‘GMO-FREE’ LABELS – ENHANCING TRANSPARENCY OR DECEIVING CONSUMERS?

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Abstract

Consumers, particularly in industrialised countries, are concerned about the application of genetic engineering in food production. There are considerations in many nations worldwide to introduce legal regulations to label food as free of genetically modified organisms (GMOs) in order to enable producers to better promote such products. However, requirements for labelling food products as ‘GMO-free’ can be very different, and therefore it is questionable whether consumers’ understanding of ‘GMO-free’ is consistent with what certain labels actually can guarantee. We conducted a consumer survey in order to explore potential gaps between expectations of ‘GMO-free’ food and production requirements in the case of the revised German regulation covering the labelling of foods as ‘GMO-free’. Our results indicate significant differences between consumers’ view and standards of production.

Keywords

Genetic Engineering, Food Labelling, Consumer Survey

1 Introduction and Background

Genetically modified organisms (GMOs) in food are a growing concern for consumers (BANSAL et al. 2007, 17). Although the harmful nature of GMOs has been questioned, especially by commercial seed providers and agricultural producers, and no scientific evidence has been provided yet to suggest that genetic modification of crops could be harmful to humans, many consumers feel a visceral reaction to the thought of eating food that has been genetically modified. Furthermore, people are concerned about the consequences genetic engineering in agriculture may have for nature and environment. Consumers, especially in industrialised countries (e.g., CURTIS et al. 2004; HANSEN 2004; BANSAL et al. 2007; LUSK and ROZAN 2008), whish to avoid GMOs in food, not only for health reasons but also because of environmental and/or religious, ethical or other non-safety related issues, and, thus, need to be informed whether genetic engineering has been applied during the production process. Hence, the question arises, what kind of labelling is appropriate in the view of consumers and how a labelling system must be designed to support consumers identifying the products they want.

There are different standards concerning the labelling of GMO-free food products worldwide, if the labels are based on standards at all. They are more or less restrictive and often allow for exemptions, especially in the field of meat and animal products (HAIGH 2004; GRUERE and RAO 2007, 53). In Germany there has been a regulation concerning the voluntary labelling of ‘GMO-free’ products since 1998 The following rules had to be kept in order to be permitted to label a product as ‘GMO-free’:

- The product should neither be genetically modified nor be made of any genetically modified ingredient;
- No additives like e.g. enzymes, which had been made by using GMOs;
- Animals must not be given any feed which had been in contact with any kind of genetic engineering. Additionally, no drugs or vaccines made by using GMOs were allowed.

All of these restrictions have been quite hard, both to control and to keep. Hence, nearly no food producer made use of the possibility to label products as 'GMO-free'. Accordingly, it was the primary aim of the revised German regulation in 2008 to make it easier for food producers to apply the label 'GMO-free'. By that, more producers shall be given the opportunity to actively promote 'GMO-free' products.

Compared to the previous regulation, requirements were lowered for animal products. Now they can be labelled as 'GMO-free' as long as no genetically modified feed crops have been used in a certain time period before slaughtering, milking or laying eggs. It is not required that the animals have been fed with non-modified crops for their whole life. Moreover, the administration of drugs as well as the use of enzymes, vitamins and amino acids that have been produced with genetically modified organisms is allowed as long as the final product does not contain any GMOs. Such additives are not allowed for vegetable produce labelled as 'GMO-free'. These facts created a heated debate whether the new regulation is of use for consumers or if it is rather misleading. Nevertheless, there are signs that producers adopt the new regulation and start to label products as 'GMO-free'.

Given this background, the present paper tries to shed light on whether the German 'GMO-free' label for animal food products really helps consumers to find the products they want, or if it rather deceives them in reality. Hence, the following questions emerge: First, what are consumers expecting from a 'GMO-free' label? How large is the gap between what consumers demand from the label 'GMO-free' and what it stands for? Second, does it make a difference in the view of consumers at which stage of the production chain and in which intensity genetic engineering has been applied? Third, does the importance of being free from any kind of genetic engineering vary between product categories in the perception of consumers? And finally, how important are different applications of genetic engineering in food production for consumers' purchase decisions?

In order to deal with these questions, we conducted an online survey in October 2008. In our questionnaire we included a choice experiment, which was supposed to deliver information about the impact of genetic engineering on product choice. Our results indicate that consumers strongly refuse genetically modified feed crops, but are rather tolerating genetic engineering in medication and feed additives.

2 Literature Review

When looking at the literature, you can find a huge number of studies that generally explore consumers' opinions and attitudes towards genetically modified (GM) food. The European Commission, for example, regularly conducts representative surveys on biotechnology (GASKELL et al. 2006). The most recent survey, conducted in 2005, comes to the conclusion, that medical and industrial biotechnologies are broadly supported by the general public, whereas a strong opposition to agricultural biotechnologies exists. A number of academic research papers try to explain the differences in consumer attitudes across countries and to explore determinants of attitudes towards genetically modified foods (e.g., SABA et al. 1998; BREDAHL 2001; NELSON 2001; SPRINGER et al. 2002; CURTIS et al. 2004; MILES et al. 2005; LUSK et al. 2005; GASKELL et al. 2006; LUSK and ROZAN 2008). In the United States, the International Food Information Council and the Food Policy Institute carried out comprehensive surveys on this issue, which indicate that American consumers have more positive attitudes towards the application of genetic engineering than Europeans (HALLMAN et al. 2002; LUSK et al. 2005; LUSK and ROZAN 2008). Consumer attitudes are directly formed by the perceived risks and benefits of genetically modified food (BREDAHL 2001, HOUSE et al. 2004), which in turn are affected by general consumer attitudes, e.g. attitudes towards the environment, consumer knowledge and trust in regulation bodies, as well as by socio-demographic characteristics (SPRINGER et al. 2004; HARTL 2008). Many authors also investigated the impact of subjective and objective knowledge as well as the level of

information and trust in risk regulation on consumer acceptability and demand for GM food (e.g., HOUSE et al. 2004; POORTINGA and PIDGEON 2005; WACHENHEIM and VANWECHEL 2004; WACHENHEIM et al. 2008). LUSK and ROZAN (2008) show that national labelling policies might have an impact on the acceptance of GM food, too, as the actions of government will change individuals' beliefs about the safety of GM food.

Furthermore, most consumers and organisations pushing for labelling want the process instead of the product labelled (EINSIEDEL 2000; MILES et al. 2005; BANSAL et al. 2007). This is because there are other concerns besides the desire for product safety for health reasons, like the effect of GMOs on the environment or ethical considerations. However, proponents of product-based regulations argue that such a kind of labelling benefits consumers by causing an increased variety of 'GMO-free' products on the shelves. This is due to the fact that product-based labelling standards are easier both to comply with and to control compared to process-based labelling standards, which in turn prevent producers from launching 'GMO-free' labelled products because normally it is to expensive and complicated to control the whole production chain, especially for animal products (GRUERE and RAO 2007). Opponents, on the other hand, argue that consumers expect from a 'GMO-free' labelled product that it has been produced without any form of genetic engineering throughout the whole production process. Accordingly, 'GMO-free' labels are only supportive for consumers if they provide this kind of expected information.

This list could be continued ad infinitum, but sound empirical results on consumer attitudes towards and expectations of 'GMO-free' labelled food products are lacking in the present literature as well as studies about the acceptability of specific applications of genetic engineering during the food production process. We only found a brief survey about the opinion of German consumers towards genetic engineering in food production from 2005 (DÖHRING 2005). About sixty percent of the respondents expected food products declared as GMO-free have not come into contact with genetic engineering on any stage of the production process. MILES et al. (2005) conducted a consumer survey in Italy, Norway and England, where more than 78% of the participants wanted processed food ingredients from a genetically modified food labelled, even if there is no genetically modified material in the final product. In another survey of the NATIONAL CONSUMER COUNCIL (NCC) in the United Kingdom in August 2001 about 79% of consumers thought that meat and other products from GM feed should be labelled as such. This proportion is substantially higher than the number of people (64 percent) in this survey who were concerned about labelling food from GM plants (NATIONAL CONSUMER COUNCIL 2001).

Regarding specific applications of biotechnology, a study of SABA et al. from 1998 found higher acceptance of genetic engineering in the fields of pharmaceutical development and hereditary illnesses compared to genetic engineering of plants and animals for food production purposes. This is not surprising, since other studies about the public acceptance of several branches of biotechnology also showed higher acceptance of genetic engineering in the fields of medicine and industry compared to agriculture (e.g., GASKELL et al. 2003; GASKELL et al. 2006; AMIN et al. 2007).

3 Survey and Methodological Approach

Given the results of the existing GMO-literature, it seems very likely that consumers' expectations are probably not met by the new labelling regulations in Germany. However, information about which applications of genetic engineering are acceptable for consumers within the process of food production are lacking in the present literature. Therefore, we decided to do an internet-based consumer survey. Online research allows the respondent to see pictures and to participate in complex choice experiments, which was relevant in our case. Furthermore, there is no influence of the interviewer as a person, so there is a smaller incentive to give socially desirable answers. Socially desirable answers are not an unusual

phenomenon in interviews considering genetic engineering particularly in Germany, because the debate about the issue is rather emotional. Before we started the survey, we applied several pre-tests of the questionnaire of which the last one was an online survey with about 100 participants in order to improve design and wording. The data collection of the online consumer survey lasted from the 17th until the 28th of October in 2008. The final sample consisted of 1012 participants recruited from an online-access panel. All participants were living in the federal state of Hesse in Germany, but for the reason that citizens of this region do not diverge significantly in their attitudes towards genetic engineering in food production from at least most European member states (LUSK et al. 2003; GASKELL et al. 2003; GASKELL et al. 2006), the results can be seen as transferable to a number of industrialised countries. However, it has to be pointed out that the resistance in Europe against GM foods is somewhat higher than, e.g., in Canada, and significantly higher than in the United States (NELSON 2001; CURTIS et al. 2004; GASKELL et al. 2006, 83; LUSK et al. 2008). The recruitment process of survey participants from the online-access panel included quotas regarding to gender, age (only within the range from 16 to 59 years, since elderly people are hardly reachable via internet) and place of residence. The average time to complete a questionnaire was about 15 minutes.

According to the literature (e.g., BREDAHL 2001; HOUSE et al. 2004; SPRINGER et al. 2004; HARTL 2008) we expected that besides socio-demographic characteristics also consumers' involvement in food products and food neophobia as well as consumption habits, attitudes towards the environment and knowledge about genetic engineering in food production would have an impact on what consumers expect from 'GMO-free' labelled food. Hence, our questionnaire consisted of the following parts: In the first part, people were asked about habits and attitudes related to food and nutrition. Food neophobia was measured using a subset of items from the scale developed by PLINER and HOBDEN (1992). The items measuring consumers' involvement in food products are based on the scales developed by Laurent and KAPFERER (1985) as well as MITTAL and LEE (1989) which measure product-unspecific consumer involvement. A reliability analysis of the pre-test data was applied to establish reduced scales of both food neophobia and involvement in food products that were used in the final questionnaire. In the second part we investigated subjective and objective measures of consumers' knowledge and experience with genetic engineering in agriculture, together with questions about image and expectations of a 'GMO-free' label. After that, people were asked in the third part to state preferences regarding the application of genetic engineering in livestock production and to complete a choice experiment in the fourth part, which should help to validate stated preferences. Then, attitudes towards genetic engineering in food production were measured using items from the scale suggested by BREDAHL (2001) and HARTL (2008). General attitudes about ethical and environmental issues in the context of genetic engineering were explored, too, before participants were asked about socio-demographics and finally got the opportunity to give feedback about the issue and the interview. Altogether, the survey was centred on the labelling of animal based products as 'GMO-free'. The products used in questions about purchase and consumption as well as in the choice experiment comprised milk, eggs, ground pork and ground beef. In addition to descriptive statistical methods, multivariate methods were applied to analyse the survey data.

4 Results

The sample is fairly representative of the German population, at least in the age group from 16-59 years. Exactly half of the participants (506 people) are male, which is due to the quota we set. The level of both income and education is higher in the sample than in the population of Germany. This is partly due to the fact that participants of online surveys usually have a higher education and therefore get higher salaries on average.

Considering knowledge and experience with genetic engineering in food production, most of the participants have worried already about genetic engineering in agriculture, at least once or twice. About 22% stated that they have thought about it oftentimes, whereas only about ten percent said that they have never thought about it prior to the survey. When they were shown one of the most common forms of the new 'GMO-free' label, more than seventy percent denied that they had seen such a label before. About 23% of the survey participants ticked the option that they had seen the label already on food products, and less than ten percent gave television or newspapers as the source where they had noticed the label already. Apparently the new label is not yet well-known in Germany.

Considering knowledge about genetic engineering, we first asked participants how well they feel informed about genetically modified food (subjective knowledge). Apparently, the majority feels not very well informed about the issue, what makes it difficult for people to assess individual risks that are associated with genetic engineering in agriculture. Such a remarkable degree of uncertainty is partly confirmed by the next question, which is supposed to measure knowledge concerning genetic engineering (objective knowledge). Survey participants were given a list of statements regarding genetic engineering in agriculture and its potential consequences. Only about 8% of respondents of our survey classified all the five of the statements correctly, while the average amount of correct classifications was about 2.6. The Spearman rank correlation coefficient between the perceived level of information and the number of correct answers as an indicator for the objective level of knowledge is highly significant with about 0.3.

As mentioned above, one of the main goals of the survey was to face consumers' expectations about the new 'GMO-free' label with what it stands for. We asked whether specific applications of genetic engineering would be acceptable for the respondents on products labelled as 'GMO-free'. Process characteristics and whether they are acceptable for labelled products are shown in Table 1. In the last column it is indicated whether products are permitted to carry the 'GMO-free' label based on the revised regulation or not.

Table 1: Expectations and fulfilment of production standards

	Should be allowed to carry the label	Should **not** be allowed to carry the label	Don't know	Allowed to carry the label based on the regulation
Food product contains genetically modified organisms, e.g. yoghurt cultures, yeasts.	25,1%	**59,6%**	15,3%	No
Food contains enzymes or has been produced with the aid of enzymes, which were being obtained from genetically modified organisms.	26,9%	**56,1%**	17%	Yes
Animal feed contains genetically modified organisms.	8,4%	**78,3%**	13,3%	Yes and no*
Animal feedstuff contains additives which have been produced with the aid of genetically modified organisms.	11,9%	**73,5%**	14,6%	Yes
Drugs and vaccines for the animals have been produced with the aid of genetically modified organisms.	23,4%	**61,2%**	15,4%	Yes

* Until a certain time period before slaughtering / milking / laying eggs.

Source: Own compilation

As can be seen from Table 1, there seems to be a clear difference between consumers' understanding of 'GMO-free' and the new legal requirements to carry the label. About 78% refused that food products should be allowed to carry the 'GMO-free' label if the fodder has been free from GMOs only for the required time period before product generation. Apart from that, the use of GMOs within the production of drugs and vaccines seems to be more

acceptable, as a proportion of more than 23% thinking that products still should be allowed to carry the label shows.

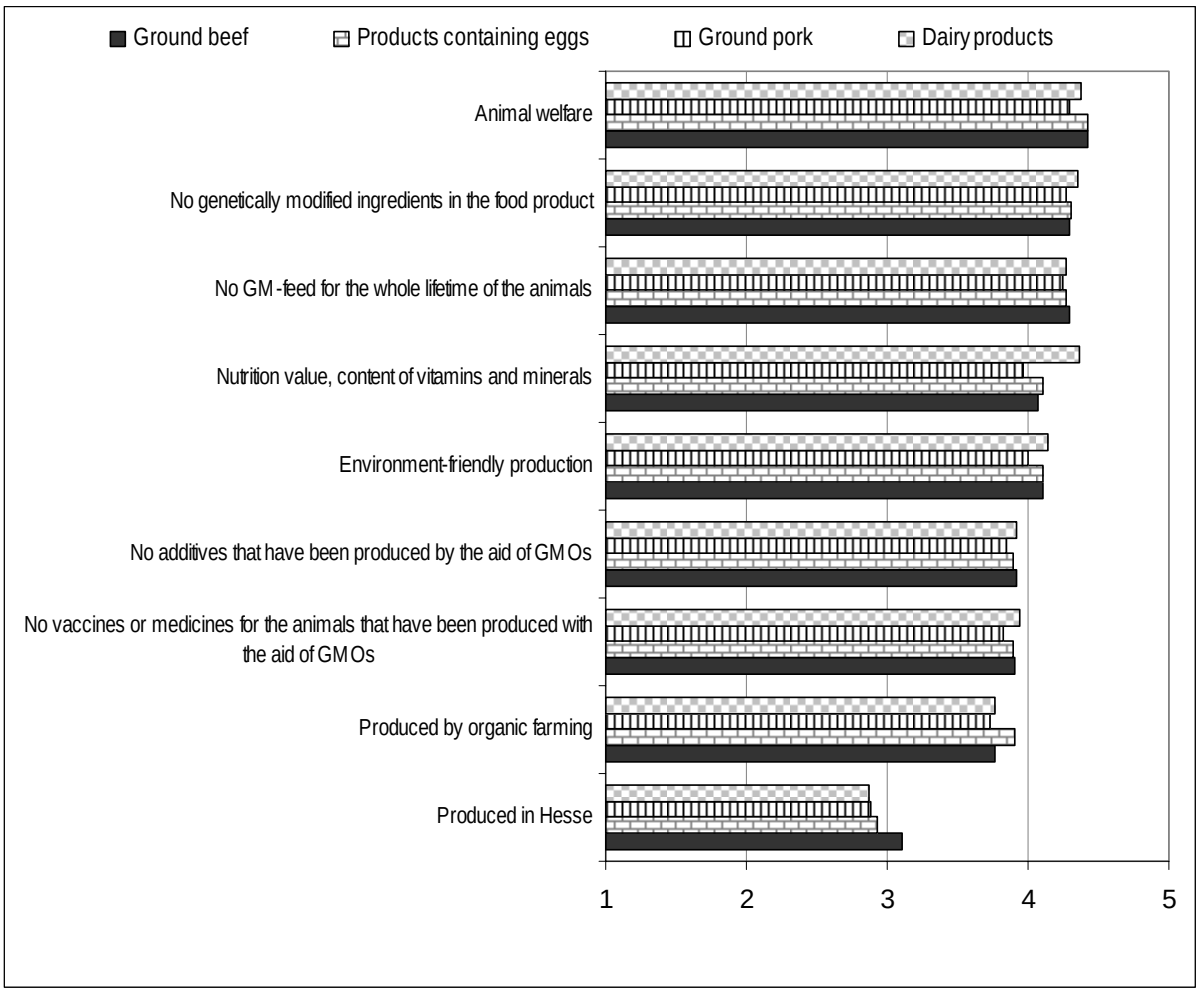
We also investigated whether people make a difference between meat products on the one hand and milk and eggs on the other hand, considering the acceptance of genetically modified organisms in animal feedstuff. According to our survey data, no difference is made: More than 90% of the respondents gave the same answer for both groups of products. 74% refused the 'GMO-free' label for products in which animals have been fed without genetically modified crops only for a certain period before the raw material was taken from them. Hence, most consumers expect from 'GMO-free' labelled products that animals have never been fed with genetically modified fodder crops in their whole life. The majority of consumers are clearly against genetically modified feed crops, whereas the tolerance for genetic engineering in the fields of medicine and food additives is somewhat higher. A further remarkable aspect is the quota of people choosing the 'Don't know'-option, which is about 15% on average. This again supports the observation that consumers are rather uncertain about the impact of genetical modifications in food production on health, well-being and nature.

For the further interview, we had to make sure consumers are informed about the meaning of different applications of biotechnology during the food production process. We included a short text in the survey, appearing for at least 20 seconds on the screen, in order to ensure that participants actually read it.

> It is possible to produce food and feed additives like vitamins and enzyms by genetic engineering without genetically altering the final products. This is done by adding genetically modified organisms (GMOs) like, e.g., bacteria, which produce these substances. Before the substances are added to the products, the GMOs have to be deleted.
> Unlike the cultivation of genetically modified plants, additives are produced in sealed areas like laboratories or chemical factories. The same technique is also applied for the production of vaccines and medicines.

After having got background information about the production of additives, vaccines and medicine by the aid of GMOs, participants were asked about the importance of certain product characteristics for the use. Before doing so, they were questioned about consumption habits of different animal products (beef products, products containing eggs, dairy products or products made from pork). This screening question made sure that participants were confronted only with a product they regularly buy. Furthermore, a special setting in the online questionnaire provided for equal numbers of the products evaluations, which means that for each of the four product types about 250 participants were consulted. Accordingly, each respondent was asked to rate the importance of characteristics of one type of product only. In Figure 1 the mean importance measured on a scale ranging from 1 ('unimportant') to 5 ('very important') is shown.

Figure 1: 'Please indicate the meaning of the following product characteristics for you when using *ground beef / products containing eggs / ground pork / milk* in the kitchen on a scale ranging from '1 = unimportant' to '5 = very important'', n=1012



Source: Own presentation.

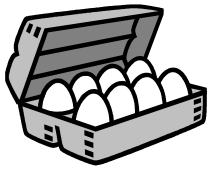
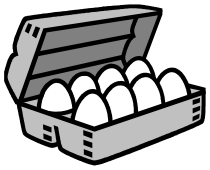
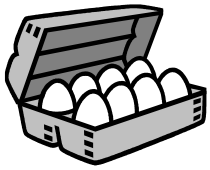
Apparently, the matter of GM-free food for the whole lifetime of farm animals is vitally in the view of consumers. Also essential is the avoidance of genetic engineering within the production of both feed additives and medical substances in the view of consumers. These aspects are regarded as even more important than the kind of farming (organic) or local origin. Yet asking people in this way about the importance of product qualities, there is no need to make a trade-off and therefore all of the aspects are likely to be rated important. However, the outcome of these stated preferences is verified by the choice experiment described in the next section.

4.1 Choice Experiment

In order to gather not only attitudes and opinions towards, but also implications for product choice of genetic engineering and conditions of the 'GMO-free' label, we asked participants to complete a choice experiment about eggs, milk, ground beef or ground pork. Product types were kept identical for each respondent with those in the previous question, except instead of products containing eggs we asked about eggs only. Accordingly, each participant was confronted with one type of product only, and for each type about 250 experiments were completed. The experiment was designed as a choice-based conjoint analysis (CBC). Choice-based conjoint analysis is a stated preference value revelation technique that allows consumers to make choices from a set of experimentally designed products defined by a

bundle of attributes (LOUVIERE, 1988). In our case, participants were provided with three product concepts plus the option not to choose any. Each product concept had one level of each of the five attributes. An example of a choice task is illustrated in Figure 2:

Figure 2: Example of a choice set within the choice experiment

A	B	C	D
Free range eggs, 10 pcs. per pack 	Free range eggs, 10 pcs. per pack 	Free range eggs, 10 pcs. per pack 	I would not choose any
1,39 € per pack	**1,99 € per pack**	**2,59 € per pack**	
GMOs in the chicken feed	Chicken feed free from GMOs at least for the last six weeks	No GMOs in the chicken feed	
Feed additives produced by GMOs	Feed additives produced without GMOs	Feed additives produced without GMOs	
Chicken vaccines produced by GMOs	Chicken vaccines produced without GMOs	Chicken vaccines produced without GMOs	
Produced in Hesse	Produced in Germany	Produced in Hesse	
☐	☐	☐	☐

Source: Own presentation.

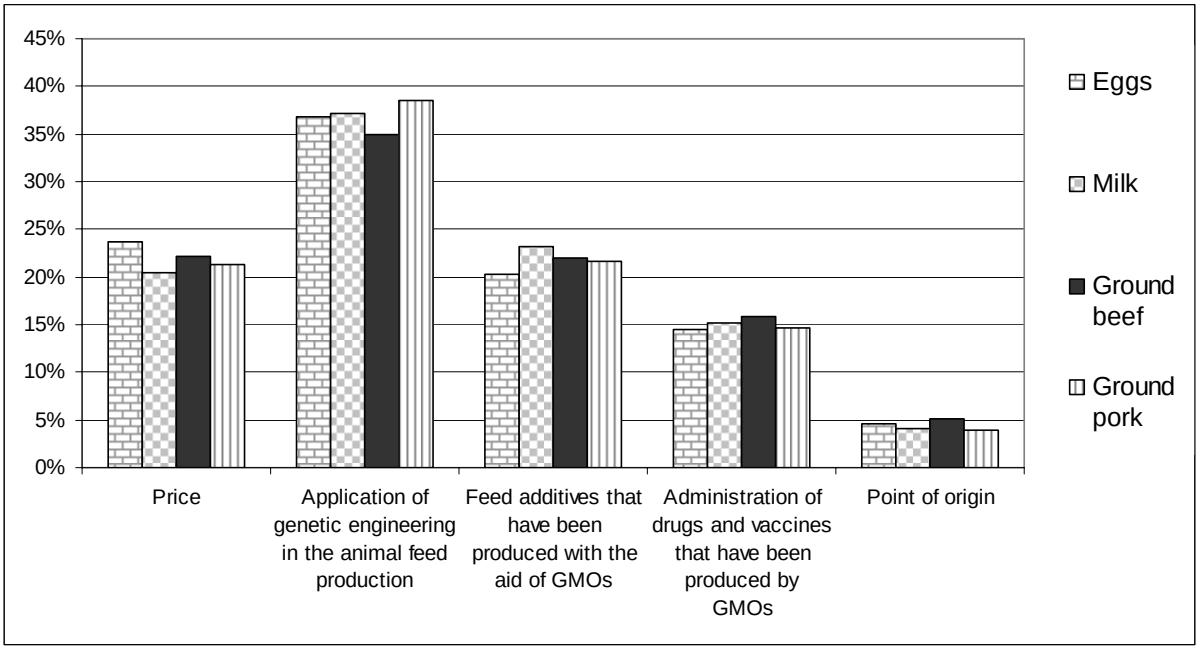
The attribute levels were randomised using SAWTOOTH SOFTWARE'S CHOICE-BASED CONJOINT SOFTWARE. An algorithm made sure that each level of all attributes appeared for an equal number of times across all surveys, but did not repeat in the other product concepts in each choice task. This was done to assure that the respondent does not see the same level (e.g., the same price) across all choice options in one task. Each respondent was provided 10 different choice tasks as if they made 10 different purchase decisions. The following attributes were considered in the experiment:

- Application of genetic engineering in the animal feed production;
- Application of feed additives that have been produced with the aid of GMOs;
- Administration of drugs and vaccines that have been produced with GMOs;
- Product origin;
- Price.

Prices in the experiment were set according to consumer prices, i.e. the lowest based on discounter prices, the medium one on the average price and the highest on prices for organic food. The discrete-choice data were analysed using the Sawtooth Software Choice-Based Conjoint multinomial logit program. The levels of the attributes are coded so that the utilities add up to zero in each attribute category.

The mean relative importance of product characteristics for participants of the experiment is shown in Figure 3.

Figure 3: Relative importance of product characteristics as a result of the choice experiment for different products, n=1001



Source: Own presentation.

As can be seen in Figure 3, highest importance was given to the characteristic of whether genetic engineering had been applied in the feed production. This observation confirms the results pictured in Table 1. Furthermore, the question whether animal feed contains additives that have been produced with the aid of GMOs appears to be as important as the price attribute. The relative importance seems to be independent of the type of product, as already mentioned above, so the ranking of attribute importance is almost identical for all four products. However, even though we tried to make the choice scenario as realistic as possible, the results of the experiment have to be treated with care. On the one hand, respondents became more sensitive to the genetic engineering issue by the initial questions. On the other hand, protest choices by people who are strongly opposing genetic engineering in agriculture might have occurred. Nevertheless, our results show that German consumers have a very high preference for food that has been produced completely without genetic engineering.

In order to better explain individual utility values of specific applications of genetic engineering during the food production process, we estimated three models. Dependent variables in this case are utility values of the characteristics 'Animal feed does not contain any GMOs at all' (ANIMAL FEED), **'**Feed additives are produced without the aid of GMOs' (FEED ADDITIVES) and 'Vaccines and medicines are produced without the aid of GMOs' (MEDICINES AND VACCINES) derived from the CBC analysis. Independent variables listed below in Table 2 can be divided into three main categories: The first one consists of socio-demographic factors and the second one can be grouped under the umbrella-term 'cognitive factors'. These terms are associated with beliefs, risk perception towards and knowledge of GM food. The third group of factors consists of more attitudinal factors, like environmental awareness and the disposition towards food in general. The reason to take this group of factors into consideration is that personal attitudes towards food and environment are supposed to significantly influence the decision to choose a food product under consideration of genetic modifications (e.g., BREDAHL 2001; WACHENHEIM and VANWECHEL 2004; HARTL 2008). Furthermore, by focusing only on socio-demographic factors and the level of information, it is impossible in most surveys to provide well-reasoned explanations for existing differences in response variables. For our model the most plausible form seemed to be a linearly additive relationship:

(1) $$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \ldots \beta_p X_{ip} + \varepsilon_i$$

Y is the dependent variable, in this case utility values of certain characteristics for individual i, and $X_{i1} \ldots X_{ip}$ are independent variables, like, e.g., gender. Also an error term ε_i is added to this assumed relationship to capture the influence of unexplained and random effects. Considering dummy variables, we chose 'Milk' for the choice experiment and 'Less than 1500 €' for income as reference categories. Furthermore, we recoded all of the socio-demographic variables into binary form after trying out different forms of coding.

Table 2: Explanatory variables

	Category	Value and description
Choice experiment	Choice experiment: Ground beef	0 = no 1 = yes
	Choice experiment: Eggs	0 = no 1 = yes
	Choice experiment: Ground pork	0 = no 1 = yes
Socio-demographic factors	Age: 30 years and older	0 = no 1 = yes
	Gender: Male	0 = no 1 = yes
	Net household income per month between 1500 and 2500 €	0 = no 1 = yes
	Net household income per month over 2500 €	0 = no 1 = yes
	Job dealing with food	0 = no 1 = yes
	Education: Highschool diploma (Abitur)	0 = no 1 = yes
	At least one kid below 18 in the household	0 = no 1 = yes
	More than one person living in the household	0 = no 1 = yes
	Mainly responsible for groceries	0 = no 1 = yes
Cognitive factors	Thought about genetic engineering in agriculture before the interview	0 = rarely or never 1 = at least several times
	Feeling informed about genetic engineering in agriculture (subjective knowledge)	1 = not at all informed 2, 3, 4, 5, 6 = very well informed
	Degree of knowledge concerning genetic engineering (objective knowledge)	Number of correct answers about genetic engineering
Attitudes	Neophile concerning food	Mean level of agreement to statements (the higher agreement, the more neophile)
	Involvement concerning food	Mean level of agreement to statements (the higher agreement, the more involved)
	Attitude towards the environment	Mean level of agreement to statements (the higher agreement, the more ecologically aware)
	Perception of risks from genetic engineering in agriculture	Mean level of agreement to statements (the higher agreement, the higher perceived risks)
	Perception of benefits from genetic engineering in agriculture	Mean level of agreement to statements (the higher agreement, the higher perceived benefits)

Source: Own presentation.

The estimation was performed using the statistical software SPSS (STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES), version 17.0. Table 3 provides estimation results for three linear regression models. We tested the models for assumptions, like independency of error terms,

homoscedasticity of the errors versus the predictions, normal distribution of the error distribution and linearity of the relationship between dependent and independent variables. No serious violation of the model assumptions could be found.

Table 3: Linear Regression: Standardised coefficients ß (p-values in brackets), n = 913

Category	ANIMAL FEED	FEED ADDITIVES	MEDICINES AND VACCINES
Constant	(0.565)	(0.743)	(0.891)
Choice experiment: Ground beef	-0.125 (0.000)	-0.097 (0.005)	-0.019 (0.613)
Choice experiment: Eggs	-0.153 (0.000)	-0.158 (0.000)	-0.083 (0.024)
Choice experiment: Ground pork	0.054 (0.125)	0.017 (0.618)	0.039 (0.281)
Age: 30 years and older	0.082 (0.011)	0.081 (0.010)	0.058 (0.085)
Gender: Male	-0.008 (0.789)	-0.054 (0.079)	-0.047 (0.149)
Net household income per month between 1500 and 2500 €	0.026 (0.486)	0.007 (0.848)	-0.025 (0.520)
Net household income per month over 2500 €	0.051 (0.193)	0.033 (0.392)	-0.032 (0.433)
Job dealing with food	-0.061 (0.038)	-0.029 (0.316)	-0.023 (0.456)
Education: Highschool diploma (Abitur)	0.035 (0.275)	-0.015 (0.633)	-0.019 (0.576)
At least one kid below 18 in the household	-0.032 (0.298)	-0.017 (0.578)	-0.024 (0.462)
More than one person living in the household	-0.015 (0.681)	-0.035 (0.326)	-0.038 (0.309)
Mainly responsible for groceries	-0.011 (0.738)	-0.074 (0.028)	-0.039 (0.274)
Thought about genetic engineering in agriculture before the interview	0.084 (0.008)	0.103 (0.001)	0.073 (0.028)
Feeling informed about genetic engineering in agriculture	0.026 (0.413)	-0.007 (0.829)	0.004 (0.896)
Degree of knowledge concerning genetic engineering	-0.006 (0.842)	-0.010 (0.739)	-0.070 (0.038)
Neophile concerning food	-0.064 (0.037)	-0.083 (0.005)	-0.063 (0.047)
Involvement concerning food	0.036 (0.244)	0.024 (0.427)	-0.004 (0.909)
Attitude towards the environment	0.100 (0.002)	0.076 (0.013)	0.080 (0.015)
Perception of risks from genetic engineering in agriculture	0.268 (0.000)	0.298 (0.000)	0.256 (0.000)
Perception of benefits from genetic engineering in agriculture	-0.131 (0.000)	-0.174 (0.000)	-0.129 (0.000)
R^2	0.267	0.307	0.204
F	16.281	19.764	11.436

Source: Own computations

Each of the three models reported in Table 3 is significant at the 99%-level, with individual standardised ß-coefficients showing almost exclusively the expected sign. Furthermore, the R^2-values in the range from 20% to 30% of explained variation are comparatively good for models comprising individual cross-sectional data. Best predictive quality got the model for the explanation of utility values for FEED ADDITIVES, which also contains the highest number of significant variables. The product categories ‘Milk’ and ‘Ground pork’ in the choice experiment lead to significantly higher utility values for FEED ADDITIVES and ANIMAL FEED, which means people are less concerned considering eggs and ground beef regarding genetic engineering within feed production chain.

Considering socio-demographic factors, utility values for GM-free production techniques rise with age, but coefficients are rather small. Coefficients for gender indicate that females have

slightly higher preferences for GM-free production chains than males. Neither education nor income nor household composition remarkably influence utility values. Altogether, the impact of socio-demographic characteristics on utility values is comparatively small, but at least there are no unexpected signs among them. Interestingly, persons who already considered genetic engineering within food production chain more often also derive higher utilities from GMO-free production methods, as coefficients of the factor 'Thought about genetic engineering in agriculture before the interview' indicates. Since this factor got a positive sign for all three of the models, it can be assumed that people who are thinking about genetic engineering more often are more concerned about the issue. This is also reflected by the signs of the variables from the last part of explanatory factors, especially by the perception of risks from genetic engineering in agriculture. The latter is by far the most significant predictor variable, suggesting the meaning of genetic engineering within the production chain on product choice is highly influenced by perceived risks. Also a lack of information about genetic engineering techniques might be responsible to some extent for choice decisions in our experiment, as the negative sign of the explanatory variable 'Degree of objective knowledge concerning genetic engineering' implies. As the model MEDICINES AND VACCINES shows, persons who are better informed about genetic engineering (Degree of objective knowledge) are less negative regarding the application of genetically modified organisms for the production of medical substances. Furthermore, respondents who are more open towards new food products (neophile) apparently receive lower utility values from GM-free production techniques. Attitudinal variables like food neophilia, perceived risks and benefits of genetic engineering as well as environmental orientation are significant in three models and have the expected signs.

5 Discussion and Conclusions

The aim of our research was to identify potential gaps between consumers' expectations of what the GM-free-label in Germany stands for, and what it actually means according to the revised regulation. Furthermore, we wanted to identify relevant factors for the acceptance of genetic engineering techniques within the food production process. We conducted a representative online survey asking more than one thousand consumers about their opinions towards food, environment, genetic engineering and what they would be willing to tolerate in food labelled as 'GMO-free'. We also conducted a short choice experiment which was supposed to validate stated attitudes and behaviour. Overall, our results confirm anticipated relationships between external variables and the preference for GMO-free production chains. In addition, a high impact of attitudinal factors on the aversion towards the application of genetic engineering in the food production, presumably built to some degree on missing or biased information, was revealed by regression models.

Due to eased requirements, more and more producers start using the 'GMO-free' label, hence consumers will find a broader range of labelled products on the shelves soon. However, our survey results demonstrate that consumers expectations of 'GMO-free' labelled food products do not comply with the requirements of the new 'GMO-free' label introduced by the German government in 2008. Accordingly, adequate information about the real claims of 'GMO-free' labels is necessary in order to avoid deception of consumers and thus enable them to make conscious buying decisions. If label requirements for animal products remain as they are today in Germany, consumers who wish to avoid any food that has come into contact with genetic engineering, not only for health reasons but also for ethical attitudes, can not rely on the 'GMO-free' label alone.

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