Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and Implications for Food Policy.

1. Introduction

The development of genetically modified (GM) food has been a matter of considerable interest and worldwide public controversy. As a result 'uncertainties', 'risks' and 'benefits' that such new technologies portray to the food industry and consumers have been widely disseminated. However, there is limited understanding of what lies behind "demand side effects" to the introduction of these 'potential food industry innovations'. Among demand influences, preference, valuation along with underpinning attitudes - leading toward potential (un)acceptance - have received attention in the literature. However, the fact that GM food is typically a potential daily consumption product (e.g., GM milk, tomato etc) makes it somehow complex. Firstly, the valuation of a new good implies the provision of information from several sources - public and private, formal and informal etc – and conditioned on that, the credibility and trustworthiness of each relevant information source. Given the information available, a further issue is that of attitude expression and formation, which ultimately leads to the final question regarding product valuation and consumer preference.

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. To date, 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' acceptance of GM food, little attention has so far been devoted to examining and evaluating the findings from these different studies in order to make recommendations for policy reform regarding the introduction of GM foods.

This paper attempts to bring together the published evidence from several studies, typically form a variety of research disciplines, but all dealing with the issue of ultimate public acceptance of GM food and its underlying behavioural processes. Specifically, this review aims to respond to some well determined questions, namely whether and under which circumstances are consumers willing to accept GM food, whether they are willing–to-pay a premium for non-GM food, 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, this paper examine what the significant attributes are, which appear to be most influential in directing consumer behaviour and from this it aims to present some possible policy strategies to deal with public uncertainty regarding to GMOs and specially GM food.

We have structured theThe paper is structured as follows six sections. First, we it exploreexplores the existing evidence on consumer attitudes to GM food-related applications. Second, we deal with the role of risk and benefit perceptions in the development of consumer attitudes is analysed, as well as how individual values and attributes are related to individual attitudes. The third section is devoted to the role of product knowledge that is also considered as being the underlying determinant of consumer risk and benefits perceptions. Fourth, the paper focuses on the potential links between attitudes and consumers' acceptance of GM products and, we examine the determinants of consumers' valuation of GM products. The paper ends with some policy implications along with specific recommendations for further work.

2. Evidence on worldwide consumer attitudes to GM technology – food related applications.

Evidence on attitudes has become clearer in European countries after the publication of Eurobarometer series after 1991. Interestingly, evidence suggests some reluctance towards the introduction of GM foods exists (Grunert et al., 2003; Bredahl, 2001), eventhought the recent Eurobarometer surveys (Gaskell et al., 2003; Gaskell et al., 2004; Gaskell et al., 2006) also reveal evidence of a progressive recovery on people's support for GM food products from 1999 to 2002. Surprisingly, a return to scepticism is found in 2005 data (Gaskell et al., 2006). This evidence reveals a split of European consumers on several dimensions, which are mainly classified into three groups regarding their perception of GM food: 'optimistic'- 25%, 'pessimistic'- 58%, and 'undecided'- 17%. Additionally to this general attitude,

national differences are also remarkable. Gaskell et al. (2003) finds that support for GM food is observed until 2002 in only four countries - Spain, Portugal, Ireland and Finland. However, 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 that there was still a considerable segment (25%) who could best be described as 'anti-GM' and others (20%) who had 'complex reservations' regarding the wholesale introduction of GM products (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, 2003; Janik-Janiec & Twardowski, 2003).

Besides Europe, evidence form the US is insightful and suggests ~~evidence~~ that is~~,~~ not significantly different from those find in Europe. Particularly, US students mainly prefer non-GM products for chips, banana, corn flakes, and corn-beef (Onyango & Govindasamy, 2004b; Lusk et al., 2002). Moreover, Hossain et al. (2003) using discrete choice modelling for GM fresh fruit and vegetables finds 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 was labelled as 'undecided'. These results are echoed in other studies such as Hossain & Onyango (2004). Finally, a study in an Asian setting - South Korea - suggests a similar picture. Indeed, Onyango et al. (2004c) found that consumers are divided in groups that range from acceptance and optimism regarding GM food improvements to pessimism and rejection.

3. The role of risk and benefit perceptions in the construction of consumer attitudes

Possibly the most accepted underlying theory of the formation of consumer attitudes is the Fishbein Multi-attribute Model (Fishbein, 1963). Under this framework, an attitude towards a product is based on knowledge about the product itself as well as its attributes, the so-called 'bottom-up' formation of attitudes (Grunert et al., 2003). However, attitudes do not depend only on one specific belief but on a handful of them. More recently, Bredahl et al. (1998) developed a more detailed model for the 'bottom-

up' consumer attitude explanation specifically regarding GM food, which implies that attitudes towards GM food technology are defined by means of a weighted sum of attitudes towards each product and its corresponding process. Therefore, each attitude also depends on the overall perceived risks and benefits associated with the product and process respectively. An important assumption of this model is that individual attributes and values influence attitudes and thereby give rise to more general attitudes (Bredahl, 1998).

Interestingly, this theoretical model has been empirically supported by some studies such as Moon & Balasubramanian (2001 & 2004); Grunert et al. (2003); Onyango (2004a); and Hossain & Onyango (2004), which state that, consumers associate, on the whole, more negative than positive attributes to agro-biotechnology. In addition, a set of evidence suggest that individual behaviours are driven by perceptions or beliefs about risks rather than the technical risk estimates provided by experts (Frewer et al., 1998). Parallel, other authors manage to find an association between perceptions of opposition and resistance to GM food explaining consumers' segmentation regarding GM food attitudes. This is the case of Gaskell et al. (2004), who analysed by means of multinomial regression and multiple regression, a set of different decision-taking strategies for each group identified among European consumers. Findings suggest that 'Pessimistic' and 'Optimistic' respondents 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 to develop 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. A recent work by Traill et al. (2006) suggests that risk and benefit perceptions are negatively, but not perfectly, correlated, and that benefits are more important than risks in the determination of consumers' willingness to consume. That being so, they conclude that it is best to measure risks and benefits separately. Finally, Yeung & Morris (2001) conceptualised risk perceptions and related them to a combination of characteristics such as: dread, unknown and extent.

Hossain et al. (2002 & 2003), Onyango et al. (2003) and Onyango et al. (2004b) detect that US consumers are optimistic about possible benefits of GM food and feed, but they are also concerned with their associated health, safety and environmentally harmful consequences. A similar conclusion is reached by Lusk et al. (2002) in a study regarding the consumption of corn chips by US students. They

conclude that, although US consumers preferred non-GM products, GM products that exhibited clear-cut benefits are acceptable. In the same line, Savadori et al. (2004) and Martinez et al. (2004) revealed that providing information on their benefits could reduce public perception of risk from biotech applications. Indeed, Loureiro & Bugbee (2005) show, by using a multiple-bounded probit methodology that the highest valued GM-associated benefits are: the 'enhanced flavour' modification followed by 'enhance nutritional value' and 'pesticide reduction'. However, these conclusions cannot be generalised. Siegrist et al. (2000b; 2000a) stated that, for north European consumers, perceived benefits do not significantly impact on consumer GMOs attitudes. Also, Bech-Larsen & Grunert (2000), stated that the Nordic populations consider the benefits to be derived from GM food as a helpful, but insufficient condition for an increase in consumer acceptance of GM food products. Fortin & Renton (2003) in their study of GM bread and milk in New Zealand reached the same conclusion. Following Bredahl (2001), it seems that exist cross-country differences in relation to consumers' risks and benefits perceptions related to GM food. In his study on European citizens, he concluded that Danish, German and British consumers identified risks as an obstacle for the perceptions of benefits associated with GM food, whereas Italians considered that risks and benefits were in a clear-cut compensatory relationship.

Indeed, consumers do not perceive GM technology as being a one-dimensional skill. Some studies, such as Gaskell et al. (2003), Grunert et al. (2001), Hossain et al. (2002 & 2003) & Savadori et al. (2004) argue that European 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 especially useful and more 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 b).Contrary to the above statements, other studies conclude that consumers do not differentiate among applications. This is the case of Bredahl (2001), who conclude that Europeans reject GM technology overall.

Finally, consumers' risk perception of GM technology has been compared to that of other risks associated to different technologies. Hwang et al. (2005 b), showed that US consumers concerns were highest for pesticides and artificial growth hormones, followed by antibiotics, genetic modification and irradiation.

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Moreover, Townsend et al. (2004b), using rating measures, concluded that for UK consumers GM food, relative to other current concerns such as cancer, terrorism and biological warming among others, 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.

As previously stated, consumers can be categorised or classified according to their attitudes towards GM food. Certainly, following Baker & Burnham (2001) and Onyango et al. (2003), 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, which shape consumer biotechnology acceptance (Onyango et al., 2003). However, different studies conclude in diverse ways regarding the significance of these personal attributes on consumer's final attitude.

Some scientists such as Frewer et al. (1998), Moon & Balasubramanian (2001 & 2004) and Loureiro (2004), refer to the relationship between both moral and ethical considerations and consumer attitudes. Contrary, Vilella-Vila et al. (2005) concluded that moral issues appear not to be relevant for attitude formation as regards GM food. Other attributes, such as education and knowledge were also analysed by Onyango (2004a), Veeman et al. (2005), Costa-Font & Mossialos (2005 a), Hwang et al. (2005 b), Noomene & Gil (2004) and Hossain et al. (2002) finding a significant influence on consumer perceptions of food biotechnology. Moreover Traill et al. (2004) also concluded that: 'a high level of education is associated with acceptance of GM benefits, and conversely the opposite holds for high levels of perceived risks'. The attribute of knowledge, due to its relevance, is analysed in some detail in the next section.

A further important relationship among the different stages of a consumer attitudinal process is their association with socio-economic and demographic attributes such as age, ethnicity, residence and income level, which are found to be directly related to consumers' attitudes towards GM food. This relation is supported by Costa-Font & Mossialos (2005 a); Hossain et al. (2002 & 2003), Veeman et al. (2005) and Noomene & Gil (2004) using mainly logit and probit models. Moreover, Siegrist (2000a), through causal models relate gender differences with benefit perceptions. Certainly, these studies consistently find that

women perceive lower benefits and are less likely to accept gene technology than men. Moreover some of them revealed that middle age, less affluent and those who live in suburban areas are more concerned with GM food. On the other hand, 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. However, the last one as well as Hwang et al. (2005 b) suggests that other issues, besides income-related factors, might well influence attitudes.

Finally, Hossain & Onyango (2004) included religious beliefs as a personal attribute for attitude construction. However, there is limited agreement on the role of religion. As an example, Hossain et al. (2002 & 2003), using a logistic model, found no evidence of a link between religiosity and GM attitudes.

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 the *conventional means of production*. 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. Vilella-Vila et al. (2005) refers 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 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'.

Besides means-end approaches, complementary theoretical frameworks have been used to explain the influence of individual values on consumer attitudes towards a GM product.   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 an 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, weit will be analysed the impact of values on trust and therefore on information strategies.

5. Individuals knowledge and consumers risk and benefit perceptions

Consumer perceptions of risks and benefits are dynamic processes insofar as attitudes towards GM technology are in continuous evolution (Frewer et al., 1998; Bredahl et al., 1998). This dynamism can be

motivated either by the increasing knowledge of GM products as well as enhanced individuals' knowledge regarding GM technologies (Bredahl et al., 1998).

It is noted that some studies link individual attributes, particularly knowledge, to consumer attitudes and perceptions towards GM food. Certainly, information is the key element of the Fishbein Multi-attribute Model. In other words, knowledge about a specific GM product and the underlying production process becomes essential in order to shape attitudes. Some studies (Boccaletti & Moro, 2000; Moon & Balasubramanian, 2001 & 2004; Moerbeek & Casimiv, 2005; and Vilella-Vila et al., 2005), have empirically shown the direct association between 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 (Koivisto Hursti & Magnusson, 2003). Moreover Saavadori et al. (2004) and Madsen & Sandoe (2005) highlight, as have other authors, that experts perceive less or different risk for all GM applications than the public.

Some differences remain to be able to disentangling the effect of different types of knowledge. 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 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 location was also analysed in House et al. (2004) reaching the conclusion that only subjective knowledge appeared to be related to consumer location. Alternatively, education was detected as the unique individual attribute related to consumer knowledge, a relationship also noted by Onyango et al. (2004a). Additionally, House et al. (2004) 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.

Some studies suggest that the level of subjective and objective knowledge, regarding to GM food, among Spanish, European and US consumers is low and that more information should be provided to consumers to increase both knowledge and understanding of these matters (Martinez et al., 2004, Noomene & Gil et al., 2004, Schilling, 2003, Szczurowska, 2005 and Vilella-Vila et al., 2005). And what is more, that the majority of these populations (European, Spanish and American) have made little effort to be informed about biotech applications in food production. In particular, 'undecided' consumers is the segment that exhibits a high desire for learning more about GM technology in order to assess more clearly their attitudes towards GM food (Onyango et al., 2004c; Hossain et al., 2002). Contrary, those consumers, who reveal either rejection or acceptance of GM food, seem to be strongly influenced by individual values and hence by subjective knowledge.

A related question is how individuals learn about risks. The process by which individuals acquire knowledge 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 issue as influencing the level of acceptance of GM products (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). Second, trust in the source of information is also important. Lastly, communication of the information must be taken into account.

As above mentioned, trust stands as a key dimension that motivates information updating and, therefore, knowledge acquisition and credibility of information sources.   Moreover, trust is directly related to individual values and envisaged as a key element of the acceptance of biotechnology (Siegrist et al., 2000b; 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, 2000a). Therefore, in order to reduce risk, consumers are likely to believe the opinion of experts who appear to hold similar values to themselves (Siegrist, 2000a, 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) revealed that benevolence and integrity of producers are key factors in building consumer trust.

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). 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). Indeed, 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.

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), 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, 2004a). 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, 2000b). Furthermore, the lack of consumer trust in institutions may seriously hinder the complete acceptance of transgenic technology (Onyango, 2004a).

Interestingly, individuals seem to accept more strongly the risks reported by environmentalists than the benefits reported by, mainly, industry and government. As Traill et al. (2004) state, the majority of

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respondents see GM in food production as having a 'middle risk level' since 'government and industry trust implies counterbalancing perceptions of GM benefits, and trust in environmental groups more risk perception'. Moreover, Frewer et al. (2004) conclude that, in their view, much of the controversy attaching in the public mind to the introduction of GM foods results from the failure of the relevant regulatory bodies to take full account of the actual concerns of the public and hence their distrust of regulators, science and industry, a view also expounded in an earlier study by Lassen et al. (2002). 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.

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 in 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 addresses those characteristics of GM food that 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.

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). That is, choices are consistent with their preferences (Baker & Burnham, 2001; Moon & Balasubramanian, 2004; and Loureiro & Bugbee, 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.

It can be stated that labelling can assist in increasing individual perception of personal control over a particular situation, in this case, 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 GM food would not be changed by increased product information (Szczurowska, 2005; Bukraba-Rylska, 2003). 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). This is the case of Kiesel et al. (2005) who revealed that provision of additional positive information - in the label – would likely increase USA consumption of the commodity that included a desirable characteristic.

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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. In fact, european regulations have introduced mandatory labelling to ensure consumers are advised that the final product contains GMOs. Mandatory regulation is seen by some authors to generate over-regulation and, with some justification, is said to increase industry costs (Moon & Balasubramanian, 2003b). Alternatively, voluntary labelling, as developed under US regulations, 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), 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 as Harrison & McLennan *(*2003); Chern *et al.* (2002) and Veeman et al. (2005), among others 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 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. From attitudes to valuation and acceptance: Consumer purchasing behaviour

Most studies using the stated preferences methodology (Lusk *et al.,* 2005c; Moon & Balasubramanian, 2003a; Onyango & Govindasamy, 2004b 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., 2003b). Drawing from an alternative approach, an nth price auction on a real market, Rousu et al. (2003) concluded that consumers were willing to pay a large premium to avoid GM contamination in an uncontaminated product. However, no evidence was found that consumers take into account the tolerance thresholds when valuing food. The discounting effects on consumers' purchase intentions was also detected by Bredahl (1999), in this study on 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), for breakfast cereals, and Gifford et al. (2005), 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 valuation and acceptance. Chern et al. (2002) in a study in Japan, Norway, Taiwan and the USA, concluded that in all countries consumers (in this case 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 and Jaeger et al., 2004), are good examples. In fact, Moon & Balasubramanian (2003b) stated that the demand for non-biotech food was 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 willingness to accept (WTA), noted that French consumers are the most averse to GM food and the most resistant to change. 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 present's 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). The premium price range data presented are simply the range of minimum and maximum percentage.

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 (2004b); 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, 2004b). 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 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. Moreover, Lusk et al. (2002), analysing US consumers' preferences for corn chips, concluded that, although consumers prefer GM products to be associated with some benefits, those benefits would not imply a willingness to pay a premium for those GM products. Canavari et al. (2005), 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, Denmark, Germany, the UK and Italy.

The relationship between consumer intentions and final purchase behaviour has also been analysed by Townsend & Campbell (2004a) 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, 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' WTP for 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, 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) 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. 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.

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 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.

Finally, some studies have also related consumer acceptance of GM food with traced production. This was highlighted in the study conducted by Nielsen et al. (2003), which stated that if consumers could be persuaded to consider GM products as conventional products, then the biotech industry would expand. If consumers were willing to pay a premium for non-GM food, the biotech industry would not expand and, should consumers reject GM varieties regardless of the price differential, then production would decline.

7. Conclusions remarks, policy and research implications

This paper 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 come up ~~that we believe it~~and maybe 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.

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However, in the lights of the large array of determinants identified in the literature, ~~we~~ it can be concluded that this personal attitude is formed by a complex decision-making process which we attempt to simplify in Figure 1. This theoretical model essentially differs from previous studies in the way that it integrates the different stages of consumer decision making process and show a general picture. As Figure 1 displays, consumer attitudes towards GM food are 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 paper 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, physicians 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~~ some main critical points, which must be considered when defining a policy decision-making strategy to dealing with GM food attitudes:

First, it must be highlighted the significant cross-country differences, in particular between Europeans and Americans, regarding to consumers process of GM food acceptance. Therefore, although it is not feasible to develop a general policy guide to deal with GM-food acceptance some recommendations are doable.

Whereas worldwide consumers' behaviour is mainly contrary to GM food acceptance, ~~To perform~~ a correct segmentation of country population is needed in order to predefine potential market niches for GM products and GM free products -recommendation already stated in Baker and Burnham (2004). In fact, this segmentation must consider many, already detected as relevant, elements such as demographic attributes, individual values as well as knowledge. This would permit policy makers to distinguish information searchers from the rest of population. Consequently, ~~This will help~~ government and media would be able to perform different –more efficient– communication strategies for the different consumer groups defined.

Since knowledge has been categorized as a singular human attribute that noticeably help on the sharpness of consumers GM food acceptance, especially objective knowledge. Policy makers must Sstart to introduceintroducing GM scientific knowledge issues –culture– during school period in order to assure a high level of objective knowledge among population. This must be especially important is countries where citizens no don't remarkably trust public authorities, as is the case in Europe. Indeed, trust is another element that policy makers must think about.

Homogenize information provided by the different sources of information, and highlight that it must be scientific it must also be relevant when dealing with risky topics as is the case of GM food.

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