (two options for each): ravioli of cultured chicken; magic cultured meatballs; slow-roast cloned lamb with salsa verde; superb cloned milk pudding; ceviche de

Name of material	Brief description
	gm soy; super hot gm chicken vindaloo; meal in a nano bag; vegan nano strawberry pudding
Emerging food technologies Chart	Poster showing all four emerging technologies to be reviewed, with key characteristics: technology, stage of development, whether commercially available and examples of application
(EFT) Fact sheets	4 x 1-page fact sheets, one for each technology
Scoring sheet for emerging technologies	2 x A4 Sheet for scoring each of the EFTs in relation to the following statements, using Likert scale from 1 strongly disagree to 5 strongly agree: • I would try this food • I would serve this food to other people • I would be worried about the health risks of this food to me and my family • I would be worried about risks of this food to others, including to people I don't know
Slides	Set of slides on the challenges of the food system
Scenarios background information and cards	1-page description each of two scenarios (A3) size. Set of 6 questions for each scenario - each question to be printed on a separate A5 (or playing card size) card. (the scenarios descriptions are presented below)
Round 2 (additional materials)	
Factsheet food and feeds safety risk analysis process	Factsheet summarising the food and feeds safety risk analysis process - A4 copies for all participant
Ethical and sustainability issues chart	2 x A3 chart for completion by each group. Columns headings contained possible issues: animal health and welfare, impact on biodiversity, impact on climate change, and other issues. Row headings contained an example application of each technology: Australian biscuits with nanoparticles of Omega 3; UK manufactured cultured beef mince; UK oats genetically modified to have enhanced Vitamin D; and Cheese imported from the US made with milk from cloned goats.

We present below the descriptions of the two scenarios used in R1.

Scenario 1: Bred on cultured meat burgers

In this scenario people are increasingly concerned about being able to afford sufficient nutritious food, given the rising numbers who are living on the margins. Fortunately, for the time being, high-tech manufacturing and processing methods have meant that people don't go hungry and food manufacturing is profitable.

There is much less international trade than previously, partly as a result of rising tensions between global power blocs. The UK like many other countries has opted to prioritise the production of foods that cover basic nutritional needs.

The main characteristics of this scenario are:

- Highly industrialised meat production. Meat from live animals is only produced in small quantities and is very expensive. Most people eat cultured meat and fish products which are manufactured by large companies.
- Food businesses have become resource efficient and highly innovative: they use modern technologies to develop new products, recycle and reuse materials and minimise their energy consumption.
- Farming is intensive and relies on the use of GM technologies to produce high yields and protect crops against pests and blight.
- Food manufacturers have made use of nano technologies to create basic foods like bread, pasta, biscuits and beans that have the same taste as familiar products but are lower in fat, salt or sugar. Nanotechnologies are also being used to enhance flavour and increase vitamin and mineral content.
- People expect ‘basic’ foods to be easy to store and prepare and nanotech packaging helps to extend shelf-life and make it easy to see when products are no longer good to eat.
- A few high-yield dairy herds have been created by cloning prize dairy cows but milk is still expensive and mainly given to children and other groups with special needs.

Most people focus on ‘value’ rather than luxury when shopping for food. Convenience is important when eating out too. People rarely eat out in restaurants. Works canteens are on the rise as people seek to get a fast lunch which will cover their nutrition needs and can be eaten quickly. Most people aren’t too fussed about ‘cheffy nonsense’.

Scenario 2: Carry on consuming

In this scenario the food supply has become much more localised. Countries around the world are experiencing resource constraints because of increasing populations and climate change impacts. The countries that used to provide the UK with fruit, vegetables and other products are exporting less so that they can feed their own citizens. The UK can no longer rely on a supply of varied, cheap and high quality foodstuffs. There has been a gradual move away from reliance on global supply chains to a more regional focus on the UK and Europe.

The main characteristics of this scenario are:

- UK vegetable production has boomed, with a mix of local production using traditional methods and highly intensive farming reliant on GM inputs to get higher yields.
- There is ongoing debate about how much priority should be given to food production, with some groups lobbying for intensified agriculture in the countryside at the expense of parks and recreational space.
- Innovations in food technology include:
  - The use of nanotechnology to slow the ripening of many kinds of fruits and vegetables so that they can be kept unrefrigerated for longer without losing quality.
  - The creation of herds of cloned animals in the countryside, making different types of high quality meat and dairy products available - at a price.
  - The accessibility of cultured meat and simplification of its production processes, giving rise to small ‘craft’ production at a local level with creative entrepreneurs combining science with design to come up with unique products.

There has also been a push for innovation within the home to meet the need for resource efficiency. Kitchens are being re-imagined as compact spaces for minimal food preparation (‘capsule kitchens’) with the emphasis on better storage of prepared foods needing minimal preparation. Some new housing developments have communal kitchen spaces.

Table A2: Programme of activities and materials used in the Round 1 public dialogue workshop

Session name / purpose	Activity	Materials
Registration Create positive atmosphere. Get relevant information from participants	Registration / coffee Ask participants to: - sign consent forms - fill in a short attitude / knowledge questionnaire. Emerging foods cafeteria: ask all participants to choose two cards showing EFTs, to reflect: a) What I would like to try b) What I would not want to eat	Attitude / knowledge questionnaire Emerging foods cafeteria Meal Cards (see Session 3) and sign. Cards showing meal options for all 4 emerging food technologies (EFTs) looked at in the REA (two options for each). (NB there will be 5 copies of each meal option to avoid getting all the same answers from participants - if the cafeteria 'runs out of' certain meals, participants will have to choose something else.)
Session 1: Welcome and Introduction to the day People know what is happening Understand the objectives Made aware of Round 2	**Plenary session**. Participants will be sitting in their allocated small groups, i.e. around two tables. Welcome and introduction to the day (including who is organising - CEP - who has commissioned - FSA - why happening now - how the session is organised - programme for the day – Health & Safety / notices (for example mobile phones). Introduce the CEP team	FSA welcome (in person or video) CEP slides or visuals of: • Programme for the day • Round 1 dialogues (locations) and Round 2 dialogue in London • H&S notices
Session 2: Ice breaker – Emerging foods cafeteria Practical introduction to the topic. Get everyone talking PD objectives addressed:	**Small group session** Ask people to introduce themselves saying their name, the food they chose to try and why they chose it Then go around group to ask what people would not want to try.	Each participant will have two cards selected from the 'Emerging foods cafeteria' during registration.'

Session name / purpose	Activity	Materials
1. What are the participants' views are on emerging food technologies? 2. How do their views differ depending on the type of technology?		
Session 3: What are emerging food technologies? Map the EFTs we are looking at so that participants become familiar with the names Explore participants' views on specific emerging food technologies Understand how views differ depending on the type of technology. Explore what shapes participants' views.	**Small group session** One group will look at food from cloned animals and cultured meat; the second group will look at GM foods and nanotechnology in food. The facilitator presents the chart of EFTs and checks that participants understand what it shows. The group discusses how familiar participants are with each of the technologies. (15 mins) Members of each group read one EFT fact sheet and discuss in pairs what they understand / don't understand. (10 mins) The group and facilitator clarify understandings about the technology and note any questions to be taken forward to a later session or shared with FSA. The group discusses initial reactions to the EFT: • What is attractive / positive about it? Why? • What is off-putting or negative about it? Why? • What questions do they have about the technology or its products? • What are the main factors affecting views? • Group B: Facilitator invites expert to ask other questions or add short insight from his experience, for example differences in perceptions in other countries. [Recorders to note how similar / different people's views are] (20 mins)	Emerging Food Technologies Chart, showing name, technology involved, stage of development (research / trial application / commercial application), examples of application in foods. Easy to understand fact sheets about the technologies (<1 page per technology) Crib sheets for each of the 4 technologies for facilitator use. Prepared sheet of flipchart paper for group report-back with: • a circle in the middle to put words or images associated with the technology / food • left side to be used to draw or write things that describe the benefits of the technology. • Right side to be used for things that describe the

Session name / purpose	Activity	Materials
	The members of the group create a visual summary of their views of the technology, using a prepared template flipchart. They will use this to describe the technology to the other group. (10 mins)	problems or disadvantages of the technology
BREAK		
	Small group session (Repeat of the exercise before the break for a second technology.) Members of each group read their second EFT fact sheet and discuss in pairs what they understand / don't understand. (10 mins) The group and facilitator clarify understandings about the technology and note any questions to be taken forward to a later session or shared with FSA. In Group A expert could provide a very brief description of how cultured meat is produced (max 2 mins). The group discusses initial reactions to the EFT: • What is attractive / positive about it? Why? • What is off-putting or negative about it? Why? • What questions do they have about the technology or its products? • What are the main factors affecting views? • How is this technology different from the one before? Why - how do you feel - tease out • Group 1: Facilitator invites expert to ask other questions or add short insight from his experience. • Do people have similar or different views? (20 mins) The members of the group create a visual summary of their views of the technology, using a prepared template flipchart. They will use this to describe the technology to the other group. (10 mins)	(As in previous exercise)
Session 4: Feedback on the EFTs discussed	**Plenary session**. Food from cloned animals - Group A:	Fact sheets (as above)

Session name / purpose	Activity	Materials
Share initial responses to EFTs between groups. Discuss similarities and differences in views and factors contributing to these. PD objectives addressed: • What are the participants' views are on emerging food technologies? • How do their views differ depending on the type of technology? • What shapes the participants' views?	1) Participants in Group B (who didn't discuss the technology) receive copies of the relevant factsheet. 2) The members group A show their visual summary and explain it. [5 mins] 3) The other participants ask questions which are either answered by first group, answered by experts or recorded to take back to FSA. [7 mins] 4) If time, expert asks a question. 5) All participants receive a questionnaire to complete for this technology. [3 mins] (15mins) Repeat the exercise above for food made using GM technology - Group B (Group B presents and Group A learns) (15 minutes) Collect up completed questionnaires	Scoring sheet for each of the EFTs with statements which each participant can agree with by placing a dot alongside it, or disagree by not marking it: • I would try this food • I would serve this food to other people • I would be worried about the health risks of this food • I would be worried about risks of this food to others.
LUNCH		
Session 4: Feedback on the EFTs discussed (CONTINUED)	**Plenary session** Repeat the exercise above for cultured meat - Group A: 1) Facilitator gives participants in Group B (who didn't discuss the technology) copies of the relevant factsheet, 2) The members group A show their visual summary and explain it. 3) The other participants ask questions which are either answered by first group, answered by experts or recorded to take back to FSA, 4) All participants complete the questionnaire for this technology (15 mins) Repeat the exercise above for nanotechnology in food - Group B (Group B presents and Group A learns) (15 minutes) General discussion if time!	

Session name / purpose	Activity	Materials
Session 5: Emerging foods and our food system Provide further context for the discussion of emerging food technologies: • What are the challenges facing our food system? • How can EFTs help to address these challenges?	**Plenary session** Description of the challenges facing our food system • A changing world • Environmental impact • A complex food system Checking participants' understanding: • Are these topics familiar? Is there anything you don't understand? • Are there other issues that should be included as challenges for our food system How might these views or attitudes change their food consumption practices? (30 mins)	Slides based on the Future Food report, to illustrate the following points: • A changing world: – Increasing global population – Changing consumption patterns • Environmental impact: – Finite resources – Climate change and emissions of greenhouse gases • A complex food system – How our food gets to us – Requirements of global supply chains – Problems of uncertainty and unpredictability.
BREAK		
Session 6: Thinking about food and the future Explore how attitudes and behaviours towards EFTs vary between people and places PD objectives addressed: • What is the acceptability of different emerging technologies?	**Small group session.** Each group is given a short description of a future scenario. Facilitator explains that the scenario is not a prediction of something that is going to happen. It is a description of a feasible future situation which we are using to help us think through how changes in the world might affect what we eat and how we feel about that. Facilitator goes through the scenario with the group, making sure that everyone is clear about the situation described. (10 mins)	Scenarios background information: Scenario descriptions for two different future scenarios Each group gets a different scenario. Scenarios cards (6 cards for each group, with different scenario-related questions)

Session name / purpose	Activity	Materials
• What shapes the participants' views? • What information would people need in order to decide whether to consume EFTs?	Facilitator offers participants a set of cards with questions related to the scenario. Each participant picks a card and reads out the question. They say which of the options they would choose and why. The facilitator invites the other members of the group to say what they would do and why. The facilitator encourages them to think about: • What would be the benefits or disadvantages of the emerging food technologies mentioned in that situation? • How do they think they would feel about those technologies in the future scenario? If their views might change, what would be the reason for that change? Then go on to another person in the group and repeat the process described. The number of questions that can be addressed in this time will vary, depending on how much participants want to discuss each question. Try to look at three or more questions. (25 mins)	
Session 7: Attitudes and behaviours Review what participants have learned about EFTs. How has this affected their attitudes towards these foods? How might it affect their behaviour? PD objectives addressed: • How do views affect their behaviour such as food choices?	**Plenary session** Have a round up of the issues that have been raised by the scenario game. • Start with someone from Group B: ask them to briefly say what was the scenario they looked at and what issues did it raise about the use of the four food technologies we have been looking at? • Then ask someone from, Group A to do the same about their scenario. Facilitator asks the group - How much did thinking about future uses change your views of any of the four technologies we have been talking about today? (10 minutes) Thinking more widely about the topics covered during the day, what are the main aspects that make emerging food technologies attractive or appealing and why? What makes them less appealing or attractive?	(EFT) Fact sheets

Session name / purpose	Activity	Materials
	Do any aspects of any of the technologies cause concern and if so, what aspects cause concern and why? Facilitator invites participants to reflect on each of the food technologies they have heard about: • Do they feel more positive or negative about eating the food themselves? Why? • Do they feel positive or negative about the food being available for consumption in the UK? Why? OPTIONAL Q IF TIME: Overall, which of the four food technologies do they feel most positive about? Why? OPTIONAL Q IF TIME: Which do they feel most negative about and why? Finally, how might these views or attitudes change their food consumption practices? • What kinds of food purchases might they change (eating out, fast food, family meals, fresh versus prepared foods etc) and in what ways? • What opportunities would the new technologies open up? • What concerns would they have about the new technologies? (20 mins)	
Round up of the day and next steps Summary of day and completion of evaluation forms by participants	**Plenary session** Give participants the same short attitude/knowledge questionnaire they completed in the morning. Completing it at the end of the day will provide information about changes in attitudes and views of the technologies. To be completed before leaving (this will be a condition of receiving their incentive). While people are completing the questionnaire, the facilitator will summarise what has come out of the session; describe the programme for Round 2 workshop and invite participants to sign up to attend. Explain that we will have to make a selection to ensure equal	Material 1: Attitude / knowledge questionnaire

Session name / purpose	Activity	Materials
	representation from all workshops so not everyone who signs up will necessarily be selected to attend.	
Close and payment of incentives	Participants hand in their completed questionnaire and contact forms and receive their incentives.	

Table A3: Programme of activities and materials used in the Round 2 public dialogue workshop

Session name / purpose	Description of activity	Materials
Registration Make everyone feel comfortable and at ease	Arrival, registration. Ask participants to complete Before questionnaires	Registration sheet Consent forms Short 'before' questionnaire
Session 1: Welcome and Introduction Welcome participants to the event. Explain purpose of the event and what will happen during the day	Welcome Welcome from FSA Who is in the room Programme for the day.	Slides
Session 2: Evolution of participant opinions since Round 1. Introductions between participants Capture any changes of opinion and further thinking about emerging food technologies since round 1. Get people from different places sharing views.	Small groups Ice-breaker with introductions: Please say your name and either the location where you attended the Round 1 dialogue event, Food Standards Agency or Collingwood Environmental Planning. Please also say, if you were a food (or drink), what food you would be. (CEP and FSA to participate) (10 mins) Facilitator prompts discussion of evolution of views since Round 1: • Have participants' views changed since Round 1 or are they the same? – In relation to which technology(ies) have they changed? – In what way did your views change?	

Session name / purpose	Description of activity	Materials
Encourage interaction between members of public and experts.	– What influenced the change? • Did you look for any further information on any of the technologies? – Which technology did you look for information on? – What information were you looking for? Where did you look? What did you find? Did you get the answers you wanted? • Did you talk to friends, colleagues, or family about the technologies? What sort of things did they want to know? Did you find any of their questions hard to answer? In what way? • Do you have any questions from the previous round or new questions yourselves? FSA staff & expert chip in on matters of information. (15 mins)	
Session 3: The system for risk analysis of new foods and feeds for sale in the UK Provide information on the system for approving new foods for sale in the UK	Plenary Short description of how FSA approves and regulates food made using emerging technologies, covering for example: Who has to apply for permission? What information must they provide? What testing is done? Whose opinions are asked for? How long does it take? Who makes the decision? What are the requirements about labelling? Is there any further monitoring of the food once approved for sale? Q&A	
Session 4: Exploring views on the risk analysis process Explore understandings and views of the system for approving new foods for sale in the UK and what aspects do or don't give consumers confidence in the process in relation to	Small group discussion: system for approving new foods in the UK. • Group goes through the diagram of the food and feed safety risk analysis process together and clarifies anything that they don't understand. (10 minutes) • Now we are going to consider how this process could work in relation to food made using one of the emerging food technologies we have discussed. • We are going to look at: – Group A: Australian biscuits with nanoparticles of Omega 3 – Group B: UK manufactured cultured beef mince.	Factsheet of the food and feeds safety risk analysis process - A4 copies. 1 card saying: Australian biscuits with nanoparticles of Omega 3 (on Table A) 1 card saying:

Session name / purpose	Description of activity	Materials
emerging food technologies. Find out whether understanding the regulatory process changes people's expected behaviour in relation to the consumption of these foods - are they more/less likely to eat them? Are they more/less likely to serve them to friends or family?	• Looking at the risks and factors analysed, what risks would you expect the FSA to take into account in relation to this technology / food? • Are there any activities such as review of relevant studies, laboratory tests, etc that you would expect to be part of the risk assessment? • Who would you expect to be involved? Do you think that the Scientific Advisory Committees and the FSA Advisory Forum on Food and Feed cover all the people who should be involved? (25 mins) Does learning about this risk analysis process make any difference to how you feel about the possibility of this kind of food (made using an emerging food technology) being sold in the UK? Would you be happy to eat this food if it had gone through this process? Why or why not? (5 mins)	UK manufactured cultured beef mince (on Table B) 2 x Note on Advisory Forum on Food and Feeds (for facilitators)
BREAK		
Session 5: Considering ethical and sustainability issues in food risk analysis Explore underlying ethical and sustainability issues about food that have come up in Round 1. Understand the extent to which these underlying issues currently affect food behaviours and practices.	Small group session. • The fourth circle refers to 'other factors' [this should, correctly, say 'other legitimate factors'] or issues other than human health risk assessment that are taken into account in risk management and communication. Examples of these issues are: animal health and welfare, health and safety, economic impact, environmental impact, trade distortion, impact on consumer choice, socio-economic factors, consumer perceptions, acceptability and preferences, including the wider interests of consumers. • Some of these issues came up in Round 1 discussions and we want to look at them a bit more this morning in relation to the same emerging food technology example you were looking at before the	2 x Chart (A2) for identifying ethical and sustainability issues and criteria for addressing them, as agreed by each group. Red and green flipchart pens Post-it notes (EFT) Factsheets available on tables for each of the 4 technologies in case needed

Session name / purpose	Description of activity	Materials
Identify whether there are any criteria agreed by members of the group that would make the food products or ingredients more acceptable in relation to each of the issues examined.	coffee break. Please note that some of the issues may not be relevant to the technology you are looking at. • Looking at **animal health and welfare**, – How important is this issue to you? – What would be good animal health and welfare in this case? Can you identify minimum standards? • What about **impact on biodiversity?** – How important is this issue to you? – Would you expect there to be limits or controls on impacts on biodiversity? How would you expect producers or government to show that these limits were being observed? • What about **impact on our climate and global warming?** – How important is this issue to you? – Should impact on climate change be taken into account in approving food and feeds for sale? Can you imagine how this might be done? • Do you think that this product might raise **other legitimate issues**? Which? What aspects seem particularly important? • Prompt: equality issues? Issues about nutrition / nutritiousness of the food? (25 mins) Draw on discussions to produce a table which considers four hypothetical food products: • Australian biscuits with nanoparticles of Omega 3 • UK manufactured cultured beef mince • UK oats genetically modified to have enhanced Vitamin D • Cheese imported from the US made with milk from cloned goats	

Session name / purpose	Description of activity	Materials
	The facilitator uses a chart similar to the 'Emerging food technologies' chart used in Round 1, to explore how the issues compare across the technologies. Note that some issues will not be relevant to some foods… For each food, record agreed or majority views in the group on four issues (animal welfare, biodiversity, climate change emissions and other issues), considering how important they are felt to be (H/M/L) and whether the overall impact is negative or positive (red/green). Facilitator to encourage participants to write post-its standards for the issues - these can be individuals' views, they don't need to be agreed. (20 mins)	
Session 6: Comparison of ethical and sustainability issues in selected emerging food technologies	Plenary Compare the charts produced by each group: The facilitator goes through the charts by technology (i.e. first by food from cloned animals, etc) to see what is the same or different between groups. The groups discuss the points where there are differences, to understand where the differences lie.	2 x Chart (A2) for identifying ethical and sustainability issues and criteria for addressing them (as above)
LUNCH		
Session 7: Communicating messages about emerging food technologies - 7a Production of messages Get participants to identify one or two important messages they would like to	Participants work in 4 teams of 4 or 5 people each. Each team prepares **material with basic information to help people like them to understand and make their minds up about the benefits or disadvantages of one of the four technologies** (CEP to allocate an emerging food technology to each group)**.** The groups should each produce at least: • a video of one or two people talking about the technology - from 1 to 2 minutes long;	Video recorder or iPad set up in a quiet place for teams to record their videos. Rough paper for groups to develop their ideas. Flip chart paper and pens for each group to write their slogan.

Session name / purpose	Description of activity	Materials
communicate about emerging food technologies. Empower participants to come up with their own messages around the future food technologies examined. Provide FSA with participants' considered views, in their own words, about what is most important.	• a written slogan or message and where it would be used (for example in newspaper, doctor's surgery, motorway billboard, etc). Each team works with one person from CEP/expert who will provide technical help to ensure they end up with a product. Facilitators encourage participants to focus on what people like them will want to know and prompt them to consider what information has changed their minds The first steps will be to agree the message and decide the points to be covered in the video and agree who will do the video. Groups will be given a time to record their video and will have to organise their work to fit in with this. FSA staff will be on hand to answer specific questions as needed. Suggest that they 'float' rather than being attached to anyone group. (60 mins)	Note: videos will only be used to as a focus for the exercise. The videos will not be shared beyond the CEP research team.
TEA BREAK		
Session 7: Communicating messages about emerging food technologies - 7b Presentation and discussion of messages	Plenary: • All the videos are shown together. • Then each group presents their slogan or message and says something about why they chose their message(s) (max 2 minutes each) (20 mins) Discussion: • To what extent do participants think that these messages would provide the kind of information consumers need to understand issues around emerging food technologies and make informed choices? • Are there any issues that were particularly easy or difficult to present? Why?	As in previous session

Session name / purpose	Description of activity	Materials
	• Are there any other ways in which the issues raised could be addressed (other forms of communication, research, transparency etc) • On reflection are there any really key issues missing /not covered that should be? (20 mins).	
Session 8: Round up of dialogue process	Plenary - Round up of dialogue process: • What have you learned? (FSA staff first, then members of the public) • Is there anything that is still unclear and needs to be explored further? (members of the public and FSA staff) • Thinking across all the technologies we have discussed, what emerging technologies that we have discussed do you think will become common over the next ten years? What foods do you think that consumers will go for? Are there any that you think will be unacceptable? (25 mins)	
Thanks and close	Thanks from CEP and FSA. Participants complete surveys and collect incentives.	Short 'After' survey. Receipt of payment forms

Analysis

The data was coded deductively using themes emerging from the literature review. Table A4 explains the codes used and how these were used to inform analysis of the SRQs.

Table A4: Thematic analysis

Name of code and related terms	**Further detail on theme**	**Relevant research question(s)**
Positive perception, feelings, views; acceptability (of emerging food technologies)	Aspects of the food that are noted as attractive, positive associations not covered by other tags.	SRQ1
Negative perception, feelings, views (of emerging food technologies)	Off-putting aspects, negative gut reactions, negative associations not covered by other tags.	SRQ1
Perceived **risk** to human health and wellbeing associated with emerging food technology(ies)	Aspects to do with, for example, taste, appearance, health and safety, nutrition, chemicals expected to damage health, etc. - including 'unknown'. Note that wider risks (for example environmental, to animal welfare) should be tagged **'contextual'**	SRQ3
Perceived **benefit** to human health and wellbeing associated with emerging food technology(ies)	Aspects to do with, for example, taste, appearance, nutrition, health and safety, etc. Note that wider benefits (for example environmental, to animal welfare) should be tagged **'contextual'**	SRQ3
Perceived **naturalness** or unnaturalness of foods	Aspects to do with naturalness, or unnaturalness for example artificial, 'not right', use of chemicals as artificial	SRQ3
Familiarity or unfamiliarity of foods	Includes whether or not previously heard of it, levels of familiarity, etc.	SRQ1
Comparison between technologies	Comparison of two or more technologies, including similarity or differences etc. NB please make sure you also tag the section for the relevant technologies and for the aspect on which they are being compared.	SRQ2
Perceived **cost** (both high and low cost)		SRQ3
Personal factors influencing perceptions (health conditions,		SRQ3, SRQ4

Name of code and related terms	**Further detail on theme**	**Relevant research question(s)**
dietary choices, knowledge, lifestyles)		
Trust or lack of trust in food system	Includes trust/lack of trust in food companies, government, public institutions; also trust in standards/regulation	SRQ3
Information about emerging food technologies	Includes use and perceptions of information on food; availability / lack of information; clarity / lack of clarity of information; what participants would want to know; food labelling	SRQ3
Contextual factors influencing attitudes towards emerging food technologies: environmental (for example biodiversity loss), social, economic, education, concern for animal rights	These factors refer to wider society and not just the individual, so economic factors are not the cost of the technology (which has a separate tag) but impact on producers, trade, etc.	SRQ3
Behaviour, including likely future behaviours	Willingness to try foods, likelihood that patterns of consumption would or would not become normalised; discussion of consistency or inconsistency between attitudes and (likely) behaviour	SRQ5
Change in attitudes over the course of the day		SRQ6
Cloning, food from cloned animals		All SRQs
Cultured meat	Including terms and ideas such as clean meat, lab-grown meat	All SRQs
Genetically modified, **GM**, GMO		All SRQs
Nanotechnology in food, **nanofood**	All references to nanotechnology that are not specifically about use in food packaging	All SRQs
Nanotechnology in food packaging, **nanopackaging**	Only references to use of nanotechnology in food packaging	All SRQs
Bred on Cultured Meat	This indicates where responses related to the scenario session and which scenario was used.	All SRQs
Carry on Consuming	This indicates where responses related to the scenario session and which scenario was used.	All SRQs

Notes: bold indicates the name of the code

Results

This section presents the main quantitative results[18] from the public dialogue workshops organised by Research Question, along with selected examples of participant's visual representations of each of the 4 emerging technologies. Whilst the sample size is small, the results tell us something about how participants responded to the workshops. These cannot be generalised to the wider population. Individual factors may affect attitudes and behavioural intentions as well as the perception of risks and benefits. A larger study could give a clearer view of these.

What are the public's views on emerging food technologies?

Participants were asked 'before' and 'after' the workshop about their levels of familiarity with, and attitudes towards, emerging food technologies – see Table A5.

Table A5. Attitudes towards emerging food technologies 'before' and 'after' the public dialogue workshop: median score across the 3 Round 1 groups

How familiar were you with each of the following food technologies? From 1 not all familiar to 5 extremely familiar

Technology	Before	After
Food from cloned animal	1	4
GM food	2.5	4
Nanotechnology in food	1	4
Cultured Meat	1	4

How positively or negatively do you feel towards each of the following food technologies? From 1 very negative to 5 very positive

Technology	Before	After
Food from cloned animal	2	3
GM food	3	4
Nanotechnology in food	3	3.5
Cultured Meat	3	3

Note: A small number of missing or incorrectly completed responses were removed giving final sample sizes of between 43-45 for familiarity and 41-45 for positive/negative attitudes, depending on the question/technology.

[18] Key findings from the public dialogue qualitative data are presented in the main report

There was a clear pattern of improved familiarity of the technologies as a result of the workshop. Before the workshop, only GM approached a 'neutral' score of 3, with the other 3 technologies being perceived as very unfamiliar.

When considering how people felt about the technologies, the median score of 2 rose after the workshop, those of food from a cloned animal and cultured meat did not change.

During the public dialogue, participants were asked to respond to a series of Likert scale statements about each of the emerging food technologies – see Table A6.

Table A6. Attitudes towards emerging food technologies (during the public dialogues): median score across the 3 Round 1 groups using scale 1 strongly disagree to 5 strongly agree[19]

Technology	I would try this food	I would serve this food to other people	I would be worried about the health risks of this food to me and my family	I would be worried about risks of this food to others, including to people I don't know
Food from cloned animal	4	3	4	3
GM food	4	3	4	4
Nanotechnology in food	4	4	3	3
Cultured Meat	4	3	3	3

Notes: For nanotechnology, 4 participants provided separate answers for nano in food and in packaging, only the nano in food responses are included. For GM 1 participant provided separate answers for GM in plant-based foods and meat. Only responses for plant based are included.

The median scores indicate that though many respondents felt slightly positively about trying the foods themselves, they were generally more cautious about serving them to other people. The exception was nanotechnology in food where participants were equally positive towards trying the food themselves and serving it to others.

There is a slight concern about health risks to family and to others for GM foods, though the risks of foods from cloned animals were more acutely perceived within the family than without. Participants were neutral about whether or not they would have concerns related to health risks of nanotechnology in food and cultured meat, whether for the family or to others.

[19] Agreement scales used: 1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree

How do views differ depending on the type of technology?

See Table A6 which presents data from questionnaires distributed during the workshop on attitudes towards the different technologies.

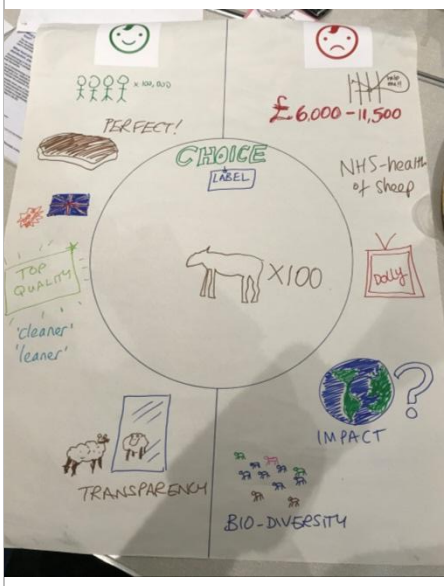
There was no obvious distinction between technologies with willingness to try oneself, though when people considered serving it to others, they only felt this degree of muted confidence for nanotechnology as the other 3 technologies had neutral median scores (see Table A6). There was a marginally higher perception of risk to health associated with cloning and GM than there was for nanotechnology and cultured meat which scored neutrally in this regard.

What shapes the public's views?

Figure A1 presents examples of flipchart representations created by participants of their views towards the emerging food technologies during the R1 public dialogue workshop.

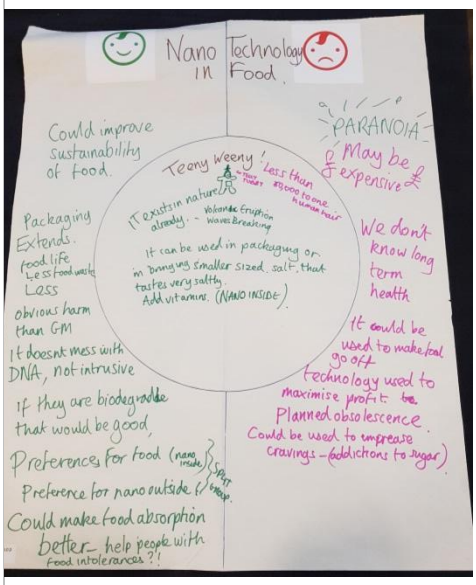
Figure A1. Examples of flipchart representations of participants views towards emerging technologies (Round 1)

Food from Cloned Animal – Wigston (A)

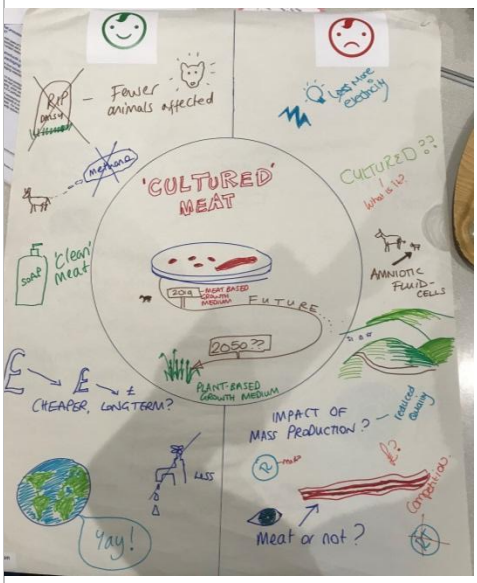


GM Food – Belfast (B)

Nanotechnology in food – Swansea (B)



Cultured meat - Wigston (A)



Do different types of people hold different views?

Quantitative data collected ‘before’ and ‘after’ the workshop on attitudes towards the emerging food technologies was compared across gender and the locations of the public dialogues.

Gender:

Of the 45 participants completing the questionnaires, 22 identified as female and 21 identified as male; 2 participants did not answer the gender question. Responses to the question ‘how positively or negatively do you feel towards each of the food technologies’ before and after the workshop are presented in Table A7.

Table A7. Response to ‘How positively or negatively do you feel towards each of the following food technologies?’ by gender: median score across all Round 1 workshops using scale from 1 very negative to 5 very positive.

Before

	F	M
Food from cloned animal	2	2.5
GM food	3	2.5
Nanotechnology in food	3	3
Cultured Meat	3	3

After

	F	M
Food from cloned animal	2	3
GM Food	3	4
Nanotechnology in food	3	4
Cultured Meat	3	4

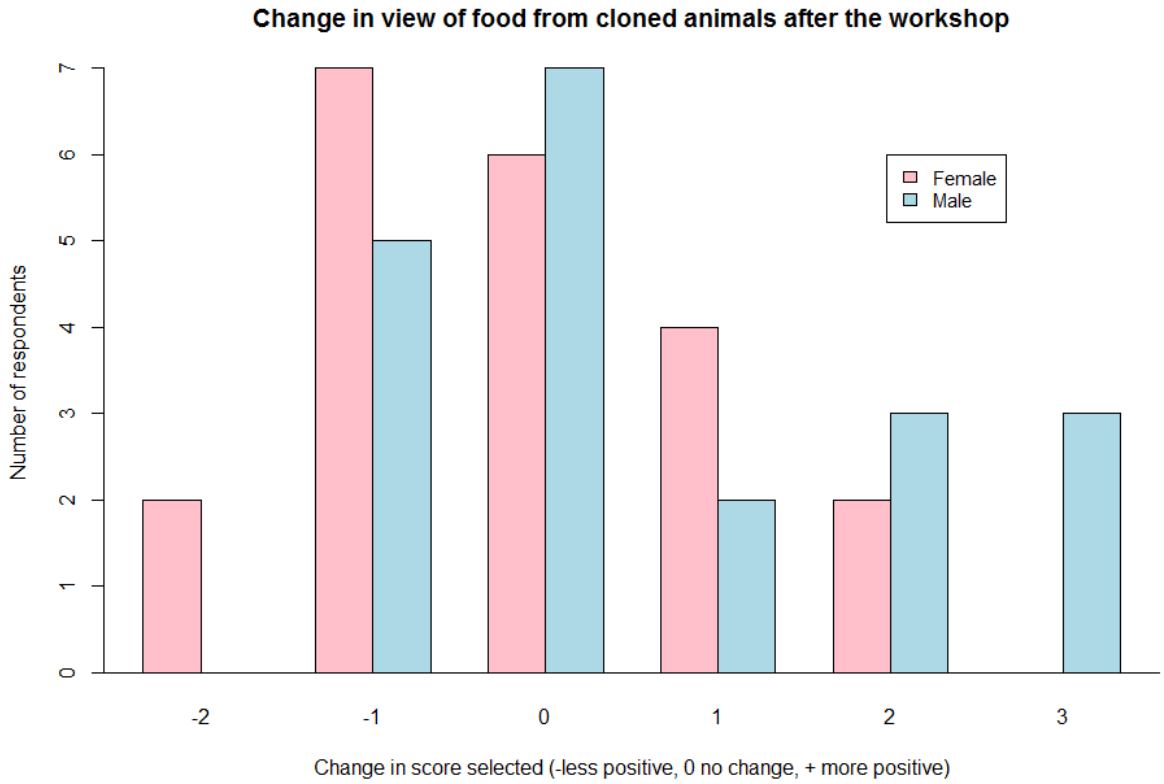
Note: A small number of missing or incorrectly completed responses were removed giving final sample sizes of between 20 and 22 for female, and 19 and 21 for male depending on the question/technology:

At the start of the workshop, men and women felt similarly and neutrally or slightly negatively about the majority of the technologies reviewed here (see Table A7). Only for food from a cloned animal and GM food was there any detectable differences; women gave food from a cloned animal a negative score compared to a borderline neutral score by men, and men gave GM foods a borderline neutral score compared with a neutral score by women.

Women were also less influenced by the workshop at this time scale (i.e. within the same day); their median scores did not change, though those of men rose in 3 out of the 4 technologies, remaining the same for food from a cloned animal only.

Though the overall positions varied little, there was some individual influence and many people changed their viewpoints during the R1 workshops - for example, see Figure A2 which presents results on the number of individuals who changed (or not) their views towards food from cloned animals within the R1 events according to gender.

Figure A2. Change in view in Round 1 towards food from cloned animals after the workshop compared with before, according to gender: based on difference in response to 'How positively or negatively do you feel towards each of the following food technologies?'[20]



This data should be interpreted with caution, because of the small sample size. Individual factors such as age or educational level may affect attitudes and behavioural intentions as well as the perception of risks and benefits. A larger study could give a clearer view of these.

Location:

Attitudes towards the different technologies across the 3 R1 locations are presented in Table A8 and Table A9.

Belfast started with the least negative feelings to the technologies and shifted the most towards a positive view as a result of the workshop, with 3 of the 4 technologies rising to a higher than neutral score (see Table A8). In Wigston, only GM food changed to a more positive feeling. Swansea also shifted slightly in this regard though the median score remained neutral or negative for all technologies.

[20] Data based on After minus Before, so that a positive (for example +1) indicates attitude is more positive, and negative (for example -1) indicates attitudes are less positive, after the workshop compared with before.

Table A8: Response to 'How positively or negatively do you feel towards each of the following food technologies?' by location: median score across all Round 1 events, using scale from 1 very negative to 5 very positive

Before

	Wigston	Belfast	Swansea
Food from cloned animal	2	3	2
GM food	3	3	2.5
Nanotechnology in food	3	3	3
Cultured Meat	3	3	2

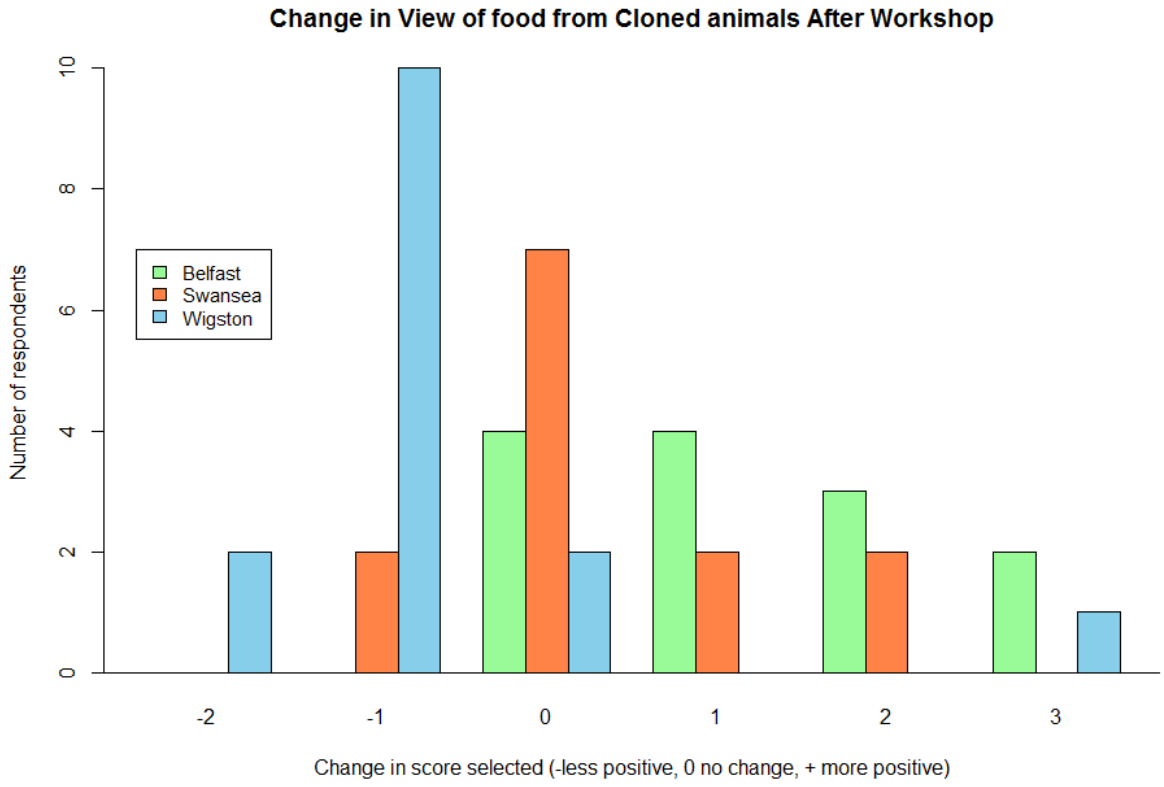
After

	Wigston	Swansea	Belfast
Food from cloned animal	2	4	2
GM Food	4	4	3
Nanotechnology in food	3	4	3
Cultured Meat	3	3	3

Note: Wigston final sample size of 15. For Belfast and Swansea a small number of missing or incorrectly completed responses were removed giving final sample sizes for Belfast of 14 or 15, and for Swansea of 13, 14 or 15 depending on the question and technology.

Figure A3 presents the number of individuals who changed (or not) their views towards food from cloned animals within the R1 events according to location. The data suggests Wigston is slightly different with more individuals becoming more negative in their views towards food from a cloned animal compared with the other 2 locations.

Figure A3: Change in view in Round 1 towards food from cloned animals after the workshop compared with before, according to location: based on difference in response to 'How positively or negatively do you feel towards each of the following food technologies?'



There are perceptible differences between the city locations with the Swansea sample generally being less willing to try or serve emerging food technologies and also having a greater degree of worry about potential risks of the technologies at family and population levels (see Table A9).

Table A9 Responses to statements in Round 1 about emerging food technologies by location: median score using scale 1 strongly disagree to 5 strongly agree[21]

I would try this food

	Wigston	Belfast	Swansea
Food from cloned animal	3	4	2
GM food	4	4	4
Nanotechnology in food	4	4	4
Cultured Meat	4	3	4

I would serve this food to other people

	Wigston	Belfast	Swansea
Food from cloned animal	3	4	2
GM food	4	3	3
Nanotechnology in food	4	4	4
Cultured Meat	4	2	3

I would be worried about the health risks of this food to me and my family

	Wigston	Belfast	Swansea
Food from cloned animal	3	3	4
GM food	3	4	4
Nanotechnology in food	3	3	3
Cultured Meat	3	3	4

I would be worried about risks of this food to others, including to people I don't know

	Wigston	Belfast	Swansea
Food from cloned animal	3	3	4
GM food	3	4	4
Nanotechnology in food	3	3	3
Cultured Meat	3	3	4

Notes: For nanotechnology, 4 participants provided separate answers for food and in packaging, only the nanotechnology in food responses are included. For GM where one participant provided separate answers for GM in plant-based foods and meat, only responses for plants based are included.

How do views affect behaviour such as food choices?

No quantitative data collected. See main report for qualitative findings.

How have views changed over time?

During the public dialogue events, participants answered questions at the start and end of the day to examine whether views changed or not – see Table A5, Table A7, Table A8, Figure A2 and Figure A3.

Over this short time frame, individual views did change in response to the information provided and the discussions that surrounded these. For example though the median score remained the same for how people felt about food from cloned animals, 14 people decreased their awarded level and 14 others increased theirs. Differences at this level would need greater sample sizes to confirm, but do emphasise that though individuals may vary, detecting population-level trend possibilities over such a short time scale is demanding.

The final 'recall' event in London involved a small sample of 15 participants selected from participants from the previous 3 regional events who indicated an interest. The participants were selected to reflect all three regional locations, an even distribution of men and women and a range of ages. During the R2 event, participants again answered questions at the start and end of the day to examine whether views had changed or not – see Table A10 and Table A11.

The median scores at the R2 event indicate that overall participants felt moderately familiar with all 4 technologies both at the start and end of the workshop, with little overall improvement in familiarity during the course of the day (see Table A10). These familiarity scores are on the whole the same as those reported by the full sample at the end of the R1 workshops which illustrated a marked improvement in familiarity since the start of R1 (see Table A5).

When considering how people felt about the technologies, the median score for both GM food and cultured meat rose at the end of the R2 workshop, while nanotechnology in food and food from a cloned animal remained the same. Overall at the end of R2 participants felt positive towards GM food, nanotechnology in food and cultured meat and neutral towards food from cloned animal.

[21] Agreement scales used: 1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree

In comparison with attitudes reported by the full sample earlier in the public dialogue process (see Table A5), attitudes towards all 4 technologies were more positive at the end of the R2 workshop (see Table A10) - in the case of food from cloned animals attitudes going from overall negative to neutral, and for GM food nanotechnology in food, and cultured meat, from overall neutral to positive.

Table A10: Attitudes towards emerging food technologies 'before' and 'after' the public dialogue session: median score in the Round 2 group

How familiar were you with each of the following food technologies? From 1 not all familiar to 5 extremely familiar

	Before	After
Food from cloned animal	4	4.5
GM food	4	4
Nanotechnology in food	4	4
Cultured Meat	4	4

How positively or negatively do you feel towards each of the following food technologies? From 1 very negative to 5 very positive

	Before	After
Food from cloned animal	3	3
GM food	3	4
Nanotechnology in food	4	4
Cultured Meat	3	4

Note: 'Before' sample sizes had no missing or incomplete responses giving final sample sizes of 15. 'After' sample sizes adjusted to remove missing responses giving final sample sizes of 13 or 14 depending on technology and question.

At the end of the R2 workshop, median scores indicate that many participants would be willing to try GM food, nanotechnology in food and cultured meat, while participants are neutral towards trying food from cloned animals (see Table A11). In comparison with attitudes reported by the full sample earlier in the public dialogue process (see Table A6), this reflects a more positive view among this sub-sample towards trying nanotechnology in food, the same positive views towards trying GM food and cultured meat, but slightly less positive views towards trying food from a cloned animal.

At the end of R2, participants were neutral about whether or not they would have concerns about the health risks for each of the 4 technologies. Compared with attitudes of the full sample at the end of R1, these results indicate overall no change

in perceptions of the health risks of nanotechnology in food and cultured meat, while slightly less concern about the health risks of food from cloned animals and GM food.

Table A11: Responses to statements in Round 2 about emerging food technologies: median score using scale 1 strongly disagree to 5 strongly[22]

Technology	I would try this food	I would be worried about the health risks of this food to me and my family
Food from cloned animal	3.5	3
GM food	4	3
Nanotechnology in food	5	3
Cultured Meat	4	3

Note: Sample sizes adjusted to remove a small number of missing responses giving final sample sizes of 12, 13 or 14 depending on technology and question.

[22] Agreement scales used: 1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree

Annex 2: reviewed literature

This annex presents the list of final literature reviewed in the REA for each emerging food technology.

GM Foods

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