FSA Citizens Forums: Nanotechnology and food

TNS-BMRB Report

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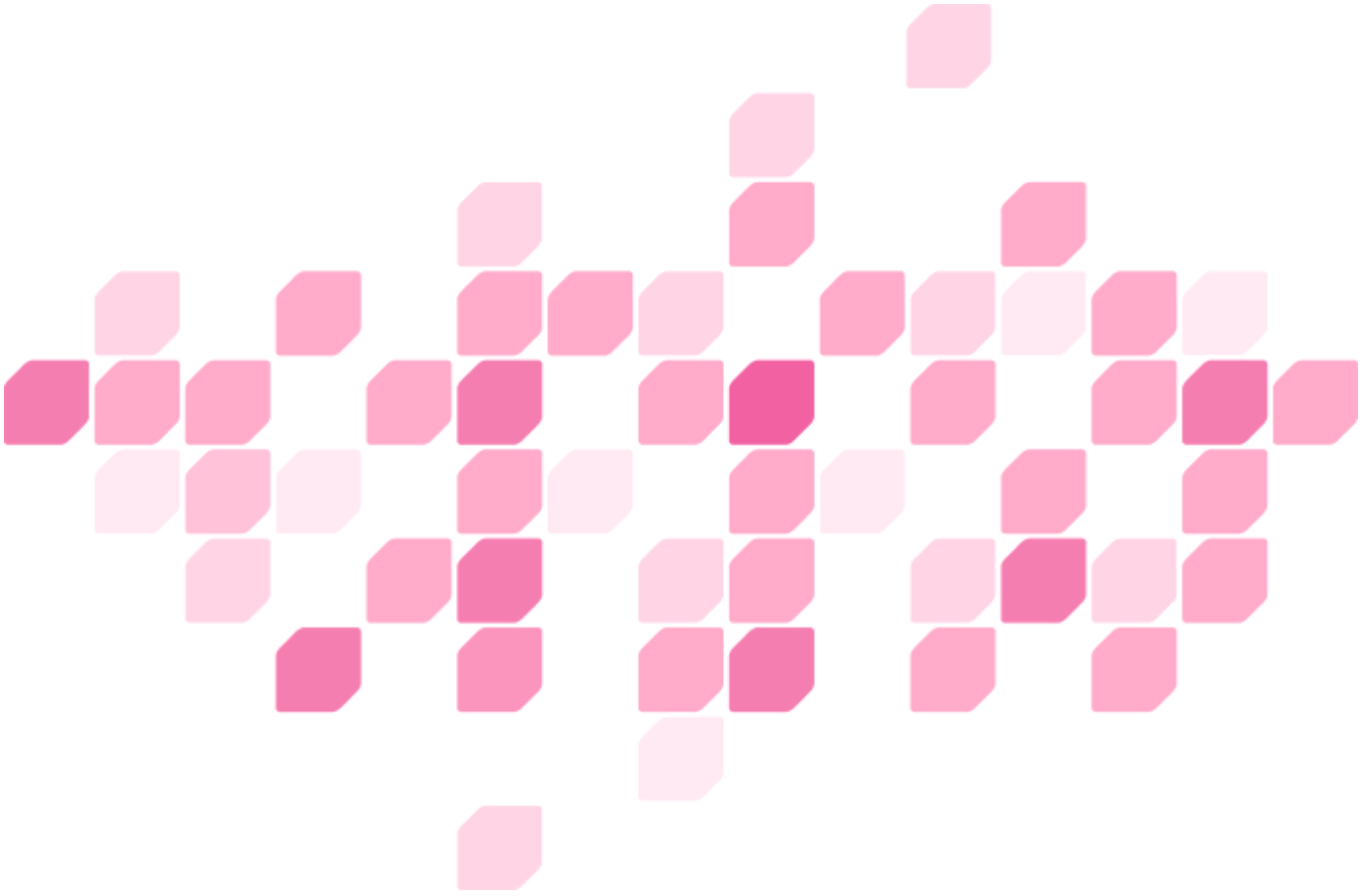


Content

Executive summary

TNS-BMRB was commissioned by the Food Standards Agency (FSA) to conduct a nationwide series of 'citizens forums', with the goal of establishing an ongoing dialogue with the public on food standards. This programme is now in its fourth year, with this year's focus exploring consumers' views about the use of nanotechnology in food and food packaging. The format was six workshops, each comprising two groups of approximately 10 participants, held in six locations across the UK and convened over three waves between November 2010 and February 2011.

Views about nanotechnology

Initial reactions to the use of nanotechnology in food and food packaging were wide-ranging. They included: some excitement about the potential benefits, particularly creating 'light' versions of traditionally unhealthy food; some concern about possible impacts on long-term health and the wider environment; and most typically, requests for more information. Questions revealed a core focus on three broad issues: whether nanotechnology was a necessary development; whether it would be in consumers' interest or merely for industry gain; and whether the benefits outweighed the risks.

- **Why are we doing this?** Questions about the necessity of using nanotechnology related to a general sense that further 'tampering' with food was unappealing and more conventional approaches could achieve similar goals, such as government campaigns for healthy eating.

- **Who's it for?** Questions about whose interests would be served by nanotechnology were prompted by suspicion that industry gain would be pursued to the detriment of consumer interests, for example by raising prices or providing lower quality or 'risky' products.

- **Is it worth it?** Questions about whether the benefits associated with nanotechnology were worth the risks reflected a considerable focus on potential risks, particularly concern about impacts on long-term health and the environment.

Further information about potential applications of nanotechnology in food and food packaging prompted more considered views about possible benefits and risks:

Food applications - Participants were initially wary about applying nanotechnology directly to food. This reflected broader concerns about food technology as a whole;

specifically that ‘tampering’ with food was unappealing, and tended to be done to boost profits for the food industry rather than to benefit consumers. In relation to nanotechnology in particular, unknown risks to health and the environment prompted further concern.

Benefits of specific food applications provoked greater enthusiasm, particularly applications that could: lower levels of salt, sugar and fat in products without affecting taste; and increase the nutrient or vitamin content. Participants valued the benefits these could bring to people with dietary concerns; however, this was tempered by concerns that this technology could undermine more traditional messages about healthy eating.

Participants were less convinced about the benefits of other food applications, such as developing products that allow consumers to feel fuller or creating foods with new textures and flavours. Unnecessary or ‘trivial’ applications were not felt to be worth risking the possible downsides associated with food technology, such as potential health risks and wider impacts on society and the environment.

Packaging applications – Participants were relatively more open to the idea of applying nanotechnology to food packaging. This was despite concerns about the use of ‘hard’ nanomaterials, which tended to be associated with packaging applications. A tendency to downplay the risks reflected an acceptance that technology would be used in food packaging and a perception that nanomaterials would not be directly ingested. In spite of this, participants sought reassurance that nanomaterials would not migrate into food, and also that nanopackaging would not undermine recent advances towards more environmentally-friendly packaging.

Specific nanopackaging applications were generally welcomed. Applying sensors to detect food spoilage, and products that extended shelf life and preserved foods were seen as valuable methods of reducing unnecessary waste, saving consumers money, and relieving pressures on landfill and food production. These would be undermined, however, if products were used merely to extend storage and haulage options for the food industry, to the detriment of food quality and price.

Safeguards

Across all workshops, participants raised concerns about the safety implications of nanotechnology; specifically querying how product safety could be ensured, whether wider impacts on long-term health and the environment would be taken into account, and who would be liable in the event of any negative consequences.

To some extent participants were reassured by information about the regulatory process for introducing novel foods. However, lack of confidence in the testing process for long-term impacts and low confidence that manufacturers and decision-makers would act in the interest of consumers meant that even at its most stringent, the regulatory process was unable to completely reassure participants.

Consumer information

Consumer information emerged spontaneously as a prerequisite for introducing nanotechnology. This would support consumers to make their own decisions about whether to consume products containing nanomaterials, and also provide reassurance that consumers were not being 'kept in the dark' about potentially significant developments.

Reactions of specific information options include:

- **Food labelling** – Despite mixed views about the efficacy of labelling, this was considered a basic requirement for consumer choice and would also ensure transparency. Labelling should be simple and straightforward, avoiding technical language, but linked to other sources of information available at varying levels of detail and technicality. Participants struggled to identify criteria for inclusion in labelling, but ultimately this focused on 'hard' or deliberately engineered nanomaterials due to their potential to accumulate within the body.

- **Register of approved products** – Participants valued an up-to-date, easily accessible, online list of all products on the market containing nanomaterials. Suggestions for further information included: detail about benefits, risks and wider impacts; links to EU dossiers detailing product applications; and details about companies working in these areas and their on-going research. It was important that the site should be provided by an independent body, with no link to benefits or profit, who could provide neutral and objective information.

- **Manufacturers' information** – A lack of trust in the motives of the food industry, meant that information would need to be regulated and provided alongside more neutral sources in order to be useful.

- **Education and awareness-raising** – Educating the public about nanotechnology was necessary to raise awareness and provide a background

to other sources of information, such as labelling and a register of approved products. Crucially, this information should be provided before products are launched on to the market, in order to avoid media scaremongering and to involve the public in an on-going debate as the research develops.

Conclusions

Despite participants' views fluctuating over the course of the workshops, participants repeatedly returned to the core questions that were raised at the initial workshop: Why are we doing this? Who will benefit? Is it worth it? This can be partly explained by the complexity and uncertainties currently associated with nanotechnology. However, it also reflects a degree of cynicism about food technology more generally. This is related to assumptions that technological advances in food are developed in the interests of business rather than consumers, and that consumers ultimately bear the costs, either through increased food prices, lower quality produce, or reduced health.

In order for consumers to feel confident about nanotechnology developments it will therefore be important to anticipate and respond to these core governance questions. Specifically, this means that regulatory processes need to be seen in a wider system of food governance. While the public interest includes safety and environmental impacts, it also includes opening up the research at an earlier stage to ensure the values of consumers help to shape the direction of travel, and that wider consequences have been thought through. This will be challenging not only for the FSA, but for a range of actors involved in the development of food nanotechnologies – not least those in research, manufacturing and retail. If government's role is reduced to only regulating what's out there, it is unlikely to be sufficient to protect the consumer interest in relation to food. Greater scope for partnership working around novel foods such as nanotechnologies could help create a space for more anticipatory and effective governance.

1. Introduction

In December 2005, the Food Standards Agency (FSA) Board agreed to develop more creative and experimental ways of engaging directly with individual consumers and to construct a new model for consumer engagement. Central to this aim was the establishment of a nationwide series of consumer forums to enable the FSA to establish an ongoing dialogue with the public on food standards.

The forums provide the opportunity for the FSA to innovate in the way it makes decisions to protect public health and consumer interests in relation to food safety. In particular, the forums help to frame issues the FSA focuses on, and ultimately the advice its gives, from a consumer perspective. Specifically, the forums aim to:

- understand the "top of mind" concerns of UK consumers;
- develop deeper understanding about particular concerns that consumers have in relation to food;
- test FSA policy and ensure that the views of consumers are taken into account at all stages of the policy making process.

This report outlines findings from year four of the citizens' forums, exploring consumers' views about the use of nanotechnology in food and food packaging. The report examines people's reactions to potential applications of nanotechnology in food and food packaging, the sort of safeguards consumers expect the Agency to enforce, and the information consumers want so that they can make informed decisions.

1.1 Approach

The Citizens' Forums use a deliberative method which, at the start of the first workshop, starts by gathering data from participants providing only minimal background information as would be the case in any normal focus group. However during the sessions, expert witnesses provide context and in-depth information to the group, informing participants' discussions. Therefore the deliberative method gains a much deeper understanding of consumer attitudes than traditional focus group discussions.

The methodology for this research into nanotechnology and food involved a series of six workshops held in six locations across the UK, convened over three waves. Each

workshop comprised two groups of approximately 10 participants; discussions in each wave lasted two hours. The first wave of meetings focused on introducing participants to basic principles of nanotechnology in food; the second wave focused more specifically on potential applications of nanotechnology in food and food packaging; and the third wave explored issues around regulation and information.

Each group was moderated by an independent facilitator, and representatives from the FSA were on hand to answer questions and help clarify any areas of uncertainty. Stimulus materials and expert presentations were used to encourage discussion and provoke debate (see appendices 2-4). The findings were subject to a full analysis, which forms the basis for this report. A full methodology can be found in appendix 1.

1.2 Report outline

Following this introduction, the second section of this report explores participants' views about potential applications of nanotechnology in food and food packaging. Section three looks at reactions to the existing regulatory process and the sort of safeguards participants expect to be enforced. Section four considers the information participants want so that they can make informed decisions. Finally, section five draws the findings together to suggest implications for the FSA.

All quotations are verbatim, drawn from transcripts of the group discussions.

2. Views about nanotechnology

Participants' views about the use of nanotechnology in food and food packaging were explored in relation to various layers of information and deliberation. This took the form of initial reactions to basic information about the principle of using nanotechnology in food, more considered views about specific potential applications, and finally, broader reflections having explored issues of safety, regulation and consumer information.

This section draws together these views – firstly by outlining participants' core reactions to nanotechnology; secondly, by detailing reactions to specific applications; and finally by reflecting on what this tells us about the acceptability of using nanotechnology in food and food packaging.

2.1 Core reactions to nanotechnology

Prior to attending the citizen's forums, participants had little or no knowledge of what nanotechnology was or how it could be used in relation to food and food packaging. In anticipation of this, the first wave of workshops provided background information about the principle of nanotechnology and an outline of some potential applications in the food area (see appendix 2). Subsequent waves built on this information, with more details of potential applications and associated benefits and risks, detailing the existing regulatory process for introducing novel foods, and exploring ideas for consumer information (see appendices 3-4).

Immediate reactions to introductory information about nanotechnology revealed some initial excitement about the possible benefits, such as producing 'light' versions of traditionally unhealthy food without reducing the taste. However, concern was also expressed about any possible impacts on long-term health and the wider environment. By far the most typical reaction was to ask for more information. During the first wave of research a large number of questions were raised, including the following:

- ***Necessity*** – Why do we need to do this?
- ***Impact*** – How far will they go with it? Is it already used in food on the market? Will food really be healthier / safer? Will it affect the taste, price? Will it affect me personally? How?

- ***Understanding science*** – How is it done? What does the process involve?
- ***Safety*** – How do they ensure safety? Who does the testing? How long do they test for? How answerable will manufacturers be if something goes wrong? Do we know enough about the long term effects? How sustainable is the packaging?
- ***Funding*** – Who will fund the research? Who funds the commercial use of the technology?
- ***Information*** – Will the public be made aware that this technology is being used?

It was acknowledged that people tended to be dubious about any new developments in food, due to suspicions about 'tampering' with food. However, the apparent lack of evidence about specific (rather than potential) benefits or risks associated with nanotechnology prompted further uncertainty. Indeed, each new layer of information about nanotechnology typically provoked a new raft of questions from participants. These questions revealed a core focus on three broad issues: whether nanotechnology was a necessary development; whether it would be in consumers' interest or merely for industry gain; and whether the benefits were worth the risks (see figure below). Each of these issues is outlined in more detail below.

Why are we doing this?

Questions about the necessity of using nanotechnology related to a general sense that it could create more problems than it could resolve. For example, people acknowledged that developing foods with lower levels of fat, salt and sugar could help to stem societal health issues, such as obesity and high cholesterol levels. However, by making it more socially acceptable to indulge in what would traditionally

be seen as ‘unhealthy’ foods, participants were concerned that this would undermine understanding about what constitutes a healthy diet.

In light of this, and assumptions about the cost and risks associated with the technology, participants felt that resources would be better spent on promoting more ‘natural’ ways to achieve the desired outcomes. For example, by encouraging people to have a balanced diet or producing food that was naturally healthy.

Who’s it for?

Questions about whose interests would be served by nanotechnology were closely connected to views about necessity. Despite interest in some of the potential benefits for consumers (see section 2.2), participants repeatedly raised concerns about the rationale for the new technology. Specifically, participants were suspicious of the benefits retailers and manufacturers would reap from introducing nanofoods and food packaging, as these were perceived to be less apparent than those for consumers. Suspicions were fuelled by initial assumptions that many of the applications for nanotechnology would apparently result in consumers needing to buy fewer products, specifically products designed to extend shelf life and reduce waste. Therefore questions were raised around why food manufacturers and retailers were interested in using technology that could potentially lead to lower sales. This made some participants suspicious of whether there were ‘hidden agendas’ at play, and whether industry gain would be pursued to the detriment of consumer interests, for example by raising prices or providing lower quality or ‘risky’ products.

Is it worth it?

A third area of uncertainty for participants was whether the benefits associated with nanotechnology were worth the risks. In part, this reflected the two previous issues – whether the rationale for introducing nanotechnology made sense, and whether it was being done in the interests of the food industry rather than the interests of consumers. It also reflected a considerable focus on the perceived risks of nanotechnology.

A typical view at the start of the research was that uncertainties associated with nanotechnology, particularly in relation to possible long-term health impacts, had the potential to outweigh relatively intangible benefits for consumers. However, the

deliberative nature of the research meant that these views were challenged and reviewed repeatedly over the course of discussions. In particular, the risks and benefits associated with nanotechnology were explored in greater depth in relation to information about specific applications. Reactions to these potential applications form the focus of the following section.

2.2 Views about potential applications

In order to ground discussions and move beyond knee-jerk reactions, stimulus materials were used to outline potential nanotechnology applications in both food and food packaging. These were presented alongside information about associated benefits and risks (see appendix 3).

Possible applications in food

Participants were initially wary about applying nanotechnology directly to food; more so than towards food packaging (see section below). This reflected views about food technology more widely, which was typically seen as 'scary', 'unnatural', and deliberately hidden from consumers. There was a sense that food technology and processing was not being developed in the interests of consumers, despite some industry marketing claims, but rather to boost profits for the food industry. In light of these views, further engineering of food products tended to be viewed unfavourably. Added to this, specific concerns about nanotechnology were also raised, including unknown risks to health and the potential for engineered 'healthy' products to undermine messages about healthy eating and lifestyle.

However, after considering a number of potential applications, participants' views became more varied. Specifically, a range of responses were expressed towards applications participants believed would hold useful benefits, such as improving the health and wellbeing of society. Whereas reservations remained for those applications that were perceived to be less 'useful', either on a personal or societal level.

These and other variations are outlined below in relation to the following food applications:

- Lowering levels of salt / sugar / fat without affecting taste or texture

- Increasing the nutrient or vitamin content of foods
- Developing foods that allow the consumer to feel fuller
- Creating foods with new textures and flavours and developing novelty foods

Lowering levels of salt / sugar / fat without affecting taste or texture

Of all the food applications considered, lowering levels of salt, sugar or fat in foods was considered to be the most useful. On a personal level, participants who admitted to a fondness for foods high in these ingredients tended to see this application as a way to feel less guilty about eating products that were acknowledged to be 'bad' for them. These were typically female participants who were already trying to lose weight but wanted to continue to eat 'treat' foods like chocolate and crisps.

"Some of the foods I like... I probably would be interested in eating them, yes, because I want to be thin, so would go for it." (Female participant, Norwich)

Beyond personal gains, broader benefits were also identified. In particular, when participants spontaneously began thinking about the impact that issues such as obesity have on the NHS, and the potential that nanofoods could have on reducing these impacts, there was a greater sense that this technology could benefit society. However, this was tempered by views of some participants, who felt it was an individual's responsibility to eat a balanced and healthy diet and therefore using nanotechnology was at best complicating this message and at worst undermining personal responsibility.

Using nanotechnology to reduce levels of salt, sugar or fat was widely seen as relatively low risk (in the context of nanotechnology in food as a whole). Underpinning this was the idea that these ingredients were expected in food products and that engineering nanoparticles for this particular purpose would be merely an extension of what was already happening. More broadly, these views reflected a distinction between perceptions of 'hard' and 'soft' nanomaterials, with this application seen as falling under the latter. In this sense, it was considered relatively more acceptable to use nanotechnology to produce nanoparticles that would be digested in a 'normal'

way, rather than 'hard' engineered materials that would be insoluble and indigestible, with the potential to accumulate in the body and the environment.

In spite of this, views about this application were not wholly favourable. In particular, participants questioned whether there would be latent effects of lowering the levels of ingredients such as salt, sugar and fat, such as consumers eating more processed foods.

"If these kinds of foods were made to be healthier, people would eat too much of them and it would also take away the point of eating 'indulgent' foods". (Male participant, Edinburgh)

Whilst not a key concern for all participants (particularly in light of fears about safety, explored below), the use of nanotechnology to produce 'healthy' foods was felt to run counter to government campaigns and cultural shifts towards healthy eating. It was felt that the introduction of nanotechnology would undermine healthy eating campaigns, such as Change4Life and '5 a day', as well as widely held beliefs that a healthy diet should maximise unprocessed foods.

Increasing the nutrient or vitamin content of foods

Similar issues to those outlined above arose in relation to using nanotechnology to increase the nutrient or vitamin content of foods. In general, this was seen to be a useful application for groups who would otherwise miss out on essential nutrients, such as individuals on diets, allergies or conditions that prevented them from getting specific nutrients from existing foods. Participants also highlighted benefits for children and young people who were felt to have a greater need but lower interest in eating a healthy diet.

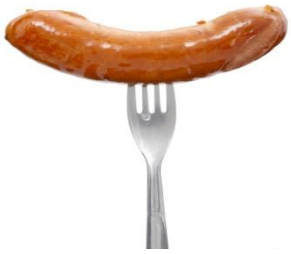
"Anything that increases the nutritional value of food I think is a great idea." (Male participant, Birmingham)

However, beyond these high need groups, views were more mixed about the value of this application. In particular, concerns were expressed about the potential cost of developing these products and whether this would result in further polarisation of diet between those who could or could not afford to buy them. There was also a sense

that this was a slightly paternalistic approach to food, unnecessarily complicating products and potentially undermining people's understanding of what constitutes a healthy diet.

As with lower fat / salt / sugar products, adding vitamins and nutrients to foodstuffs was not seen as a particularly new idea, with participants having purchased products such as fortified cereals or specific vitamin and mineral supplements. As such, there was a sense that using nanotechnology to this end would not be something novel or particularly concerning in terms of health risks.

Developing foods that allow the consumer to feel fuller



Mixed views were expressed by participants regarding this application. Whilst potential benefits were highlighted, on the whole these were associated with being more appropriate for other countries or unique circumstances, such as international disaster situations where food shortage was an issue.[1]

"I am quite interested because of the developing world... It would be quite handy if we... could feed more people, we could do more things. Certainly I know the army and all the services have dried foods which they obviously use technology to enable them to travel huge distances carrying a very small amount of food with them." (Male participant, Norwich)

Notwithstanding this, more immediate uses were also identified. For example, the idea that if this application was used in 'junk' food and confectionery on the UK market, it could result in people eating less of these types of food, leading to a healthier diet.

"We always go for a quick fix, don't we? So that means we are eating crisps with loads of salt on it, which is really bad for us, and until we feel full we continue to do so, don't we? If you had that on the market, to sort of make you feel more fuller plus with less salt, it would be ideal wouldn't it." (Female participant, London)

[1] Given that this application is primarily a diet tool, this perceived use perhaps reflects more general confusion about the potential benefits of some applications.

However, once again, a number of societal issues were raised by this application. As with the previous two applications, this was seen as complicating food and undermining people's understanding of what constitutes healthy eating. In particular, it was felt that this application could have potentially serious consequences for people susceptible to eating disorders, such as teenage girls.

"My only thing is how can you measure the way the sociological aspects of it, people's behaviour, in terms of you are getting food that makes you feel full, you can see young teenage girls, models and people who have problems with their weight, could be attracted by it and it could lead to problems in the future." (Male participant, London)

Creating foods with new textures and flavours and developing novelty foods

Participants were fairly consistent in their views that there was no need to create and develop new foods with different flavours and textures. Changing textures or flavourings, such as in the example of creating low-fat nanotextured mayonnaise to be as creamy as a full-fat alternative, was described as 'trivial' and 'unnecessary'. It was held that there were already products available on the market that allowed consumers to make choices between purchasing full or low-fat products and that there was no need to create further versions. This was despite views expressed earlier in the research that 'light' products tended to be less tasty than full fat / salt / sugar versions and that this was a considerable drawback to buying such products. However, this apparent contradiction is perhaps best understood in light of participants' focus on risks and unknown health impacts that underpinned much of the discussion on nanotechnology applications in food. This was despite relatively low risks associated with the 'soft' nanomaterials in this particular application, again illustrating general suspicion of using technology to 'tamper' with food.

These sentiments extended and peaked in relation to applying nanotechnology processes to create novelty products that changed their flavour or appearance. Participants believed that the only market these products would appeal to would be children and young people and that on the whole, parents would not be happy with their children consuming food that had unknown long-term consequences for health.

"Kids would probably go for it wouldn't they I imagine. The magic factor. That sounds really scary." (Male participant, London)

Furthermore, the production of these types of products was felt to lead to children and young people to believing that it is acceptable to manipulate the flavours of foods was also considered off-putting. Creating products such as drinks that could change flavour were unanimously viewed as being of very low benefit to consumers.

"If you want something with a different taste then you choose a different product or if you want something with a different colour you choose something with that colour...I just don't see the point..." (Male participant, Edinburgh)

Potential food packaging applications

On the whole, participants were relatively more open to and accepting of the idea of applying nanotechnology to food packaging rather than directly to food. For example, food packaging applications using nanomaterials for purposes of extending shelf-life and better preserving food or more accurately detecting when food begins to spoil, were generally viewed as useful applications. This was in spite of previously expressed concerns about the use of 'hard' nanomaterials (which tended to be associated with packaging applications), based on the view that insufficient research had been conducted into how these materials reacted with the body. This is perhaps explained by people's expectation and acceptance that technology would be used in food packaging and also a perception that consumers would not directly ingest these nanomaterials therefore reducing the perception of the risks associated with these applications.

"The majority of people will probably not think too hard about that [packaging], because we are not consuming it directly into our bodies. The safety aspect is not so obvious." (Female participant, Norwich)

However, concerns were still expressed about whether products would be tested to ensure nanomaterials could not migrate into the food. In addition, participants expressed a desire for further information about how environmentally friendly food packaging would be and whether it would be easily recyclable. This was of particular importance for participants who felt significant advances had been made in making food packaging more environmentally friendly in recent years. These advances would

be undermined if nanopackaging was more difficult to recycle or if nanomaterials were unintentionally released into the environment when a product was discarded.

"It seems as though they need to do more research into the packaging at the moment, to find out if nanoparticles are going to end up in the atmosphere, you know, or if on landfill if it is going to recycled it and is going to transform into food or whatever." (Female participant, Leeds)

Furthermore, it was also acknowledged that views on nanopackaging would, to a certain extent, depend on whether there were additional costs for the consumer. It was largely felt that the costs of additional technology in packaging should be absorbed by manufacturers and retailers and not passed onto consumers.

"But is that going to cost us more because of the technology that has gone into it? Are the prices going to rise?" (Female participant, Birmingham)

Views about the following packaging applications are outlined below:

- Extending shelf life and preserving foods
- Sensors detecting food spoilage

Extending shelf life and preserving foods

The idea that nanotechnology could be used to prolong and preserve foods was generally welcomed by participants. Waste was acknowledged to be a significant issue, both at an individual and societal level. Using nanotechnology to prevent waste was therefore viewed as appealing at both these levels:

For individuals, applying this technology to everyday fresh produce, such as milk, fruit and vegetables, would result in less household waste, which in turn, would save consumers money through not re-purchasing products. It could also preserve the taste and nutrients of fresh products, to some extent countering earlier concerns about the potential for nanotechnology to undermine healthy eating messages (see section on food applications above).

"I like the thing about being able to tell when something has deteriorated or not. I think it might stop people throwing food away unnecessarily." (Male participant, Leeds)

For society, the idea of preserving food to avoid waste appealed to people's sense that waste of any kind was inherently 'bad'. In particular, participants identified environmental benefits of reducing waste on a large scale, such as less landfill and less demand on food production.

As mentioned above, however, these assumed benefits were predicated on further research demonstrating that nanomaterials were not able to migrate from packaging into food or the environment when discarded.

While the groups tended to be relatively positive about these benefits, a degree of cynicism was voiced about who would ultimately benefit. Experiences of fresh produce that 'suddenly' went off as soon as it was opened at home prompted suspicion that technology was currently being used to preserve food beyond its natural limit, to the detriment of taste, quality and lifespan outside the supermarket. For some participants, this prompted suspicion that technological developments were primarily for the benefit of the food industry, in order to extend storage and haulage options, rather than to ensure freshness for consumers.

Sensors detecting food spoilage

Participants were initially uncertain about this application as they felt it could have the effect of 'dumbing down' consumers, by-passing their own senses to detect food spoilage and removing a direct connection with food. Furthermore, there was a sense that 'sell-by' and 'use-by' dates on food packaging already functioned as sufficient tools to reduce spoilage.

However, when participants undertook a 'homework' diary task, requiring them to identify how often they threw food away (see appendix 2), this application gained more support. There was greater recognition that this application could help to reduce unnecessary household food waste, particularly in respect of fresh fruit, vegetables, meat, fish and dairy products. These were most commonly wasted and it

was felt that sensors could reduce the amount of these products that were thrown away. Additional benefits were also recognised for people with sight or smell impairments.

"I buy pieces of chicken fillets and then you know, it's probably the sell by date [that I use to assess spoilage] and I am not quite sure so I throw it out. If it had a sensor saying that it is not off, I would feel more confident and I would cook it." (Female participant, London)

However, more significant benefits were associated with larger scale applications, such as catering in schools, hospitals and workplaces. In particular, participants who had suffered from food poisoning acknowledged that clearer indications of food spoilage would be beneficial to avoid contaminating food. This was further supported by one participant who had previous experience of inspecting food premises and welcomed the application of nanotechnology at this scale.

"I think the idea of the packaging is a good idea to show you when the food has gone off, because I used to do food inspections myself at food premises and every so often we used to do blitzes on who was keeping food that was out of date and it was a nightmare. If you got packaging that actually changed colour and showed it, I think it would be a fantastic idea." (Male participant, Birmingham)

Once again, it is important to note that any assumed benefits of this application were predicated on there being minimal impact on the environment or product prices.

2.3 Acceptability

In general, the perceived acceptability of introducing nanotechnology in food and food packaging reflected participants core reactions (see section 2.1) as these continued to influence their wider views throughout the research process. Yet, the focus on specific applications highlighted patterns and variations between participants' views, revealing differing levels of acceptability. These variations were most obviously highlighted by the following issues:

- Attitudes towards risks and benefits;
- Attitudes towards food production and food technology; and
- Confidence in authorities to be informative and transparent.

Attitudes towards risks and benefits

Participants' views about the acceptability of nanotechnology were dependent upon their attitudes towards the associated risks and benefits. The process of weighing up the risks and benefits appeared to be a highly personal calculation, resulting in variations between those who could be considered risk-averse and those who were more accepting of the inherent risks. For example, more risk conscious participants expressed a need for absolute confirmation that nanotechnology was safe before they would consider any potential benefits; whereas others were more accepting of the idea that new technologies inevitably have some degree of risk and that some benefits may outweigh these risks.

These feelings generally dictated overall views of nanotechnology, with applications perceived as 'low-risk' tending to be more acceptable. This perhaps explains why there was a greater acceptance of using nanotechnology in relation to packaging rather than to food itself, as the risks were perceived to be lower. As mentioned previously, this was in spite of the relatively higher risks of 'hard' nanomaterials associated with packaging applications, reflecting a tendency to accentuate risks of food applications and/or attenuate risks of packaging applications.

The degree to which benefits of using nanotechnology were traded off against risks often depended on an individual's circumstances and whether they could foresee any specific risks or benefits for themselves or their families. Participants with health conditions, such as being obese, having diabetes or being gluten intolerant, considered what applications of nanotechnology would mean for their condition and whether the benefits would outweigh the risks, or vice versa. For example, participants seeking to lose weight were more inclined to focus on the benefits of reducing the fat content of foods over the potential risks. Similarly, being on prescription medication, such as warfarin, resulted in participants being more concerned about how nanomaterials would interact with their medication and affect their wellbeing, over the benefits of having additional vitamins and nutrients within food. These trade offs were generally made in relation to personal circumstances, and to a lesser extent when thinking of other people in society with specific conditions. For example, in relation to how applications such as food making consumers feel fuller would impact on people with eating disorders.

"I think that would need to be controlled quite heavily, you get girls with anorexia and that, if they ate a lot of that that could cause them more problems." (Male participant, Norwich)

It is important to note that the potential long-term effect of nanotechnology on health was considered to be the most prominent risk overall, taking into account perceptions of risks in general and in relation to personal circumstances.

Attitude to food production and technology

Another issue affecting participants' acceptance of nanotechnology in food and food packaging arose in relation to their attitudes to food production and utilising technology in food more generally.

Typically, younger participants tended to be more accepting that technological processes were involved in food production, whilst older participants preferred to focus on ideals that food should be produced in the most 'natural' and organic way possible. As such, older participants tended to be less accepting of applying nanotechnology to food because of a sense that food should not rely on processing as much. This was not simply related to the risks of such processes, but also to the type of society that would be created through technologies – such as diminished personal responsibility for healthy eating and confusion about what constitutes a healthy diet.

Participants who resented the use of food technologies felt there were alternatives, such as investing more resources in either growing food naturally or educating people about the benefits of healthy eating that could be pursued instead. Lower acceptance of nanotechnology based on attitudes to food production often reflected the key questions that formed people's core reactions (see section 2.1).

Confidence in authorities to be informative and transparent

A further factor affecting participants' acceptance of nanotechnology centred on their level of confidence in authorities, such as the government and the food industry, to be as informative and transparent as possible about the risks and benefits associated with nanotechnology. It was felt that effective communication from industry and government was crucial to enabling consumers to make informed choices about

whether to purchase food products that had been manufactured using nanotechnology. Specifically, participants felt that the degree of acceptability they viewed nanotechnology with would also be contingent on their level of confidence in government and industry to oversee regulatory and safety processes and to provide information to consumers in a clear, transparent and accessible manner. These areas are considered in subsequent sections.

3. Safeguards

Across all workshops, participants raised concerns about the safety implications of using nanotechnology in food and food packaging. Typically these focused on the following areas:

- **Product testing**: How can they ensure that products are safe for me and my family? What kind of testing is undertaken, by whom, and for how long?
- **Uncertainty**: Do we know enough about the long-term effects? Or what happens if we consume high levels of nanomaterials? How much certainty is there amongst the scientific community about the impact of this technology?
- **Liability**: Who would be responsible if something goes wrong? How answerable will manufacturers be to government if a product subsequently proves to be dangerous?
- **Wider impacts**: Would wider impacts of this technology, such as on the environment or attitudes towards food, be taken into account before products are introduced?

In the final wave of workshops, FSA representatives presented information about the existing regulatory process governing the introduction of novel foods. The presentation covered the stages that a novel or new food would be subject to before being approved for sale in the EU (see appendix 4). Underpinning these stages was a time line that highlighted the length of time from a food being submitted for approval to it actually being approved. Reactions to this information were generally positive, with participants commenting on the apparent robustness of the process. In particular, participants valued the high level of priority and attention implied by the involvement of all EU member states.

"I didn't think it would go to the European level. I suppose that did quite shock me… in a good way." (Female participant, Birmingham)

Despite these views, a number of concerns were raised, focusing both on the regulatory process itself and issues that were felt to be beyond the scope of the process.

Concerns about the regulatory process

Uncertainties about the independence and rigour of **product testing** were significant concerns for participants. A general lack of trust in the integrity of manufacturers meant that reliance on their evidence dossiers, rather than independent testing, was not felt to be robust enough. Participants expressed a desire for the regulatory process to include independent testing of products.

"Of course their aim is to get [products] through, so how honest are they actually going to be? I mean, I know they're supposed to be but I wouldn't trust them." (Female participant, Norwich)

Participants also wanted more detail about the type of testing undertaken, such as whether this included reactions to medications, implications for people with specific health conditions, and whether the quantity consumed carried varying degrees of risk. Most crucially, participants wanted to know that any long-term health risks would be identified. Despite reassurances that the testing process accounted for long-term health implications, participants felt this would only be possible through extensive testing over long periods, such as 'from cradle to grave', and therefore current provisions were inadequate.

Reactions to the **length** of the regulatory process varied widely. Those who felt it was too short generally appeared to be confusing this evaluation stage with the length of product testing. Indeed, participants in Leeds and Birmingham were reassured when informed by FSA representatives that possibly four to five years of testing would have already been undertaken prior to the application being submitted for evaluation. For others, the length of the process seemed sufficient and implied relatively thorough consideration.

"I knew they would have standards and you know that things have to be checked, but it's the length of time that they take to approve something which is reassuring. It tells me that they are actually looking at it properly, it's not just something that's been rushed through." (Female participant, Birmingham)

The **evaluation criteria** used to assess applications was considered to be fairly narrow, potentially missing out areas of considerable concern for participants. These included possible environmental impacts, such as whether products could be recycled or whether their manufacture resulted in unwanted by-products or effluent, and issues of consumer interest, such as whether a product provided a substantial

benefit to consumers. It was unclear whether issues like these, which did not pose a direct safety risk to consumers, would be taken into account as part of the regulatory process.

In addition, participants expressed concerns about the **independence and reliability of decision-makers**. In particular, the possibility of majority voting by EU member states was felt to undermine the robustness of the process. This was due to assumptions about differing levels of expertise, standards, political differences and potential for corruption across member states and the view that a majority vote by countries with less stringent controls could undermine perceived high standards in the UK.

Connected to this point, fears were expressed about the power of manufacturers to manipulate the regulatory process and/or decision-makers in order to get approval for their products. Publicised scandals involving contaminated products, such as contaminated chicken carcasses being sold in the UK in 2000[2], were highlighted as evidence of the dubious motives of food manufacturers and their ability to by-pass regulatory processes.

Participant 1: *"Anything that anybody can make millions out of, they are going to be the winner."*

Participant 2: *"And if we are looking at this in real life, whatever business, whatever industry there's always going to be fraud."*

(Male participants, Leeds)

In order to have more confidence in regulation, participants called for greater transparency of the application and decision-making process, including the publication of all applications whether approved or not, together with on-going independent evaluation of regulatory committees in all member states.

Concerns about safety beyond the scope of the regulatory process

Irrespective of their views about the robustness of the regulatory process, participants identified a number of potential weaknesses in other areas that raised

[2] See Guardian article (22nd December 2000) *"Gang guilty of £2.5m rotten poultry scam"* - http://www.guardian.co.uk/uk/2000/dec/22/foodanddrink

safety concerns about introducing products containing nanomaterials on to the market. In particular, participants wanted to know what happened to a product once it had been approved. The apparent lack of any **follow up** monitoring once a product was on the market, such as regular safety reviews and updated testing, was a particular cause of concern.

Finally, participants wanted to know who would be **liable** should a product subsequently be found to be unsafe. Beef contaminated with BSE, Thalidomide, the *"tobacco industry cover-up"* and asbestos were all cited as examples where consumers had been told products were safe but were later revealed to be dangerous. A subsequent lack of confidence in messages about product safety prompted calls for greater accountability as this would provide reassurance that safety testing had been carried out responsibly and would also ensure recompense should something go wrong. Views on who this should be, included both manufacturers and government bodies (including the FSA). Participants wanted 'someone senior' in these bodies who would be personally held accountable for any errors.

"I think [the regulatory process] is good but the thing is… yes, there is doubts and basically if there is doubts who is going to sanction it when something goes wrong? Who is going to actually hold their hands up?" (Male participant, London)

Impact on views about nanotechnology in food

Overall, the regulatory process provided a degree of reassurance that measures were in place to safeguard consumers. This was broadly 'as expected', based on assumptions about relatively stringent controls in the UK. Further to this, added reassurance was provided by the involvement of all EU member states.

Yet in spite of this, the regulatory process (as presented during the workshops) did not appear to address some of the fundamental concerns participants articulated throughout the research – *why are we doing this?* and *what are the long-term health implications?* Lack of confidence in the testing process for long-term impacts and low confidence that manufacturers and decision-makers would act in the interest of consumers in the broadest sense (i.e. going beyond safety, requiring a genuine benefit to consumers) meant that even at its most stringent, the regulatory process could not overcome these remaining uncertainties.

Beyond the changes to the regulatory process outlined above, participants called for more information to enable consumers to decide for themselves whether they would buy products containing nanomaterials. Consumer information provides the focus of the following section.

4. Consumer information

Consumer information emerged spontaneously as a prerequisite for introducing food and food packaging containing nanomaterials. Regardless of how acceptable participants found the developments, some form of information was felt to be essential to ensure consumers were able to make their own decisions about whether to consume products containing nanomaterials.

"It's new technology to us as the consumers, so we need to have all of the information available to us… nothing held back, but like I said, we need to make an informed choice." (Female participant, Leeds)

Prior to any probing, the types of information that were suggested included:

- Dedicated websites
- Food labels
- Leaflets / stands / road shows
- TV infomercials
- National debate

According to participants, information in all these formats should be simple and accessible to all, providing multiple levels of detail to suit varying levels of interest. The types of information participants wanted to have available included what the ingredients were, why they had been added, the benefits and risks associated with those ingredients, as well as information about the tests conducted as part of the application process. Whether or not people chose to look into this information, it was felt to be important that it was publicly available for the sake of transparency and accountability.

Crucially, participants highlighted that a co-ordinated campaign, incorporating information, awareness building and education, was important to enable fully informed choices. While this broad approach was acknowledged to be extensive (and potentially expensive), it was felt to be warranted by the significance of food as a public issue, and that nanotechnology was perceived to be a significant development within this area.

"If it's something you're putting inside your body… you want to read about it don't you." (Female participant, Norwich)

Reactions to consumer information options

A number of consumer information options were explored with participants, including: food labelling; a register of approved products; information provided by manufacturers; and education and awareness-raising. Each of these is considered below.

4.1 Food labelling

Labelling products and packaging containing nanomaterials was considered a fundamental requirement, even though mixed views were expressed about the efficacy of labelling generally. It was acknowledged that it was largely down to individual preference as to whether people would read or act upon the label. However, specific characteristics of nanotechnology were felt to justify the need for labelling in this case. These included: the perception that nanomaterials were artificially produced; that this was considered a significant development in food technology; and that uncertainties remained about wider impacts, such as on long-term health, attitudes towards food, and the environment. Even those participants who were less concerned about the risks and uncertainties still suggested some form of labelling to ensure that manufacturers were being open and transparent about their food processes.

Information to be included on labels should be simple and straightforward. The label should be prominent, letting people know at a glance that the product contained nanomaterials. Whilst it was recognised that a conspicuous label could be off-putting to consumers, putting information in the ingredients list was generally viewed as hiding the information and therefore not sufficient.

A symbol, similar to the recycling logo, was suggested across many of the workshops. This would provide an instantly recognisable sign that could be applied consistently across all products containing nanomaterials. An added benefit of a symbol would be to avoid using more extensive

scientific language, including the phrase 'nanotechnology', which was felt to be unclear and 'daunting'.

"We've referred to the N again here and said for further information contact www or a free phone number… It's not too threatening but it's telling people to be aware that there's something in there." (Female participant, Norwich)

There was limited consideration about what type of nanomaterials should be labelled. In part, this was due to on-going confusion about definitions, such as the distinction between hard and soft, and engineered and natural nanomaterials; it was also due to remaining uncertainties about the potential risks and benefits of individual nanomaterials. Initially, participants tended to talk about nanomaterials in the collective singular, suggesting blanket labelling. However, upon further probing it was clear that particular concern was placed on hard or engineered nanomaterials due to their potential to accumulate within the body.

"Something that has been artificially produced then it has got to appear on the label." (Male participant, Leeds)

Ultimately, suggestions focused on consistent labelling of deliberately engineered nanomaterials, with some pushing for colour coding to indicate soft or hard nanomaterials or possibly a spectrum indicating the degree of risk or uncertainty. Variations also emerged between labelling of nanomaterials in food and food packaging, with the latter viewed as less of a priority for labelling.

In addition to a simple logo, suggestions for further information to be provided on products included:

- brief information about the purpose of the nanomaterial (e.g. barrier to prevent the entry of oxygen);
- a summary of the potential risks and uncertainties;
- nanomaterials to be listed in the ingredients (e.g. nanosalt);
- recommended daily intake based on safe consumption levels;
- links to further information.

With the exception of the final point, there was limited consistency about the extent of information that should be provided directly on products. This reflected people's

views about the efficacy of labelling more generally and assumptions about whether people would engage with the information.

In relation to links to further information, this was considered to be important in order to make labelling meaningful and useful. Raising awareness would be required to ensure labels were not overlooked or unnecessarily off-putting. In addition, further information would need to be easily accessible to provide varying degrees of detail and formats according to consumer preferences. One suggestion included adding a unique number for each product on to the label, which would link to other forms of information, such as a website, to provide more detail about that specific product.

"There is a limit to how much they can put on a label… It would be possible to, you know, put an N on the thing if nanotechnology was used, then if people were interested they could find out more about it." (Male participant, Norwich)

Mixed views were expressed about the perceived impact of labelling nanomaterials. As noted above, at a personal level some participants tended to be fairly dismissive of the impact of labelling. Reasons for not taking notice of labels included a reluctance to analyse their food, confusion about inconsistently presented and technical information, a realistic assessment of their propensity to read product labels whilst shopping, and an assumption that once a product has reached the shelves it should be safe and there was therefore no need for further information. However, exceptions to these views were expressed by a number of participants who were either well informed about food issues, had particular health concerns, or were suspicious of processed food and/or additives. These participants developed a habit of checking labels for specific ingredients.

Given this relatively limited propensity to read food labels, overwhelming support for labelling of nanomaterials therefore appeared to be based on the perceived uncertainties and risks associated with the technology. Specifically, labelling was seen as a tool for promoting transparency and accountability in an otherwise uncertain area. For example, while some concern was expressed that labelling would 'blow the risks out of proportion', more typically participants welcomed the potential for labelling to serve as a prompt to encourage consumers to do their own research into the issue, and also to keep manufacturers on their toes. This latter point assumed that consumer wariness would ensure manufacturers had thoroughly

weighed up the benefits and risks prior to including nanomaterials in their products and had communicated this effectively to consumers.

"If they are marketing it to say that there is a benefit to you and a benefit to your health in buying these products, then it's how they actually market it. They're obviously not going about it the right way if they don't [buy it]." (Female participant, Aberdeen)

Underpinning this view was the idea that labelling would prompt greater information and transparency about food processes in order to avoid unnecessarily alarming consumers. Participants felt that should the benefits prove to be substantial and the long-term risks reduced, then labelling could ultimately become a selling point. According to participants, in order for this to happen, consumers would have to feel they understood the issues involved and felt that developments were being pursued for positive reasons.

4.2 Register of current products

Connected to discussions about labelling, participants spontaneously raised the idea of a website that would provide follow up detail about nanomaterials included in products. This was later probed in terms of a register of products approved for the market by the European Food Safety Authority, one of the recommendations from the House of Lords review into nanotechnology and food.[3]

Views were fairly consistent in relation to what this source of information should provide – an up-to-date, easily accessible, online list of all products on the market containing nanomaterials. The level of subsequent detail provoked more mixed responses, including: information about benefits, risks and wider impacts, such as on the environment; links to EU dossiers detailing product applications; and details about companies working in these areas and their on-going research.

The key focus of discussions about a register was on who should provide the information. Primarily, participants wanted an independent body with no link to benefits or profit, who could provide neutral and objective information. In addition, it

[3] House of Lords Science and Technology Committee (2010) *Nanotechnologies and Food: 1st report of session 2009-10* (vol 1) London: The Stationery Office Limited

should be a well-known and respected official body, in order for consumers to feel able to trust the information. Government bodies, such as the FSA, were initially felt to be too close to food producers, potentially benefiting from investment and taxation. However, difficulty identifying plausible alternatives meant that the FSA was deemed the best body to provide this information.

"There has got to be, like, a site we can trust. I mean the Food Standards Authority would be okay for me at the moment." (Male participant, Norwich)

In terms of impact, a register would primarily reassure consumers that nothing was being hidden from them. This was irrespective of whether or not participants felt they would deliberately seek out and read this information. Indeed, as with labelling, participants were divided as to whether they would want to read this information. However, it was sufficient that the information was publicly available and participants felt reassured by the transparency this conferred.

4.3 Information provided by manufacturers

Participants were prompted about a possible option of requiring manufacturers to provide information about nanomaterials contained in their products; for example, providing a link to further information on the manufacturer's website.

Initial reactions to this idea once again highlighted a lack of trust in information provided by manufacturers. The assumption that manufacturers were solely driven by profit meant they would be expected to mislead consumers about the risks and benefits in the interests of short-term gain. However, if this information was regulated by government and/or consumer groups then it was felt to be more reliable and could also make manufacturers more accountable.

However, while this option was ultimately recognised as having certain benefits it was not considered sufficient as the only or main source of information on nanomaterials in food. Rather, some participants spontaneously suggested requiring manufacturers to pay into a central pot to fund other more independent sources of information.

4.4 Education and awareness-raising

As mentioned previously, participants outlined a broad consumer information approach that included an element of educating the public about nanotechnology and raising awareness of developments in this area. Education would act as a stimulus and background for people to engage with other forms of consumer information, such as labelling and a register of approved products. The complexity and assumed significance of nanotechnology meant that education was deemed necessary in order empower people to make informed decisions about what they consume. Indeed, some participants felt it was the government's responsibility to inform the public in as widespread a manner as possible given the assumed breadth of impact of nanotechnology.

Types of education and awareness-raising focused on mass media broadcasts, such as the Change4Life campaign and television programmes like 'Jimmy's Farm'. Getting a well-known and trusted celebrity to front a campaign would provide a credible image and help to ensure the widest possible audience.

"People like that have got a knack of sort of making complex processes watchable… that sort of publicity probably does a lot more than loads of leaflets and things like that." (Male participant, Norwich)

Crucially, this information should be provided before products are launched on to the market. This was deemed necessary both to avoid last minute scaremongering by the media, but also to involve the public in an on-going debate as the research develops.

Other suggestions for education and consumer information were wide ranging, including:

- Information points at supermarkets
- Public champions to spread the word
- Day-time television debates
- Documentaries exploring the research and manufacturing of nanotechnology in food
- An iPhone app to scan product codes for more information
- A nano section in the supermarket, similar to that for organic produce

The fundamental point throughout all these suggestions was that participants felt it was important to make information accessible to ensure that it got to as many people as possible. Ultimately, participants wanted to feel they were not being kept in the dark about what was considered a significant development in food technology.

"I think the more information they give us the more we'll trust them." (Female participant, Edinburgh)

5. Conclusions

Participants' views about nanotechnology and food developed over the course of the research. By the final workshop participants spontaneously debated complex information about the potential risks and benefits of nanotechnology in food and food packaging. In part, these discussions revealed varying degrees of acceptability of different applications, reflecting participants' differing attitudes towards the risks and benefits, and technology more generally, as well as their confidence in authorities to protect their interests (see section 2).

However, just as important was the direction of food technologies. Participants repeatedly returned to the core questions that were raised at the initial workshop: Why are we doing this? Who will benefit? Is it worth it? The fact that these questions persistently underpinned people's views can be partly explained by the complexity and uncertainties currently associated with nanotechnology. Indeed, relatively hypothetical discussions about *potential* risks and benefits associated with a breadth of applications, together with a lack of research about the potentially wide-ranging impacts inevitably affected people's confidence about the claims being linked with nanotechnology.

Perhaps of greater significance, however, is the fact that these questions seem to reflect a degree of cynicism about food technology more generally. Specifically, participants assumed that technological advances in food tended to be developed in the interests of business rather than consumers, and that consumers ultimately bore the costs, either through increased food prices, lower quality produce, or reduced health.

In order for consumers to feel confident about nanotechnology developments it will therefore be important to anticipate and respond to these core governance questions.

- **Why are we doing this?** To better understand the rationale behind developments in nanotechnology, participants wanted greater transparency and openness about decision-making, as well as wanting a say about the type of food we make and the societal consequences of doing so. In particular, participants wanted publicly available information about the motivations of those involved in its development, how the technology is

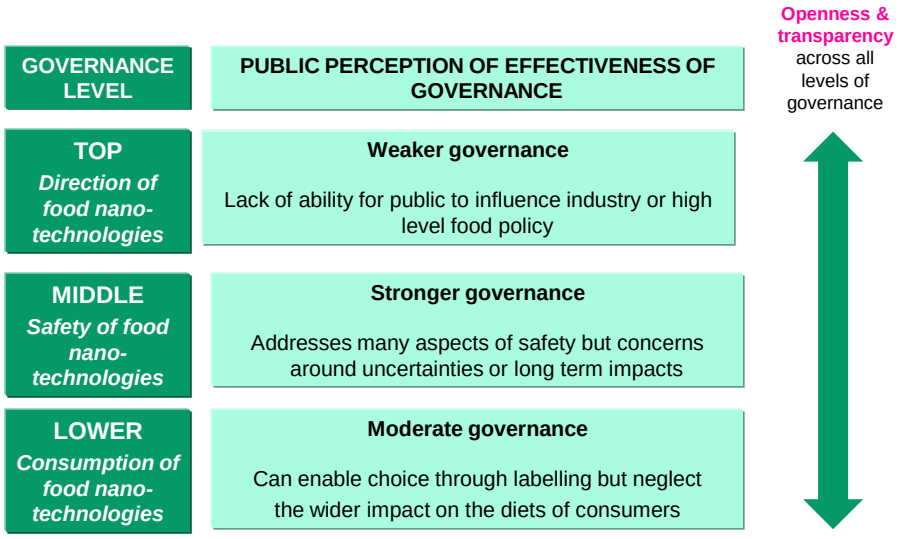
researched and regulated, and honesty about the uncertainties associated with the technology. Crucially, this openness was deemed necessary even if participants acknowledged that they were unlikely to review the information.

- **Who benefits?** Related to the above, acceptability of the various applications depended to a certain extent on whether they were felt to be in the interest of consumers, rather than for short-term profits for the food industry. As the food industry was viewed as being inherently self-interested, participants wanted government to act on behalf of the public interest. This went beyond ensuring consumer safety, for example by evaluating novel food applications against consumer interest criteria to ensure consumers will benefit from any new application.

- **Is it worth it?** Whether a product was deemed to be 'worth it' depended on the wider consequences of a technology and perceptions of personal risks and benefits. Participants wanted an enabling consumer governance framework in order to make their own decision about whether specific products were worth consuming. This went beyond labelling, to include consumer involvement, awareness and education, alongside publicly available technical information.

It is important to note here that consumer behaviour tends to be influenced by a wide range of factors, including but not restricted to individual choice based on informed decision-making (as implied above). Wider pressures, such as cost, novelty, social desirability, habits and social norms also play a part. To some extent this was acknowledged by participants, who suggested that once products were on supermarket shelves they were likely to become more 'normal' over time. However, a distinction was made between this 'passive' acceptance of products compared to a more considered judgement about the acceptability of nanotechnology. It was felt to be important that consumption of nanoproducts should not be taken as a 'green light' or be seen as widely embracing the use of the technology without the concerns raised throughout this report being properly addressed.

In relation to governance, participants' views appear to indicate three tiers of implications (see figure below):



- **Top level: *Direction of science and technology*** – As mentioned previously, technological advances were seen to be driven by industry in a fairly unstructured way. In order to feel more confident about these developments, stronger governance structures would be required to ensure industry motives were transparent. Further to this, incorporating an element of public interest at this level was deemed important to ensure that developments considered benefits for consumers rather than benefits purely for industry. This included suggestions for further public debate about the direction of technology in food and calls for transparency about future developments.

- **Middle level: *Safety of technology*** – In contrast to the perceived vagueness of top level governance, participants were generally reassured by the rigour of regulation processes. Institutional structures in this area tended to be stronger than, or at least as strong as, expected. Concerns centred on whether these structures were too narrowly focused on safety, ignoring less immediate issues, such as environmental or behavioural impacts. It was suggested that regulatory processes should incorporate a public interest component that would evaluate novel food applications against these broader issues.

- **Lower level: *Consumption of food technology*** – Governance at this level centred on providing information that would enable consumers to make informed choices. The complexity of nanotechnology meant that labelling was considered a necessary but not sufficient response, hence calls for wider approaches incorporating involvement, education and awareness-raising.

However, recognition that consumer behaviour is driven by wide-ranging factors, together with a desire for greater emphasis on consumer interest, imply a need for broader responses to the governance of consumption. Specifically, this needs to take into account any wider implications of nanoapplications, such as whether nanoproducts could change consumer behaviour and whether this would be a desirable outcome.

Overall, regulatory processes need to be seen in a wider system of food governance. While the public interest includes safety and environmental impacts, it also includes opening up the research at an earlier stage to ensure the values of consumers help to shape the direction of travel and wider consequences have been thought through. This will be challenging not only for the FSA, but for a range of actors involved in the development of food nanotechnologies - not least those in research, manufacturing and retail. If government's role is reduced to only regulating what's out there, it is unlikely to be sufficient to protect the consumer interest in relation to food. Greater scope for partnership working around novel foods such as nanotechnologies could help create a space for more anticipatory and effective governance.

Technical appendix

Qualitative research

Client	• Food Standards Agency
Conducted by	• BMRB Ltd
Objectives	• FSA want to understand the consumer view of nanotechnology being used in food, the sort of safeguards they expect the Agency to enforce and the information on nanotechnology they want so that they can make informed decisions.
Universe	• Consumers (general public)
Sample size	• 12 groups; approximately 10 people per group
Fieldwork period	• November 2010 – February 2011
Method	• Group discussions over three reconvened waves
Recruitment	• Free-find
Incentives	• £40 wave 1; £45 wave 2; £55 wave 3
Interviewers	• Seven moderators
Questionnaire	• Included in appendices
Analysis	• Please note that the results of this qualitative research are indicative and cannot be projected onto the overall population.