An Evaluation of the Perceptions of Products derived from Gene Technology among Undergraduates at the University of Malta

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Abstract: *A pilot study on the perceptions of genetically engineered-derived produce was carried out among undergraduates in their final year of study at the University of Malta.* 68% of the students interviewed accepted the idea of genetically modifying plants (GM) but the idea of creating GM animals was not acceptable to the same cohort with approval falling to 30.2% of the group. Gender was found to be important in influencing choices made by students. Females were less accepting of GM organisms and they were significantly less likely to buy GM produce, such as GM derived milk ($p<0.001$), tomatoes ($p<0.05$), and beef $p<0.01$) than males. Subject background was also found to influence student opinions. Students with a strong background in biology were less likely to have faith in statements concerning GM products made by the farming community ($p<0.05$). However, the same students were more willing to accept statements about GM products by government organisations ($p<0.01$) and environmental groups ($p<0.05$) than those who had minimal or no biology in their background. The study is interesting, as it shows that at a fundamental level, complex factors are influencing the individual's choices on biotech derived products.*

Keywords: *Gene technology, perceptions.*

Introduction

It has been over a decade since the first generation of genetically modified (GM) crops reached the world food and feed markets. Genetically modified crops are produced by biotechnology and involve the deliberate transfer of genes across species in a way that cannot occur in nature. Almost all of the major food crops, including soyabean, maize, rice and canola, have been modified in this way, to show traits such as resistance to insect pests and tolerance to herbicides. Hybrids containing up to three stacked genes have also been produced by traditional crossing of GM plant varieties expressing up to three different transformation events. From

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an agricultural perspective, these modifications have been of benefit to the farming community, with increases in yield per hectare of cultivated land, improved weed control[1] and increased use of conservation tillage[2] being reported for different crops. Globally, farmers have been largely supportive of the technology, so that in 2007, the global area of GM crops registered an increase for the tenth consecutive year reaching a total of 114 million hectares.[3] This corresponds to a 60-fold increase between 1997 and 2007, making it the fastest adopted crop technology in recent history. Following on from this commercial success, companies are now focussing on developing second and third generation biotechnology crops. The difference between the terms first, second and third generation crops stem from the intended use of the genetically modified plant. So first generation biotech crops, are crops that have been genetically modified to improve the yield or appearance of the plant. An example of this type of modification would be the Carnation *Dianthus caryophyllus* that has been modified to express a vivid violet colour. Second generation biotechnology crops are modified expressly for secondary uses not associated with food use, such as the increase of oil production in plants for processing into biofuels. Third generation crops are the 'Holy Grail' of biotechnology. These crops would be genetically modified to produce pharmaceuticals such as vaccines or antibodies.

Although GM crops have been largely accepted by the farming community, they are not without their detractors and European consumers count among the staunchest opponents of GM-derived food. The most recent Eurobarometer survey[4] on citizens within the EU member states assessed their perceptions of biotechnology and showed that only 27% of those asked support GM derived foods. This value does vary between countries so that the Czech Republic and Finland showed the highest levels of support (46% and 38% respectively), while Luxembourg and Latvia showed the lowest levels of support (13% and 15%). Various studies have been carried out to investigate how the public formulates risk. In 1994 it was shown that compared with other food hazards, persons classified food derived by gene technology as having a moderately severe risk.[5] Furthermore, when classifying their

[1] R.K. Roberts R.K., R. Pendergrass, and R.M. Hayes, 'Economic analysis of alternative herbicide regimes on Round Up Ready soybean', *Journal of Production Agriculture*, 12, (3), 1999, pp. 449–54.
[2] J.W. Keeling, P.A. Dotray, T.S. Osborn, and B.S. Asher, 'Post emergence weed management with Round up Ultra, Buctril and Staple in Texas High Plains Cotton', in *Proceedings of the Beltwide Cotton Conference*, 1, Memphis, 1998, pp. 861–62.
[3] 'Global GM crops – a world view', *Science*, 320, 2008, pp. 466–67.
[4] Eurobarometer: 'Europeans and Biotechnology in 2005. Patterns and Trends.' Available online at (http://ec.europa.eu/research/press/2006/pdf/pr1906_eb_64_3_final_report-may2006_en.pdf) (last accessed December 2008).
[5] P. Sparks and R. Shepherd, 'Public perceptions of the potential hazards associated with food production and food consumption: An empirical study', *Risk Analysis*, 14, 1994, pp. 870–75.

level of acceptance of the technology, persons utilised a scale of acceptance varying with the type of application. Applications involving plants were viewed as more acceptable than those involving animals.[6] For example, in the States, half of the Americans interviewed supported plant based genetic modifications whereas only a quarter approved of its use in animal agriculture.[7]

Modulating the level of acceptance are multiple factors that all play a role in influencing perception of risk. For example, confidence in social organisations such as government organisations, biotech companies and the scientific community in general, is known to have a positive bearing on risk perception. While trust in environmental groups is correlated with the perception that GM products are more risky.[8] Gender differences are also seen in the acceptance of gene technology. In repeated studies, it was shown that females perceived less benefit and demonstrated less acceptance of gene technology and genetically modified foods.[9] There have been suggestions that this lack of support is related to women's traditional role of nurturer and care providers and this in turn is thought to result in a greater concern with health and safety than men.[10] Age has also been shown to be related to perceptions of gene technology. Socio-demogaphic analysis shows that the lowest level of rejection is among students and youths (15–24 years old). This higher level of acceptance has been shown to not be linked to a greater level of knowledge.[11]

The link between previous knowledge and support for biotechnology appears to be tenuous. Some studies such as that on 604 persons from the state of New Jersey show that there was significantly more support for genetic engineering among scientists, engineers and medics who belonged to science groups and organisations. Those who said they belonged to environmental groups were statistically no more or less likely to approve of the genetic engineering of organisms.[12] However amongst European subjects this relationship does not necessarily hold. In fact, a study of

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[6] L.C. Frewer, C. Howard, and R. Shepherd, 'Public concerns in the United Kingdom about general and specific applications of genetic engineering: Risk, Benefit and Ethics', *Science, Technology and Human values*, 22, 1997, pp. 98–124.

[7] W. Hallman, W.C. Hebden, H. Aquino, C. Cuite, and J. Lang, 'Public perceptions of genetically modified foods: A national study of American knowledge and opinion', New Brunswick, NJ: Food Policy Institute, Rutgers University, 2003.

[8] Ibid.

[9] M. Siegrist, 'The influence of trust and perceptions of risks and benefits on the acceptance of gene technology', *Risk Analysis*, 20, 2000, pp. 195–203, and H. Moerbeek and G. Casimir, 'Gender differences in consumers' acceptance of genetically modified foods', *International Journal of Consumer Studies*, 29, 2005, pp. 308–18.

[10] Ibid.

[11] W.K. Hallman and J. Metcalfe, 'Public perceptions of agricultural biotechnology: A survey of New Jersey residents', Food Policy Institute, Cook College, Rutger. The State University of New Jersey, 1994. Available online at www.foodpolicyinstitute.org. (Last accessed December 2008).

[12] Ibid.

the attitudes of citizens in the Netherlands, Denmark and Germany showed that those who had the greatest knowledge had the least support for biotechnology.[13] More recently, it was shown that in Italy it is the type of knowledge that plays a part in shaping support for biotechnology. In fact, media-derived knowledge alone does not correlate with a greater level of support for biotechnology.[14]

With respect to the situation in Malta, only one relevant study has been carried out to date. Published in 2005 and also part of the same Eurobarometer study[15] to assess European citizens views of science, technology and social values, 1,000 Maltese were interviewed from among the general population. Of these, 55% or well over 500 persons reported being familiar with 'the technology involved in the creation of 'GM foods'. 22% reported being familiar with gene therapy. 28% of the sample reported being familiar with nanotechnology and 1 in 5 persons from the general population reported being familiar with pharmacogenetics. From the same number sampled, 36% reported being in favour of GM foods, which is 9% above the European average of 27%. While these results are of interest, the level of knowledge claimed by participants in this study seems to be very high. In order to try to understand what factors are affecting this high support, a study was carried out using a cohort of undergraduates at the University of Malta. The study which is being reported herein formed a preliminary assessment in a larger study of 250 students in post-secondary education.

Method used

The undergraduate students participating in this work were all in their final year of a full-time programme of study at the University of Malta, reading law, science engineering, medicine or archaeology. 52 students were randomly asked to participate on a completely voluntary basis whilst on campus and a questionnaire based on that developed by Hallman and Metcalfe[16] was administered throughout the period between April to May 2006. In the first section, students were asked to explain the term 'genetic engineering' in order to assess their level of understanding of the term. They were then asked to describe if they had any formal training in the area, to rate their own understanding of the subject and to list the source of their knowledge. The second section contained questions that dealt with the students' level of approval of the products of the biotechnology industry and a third section investigated factors that could be influencing student perceptions. Students were given the option of selecting

[13] R. Almas and B. Nygard, *New biotechnologies: Attitudes, social movements, and regulation.* Prague: European Congress of Rural Sociology, 1995.

[14] M. Bucchi and F. Neresini, 'Biotech remains unloved by the more informed', *Nature*, 416, 2002, p. 261.

[15] Cfr. n. 4, *supra.*

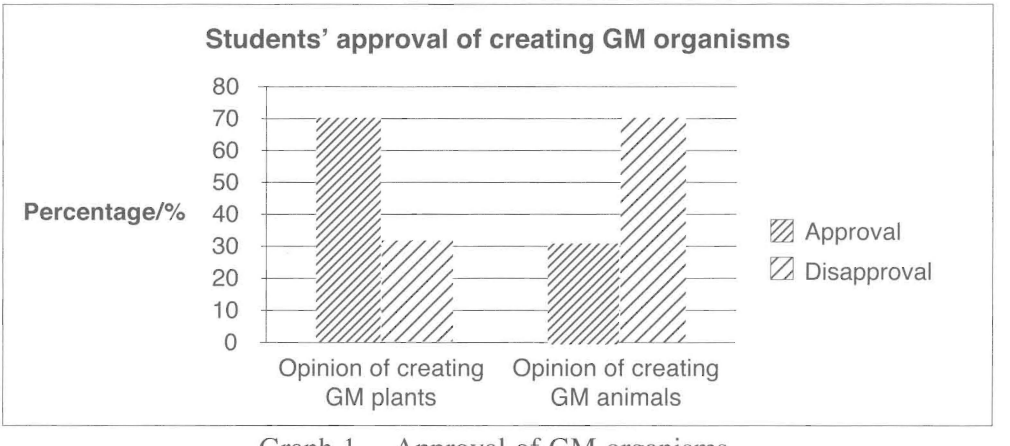
[16] Cfr. n. 11, *supra.*

a positive (*approve/willing*) response, a negative option (*disapprove/not willing*), *a not sure* option or a *no answer* if they had no opinion on the subject.

In this paper, the students' approval of GM-derived products and their willingness to use these products is evaluated. 57.9% of the participants were males, 42.1% were females. The cohort studied did not have a uniform exposure to biology. 53.8% had a strong background in biology having studied biology beyond post-secondary level. The remaining 46.2% had had minimal exposure to biology and these were identified as never having studied biology or having studied biology up to secondary level alone.

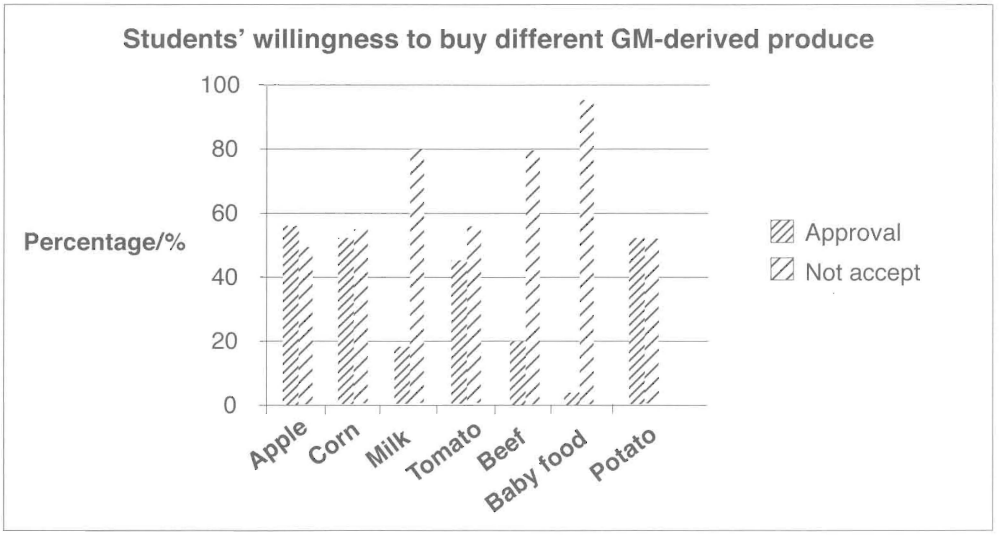
Results

In this study the results of the students' perceptions of genetically engineered products is presented. In answer to the first question (see Table 1) asking whether students approve of creating GM plants, 68.9% of the whole cohort reported that they approved of creating GM plants. However, this approval fell to 30.2% of the cohort when the students were asked to state whether they approved of GM animals (see graph 1 below).



Graph 1. Approval of GM organisms.

Next students were asked to state whether they would choose a GM product if it retailed at exactly the same price as its non GM counterpart (Graph 2). Here students' opinion varied according to product type. Approximately half the group studied were willing to buy GM apples, potatoes and corn (53.8% approval, 49.9% approval and 47.9% approval respectively). In contrast, students' willingness to buy GM or GM-derived products such as GM beef, milk and baby food fell sharply to 21.1%, 19.2% and 5.76% respectively. With the exception of GM derived baby food, products that are derived from GM animals raised more objections than GM plant derived products. The response to GM-derived baby food is interesting in that, regardless of its origin, the students were simply unwilling to accept the product.



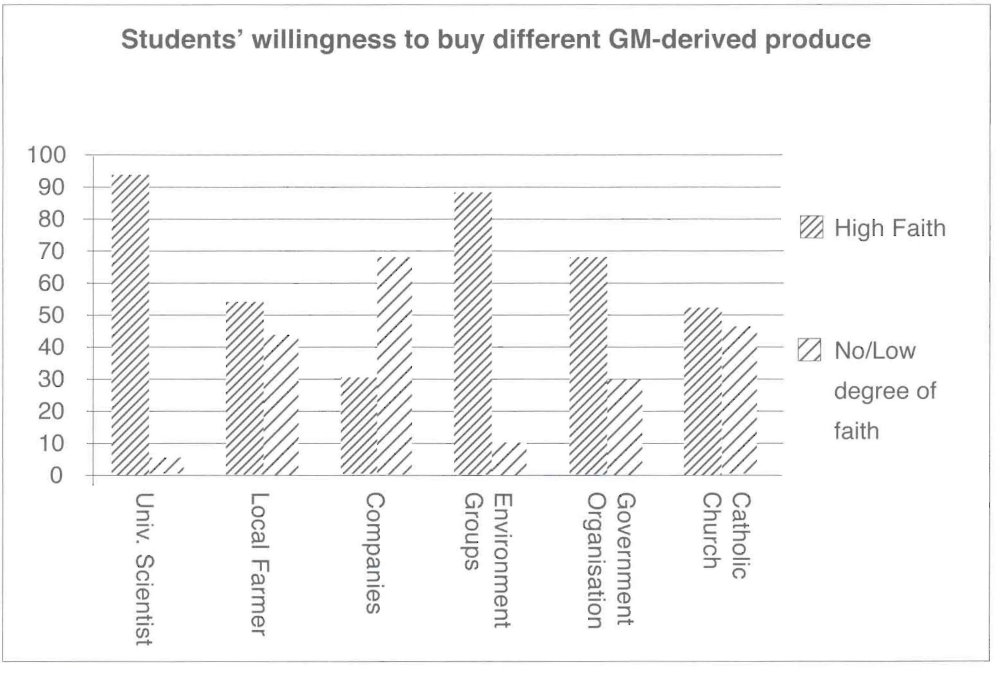
Graph 2. Willingness to buy GM-derived produce.

In order to determine which variables were influencing students' attitudes to GM products, a chi- squared test was applied. The data collected from the answers to questions 1–3 in Tables 1 and 2 were analysed separately by gender and then by background level of biology. The results are presented in the same tables respectively. No statistically significant differences between males and females and between levels of biology knowledge were seen to be influencing the students' approval of GM plants and animals. However, gender was found to play a significant difference in the willingness of undergraduates to actually purchase certain genetically engineered products. Females were significantly less likely to be willing to buy GM derived milk ($p<0.001$), to select GM tomatoes ($p<0.05$) and to purchase GM beef ($p<0.01$) than males. The level of previous knowledge and exposure to biology did not appear to have a bearing on undergraduates' willingness to buy genetically engineered products. No statistically significant differences in choices were found between students who had studied biology up to undergraduate level and those that had had minimal exposure to biology.

The students were then asked who they would trust to provide them with reliable information concerning GM products (question 4, Table 1–2). The results are presented in graph 3 and these confirm that this cohort places relatively great faith in social institutions. More than 50% of the students said that they had faith in statements on GM products made by five of the six institutions listed in the question. Students had the greatest faith in the statements made by University scientists, followed by environmental groups and government organizations

(96.1%, 88.4% and 68.0% respectively). Organisations such as farmers and the Catholic Church were also a source of information for students with 55% and 53% of students stating that they would have faith in statements made by these institutions. Students expressed the least faith in statements made by the companies that produce GM products.

Chi squared tests were then carried out on the data to determine whether the students' confidence in statements made on GM products by social institutions was influenced by gender or background knowledge (Tables 1.0-2.0). No statistically significant differences were seen between males and females and therefore gender does not appear to be influencing the students' faith in institutions. However, when the data was analysed by levels of background biological knowledge, statistically significant differences were seen in the amount of faith students had in certain institutions. Students with a biology background were less likely to have faith in statements made by the farming community ($p<0.05$). Yet, the same group were more likely to accept and have faith in statements made by government organisations ($p<0.01$). A weak difference was seen in the level of faith students had in statements made by environmental groups. Students with a biology background were more likely to have faith in statements made by environmental groups than those with minimum biology in their background ($p<0.052$).



Graph 3. Students' faith in statements made by different institutions.

Table 1 Data analysed according to Gender

#	n=52	Male		Female		Chi Square	P value
		Willing %	Not Willing %	Willing %	Not Willing %		
1.	Do you approve or disapprove of creating GM plants using genetically engineered techniques?	40.4	9.52	28.5	21.4	2.78	0.09
2.	Do you approve or disapprove of creating GM animals using genetically engineered techniques?	18.6	34.8	11.6	34.8	0.48	0.48
3.	How willing would you be to buy the following GE products if they were available at the same price as non GE products?						
	A. Apple	32.6	23.0	21.1	23.0	0.60	0.43
	B. Com	28.8	26.9	19.2	25	0.34	0.55
	C. Milk	19.2	36.5	0	44.2	9.81	0.0017**
	D. Tomatoes	32.6	23.0	13.4	30.7	4.10	0.045*
	E. Beef	19.2	36.5	1.92	42.0	6.98	0.008**
	F. Baby Food	3.8	51.9	1.92	42.3	0.15	0.69
	G. Potatoes	28.8	26.9	21.1	23.0	0.07	0.78
4.	How much faith would you have in statements about GE produce made by the following institutions?						
	A. University Scientist	55.7	1.92	42.3	1.92	0.02	0.86
	B. Local Farmer	30.7	25	25	19.2	0.009	0.92
	C. Companies	23.0	32.6	7.69	36.5	3.46	0.06
	D. Environmental groups	46.1	9.61	42.3	1.92	2.08	0.14
	E. Government Organisations	38.0	18.0	30.0	14.0	0.001	0.98
	F. Catholic Church	30.7	25	23.0	21.1	0.04	0.82

*statistically significant at $p<0.05$
**statistically significant at $p<0.01$

Table 2 Data analysed according to the level of Biology in their Educational Background.

#	n=52	Biology		Minimal Biology		Chi Square	P value
		Willing %	Not Willing %	Willing %	Not Willing %		
1.	Do you approve or disapprove of creating GM plants using genetically engineered techniques?	35.7	11.9	33.3	19.0	0.63	0.42
2.	Do you approve or disapprove of creating GM animals using genetically engineered techniques?	18.6	30.2	11.6	39.5	1.20	0.27
3.	How willing would you be to buy the following GE products if they were available at the same price as non GE products?						
	A. Apple	25	28.8	28.8	17.3	1.34	0.24
	B. Com	21.1	32.6	26.9	19.2	1.87	0.17
	C. Milk	9.6	44.2	9.61	36.5	0.07	0.78
	D. Tomatoes	19.2	34.6	26.9	19.2	2.66	0.10
	E. Beef	9.61	44.2	11.5	34.6	0.39	0.52
	F. Baby Food	5.76	48.0	0	46.1	2.72	0.09
	G. Potatoes	30.7	23.0	19.2	26.9	1.23	0.26
4.	How much faith would you have in statements about GE produce made by the following institutions?						
	A. University Scientist	53.8	0	42.3	3.8	2.42	0.119
	B. Local Farmer	23.0	30.7	32.6	13.4	4.10	0.04*
	C. Companies	19.2	34.6	11.5	34.6	0.69	0.40
	D. Environmental groups	51.9	1.92	36.5	9.61	3.77	0.05*
	E. Government Organisations	46.0	10.0	22.0	22.0	5.85	0.01*
	F. Catholic Church	25.0	28.8	28.8	17.3	1.34	0.24

*statistically significant at $p<0.05$

Chi squared tests were then carried out on the data to determine whether the students' confidence in statements made on GM products by social institutions was influenced by gender or background knowledge (Tables 1.0–2.0). No statistically significant differences were seen between males and females and therefore gender does not appear to be influencing the students' faith in institutions. However, when the data was analysed by levels of background biological knowledge, statistically significant differences were seen in the amount of faith students had in certain institutions. Students with a biology background were less likely to have faith in statements made by the farming community ($p<0.05$). Yet, the same group were more likely to accept and have faith in statements made by government organisations ($p<0.01$). A weak difference was seen in the level of faith students had in statements made by environmental groups. Students with a biology background were more likely to have faith in statements made by environmental groups than those with minimum biology in their background ($p<0.052$).

Discussion

It was noted that young adults in the study, showed lower levels of rejection for gene technology than those reported in studies on the general EU population. This is consistent with published data that shows this age group is more accepting of technology, more likely to buy GM produce and less likely to hold menacing images of GM food than older people.[17] Despite this known relationship, the undergraduates in this study still showed levels of approval for GM plants that were considerably higher than the EU average (68% compared to the EU average of 27%). Admittedly, the question asked in the EU study was not identical to that used in this work. The former specifically addressed acceptance of GM food, while in this study students were asked whether they approve of the creation of GM plants and animals. It is possible for a person to approve of the creation of GM plants but be unwilling to accept its use as food. Despite this difference, there certainly is a high approval for biotech derived organisms in this cohort. This could stem from the absence of negative press reports, media attention or balanced debates concerning GM produce locally, which in turn seem to be fueling a positive, although slightly naive opinion. Some confusion over what exactly constitutes a GM organism in the group without a strong biology background could also have influenced the opinions, although further studies would be needed to confirm this. The idea of creating GM animals was rejected by this group and this is consistent with published data[18] that appears to be related to considerations of morality and fear of playing God.

[18] Cfr. n. 4, *supra*.

[18] Cfr. nn. 6 and 7, *supra*.

A question that arises is whether the higher acceptance of GM plants observed in this study actually translates into greater willingness to purchase GM products. From the results obtained here it does not seem to be so. On average, about 45% of the students studied claimed to be willing to buy GM produce. While the level of biology in the students' background did not appear to have a significant effect on selection of products, gender played a significant part. Females were always more conservative in their choices, with larger numbers rejecting the GM product. This gender difference is likely to be important in the final acceptance of GM products by a household, since females tend to be involved in selection and purchase of household products. Even if males do end up shopping, they tend to shop according to a list made by their partners.[19]

In this study, the students placed the greatest faith in statements on GM produce made by University scientists. This is in agreement with other studies such as that carried out on American undergraduates.[20] Maltese undergraduates differed in their second and third choices and would trust more alternative sources such as environmental organisations followed by governmental organisations. It is established that confidence in social organisations such as government organisations is linked to positive perceptions of the risks associated with GM crops[21] and this could be yet another factor influencing the pro-GM stance of Maltese undergraduates. Their faith in traditional social institutions is translating into acceptance of gene technology. Interestingly, the study shows that at least for this group, having a background in biology was correlated with relying on a different and wider set of institutions for information concerning GM products. This is the first time that this result has been reported and it would be interesting to see if the same association shows up with larger numbers of students.

Finally, this study shows that acceptance of genetically modified produce is not set at a fixed value but is dependent on and varies greatly according to the type of produce. Therefore general questions concerning GM products are more likely to be answered with approval while questions referring to specific products are more likely engage serious questioning thought. It is therefore more realistic to ask individuals to rate their acceptance of individual products rather than their general willingness to accept GM – derived food.

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[19] Cfr. Moerbeek in n. 9, *supra*.

[20] A.J. Knight, 'Does Application matter? An examination of public perception of agricultural biotechnology applications', *Agbioforum: Journal of Agribiotechnology, Management and Economics*, Vol. 9 (2), 2006, pp. 121–28. Available on the World Wide Web: http://www.agbioforum.org, and T.J. Hoban *Social Acceptance of Biotechnology*, Paper presented at the Proceedings of the Institute of Food Technology Annual General Meeting, New Orleans, LA, and Chicago, 2001.

[21] Cfr. Halman n. 7, *supra*.

Conclusions

The small size of this study could result in statistically significant differences being missed however, despite this limitation, this study still gives an interesting picture of the attitudes and the degree of acceptance of GM products in a cohort of undergraduates. The study shows that age, gender and education are important in influencing choices and in particular, it shows that females are a formidable reckoning force in the acceptance of GM produce as they are more likely to reject the product. This could have important effects on the local market for GM produce, since ultimately women are more likely to be involved in purchase and selection of food products for the household. Finally, the study also showed that acceptance of GM products, was not set at a constant value, but rather, varied according to the type of product.