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WP 3: Economic costs and benefits of traceability coexistence

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1 Executive summary

1. Introduction and Objectives

The development and introduction of genetically modified (GM) food is, and has been, a controversial matter in Europe and worldwide. Many consumers remain wary of the stated benefits of GM foods. There is, however, limited understanding of consumer resistance to its introduction. Studies using qualitative and quantitative research methods are reviewed here with attention specifically focussed on the attitudes of European consumers. This literature review had the dual objectives of investigating consumers' Willingness-to-pay (WTP) a premium for non-GM products and their reactions to GM labelling and traceability.

The studies reviewed suggested that, as regards GM products, consumers can be considered to be optimistic, pessimistic or undecided in their attitude. Consumer perceptions of risks and benefits associated with any product are dynamic processes such that attitudes towards a product, including those incorporating GM technology, are in a state of continuous flux and evolution, what means not exact and stable.

2. Research methodologies

In examining consumer purchase behaviour and valuation there are a number of different methodologies that could be used by researchers, among them being contingent valuation of consumer willingness-to-pay for, or to accept, products; choice experiments or conjoint analysis based on consumers' multi-attribute utility maximization, and revealed preference methods -such as experimental auctions. An alternative methodology is that of Certainty Equivalent (CE) and 'blind taste' experiments.

3. Consumer behaviour, attitudes and perceptions

Not all consumers perceive GM technology as being one-dimensional and often distinguish between different applications of GM technology with attitudes toward, and acceptance of, a GM product, dependant on the proposed end use.

While it is clear that there is some degree of resistance to the introduction of GM food worldwide, the extent of that resistance varies from country to country and over time.

The attitude of any individual towards a GM food product is determined by both attributes that attach to that individual such as age, level of education, present knowledge of GM technology, cultural background and religion among others, but also the ‘value set’ of the individual and the manner in which they order and rank their private life priorities. The individual attributes and values held by individual consumers, determined in part by their social and cultural environment, become the key determinants of their attitude towards any product including GM food goods.

There appears to be a direct and positive relationship where an individual who increases their knowledge of GM technology also appears to increase their support of GM applications – see section 5. As such, it is instructive to differentiate between the ‘objective knowledge’ presently held by individual consumers, which can be defined as the ‘real’ substantive knowledge they may have about GM food, and their ‘subjective knowledge’, which refers essentially to what they think they know about GM food.

4. Communication and consumer trust

The extent to which consumers trust the source of information that propagates information about GM products, is a key element in consumer acceptance of biotechnology; it is important that the information received by worldwide consumers is not only ‘believable’ but also credible and well communicated. Communication campaigns are therefore a very important element, and need to focus more specifically on providing information that address those characteristics of GM food that presently may be negatively influencing the fears of individual consumers. Moreover, since consumers consider governments and scientists to be the main propagandists of

information regarding GM technology and its control within society, it would be important to assure that all sources of information use proven scientific data, applying a kind of precautionary principle for information dissemination.

The issue of mandatory or voluntary labelling of food products that contain some element of GMO provenance, has generated much learned discussion but little consensus of opinion has so far been reached with, for example, voluntary labelling requirements in the USA and mandatory labelling within the EU, see section 5.

Using stated preference methodologies, the evidence to date suggests that consumers are willing to pay a premium for non-GM food placing a higher value on non-GM food than GM food. Consumers in some countries appear to be more willing to purchase GM food products than are consumers in other countries. Generally speaking, present evidence suggests that European consumers are more willing to pay a higher price for non-GM foods than are their North American counterparts (Lusk *et al.* 2004a; Jaeger *et al.* 2004 and Moon & Balasubramanian 2003).

There is some evidence that suggests that when consumers are presented with information detailing a positive benefit of a GM food product, such as an environmental or health benefit, that they modify in some level their valuation of non-biotech foods relative to GM foods (Loureiro & Bugbee 2005). Although consumers appear to prefer GM products to be associated with benefits, this does not necessarily imply a willingness to buy and/or pay a premium for a GM product.. The perceived risk(s) associated with GM food products appear to have a negative impact on consumers' willingness to accept GM food.

5. Conclusion

In conclusion, it can be stated that personal attitudes towards GM food are formed by a complex decision-making process driven by three main dimensions: risks and benefit perceptions associated to GM food and their between compensation, individual values and attributes associated to each person and Knowledge and its relation with values. These three elements are strongly connected and their parallel study must be needed in order to obtain answers of current consumer's behaviour. In addition, we conclude that

the most appropriate method of examining consumer valuation of GM foods would appear to be by way of choice experiments.

2 Introduction to the review

2.1 Preamble

The development of genetically modified (GM) food and feed has been a matter of considerable interest and public controversy in Europe, as well as worldwide, as a result of the ‘uncertainties’, ‘risks’ and ‘benefits’ that such new technologies portray to the food industry and consumers. However, there is limited understanding of what lies behind demand side resistance to the introduction of these ‘potential innovations’ by the food and feed industry. One of the areas that capture significant public interest refers to demand influences - reference and valuation - as well as attitudes leading to potential acceptance or rejection of the level of genetic engineering current in the food industry. Indeed, understanding the process that explains the valuation of new products, especially if it is a potential daily consumption product, is not an easy task. The valuation of a new good implies in the first place the provision of information from several sources - public and private, formal and informal etc – and the credibility and trustworthiness of each relevant information source. Given the information available, a further issue is that of attitude formation, which ultimately leads to the final question regarding product valuation and consumer preference also based on his cultural environment.

The subject of GM food has been of particular interest given the number and variety of issues at stake. Indeed, the European Union maintained a long “de facto” moratorium against the importation of GM food that only ended in 2005, the rationale being the application of the precautionary principle having regard to health and environmental concerns as well as the underlying protection of European agriculture and the need of filling in the regulatory gaps as done for instance by the 1829/03/EC and 1830/03/EC regulations on GMO detection methods and mandatory traceability. Nowadays, while new transformation events of maize and other crops are being authorised in Europe, the debate still remains as to whether individuals and their surrounding cultural society

value these GM food products, whether they perceive any risks and/or benefits for their health and the environment and, of course, whether the development of biotechnology in food products will remain a controversial subject. Even though there is a growing body of literature concerning consumers' level of acceptance of GM food, little effort has so far been devoted to examining and evaluating the findings from these different studies in order to make recommendations for stakeholders regarding the introduction of GM foods.

2.2 Objectives

This review is Deliverable 3.3 of the Co-Extra Project's Work Package 3 and is entitled in the revised Description of Work (May 2006) as a 'Review on consumers' attitudes towards GMO'. It examines reports and studies on the public acceptance of GM food and is a pre-cursor to a survey to be carried out later in WP3.. This study includes five EU partner countries investigating consumers' willingness-to-pay (WTP) a premium for non-GM food products and consumers' reaction to GM labelling and EU traceability requirements. Clearly, reviewing WTP methodologies and previous empirical results will be crucial in this. We attempt to respond to some well determined questions, namely whether European consumers are willing accept GM food, whether they are willing-to-pay a premium for non-GM versus GM food (as a contrast), and the extent to which they trust the available information regarding the possible safety and public health effects of consuming GM foods. Furthermore, given that market research studies focus on the examination of relevant attributes influencing individuals' product acceptance, we specifically examine what the significant attributes are which appear to be most influential in directing consumer behaviour.

2.3 Methods

In selecting the items to review, we selected studies that used both qualitative and quantitative research methods. The quantitative studies were mainly surveys relating responses on consumers' attitudes, consumers' declared or stated preferences (using contingent valuation and/or conjoint analysis) and consumers' revealed preferences (using experimental economic methods, including auctions) about GM food worldwide. Our review mainly refers to scientific papers published in peer-reviewed journals.

Given that consumer attitudes have been examined over many years from many different disciplinary backgrounds, we will introduce the discussion streams using different theoretical backgrounds, analytical tools, and methodological frameworks in order to obtain a realistic picture of consumers' attitudes.

Our search was carried out by searching the most relevant electronic databases including Agricola, Blackwell-Synergy, CAB Abstracts, EBSCO, Ecolint, Kluwer, Proquest, Science Direct-Elsevier and Springer Verlag- using the broad key words of GM food, biotechnology and attitudes.

2.4 Relevance of the literature review

From this review we attempt to provide a picture of the evidence that comes from the different studies, in order to enable the choice of the relevant research questions as well as the most appropriate analytical and methodological approaches needed to carry out a wide study of current European consumer behaviour regarding GM food and feedstuffs, later on in WP 3 of Co-extra.

2.5 Structure of the review

As shown in Figure 1, we have structured this review as follows. First, we examine the existing evidence on consumer attitudes to GM technology, and especially evidence on food and feed-related applications. Second, the construction of consumer attitudes is considered and examined in more detail. This necessitated looking at how individual values and attributes are related to individual attitudes. The role of risk and benefit perceptions in the development of consumer attitudes is also analysed. Next, the role of product knowledge as being the underlying determinant of consumer risk and benefits perceptions, and how trustworthy the presently provided information may be as the current means of informing the consumer with product knowledge, is considered. We then focus on the existing links between attitudes and consumers' acceptance of GM products and, finally, we examine the determinants of consumers' valuation of GM products, as well as the underlying behavioural connections to consumer acceptance and individual attitudes towards GM products.

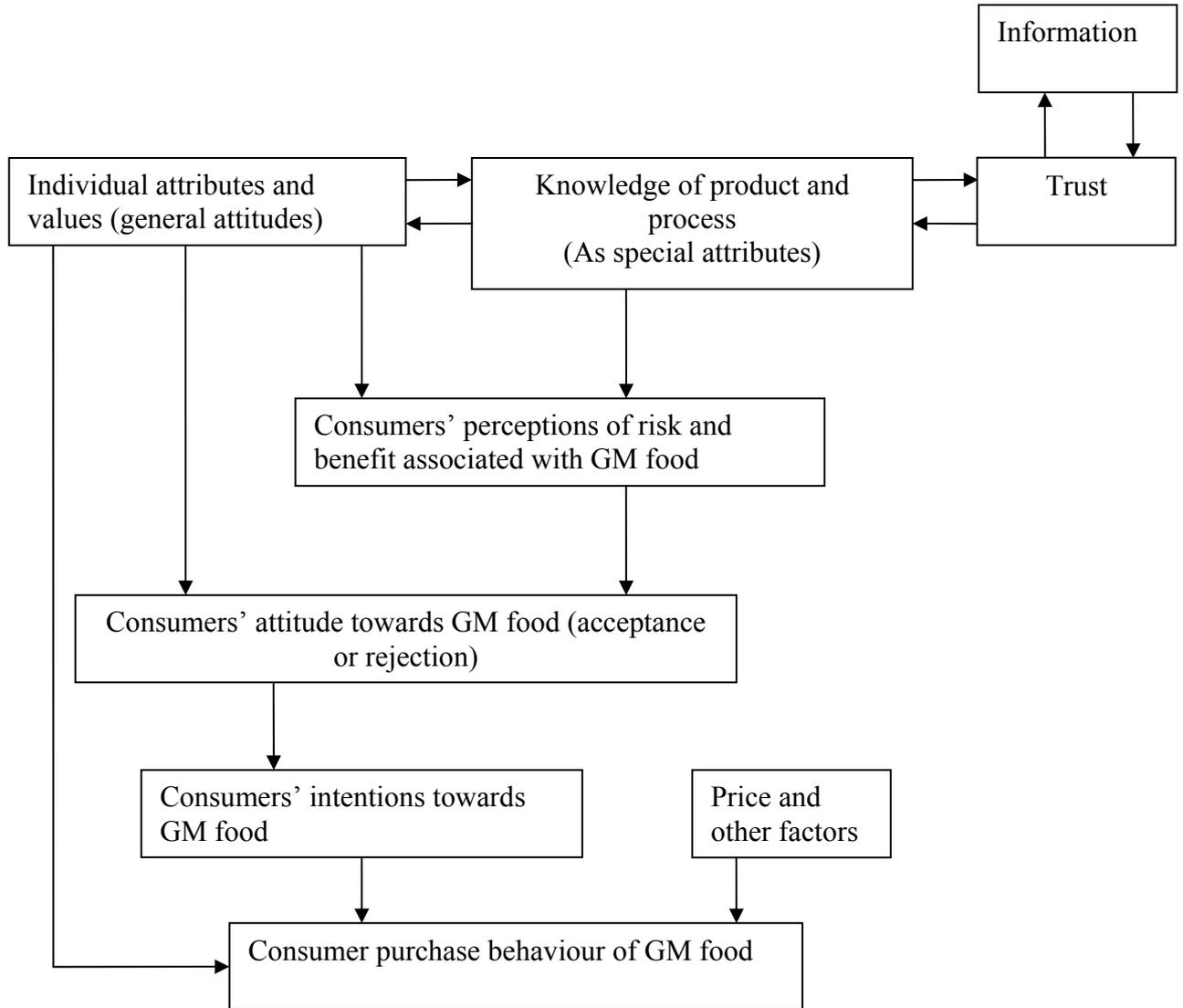


Figure 1. Consumer process of acceptance and valuation of GM food.

3 Consumers' attitudes and risk and benefit perceptions towards GM food

3.1 Introduction

“In order to discuss this point it will be helpful to firstly present a clear distinction of four basic concepts, mainly by means of dictionary definitions. First, attitude was defined by Ajzen (2005) as: a disposition to respond favourably or unfavourably to an object, person, institution or event..., these responses must reflect positive or negative evaluations of the attitude object. Therefore, in order to develop these further, respondents must report an opinion regarding the object, person, institution or event. Indeed, an opinion is defined as a belief or judgement which appears to be likely or true,

but that is not based on proof. Moreover opinion is constructed on a person's perception of the object, person, institution or event. Furthermore, perception is the process of acquiring, interpreting, selecting, and organizing sensory information. Finally, behaviour refers to the actions or reactions of an object or organism. Hence, the last step of the process”.

As Figure 1 shows, the acceptance and valuation of GM food depends on individuals' attitudes, which, in turn, are determined by attitudes and risk and benefit perceptions among other determinants. Risk and benefit perceptions have received significant attention in the cognitive psychology literature and have been introduced as a relevant determinant of individuals' attitudes (Boecker, 2005). In this section, we attempt to provide a brief description of current evidence on *consumer attitudes* towards GM food technology from a range of different studies.

3.2 General evidence

Evidence on attitudes has become clearer in European countries mainly since the publication from 1991 of Eurobarometer. Reluctance towards the introduction of GM foods exists (Grunert *et al.*, 2003; Bredahl, 2001), though the Eurobarometer survey (Gaskell *et al.*, 2003; Gaskell *et al.*, 2004; Gaskell *et al.*, 2006) also reveals some evidence of a recovery of people's support for GM food products from 1999 to 2002. Nevertheless, a return to a refuse in 2005 has been also observed (Gaskell *et al.*, 2006). This survey also presents a division among European consumers, which are mainly split into three groups regarding their perception of GM food: ‘optimistic’- 25%, ‘pessimistic’- 58%, and ‘undecided’- 17%. This classification, as it is explained further on can be determined due to social values and the influence of information on consumers' perceptions. Additionally to this general attitude, national differences also exist. Interestingly, Gaskell *et al.* (2003) finds that overall support for GM food is seen until 2002 in only four countries - Spain, Portugal, Ireland and Finland. This has changed in 2005, when the high supporter countries were – Spain, Malta, Portugal, Czech Republic, Ireland, Italy and Lithuania. Indeed, in a recent study in Ireland using cluster analysis techniques, it was revealed, using GM yogurt, that there was still a considerable segment (24%) who could best be described as ‘anti-GM’, others (20%) who had ‘complex reservations’ regarding the wholesale introduction of GM products, the rest were divided among 21% of acceptors and approximately 33% that prefer a

non-GM ingredient (O'Connor *et al.*, 2006). Bech-Larsen & Grunert (2000) and Honkanen & Verplanken (2004), when analysing attitudes towards GM technology, confirm the negative attitude of the Nordic populations towards GM food. The same conclusion is achieved in some surveys for consumers in Poland, who in general have a significant distrust of genetic modification, especially where this may occur in food products (Szczurowska, 2005; Bukraba-Rylska, 2005; Janik-Janiec & Twardowski, 2003).

Moreover, some conjoint analyses also provide evidence on US attitudes. Indeed, Lusk *et al.* (2002) suggest that US students mainly prefer non-GM products. Similar results have been found for banana, corn flakes, and corn-beef (Onyango & Govindasamy, 2004) using US data. Other studies (Hossain *et al.* 2003), have examined the role of attitudes to GM fresh fruit and vegetables using discrete choice methods. Interestingly, they divided US society into two main segments: those who are totally opposed to GM technology and those who *would accept GM technology if there were some demonstrable benefits to the consumer*. This last group could also be labelled as ‘undecided’ or “Keeping an open mind” and these results are echoed in other studies (e.g. Hossain & Onyango, 2004).

Finally, a study in an Asian setting - South Korea - suggests a similar picture. Indeed, Onyango *et al.* (2004), through principal components and cluster analysis, found that consumers are divided in groups that range from acceptance and optimism regarding GM food improvements to pessimism and rejection. It is important to highlight that this country has mandatory labelling policies regarding to GM food.

3.3 The formation of consumer attitudes

One of the main theories regarding the formation of consumer attitudes towards a product is the Fishbein Multi-attribute Model (Fishbein, 1963). This theory states that a consumer attitude is a function of the beliefs that each individual person develops on the attributes of a product weighted by an evaluation of each product attribute that is:

$$A_0 = \sum_{i=1}^n b_i e_i$$

Where, A_0 = attitude towards a product, b_i = belief i in product attributes

e_i = evaluation that a person develops towards the attribute i of the product.

This model implies that an attitude towards any product is based on knowledge about the product itself and its attributes, the so-called ‘bottom-up’ formation of attitudes (Grunert *et al.* 2003). Moreover, it assumes that attitudes do not depend only on one specific belief but on a handful of them. Yet, some conceptual development has been taking place on the meaning of belief. Fishbein & Ajzen (1975) depart from each individual’s information of each object or product and examine the internal process of classifying the ‘available’ information. This is different among individuals and is either directly or indirectly related to individual values, partly inherited from the cultural environment. This relationship will be analysed further in the next section, when looking at the ‘top-down’ approach to the formation of attitudes. Bredahl *et al.* (1998) developed a more detailed model for the ‘bottom-up’ consumer attitude explanation specifically regarding GM food:

$$A = w_1 A_{prod} + w_2 A_{proc}$$

This model implies that attitudes towards GM food technology are defined by means of a weighted sum of attitudes towards each product and its corresponding process. Moreover, each attitude also depends on the overall perceived risks and benefits associated with the product and process respectively, that is:

$$A_{prod} = v_1 B_{prod} + v_2 R_{prod} + \sum_i u_i GA_i$$

$$A_{proc} = y_1 B_{proc} + y_2 R_{proc} + \sum_i z_i GA_i$$

Where: B_{proc} , R_{proc} = overall benefits and risks associated with the process

B_{prod} , R_{prod} = overall benefits and risks associated with the product and

GA = general attitude.

This model also assumes that individual attributes and values influence particular attitudes towards a product or a process and thereby give rise to more general attitudes (at the society level) (Bredahl *et al.*, 1998). Interestingly, this theoretical model has been empirically supported by many studies such as Moon & Balasubramanian (2001 & 2004); Grunert *et al.* (2003); Onyango (2004); and Hossain & Onyango (2004), which state that, although acceptance of agri-biotech depends on risk and benefit perceptions,

consumers associate, on the whole, more negative attributes to agri-biotechnology than positive ones. Moreover, other studies suggest that individual behaviours are driven by perceptions or beliefs about risks of GM food and feed, rather than the technical risk estimates provided by experts. This explains the fact that, even though US consumers are optimistic about possible benefits of GM food and feed, they are also concerned with their associated health, safety and environmental consequences (Frewer *et al.* 1998), Hossain *et al.* (2002 & 2003), Onyango *et al.* (2003) and Onyango *et al.* (2004) In the same way, Siegrist *et al.* (2000) stated, also through the use of causal models, that for German consumers' perceived benefits have a significant, although weak, impact on perceived risk for gene technology. Furthermore, Bech-Larsen & Grunert (2000) states that for Nordic populations the benefits to be derived from GM food are a helpful, but insufficient condition for an increase in consumer positive attitudes and consumer acceptance of GM food products. A dissimilar conclusion is reached by Lusk *et al.* (2002) in a study of the consumption of corn chips by US students. They used conjoint analysis and conclude that, although US consumers preferred non-GM products, GM products that exhibited clear-cut benefits were acceptable. The same as, Loureiro & Bugbee (2005), who showed, by using a multiple-bounded probit methodology, that US consumer's value more highly the 'enhanced flavour' modification followed by 'enhance nutritional value' and 'pesticide reduction'. In the same way, a recent work by Traill *et al.* (2006) using regression analysis suggests that risk and benefit perceptions are negatively, but not perfectly, correlated, and that benefits are more important than risks in the determination of UK and US consumers' willingness to consume. That being so, they conclude that it is best to measure risks and benefits separately.

3.4 Risk perception frameworks

Consumer perceptions of risks and benefits are dynamic processes, so that attitudes towards GM technology are in continuous evolution (Frewer *et al.* 1998; Bredahl *et al.* 1998). Attitude variation can be motivated either by the increasing knowledge of GM products as well as enhanced individuals' knowledge regarding GM technologies (Bredahl *et al.* 1998). Furthermore, other individual attributes such as socio-economic characteristics (age, income level...) can also evolve over time and could be responsible for any subsequent attitude changes.

There are numerous alternative methodological frameworks useful in examining risks and benefit perceptions. Gaskell *et al.* (2004) analysed, by means of multinomial regression and multiple regression, a set of different decision-taking strategies for each of four groups identified among European consumers. ‘Pessimistic’ and ‘Optimistic’, individuals tend to develop what is known as a lexicographic process, where a product attribute (risk or no-risk) dominates the decision. On the other hand, the ‘undecided’ use an expected utility method (SEU), which consists of a combination of all the possible costs and benefits weighted by their probabilities to explain learning of GM food technology and products. Moreover, Yeung & Morris (2001) conceptualised risk perceptions and related them to a combination of characteristics such as: *dread, unknown and extent*.

However, dread and unknown are more relevant to attitude formation than extent. Indeed, given that information on GM technology is not well enough disseminated (Martinez *et al.*, 2004, Noomene & Gil *et al.*, 2004, Schilling, 2003, Szczurowska, 2005 and Vilella-Vila *et al.*, 2005), and is still subject to some possible scientific uncertainty, information available in the system is affected by food scandals, such as mad cow, and the food scares that people ‘associate’ with GM technologies. Interestingly, a causal model study regarding different modern technologies (Siegrist, 2000) concludes that it is not feasible to change German students’ perception of risk regarding a technology (in general) by highlighting related benefits associated with it. This can be due to the persistent perception of dread over time or, similarly, by the existence of some lexicographic preference that impedes careful cost-benefit reasoning. The same conclusion is reached by Fortin & Renton (2003) in their study of GM bread and milk in New Zealand by using a different methodological approach, an ANCOVA analysis, Traill *et al.* (2006) also came to similar conclusions.

Consumers do not perceive GM technology as being a one-dimensional skill. Indeed, some studies, such as Gaskell *et al.* (2002), Grunert *et al.* (2001), Hossain *et al.* (2002 & 2003), argue that EU and US consumers distinguish between different types of applications within biotechnology. Moreover, they state that consumer attitudes and their consequent acceptance of a GM technology depend on the purpose of its use. More precisely, medical applications of GM are supported, whereas agri-food applications are not since they are characterised as not useful and risky. In a similar way, consumers

consider GM technology on plants in a less negative way than on bacterium, animals or human genetic material (Frewer *et al.*, 1998; and Onyango *et al.*, 2004).

Contrary to the above statements, other studies conclude that consumers do not differentiate among applications. This is the case of Bredahl (2001), who analysed Danish, German, Italian and British consumers' attitudes by means of structural equation models. He noticed that Europeans generally reject all applications of GM technology. However, some cross-country differences regarding risk-benefit perceptions were found. Danish, German and British consumers identified risks as an obstacle for the perception of benefits associated with GM food supporting Siegrist *et al* (2000) and Beech Larsen *et al.* (2000). By contrast Italians considered that risks and benefits were in a clear-cut compensatory relationship. Martinez *et al.* (2004) noted, using cluster analysis, that Spanish students could have a positive attitude towards GM food if more information about product benefits would be provided. Interestingly, Savadori *et al.* (2004) using principal components factor analysis and regression analysis showed that experts perceived less risk for all GM applications than the public generally, showing that knowledge influences attitudes. However, for both groups, risks from food-related applications were perceived to be higher than risks of medical applications.

Finally, consumers' risk perception of GM technology has been compared to that of other risks associated to different technologies. Hwang *et al.* (2005 b), using factor analysis, showed that US concerns were highest for pesticides and artificial growth hormones, followed by antibiotics, genetic modification and irradiation. The same study, through a cluster analysis, permitted different consumer segments to be distinguished. The first segment was mainly concerned with growth hormones, GM and irradiation technologies; the second with the use of pesticides; and, finally, the third segment was mainly concerned with the use of artificial colours/flavours, preservatives, and pasteurisation. Townsend *et al.* (2004b) used rating measures to compare UK consumers attitudes to GM food, compared with concerns about issues such as cancer, terrorism and biological warming among others. GM food was 'not dreaded', was thought to be 'controllable', was not viewed as 'unethical', and was seen as the least 'risky' among all other consumer concerns.

4 Individual attributes and values: the construction of perceptions and attitudes towards GM food

4.1 Introduction

From the previous section it is clear that there is some worldwide resistance to GM food though the level of acceptance or resistance differs among countries. Therefore, it is important to examine the factors that underpin the 'stylised fact' and specifically the extent and reasons to which risks are more strongly perceived than benefits. Referring back to Figure 1 above, we now focus on how attitudes and perceptions are raised and formed. This section covers the relevance of individual values and attributes.

4.2 Basic concepts

It is important to clarify some fundamental issues at the outset. Individual attributes are defined, not only as those characteristics that define an individual's personality but also those characteristics such as socio-demographic and economic attributes. Traits such as education, knowledge and religion are also considered and explored as it might be considered that such characteristics may provide some influence on certain observed or unobserved attributes. However, the attribute of knowledge, due to its relevance, is analysed in some detail in the next section.

In contrast, individual 'values' can be defined as personal evaluative feelings that state the order of priorities in an individual's life. Yet, given that information develops as well as the individual's interaction with that knowledge, learning takes place and neither values nor some attributes remain unchanged over time. Therefore, it is important to use these variables to examine how attributes affect attitudes to GM food.

4.3 The relevance of individual attitudes

As previously stated, consumers can be categorised or classified according to their attitudes towards GM food. Certainly, following Baker & Burnham (2001), the US consumers 'attitudinal' segment can be partially explained by cognitive variables that are not necessarily observed. Namely, individual attributes and values can become key determinants of consumer attitudes. However, the same study concluded that socio-economic variables were not significant in explaining the segment to which consumers belonged, which might suggest that other issues, besides income-related factors, might

well influence attitudes. The same segmentation has also been performed by Hwang *et al.* (2005 b), in which eight food production and processing technologies, including GM food, were compared and examined. This study characterized each population group by age, gender, ethnicity, education, and household size. The results revealed that the respondents that expressed the highest levels of concern about all eight technologies appeared to be females with lower educational attainment, low household income, were middle-aged and from minority racial groups. However, they state that there was considerable heterogeneity in how personal and household characteristics affect stated concerns. Therefore, from these studies, one might well hypothesise that the effect of unobserved variables might well provide an explanation of the heterogeneity of some results.

Other authors such as Frewer *et al.* (1998), Moon & Balasubramanian (2001 & 2004) and Loureiro & Hine (2004), refer to moral and ethical considerations, while Onyango (2004), Veeman *et al.* (2005) and Costa-Font & Mossialos (2005 a) include education and knowledge, and Hossain & Onyango (2004) include religious beliefs. Onyango *et al.* (2003) argue that all these individual attributes are key elements, which shape agri-biotechnology acceptance. Most of these studies used regression models or cluster analysis. However, there is limited agreement on the role of religion. Hossain *et al.* (2002 & 2003), using a logistic model, found no evidence of a link between *religiosity (does this mean which religious belief [jew, christian, Moslem etc] or does it mean type of belief [protestant, catholic, Baptist, fundamentalist etc..)* and GM attitudes. Moreover, Vilella-Vila *et al.* (2005) concluded that moral issues appear not to be relevant for attitude formation as regards GM food.

Other authors, such as Costa-Font & Mossialos (2005 a); Hossain *et al.* (2002 & 2003) and Veeman *et al.* (2005) revealed, by means of probit and logit models, that socio-economic and demographic attributes such as age, ethnicity, residence and income level are directly related to consumers' attitudes towards GM food. In particular, the study developed by Hossain *et al.* (2003) reported that for US consumers, 'male, white and middle-aged are more supportive of GM foods'. On the other hand, 'liberals and suburban consumers are more resistant to the use of this technology in food production'. Moreover, Noomene & Gil (2004), by using a probit model, positively related income level with knowledge and interest regarding GM food technology in Spain. However,

Frewer *et al.* (1998) revealed no significant gender differences among respondents with high level of environmental concern. In a similar manner, Hossain & Onyango (2004) and Baker & Burnham (2001) concluded that economic and demographic attributes are not important in defining consumers' attitudes towards GM technology.

A further important relationship among the different stages of a consumer attitudinal process is the one detected by Siegrist (2000) through causal models. Individual attributes such as gender differences are related to benefit perceptions. In particular, women perceive lower benefits and are less likely to accept gene technology than men. In the way, Hossain *et al.* (2002) found that factors such as age, gender, education, political views, consumers' habits, and income, are significantly related to consumer perceptions of food biotechnology. Moreover Traill *et al.* (2004) also conclude that: 'a high level of education is associated with acceptance of GM benefits, and conversely the opposite holds for high levels of perceived risks'.

As is revealed in Figure 1, individual attributes are determinants of attitudes or perceptions toward GM technology. Yet, besides being determinants, they also play an important role in determining the willingness-to pay for GM versus non-GM food. Moreover, education and age seem not to be relevant in the formation of consumer purchase intentions regarding GM versus non-GM food (Loureiro, & Bugbee 2005). The same conclusion, from a tobit model, was reported by Gifford *et al.* (2005) who suggested the non-relevant influence of demographic variables on consumers WTP for non-GM or WTA GM food. Moreover, Huffman, (2003) by means of a random nth price auction with US consumers and a probit analysis, determined that socio-demographic attributes of consumers do not affect willingness to pay for non-GM food. Other studies look at different issues. For instance the income variable seems to have a positive impact on consumers' WTP for non-GM food (Loureiro & Bugbee, 2005 and Noomene & Gil, 2004). Moreover, for Italian consumers knowledge and trust seem to be factors to explain their WTP for non-GM food versus GM-food (Canavari *et al.* 2005).

4.4 The role of individual values

Besides individual attributes, individual values should be taken into account when analysing the construction of consumers' attitudes (Verdurme & Viaene, 2002). Following the 'top down' formation theory of attitudes, consumers' attitudes towards a

product are affected by more general individual attitudes and values (Grunert *et al.* 2003 & 2004; Bredahl, 2001). The value set of an individual consumer will thus be derived from that consumer's attitude towards the environment, technology, culture and so on. Yet, this approach complements the so-called 'bottom up' approach and both give rise to some recursive system.

A relevant theory regarding the role of values on consumer attitude formation is the 'means-end' approach. This approach basically links product perceptions with consumers' values. Grunert *et al.* (2001) empirically validated the cognitive 'means-end approach' theory with three GM products - cheese, candy and salmon. Grunert and colleagues specifically used the 'laddering' method and noted that Danish, Finnish, Norwegian and Swedish consumers preferred conventional products to GM products essentially because of its *conventional production process*. The key element of this finding is that consumers associate conventional production with safe and healthy products and view these as either general attributes or personal values. On the other hand, GM products are associated with two negative general values, that is, uncertainty and poor health. Other studies such as Vilella-Vila *et al.* (2005) refer to the effect of perceptions of equity in a world where a few companies distribute GM product, i.e. a seemingly monopolistic market. Something similar takes place when comparing consumer attitudes towards GM and organic food. Dreezens *et al.* (2005) observed that consumers relate GM and organic food to power and universalism values. Explicitly, respondents who contend that man should be dominant over the natural environment, present the least negative feelings towards GM food. On the other hand, respondents favouring organic food production systems, reveal their inherent opposition to man dominating nature. Therefore, attitudes regarding GM and organic food were negatively related.

Other relevant studies that find empirical evidence of the role of individual values as determinants of consumer attitudes towards GM food are Bredahl (2001), Traill *et al.* (2004) and Gaskell *et al.* (2003). These studies refer to both European and US consumers with regard to GM food and find that consumers can be classified as: (i) 'opposed' to biotech, entailing concern about nature as well as technology (post materialistic); and (ii) 'optimistic' about biotech and who are more materialistic. In addition, Brant *et al.* (2004) also noted other human general attitudes, which seemed to

be also significant in explaining consumer attitudes towards GM food. These were ‘sport fan, present thinking, auto-innovativeness interest, poetry, retirement, education and physical needs’.

Indeed, individual values are found to be influential in consumer attitudes towards a GM product in other theoretical frameworks. Honkanen & Verplanken (2004) distinguish between ‘*valence attitudes*’ that define the agreement with the product either favourably or unfavourably- from ‘*centrality attitudes*’, which consider the importance or relationship to values. They state that ‘attitudes strongly associated to general attitudes or values are more difficult to modify than those based only on knowledge of product attributes and services’. If individual’s attitudes are not strongly related to values, due to lack of information, contradictory beliefs, or lack of involvement, then it will be easy for them to internalise information and, as a consequence, be subject to potential modifications. In the next section, we will analyse the impact of values on trust and therefore on information strategies.

5 Trust and Information

5.1 Knowledge as a special individual attribute

Some studies clearly classify how individuals can be categorised regarding their attitude to GM food, and also the relationship existing between their attitudes and risk and benefit perceptions. Moreover, it is noted that some studies link individual attributes, particularly knowledge, to consumer attitudes and perceptions towards GM food. Indeed, information is the key element of the Fishbein Multi-attribute Model. In other words, knowledge about a GM product and the production process behind it becomes essential in order to shape attitudes. Madsen & Sandoe (2005) highlight, as have other authors, in their study of Herbicide-Resistant (HR) crops, that the extent of knowledge on GMO held by individuals determines to a greater or lesser degree, their attitude toward GM foods. The general public believe that HR crops are risky because of the unknown long-term effects on the environment and health, whereas experts believe that the risk, if any, is not in the genetic modification but the introduced herbicide resistance trait. Some studies (Boccaletti & Moro, 2000; Moon & Balasubramanian, 2001 & 2004; Moerbeek & Casimiv, 2005; and Vilella-Vila *et al.*, 2005), drawing on regression analyses, have empirically proven the direct association between GM knowledge and

attitudes, revealing that there is a direct and positive relation between an increasing knowledge of GM technology and an increasing support to GM applications in Poland (Koivisto Hursti & Magnusson, 2003).

However, some differences remain on disentangling the effect of different types of knowledge. Here, it is worthwhile to differentiate between the ‘objective knowledge’, which can be defined as the real knowledge people have about GM food, and ‘subjective knowledge’, which refers essentially to what consumers think they know about GM food. Subjective knowledge is also clearly related to general attitudes and values. Some studies have analysed the importance of each type of knowledge in the task of building attitudes towards GM food. Interestingly, House *et al.* (2004) noted from their use of a probit ordered model that the two types of knowledge are important in the process of attitude-building towards GM food among US, UK and French consumers. However, each type of knowledge exerts different influences. The association between consumer knowledge and consumer country was also analysed in the House *et al.* (2004) study reaching the conclusion that only subjective knowledge appeared to be related to consumer country. However education was detected as the other individual attribute related to consumer knowledge, a relationship also noted by Onyango *et al.* (2004). The House *et al.* (2004) study revealed that while subjective knowledge appears to be related to acceptance, objective knowledge seems not to be so related. This conclusion was also noticed by Lusk *et al.* (2004) who found that individuals with higher levels of subjective knowledge were less influenced by new information. Therefore we can say that both subjective or objective knowledge are relevant in shaping consumers attitudes although with different levels of impact.

In the rest of this section the focus will be on the role of knowledge in the construction of consumer perceptions and attitude towards GM food. Given that knowledge and attitudes are in continuous flux, see point 3.3, an attempt is made to determine the main factors of knowledge change. This, as we will see below, are trust and information which, at one and the same time, are flexible and capable of amendment.

5.2 Information

Those consumers, who reveal either rejection or acceptance of GM food, seem to be strongly influenced by individual values as opposed to those labelled as ‘undecided’

who do not have a clear perception or attitude towards GM technology. This last segment also exhibits a high desire for learning more about GM technology in order to assess more clearly their attitudes towards GM food (Onyango *et al.* 2004; Hossain *et al.* 2002). Furthermore, as Martinez *et al.* (2004), Noomene & Gil *et al.* (2004), Schilling (2003), Szczurowska (2005) and Vilella-Vila *et al.* (2005) state, European, Spanish and US consumers do not think they have sufficient information regarding GM food. Moreover, they also accept that they have made little effort to be informed about biotech applications in food production.

Another issue refers to how individuals learn about risks. Indeed, the process by which individuals acquire information regarding GM food is not straightforward. There are three main elements which are interrelated and that must be taken into account. First, information ‘substantial content’ is a key element on the level of acceptance of a GM product (Bredahl *et al.* 1998). This implies concrete, reliable, accurate and, as tangible as possible, information (Frewer *et al.* 1998; Yee *et al.* 2005, Costa-Font & Mossialos 2005 a). Information achieving ‘substantial content’ can be named as ‘effective’. Second, trust in the source of information is also important. Lastly, communication of the information must be taken into account.

5.3 Trust

Trust can be understood as a key element that regulates information updating and, therefore, knowledge acquisition and credibility of information sources. Moreover, trust is directly related to individual values (Siegrist *et al.* 2000), which, coupled with knowledge, are key determinants of personal attitudes and perceptions. Given that acceptance of a technology is also directly determined by the perceived risk and benefit, trust can be envisaged as a key element of the acceptance of biotechnology (Siegrist *et al.* 2000; Koivisto Hursti & Magnusson, 2003; Huffman *et al.* 2004). In addition, it can be stated that trust is also determined by individual attributes such as schooling, age and religious affiliation (Huffman *et al.* 2004).

The concept of trust is related to confidence and credibility in someone or something. ‘Trusting in someone involves a risk that the person will act unreliably’ (Siegrist, 2000). Therefore, in order to reduce risk, consumers are likely to believe the opinion of experts who appear to hold similar values to themselves (Siegrist, 2000, Cook, *et al.*

2002) Consequently, to increase consumers' knowledge it is important that the information received by consumers is not only 'believable' but credible (Bredahl *et al.* 1998). The building of credibility was analysed by Yee *et al.* (2005) using structural equation models. The Yee *et al.* (2005) study revealed that benevolence and integrity are characteristics that people associate with honesty and correct compliance with regulations, and therefore are key factors in building consumer trust with producers.

Many studies have revealed that for GM technology and, especially GM food, consumer organisations, environmental groups and scientists are considered to be more trustworthy than the biotech industry and government (Bredahl *et al.* 1998; Onyango *et al.* 2003; Savadori *et al.* 2004; and Veeman *et al.* 2005). However, some studies have noted that US consumers are rather more sceptical towards information provided by scientists (Hossain *et al.*, 2002). Interestingly, Eurobarometer data reveals that Europeans' most trusted stakeholders are doctors, university scientists, consumer organisations and patients' organisations, followed by scientists working in industry, newspapers and magazines, environmental groups, shops, farmers and the EU. Governments and industry are the least trusted (Gaskell *et al.*, 2003). Vilella-Vila *et al.* (2005) reported that trust in public authorities appeared to be in decline, especially in the UK. Moreover, cross-country comparisons developed by Traill *et al.* (2004) revealed that Americans exhibited a more favourable and trusting attitude towards GM technology than Europeans. Therefore, an explanation of the difference in attitude to GM food between the citizens of Europe and the US might well refer to trust on the sources of information regarding to GM technology.

It is also appropriate here to highlight the importance of consumer perception about which stakeholder appears to be the most influential regarding GM technology. Results obtained from two studies conducted by Frewer *et al.* (1996) and Moon & Balasubramanian (2001) in the first instance by use of variance analysis of revealed preference data, and by use of a probit model, in the second case, revealed that US and UK consumers considered government and science as the main actors regarding GM technology control. Therefore, trust in government and industry can be concluded to be an important determinant of attitudes towards GM technologies (Hossain *et al.*, 2003; Hossain & Onyango, 2004; and Onyango, 2004). Consequently, the fact that consumers appear not to trust government and industry infers that merely underlining the

associated benefits of GM food over conventionally produced food is not sufficient stimulus to modify consumers' perceptions towards such a technology (Siegrist, 2000). Furthermore, the lack of consumer trust in institutions may seriously hinder the complete acceptance of transgenic technology (Onyango 2004).

As already explained, worldwide the population seem to generally accept the risks reported by environmentalists such as NGOs, more than the benefits reported by industry and government. As Traill *et al.* (2004) state, the majority of respondents see GM in food production as having a 'middle risk level' since 'government and industry trust implies counterbalancing perceptions of GM benefits with trust in environmental groups' risk perception'. On the other hand, Savadori *et al.*, (2004) show that providing information on their benefits, by scientists, doctors..., could reduce public perceptions of risk from biotech applications. Frewer *et al.* (2003) and Lassen *et al.*(2002) consider that much of the controversy attaching in the public mind to the introduction of GM foods results from the failure of relevant regulatory bodies to take full account of the concerns of the public resulting in their distrust of regulators, science and industry, possibly due to previous failure of communication and information (on issues such as mad cow disease, dioxin etc..). This evident distrust is despite the introduction in the EU of the European Food Safety Authority (Jensen & Sandoe, 2002).

A different approach to explaining the relationship between trust, information and consumer attitudes can be attained as follows. Not 'trusting' not only drives information provision but consumer attitudes to GM food and aids in determining individuals' trust levels: 'that is, the relationship between trust, information source and impact of this information on risk perceptions is more complex than a simple one-way causal relation' (Frewer *et al.* 2003). This approach was demonstrated by use of a multi-sample structural equation model in Denmark, Germany, Italy and the UK. In particular, Frewer *et al.* (2003) revealed that 'people who favour the use of genetic modification are more likely to trust a source promoting its benefits whereas those who oppose its development are more likely to distrust the same source providing the same information'. Similarly, Lusk *et al.*, (2004) found that consumers' reaction to information depended on their prior acceptance of GM food. Therefore, trust and values are potentially associated as long as values determine the extent to which people select amongst alternative information sources. In the same way, Verdurme & Viaene (2003),

revealed that the category of ‘green opponents’ of GM technology will only react to positive information about GM food, by becoming even more firmly against GM food. So information about GM food can have an opposite effect depending on the prior attitudes of the receiver.

5.4 Communication

It is clear that the impact of information provision on consumers’ knowledge depends essentially on the level of trust that individuals have as well as on the source of the information. However, it is important to highlight that the means by which information is conveyed to the public is not irrelevant. Frewer *et al.*, (1998) highlighted the relevance of developing effective risk-benefit communication strategies, not only in the acceptance of a new technique but also in a crisis context, in order to enable the public to make informed choices. Since the majority of the information regarding new technologies such as GM food is disseminated by the mass media, Vilella-Vila *et al.* (2005) stated in their study some key points for a good media communication strategy: (i) to inform the people about not only risks but also about benefits in an objective manner; (ii) for consumers to obtain their information from trusted organizations; and (iii) to provide information in a credible and persuasive manner. Hence, simply providing information on the risk and benefits of GM food would not be sufficient of itself, to promote attitudinal change in consumers (Frewer *et al.* 2003; and Bührlen 2005).

Communication campaigns may, in future, need to focus on providing information that address those characteristics of GM food that presently negatively influence individual consumers fears in so far as those fears might constrain the development of the market for GM food (Costa-Font & Mossialos 2005 a). Indeed, when conflicting information is presented to them, consumers tend to favour any prior beliefs they may have held, such as ‘subjective knowledge’ based on individual values (Costa-Font & Mossialos 2005 a). Additionally, Costa-Font & Mossialos (2005 b) also revealed that if there is a ‘trade-off’ between individual values and attitudes in the mind of consumers towards the product derived from ‘objective knowledge’, individual values prevail over attitudes to the detriment of biotechnology and GM food. Additionally, A. Verdurme (2003) has shown that it may be worthwhile to develop a segmented communication approach in which information is specifically developed for a particular type of consumer. In her research

she distinguished between the ‘believers’, the ‘balancers’, the ‘halfhearted’, and the ‘green opponents’.

5.5 Labeling as a communication strategy

One important consumer source of information is product labelling. Labelling appears as a mechanism for communication of information so as to enable consumers to undertake an informed choice (Gath & Alvensleben, 1998, Noussair *et al.*, 2004). That is, choices are consistent with their preferences (Baker & Burnham, 2001; Moon & Balasubramanian 2004; and Loureiro & Bugbee, 2005). Consumers in Poland believe very strongly that food products that contain GM components (93%) should be clearly labelled as such (Szczurowska, 2005). Moreover, labelling can provide additional information about GM technology and its benefits thus raising awareness and improving transparency (Frewer *et al.* 1998). As a consequence, consumer trust in the biotech industry should increase. This belief would appear to be a minority view in Poland where most consumers seem to be resolutely against genetic modification of food plants and animals (Szczurowska, 2005; Bukraba-Rylska, 2003).

It can be stated that labelling can assist in increasing individual perception of personal control over a particular situation, in this instance, over the consumption of GM food (Frewer *et al.* 1998). However, this study did not find empirical evidence regarding an increase in consumers’ perception of personal control. Therefore, it might be concluded that consumers’ attitudes toward GMO in food would not be changed by increased product information. There is evidence, however, that consumers may change their attitude to GM food based on their own experiences with products produced using GM techniques that involve clear consumer benefits (Grunert *et al.* 2003). On the other hand, studies such as that by Kiesel *et al.* (2005) in the USA, revealed that provision of additional positive information - in the label – would likely increase consumption of the commodity that included a desirable characteristic. The latter study was based on consumer maximization theory, using scan data on GM milk.

Different labelling policies exist and, therefore, different product communication strategies are followed, which are influenced both by regulations and driven by the product companies themselves. First, mandatory labelling is required in many countries. European regulations, among others have introduced mandatory labelling to ensure

consumers are advised that the final product contains GMOs. Mandatory regulation is seen by some to be over-regulation and, with some justification, is said to increase industry costs (Moon & Balasubramanian 2003b). Alternatively, voluntary labelling, as developed under US regulations among others, generates the opportunity for companies to label their products as including GM but does not permit consumers to gather all the information regarding the product they might wish to acquire. Therefore, ‘only consumers who value non-biotech food pay higher prices’ (Moon & Balasubramanian 2003b). The issue of mandatory or voluntary labelling of food products has generated much discussion. Some studies, such as Moon & Balasubramanian (2003b), conclude that voluntary labelling appears to be an effective approach but for others such as Lusk *et al.* (2005a, Noussair *et al.*, 2004), voluntary labelling is viewed as clearly insufficient, concluding that European mandatory labelling has increased consumers’ welfare. Moreover, this study also suggested that, if segregation costs diminished and consumers perceived an increase of GM products on the US market, a mandatory labelling policy would be needed in the USA.

Consumer labelling preferences have been analysed by studies such as Harrison & McLennan (2003); Chern *et al.* (2002) and Veeman *et al.* (2005) concluding that consumers in the US, Japan, Norway, Taiwan and Canada support mandatory labelling of GM food. Alternatively, Loureiro & Hine (2004) stated that US consumers had divergent opinions regarding labelling policies based on consumer trust in government. Indeed, some US consumers are confident with the Food and Drugs Administration (FDA) safety regulations and implicitly, therefore, with voluntary labelling, whereas, others were not. Finally, it is instructive to take account of the conclusion reached by Harrison & McLennan (2003) who noted that US consumers revealed their desire for more information regarding GM technology as well as the GM content of the product itself. This result suggests that consumers preferred labelling formats containing a description of the benefits of biotechnology as well as a biotech logo.

6 Consumers' acceptance of GM food, and willingness-to-pay a premium for, non-GM food

6.1 Product valuation, individual intentions and purchase behaviour

Two main theories have been used for analysing acceptance and purchase performance behaviour regarding GM versus non-GM products. These are the random utility model, more precisely, Lancaster's theory of consumer demand, and the Theory of Planned Behaviour, based on causal relations. Lancaster's theory of consumer demand (Lancaster, 1966) states that consumers make product choices with a view to maximising utility, among observable factor, based on their evaluation of the combination of attributes provided by each product.

The Theory of Planned Behaviour states that 'a person's intention to perform, or not, a behaviour is the most important immediate determinant of an action' (Ajzen, 2005). These theory links individuals' attitudes regarding acceptance or rejection of a product, with a valuation of the product reached by means of intentions. Moreover, the theory considers that consumer intentions are defined by three main elements. First, the individual's *attitudes towards the behaviour* (which has already been analysed above), next a *subjective norm*, which consists of the individuals' perception of social pressure of performing the behaviour and, finally, the *perceived behavioural control*. This last element consists of the individual's perception of his ability to perform the behaviour. Indeed, as Ajzen (2005) states, these three elements do not impact on consumer intention in the same way either for different intentions or for the same intention but for different people. An important element that makes this theory useful for analysing GM versus non GM purchase behaviour is *perceived behavioural control* (PBC), since it is used to explain intentions with a perceived impediment associated, for the case of GM versus non-GM food the limited 'inability to identify GM food' (Cook, et al. 2002).

6.2 Methodological approaches

In empirically examining consumer purchase behaviour and valuation there is an array of different methodologies that can be employed. First, possibly the most common method, are contingent valuation techniques based on estimating the consumer's declared compensation for GM food or equivalent valuation for non-GM food, namely the willingness to pay for non-GM products, or to accept, GM products. This technique

uses a hypothetical market format and can be used both in survey and experimental settings though survey questionnaires are the most common approach used. Alternatively, some techniques can be implemented in experimental settings. The latter refers mainly to choice experiments and, most notably, conjoint analysis based on consumers' multi-attribute utility maximization. This technique relies on the premise that a good or service valuation depends on its attributes, and accordingly by changing its attributes, one might obtain a different overall valuation of each good. The methodology is therefore more flexible than contingent valuation techniques as it focuses on identified attributes and permits identifying clearly the drivers of consumer value. Briefly, it consists in presenting individuals with a variety of scenarios founded on product attributes and its related levels in order to discover the relative importance of each attribute on consumer utility and any possible underlying trade-offs between them. Consumers are asked to state their preferences over a set of alternative choice scenarios with different attribute intensities, and responses are analysed using statistical discrete choice models. Finally, revealed preference methods, are employed in experimental settings. This technique consists of performing normal auctions for real products in a non-real market.

One special application of experimental evidence methodologies utilised whenever there is risks information, is the elicitation of Certainty Equivalent (CE) or monetary valuation of lotteries or pairs of probability/outcome scenarios. Indeed, Lusk & Coble (2005) stated 'the amount of money that makes the individual indifferent between consuming the GM food with an outcome Z and receiving the certain amount non-random money CE. That is, CE represents the monetary value of consuming the GM food to the individual' and relies on choice experiment under risk. Interestingly, comparing revealed and state preferences, Lusk *et al* (2005c) found that 'non-hypothetical premiums were lower than hypothetical; also WTA measures exceed premiums estimated using the WTP'. This study also revealed that 'conducting the valuation task face to face generated lower premiums for non-GM food than by phone or mail'. An alternative methodology worthy of mention, is the use of blind taste experiments. This experimental methodology was employed by Townsend & Campbell (2004) as a psychologically grounded methodology but is design intensive.

6.3 Consumer GM- versus non-GM- purchase behaviour

Most studies using the stated preferences methodology (Lusk *et al.*, 2005c; Moon & Balasubramanian, 2003a; Onyango & Govindasamy, 2004 and Chern *et al.*, 2002) have found evidence that consumers are willing to pay a premium for non-GM food. Therefore, consumers place a higher value on non-GM food relative to GM food (Lusk *et al.*, 2003). Drawing from an alternative approach, an n^{th} price auction on a real market, Rousu *et al.* (2003) concluded that consumers would reduce their demand between 7 and 13% for each food relative to GM free food, when tolerance limits for GM food lie between 1 and 5% respectively. In this study, consumers were willing to pay a large premium to avoid GM contamination in an uncontaminated product. However, no evidence was found that consumers' value food more highly with a 1% GM tolerance than they do those foods with 5% tolerance limits. The authors suggested that if the US decided to allow a tolerance of GM material in food products, the 5% limit would be more widely accepted, for all stakeholders, than a 1% limit. The discounting effects on consumers' purchase intentions was also detected by Bredahl (1999), a study of bread, ice cream and pasta, produced with GM enzymes and conducted with Finnish, German and Italian consumers. In spite of this general conclusion, other studies such as Moon & Balasubramanian, (2003b) using a closed ended question and payment card format for breakfast cereals, and Gifford *et al.* (2005), using experimental auction markets for potatoes, potato chips, milk, milk chocolate, corn, and tortilla chips, found that a US potential niche market for non-biotech foods could emerge if consumers were given the right to choose between biotech and non-biotech food.

Cross-country differences regarding consumer purchasing behaviour have been observed for consumer attitudes. Chern *et al.* (2002) in a study in Japan, Norway, Taiwan and the USA, concluded that in all countries consumers (in this study, all were students) were willing to pay higher premiums for non-GM food although American and Taiwanese students were more favourable to GM foods than Norwegian and Japanese ones. Generally speaking, most studies reported that European consumers are willing to pay higher premia for non-GM foods compared North American consumers. Lusk *et al.* (2005c) who employed stated preference approaches and Jaeger *et al.* (2004), who used revealed preference tools, are good examples of this last statement. Some other studies also compare US consumers' behaviour with that from other countries.

Moon & Balasubramanian (2003b) stated that the demand for non-biotech food is greater in the UK than in the USA. Also, Lusk *et al.* (2003b), analysing consumers' WTP for hormone-treated/GM-fed beef, noted that European consumers placed much higher value on beef from animals not fed with genetically modified corn than US consumers. Additionally, Lusk *et al.* (2004), comparing US, French and UK consumers WTA using a fifth price experimental auction for chocolate chip cookies, noted that French consumers are the most averse to GM food and the most resistant to change. The same conclusion was arrived at by Jaeger *et al.* (2004) using experimental economic evidence with GM cookies. Differences between the EU and the US consumer behaviour, can be explained by the diversity of government trust and media coverage between the two populations.

Table 1 below presents data synthesising a number of recent studies that reveal the level of premium some consumers in a number of different countries might be prepared to pay for some different food products that do not contain GM ingredients. It is freely adapted from Lusk *et al.* (2005b) with the addition of data from a recent paper (Kaneko & Chern, 2005). These studies are fully referenced in the Lusk *et al.* (2005) paper and also in this review. The Kaneko & Chern (2005) study focussed on consumer willingness to pay for genetically modified vegetable oil, cornflakes, GM-fed salmon and GM salmon and was derived from a telephone survey in 48 states of the USA. The premium price range data presented are simply the range of minimum and maximum percent figures as stated in Table 1 of the Lusk *et al.* (2005b) paper.

Table 1. A comparison of price premia for some non-GM foods (in US and Europe).

Product	Tangible consumer benefit?	Percent premium for non-GM (%)
Beef	No	10 to 110
	Yes	-33
Salmon	No	28 to 54
	No	30 to 67
Potato	No	5 to 17
Rice	Yes	-19 to -38

Vegetable oil	No	5 to 62
Soybean oil	No	-16
Potato chips	No Yes	8 to 9 -63
Corn chips	No Yes	10 to 16 -0.33
Cornflakes	No	14 to 40
Breakfast cereal	No	28 to 96

Source: Adapted from Lusk *et al* (2005b) and Kaneko & Chern (2005).

Other relevant elements have also to be taken into account when a purchasing decision is made. First, the information regarding benefits associated with GM food. Interestingly, Moon & Balasubramanian, (2003b); Onyango & Govindasamy (2004); Lusk *et al.* (2004a) and Lusk *et al* (2005c) using alternative methodological approaches, found that when UK and US respondents were faced with positive information regarding GM food, such as environmental or health benefits, valuation of non-biotech foods relative to GM foods is modified, indicating a potential niche for GM-foods in the future (Magnusson & Koivisto Hursti, 2002; Mucci & Hough, 2003; Onyango & Govindasamy 2004). Similar conclusions were reached by Frewer *et al.* (1996) who analysed UK consumers' real purchasing behaviour for yogurt, tomato and chicken drumsticks and Mucci & Hough (2003), where consumers indicated that they may be more willing to accept genetic modification to food products where there were benefits to health and the environment but less likely to accept GM where the main benefits were to increase shelf-life of a product or to reduce the purchase price. The Frewer *et al* study specifically linked the likelihood of purchasing GM products with perceived 'naturalness' of the products. In a more recent study (Tenbült *et al*, 2005), it was concluded that consumers were less likely to accept genetic modification to food products that they considered to be "natural" (as conventional) and they would, therefore, be more likely to resist buying products of that type that incorporated GM.

However, Jaeger *et al.* (2004), using a non-hypothetical market experiment setting, indicated that information seemed not to be a positive factor in increasing WTA monetary compensation for consuming GM food. Alternatively, Lusk *et al.* (2002), analysing US consumers' preferences for corn chips with conjoint analysis, concluding that, although consumers prefer GM products to be associated with some benefits, those benefits would not imply a willingness buy for those GM products. Canavari *et al.* (2005), using probit analysis to model Italian consumers' utility maximization, concluded that Italians were not willing to buy GM food products even if they were nutritionally enhanced. However, enhancement could help increase consumer acceptance of GM food products in Italy generally, but only if it is a plant based food product and not an animal based food product. Indeed, acceptance of GM technology does not imply a willingness to buy. The same conclusion was reached by Bredahl (1999), in a study conducted in four countries, that of Denmark, Germany, the UK and Italy.

The relationship between consumer intentions and final purchase behaviour has also been analysed by Townsend & Campbell (2004) with a blind taste experiment. The study revealed that, although the majority of the UK participants were willing to taste GM food (intention), only half of the sample stated their willingness to buy GM food when it became available. This study also revealed, using a logistic regression analysis, that dread and concerns about future risks portended by GM animals used in food, were key determinants of unwillingness to purchase GM food. That is, perceived risks have a negative impact on consumers' WTA (accept) GM food (Loureiro & Bugbee, 2005). The negative impact on consumer demand (WTP) for GM products of information reporting risks associated with GM food, was empirically displayed by Rousu *et al.*, (2004), who, using a random nth price auction for tortilla chips, russet potatoes and vegetable oil, noted that negative GM-product information supplied by environmental groups could significantly reduce the consumer demand for GM food products. Moreover, risk perceptions had more impact on choice than benefits (Lusk & Coble, 2005a).

As well as the type of product and perceived associated risk, price is also linked to consumers' purchasing intentions (Boccaletti & Moro, 2000, Veeman *et al.*, 2005, Bredahl, 1999). Bukenya & Wright, (2004), concluded that Alabama's grocery

shoppers could be classified into three groups: those that will not consume GM tomatoes at any price, who are 45% of the sample; 35% who said that they would consume GM-tomatoes if they became cheaper than conventional tomatoes; and, finally, the remaining 20%, who would consume GM tomatoes at the same price as traditional ones. Therefore, for only a small proportion of the sample, price is a significant factor, which explains consumers' attitudes towards GM food. Canavari *et al.* (2005), in a study of Italian consumers, reached the same conclusion. Additionally, Hwang *et al.* (2005 a) using a conjoint analysis for bread, corn and eggs, stated that consumers use price as a signal of product quality, though heterogeneously amongst products. The study determined that, for GM bread and GM corn, purchasing intentions increased as their price decreased until a limit was reached. Therefore, it can be said that consumers do not relate GM food with high quality food. In the case of eggs, the price was monotonic over the whole price range. The authors analysed the possible marketing strategies arising from these results.

Finally, it can be said that there exist other factors capable of explaining consumer purchasing behaviour, such as: ingredients and labelling (Veeman *et al.* 2005); 'attitudinal' variables (Loureiro & Bugbee, 2005; Bredahl, 2001; Gifford, *et al.* 2005); knowledge of science and trust in science (Canavari *et al.* 2005); government policies (Lusk *et al.* 2006); and products' brands and place of purchasing (Lusk *et al.* 2002). In addition Cook, *et al.* (2002), following the Theory of Planned Behaviour and defining a probit model, proved that self-identity - *a label that people use to describe themselves. It is assumed to be the product of social interaction and the cause of subsequent behaviour* Biddle, Bank, & Slavings (1987), from Cook, et al. (2002) - is also an important influence on purchasing intention. The study also suggested gender differences regarding GM behavioural purchase intentions, that is, males seemed to be more likely to feel in control when purchasing GM food than females.

7 Conclusion

This review has attempted to systematically summarise the evidence on the acceptance of GM food and its underlying processes. In doing so this study brings together in different sections of the paper the published findings on the main issues under discussion including risks and benefits perceptions, trust, knowledge, and valuation as well as purchasing decisions. On the basis of this evidence, we have come up with a

tentative general framework that we believe it can contribute to further research in the area. On the basis of the literature scrutinised, we ascertain that the population inspected in the set of studies examined can be segregated in three main groups regarding to GM food attitudes, namely: (i) anti-GM food or pessimistic, (ii) risk-tolerant or information searchers and finally (iii) GM-accepters or optimistic. Yet, different compositions of such groups in a specific society determines final country acceptance of GM food. On this basis it is become apparent that in the U.S. and some European countries such as Spain and Portugal among others, the population is found to be broadly more tolerant to GM food as compared to France or the Nordic population.

However, in the lights of the large array of determinants identified in the literature, we conclude that this personal attitude is formed by a complex decision-making process driven by three main dimensions.

First, risks and benefit perceptions associated to GM food as well as their weights in determining acceptance and final decisions. Indeed, in most European countries, and specifically in particular Nordic countries, Britain and Germany consumers find benefits associated to GM food as insufficient to overcome their associated (perceived) risk. On the other hand, in the US and also in some European countries as Spain and Italy, consumers mainly reveals some perceptions of risks and benefits associated to GM food but benefits can potentially outweigh risks.

Socio-economic and demographic attributes, such as age, ethnicity, residence and income level have been detected by many authors to be related with either benefit perception or consumer acceptability of GM food - worldwide level. Nevertheless, there are also some studies, which do not support this statement. Therefore it will be important to further analyse this issue by means of a cross-country study that consider this issue over time.

Second, individual values and attributes associated appear as key determinants underpinning consumer attitudes. Risk and benefit perceptions towards a GM product are found to be conditioned to what is known as “individual values” such as environmentalism, conservationism, materialism, equity etc. Moreover, the stronger this association – determining the strength of the trade-off perception vs. values- the more

pervasive becomes the influence of underlying individual attitudes. On the other hand, the less important the role of values the more important it becomes the role of new information in order so as to shift consumer behaviour.

Finally, knowledge and its relation with values must be considered as an especial human complex attribute. Indeed, knowledge can be divided into “objective” and “subjective”, being the second the most related with values and with more impact on individuals attitude development. This review explains that in countries where limited knowledge of GM food exists, one would expect to find information searchers whilst in those with very negative (positive) information conveyed one might find pessimistic (optimistic) attitudes. In a way, values can be argued to predetermine knowledge as a filter of information by means of elements such as trust and confidence. Therefore the level of trust of consumers on the different sources of information must also be considered. In fact, worldwide consumers trust more those sources of information that are supposed to be driven towards the protection of individuals’ wellbeing and environmental rights. This is the case of consumer organisations, environmental groups, doctors and also scientists. In contrast, biotech industry and governments are less trusted. Nevertheless, an important trust divergence exists among Europeans and Americans, since the last ones reveal more reliance on the FDA than Europeans on either the EU or the worldwide biotech technology.

These three elements are strongly connected and their parallel study we believe it is needed so as to understand consumer’s behaviour. It is a combination of how people perceive, learn and process information on new food technology developments what ultimately determines acceptance. Therefore, policies to tackle acceptance of new developments in the food industry should operate in different arenas including the media, the education system and a correct population analysis to determine information availability and processing, but through individuals transmission of values and societal trust enhancing factors and, finally by being able to communicate the benefits of new developments, especially when those overcome potential perceptions of risk, to avoid the existence of ambiguity in the existing information channels.

The last concept analysed is consumers purchase behaviour regarding GM food, which is mainly negative. That is, all the papers revised, whatever the technique of analysis

used – stated preferences, real markets, blind taste, etc -, detected that, on the one hand consumers mainly prefer GM free food, until the point to pay a premium for them. And on the other, that cross country differences exist. The main difference is among Americans and Europeans. Indeed, the formers seem to be more tolerant to GM food. This can be explained from a policy view by two main different elements: trust among stakeholders, already analysed and information policies, US consumers do not have complete information about the food products due to the voluntary labelling policy, whereas in Europe, more detailed information exists but possibly the GM threshold is not well enough defined and communicated to consumers. For Europeans the essential is to purchase GM free food, not mater the GM threshold. This is important when analysing the right of consumers to have the necessary information to perform adequate choices. We can conclude therefore, that US consumers are more tolerant with GM products because they don't know in detail what they are consuming. However, they have trust on the safety governmental policies which allow that products to be on the market.

Finally, consumer behaviour also can be related with the associated benefits of GM food. Indeed, these benefits can be of many different types and the only considered by consumers are the ones implying health and environmental benefits. Moreover there are conflicting results as regards the impact of these benefits on consumers' behaviour. Some authors consider them relevant and others not enough. Otherwise negative information associated with GM food seems to have negative impact to consumer behaviour a propos GM food. As well as for attitude formation other factors also seem to influence consumers purchasing behaviour such as gender, age, knowledge and so on.

All in all, this paper has detected three main critical points, which must be considered when defining stakeholders' decision-making strategies to dealing with GM food attitudes:

- To perform a correct segregation of country population in order to predefine potential market niches for GM products and GM free products. This will help government, media and producers to perform different –more efficient– communication strategies for the different consumer groups defined. Moreover, this segregation would also permit to determine the segments that

would consider benefits and risks for each product and those who would only consider risks.

- Start to introduce GM scientific knowledge issues –culture– during school period in order to assure a high level of objective knowledge among population.
- Homogenize information provided by the different sources of information, and highlight that it must be scientific.

We also aim to highlight that there is a clear-cut need to investigate the attributes that lie behind the valuation of GM food. To do so, we consider that the most appropriate technique for this purpose is the choice experiment methodology. Particularly, this methodology, allows researchers either to detect the desired attributes associated to the product on study or the level of each attribute. This would permit the overall verification of consumer attitudes and values relating to GM foods and also would distinguish the extent to which the different attributes that may conflict with each other might exert influence on consumer values.

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Has the Noussair, Robin and Ruffieux 2004 paper been taken into consideration?