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

A review to collate information on external communication as a basis of innovation success

WP2

04.04.2013

DELIVERABLE N° 2.2

Author

Machiel J. Reinders, Ivo A. van der Lans, Arnout R.H. Fischer, Hans C.M. van Trijp

Deliverable lead beneficiaries

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Project	
Project acronym:	Connect4Action
Project full title:	Strategies for improving communication between social and consumer scientists, food technology developers and consumers
Grant agreement no.:	289023-CSA-SA
Project start date:	01.12.2011
Document:	
Title:	A review to collate information on external communication as a basis of innovation success
Deliverable No.:	D 2.2.
Authors:	Machiel J. Reinders (Stiching Dienst Landbouw-kundig Onderzoek/DLO) Ivo A. van der Lans (Wageningen University) Arnout R.H. Fischer (Wageningen University) Hans C.M. van Trijp (Wageningen University)
Reviewer:	prof.dr.ir. JCM van Trijp
Delivery date:	18.12.2012
Due date of deliverable:	01.01.2013
Dissemination level:	PU
Status:	Final

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prof.dr.ir. JCM van Trijp Working Package Leader

Signature Working Package leader

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 2.2. Short Summary

The objective of work package 2: “Identify success factors” is to identify relevant success factors and barriers in the scientific literature on internal (between relevant disciplines) and external (from and to the public and end-users) communication strategies to enhance food technology innovation success across a wider variety of application areas. As part of this, their implications for successful innovation in the area of food technology will be reviewed.

Utilising a comprehensive review of the existing literature regarding external communication (i.e/ from and to the public and end-users), deliverable 2.2. constitutes the report on success factors and critical points – do’s and don’ts – of the external dialogue.

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1. Introduction

Companies that are able to uncover or even anticipate consumer demand, deliver against it and communicate this effectively to consumers have a higher chance of survival and success in the marketplace (Costa & Jongen, 2006). Especially in the highly competitive food industry, which is strongly market-driven, it is critical to very carefully listen and communicate to consumers, based on knowing their preferences (Suwannaporn & Speece, 2010). If successful technological innovation is to occur in the food industry, new products should not merely reflect technological possibilities, but also consumer priorities and preferences (e.g., van Kleef, van Trijp, & Luning, 2005).

Based on insights from the market-oriented literature (Kohli & Jaworski, 1990), three stages can be identified in this process. These stage are (1) eliciting consumer needs and wants, (2) making these insights actionable within the organisation and (3) acting upon it in delivering consumers superior products. The first stage refers to the generation of market information. The second stage can be characterised by dissemination of the generated information within the organisation such that relevant functions and disciplines have access to it in an actionable format. The third stage of a market orientation is responsiveness to the market. Responsiveness is the action taken in answer to the information that is generated and disseminated.

Adapting effectively to market needs requires communication and dissemination among virtually all key players that are involved in the technology development and commercialisation process: food scientists and food technology developers to design and develop a new product, marketers and consumer scientists to commercialize the product, manufacturing to gear up and produce it, and so on. Only through effective communication at the stages of information dissemination and responsiveness, the necessary coordinated activity can be managed in responding to the market in a market-oriented way. In turn, after responsive actions are designed and communicated to the market, the process of generating market information starts again.

The market orientation process thus involves two critical types of communication:

a) **external** communication between food technology development and the final consumer (consumer groups, mass media, policy makers and NGOs) in eliciting consumer needs and delivering products (stages 1 and 3), and
b) **internal** communication between the different (scientific) disciplines involved in food technology development and commercialisation, such as food scientists, food technology developers, marketers, consumer scientists and social scientists from both (applied) research and food companies (stage 2).

This report focuses on external communication. Distinct types of external communication between business and consumers can be identified for the first stage of needs and want elicitation and the third stage of market responsiveness. A hybrid form of continuous

communication is another possibility where consumer demand and responsiveness are integrated (Figure 1). This distinction results in different research methodologies applied and degree of interactivity involved. At the level of communication from the consumer to the company or business, consumer needs and wants (consumer research for “inspiration”) are often identified through market research methods such as surveys, controlled experiments, focus groups (see van Kleef, et al., 2005) in which often also the current need and want fulfilment is investigated. Business to consumer communication, involves similar market research methods but now with the aim to identify consumer responses to newly developed product propositions (consumer research for “verification”) that are positioned through advertising, product labelling and branding. Whereas the two previous forms of communication depend on the use of traditional market research methodologies (keeping the consumer and company/business at “arm length”), more recently there is a shift towards communication methods that are based on more direct and continuous interaction between the consumer and the business/company, such as through co-development practice.

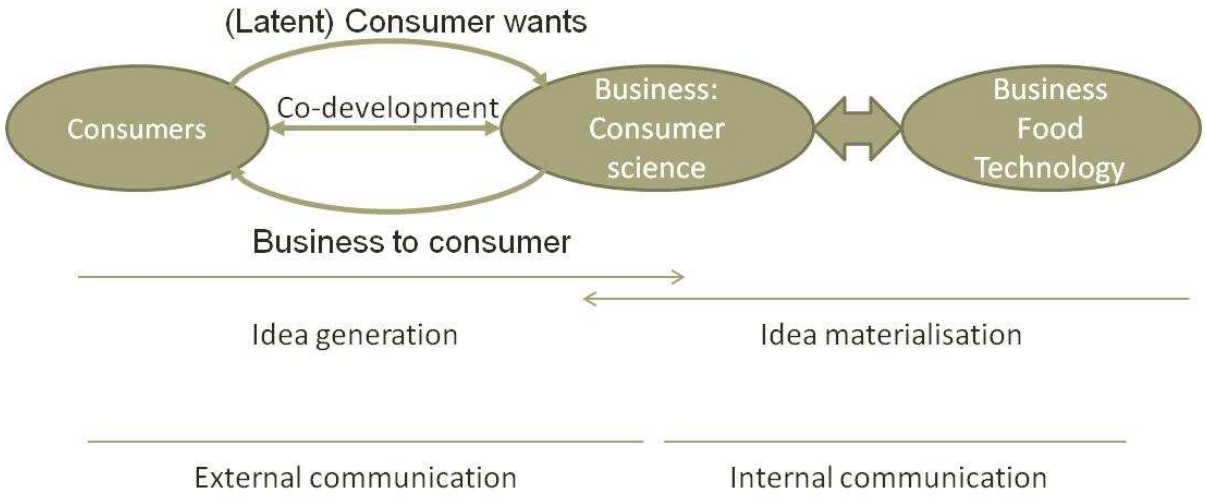

Figure 1: Three modes of communication between food technology business and consumers

These three modes of communication may have different relevance for communicating with consumers on new technologies in food, possibly addressing different factors related to successful innovation. Also, the different modes of communication may require different tools to study the information stream, depending on the stage of technology development or application, and the framing of the communication.

The EU FP7 CONNECT4ACTION project aims to investigate communication between food technologists and consumer sciences. In line with the description of work of this project, the objective of this study is to systematically extract key findings from the scientific literature on consumer acceptance (and rejection) of agri-food-related technologies and how these can be managed effectively through better external communication between food technology developers, consumer scientists and the public. The key contribution of this

study is to ensure that the project will build on, and exploit, existing knowledge. In addition, lessons from existing practices will be taken into account.

For this aim, a comprehensive review of the scientific literature will be conducted to collate information on the communication between the food technology implementing businesses and the end-consumers.

The current review on the external communication between food technology implementing businesses and consumers points out several relevant contributions or aspects.

First, this study aims to identify evidence-based strategies to external communication that contribute to innovation-adoption success and on the specifics of these strategies (do's and don'ts). The results of the review will form the basis for the synthesis of critical points in the innovation process where input from consumer science and related disciplines may optimise product development. A synthesis of proven communication and framing approaches from these three modes of communication between food technology business and consumers should provide a more comprehensive overall model than available at this moment in time. This model can then be applied to develop successful strategies for market introduction of new-technology food products. For that reason the contribution of the published research towards marketing strategies will be evaluated.

Second, this review aims to investigate to what extent different constructs and methods are used for different aims in scientific practice. As such, it will also assess the relevance of the published body of papers in the advancement of food consumer science, using a framework proposed in a recent paper, where it has been argued that relevant knowledge creation in consumer science either provides relevant new theorising, and testing (deductive) but also by observing and providing meaning to substantive ('real world') findings (observations and inductive) (Lynch Jr, Alba, Krishna, Morwitz, & Gürhan-Canli, 2012). A similar distinction was made in some more detail by distinguishing between the five steps in the empirical cycle (based on de Groot, 1969): observation-induction-deduction-testing-evaluation.

Both these sources distinguish between identifying societally relevant phenomena, inducing a model based on phenomena, from which subsequently hypotheses are deduced and the predictions tested, followed by interpretation of outcomes towards societally relevant actions. We argue that the role of applied consumer science in new product development is both societally and scientifically relevant by evaluating the use of conceptual theories against real world phenomena, or by observing and theorising on substantive phenomena in society that are not yet sufficiently captured by generally accepted theories or models.

Food technology becomes relevant to food marketing and development of new products when it is truly applied to products. The implementation of food technologies in products can have effects on consumer acceptance of such products in three ways (Fischer, van Trijp, Hofenk, Ronteltap, & Tudoran, 2013). The first way is by the societal attitude towards a technology on its own. This can lead to categorical rejection of (or negative attitudes

towards) any products produced with the technologies. Genetic modification in Europe and irradiation in general, are technologies where consumer perception is strongly and negatively influenced by the technology on its own. The second way is through product characteristics relevant to the consumer. The technology may change the product and thus introduce desirable or undesirable consumer attributes to the mix of product attributes. An example can be the tenderisation of meat through shockwaves, where naturalness and value of prime beef are lowered, but cheaper tender meat is produced. A third way is that a technology may allow producers and chain actors to optimise their production and marketing chains without immediate relation to the consumers. This last route is of little relevant in the current review. In the current review we therefore distinguish between consumer research aimed at technologies as such, and consumer research aimed at products embodying technologies, to gather an as complete as possible view across the topics.

This comprehensive review will draw on the literature in the consumer and food technology sciences, with an emphasis on the identification of the critical success and failure factors in the communication to and from consumers. More specifically, focus in the literature review will be on the technology acceptance literature (which is primarily based in (risk)psychology, describing and predicting societal acceptance of new technologies), new product development literature (which is primarily based in marketing and consumer behaviour, describing and predicting effect of market push and consumer pull, and diffusion of innovations) and consumer-producer interaction literature (which is primarily based in innovation sciences, describing and predicting efficacy of consumer engagement). To arrive at evidence-based conclusions on the impact of communication with consumers it is however important to be able to draw comparisons between different studies. The broad range of different methods used, makes such comparison challenging. The aim of the current report is to provide such comparison. A complication is that even when similar methods are used, differences in implementation and quality of these methods will complicate comparability (see e.g. Frewer et al., in press). The current review will provide an overview of approaches used to extract consumer opinions on technologies, consumer response to communication by the business, and methods how business and consumer can interact.

Finally, this study will explicitly take the three modes of communication into account. It will include methodological considerations in the dialogue from the end consumer to the food technology developer (consumer to business). The literature review will focus on the methodologies for extracting consumer needs regarding emerging technologies and their implementation in actual food products. This review will also examine communication strategies in the communication from food technology and new-product developers to the end-consumer (business to consumer), and will concentrate on interactive consumer-business communication in the new product development process (co-development).

2. Method

Since each external communication stream (i.e., communication from the consumer to business, from business to consumers, and co-development) has its own best methods and jargon, three separate literature searches were carried out. Across the three reviews, the same structure was applied in identification and coding of the relevant articles, to make the outcomes comparable.

The paper identification and coding procedure consisted of four steps:

(a) To identify relevant search terms and their synonyms used in the different fields, position papers, meta-analyses and reviews were used to extract topics that need to be addressed. Initially, such papers were identified in WoS and Scopus, two major reference data bases using keywords from our own expertise. Additional reviews were added based on reference search and emerging additional keywords until saturation in the list of papers occurred (i.e. no or very little added information to be expected by adding more papers). Based on these papers, specific lists of factors and methods are connected which were used to create the keywords for the subsequent search for papers exhibiting best practice in the field.

(b) Based on the keywords for relevant constructs and methods identified in the first stage, a systematic search was applied to WoS and Scopus to identify all recent papers that might be relevant for identifying current best practices in the field. Keywords were combined into a separate search string for each type of communication. The search terms were included in the topic field in WoS (TS), and in the keywords, title, or abstract fields of Scopus. Searches were limited to journal papers published in English between 2000 and 2012.

(c) Subsequently, the abstracts of the retrieved papers were screened to disregard irrelevant papers using the following five exclusion criteria:
   A. Consumer opinion is not central to the research;
   B. Technology opinion not central to the research;
   C. Food is not central to the research;
   D. No [consumer-to-business / business-to-consumer / Interactive] communication aspect reported in the paper;
   E. The papers is a (1) Duplicate (2) Non English (3) No journal paper (4) Outside time frame.

(d) Selected papers were coded towards the issues in the research objectives: i.e. (i) the contribution of the research to successful new-product development; (ii) the stage in the development process; (iii) whether the communication is about the technology in itself, or the technology embodied in a product. In addition, background characteristics of the study were differentially coded to capture details most relevant to the type of communication.

3. Results on Extracting information from Consumers for use by Business

For food technologists it is important to have information from consumers on their evaluation of new food technologies. To generate that information a communication mode from consumers to food technology developers is needed. Consumer and societal research conducted by consumer scientists elicits these consumer opinions on new food technologies. Their output and relevance to food technology developers is reviewed in the following section.

3.1 Keywords and coding scheme

From previous research on consumer perception of new technologies in food (Fife-Schaw, Barnett, Chenoweth, Morrison, & Lundéhn, 2008; Frewer et al., 2011; Grunert, Verbeke, Kügler, Saeed, & Scholderer, 2011; Olsen, Grunert, & Sonne, 2010; Ronteltap, Fischer, & Tobi, 2011; Ronteltap, van Trijp, Renes, & Frewer, 2007) twelve essential types of consumer constructs have been identified that are essential to businesses aiming to extract information from consumers: (1) Attitude and/or acceptance, willingness to pay or intention to buy, (2) Emotion, (3) Associations, (4) Experience, (5) Risk perception, (6) Benefit perception, (7) Quality perception, (8) Subjective norm, (9) Perceived control, (10) Awareness and knowledge, (11) Trust, and (12) Values and ethics. Emotion, associations and quality perception were mentioned once in these papers, all other indicators in at least two of these papers. Based on these terms, different synonyms for technology, and the additions, food, consumer, product, and research, a search string was developed (Table 3.1).

The search was conducted on 14 June 2012 in Web of Science, which yielded 247 papers, and in Scopus, which yielded 538 papers. After automatic removal of duplicates, 640 papers in total remained for screening. 303 papers were eliminated because consumer opinions were not central to the research. A further 55 papers were eliminated because the abstract suggested that the paper was not about the a new technology or its implementation. Three more papers were eliminated because they were outside the food domain, and another two papers were excluded because they did not address communication. Finally, eight papers were eliminated because they were duplicates (not automatically detected), not published in English or outside the time frame.

This resulted in 132 papers being judged relevant after abstract screening. Full text versions of the papers were retrieved. When the paper could not be retrieved a copy was requested through the interlibrary service of the host institution. Ten papers were not retrievable even after this additional step and were excluded at this stage. The remaining 122 were coded in detail (see Table 3.1.).

Table 3.1: Overview of search terms in Scopus and web of science

Scopus	**Web of Science**	**Remark**
TITLE-ABS-KEY	TS=	Search in paper title, paper abstracts and provided keywords.
((acceptance OR attitud* OR emoti* OR associati* OR experien* OR "risk perception" OR "benefit perception" OR "perceived quality" OR "subjective norm" OR "perceived control" OR awareness OR knowledge OR trust OR values OR ethics OR involvement OR motivat*)	((acceptance OR attitud* OR emoti* OR associati* OR experien* OR 'risk perception' OR 'benefit perception' OR 'perceived quality' OR 'subjective norm' OR 'perceived control' OR awareness OR knowledge OR trust OR values OR ethics OR involvement OR motivat*)	Include key terms identified from the review papers
AND (technolog* OR engineer* OR innov* OR (genetic* OR pesticid* OR irradiati* OR sterali* OR fortifi* OR synthetic OR colo* OR nano* OR protect*))	AND (technolog* OR engineer* OR innov* OR (genetic* OR pesticid* OR irradiati* OR sterali* OR fortifi* OR synthetic OR colo* OR nano* OR protect*))	Limit to papers mentioning food relevant novel technologies
AND (food)	AND (food)	Limit to papers that at least mention food
AND (consumer)	AND (consumer)	Limit to papers that at least mention consumer
AND (product*)	AND (product*)	Limit to papers that at least mention products
AND (research))	AND (research)))	Limit to papers that mention research
AND (LIMIT-TO(DOCTYPE, "ar") OR LIMIT-TO(DOCTYPE, "re")) AND (LIMIT-TO(PUBYEAR, 2012) OR LIMIT-TO(PUBYEAR, 2011) OR LIMIT-TO(PUBYEAR, 2010) OR LIMIT-TO(PUBYEAR, 2009) OR LIMIT-TO(PUBYEAR, 2008) OR LIMIT-TO(PUBYEAR, 2007) OR LIMIT-TO(PUBYEAR, 2006) OR LIMIT-TO(PUBYEAR, 2005) OR LIMIT-TO(PUBYEAR, 2004) OR LIMIT-TO(PUBYEAR, 2003) OR LIMIT-TO(PUBYEAR, 2002) OR LIMIT-TO(PUBYEAR, 2001) OR LIMIT-TO(PUBYEAR, 2000)) AND (LIMIT-TO(LANGUAGE, "English")) AND (LIMIT-TO(SRCTYPE, "j"))	AND Language=(English) AND Document Types=(Article) Timespan 2000-2012	Limit to article or reviews published in scientific journals in the English language between 2000 and 2012
Scopus: 538	Web of Science: 247	Number of hits in search conducted on 14-6-2012
135 duplicates between Scopus and Web of Science: 640 Unique references		
Exclude papers that do not have the word "consumer" in either title or abstract (n-136): 504 papers dealing with consumers		
N=303		A. Consumer opinion is not central to the research
N=55		B. Technology opinion not central to the research
N=3		C. Food is not central to the research
N=2		D. No [consumer-to-business / business-to-consumer/ interactive] communication aspect reported
N=8		E. The papers is a (1) Duplicate (2) Non English (3) No journal paper (4) Outside time frame
Paper for inclusion: N=132		
N=10, leaving 122 papers to be coded.		Non retrievable

3.2 Results

Five of the 122 papers selected after abstract screening were reviews that gave an overview of how consumer acceptance of technologies links in with the development of products based on those technologies. Eighty four papers contained relevant empirical consumer data related to new food technologies or their implementation. Review papers, and papers reporting data on consumer opinions towards a new food technology and its implementation were included, other papers and papers in which the data was of extremely low quality were excluded. Out of the papers, 48 reported a sample drawn from the general population, 11 a sample from a specified target population other than the general population (e.g., pregnant women), 23 a convenience sample without any claims on the specifics of the population. Two papers did not report on their sampling frame. Data reported was collected between 1998 and 2010. The number of participants ranged between 8 and 2993 (median=201, lower quartile=86, upper quartile=449 participants). Most papers reported on data from the USA (N=19) followed by the UK (N=10), Brazil, Denmark, and Spain (each N=6), Ireland, Italy, the Netherlands, New Zealand (each N=5), Australia (N=4), Canada, Germany, Greece, Poland, and France (each N=3), Kenya, Taiwan, Turkey, Norway (each N=2), and Austria, Belgium, China, Croatia, Finland, Jamaica, Malaysia, Nigeria, Switzerland, Tanzania, Thailand and Uruguay (N=1 each). Eleven papers reported participants from multiple countries.

3.3 What do we learn about communication stream from consumer to business: How to extract consumer demands for new technology

Across different methods it becomes clear that new technologies in themselves are unlikely to have a positive influence on consumer demand for technologies embodying them. In cases where consumer demand for the new technologies is present, this appears to relate more to clear and immediate benefits to the end user than to a positive opinion on the technology itself (see e.g. Schenk et al., 2011), New technologies do carry uncertainty about possible negative consequences, which makes risk perception, trust in the chain actors involved in the introduction of the new technology, and end user knowledge about the new technology important determinants for acceptance, or rejection of new technologies. Thus it is essential to develop new technologies that bring sufficient end user benefits, and that do not result in high risk perception. Development of such technologies should be taken up by trusted stakeholders. Specifics of these high level determinants, are however, dependent on the different technologies and their implementation in a product. Different methods are in use to identify the specifics for different

Identification of determinants of acceptance: qualitative approaches

Nine papers conduct exploratory qualitative research, based on the assumption that each new technology has its own specific characteristics that can trigger unanticipated consumer associations. For example, the extent to which an innovative edible coating is used for different products may raise different levels of concerns, which should inform food technologists that a 'one-type-fits-all' approach may not be useful for this type of innovation (Wan, Lee, & Lee, 2007). It may also alert technologists that solving problems that consumers do not consider a problem at all does not give a marketing advantage, as was shown in the case of tampering detectors, where consumers considered the current measure good enough, and considered it the responsibility of the supplier in any case to provide non-tampered with products to the consumer (Pascall, Lee, Fraser, & Halim, 2009). Note that such technologies may still be worthwhile to follow up on, as it may allow better in store product management (cf. the third road proposed by Fischer, et al., 2013), but that the actual consumer to business communication is of less relevance in this case. Qualitative approaches can also help to explore how communication in specific ways may lead to re-evaluation of technologies. For example by discussing tomato breeding through genomics with consumers, it could be learned how to dissociate these tomatoes from the negatively loaded GM label (van den Heuvel, Renes, Gremmen, van Woerkum, & van Trijp, 2008). In cases where misconceptions by consumers can easily arise, qualitative methods such as in-depth interviews or focus groups are well suited to figure out the source of consumer misconceptions, which is hard to envisage a priori (Barrios & Costell, 2004).

However, the use of these methods sometimes re-establishes well-known determinants for consumer acceptance. An example is a study into food-hazard characteristics that confirmed seminal insights into risk perception including the risk dimension on dread and familiarity (McCarthy, Brennan, Ritson, & De Boer, 2006). While this provides confirmation about established determinants (from Fife-Schaw & Rowe, 1996; Slovic, 1987), the added relevant insights of such studies may be limited, and find their main purpose in developing questions for subsequent quantitative surveys (Bogue, Sorenson, & O' Keeffe, 2009; Henson, Cranfield, & Herath, 2010).

Quantification of consumer opinions towards new technologies in food products.

There are many papers that study consumer opinions towards novel technologies by comparing products in which the novel technology is implemented with products without such technology. This provides insights into the combination of attributes among which a novel technology and its risk and benefits , that are more likely to create demand for future products. From these opinions towards products embodying novel technologies, consumer attitude towards the technology is inferred . Main proxies for successful introduction are willingness to pay (WTP) (Bredahl, 2001; Jaeger & Harker, 2005; Jaeger et al., 2004; Kassardjian, Gamble, Gunson, & Jaeger, 2005; Kimenju & De Groote, 2008; Posri, Shankar, &

Chadbunchachai, 2006; Teratanavat & Hooker, 2006), or similarly willingness to accept (WTA) (Lusk et al., 2004; Lusk et al., 2006). Both WTP and WTA confer a monetary value consumers assign to a technology. This may be the willingness to pay a price-premium from which it is inferred that consumer perceive the technology and its consequences to add value to a products. This was the case in for s example consumers that reported to be willing to pay more for specific characteristics of cow-peas in Ghana (Langyintuo, Ntoukam, Murdock, Lowenberg-DeBoer, & Miller, 2004) or GM crops in Kenya (Kimenju & De Groote, 2008). Alternatively the same technology in a different application or cultural context have resulted in consumers being willing to adopt a product with the technology at a discount (i.e. a negative willingness to pay for the inclusion of the technology attribute), from which it is inferred that consumer perceive the technology as negative. This has been shown in cases where consumers indicated they would be willing to pay less for GM than non-GM tomatoes in Turkey (Goktolga & Esengun, 2009), or a product with nanotechnology involved (Siegrist, Stampfli, & Kastenholz, 2009).

Another group of papers focuses on generic attitudes towards new technologies and how these are formed (e.g. Bredahl, 2001; Chen, 2008; Chen & Li, 2007; Costa-Font & Gil, 2009; Frewer, Scholderer, & Bredahl, 2003; Klerck & Sweeney, 2007; Lennon et al., 2009; Thøersen & Zhou, 2012).

Many of these papers mention risk and benefit perceptions as important elements for the final attitude towards a technology as a whole. Risk perception is generally shown to be a major driver that negatively influences willingness to pay and generic attitudes (Martinez-Poveda, Molla-Bauza, Gomis, & Martinez, 2009). Benefit perceptions of the new technology are increasingly explored as a way to offset risks (Frewer, et al., 2003; Knight, 2007). While benefit perception, trust and knowledge are often considered at the level of the technology, benefits for specific products are more often considered in terms of perceived quality (Olsen et al., 2011; Sorenson & Henchion, 2011).

Risk and benefit perceptions are however not straightforwardly adding up to an overall opinion. It has been shown that risks and benefits are both interpreted against an existing general attitude towards the technology. Thus risks are perceived as larger and benefits as smaller when people have a preconceived negative attitude about a product (and vice versa for a preconceived positive attitude) (Bredahl, 2001). In practice this means that risk and benefit perceptions are often more strongly negatively correlated within a single participant than expected based on measures of risk and benefit perception collected across different participants (cf. other sources outside the current review Alhakami & Slovic, 1994; Finucane, Alhakami, Slovic, & Johnson, 2000). Therefor extrapolation of an overall attitude based on risk and benefit perceptions measured in isolation is unlikely to be predictive for the actual consumer opinion, and should be avoided.

In addition, it has been shown that the lack of knowledge, in a situation in which risk may play a role requires trust in information sources for the information provided to be used in forming an opinion. Trust towards the agent introducing foods, or controlling the food chain, can influence the relation between perceived risks and benefits and generic attitude; where

trustworthy agents are more likely in influencing consumers towards their point of view (Rampl, Eberhardt, Schütte, & Kenning, 2012; Traill et al., 2004). This is however not limited to market agents, and may extend to other organisations, which may be negative about a technology. For example, if a trusted environmental NGO is negative about a technology, their arguments may carry more weight than those of a non-trusted technology developer, regardless of the scientific quality of these arguments.

Opinions are generally positively affected by increasing knowledge about a new technology with consumers. For example, when participants were explained how HPP pasteurisation worked they were more positive and less worried about its application (Deliza, Rosenthal, Abadio, Silva, & Castillo, 2005). A distinction between objective knowledge (as in a test asking questions about characteristics of the technology) and subjective knowledge (the idea of the participants they know enough) is often made. It has been shown that both types of knowledge tend to lower risk perceptions, however they do so differently (Klerck & Sweeney, 2007). Measuring objective knowledge is difficult however; as evidenced by the broad range of different questions used. In addition, the test questions tend to reflect topics of importance in the mind of the food technologist, which may not necessarily align with relevant technology characteristics from the consumer point of view.

Combined qualitative and quantitative approaches

Besides the frequently studied determinants for acceptance (risk perception, benefit or quality perception, trust and knowledge, see Table 3.2), specific determinants are often only partially known. Qualitative methods are a good way to add those. By creating multi-method research that include less restricted, qualitative or mixed methods the necessary ecological validity and the chances of identifying all factors of relevance can be increased (Barrios & Costell, 2004; Iop, Teixeira, & Deliza, 2006; Jaeger, 2006). Multi-method approaches remain scarce however, with only ten out of 84 papers reporting more than one type of method. Three of those papers combine rating of laboratory versions of a potential future product on sensory attributes (quantitative) with interviews, to investigate to what extent sensory and attitudinal constructs interact. From these preliminary results it appears that the knowledge that a product is created with a positively perceived technology shifts sensory appraisal towards a more positive judgement, and vice versa for negatively perceived technologies (Caporale & Monteleone, 2004; Jaeger, 2006); therefore the current practice of sensory testing without providing the context of the used technology will only give a partial answer to consumer acceptance of new products; and information on the technology should be consistently varied to arrive at the best possible prediction of even sensory acceptance of products.

For answering technology-specific research questions, where the specific properties of a technology have not been studied in detail, further development of mixed methods holds great potential as it combines the possibility to quantify results with a method sensitive to pick up on the specific properties of the technology.

3.4 Technology or product with embedded technology

In the studies it can be noted that there are two streams of research for on consumer opinions about new technologies. A first stream estimates consumer response towards a new technology based on fictitious applications of the new technologies within a product, while the second stream of research investigates consumer response to the new technology on its own (cf, two roads to consumer uptake identified by Fischer, et al., 2013).

Consumer evaluations of a technology are investigated both at the level of the technology as a whole, and at the level of products embodying that technology. In the scientific literature that we are reviewing, the latter is often selected to provide consumers with a more realistic choice context, which is assumed to be a more relevant predictor for likelihood of success of food products developed with the new technology (Krystallis, Linardakis, & Mamalis, 2010), although several studies investigate technology acceptance in general (Verdurme, Viaene, & Gellynck, 2003), or use the product to arrive at the valuation of the technology attribute in context (Siegrist, et al., 2009). With the exception of one study (Frewer, et al., 2003) that did not find differences when comparing products embodying technologies or technologies in themselves, there is little attention to the fact that this may lead to differences in opinion with consumers. In practice the choice to measure attitudes to and acceptance of a new technology in the context of product comparison or to measure generic attitudes aimed at the new technology in general occurs about equally often and seems mainly informed by pragmatic reasons undisclosed in the literature.

Characteristics of a technology studied as a product attribute do contribute to overall evaluation of future products (Iop, et al., 2006; Jaeger, 2006; Moskowitz & Hartmann, 2008), and are more important if the technology results in minor changes between products, as the innovative technology is the main distinguishing attribute between the products in those cases (Barrios & Costell, 2004). In these cases where the technology can easily matter it seems of more importance to study not only the technology in the context of a product, but also to understand the specific perceptions associated with the technology in itself (Barrios & Costell, 2004). Specific examples of what exactly this contribution might be to new-product development were however not identified.

Across all reviewed papers, the vast majority utilises hypothetical product descriptions, or technology descriptions. This creates a stream of information from consumers about possible future products and technologies that may be of particular use in the early stages of product and technology development. There are also a few papers that investigate scenarios discussing market introduction, or post market-introduction reflections of consumers. The information from these studies may be most useful for redesign of a product, or a market placement strategy.

3.5 Methods used, and comparability of results

It is of note that a number of the data-collection methods suggested as useful for the early stages of new-product development in previous reviews (e.g. van Kleef, et al., 2005) was not encountered (free elicitation; lead user analysis; Kelly's repertory grid; Zaltman metaphor elicitation technique; and Q methodology). On the other hand a single case of semiotic analysis, and a variation on a Delphi study was observed beyond those techniques identified in previous reviews. This indicates that there are several methods for extracting data from consumers that are either deemed to be insufficiently useful, or not sufficiently integrated in the toolbox of consumer researchers to be applied. It is outside the scope of the current report to evaluate reasons for limited use of these techniques in the context of (the implementation of) new food technologies, and how this affects extracting of information from consumers in detail. It is also argued that the current methods of eliciting information from consumers are limited in eliciting relevant future scenarios for the development of technologies, and consumer scientists should switch to interactive modes of communication with consumers (Moskowitz, German, & Saguy, 2005; Moskowitz & Hartmann, 2008).

Of those methods more frequently used, surveys are a relevant method when a clear a priori idea of relevant attributes and contexts is known (Barrios & Costell, 2004; Iop, et al., 2006). Reliance on single, small-scale surveys is an efficient type of data collection if specific research questions for specific applications of a technology exist. Such isolated surveys have, however, limited relevance to develop a more generally applicable resource for predicting consumer response. Merging data to form meta-data, or other systematic ways to aggregate data across multiple studies is required to more systematically investigate the specific contextual confounds in detail (Moskowitz, et al., 2005; Moskowitz & Hartmann, 2008). This will allow for better consumer understanding for consumer-oriented technology-involved new food-product development. Recent effort at creating systematic reviews and meta-analysis on, for example, genetic modification will partially fill this gap (see e.g. Frewer, et al., in press not identified within the current search; Lusk, Jamal, Kurlander, Roucan, & Taulman, 2005), although the comparability of data and the difference in quality of published literature is too large to make detailed predictions. In an ideal world there would be a limited range of generally accepted methods and tools, subjected to rigorous development and validation. Although this has been realised for some time (Churchill, 1979 not from the current review) in practice a broad range of techniques and measures remains used.

In spite of the frequent use of similar constructs (risk perception, benefit perception, trust, knowledge, attitude, willingness to pay) there are only a few commonly adopted measures. The lack of generally agreed upon theories make the difference in results large, and the comparability of information extracted consumer information low. Many papers did not provide the exact question used nor a reference to a paper where the items were derived from, making aggregation and/or replication of the data difficult. In the 34 papers that provided the items in full, the number of different and/or self-created items formed the

vast majority; this shows that scales are selected based on the individual study, with little attention for aggregation of data for more comprehensive use. Only three papers used the same scale for attitudes, the scale originally developed by Bredahl (2001), and also used by Chen in two papers (Chen, 2008; Chen & Li, 2007). Sensory tests in developing products sensory acceptance were somewhat more consistent by using the same acceptance scale in five different papers (Peryam & Pilgrim, 1957).

To create theoretical models, causal relations need to be established to create internally valid models (Jaeger, 2006). In case of experimental designs the causal effect is clear (Da Costa, 2000; Deliza, et al., 2005; Frewer, Kole, Van De Kroon, & De Lauwere, 2005); but even in experimental studies, the range of different variables and products shows little sign of convergence towards a generally agreed upon theoretical framework at present.

The lack of integrative models for contextual effects (Moskowitz, et al., 2005) makes it difficult to define a relevant and complete set of a priori determinants, to be measured in consistent ways. The few papers starting from a coherent theoretical model often use the theory of planned behaviour (Ajzen, 1991 not in the current review) with straightforward application to food (e.g. Saba & Vassallo, 2002). Other studies add variation, for examples by showing cultural differences in the regression weights in the theory of planned behaviour (Chen & Li, 2007), add selected determinants to the theory of planned behaviour (Spence & Townsend, 2006), or aim to integrate the theory of planned behaviour with the model proposed by Bredahl (2001), thus contributing to theoretical synthesis (Chen, 2008). Many papers, however, use other determinants, making comparisons difficult. Collecting the generic attitude and its determinants towards the technology, is hampered by the lack of knowledge and foresight capacity of consumers, which are likely to make any conclusions tentative, and open to change during technology development (Moskowitz & Hartmann, 2008) even during interviewing. This makes the predictive power of any results subject to either random or systematic changes. Even the best outcomes will therefore only provide a partial prediction of success in developing positively perceived technologies and their applications.

Evidence-based overviews do require that substantial numbers of publications are available for such overviews. This makes it difficult to arrive at robust ideas of factors driving consumer acceptance of new technologies in the early days of technology development and implementation based on the current literature. More coordinated data collection to allow comparability might help to overcome this to some degree.

3.6 Contribution of the published research towards marketing strategies: what to communicate, when.

The reviewed literature provides information about consumers' views on technology, which can be useful to food technology development; for example by warning food developers what technology attributes will raise risk perception, or to what extent initial attitudes are likely to be negative. In addition, the literature gives insight in properties of a technology a

consumer assesses as positive, and insight in differences between consumers. By actively creating technology and derived products in ways that reduce these perceptions, success rates may be improved. Alternatively, by having a good knowledge on positivity and/or negativity of public response, expected volumes at certain prices may be estimated more accurately; which may influence business development before major investments has been committed to.

There is little to no evidence of follow up in these sources on whether this information is taken up by the technical community, nor is there much information about eliciting consumer needs and wants of attributes of a technology itself. Although this may be, in part, due to limitations of the search strategy, the lack of any evaluation in the published literature of the actual influence the consumer data has on business decisions (reported in not a single paper) as well as the lack of clear recommendation to business (except for 3 papers Montri, Kelley, & Sánchez, 2006; Posri, et al., 2006; Sparke & Menrad, 2011), implies that there is little attention in scientific practice to investigate uptake of consumer research. Twenty five papers do give some suggestions for use of the data and how to collect more data on substantive phenomena such as the need for more cross-cultural comparisons (Costa-Font & Gil, 2009; Lusk, et al., 2006) and the suggestion to use specific methods or combinations of methods more frequently (e.g. Krystallis, et al., 2010; Olsen, et al., 2011). However, these recommendations are more scientific in nature and directed at improving consumer science as a discipline in itself. A total of 57 out of 84 papers do not make any suggestion about the use of the paper to further societal of scientific development of the field beyond the data reported in the paper.

3.7 In summary

In sum, when developing novel food technologies :

1) Studies into consumer communication, or opinion elicitation to inform business should aim to quantify well established determinants of acceptance in order to either predict acceptance, or to develop technologies in such a way that barriers to acceptance are reduced: Risk perception, benefit perception, attitude and/or intentions, knowledge and trust.
2) Consumer communication to business should aim to identify specific perceptions that are unique to the technology or application under development;
3) Consumer communication to business should aim at developing more generic insights how different perceptions relate to each other; this will provide better insight to new technology developers what to do in completely new situations; those where no data is available yet.
4) Consumer communication to business should aim at eliciting opinions on the technology, either in isolation, or derived from hypothetical product embodying the technology. Combining these approaches may lead to better understanding of the complexities of different levels of abstraction (Daamen, Van der Lans, & Midden, 1990) although the

single paper in the current review that compared technology in general with specific applications did not show conclusive evidence for such differences (Frewer, et al., 2003)

5) Consumer communication to business should be followed up by an evaluation of the extent to which the information provided by consumers actually leads to more success in food technology development and implementation, to allow for a true assessment of the efficiency and effectiveness of information about consumers' opinions and the methods for eliciting that.

Table 3.2: Collection of consumer information on acceptance new technologies for use by business

What information does the business need from the consumer / How does the business extract that information	Total	Acceptance or Attitude [b,e] 62				Risk perception [a,c,d,e,f]	Perceived benefit [b,c,d,e,f]	Perceived quality [b]	Awareness and Knowledge [c,d]	Trust [a,c,d,f]	Values and ethics [d,f]	Socio-demographics
		Generic attitude	Contextualised	Combination of context and free	Sensory							
	24	24	3	11	25	33	30	18	15	16	23	
Measure description												
• Items not provided and not sourced		2	2	0	0							
• Items partially provided, and not sourced		2	0	1	0							
• Items not (fully) provided, reference to source is given		3	1	0	0							
• Items provided in full, no or incomplete reference to source provided		6	8	2	3							
• Items provided in full and reference to source provided		7	0	0	8							
• Sources		twice (Bredahl, 2001); 5 times previous work by same author team	No source more than once, twice previous work by same author team	N.A.	5 times (Peryam & Pilgrim, 1957)							
Type of Research Question												
o Qualitative / Exploratory	9	1	1	0	3	1	2	4	1	1	1	1
o Quantification	76	17	24	2	11	22	29	28	15	13	15	21
o Theory testing	10	9	0	1	0	6	6	2	5	3	1	1
o Evaluation of uptake by technology developers	0	0	0	0	0	0	0	0	0	0	0	0
Data collection techniques (based on Grunert et al., 2008; van Kleef, et al., 2005)												
Qualitative												
• Interview	8	1	1	0	0	3	5	2	1	0	2	1
• Focus group	8	1	3	0	0	2	2	3	1	2	1	1
• Observation	1	1	0	0	0	0	0	0	0	0	0	1
Quantitative												
• Survey	36	20	3	2	2	18	18	10	14	12	11	12
• Sensory testing	13	0	1	0	10	0	0	9	0	0	0	1
• Experiment	17	2	10	1	2	3	5	6	1	2	2	3
• Conjoint	8	0	8	0	0	0	5	5	1	0	0	6
Hybrid												
• Laddering	3	1	0	0	0	0	2	2	0	0	0	0
• Delphi	1	0	0	0	0	1	1	0	0	0	1	0
• Semiotic	1	0	0	0	0	0	0	0	0	0	0	0
Number of methods mentioned in a paper												
• 1	73	22	22	30	8	24	30	24	18	14	15	21
• 2	9	2	2	0	3	1	2	5	0	1	1	2
• 3	1	0	0	0	0	0	1	1	0	0	0	0
Type of product sampled												
- Hypothetical	41	18	3	19	1	12	19	15	10	8	7	15
- Test product (not intended for sale)	8	0	0	0	8	0	0	5	0	0	0	0
- Finished product pre-market	4	2	1	0	1	2	2	1	1	1	0	1
- Available product	8	4	4	0	1	4	4	2	2	1	3	3
Technology												
- Genetic modification	27	12	11	3	1	12	13	5	8	7	6	8
- Functional foods	15	4	6	0	5	1	4	8	2	1	0	6
- Internet shopping	3	2	1	0	0	1	1	0	1	0	1	0
- HPP/PEF	4	1	3	0	0	0	4	3	0	1	1	0
- Irradiation	2	0	1	0	1	0	0	1	1	0	0	1
- Nanotechnology	1	0	1	0	0	0	1	1	0	0	0	0
- Pesticides	1	1	0	0	0	0	0	1	1	0	0	0
- Mechanical production systems	2	2	0	0	0	0	0	1	0	1	2	1
- Other	7	2	1	0	4	0	2	3	0	0	0	2

4. Results on Communication from Business to Consumer

Once a technology or a product embodying that technology is envisioned or developed it is important that consumers are informed about it, although communication about a technology under development might be advisable, if only for reasons of transparency. This might be because the technology has resulted in novel food attributes that are desirable to the consumer and hence can lead to a price premium. Of course the product will only have a competitive advantage, if they know about the added benefit. Alternatively, for ethical or legal reasons, or to maintain consumer trust, a food technologist may need to communicate about the technology to the consumer, even if no clear consumer benefit can be identified. In the following section, the research on ways in which producers can communicate a food technology or its implementation in a product to the consumer is reviewed.

4.1 Keywords and coding scheme

To establish a list of keywords related to business to consumer communication, eight essential marketing communication methods have been identified from previous research: (1) General information (public understanding of science) (Young, 2003), (2) Advertising (Steenkamp & Gielens, 2003), (3) Labelling and certification (Cowburn & Stockley, 2005), (4) Price, (5) Sales promotion, (6) Product placement, (7) Public relations, and (8) Branding. In addition, previous research lists communication vehicles (medium) which are used to reach the consumer: printed communication (Wilson & Sherrell, 1993), oral communication (Wilson & Sherrell, 1993), on-pack communication, audio and video communication (Wilson & Sherrell, 1993), online communication and word-of-mouth. Finally, dissemination of information regarding a new technology may be based on different communication sources. Based on the literature (e.g., Siegrist, Cousin, Kastenholz, & Wiek, 2007), we distinguished the following communication sources: company, experts, or government.

The part of the search string incorporating these keywords can be found in Table 4.1. In a similar manner as the previous section, the review will follow a two-step approach, where the main conclusions from identified review papers will be used as a starting point for a more cursory analysis of the identified empirical studies.

The search was conducted on 2 July 2012 in Web of Science, which yielded 886 papers, and in Scopus which yielded 1986 papers. After combinations of these lists and automatic removal of duplicates, 2468 papers remained for coding. In addition, after limiting to papers with the word consumer in the title or the abstract, 1963 abstracts remained.

4.2 Results

532 papers were eliminated because they suggested that the paper did not contain any empirical consumer behaviour research. A further 587 papers were eliminated because the abstract suggested that the paper was not about the introduction of new technology. 209 more papers were eliminated because they were outside the food domain. 346 more papers were excluded because they did not seem to be about business to consumer communication. Finally, 171 papers were eliminated because they were duplicate, not published in English or outside the time frame.

After screening of the abstracts, 129 papers were judged to be relevant. Out of these 129 papers, 24 papers were irretrievable. Of the remaining 105 papers, 53 papers contained relevant empirical data on communication to consumers with regard to new food technology and an additional 15 non-empirical papers gave an overview or suggestions how to communicate new food technology to consumers. Papers that did not contain data on consumer communication of the new food technology (n =9), that are not dealing with new food technology (n = 11), papers that are not dealing with consumer research (n = 4), papers that did not contain empirical research (n = 2) or a combination of these reasons (n = 11) were excluded. Twenty papers reported a sample representative of the overall population, 14 a convenience sample, and 17 a representative sample from a specified target group. Examples of specific target groups are consumers who are primarily responsible for purchases, women shoppers, or consumers within a specific age range. Data in the studies was collected between 2000 and 2009. The number of participants ranged between 30 and 3275 (Median=349 – p25=107, p75=564 participants). Most studies are from the USA (12), followed by Brazil, Canada (each 4), Australia, Greece, and the Netherlands (each 3). Most of the empirical work conducted in the investigated papers are quantitative studies. 25 papers (47% of the studies) are based on surveys, and 21 papers (40% of the studies) contain experimental studies, out of which 40% is some kind of conjoint experiment. In contrast, only 7 (which equals 13% of the examined papers) papers contained qualitative studies (4 focus groups papers, 2 case study papers and 1 laddering interview paper).

With regard to the target technology, out of the total of 68 papers, 35 papers were about genetic modification, 9 papers described functional foods, 5 papers dealt with food irradiation and 4 papers discussed high pressure technology. Eight papers were talking about new food products in general, without mentioning a specific technology.

Table 4.1: *search string used for business to consumer communication search*

Scopus	Web of Science	Remark
TITLE-ABS-KEY	TS=	Search in paper title, paper abstracts and provided keywords.
((communicat* OR "marketing" OR advertis* OR label* OR certif* OR endors* OR educat* OR inform* OR promot* OR messag* OR introduc* OR "academic outreach" OR "science communication" OR "technology communication")	((communicat* OR "marketing" OR advertis* OR label* OR certif* OR endors* OR educat* OR inform* OR promot* OR messag* OR introduc* OR "academic outreach" OR "science communication" OR "technology communication")	Include key terms identified from the review papers
AND (technolog* OR engineer* OR innov* OR (genetic* OR pesticid* OR irradiati* OR sterali* OR fortifi* OR synthetic OR colo* OR nano* OR protect*))	AND (technolog* OR engineer* OR innov* OR (genetic* OR pesticid* OR irradiati* OR sterali* OR fortifi* OR synthetic OR colo* OR nano* OR protect*))	Limit to papers mentioning food relevant novel technologies
AND (food)	AND (food)	Limit to papers that at least mention food
AND (consumer)	AND (consumer)	Limit to papers that at least mention consumer
AND (product*)	AND (product*)	Limit to papers that at least mention products
AND (research))	AND (research)))	Limit to papers that mention research
AND (LIMIT-TO(DOCTYPE, "ar") OR LIMIT-TO(DOCTYPE, "re")) AND (LIMIT-TO(PUBYEAR, 2012) OR LIMIT-TO(PUBYEAR, 2011) OR LIMIT-TO(PUBYEAR, 2010) OR LIMIT-TO(PUBYEAR, 2009) OR LIMIT-TO(PUBYEAR, 2008) OR LIMIT-TO(PUBYEAR, 2007) OR LIMIT-TO(PUBYEAR, 2006) OR LIMIT-TO(PUBYEAR, 2005) OR LIMIT-TO(PUBYEAR, 2004) OR LIMIT-TO(PUBYEAR, 2003) OR LIMIT-TO(PUBYEAR, 2002) OR LIMIT-TO(PUBYEAR, 2001) OR LIMIT-TO(PUBYEAR, 2000)) AND (LIMIT-TO(LANGUAGE, "English")) AND (LIMIT-TO(SRCTYPE, "j"))	AND Language=(English) AND Document Types=(Article) Timespan 2000-2012	Limit to article or reviews published in scientific journals in the English language between 2000 and 2012
Scopus: 1986	Web of Science: 886	Number of hits in search conducted on 2-7-2012
572 duplicates between Scopus and Web of Science: 2300 Unique references		
Exclude papers that do not have the word “consumer” in either title or abstract (n-337): 1963 papers dealing with consumers		
N=532		Consumer opinion is not central to the research
N=587		Technology opinion not central to the research
N=209		Food is not central to the research
N=346		No [consumer-to-business/ business-to-consumer/ Interactive] communication aspect reported in paper
N=171		The papers is a (1) Duplicate (2) Non English (3) No journal paper (4) Outside time frame
Papers from review on C2B and Interactive communication: N = 11		
Paper for inclusion: N=129		
N=24, leaving 105 papers to be coded.		Non retrievable

4.3 What do we learn about communication stream from business to consumers: Successful ways to communicate about new technologies

New technology features need to be convincingly and responsibly communicated to consumers, which requires a careful selection of the types of risks and benefits to communicate, the level of detail provided to consumers, and the ascribed role (e.g., replacing existing foods or introducing new type of foods) (van Kleef, van Trijp, van den Borne, & Zondervan, 2012). Most papers assess efficacy of a communication of a technology to consumers by measuring consumer evaluations operationalized as: acceptance, attitude, risk perceptions or benefit perceptions. Messages should be designed such that consumers find them believable and that they also convince consumers that making healthy or profitable food choices is achievable (Deliza, et al., 2005). In this respect, information about a consumer health benefit can reduce perceptions of risks (Brown & Ping, 2001). In addition, it is necessary to be explicit as possible in how products are produced and therefore it is worthwhile to test comprehensive information surrounding a product regardless of whether there is a mandatory obligation to provide such information (Evans & Cox, 2006). Finally, the expert view of what is important in the acceptance of a new food technology may not tally with the public view. This implies that communicators must not solely rely on expert views of what should or should not be communicated towards consumers (Frewer, et al., 2003). Other studies tapped into the discussion between voluntary and mandatory labeling. Findings show that voluntary labeling has a longer breath than mandatory labeling. According to (Phillips & Corkindale, 2002, p. 119), proactive labelling efforts, which offer consumers real and transparent choices, have been successful in the past.

When it comes to new technologies, most people do not like change. Indeed, new innovative products will almost certainly trigger some level of fear, uncertainty, or doubt (Phillips & Corkindale, 2002). This “emotional dimension” of concerns about technology’s potential risk and threats to public health or the environment is less readily addressed and can have a profound impact on consumers’ acceptance of new technology (D'Souza & Quazi, 2005). Overcoming such emotional responses cannot be achieved simply through straightforward marketing campaigns (Phillips & Corkindale, 2002). Specifically for food, it appears that consumers like better, and feel more positively toward, food labels with a more neutral word like "engineering" than labels with an emotionally charged word like "biotechnology" or "genetic modification". Only 7 papers explicitly focused on emotions. Some recommendations are provided regarding emotions nevertheless. For example, (Klerck & Sweeney, 2007) state that consumers should be diverted from a mentality of fear and actively engaged in a cognitive evaluation process that is based on salient risks and benefits. Managers must identify the causes of psychological risk to address these concerns in their communication strategies (Klerck & Sweeney, 2007).

A number of studies focused on the role of branding in communicating a food technology. First, (Verdurme, et al., 2003) indicated that consumers are much more willing to purchase leading branded GM food products than generic GM foods as consumers are more familiar towards leading brands. In this respect, using a familiar brand might facilitate the acceptance of genetically modified foods (Baker & Mazzocco, 2005). Furthermore, branding may be particularly effective when coupled with a beneficial product property such as enhanced nutrition, longer shelf life, or a distinctive flavor (Baker & Mazzocco, 2005). Finally, government sponsored certification may help protect a company's brand name by providing independent verification of the safety of foods sold under its brand (Baker & Mazzocco, 2005).

For food technology developers to communicate effectively to the public and consumers, they need to carry out careful research of the different audiences to which they want to communicate (Bubela et al., 2009). Each of these different audiences need a different approach, since trust and the perception of media portrayals will vary by an individual's social identity and values. This implies that for each type of audience, scientists need to switch the 'frame' by which they communicate about a scientific topic. Or, as said by (Bubela, et al., 2009, p. 517) "drawing upon research to explore alternative storylines, metaphors and examples that more effectively communicate both the nature and the relevance of a scientific topic."

Different audiences can be identified by segmentation of the market. A segmentation approach has several aspects. It is best to first target those consumers who first adopt new foods (the so called early adopters) (Arvanitoyannis & Krystallis, 2005; Baker & Burnham, 2001). These consumers have the greatest potential to perceive consumption benefits of novel foods based on new technologies as more important than their inherent risks (Arvanitoyannis & Krystallis, 2005). Another successful approach can be to identify a specific target such as supermarket shoppers (Deliza, et al., 2005; Deliza, Rosenthal, Hedderley, & Jaeger, 2010; Kim & Boyd, 2006), consumers primary responsible for shopping (Rimal, McWatters, Hashim, & Fletcher, 2004; van den Heuvel, van Trijp, Gremmen, Jan Renes, & van Woerkum, 2006; Van Kleef, Van Trijp, Luning, & Jongen, 2002), specific age groups (Heiskanen et al., 2007; Qin & Brown, 2006) or a specific gender (Heslop, 2006; Rousu & Lusk, 2009). Communication should be targeted at those consumers for which the technology could provide a solution to overt or latent demand. Achieving trial and subsequent consumption of GM foods may need to be directly prompted by targeted marketing to those for which GM may fulfill an otherwise non achievable demand (Phillips & Corkindale, 2002, p. 117). However, before targeted communication could take place, this also implies that new product development should be focused on those products that provide a substantial benefit for at least a specific group. Depending on the segmentation of the market, different segments should be targeted at different phases of product development (i.e., clinical studies, public relation or advertising) (Mark-Herbert, 2003).

Finally, it is important to communicate not only with consumers, but also take account of the viewpoints and communication by other stakeholders and to recognize the differing

assumptions and imperatives of scientists, journalists and key publics (Bubela, et al., 2009). By involving dominant stakeholders in the communication possible controversial issues could be resolved (D'Souza & Quazi, 2005). This allows marketing communication to manage negative news about and campaigns against new food technologies. When introducing new food technologies involvement is needed by a variety of stakeholders like physicians, pharmacists, other health practitioners, the business community, and the ultimate consumers (Crawford & Leventis, 2005). Especially when developing novel technologies that contribute to health "success will come from working together between private-sector food companies and public health or development professionals to create the demand for fortified products by tailoring products and communicating the benefits of the fortified product to each particular audience." (Griffiths, 2003)

4.4 Technology or product with embedded technology

Comparable to consumer evaluations of a technology, communication to consumers can both be at the level of the technology as a whole, as well as at the level of products embodying that technology. Providing general information about the technology (public understanding of science) receives substantial attention in the literature. In these studies, there is a rather one-sided emphasis on consumer perception type constructs like acceptance, attitude, risk perception en benefit perception en knowledge. However, as concluded by Phillips & Corkindale (2002), consumer adoption of the technology and subsequent market growth through the route of communicating the benefits of a technology in general is hard to achieve (Phillips & Corkindale, 2002). Instead, they suggest that acceptance of new technologies may be more successful as consumer evaluation would be directly prompted by personal and relevant benefits that are present in the product. Stated differently, people will buy what they see, need, and benefit them (Phillips & Corkindale, 2002, p. 117). It is better to communicate as context-specific and concrete as possible. For example, (Aerni, Scholderer, & Ermen, 2011) argue that once consumers are confronted with a real product that contains a new technology, they tend to switch from a general mode of acceptance or rejection of the technology to a more differentiated mode in which the technology is assessed in the context of the particular qualities and the price of the product (Aerni, et al., 2011). In addition, (Barrios & Costell, 2004) state that the effect of a new food technology needs to be studied within a relevant context of other attributes to arrive at a fair prediction of consumer behavior (Barrios & Costell, 2004).

Based on the review, we can conclude that those studies that examined real products with a technology mostly focus on the market introduction or post-market introduction stages. However, while there is overwhelming evidence that the actual product evaluation and acceptance will determine technology acceptance to a major extent, the majority of the studies that we reviewed used hypothetical products or product descriptions instead of real products.

Furthermore, it is striking that so few papers pay attention to other marketing communication methods than labeling, pricing or branding that are available and test their effectiveness. Some communication methods that were occasionally mentioned in the papers are: health claims, product appearance, packaging, product info (expiry data, ingredients), country-of-origin, taste. No papers were identified that studied sales promotions or product placement. Apparently, within the food domain, these tools are not examined in combination with communication of novel technology.

4.5 Methods used, and comparability of results

With regard to the way of communication, most papers examined printed information (42% of the studies) or on pack information (15% of the studies). Moreover, most studies looked at company or government as communication sources. Also, experts are relatively often mentioned as communication source.

Sixty two percent of the studies mentioned a construct related to acceptance of the technology (buying intention, willingness-to-pay, product choice) and another 51% of the studies contained a construct related to attitude towards the technology (attitude, preference, etcetera). Other constructs that are mentioned in the reviewed papers are emotions and concerns (13%), associations (19%), risk perception (38%), benefit perception (34%), awareness and knowledge (38%), trust (21%) and socio-demographics (51%) (see Table 4.2).

Finally, other relevant aspects with regard to communication to consumers mentioned in the papers are: communication format (FAQ, Case study, Flowchart), message framing (positive/ negative); Agreement between experts; Beneficiary stakeholder group (consumer/ science/ industry).

As with the communication stream from consumers to business, there is little convergence in the measures for success. In addition, since the specific characteristics of the product or technology communicated about differ between studies, comparison and generalisations are hard to achieve.

4.6 Contribution of the published research towards marketing strategies: what to communicate, when

The reviewed literature provides information about communicating new technology to consumers, which can be useful to food technology development; for example by helping food developers what type of message framing could help to lower risk perceptions of consumers, or what kind of labelling proves to be more successful. Information about the technology, including such information presented on labels or in advertising can contribute to public acceptance.

However, important communication channels in the acceptance and diffusion of innovations, like online communication or the role of word-of-mouth communication are hardly investigated, which seem to be in contrast with the fact that general marketing literature underlines their importance, for example in the literature on diffusion of innovations. One of the main instigators that could help new products to cross the chasm between being a success in a niche market of innovators and being a public success is by means of effective word-of-mouth. Evidently, the literature focuses on communication aspects that are measurable and are within the direct control of the company. In addition, the use of information technology has the potential to facilitate communication between the product development team and the consumer (Dahan & Hauser, 2002). Today it is possible to generate food product concepts qualitatively from consumers as well as to test them 'on-line' using consumer panels thereby minimizing risk and speeding time to market (Dahan & Hauser, 2002, p. 63).

The current review shows that aiming the right message at the right people is very important. Segmentation approaches either aimed at identifying early adopters, or specific target groups, can be useful to identify whom to aim the message at. However, no clear suggestion how to differentiate communication between identified target groups was identified in the literature.

Stakeholder management is another important facet that should be taken into account in the communication of new technologies. However, relatively few information on this aspect could be retrieved from the papers, which is at least partially due to the fact that we did not explicitly searched for papers that deal with other stakeholders besides consumers.

4.7 In summary

In sum, based on the review of the literature we can conclude that:

1) Communication to consumers should focus on different formats and framings of communication messages within a product-specific context instead of providing general information;
2) Communication to consumers should not only take cognitive, rational aspects into account (cost-benefits considerations), but also pay attention to consumers' emotions;
3) Communication to consumers should identify, develop and test communication methods for different market segments;
4) Communication to consumers should allow for a broad approach of technology communication, in which also communication to and from relevant stakeholders is included.

Table 4.2: Overview of communication constructs in reviewed papers

What consumer behaviour determinant does the business wants to affect / How does the business do that (communication method)		Acceptance	Attitude	Emotions and concerns	Associations and Beliefs	Risk perception	Perceived benefit	Awareness and Knowledge	Trust	Socio-demographics
	N=68	33	27	7	10	20	18	20	11	27
WHAT – technology										
• General information	18	8	8	4	5	8	9	8	4	10
WHAT – product										
• Advertising	3	0	1	0	0	0	0	1	0	1
• Labelling and certification	20	9	8	0	2	9	5	9	3	7
• Price	13	9	7	1	0	4	0	5	2	10
• Sales promotion	0	0	0	0	0	0	0	0	0	0
• Product placement	0	0	0	0	0	0	0	0	0	0
• Public relations	1	0	0	0	0	0	0	0	0	0
• Brand	11	8	7	0	1	3	1	3	1	8
HOW – way of communication										
• Oral	1	1	1	1	1	1	1	1	1	0
• Print	22	12	10	4	5	9	9	8	6	10
• On pack	8	6	5	0	2	2	2	3	0	4
• Audio and video	2	1	1	0	0	1	1	1	0	1
• Online interactions/ Social media	0	0	0	0	0	0	0	0	0	0
• Word-of-mouth	0	0	0	0	0	0	0	0	0	0
WHO – Communication source										
• Company	9	7	5	1	1	5	1	3	1	4
• Experts	4	2	3	0	1	2	2	1	2	0
• Government	7	4	3	0	1	5	3	3	2	3
When in product development (phase)										
- Hypothetical product	35	21	17	2	5	15	12	11	8	18
- Idea formation	0	0	0	0	0	0	0	0	0	0
- Prototype	3	2	3	0	1	2	2	1	1	0
- Pre market	2	0	0	0	1	0	0	0	0	0
- Market introduction	4	2	2	2	0	1	0	2	0	2
- Post market	6	3	2	1	0	1	0	2	0	3
Which technology										
- GM	35	19	14	4	5	16	14	13	7	13
- Functional foods	9	4	3	1	0	0	1	1	3	5
- Food irradiation	5	3	2	2	1	2	2	5	1	4
- High pressure processing	4	2	3	1	2	0	1	0	0	3
- New foods in general	8	2	1	0	1	0	1	0	0	1

5. Results on Co-Development

For technology and new-product developers it is often difficult to fully anticipate how their technologies and the products embodying them will be interpreted, used, adjusted and further developed by the end-users in their daily lives (Von Hippel, 1976). End-users often have their own specific ideas about possible advantages, and about how these can be exploited and used for different purposes. They may also have specific ideas about limitations and how these can be coped with. Some of these ideas may concern desirable adjustments to the implementation of the technology and/or the design of the product. The involvement of end-users as stakeholders early in the development of a new technology or product embodying it, aims to capture the more actual-experience driven view that end-users apparently have to a larger extent than innovation teams, into the development process itself (von Hippel, 1986). This allows earlier usage of end-user evaluations on developed ideas and "up-stream" development, compared to feedback based on more traditional "downstream" market research after a particular product-development stage has finished (Nahuis, Moors, & Smits, 2012; also see Chapter 4). In addition, by presenting end-users with early ideas, the potentially changing demands under influence of new usage situations following from the proposed technology and products can be better incorporated into technology development, compared to infrequent sampling of end-user opinions at fixed points in time (as described in Chapter 3). This co-development approach, has its own challenges however. This section of the report reviews the current status quo of this approach relevant to the development of new food technologies and products embodying them.

5.1 Keywords and coding scheme

In the initial literature search, we used the keywords lead user, user innovation, co-innovation, co-design, and co-creation to find review papers from which additional keywords were to be extracted for the final search for research papers on interactive consumer-business communication in the new product development (NPD) process. The obtained reviews (e.g., Bogers & West, 2012; Greer & Lei, 2012; Hoyer, Chandy, Dorotic, Krafft, & Singh, 2010) suggested to include as additional (combinations of) keywords: collaborative/participatory/distributed/user-centred/consumer innovation, consumer/public involvement/engagement/participation, crowdsourcing, and co-development. The part of the search string incorporating these keywords can be found in Table 5.1. The other parts of the search string are equivalent to those in rows 2 to 7 in Tables 3.1 and 4.1.

Table 5.1: Part of the search string for identifying research papers on interactive consumer-business communication in Scopus and Web of Science, and results of abstract screening

Part of Search String and Number of Identified Abstracts		**Remark**
Scopus	*Web of Science*	
TITLE-ABS-KEY	TS=	Search in paper title, paper abstracts and provided keywords.
(("lead user*" OR "collaborat* innovat*" OR "user innovat*" OR "participat* innovat*" OR "distribut* innovat*" OR ((consumer* OR public OR customer*) AND (involv* OR engag* OR participat*)) OR "crowdsourc*" OR "co-creat*" OR "co-innovat*" OR "co-desig*" OR "co-develop*" OR "co-production" OR "customer new product development" OR "user-centr* innovat*" OR "distributed innovat*")	(('lead user*' OR 'collaborat* innovat*' OR 'user innovat*' OR 'participat* innovat*' OR 'distribut* innovat*' OR ((consumer* OR public OR customer*) AND (involv* OR engag* OR participat*)) OR 'crowdsourc*' OR 'co-creat*' OR 'co-innovat*' OR 'co-desig*' OR 'co-develop*' OR 'co-production' OR 'customer new product development' OR 'user-centr* innovat*' OR 'distributed innovat*')	Include key terms identified from the review papers
Identified Abstracts: N=271	Identified Abstracts: N=90	Number of hits in search conducted on July 11th, 2012
Duplicates between Scopus and Web of Science: N=49 Unique references : N=212		
Results Abstract Screening		**Remark**
N=202		A. Consumer opinion is not central to the research
N=45		B. Technology opinion not central to the research
N=5		C. Food is not central to the research
N=4		D. No [consumer-to-business / business-to-consumer / Interactive] communication aspect reported in paper
N=0		E. The papers is a (1) Duplicate (2) Non English (3) No journal paper (4) Outside time frame
Papers for inclusion: N=5		
Papers not to be completely ruled out for inclusion: N = 23		

5.2 Results

Using the search string, 271 abstracts were retrieved from Scopus and 90 abstracts from Web of Science. Cutting out the overlap between Scopus and Web of Science, 312 unique abstracts remained. 150 of these abstracts were also identified in the search for research papers on consumer-to-business communication. Screening of the abstracts suggested that five papers were very likely to deal with the combination of consumer research, technological innovations in NPD, food products, and interactive consumer-business communication in the NPD process. For 23 abstracts it was decided that it could not be completely ruled out that the paper was about such combination. Of the remaining abstracts, 202 were eliminated because they suggested that the paper did not contain any empirical consumer behaviour research. A further 45 papers were eliminated because the abstract suggested that the paper was not about the introduction of new technology. Five more papers were eliminated because they were outside the food domain. Four more papers were excluded because they did not seem to be about interactive consumer-business communication in the NPD process.

Upon reading the total of 28 'very likely' and 'not completely ruled out' papers, it turned out that really none of the papers was dealing with the combination of consumer research, technological innovations in NPD, food, and interactive consumer-business communication in the NPD process (18 papers were excluded because they did not address empirical consumer research, 3 were excluded because they were not technology-related, 1 was excluded because of not food-related, 5 were excluded because they did not focus on close consumer-business interaction, and 1 additional publication because the full paper could not be retrieved). Two additional papers were estimated to be relevant for the close consumer-business interaction review while they were screened for consumer-to-business communication. Upon closer inspection, they also turned out to be irrelevant (one because of the description of the consumer research in the study was completely incomprehensible, and one because it did not deal with interactive consumer-business communication).

Our first conclusion therefore is that there is a severe lack in the academic literature of research papers dealing with the effectiveness of interactive consumer-business communication in NPD in the food sector involving the application of some new technology. A similar lack of research papers occurs in the somewhat related area of co-design toolkits for mass customization (Piller, 2004). Our review about do's and don'ts for interactive consumer-business interaction in NPD will therefore be based on two review papers (Munksgaard & Freytag, 2011; Sarkar & Costa, 2008), one sort of position paper (Moskowitz & Hartmann, 2008), and one case study (Rossi, 2011) that discuss such communication in the context of NPD in food, but without any link to the application of new technologies, and recent review and position papers on interactive consumer-business interaction in the NPD process outside the food domain, also without a focus on the application of new technologies.

5.3 What do we learn about interactive communication: How to facilitate the discussion and selection of topics of relevance

The idea of interactive consumer-business communication in the NPD process started with Von Hippel's (1986) lead-user approach. In this approach experienced employees from both marketing and technical departments first try to learn about the needs and usage behaviour of leading-edge users, after which they work together with them to transform preliminary into final concepts, which are then evaluated by the whole group (Lilien, Morrison, Searls, Sonnack, & von Hippel, 2002). Other names under which interactive consumer-business communication in the NPD process appears in the literature are user innovation, collaborative innovation with (individual) customers, and consumer co-creation (Bogers & West, 2012; Greer & Lei, 2012; Hoyer, et al., 2010).

The lead-user approach ranked as one of the Marketing Science Institute's top research priorities for 2008-2010, as it is assumed to provide companies with increased efficiency and effectiveness in all stages of the NPD process (ideation, product development, commercialization, and post-launch) (Hoyer, et al., 2010), but perhaps mostly in the early and the late stage of the NPD process (Munksgaard & Freytag, 2011). The latter authors mention both process-related advantages (faster and more systematic process, and improved internal collaboration) and output-related advantages (improved access to knowledge and ideas, more radical solutions, solutions that get better market acceptance, and increased public welfare). In the context of the implementation of new technologies in the food industry, the approach (and other open-innovation activities) has been emphasized by Sarkar and Costa (2008) as means "to enhance the public acceptance of emerging technologies and the success of products thereof" (p.575).

Several authors give prerequisites and guidelines for enhancing the efficiency and effectiveness of consumer-business communication in NPD. One prerequisite is that the participating consumers are both sufficiently knowledgeable and motivated to create innovations that meet consumer needs that have not been addressed so far (Bogers & West, 2012; Greer & Lei, 2012). As such, they should be able to give information about preferred features, design flaws, and different ways in which products are, or can be used (Greer & Lei, 2012), as well as about beliefs, values, habits, desires, motives, emotions, and needs, and finally rational, emotional, creative new-product ideas, and input for brand identity construction and enrichment (Rossi, 2011). Furthermore, they need to be proactive and have an internal locus of control (Greer & Lei, 2012). They typically are innovators (those who are the earliest to adopt new products), lead users (those who are the earliest to face needs that will be more generally felt needs at some point in time), emergent consumers (those who are especially capable of identifying product features that many consumers will find appealing and useful), and market mavens (those who have information about many products, the places where to buy them) (Hoyer, et al., 2010).

Participants' motivation to create innovations that meet consumer needs that have not been addressed so far, is crucial (Bogers & West, 2012; Greer & Lei, 2012). The motivation for consumers to participate in interactive consumer-business communication is not so much a monetary one. Greer and Lei (2012) even warn that extrinsic rewards can undermine creativity. Instead it can be a utilitarian one in the sense that they hope to be able to buy, at some time, products that better fit their own needs. Second, it can be hedonic as they may experience enjoyment, excitement, and fun due to the cognitive stimulation (Greer & Lei, 2012; also, see F. T. Piller, 2004, in the context of co-design for mass customization). Third, they might be motivated by the promise of some social status and sense of accomplishment and self-confidence, through the recognition of their ideas by the firm and other consumers involved in interactive consumer-business communication (Rossi, 2011). Fourth, they might be motivated by the possibility to gain technology, product, or service knowledge and finally also by altruistic reasons, as better products may be good for others (Hoyer, et al., 2010).

Piller (2004) states that the complexity and effort that co-design activities bring along may hamper the success of mass customization strategies and that there should be a balance between participant skills and the challenge of the task. This may be the reason for why, interactive consumer-business communication seems to be less prominent in industries in which high technical sophistication is needed (Greer & Lei, 2012). The effort that is required from consumers in the co-creation process can be reduced by using toolkits and by modularization of the process so that participants can focus on those particular aspects for which they feel most equipped and motivated (Greer & Lei, 2012; Hoyer, et al., 2010). Examples of such tools are the two methods discussed by (Moskowitz & Hartmann, 2008): Kearon's BrainJuicer®[1] and a method that Decision Analyst Inc. uses. Kearon's (2006) BrainJuicer® asks a number of identified 'gifted creatives' to online produce and rate a large number of innovative ideas. Decision Analyst Inc. uses a panel of creatives in 'virtual, time-extended multiple-day sessions' conducted with an online bulletin board (Namiranian and Ishmael, 2005[2]).

Information acquisition processes may be needed to overcome consumers': i) possible inability to express their needs, ii) possible inability to recall the problems they encountered, limiting effects of real-world experiences on their ideas, iii) lack of foresight, and iv) lack of experience (Greer & Lei, 2012). These barriers could be one of the reasons why participants tend to come up with incremental rather than radical new product ideas (Moskowitz & Hartmann, 2008). To arrive at more radical innovations, the company also put some 'own' ideas on the list, e.g. ideas that are in line with the company's development strategy (Rossi, 2011).

Setting up, conducting and implementing interactive consumer-technology dialogues is labour intensive. Participants typically react fast (Rossi, 2011), and therefore the firm has to make sure that consumers get immediate feedback on their input (Pillar, Schubert, Koch, & Moslein, 2005). It may even be necessary to develop some parallel short-time activities to show that the company holds its promises, especially to keep those participants interested

[1] See: www.brainjuicer.com/
[2] See: http://www.decisionanalyst.com/Index.dai

whose ideas are not selected for further consideration and elaboration (Rossi, 2011). At least, it has to be made clear in advance that realization of ideas can take very long, due to complexity of procedures and tests.

In spite of the high ambitions in these approaches, to date there is little empirical evidence, apart from a few case studies, in the academic and practice-oriented peer-reviewed literature for open-innovation practices, their rationale, and their market outcome in the food sector (Sarkar & Costa, 2008). Moskowitz and Hartmann (2008) do mention two initiatives involving interactive consumer-business communication: BrainJuicer® and a panel of Decision Analyst Inc. In both these initiatives, creative consumers are asked to online produce and rate a large number of innovative ideas. Unfortunately, no empirical results are given from these initiatives, nor any recommendations for their application. Munksgaard and Hartmann (2011) reviewed a number of studies and concluded that none of them contained a check of whether the lead-user approach has led to higher returns or superior profit. At the same time, they state that management often saw considerable potential in continuing the approach.

In general, one can say that so far only very limited research has been carried out on interactive consumer-business communication, even outside the food domain, and many research questions still need to be addressed (Hoyer, et al., 2010). Form a practical point of view, challenges are to combine knowledge of consumer needs with knowledge about possible solutions, to make sure that the supply is continuous, to find a way to appropriate value from those innovations (there is the risk that participants mainly come up with ideas that are not so much preferred by the main market), and to address the issues of intellectual property rights.

5.4 Technology or product with embedded technology

The interactive communication mode can supply input of consumers in all phases of development, and may span multiple phases as a consequence of its iterative nature. Its application to new technology development has, however, been too scarce to distinguish between product or technology development to date.

5.5 Methods used, and comparability of results

Since studies on interactive consumer-business communication within the food domain are non-existent, nothing can be said about methods and comparability of the results. Instead, the relative novelty of the methods used in other domains, and the limited application has resulted in many challenges in creating generally agreed best methods and comparable results. Methodological challenges lie in developing best practice in the field and arriving at generally agreed rigorous reporting standards.

For implementation in food technology development, it should be noted that this mode is not suited for all situations. It requires a cooperative and open atmosphere. If food

technology developers are not willing to share their information with the public (e.g. because of secrecy of results), future application of interactive communication will be problematic.

5.6 Contribution of the published research towards marketing strategies: what to communicate, when.

Contribution of the published research towards marketing strategies: what to communicate, when Hoyer et al. (2010) claim that most firms are low on interactive consumer-business communication. This is especially the case in the food industry as it is more often associated with fast-growing, technology-intensive industries (information & communication, pharmaceuticals) (Munksgaard & Freytag, 2011; Sarkar & Costa, 2008). The lack of open innovation in the food industry may be due to the fact that consumers tend to be wary of radically new food products and changes in their food-consumption pattern (Moskowitz & Hartmann, 2008; Sarkar & Costa, 2008). Two additional reasons could be that 1) lead users in food (buying specialty foods) are really different from other consumers (buying mass-manufactured products), and 2) the food industry is characterized by dominating counterparts, such as retailers (Munksgaard & Freytag, 2011). Another reason may reside in the thought that consumers typically know what is 'today', and don't know about what will be tomorrow (Moskowitz & Hartmann, 2008). As an aside, Moskowitz and Hartmann (2008) notice that the focus in the food industry is not so much on product innovations, but more on innovations/expertise in marketing, packaging, distribution, and line extensions.

Interactive consumer-business communication is typically organized in communities in which there is a cooperative atmosphere that allows for idea generation by trial and error and in which consumers may elaborate on each other's ideas. Such interaction among consumers may reduce uncertainty and confusion. Therefore community management is very important (Bogers & West, 2012) and it may be facilitated by the internet (Greer & Lei, 2012; Rossi, 2011).

In return for the effort that participants put in expressing their needs and possible solutions, the company has to dedicate itself to evaluate, to study, to delve into, and to verify these solutions (Rossi, 2011), because, as in mass customization (Piller, 2004), trust, openness and empathy are very important (Greer & Lei, 2012). The company should guarantee maximum transparency in handling of information, keep the community up to date on the idea evaluation process, communicate in a clear and public manner on the feasibility of ideas, and give motivations for its final decisions (Rossi, 2011). This may however be at odds with the firm-level requirements of secrecy.

A condition sine qua non for successful incorporation of interactive consumer-business communication in the NPD process is that the activity should be fully embedded in the organization, which includes involvement and support of top-level management as well as inclusion of the approach in the company's code of conduct and encouragement and

rewards for employees that work with the method (Munksgaard & Freytag, 2011; Rossi, 2011). This is equally valid for firms that adopt the idea of mass customization (Piller, 2004).

5.7 In summary

In sum,

1. Interactive communication between technology developers and consumers remains a promising way forward, but current lack of evidence makes it hard to estimate the best practices for developing this type of communication;
2. Interactive communication between technology developers and consumers requires major commitment of food technologists to integrate this methods into their day to day practice;
3. Interactive communication between technology developers and consumers requires development of techniques to allow the involved consumers to form an opinion on future development paths of the technology.

6. Discussion and recommendations

The EU FP7 CONNECT4ACTION project aims to investigate communication between food technologists and consumer sciences. The objective of this study is to systematically extract key findings from the scientific literature on external communication between food technology developers, consumer scientists and the public. For this aim, a comprehensive review of the scientific literature is conducted to collate information on the communication between the food technology implementing businesses and the end-consumers. In this chapter, strategic implications of successful external communication are discussed based on the findings in the literature, followed by the specifics of these implications for practice (do's and don'ts).

Another goal of this review was to assess the relevance of the published body of papers in the advancement of food consumer science. Therefore, we performed a SWOT-analyses for public scientific research on new food technologies. Since this is beyond the main scope of this study, we incorporated this SWOT-analysis in the appendix (see Appendix),

6.1 How to communicate with the public

Communication with the public in the development of novel food technologies consists of two information modes, information from the public as input for the product development process, and public response to information from the company at different moments in the development of a novel product. Traditionally, these streams of communications have been studied independently.

At the start of the innovation funnel opportunities are explored by sampling information about the latent demand of consumers, these are subsequently communicated to food technology developers, who develop technologies and products. Subsequent product testing and communication of the new technology with consumers is than applied to explore appreciation of the novel technologies implemented into products.

This will always create some distance time between the two moments of communication between technologists and consumers (receiving consumer input, testing communication about the technology), which can result in a disconnect between demand and the realised product, especially in technologies in the early stage of the development this may lead to major differences between expectations based on initial consumer communication to food technology developers, and consumer evaluation of the communication of the finalised technologies or the product in which these are embodied.

To eliminate this disconnect between initial consumer demand elicitation and final products to be marketed in innovation science, there has been much emphasis on user-producer interaction or co-development where repeated interaction between technology developers and consumers to guarantee continuous communication and eliminate

unwanted disconnection between technologists and consumers. Interactive communication may replace or supplement classical techniques for communicating with the public, in particular those aimed at investigating consumer demand (chapter 3) and market research (chapter 4).

6.1.1 Consumer wants

Consumer communication can provide an early insight into potential problems in the technology under development. These insights can be collected by quantifying risk, benefit perceptions, attitude, knowledge of the technology and trust in the developers. Ethical views personal values, and awareness and knowledge of respondents with regard to the technology under investigation, are often studied in order to predict consumer response to new technologies. In addition, consumer segments are sometimes identified to understand different responses of specific consumer groups on novel technologies.

Additional issues of importance with the technology at hand should be elicited for each technology separately, as these will likely differ between technologies. Such insights are likely to be most relevant in the early stages of technology development when there is still sufficient possibility to adapt the technology. This in itself introduces the difficulty to ask the consumer to provide information about a technology in the context of a non-existing or abstract product. In the published literature there is little evidence that consumer demand is often included in the early stage of the development of a technology. Much of the effort appears invested in studying the demand for products that have specific end-user benefits that are created by the technology, rather than investigating response to the technology itself. To quantify existing ideas with the researcher, the technology or a hypothetical product can be introduced to the consumer in surveys and experiments, whose opinion is recorded. This results in information on consumer opinions on the technology in itself, or the contribution of the technology to the evaluation of a product. If societal demands are included into technology development itself, this is most frequently be adding technology assessment expertise to the technology development team (see e.g. Rip, 1995), while consumer research becomes active much closer to the moment the first generation of products embodying the technology enters the market.

Consumer researchers mainly apply surveys and experiments to quantify responses and interviews, focus groups and laddering interviews to identify technology-specific issues. In cases where these instruments do not deliver sufficient information other methods such as Q-sort, Delphi, or repertory grid can provide a bridge between identifying issues of importance, and quantifying consumer opinions. Alternatively, a multi-method approach can be adopted where an initial stage applying interview, focus groups or laddering is used to identify issues of importance followed by a survey or experiment to quantify these issues.

At the present time it is hard to generalise across previous research as there is little consistency in the adoption of measures. More consistent use of high quality, (cross)validated scales for these constructs would provide a much better baseline for future

comparisons. There is a call in several papers to work towards more generally applied instruments, and by adopting widely used scales a contribution to this demand can be made. This extends to the creation of descriptions, scenarios and/or hypothetical products applied to help consumers visualise the technology and form an opinion. At present, there appears to be little consistency or argumentation on how these scenarios are created, and scenarios are often not fully presented in the published paper.

6.1.2 Business to consumers

The literature reveals different positioning and communication strategies that can be used to communicate a product containing a new technology to the public. These strategies can be used at any stage in technology development and new product development. Besides the fact that we again (as was also the case in extracting consumer wants) observed a lack of consistent use of comparable methods and presentation of products, which hamper benchmarking over different technologies, we observed a number of other reasons why communication is hampered.

First, we see that both general communication strategies (for example, how to communicate about functional foods) and more specific forms of communication strategies (for example, labelling) are used. Sometimes, the technology itself is subject of communication, for example, by making use of hypothetical products that contain this technology, while other studies aim to look at the effect of communicating the technology in real products through labelling and branding. Nevertheless, it is clear that a lot of these studies have a lack of "context". Stated differently, they lack concrete and specific product information that is needed to allow consumers to provide their evaluation, including the technology attribute. A lot of studies solely focus on the technology and sometimes two or three other product attributes in a stylistic conjoint experiment. These studies miss the totality of the product experience (different qualities, feelings and price). Moreover, most of the times the role of broader marketing efforts (sales promotion, etcetera) are not taken into account. Also these studies lack a time perspective, for example by using longitudinal designs. It could be possible that people "learn to appreciate" a new technology. These processes are overlooked when making snapshots at single measurement moments.

Furthermore, we notice that both functional (product benefits) and affective aspects (emotions and concerns) are taken into account, but that functional aspects prevail. Moreover, ("cold") cognitions and emotions are poorly integrated. When communicating about a new product it is recommended to take account of consumer emotions towards a product, besides thoughts.

Literature on communication focuses both on communicating to the general population as well as communicating to specific segments. Different "frames" should be used for different groups. Besides the fact that a lot of studies specifically focus at "consumers who are primarily responsible for purchasing groceries", current literature lacks segmented communication approaches. It is interesting to provide and test different

information with different consumer segments in order to get insight in how to target specific target groups.

Finally, communication is mainly provided through printed information (leaflets, media) from the perspective of the actor that provides the product or technology. Other forms of communication are rarely studied. Almost no studies looked at the role of word-of-mouth communication and the effects of communication and information from other stakeholders in the chain as well as the media. Inclusion of other stakeholders in your communication efforts helps to anticipate possible controversial issues.

6.1.3 Co-development

The idea of interactive business-consumer communication in a co-development process seems to be a very attractive idea, and has been put forward by several authors as the way to go. These authors also give various recommendations for optimizing the effectiveness of such interactive business-consumer communication. Unfortunately, it seems that, at least in the academic literature that we investigated, a body of empirical evidence for its effectiveness is only starting to emerge, especially when it comes to new-product development in food and when it comes to the involvement of consumers into the implementation of new technologies in products. Of course, the opportunities for such communication are drastically facilitated by the birth of Internet 2.0, and the best is very likely still yet to come.

6.1.4 Absorption of information into technology development

While this has been the topic of the complementary review in this workpackage (Jacobsen, Lähteenmäki, Grunert, Dekker, & Steenbekkers, 2012), it is important to note at this time, that any information retrieved from the consumer can be relevant to food technology developers only if they manage absorb the information into the development process (Zahra & George, 2002). This requires that relevant information is acquired at the relevant time in development, is understood and assimilated into the goals of the development team, is transformed into technology requirements and is actually used to develop a technology. In the co-development literature the preparedness of organisation to absorb the outcomes of the communication is discussed as a boundary condition, without providing clear insight how this can be achieved. In neither the consumer to business, nor the business to consumer literature, much attention is given to the necessity of absorption of the information into the technology development team, or the evaluation of predictor for success and failure therein.

6.2 Do’s and don’ts in practice

A major aim of this review was to identify evidence-based strategies to external communication between food-technology implementing businesses and consumers that contribute to innovation success and on the specifics of these strategies (do’s and don’ts). In

this paragraph these do's and don'ts for each of the three modes of external communication are provided.

6.2.1 Do's and Don'ts in Consumer-to-Business communication

Do:

- Study consumer products in a realistic choice content.
    - To make clear assessments of consumer preferences or willingness to pay, hypothetical products or the measurement of attitude towards a technology in general often show limited predictive power for consumer behaviour. A realistic situation and consumer goal may solve this issue to some extent.
- Consistently use the same existing and validated scales.
    - To make claims about consumer behaviour in certain situations as compared to other situations, it is necessary to be able to compare consumer evaluations of different products, in different target groups, at different points in time. For that reason, it is essential that the instruments used are (1) of the highest possible quality, i.e. psychometrically validated, to be confident the measured consumer evaluation is indeed the one claimed and (2) of the same scale, to allow comparison of effects across different products samples and situations.
- Use multiple methods to triangulate towards real world effects, if one method is not certain enough.
    - The more evidence is available from different approaches that point in the same direction, the larger the chance that the identified consumer perceptions are indicative of consumer behaviour. If qualitative studies, perception studies and sales studies all point in the same direction a more confident decision can be made.
- Use the most relevant method to collect data to answer the specific research question.
    - Focus groups and other qualitative methods are good methods to identify topics of research and develop insights in consumer decision making, however, these methods are of limited use when specific preferences, situations and/or consumer segments are to be separated. In these case surveys and other quantitative methods are much more relevant.
- If aiming to study real world impact of research, make sure to include evaluation of real world impact.
    - For managing product introduction, it is important to consider to what extent consumer research is predictive of product success. These measures are extremely rare and limit efficacy of consumer research both in practice and in theory.
- Start building a body of evidence of interventions with effects in the real world.

- For future product introduction, it is important to consider what outcomes of consumer research are in reality predictive of product success. A database with evaluation of past performance of consumer studies on product introduction is likely to support future market introduction.

Do not:

- Overly rely on hypothetical products and situations to predict real world success.
  - Real world situations are much more complex than those presented in most hypothetical products and situations. Hypothetical products and situations are likely to deviate from the final product in many important ways. E.g. packaging design may influence choice to a large extent. Therefore, be aware that generalising results from hypothetical products to real world situations is not trivial, and will result in less strong predictions than might have been expected based on the tests with the hypothetical product.
- Assume that results of attitudes towards technology, measured in isolation, are strong predictors of product choice.
  - In real choice situations, attitudes towards technology are only one among many environmental and product-related factors that determine choice. Attitudes towards technology in isolation only predict a small amount of variance in product choices made. Other, situational factors such as consumer goals, fatigue, and the shopping environment at the moment of purchase maybe as much or even more influential than attitudes.

6.2.2 Do's and Don'ts in Business-to-Consumer communication

Do:

- Pay attention to other marketing communications methods besides labelling, branding and pricing and test their effectiveness in the context of new food technologies.
  - The toolkit for marketing communication is much broader than most of the studies reveal. Examples of possible marketing tools are advertising, sales promotion, product placement, direct marketing, social media. The effectiveness of these communication instruments in the context of a new food technology is less clear and is worthwhile further studying.
- Focus on product-specific communication about products that contain a new food technology instead of general communication about a new food technology.
  - Public acceptance of new technologies is conditional upon the products that are sold on the market incorporating these new technologies. Acceptance of these products is prompted by personal and relevant benefits. As such, product-specific communication requires a careful selection of the types of risks and benefits to communicate. Furthermore, it requires testing the effect

of providing specific information surrounding a product (for example, on pack information or in-store displays).
    - Also pay attention to consumers' emotions next to taking a narrow approach to only taking cognitive, rational aspects into account (cost-benefits considerations), in communication to consumers.
    - For example, investigate which terminology and words are emotionally laden and can be used or should be avoided in communication on new food technology.
- Take notice of differences between values and needs of consumers and use segmentation analysis to identify these different groups and to design differentiated communication plans.
    - Empirical evidence shows that it is best to first target those consumers who first adopt new products (the so called early adopters). These consumers have the greatest potential to perceive consumption benefits of novel foods based on new technologies as more important than their inherent risks and could help further uptake of these technologies. Furthermore, communication should be targeted at those specific groups of consumers for which the technology could provide a substantial benefit for at least a specific group.
- Involve different stakeholders in the different stages of the NPD process and use their viewpoints to get a more complete picture of how the new food technology is perceived among different groups in society.

Do not:

- Test another extension of the Theory of Planned Behavior. Testing marginal effects of additional variables of a well-known consumer behaviour model does not help to better communicate to consumers.
- Rely solely on expert views of what should or should not be communicated towards consumers. Experts clearly have other perceptions of risks and benefits than consumers do!

6.2.3 Do's and Don'ts in Interactive business-consumer communication

Do:

- Select knowledgeable, proactive, and motivated participants with an internal locus of control (i.e. innovators, lead users, emergent consumers, and market mavens).
- Stimulate participants to express their needs, habits, desired features, beliefs, values, perceptions, and new-product ideas.
- 'Provoke' participants to come up with radical innovations by also confronting them with your own ideas.
- Put time and effort in the management of the community.
- Make sure that participants are informed about each other's input (perhaps after moderation).

- Provide and stress utilitarian, hedonic, social-recognition, cognitive, and societal benefits for the participants.
- Make sure that there is an adequate balance between participants' skills and complexity of the co-design activities, by
    - using toolkits,
    - modularization of the process,
    - using information-acquisition processes.
- Put considerable effort in the process yourself and show that you do so, while demonstrating (and creating) trust, openness and empathy.
- Give input and react quickly and frequently. If quick reactions are not possible, at least explain why this is so.
- Embed the efforts that go into the interactive business-consumer communication, in the whole organization.
- Think in advance about potential problems with confidentiality and intellectual-property rights.

Do not:

- Trust that starting and fully exploiting interactive business-consumer communication for new-product development in the food industry involving new technologies is a piece of cake.

6.3 General discussion (limitations)

Searching for empirical, public, scientific journal articles in the Web of Science and Scopus, we identified a large number of papers about consumer-to-business and business-to-consumer communication in the context of the implementation of new technologies in food products. Unfortunately, there were virtually none such papers on interactive consumer-business communication. The latter may of course be due to an omission of relevant search terms. This does however seem less likely as also no additional papers on interactive consumer-business communication popped up from the searches for papers about consumer-to-business and business-to-consumer communication. As a remedy we aggregated findings from reviews on interactive business-consumer communication, which also contain review studies outside the food domain and outside the domain of new-technology implementation. We decided not to extend our search to include books, book chapters, and reports, although the review papers contained quite some references to such sources.

In addition, the lack of evaluation of the actual impact on business decisions makes the value of the studies (and therefore the provability of our recommendations) from an applied point of view limited, especially for consumer-to-business communication and interactive consumer-business communication. The lack of evaluation of the uptake of scientific results may be caused by several reasons: (1) Companies may not want to disclose how they use scientific findings, or (2) The academic funding structure aims at projects with a limited

lifespan, while the actual impact of findings will often occur much later. Thus no resources are available to actually conduct the evaluation. Similar problems have been noticed before (Fischer, Wentholt, Rowe, & Frewer, submitted; Rowe & Frewer, 2000); and in these papers it has been argued that claims about the value of applied research without such evaluation should be interpreted with extreme care. For instance, we can conclude that particular constructs and particular methods are incorporated most often in scientific studies, but we do not know whether measuring one construct with a particular method leads to more success in a particular stage of the new-product development process, than some other construct-method combination. As such, the scientific literature appears to be at arm-length distance from the real new product development, judging also from the frequent use of hypothetical products in the studies that we reviewed. It may be the case that validations against real-world consequences are available in book chapters, and in privately funded, confidential reports, although we do reckon that would this be the case then more of these studies would leak out to public, scientific journals.

Another reason why our recommendations might be less solid, is due to the fact that the use of non-standardised instruments or manipulations makes aggregation of data further impossible, an issue that has held back the creation of a solid body of evidence in this field (Frewer, et al., in press; Lusk, et al., 2005). In these studies, like in the willingness to pay studies, the broad range of operationalisations, selection of variables and different products does not add up to a systematic program of identification and confirmation of causal effects. Even more, the interrelations, allowed for by structural equation modelling and the psychological framing of the constructs makes specific causal and mediating effects tentative as the exact direction of the effect is more based on a priori assumptions of the researcher than unambiguity in the data (Diamantopoulos & Siguaw, 2000).

Finally, in the current report, we have considered the impact of novel technologies on product acceptance. In doing so we have considered a novel technology as a product attribute, more specifically an intrinsic credence attribute. The reviewed literature has focussed on investigating this attribute (technology perceptions) and its influence on the product embodying the technology (multi attribute product evaluation). By managing the public perception of the technology in the idea formation, development and market introduction of a product, this knowledge can be used to minimise chances of market failure. The current analysis does not say much about the development of a new technology itself, however, nor the influence that consumer scientists may have in that. While we did not explicitly limit the review in this account, the marketing and consumer behaviour literatures do not focus much on the development of underlying technologies themselves. Some knowledge can be derived from risk perception literature. Slovic (1987) attributes a reduced preference for technologies that have a potentially dreaded impact (fatal, affecting many people at once), or that have many properties not yet known by science. This implies that technologies can be considered to have attributes increasing or reducing acceptance. At the level of technology development, this is however much less systematically investigated compared to the domain of product development. In practice, most early input in socially

responsible technology development is based in technology assessments, which provide ethical guidelines to technology development (see e.g. Rip, 1995, 2005; Rip & Kemp, 1998; Rip & Schot, 2002).

Because of its abstract nature, early phases of technology development seem so far not heavily depending on end-users. It might be an interesting approach for the future to bring in end-users not only in product development, but also in technology development.

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8. Appendix: SWOT-analysis for public scientific research

Another aim of this study was to assess the relevance of the published body of papers in the advancement of food consumer science. Based on the requirements for relevant and high quality applied research in the consumer sciences for food technologies and the reviewed literature, strength and weaknesses of the scientific field are identified. These are compared against external opportunities and threats.

8.1 Outcomes of SWOT analysis

From the literature review, the main strengths of the field are shown to be:

1) A good capacity to **create initial evidence of relations, theories and quantifications of effects**. Thus the field seems well suited to bring theories developed elsewhere into practice. The caveat of this is, however, that once a theory has been shown to be applicable, further replications of this type should be carried out in such way that they contribute to a solid reservoir of data for evidence-based science.
2) The fairly large number of qualitative and exploratory studies show the field is **open minded towards unanticipated real world effects.** This allows the field to pick up unanticipated but relevant issues quickly. The risk of this approach is however that if no novel relevant issues emerge, a lot of energy is invested in exploring issues that are largely already known, thus adding little of relevance to the scientific or applied field as a whole.

The main weaknesses are:

1) There remains an **inconsistent use of instruments and manipulations**. The lack of standard operational procedures and standardised instruments for measuring consumer data makes comparison of studies over times, across technologies and between countries and even within countries difficult, if not impossible. Also replicability and quality control of the instruments and measures is often not sufficiently clear from the reported papers. Thus it is likely that much effort has to be duplicated as the lack of common standards make it difficult to extrapolate from available results. This makes the value of these studies for scientific progress in theory development limited.

2) Although many methods have been developed, **most research adopts a very limited range of methods.** This may be indicative that the current methods are the best ones available, in which case evidence for that claim is needed, or that the methods is guided to a certain extent by prior experience of researchers and funders rather than by tailoring methods to the research questions.

3) Although applied research claims to contribute to solving real world problems, **there is a lack of evaluation of outcomes against its real world effects.** Most studies use hypothetical products, and little or no evaluation of application in actual products are reported. Thus claims to societal relevance of the research lack evidence.

4) Only **very limited research has been carried out on interactive consumer-business communication**, even outside the food and technology-implementation domains.

5) Most research uses a **limited scope with regard to the constructs used**. Most consumer constructs focus on attitude or acceptance and are closely tight to the constructs that are used in behavioural models like the Theory of Planned Behaviour. Moreover, these constructs are cognitive and explicit. Automatic and implicit constructs could enrich the field. In addition, reductionism, while necessary to study effects, is not leading to relevantly complete models to predict behaviour.

A number of **opportunities** and **threats** can be identified for the field.

Opportunities are:

1) Increasing **emphasis on societal relevant research** for example in the agrifood pillar of Horizon 2020 and in national research programs will generate funding opportunities for applied research and hopefully also for assessments of actual impacts.
2) **Continued development of new technologies in food will continue** both from practical point of view (we need for 4 times more proteins at half the environmental impact of today by 2050 (FAO/WHO report)) and by advances in fundamental science (e.g. nano-science and synthetic biology). This will generate both topics for research and funding opportunities.
3) **Increased emphasis on evidence-based science** not only in medical science but increasingly also in social science will generate a demand for high quality, relevant data on real world phenomena.
4) **Increased number of (open access) scientific journals** will create the opportunity to publish more of the world in a publicly available format.
5) **Increased ways to collect and analyse data.** Continuing developments within ICT make it possible to collect and analyse data in faster and more advanced ways. For example, facilitated by the internet and the widespread use of smartphones it is now possible to collect data relatively easy and at low cost. Moreover, sophisticated tools like eye trackers or virtual reality make it possible to obtain more insight in consumer responses and decision making. The availability of click-and-go statistical software increasingly facilitates data analysis.

The following threats can be identified:

1) **Economic downturn leads to governmental budget cuts in research programs.** This results in fewer, or cheaper programs to be funded. In practice it can be expected that high risk and expensive, long term programs will suffer most

2) **Economic downturn leads to industry budget cuts in research programs.** This results in fewer, or cheaper program to be funded. In practice high risk and expensive, long term programs will suffer most
3) **Confidentiality in industry research** makes a lot of real world phenomena and studies into societal response to new technologies and the products created with those unavailable for the scientific discourse. This limits the availability of empirical results and biases reports towards hypothetical products.
4) **Increased publish or perish in academia.** Increasingly across Europe researchers at universities and research institutes are judged on the quantity of papers. To cope with this and to create a positive career perspective, researchers are pressed towards limiting the amount of original thought per paper (spread the ideas thin), collect and analyse lots of data with as little effort as possible and shy away from novel, time consuming, high risk research. This threatens progress in the field, as quality control may suffer and much research will be repetitive without being sufficiently aligned with the best practice in the field to allow data aggregation in e.g. meta-analyses.

The different combinations of strengths, weaknesses, opportunities and threats can be combined in a so-called confrontation matrix (Table 4.1). Arranging the different combinations helps to systematically identify the most important challenges the scientific field is facing. Notice that for each opportunity we can ask the question how this opportunity can help to further enhance the strengths of the field or reduce the weaknesses. For each threat the question can be asked how this threat can help to enhance or reduce the strengths and weaknesses of the field.

We will describe the most relevant combinations below.

Table 8.1: SWOT analysis

		Opportunities					**Threats**			
		Increasing emphasis on societally relevant research (e.g., Horizon 2020)	Continued development of new technologies as object of study and source	Increased emphasis on evidence based science	Increasing number of scientific journals	Increased options to collect and analyse data	Economic downturn leading to budget cuts in governmental funding	Economic downturn leading to budget cuts in industry funding	Confidentiality in industry contracts	Increase in publish or perish culture in academia
Strengths	Creation of initial evidence supporting applicability of existing theory	+[a]	+[b]		+[c]	+[d]	-[h]			+[i]
	Open minded for qualitative research and novel phenomena in the real world	++[e]			+[f]	+[g]		-[j]		-[k]
Weaknesses	Inconsistent use of instruments and manipulation			+[l]		-[m]			-[v]	-[w]
	Limited use of the range of methods			-[n]						-[x]
	Lack of evaluation of outcomes against real world consequences	+[o]				+[p]	--[y]	--[z]	--[aa]	-[bb]
	Limited research on interactive communication	+[q]		+[r]		+[s]		-[cc]	-[dd]	-[ee]
	Limited scope of constructs			+[t]		+[u]				-[ff]

NB. + strength will be enhanced, weakness will be reduced, - strength will be reduced or weakness will be strengthened.

Strengths and opportunities:

a) The current field in which initial evidence is created for bringing a certain theory into practice seems to fit very well with the trend of increasing emphasis on societally relevant research.
b) The strength of the creation of initial evidence will be further facilitated by the continuous introduction of new technologies within the food industry.
c) The current field appears well equipped to produce articles for new scientific journals where existing theories are brought to the attention of new audiences papers and where the applicability of existing theories for specific applications are shown.
d) New possibilities to collect and analyse data help to further strengthen the advantage of the field in creating initial evidence.
e) The increasing demand for public-private collaboration requires an open minded view of researchers to identify real problems of relevance to the private partners. The current field is sufficiently open minded to provide such research.
f) The increasing number of journals will allow publication of open minded, exploratory and often qualitative research of relevance to real world problems.
g) The output of qualitative and exploratory studies as a result of the field's open mindedness can be further facilitated by the increased options to collect and analyse data.

Strengths and threats:

h) Much of the theory related research is still funded with at least some government support, and the further limitation of these resources is likely to reduce the capacity for such research in the field.
i) The increased pressure to publish or perish in academia is likely to result in many (almost) replications of studies based on existing theories with little variations and little original scientific advancement, aimed at different publics in order to generate the required number of publications to pursue an academic career. This is also made possible by increased computing power making statistical inferences cheap.
j) Reduced industry funding is likely to limit capacity for the exploration of real world phenomena.
k) Increased publish or perish requirements will shift the balance away from labour intensive methods such as interpretative or qualitative research in favour of simple application of existing models.

Weaknesses and opportunities:

l) Increased emphasis on evidence based science may force the field to start adopting more rigorous and uniform scales and methods. The editors and reviewers of the journals will have a central role here.

m) When it becomes easier and cheaper to collect and analyse data, more researchers are going to collect data, which could possibly inflate the inconsistent use of instruments and manipulations.
n) Increased emphasis on evidence based science will promote the use of a small range of well-defined methods, which may reduce the capacity in the field to adopt the most suited method for a specific problem.
o) Increasing emphasis on societal relevant research and the involvement of private partners in e.g. Horizon 2020 makes evaluation of the efficacy of the research for actual industry more likely. The field should work towards creating capacity and methods for such evaluations.
p) New technologies to collect data in real life settings (e.g., biometric technologies, scanner data) makes it relatively easier to test real world effects.
q) Increasing emphasis on societally relevant research evoke the emergence of studies that try to provide empirical evidence on interactive consumer-business communication as the “true way” to innovation success.
r) An increased emphasis on evidence based science will stimulate research on interactive communication.
s) New options to collect and analyse data could facilitate relatively complex empirical studies, like testing the effects of interactive consumer-company communication.
t) An increased emphasis on evidence based science will stimulate using a broader scope of constructs.
u) New options to collect and analyse data could help to develop and test other constructs.

Weaknesses and threats:

v) Confidentiality of industry contracts makes it hard to further develop a standard range of methods and measures as best practices are hard to scope.
w) Increased demand to public or perish will reduce time that researchers take to develop or choose the best available techniques, in favour of scales that are within their own arsenal.
x) Increased demand to public or perish will reduce time that researchers take to master novel methods.
y) Lack of long term government contracts makes tracking of the real world effects difficult to realize.
z) Lack of long term industry contracts makes tracking of the real world effects difficult to realize.
aa) Confidentiality makes publishing on real world effects difficult to realize.
bb) Increased demand to public or perish will reduce effort that researchers can invest in long term, complex research such as the evaluation of real world effects.

cc) Lack of long term industry contracts makes development of empirical evidence on interactive communication less likely, since industry is needed for realizing this evidence.

dd) Confidentiality of industry contracts makes development of empirical evidence on interactive communication less likely.

ee) Increased demand to public or perish makes it less likely that researchers will invest time in relatively complex empirical studies, like testing the effects of interactive consumer-company communication.

ff) Increased demand to public or perish will reduce time that researchers can make to explore the development and use of other concepts and constructs.

8.2 Furthering the applied field of communication in relation to new food technology

Past food technologies have resulted in a large body of research on communication between technology development and the consumer. The research field consists of open minded and productive researchers who produce a lot of suggestions on how to further novel technology development in food.

As an applied research field, we are on a crossroads. Where past research has delivered much incidental knowledge, progress in the field as a whole is becoming increasingly frustrated by a lack of systematic aggregation of the available evidence to form a robust and reliable body of knowledge. To further the field of communication in relation to new food technology development there is an urgent need to work towards shared methods and scales allowing the creation of a shared body of evidence. As a consequence, we suggest that research in the field is best organised as one of three exercises, that all have their own role in furthering this applied field:

When engaging in a study first of all:

(1) Consider whether sufficient theoretical ideas/measurement approaches have been shown of relevance in prior research

YES – DO: choose the most relevant approach, select generally used scales and manipulations within that approach. If conducted in this way, the study will contribute to the aggregated body of evidence in the field. DO NOT: Construct your own scales from scratch, or use rarely used scales or methods. PROBLEM: No currently agreed upon best practice for scales and manipulations exist

NO –

(2) Consider whether previously unused theories/measurement methods fit the issue in hand

YES – DO: Choose the most relevant theory, and provide anecdotal evidence this theory may work. This will provide new theoretical insights into the field DONOT: Create additional

evidence a theory may work after this has already been shown, at that stage serious effort in creating robust body of using generally used scale is required (research type 1).

NO-

(3) Identification of specific issues related to the field of food technology needed. Specific theory building relevant.

If nothing else works DO: Use exploratory methods to provide an overview of relevant issues in the field. This will provide new insights into the field, which may result in theory development. DONOT: Use this method if the issues are already known (because of similar research). Either use approach 2 if the issues are known but no theory is shown relevant to explain them, or approach 1 if a theory is relevant and shown to apply to the field.