Connect4Action Strategies for improving communication between social and consumer scientists, food technology developers and consumers

SEVENTH FRAMEWORK PROGRAMME

Theme: Food, Agriculture and Fisheries, and Biotechnology

The Connect4Action Delphi study: Report of the Round 1 outcomes

WP3

Date

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Project Objective

The objective of the CONNECT4ACTION project is to improve communication between consumers, consumer scientists, food technology developers, and other key players in the food technology development and commercialisation process. Focusing on communication and knowledge exchange between food technologists and consumer scientists, the results of the CONNECT4ACTION project will contribute to improvement of the multidisciplinary dialogue and to increase consumer acceptance of new food products, thereby lower the failure rate of new (food) technologies in Europe.

A large group of stakeholders (food scientists and technologists from companies, universities and research institutes, together with consumer scientists, ethical experts, representatives of science media/journalist, and consumers) will be connected with the project and each other via the online CONNECT4ACTION community. This online community strengthens the project with input and feedback during various stages and serves as showcase of improved communication.

Based on effective communication strategies identified in the relevant literatures and, subsequently, opinions of experts based on their daily practices and experiences, this project will deliver an improved communication framework, accompanied by tools and training materials that enable food technology developers and other key players to step-by-step improve their food technology development processes.

This FP7 experienced consortium, consisting of a broad, multidisciplinary network of key players that are involved in food technology development and commercialisation, has the expertise and experience from the field to disseminate and successfully implement innovative communication strategies into daily life activities. Dissemination of project outcomes receives great attention, even after the project is finished. Finally, the networking effort of CONNECT4ACTION will result in a strengthened European cooperation between public and private stakeholders.

Deliverable 3.2 Short Summary
This deliverable reports on a first round Delphi survey conducted in autumn 2012. The survey asks participants 'to articulate key priorities, preferences and identify perceived barriers to inclusion of consumer science data regarding technology acceptance into product development' (DoW, p22). In all 75 usable responses were received to an on-line questionnaire.
The survey identified three critical points of communication which influence whether commercialisation is successful: 1. Communication with consumers to determine their preferences so that products produced using a new food technology will be developed and purchased by them. 2. Communication with consumers to inform them about new food technologies to prevent subsequent rejection of resultant products. 3. Communication between actors in the chain extending from technology development to retail. The main communication difficulty results from inter-disciplinary differences, as key actors have different goals, different mind-sets, use different methods and terminology, and may have a low awareness of what others try to do.

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1. Executive summary

This deliverable reports on the administration and findings from a first round Delphi survey conducted in autumn 2012. The survey asks participants 'to articulate key priorities, preferences and identify perceived barriers to inclusion of consumer science data regarding technology acceptance into product development' (DoW, p22).

The sampling frame consisted of members of the Connect4Action (C4A) community boosted by relevant contacts of C4A consortium members. An on-line questionnaire was administered in September-October 2012 and, after one follow-up contact, 75 usable responses were finally received. Over two thirds of respondents had experience in developing new food products. The sample has a bias towards academics and other researchers who comprise 59% of the total sample. However the split between consumer scientists (CS) and food technologists (FT), and geographical distribution are much more even.

●Contextual questions found consensus that development of new food technologies is important to enhance European competitiveness in the agri-food sector, and that communication between key actors along the process of food technology development is important to avoid commercial failure.

●The survey identified three critical points of communication which influence whether commercialisation is successful:

1. Communication with consumers to determine their preferences so that products produced using a new food technology will be developed and purchased by them. However acquiring such information can be problematic due to the different rates at which FTD occurs and consumer preferences change, and the difficulty of detecting the potential of new products using existing CS methods. In practice, it was widely believed that development is driven more by technological advances than by consumer preferences.
The way forward lies in early engagement with consumers, before technological development starts. One way might be to embed consumer opinion in the development process through collaborative innovation.

2. Communication with consumers to inform them about new food technologies to prevent subsequent rejection of resultant products. The barrier here is the difficulty for the non-specialist citizen in acquiring, understanding and evaluating information about the process. Acceptance of the product is more likely if communication is transparent, comprehensible and trustworthy, and

available before product launch to prepare consumers. Information that is apparently biased, or hides 'bad news' or uncertainties is counter-productive. There may also be a need to pre-empt or counter myths or misrepresentation by, for example, some NGOs or the media.

3. Communication between actors in the chain extending from technology development to retail. This is probably easier if most necessary skills are concentrated in a single large company. Although attention was focused on FTs and CSs, there are other key actors including consumer 'gatekeepers' who mediate consumer preferences.

● Communication problems exist between key actors and can even determine commercial failure. The main communication difficulty results from inter-disciplinary differences, as key actors have different goals, different mind-sets, use different methods and terminology, and may have a low awareness of what others try to do. Furthermore, communication may not be seen as a core task and is under-resourced. Examples of more specific consequences of poor communication between CSs and FTs include the delivery by CSs of information that does not meet FTs' requirements, and a failure by FTs to understand the significance of the CS information provided or to utilise it effectively.

● Improved flows of knowledge could be obtained by establishing inclusive multi-disciplinary teams and promoting dialogue and understanding of each other's disciplines, establishing a shared vision, and having clear objectives that fit with the goals and priorities of all parties. Intermediaries or facilitators could be instrumental in promoting inter-disciplinary dialogue.

●Adoption of new technology by end-users of the technology (e.g. food manufacturers) will also be important.

● Altogether this summary presents a negative picture of communication. However, some respondents reported that effective inter-disciplinary work *does* occur, and is achieved by working in multi-disciplinary teams, and by establishing good working relationships between individuals from different disciplines who have developed a good mutual understanding of each other's work.

2. Introduction

This report presents the main outputs from the first round questionnaire of a Delphi study which was administered during late September and mid-October 2012.
As stated in the Description of Work (DoW) for Connect4Action, the principal objective of Work Package (WP) 3 is:

'To **identify barriers and critical factors which prevent effective communication between key actors**, policy-makers, stakeholders and end-users in the process of food technology development and commercialisation.'

Together with 2 subsequent activities, namely a second round Delphi questionnaire (Task 3.3) and an online forum discussion (Task 3.4), WP3 also addresses the following four sub-objectives:

i. To **identify barriers and critical points of communication** at the three stages of food technology development. (See Section 3 for an explanation of the 3 stages.)
ii. To identify **what consumer science information is needed by food technologists** to optimise the development of **actionable activities salient** to new technologies and food product development.
iii. To identify **whether food technologists are articulating questions which can be answered** by consumer science research.
iv. To collate stakeholder and expert views **regarding the development of a strategy** for the development of an effective dialogue with all key stakeholders, including consumers.

In addition the results of the Delphi study relating to communication and dialogue needs provide an input to Task 4.1, the development of a framework for internal and external dialogue at the 3 different stages of the innovation process. To this end the Delphi study **will elucidate success factors and barriers (key priorities for improved communication**).

3. The Delphi technique

3.1 Introduction

The Delphi technique is a widely used research tool, practised with many variants, used for developing understanding or problem solving within a particular field (Powell, 2003, Hasson & Keeney 2011, Mullen, 2003). It is used where there is a lack of objective data by drawing on, and sharing, the knowledge and experience of experts (Fink et al 1991, cited in Powell, 2003). In their seminal book Linstone and Turoff (1975) provide a broad description:

'Delphi may be characterised as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem.'

Rowe and Wright (1999) identify 4 key features of a Delphi study: participation is anonymous, data collection proceeds iteratively in a number of rounds, controlled feedback is provided to participants of the results of each round; and at the end of the process group response is statistically aggregated. Broadly the procedure followed is that a group of experts in the subject of research (the 'panel') are recruited to the study. Data collection is by means of pen and paper or on-line questionnaires which panel members are asked to complete. After each round, the results are collated and communicated as feedback to participants, though without disclosing the identity of individual contributors, and a further questionnaire is administered. The number of rounds will depend on some pre-defined stopping criterion. It is generally found that opinions will converge as the number of rounds increases.

Pros

As Rowe et al (1991) explain, 'The Delphi technique aims to make use of the positive attributes of interacting groups while removing the negative aspects largely attributed to the social difficulties within such groups'. Negative aspects of groups include the effects of power, status, strong personalities and group pressure which can cause individuals to be reluctant to express their views or to change a previously expressed view (due to face-saving), (Mullen, 2003) and also 'social loafing' (exerting less effort than when working alone). By contrast, in a Delphi study, because there is only written, anonymous communication, each participant has an equal chance to present their ideas, unbiased by the identities of others. Positive aspects of interactive group working such as the exchange of knowledge and ideas, and the stimulation of synergies are provided in the Delphi technique through the provision of controlled feedback. Indeed, the method can lead to more accurate judgements and forecasts than interacting groups (Rowe and Wright, 1999). On the other hand there is a lack of accountability to individuals for their responses (Mullen, 2003).

In addition, the Delphi method makes possible the interaction of geographically dispersed experts (different continents, different time zones) for which face-to-face or telephone/internet meetings

are difficult to arrange. This confers the capability to include a wider range of experts than would otherwise be possible (Wentholt et al, 2010).

Cons

In common with other social research methods, a number of biases can be introduced into any Delphi study, although they can be minimised with careful technique. These can result from many sources including: poor wording of questions; selection bias with regard to experts; researcher bias resulting in partiality when selecting questions and providing feedback; and changes in the panel size and composition due to dropping out between rounds (attrition).

A much more intransigent problem is the inability so far to establish the scientific rigour of the Delphi technique (Hasson and Keeney, 2011). Rowe and Wright (1999) identify the 'lack of control of important group, task, and technique characteristics' as a barrier to assessing its effectiveness.

Types of Delphi

There are many variations on the basic Delphi technique (see Mullen, 2003). Its first uses ('Classical Delphi') were as a tool for decision-making in the field of technological forecasting among homogeneous groups of experts (Turoff, 1975). Characteristically the output sought was a stable collective estimate of quantitative values (Van Zolingen & Klaassen, 2003). The principle variant, the policy Delphi, was developed in the 1970s as an instrument for policy development. Rather than attempting to achieve stability, it aims to clarify divergent views among experts and elucidate arguments (Van Zolingen & Klaassen, 2003), and generate ideas, commentary and evaluation (Padel & Midmore, 2005).

3.2 Methodological issues

In designing the Delphi instrument, a number of issues must be addressed.

a. Recruitment of experts

Although Delphi studies usually recruit individuals who have very specific high-level expertise, others may recruit anyone with relevant knowledge and experience. Depending on the research question, the panel may all belong to a single discipline; alternatively a very broad range of experts may be necessary. Van Zolingen and Klaassen (2003) suggest that a heterogeneous panel may require the construction of several, partly different questionnaires so that all are presented with questions within their field of ability. Purposive sampling is generally employed as representative sampling techniques are inappropriate because of the need to pin-point experts with particular skills. Panel size varies, with Cantrill et al reporting between 4 to 3000, depending on the study's purpose.

b. Constructing the first round questionnaire

To identify the issues and scope of the first round questions a comprehensive literature review may be used. However, this approach has been criticised as being too narrow, and insufficiently open to the most recent ideas, knowledge and developments, which may be known to panellists (e.g. Van Zolingen and Klaassen, 2003, Franklin & Hart, 2007). As all future rounds are built upon it, this will bias the study's eventual outcome. It is therefore common to have some sort of brain-storming activity to identify all salient topics and questions to ensure that no key area is omitted in the first round questionnaire. This may be done by means of an expert workshop, by interviewing participants, or by a preliminary unstructured questionnaire requiring a narrative response, to which content analysis is then applied (e.g. Padel & Midmore, 2005).

c. Feedback.

As already described, responses from each round are collated, summarised and subsequently fed back anonymously to participants, along with a further questionnaire. It is by this means that the knowledge of individuals is shared with the whole group, and that participants are alerted to the complexity of issues, persuaded to think, and have their own assumptions challenged (Coates 1975 cited by Linstone & Turoff, 2011). In the light of the feedback received participants may revise their opinions.
In the Classical Delphi, used for forecasting, participants are typically asked to provide quantitative data (e.g. estimates of values) and the underlying reasons for their answers. Feedback for quantitative responses usually consists of measures of central tendency and dispersion accompanied by the main arguments in support of the values articulated. More qualitative studies will also generate quantitative feedback (for example scoring on Likert scales) as well as the main related arguments.

d. The second and subsequent round questionnaires

Most simply, and especially for Classical Delphi, this will be the same as in the previous round. Respondents will be provided with their own responses, as well as those of the group, and allowed to modify their answer in light of the group opinion and the main supporting arguments presented. The second round of a Policy Delphi typically consists of structured questions based on the key issues and arguments articulated in the previous round (e.g. Padel & Midmore, 2005).

e. Consensus

As in a face-to-face meeting, it is expected that the opinions of experts will be modified during the Delphi process. Experience shows that responses converge as the rounds progress. Although gaining consensus is often reported as the aim of Delphi studies, Linstone & Turoff (2011) explicitly highlight this as a misperception:
'…. as a reviewer of TFSC it has often been necessary to correct the mistaken impression that the aim of Delphi is consensus. Our 1975 book clearly states that Delphi is "a method for structuring a group communication process", not a method aimed to produce consensus. The number of rounds should be based on when stability is attained, not when consensus is achieved'.
The Delphi study can be used to explore and understand the range of final positions and their underlying rationale, and to explore disagreements (part from Mullen, 2003)

f. Number of rounds and attrition

Franklin and Hart (2007) argue that a policy Delphi should consist of at least 4 rounds of questionnaires to achieve stability. However, most commonly there are 2 or 3 rounds. Prolongation beyond that runs the risk of unacceptable attrition rates that will undermine the validity of the final group position.

4. Method

Questionnaire design
As set out under Tasks 3.1 and 3.2 in the DoW, a first-round questionnaire was developed by project partners from UNIBO, UNEW and DLO. The information sought by the questionnaire is summarised in the DoW (p22):
'In round 1, participants will be asked to articulate key priorities, preferences and perceived barriers to inclusion of consumer science data regarding technology acceptance into product development.'

The questionnaire incorporated material generated from a Consortium discussion held during the Connect4Action Consortium meeting in January 2012 (Task 3.1), and themes identified in relevant academic literature. A draft questionnaire was reviewed by expert Consortium members from TNO and ICC and subsequently revised. The final questionnaire appears as Appendix 1 and is structured in 3 sections:

Part 1 includes four broad contextual questions which address: the role of new food technologies in enhancing competitiveness; the determinants of the commercial success or failure of new food

technologies; the importance for communication between key actors to avoid commercial failure, and the identification of critical communication problems.

Part 2 contained a series of 11 questions, each consisting of a statement followed by a closed-choice question ('Do you Agree with the statement/Disagree/No opinion?') and a request for respondents to explain their answer. These questions, which incorporated items recognised as bottlenecks in the literature, related to three key stages in the food technology development and commercialisation process, namely:

1. Generation of market information concerning consumer needs and preferences, and exogenous factors which influence them. (Questions a and b)

2. Dissemination of this market information by means of internal communication between the key actors in the technological development and commercialisation process. (Questions c, d, f, g, h)

3. The response by the key actors to the market information that has been generated (concerning consumer preferences). (Questions e, i, j,k)

Part 3 sought classification information including age, country, gender, job , sector, and experience in developing new food products. As explained in the DoW (p22), '*Segmentation of the data across different expertise groups will allow identification of priorities of food technologists, consumer scientists, and other key stakeholder groups.'*

The questions were preceded by a message from project partners which explained the purpose and modus operandi for the Delphi study, contained assurances of the anonymity of responses, and expressed thanks to participants for their contribution.

Identifying participants

As explained in Section 2, purposive sampling is usually employed in Delphi studies. It was envisaged that the sample for the C4A Delphi study would be drawn from an online community of stakeholders established specially for the project, as described under Task 1.1, and consisting of food technologists, product developers, consumer scientists *inter alia*, across various sectors (e.g. industry, universities/research institutes, the media and NGOs) from around Europe. For the C4A Delphi study, the intention was to administer the questionnaire to approximately 400 members of this community.

However, due to a lower-then-expected recruitment to the community, the total number of stakeholders identified by WP1 was 123. Therefore, in anticipation of non-response lowering the final sample size still further, steps were taken to boost the number of contacts. Consequently project members were asked to identify individuals from amongst their personal contacts outside academia for inclusion in the study. This yielded a further 233 names excluding non-contactable e-mail addresses (see Table 3.1). 'Targeted Contacts' were individuals known to have interests

and/or experience specifically relevant to the study whereas 'Untargeted Contacts' were drawn from more wide-ranging contact lists.

Table 4.1: Round 1 Delphi study: Response rate

Source of contacts	Sent out	Completed usable questionnaires, total	Response %
C4A community, registration complete	53	17	32.1
C4A community, registration incomplete	70	15	21.4
Targeted Contacts	42	13	30.9
Untargeted Contacts	188	27	14.3
Unknown source*	3	3	100.0
Total	**356**	**75**	**21.1**

* May have been delegated the task by the named contact; alternatively may have 'found' the project website independently.

Having only incomplete information available for sample stratification, the questionnaire was sent to all 356 individuals.

Administering the Delphi questionnaire

Data collection took place between mid-September and late-October 2012. The questionnaire was available for completion on-line, at the C4A website. C4A Community members and Targeted Contacts were contacted with a personalised e-mail, and Untargeted Contacts with a non-personalised message explaining the purpose and format of the study, and requesting them to complete the questionnaire. A reminder was sent after 3 weeks, and the database was closed 2 weeks after the deadline. The questionnaire was also available in Italian (in paper format), and stakeholders were advised that they could respond in English, Italian, Spanish or Portuguese', and that a paper version was also available on request.

Responses submitted on-line were automatically tabulated in an Excel spreadsheet downloadable by the survey manager. Data were entered manually for six returns made as Word documents. Translation from Italian and Spanish was necessary for 2 returns. In all 83 responses were received, of which 8 contained limited or no information, yielding a total of 75 usable responses. However this included a few incomplete responses, in particular there was a failure by some respondents to provide explanations for all their closed-choice responses to questions in Part 2.

5. Respondent characteristics

The composition of the final sample is shown in Tables 4.1 to 4.3. Table 4.1 shows a bias towards academia and other researchers (employed in: government research; food industry; government institution, or as contract / freelance researchers) who comprise 59% of the sample.

Table 5.1: Composition of sample

	Interest						
Sector	Consumer or social scientist (CS)	CS and other	Food technologist (FT)	FT and other	CST and FT	Other	**Total**
Primary production	1		1			1	**3**
Food industry							
SME	1		2		1		**4**
Large	2		1	1	1	1	**6**
Multinational			2	1			**3**
Other (ref 13)					1		**1**
Academia/ research centre*	10	0	12	2	6	12	**44**
Regulation/ Government	1	2				3	**6**
NGO					1		**1**
Media							**0**
Other	2	1	2			2	**5**
Missing	1				1		**2**
Total	**18**	**3**	**20**	**4**	**11**	**19**	**75**

There is an almost even split between Consumer Scientists and Food Technologists. One quarter of respondents indicated their interest as being neither CS or FT, and are classified as 'Other'. This group contains several respondents with a professional interest in food safety. In the following sections, 'Consumer or social scientist' and 'CS and Other' are amalgamated into a single group, 'CS'. 'Food technologists' and 'FT and Other' are amalgamated into a single group, 'FT'.

Table 4.2 shows that 55% of respondents are male and that geographical coverage includes all the main areas of Europe, including some non-member states. The mean age of respondents was 45 years (minimum 25; maximum 65) and the mean years of experience was 18 (minimum 3; maximum 40).

Table 5.2: Place of residence by country grouping and gender

Country	Females	Males	**Total**
Central/Eastern Europe	8	5	**13**
Northern Europe	13	17	**30**
Southern Europe*	12	17	**29**
Rest of World	1	2	**3**
Total	**34**	**41**	**75**

*includes France (2 males; 0 females)

Experience and inter-disciplinary working

Altogether, 51 respondents (68%) reported experience in developing new food products. Of these, 34 had worked as part of a food technology team, including 12 of the 13 food industry respondents. Out of the 75 respondents, 29 had cross-disciplinary experience: 6 social/consumer scientists had worked with Food Technologists; 12 Food Technologists had worked with Consumer Scientists, and 11 respondents had cross-disciplinary skills, their stated interests including both consumer science and food technology.

Table 5.3: Respondents with experience in developing new food products by sector and interests

Sector			Interest	
Academia / Research	29		Consumer or social science	11
Food industry	13		Food technology	23
Primary production	3		CS and FT	11
Regulation / government	1		Other	6
Other	5			
Total	51			51

A very high proportion of Food technologists had development experience (96%) compared to just over half of consumer scientists.

6. Analysis

6.1 Introduction

A simple numerical analysis of closed-choice questions was performed to identify the degree of agreement or disagreement with each statement. A thematic analysis of the associated explanatory comments was also conducted.

The dataset was characterised by the diverse range of responses received for each question, and their distribution throughout the sample. In particular, segmentation did not reveal any consistent differences between the responses of those from the food industry or academia/research (the 2 largest sectoral groupings) or between food technologists (FT) and consumer scientists (CS) (the biggest interest groupings).

The most useful segmentation was between those with / without experience of developing new food products. The so-called 'Experienced' respondents are defined as having been professionally involved with developing new food products, and were identified by having answered 'Yes' to one or more of the following questions in Section 3 of the questionnaire:

i. I have been involved in developing new food products

ii. I work or have worked as part of a food technology team developing new food products

iii. I have worked with Natural Scientists in developing new food products

iv. I have worked with Social and/or Consumer Scientists in developing new food products

As shown in Table 4.3, 45% (23/51) of 'Experienced' respondents are Food technologists. Segmentation by Question ii alone (experience of working on a food technology team) was occasionally illuminating, although this group is also dominated numerically by food technologists (18) followed by those with interests in both FT and CS (8), CS (5) and 'Other' (3).

Food industry respondents are also identified occasionally in the analysis. This is a small group (n=12) again dominated numerically by FTs (6) followed by CSs (3), then interests in both FT and CS (2), and finally 'Other' (1).

Also noteworthy is the relatively high proportion of 'No opinion' responses obtained: indeed for some questions it is actually the commonest response. A possible interpretation is that in the absence of a 'Don't know' option, 'No opinion' conflates the two responses 'Neither agree or disagree' and 'Don't know'.

A small number of answers to some questions are missing ('No answer'), and consequently some tables show less than 75 responses. When calculating percentages for each question's responses,

the denominator excludes 'No answer' responses (i.e. is <75 for some questions) but includes 'No opinion' responses.

Although not a necessary outcome (see Section 2.2e) an important concept in Delphi studies is that of consensus. For this study, consensus was defined as the situation where 80% of respondents who answered a particular question gave the same answer. Also of interest is whether there are disputes or controversies. These were defined as occurring where opposing answers to an individual question (Yes/No, or Agree/Disagree) are each chosen by at least 20% of respondents.

6.2 Part 1 questions

Part 1 contained 4 contextualisation questions.

Q1a. Is the development of new food technologies important to enhance European competitiveness in the agri-food sector?

Table 6.1: Response to Part 1 Question 1a.

Response	Frequency	Percentage*
Yes	71	97.3
No	1	1.4
No opinion	1	1.4
Total	73	100.1

* Totals do not sum to 100.0 due to rounding

There was almost unanimous agreement with this statement and a number of explanations are provided in respondents' comments. As a generality, innovation is necessary to be competitive. The development of new food technologies was capable of enhancing European competitiveness in a number of ways: by making production more efficient by decreasing costs and increasing the value-added obtainable from inputs; by providing products with improvements to attributes valued by consumers such as nutrient or health properties, and safety and hygiene (such as longer shelf life); and by meeting changing consumer tastes, for example for simple, quick-to-prepare and healthy food.

There was a need for Europe to respond to the strong competition from other continents and not be left behind. The EU was better placed to fight on the basis of knowledge-intensity rather than its endowments of natural resources. It was important for the EU to assess the potential of new technology and not leave it to the rest of the world.

Various challenges could be met by new technology. It could help make production methods more sustainable by lowering their energy and/or water requirements, and contribute to efforts to secure long term world food security in the face of climate change and population growth.

Q1b. List the factors which you consider most relevant to determine the commercial success or failure of new food technologies

If there is any factor which is specific only to either success or failure, please state this

The majority of factors mentioned by respondents related to consumer acceptance of new food technologies. Many respondents commented on product attributes and their appeal and acceptability to consumers, for example price, quality, convenience, healthiness, appearance, safety and ethical issues. The need for the product was also mentioned – whether it provided the solution to a real problem and was better than any existing alternatives, and whether the benefits were proven. Consumer tastes were considered by some to change fairly quickly, and so the time taken to reach market could be critical.

Hence, communication with consumers was important and could be used to understand the needs of (target) consumers. Furthermore communication was necessary to provide understandable information to consumers about the technological process, and to overcome any fears (e.g. about risk). Early communication, transparency and the establishment of trust supported success, whereas a background of techno-scientific disputes would have a negative effect. Labelling was helpful

Other factors mentioned by respondents related to the supply chain. Poor communication between scientists and producers would result in failure. An acceptable distribution of income along the supply chain – so all the main actors would benefit – was necessary. The price of adopting the new technology (return on capital investment) by manufacturers, and the time before a positive return was made would determine whether they would adopt the technology. The feasibility would partly be related to the 'fit' with a company's current configuration. The availability of professional expertise to run the processes in food production plants would also be crucial.

Acceptance of the products by key decision-makers in the retail sector was critical to success, as were good marketing strategies and sales development activity.

Q1c. In your opinion, is communication between key actors (food technologists, consumer scientists, consumers, policy makers, etc.) along the process of food technology development important to avoid commercial failure?

In all, over 90% of respondents agreed with this statement, although communication was only one of a number of success factors. Communication was necessary to understand consumer needs and demands and consequently secure relevant and improved final products.

Table 6.2: Response to Part 1 Question 1c.

Response	Frequency	Percentage
Yes	66	91.7
No	2	2.7
No opinion	4	5.6
Total	72	100.0

It was considered difficult to develop a successful new product without constructive contact occurring between the key actors. Good communication achieves integration of their work, avoids misunderstandings, and ensures the resulting product suits the differing objectives, needs and priorities of all actors.

Communication was necessary throughout the process – from product idea to launch. Failures resulted when the research and development period was dominated by technology experts and engineers with a lack of understanding of consumer behaviour. Rather, it is important to ascertain as early as possible whether proposed activities are realistic. Communication between all links in the chain was necessary, as was the capacity for rapid communication (for example to react quickly in the event of a product recall), and to transmit results and respond to feedback. Another important factor, which is returned to in the next section, is the ability to 'speak each other's language'.

Communication was valuable in aiding consumer acceptance and avoiding rejection of a technology. Early communication and transparency with consumers were important, whereas poor answers and lies were detrimental. Awareness of possible objections and preparation of consumer attitudes in advance of product launch were helpful. This might be achieved by integrating consumers into the development process as co-innovators. More widely, there was a need to avoid or counter myths or misplaced consumer concerns from arising, and to counteract some NGOs and the media. Often communication failed because it was through a middle person lacking knowledge and authority on the technology.

Q1d. Can you identify any communication problems between key actors which in your opinion may determine the failure of new food technologies?

This question lacked consensus, with 63% agreeing with the statement and 11% disagreeing (although none provided an explanation). What is striking is that one quarter registered 'No opinion'. The greatest incidence of 'No opinion' was evident in the Consumer/social science group, whereas those with experience of food technology development, or working in the food industry, or with interests in food technology are *least* likely to express 'No opinion'.

Table 6.3: Response to Part 1 Question 1d.

	All respondents	Consumer scientists
Response	Percentage*	Percentage*
Yes	63.4	52.6
No	11.3	10.5
No opinion	25.4	36.8
Total	100.1	99.9

* Totals do not sum to 100.0 due to rounding

As already mentioned in Q1b, various communication gaps were identified. There was a need to communicate with the public so that they would accept the products resulting from the new technology. This should occur before and during development when information about preferences and ability to pay should be elicited. It was also important before product launch, when several problems were identified: poor scientific literacy in the population and the need to make explanations intelligible; mis-representation of facts by influential speakers and organisations; the appearance of bias by scientists, and the undermining of trust by attempts to camouflage or hide knowledge or uncertainties. The means of communication should be considered too. For example older people would be particularly affected if there was a lack of television and radio exposure.

Other problems include scientists sometimes working in isolation without considering acceptance by industry or consumers, and consumer scientists provided information about human preferences that was too general and lacking specific detail to be useful.

Communication could be difficult to achieve because of the different 'languages' which different actors speak (see also Q2g), making inter-action between the disciplines difficult. For example perceptions of risk could be quite different. Overall, problems arose when there was not a common understanding along the whole chain about what the development does and of its significance. Multi-disciplinary teams would help overcome this. Some actors take the opposite approach and engage in lobbying to achieve their aim, rather than in communication with the public.

Part 2

Q2a. It is important to take account of consumer preferences when developing new food products.

Table 6.4: Response to Part 2 Question a.

Response	Frequency	Percentage
Agree	69	93.2
Disagree	4	5.4
No opinion	1	1.4
Total	74	100.0

Many regarded this statement as a self-evident truth. Products were for consumers, and they wouldn't buy a particular product if they didn't like it. It was therefore important to engage with consumers at an early stage to avoid simple mistakes, and ensure improvements could be made during research and development, before production started. Co-innovation, involving interaction with consumers from the earliest stage, could be useful. It was also important to take into account preferences for existing products to help shape new products.

Both consumer scientists and food technologists took the view that consumers don't know everything. Quite often consumers didn't know what they wanted, but might respond once the product was available. In this case it was the 'consumer supplier' who would usefully communicate with customers and product developers. Moreover consumer preferences could be influenced and new preferences established. Respondents articulated this idea both as 'manipulation' of consumers, but also as educating them about products and the underlying technology. For example, consumer preferences might be shaped by misinformation such that they held irrational fears about a product, and poor consumer understanding of science, technology and final products hampered their acceptance. Governments would have a role in improving scientific literacy.

Q2b. Successful food technology development needs more effective consumer research methods to gather information about consumer preferences.

Table 6.5: Response to Part 2 Question b.

Response	Frequency	Percentage
Agree	56	76.7
Disagree	9	11.0
No opinion	9	12.3
Total	74	100.0

77% of respondents agreed with this statement, signalling their view that current methods are NOT satisfactory. Levels of agreement among both consumer scientist responders and the group

with experience in food technology development were similar to this. The figure for food industry respondents is even higher, with 90% agreeing with the statement. Commonly respondents commented on the importance of information about consumer preferences when developing commercially successful food technology. Broadly, two uses of consumer research were identified: understanding needs and developing products; and affecting consumer attitudes to improve acceptance.

Some difficulties related to timing. In particular, consumer preferences are rapidly changing and are a moving target, and it requires a continuous effort to understand them. This compounds the problem of the long development times – perhaps 10 years or more – and the possibility that preferences will have changed in the meantime. Methods are developing, but more studies are required to validate new methods. Sometimes there was a distrust of results.
Comments from those who disagreed are limited: appropriate consumer research methods are available but they are not always applied correctly (for example the generalisation of results about consumer preferences from one country to another); research is not specifically targeted on the product and market in question; results needed to be more reliable, and finally that better statistical approaches were required in the area of qualitative research.

2c. Information about consumer requirements, priorities and needs are not communicated effectively to food technology developers.

As shown in Table 5.6, overall one third of all respondents agreed with this statement, but the largest proportion (49%) indicated 'No opinion'. Additional comments provided by some respondents confirm that for them 'No opinion' definitely means 'Don't know', rather than 'Neither agreeing or disagreeing'.
This issue is controversial for some sub-groups where substantive levels of both agreement and disagreement are evident, implying variation between different circumstances.

Table 6.6: Response to Part 2 Question c.

	All respondents (n=74)	Experienced (n=51)	Worked in FT team (n=33)
Response	Percentage	Percentage	Percentage
Agree	33.8	40.0	51.5
Disagree	17.6	22.0	21.2
No opinion	48.6	38.0	26.5
Total	100.0	100.0	100.0

The success of communication varied between companies and products. It was reported that successful communication occurred in large companies which were engaged in both R and D and consumer research activities.

Several reasons were suggested for why food technologists did not receive appropriate communication about consumers: low awareness of its availability or how to access it; a poor understanding of the significance of such information (e.g. impact of products; signals about fears and beliefs about food); low priority (e.g. for spending) given to such communication; a different mind-set whereby technologists had a different understanding of consumer requirements from that of consumer scientists, and finally the barrier caused by 'speaking different languages'.

2d. New consumer research findings often reach food technology developers too late to be of any use

As for the previous question, the majority of respondents (50%) expressed 'No opinion', and opinion was divided between whether findings arrive too late or not.

Table 6.7: Response to Part 2 Question d.

	All respondents	Experienced (n=51)	Worked in FT team (n=33)
Response	Percentage	Percentage	Percentage
Agree	27.0	26.0	36.4
Disagree	23.0	26.0	24.2
No opinion	50.0	48.0	39.4
Total	100.0	100.0	100.0

Respondents who agreed motivated their responses in a number of ways: the lack of close relations between research institutions and producers; technology development is often one step ahead compared to consumer research; that food technology developers probably do not know where to get such information in good time; they do not understand consumer research findings and do not take into account the future consumer acceptance of their products. Other comments related more generally to communication: industry is much more focused on the production side of the chain than the consumer side; there is a gap of language/communication between consumer scientists and food technology developers; every new food product is different and targeted at different consumer segments and understanding the needs of these segments requires targeted research, whereas scientific consumer research findings do not provide such targeted research.

Respondents who disagreed motivated their response differently: Information comes later than ideal, but is still of some use. Other comments related to communication more generally: a lot of information is available, but is not comprehensible to food technology developers due to different languages used, and a lack of good dialogue with consumer scientists, and also a lack of initiative by technology developers in using such information.

2e. Consumer scientists do not make an effective use of information on food technology development in their research.

Table 6.8: Response to Part 2 Question e.

	All respondents	Experienced (n=50)	Worked in FT team (n=33)
Response	Percentage	Percentage	Percentage
Agree	25.7	32.0	36.4
Disagree	18.9	22.0	21.2
No opinion	55.4	46.0	42.4
Total	100.0	100.0	100.0

Again there is some dispute with respect of this question. The largest group indicated 'No opinion', some commenting that the question was beyond their experience. The explanations provided by those who agreed with the statement included: working in separate areas; poor understanding of technology by consumer scientists (and the consequent production of poor questionnaires); ineffective information exchange policy; lack of 2-way communication, and a lack of available information about the technology.

Those who disagreed (and believed that consumer scientists DO make effective use of development information), reported personal experience of close working between consumer scientists and food technologists. One commented that good consumer scientists always signal relevant information to act as a feedback on food technology strategies. Lack of information was not the barrier, some believed; rather the problem was that it was not possible to find a well-defined solution to a complex problem, or when objectives were not clear.

2f. Consumer scientists do not interpret research about consumer priorities and preferences in a way that would be actionable and salient to new technology development

Table 6.9: Response to Part 2 Question f.

	All respondents	Experienced (n=50)	Worked in FT team (n=33)
Response	Percentage	Percentage	Percentage
Agree	27.0	28.0	36.4
Disagree	24.3	30.0	30.3
No opinion	48.6	42.0	33.3
Total	100.0	100.0	100.0

Again the majority of respondents (49%) expressed no opinion, and 'agree' respondents (27%) are slightly more than 'not-agree' respondents (24%).

Some respondents who agreed with this statement ascribe the reason for this situation to the focus of consumer research on 'facts' and not on changes of consumer behaviour, so they cannot 'detect' the potential of new products. Some others cite communication and technical language problems, more precisely the lack of capacity, or the unwillingness, of consumer scientists to communicate (and translate) results of their research.

Those who disagree (and consider that consumer scientists DO interpret their research so it is actionable) provided the following explanations: that consumer scientists do investigate consumer preferences and needs and then signal relevant information to act as a feedback on food technology development strategies. However, some others suggested that complications can occur due to the variable ability of individual consumer scientists, and losses of translation from the general language of consumers to 'food-engineering language'. There is also difficulty in providing access for social scientists to specialists in the production company because of mistrust, trade secrets and the need to pay for the work of external collaborators. It is difficult for other research groups to share the information.

A possible solution is to adopt a more scenario-structured way of thinking which might overcome the problem of consumer research being more factual and historically case based. One respondent proposed rephrasing the sentence as '*The study of consumer sciences should be addressed to understand the benefits for the consumer of new technologies'*.

2g: Disciplinary differences represent an important barrier to communication between food technologists and consumer scientists.'

As Table 5.10 shows, there was a much higher level of agreement with this statement compared to the previous 4 questions. A narrower range of views was expressed.

Table 6.10: Response to Part 2 Question g.

	All respondents (n=72)
Response	Percentage
Agree	70.8
Disagree	15.3
No opinion	13.9
Total	100.0

Those who agreed acknowledged that it can be a challenge for different disciplines to understand each other. Many comments were made. All are specialists focusing narrowly on their own work and only very few acquire a high level of expertise in 2 completely different disciplines. The two groups have different interests, perspectives, and perceptions of what is important. The final

product produced by each is different, with consumer scientists possibly having greater latitude in producing their output. Furthermore, the 2 groups speak different languages with different terminology, and even the same words can have different meanings. There are also gaps in understanding the significance what is being said or written. Consumer scientists don't understand the technical information well enough to be able to communicate scientific facts to consumers.

Again, some of those who disagreed cited positive experiences of multi-disciplinary work, for example where specialists worked in multi-disciplinary teams, such as happened in large food companies. It was also suggested that the problem was actually of having far too little communication, rather than of misunderstandings.

Suggestions to remedy the situation were offered. Giving explicit recognition of good communication as an important step would help. The use of intermediary agents (such as food associations, other professional organisations) could help promote inter-disciplinary dialogue. Giving greater priority to properly understanding each other's discipline - for consumer scientists the technological aspects, and for technologists the contribution that consumer scientists can make - was important, as was establishing common meanings. Lastly, it was observed that when working together in multi-disciplinary teams, communication ceases to be a problem.

2h. There is poor communication between different food chain actors when developing food technologies.

Nearly two thirds of respondents agreed with this statement. The highest level of agreement with this statement is found in the group who had worked as part of a food technology team developing new food products.

Table 6.11: Response to Part 2 Question h.

	All respondent (n=73)	Experienced (n=50)	Worked in FT team (n=31)
Response	Percentage*	Percentage	Percentage*
Agree	64.4	68.0	78.8
Disagree	11.0	12.0	6.1
No opinion	24.7	20.0	15.2
Total	100.1	100.0	100.1

Note: Totals do not sum to 100 due to rounding

A variety of explanations were offered by respondents in agreement with this statement. Again the need for more (and regular) communication between actors was cited as a problem. This was hampered by a lack of time to listen, competition between actors, and not understanding how to approach each other. The issue of identifying which specific actors need to communicate was raised. This was expressed by a consumer scientist working in industry thus: *'Genuine technological research requires full concentration on technical problems. It is the context before and after research activities that should foster adequate communication'*.

Other reasons were related to legal gateways. Protection of IPRs can be a barrier to information sharing; there is apparently different legislation in every country, and chain relationships are poor due to the lack of a reliable legal framework for business-to-business contracts. It can be difficult to identify the right partners who have the capacity to contribute.
It was again pointed out that communication is not always a problem, for example in large companies where the supply chain is wholly integrated.

2i. The food technology development process is too slow in responding to changes in consumer needs and concerns

This is a highly debated statement with which the majority of respondents (40%) disagreed (i.e. they consider the development process is NOT too slow in responding). The question was, however, disputed by food technologists with substantial proportions in both the 'Agree' and 'Disagree' categories. Consumer scientists were split between 'Disagree' and 'No opinion' responses.

Table 6.12: Response to Part 2 Question i.

	All respondents (n=72)	FT (n=23)	CS (n=20)
Response	Percentage	Percentage	Percentage
Agree	25.0	34.8	5.0
Disagree	40.3	43.5	45.0
No opinion	34.7	21.7	50.0
Total	100.0	100.0	100.0

* Totals do not sum to 100 due to rounding

A key issue is the relative speed of changes in consumer tastes and food technology development (FTD). Explanations provided by those in agreement with the statement are varied and include the rapid changes in consumer needs compared to the slower rate of technology development, and the related difficulty of synchronizing food chain timings and expectations. A couple of respondents ascribe part of the responsibility to scarce support from policymakers, who should coordinate with the private sector. One respondent adds that it depends on the particular food sector, while another one on the country (true for Europe but false for other countries like Japan).
Several different views were expressed by respondents who disagreed with the statement. Some explained that the FTD process is not too slow as, usually, consumer needs do not change quickly and are quite stable. (Changing needs are focused on health and wellbeing and are often connected with financial affluence.) Thus technological development and changes in consumer needs are both quite 'slow'. Nonetheless '*a good technologist knows that a striking innovation should be available in reasonable time to be able to influence the market*'. Another respondent states that food technology development goes fairly quickly to react to consumer's needs (so both technological development and change in consumer needs are quite 'fast'). Two respondents state

the exact opposite, that the food technology development process is too advanced and too fast with respect to consumer needs. Moreover, food safety and risk assessment do not keep pace.
Other respondents elaborated arguments which suggested the independence of FTD from consumer demands: private companies develop new processes ahead of consumer demands; the tempo in the industry is dictated by market leader companies who offer new trends and products; and developments in food technology emerge as a proper answer to very specific technical and economic problems. Food technology development does not always occur in response to real consumers' needs; it may result from inaccurate consumer information, and it may actually drive consumer preferences through aggressive advertising.
One respondent states the real problem is not time, but the sensitivity of consumers to the application of technology to food. Food is a unique product in that consumers actually put it in their mouths. Consequently they will not buy a product because it is new technology (in contrast to new computing gadgets, for example), making it much more difficult to have a successful innovation compared to other sectors.

2j. The development of food technologies is driven more by technological advances than by consumer preferences and needs

Table 6.13: Response to Part 2 Question j.

	All respondents	Food industry (n=11)	Experienced (n=50)
Response	Percentage	Percentage	Percentage
Agree	63.4	81.8	64.0
Disagree	16.9	9.1	18.0
No opinion	19.7	9.1	18.0
Total	100.0	100.0	100.0

Almost two thirds of respondents agreed with this statement, and a very high level of agreement is evident among Food Industry respondents.
The majority of 'agree' respondents emphasize this statement, and propose various reasons why technological advances, rather than consumer preferences, drive FTD. These are mainly economic reasons (profit), and to a less extent social reasons: investigating consumer preferences is time consuming and difficult for people not familiar with consumer science; ongoing communication between food technologists about technological advances is much closer than that with consumers. One respondent proposes a neutral position whereby this technology push is 'not *a priori* good or bad'. Determining and fulfilling the needs of other end-users was also a purpose: 'New technical and technological developments have enabled easier control and management processes'. This might apply to smart packaging, for example.

Although agreeing, some respondents specify there are in fact various factors influencing technological development (economic, social, environmental sustainability, and consumers). Nowadays some products are developed to meet consumer preferences/needs, whereas in the past they were not considered. One respondent states that consumers' preferences have already been explored in the past and it is consequently difficult to find new areas for development.
Other respondents disagreed, however, specifying that it is not always the case that technological advances (rather than consumer preferences) drive FTD, and that a lot of variation exists. Some specified that both technological advances AND consumer needs could be drivers, and that nowadays technological development tries to satisfy consumer preferences. One respondent argues that the actual product development process is determined by the interaction between consumer expectations and demand; the technical capacity of the food producer, and emerging knowledge from food science research.

2k. Communication with end users/consumers about new food technologies is critical to consumer acceptance

Table 6.14: Response to Part 2 Question k.

	All respondents	
Response	Frequency	Percentage
Agree	68	94.4
Disagree	2	2.8
No opinion	5	2.8
Total	72	100.0

A very large consensus is found for this statement (94%). Comments from the majority of 'agree' respondents are along the same lines. Nowadays consumers are more demanding for information about what food scientists are doing with their food. Often consumers can't understand the technology, but as information becomes available, consumers will become familiar with its advantages, which can facilitate acceptance of the products. Consumers have their own a priori opinions of what is good and what is wrong with food. (In food tradition matters, unlike e.g. electronic devices where innovation is the content triggering purchase). Information can make the difference between choosing one product over another.
However, new food technologies are difficult to communicate because of the difficulty for consumers in understanding the technical aspects. Some guidelines for communication in support of consumer acceptance can be derived from respondents' comments: (a) Explain what you are doing with regard to the development of new technologies and explain the reason or need for such technologies; (b) communication should be frank and sincere (i.e. advertisements should not be misleading); (c) communication has to be on a solid scientific basis; (d) communication should preferably be independent, i.e. not advertisement; (e) identify who it is key to influence, evaluate and provide adequate input to; (e) communication should not favour science only, but also giving

the consumer a full picture; (f) the suspicion of side effects regarding the technology requires to be eliminated from consumers' minds.
A minority of respondents restrict their agreement to the sentence: it is only partly true; it is crucial if the new products costs more money; it is important, but not crucial (consumer acceptance does not completely depend on communication).
Only one respondent who disagreed with the statement gave a comment, stating that consumers will accept products resulting from the use of new technologies if they guarantee safety of consumption, quality and pleasant sensory properties.

7. Discussion and conclusions

The Round 1 Delphi study found clear consensus on some issues, underscoring the importance of communication during food technology development:

- Communication between key actors during development is important to avoid commercial failure;
- Consumer preferences need to be taken account of when developing new food products;
- Communication with end users and consumers is critical to consumer acceptance.

However on several issues the picture is less clear. Respondents indicated that in some circumstances communication is effective (although in others it isn't), and that successful communication is achieved for some technologies and products and by some companies, but not others. Clearly it will be beneficial to pinpoint what ingredients are necessary for successful communication to occur.

The need to produce products that consumers want to buy was critical in determining the commercial success or failure of new food technologies, though there was not complete agreement on how to achieve this. The main approach suggested was to use consumer research methods to identify product attributes that fulfil consumers' wants and needs, and then develop appropriate products. However, acquiring such information is problematic, partly due to the difficulty of synchronising consumer science and FTD activities. Two views were expressed. First, consumer preferences are assumed to change relatively quickly. Given the long development times for technologically innovative processes and products, consumer preferences, established at the start, may have changed by the eventual product launch. So it was proposed that consumer science needs improved research methods which are better able to deal with such a moving target.

An alternative view is that consumers are conservative, so consumer preferences are actually slow-changing and lag behind technological development which is relatively quick, leading to rejection. Consumer science can't detect the potential of new products so, as one respondent wrote, '*The study of consumer sciences should be addressed to understand the benefits for the consumer of new technologies'*. Innovative products may be in some way far removed from familiar current equivalents, so social and consumer scientists needed better means of visualising such products.

Furthermore, there was a lack of clarity about when consumer information is needed in the FTD process: whether it is before the technological development process begins, or when actual products using the process are developed. The argument above suggests that understanding consumer preferences is the starting point whereas there was strong agreement that development of food technologies is driven more by technological advances than by consumer preferences and needs. A minority proposed an 'end-of-pipe' approach, whereby the product was developed and then producers and marketers were pro-active in shaping consumer opinions. This approach addresses the problem that consumers may not know what they want until they are presented with it.

A second critical need for effective communication was for promoting the acceptance by consumers of products derived from new food technologies. Comprehensibility, accuracy and trustworthiness concerning information about new food technologies were crucial for success (e.g. making clear what improvements exist over current alternative products). Risk and uncertainty should be communicated honestly whereas lies and evasion were counter-productive in the long run. Barriers in communicating to consumers included difficulty in comprehension and poor scientific literacy (and the implied inability to critically evaluate information), which can lead to irrational responses to new technologies (e.g. GMO) due to a lack of understanding. There was also a need to counteract 'myths' propagated by interest groups and arising from inadequate information. Background scientific disputes were unhelpful.

The timing of such communication with consumers was mentioned. To avoid rejection, it was essential to communicate with consumers from the earliest stages even before product development. One suggested approach to ensuring the development of products that consumers will actually want is to use the process of co-innovation in which consumers are actively engaged during process and/or product development. A key question is to identify who are the appropriate people for developers to engage with in this process – consumers, consumer gate-keepers or others.

Food technology development and successful commercialisation involves many different actors, and is an inter-disciplinary activity. Communication between actors is important. There must be a common understanding of what the development does; a shared vision of what is proposed and how it will be achieved; and the development must fit with the objectives of and deliver benefits to all actors. All must benefit from the project, or else some will fail to remain committed to it.

Disciplinary differences were the most commonly mentioned barrier to achieving such communication and knowledge transfer. Key actors 'speak different languages' have different approaches and terminology, and appear not to always understand what others are trying to do, or its relevance to their own work. Scientists were quite often depicted (particularly in the past) as working in isolation without consideration for the acceptability of final products to either consumers, or to manufacturers. Consumer scientists sometimes have an inadequate understanding of the science or its applications, reducing the value of their work. Moreover, information provided by consumer scientists was sometimes of limited use being too general and unreliable, whereas there was a need for consumer research to be more targeted, on precise market segments, geographical locations, and specific products. Some food technology developers had a low awareness of what consumer science had to offer, and of how to apply consumer science information.

Commonly a low priority was given to communication, even to the extent that there is no communication at all between actors. There was also a failure to identify all the key actors. As well as technology developers, scientists, and consumer scientists, other key roles were identified. These include the 'consumer suppliers' or retail managers who decide what to sell and who can be envisaged as 'consumer gatekeepers' and shapers of consumer preferences. Food manufacturers are consumers of the innovative technology and their decision to adopt the technology is also critical to its success, and depends upon their assessment of the potential market and the likely return on investment *inter alia*. On the grounds of specialisation, it was infeasible for scientists who are engaged in cutting edge science to also have the capacity to engage with product development and consumer research. Notwithstanding the inclusion of several respondents who are trained in both consumer/social science and technological development, professionals who can bridge such gaps were needed, for example to act as intermediaries between laboratory scientists and product developers, or to help social scientists to understand the technology and its implications properly.

The suggested solution lies in providing resources explicitly for communication including establishing multi-disciplinary teams and building relationships between actors. This could be promoted by appointing a team leader or intermediary with a specific remit to aid effective communication and inter-disciplinary understanding. It was necessary to establish effective

channels of communication so that information was transferred in a timely fashion. Large companies appear able to internalise technological development, product development and consumer research functions, but outside these, by implication, inter-institutional communication is problematic, partly due to legal issues (contracts between firms, especially in different countries), and protecting commercial secrets and IPR issues.

Overall this account gives a negative impression of communication. However, this is not always the case. Success was reported by some respondents, achieved by multi-disciplinary teams, and by establishing good working relationships between individuals from different disciplines who nevertheless developed a good mutual understanding of each other's work.

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Appendix 1: The Delphi round 1 questionnaire

Improving the effectiveness of food technology development-
A stakeholder Delphi survey

We are carrying out a Delphi survey to identify the important factors which hinder and facilitate effective communication between important stakeholders in food technology development and commercialization. Among the Connect4Action community that is currently being built, we have identified you as an important stakeholder in this area, and it would help our research very much indeed if you took part in our Delphi survey.
A Delphi study usually consists of 2 or more rounds. In the first round, we will ask some general questions about important issues which can be considered as relevant information for food technology development. A second version of the survey will be sent to you in a few weeks, along with anonymised summaries of respondents' views. In the second survey, we will go into greater depth on certain topics which were found most relevant by the participants, or where there was a high level of disagreement between different participants.

An important element of Delphi studies is that participation is *anonymous*. The answers provided by each participant are treated as confidential, and when we feed back results, the names of participants will not appear. Participants will not be identifiable by name in any published outputs of the project.

We estimate it will take about 10-15 minutes to answer the questions.

Please contact Marian Raley (m.e.raley@ncl.ac.uk) if you would prefer the survey as a Word document.

Many thanks for your help!
Yours sincerely,
Professor Lynn Frewer, Newcastle University, UK
Professor Mario Mazzocchi, University of Bologna, Italy
Dr Maddalena Ragona, University of Bologna, Italy
Dr Siet Sijtsema, LEI, Wageningen University & Research centre, The Netherlands

Part 1 – Your opinions about key issues in food technology development

A wide variety of new food technologies have been developed over the last few decades which can be applied to novel food product development, for example food quality or nutritional improvements. While some of these new food technologies have been accepted easily by consumers, others have been met with consumer rejection. We would like to hear your opinion about key issues in food technology development and application.

1a. In your opinion, is the development of new food technologies important to enhance European competitiveness in the agri-food sector?
(Please indicate with X)

Yes

No

No opinion

Please explain your response

……
……
……

1b. Could you please list the factors which you consider most relevant to determine the commercial success or failure of new food technologies?
If there is any factor which is specific only to either success or failure, please state this

……
……
……

1c. In your opinion, is communication between key actors (food technologists, consumer scientists, consumers, policy makers, etc.) along the process of food technology development important to avoid commercial failure?*(Please indicate with X)*

Yes
No
No opinion

Please explain your response

……
……
……

1d. Can you identify any communication problems between key actors which in your opinion may determine the failure of new food technologies?*(Please indicate with X)*

Yes
No
No opinion
If yes, please explain what these are

……
……

Part 2 – Your opinions about communication on food technology development

Please indicate (using an X) whether you ***agree*** **or** ***disagree*** with the following statements

a. It is important to take account of consumer preferences when developing new food products.
Agree *Disagree* *No opinion*

Please explain your answer

……
……

b. Successful food technology development needs more effective consumer research methods to gather information about consumer preferences.
Agree *Disagree* *No opinion*

Please explain your answer

……
……

c. Information about consumer requirements, priorities and needs are not communicated effectively to food technology developers.
Agree *Disagree* *No opinion*

Please explain your answer
……
……

d. New consumer research findings often reach food technology developers too late to be of any use.
Agree *Disagree* *No opinion*

Please explain your answer
……
……

e. **Consumer scientists do not make an effective use of information on food technology development in their research.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

f. **Consumer scientists do not interpret research about consumer priorities and preferences in a way that would be actionable and salient to new technology development.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

g. **Disciplinary differences represent an important barrier to communication between food technologists and consumer scientists.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

h. **There is poor communication between different food chain actors when developing food technologies.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

i. **The food technology development process is too slow in responding to changes in consumer needs and concerns.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

j. **The development of food technologies is driven more by technological advances than by consumer preferences and needs.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

k. **Communication with end users/consumers about new food technologies is critical to consumer acceptance.**
Agree *Disagree* *No opinion*

Please explain your answer
……
……

Anything else you would like to add?
……
……
……
……

Part 3 – Information about you

a. **Age: ……..**

b. **Country of residence ……**

c. **Gender : Male Female** *(Please delete as appropriate)*

d. **Job title ……**

e. **Number of years in the job / experience ……..**

f. **Sector** *(Please indicate using an X)*

i. **Primary production**
ii. **Food industry SMEs**
iii. **Food industry large**
iv. **Food industry multinational**
v. **Academia**
vi. **Regulation / governments**
vii. **NGO**
viii. **Media**
ix. **Other (please specify) ……**

Please indicate *(using an X)* **which of the following apply:**

i. I have been involved in developing new food products
YES ***NO***

ii. I work or have worked as part of a food technology team developing new food products
YES ***NO***

iii. I have worked with Natural Scientists in developing new food products
YES ***NO***

iv. I have worked with Social and/or Consumer Scientists in developing new food products
YES ***NO***

v. My interest in food technology development is as
(more than one answer is allowed)
a. A food technologist
b. A consumer or social scientists
c. Other (please state)……

Please provide your e-mail address here……

This information will not be linked to your survey responses in our database. We would like to contact you with a follow-up questionnaire in a few weeks' time. Please be assured that your anonymity will be respected.

Thank you very much for filling in this survey.

[For paper version] Please return to:

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