Consumer willingness to pay for genetically modified potatoes in Ireland: an experimental auction approach

Thorne, F[1]., Loughran, D.[1 & 4], Fox, S.[2], Mullins, E.[3], and Wallace, M.[4]

[1]Agricultural Economics Department, Rural Economy and Development Programme, Teagasc, Dublin 15, Ireland
[2]Crops, Environment and land Use Programme, Teagasc, Carlow, Ireland
[3]Dept. of Agricultural Economics, Kansas State University, USA
[4]Dept. Agribusiness and Rural Development, UCD, Ireland

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Corresponding author: fiona.thorne@teagtasc.ie

Abstract

The introduction of genetically modified (GM) crops to Europe has been a significant source of tension among EU member states. While the political landscape is much divided there is also much unknown at the consumer level. The question of whether European consumers want GM foods made available to them or not has yet to be answered definitively. Hence, this research is considered timely; the objective is to examine willingness to pay (either a positive or negative amount) for GM Late Blight resistant (GMLBR) potatoes in Ireland. The methods used in this study serve as a new departure in the experimental auctions literature, whereby willingness to purchase bids for a new technology can have a positive and negative value in a single experiment. The results show that the majority of consumers' that participated in the experiment derived a greater utility from the conventional potato product compared to the GM potato product when priced at equivalent values. 3 out of 4 participants required the GM product to be priced at a discount in order for the utility to be derived from the GM product to be the same as the utility derived from the conventional product. However, the findings from this research would indicate that if the entry price point for the GMLBR potato product was correctly positioned then a market for the product could exist. Further investigation of the factors that influenced the participants' willingness to purchase the GMLBR potato indicated that education level, presence of children in the household and frequency of potato purchases significantly affected the purchase decision.

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Corresponding author: fiona.thorne@teagtasc.ie

Introduction

The introduction of genetically modified (GM) crops to Europe has been a significant source of tension among EU member states. Compared to a constantly increasing acreage across the primary crop producing regions of the world (170 million ha grown in 2013), only ~200,000ha were grown in the EU last year (ISAA, 2014). While the political arena is still very divided there is also much unknown at the consumer level. The question of whether European consumers want GM foods made available to them or not has yet to be answered definitively. The objective of this study was to construct experimental auction markets to investigate (i) consumer awareness about GM technology and (ii) to examine the willingness to pay (either a positive or negative amount) for a GM food product (specifically GM Late Blight resistant (GMLBR) potatoes in Ireland). The paper proceeds as follows: the background to potato production in Ireland and the case for GMLBR potato; followed by the materials and methods used in the experimental auctions, the results and finally conclusions and implications of the research.

Background to Potato Production in Ireland and GM Potatoes

Potato Blight is one of the main agronomic issues affecting Irish potato producers. Haverkort *et al.,* (2008) estimated that loses associated with this oomycete pathogen amount to approximately 16 percent of output value per annum across the EU. Irish potato farmers spray their potatoes for blight on a weekly basis at high rates, on average 15 times per season. The first case of fungicide resistance in Ireland was confirmed in 1980 (Dowley and O'Sullivan, 1981) and in 1989 the presence of the A2 mating type was confirmed (O'Sullivan and Dowley, 1991). In 1983, an increase in virulence was recorded (O'Sullivan and Dowley, 1983) and subsequently the in store spread of the disease was also recognised (Dowley and O'Sullivan, 1991). In addition, over the recent past, highly aggressive strains of blight have emerged across Europe that are exhibiting levels of fungicide resistance (Cooke *et al.* 2008)

As blight rapidly changes and becomes more destructive to farmers crops, the chemistry to combat the fungus has also dramatically improved. However, looking forward, the potato sector faces significant challenges as increased EU legislation will curtail the amount and type of crop protection products that farmers can use (Teagasc, 2013). As conventional potatoes get sprayed up to 15 times per growing season to preserve the crop, this will be a major issue for Irish potato growers.

Background to GM food acceptance in Europe

Polls conducted across Europe show that consumers regard the genetic modification of food crops with scepticism and uncertainty. In 2010, the latest Eurobarometer survey examining consumer opinion of genetic modification showed that 61 per cent of European consumers were opposed to the use of Genetically Modified (GM) foods (Eurobarometer, 2010). The Eurobarometer poll for Ireland was categorised by a prevailing lack of consensus with 42% of

Corresponding author: fiona.thorne@teagtasc.ie

respondents In Ireland saying they didn't know whether or not GM foods should be encouraged (Eurobarometer, 2010).

Previous research on consumer attitudes towards GM foods in the EU, such as valuation studies by Boccaletti and Moro (2000), Burton and Pearse (2003) and Moon and Balasubramanian (2003) suggest that there is significant resistance to GM foods in Europe. Collectively the results of these studies indicate that conventional and organic foods can be successfully priced at a premium to GM foods. However, there is also a body of literature that identifies a sub set (albeit a relatively small sub set of the population) of the EU consumer population that may be willing to accept GM foods based on price and non-price related factors (Moon and Balasubramanian, 2003; Spence and Townsend, 2006).

Similar results are provided by a study conducted in the UK by the Institute Of Grocery Distribution in 2012. The survey indicated that just over half of shoppers (51%) neither supported nor opposed GM foods, or had yet to form an opinion. This compared with 13% who were strongly opposed and 3% who were strongly in favour (Institute of Grocery Distribution, 2012). Also in the UK, it has been reported that consumers have become less opposed to GM technology in recent years. A 2008 Food Standards Agency (FSA) survey exploring attitudes towards GM foods described just 31 per cent of respondents as negative towards GM, a decrease of 26 per cent from their 1999 study (FSA, 2009).

A number of GM food acceptance studies have been conducted in Ireland. Vilei and McCarthy (2001) report survey results showing that only 11 percent of respondents believed that gene technology was a positive development while 66 percent regarded it as being negative. O'Connor *et al* (2006) examined Irish consumer acceptance of GM products using cluster analysis and found that about 1 in 5 respondents would accept GM foods offering specific consumer benefits.

Material and Methods

Experimental Auctions Valuation Methodology

Experimental auctions provide a method for eliciting the value of new goods and services that does not rely on the hypothetical rating of the survey participants as is the case with contingent valuation methods. Experimental auctions are used to measure the value of novel goods or improvements in goods such as flavour, nutritional value or food safety. Traditionally experimental auctions elicit either a consumers' willingness to pay (WTP)(e.g Fox, 1995; Fox *et al*., 1998; Roosen *et al.,* 1998; Lusk *et al.,* 2001) or willingness to accept (WTA)(Lusk *et al.,* 2004). WTP auctions assume that the good you wish to value is a superior product to the one that already exists on the market. WTA auctions assume that the good in question is an inferior product. Many experimental auction practitioners will be interested in estimating demand for goods for which people have different perceptions of quality and risk. However, controversial goods such as GM foods can invoke varying opinions from one person

to another (as outlined in the background section earlier). For example, one person may be positively disposed towards GM because of potential pesticide and herbicide reduction, while another may think that any such benefits are outweighed by even vaguely perceived health risks associated with GM products, due to a perception that this phenomenon is specific only to GM derived varieties. While it was hypothesized that the majority of consumers would favour the conventional fresh potato product, the experiment was designed in such a way that consumers could equally express preferences for purchasing the GM over the conventional product.

To account for different perceptions of quality and risk which are known to exist in the market place this current study incorporated both positive and negative bids for the WTP purchase decision. In order to do this, participants were provided with the choice as to whether they wanted to bid positively or negatively in the auction. If the participant believed they would require compensation in order to consume the product, they would bid negatively in the auction. If the participant felt that the alternative product was superior to the one already on the market and that they would pay bid positively.

Typically experimental auctions do not allow participants to place negative values on bids. When negative values appear in auctions, bids are truncated at zero. This is based on the assumption that participants who bid negatively would pay nothing for the good. This practice serves to inflate summary statistics such as the mean and median bid if participants place negative values on the good (Lusk and Shogren, 2007). Buhr *et al.* (1993), Fox *et al.* (1998) and Lusk et al. (2001) try to overcome the issue of negative values by eliciting a preference ranking between goods prior to the auction. Subjects are then separated, endowed with the good they least prefer, and are asked to bid to exchange the endowed good for one of the more preferred goods. In such cases, all bids were then positive or zero. However, these methods place subjects in predetermined groups that do not allow for whole market feedback. This practise can in turn provide distorted results.

Auction Mechanism

The experimental auctions procedure followed in this research was a third price, sealed-bid auction mechanism that induced each participant to submit a bid equal to his/her actual valuation of the item being auctioned. Each subject was given a 2.5kg bag of conventionally grown potatoes. Subjects then participated in a third price auction to obtain an otherwise identical bag of what they perceived were GMLBR potatoes. The two highest bidders exchanged their bag of potatoes for the GM potatoes and paid the third highest bid price. All other subjects retained their bag of conventional potatoes.

The third price auction was used for a number of reasons. Most importantly, it was considered necessary to use an auction mechanism that was incentive compatible. Although the second price auction is the most commonly used in the literature, several studies have shown that

subjects tend to 'overbid' in second price auctions (e.g Kagel et al., 1987; Rutstrom, 1998). Shogren et al. (2001) found that the random nth price model worked well for off-margin bidders (those with values relatively far away from the market price) but did not work as well as the 2nd price auction for on margin bidders. The third price auction attempts to engage bidders at both ends of the margin while still allowing for a highly negative reaction from the subjects concerned.

It was also considered necessary to use an auction that encouraged the subjects to incorporate feedback from the market into their bidding decisions. However, when subjects are allowed to incorporate feedback through posted prices, there is the potential for bidders to become affiliated (Milgrom and Webber, 1982). List and Shogren (1999) found that bidder affiliation only had a very small impact on bids in an auction similar to the one employed here (List and Shogren, 1999). As a further attempt to decrease the chances of bidder affiliation, instead of using a large number of repeated rounds, just 3 rounds of auction were used in the main experiment.

Although the product used was raw potatoes, this did not prohibit the implementation of a consumption clause. Participants were informed that the cooked product was available in the adjacent kitchen in each venue, and depending on what product they finished the auction with, they would be obliged to consume a small portion of cooked potato. To remove bias participants were informed that the labelling was accurate but for the purposes of the study no GMLBR potatoes were displayed or consumed[1].

Sample

147 participants were recruited in 5 locations in Ireland: Fingal (Co.Dublin); Galway City (Co.Galway); Dundalk (Co.Louth); Tullamore (Co.Offaly); and Fermoy (Co.Cork). Participants were recruited by advertisement in local newspapers. This process was chosen as a low cost recruitment method. The 5 locations were chosen because they geographically represent the Republic of Ireland. Care was taken to ensure that the test conditions at each experiment were as similar as possible. Participants were screened at recruitment to ensure that they were the were female[2]. In total there were 147 participants across the 5 locations, with a maximum number of participants per location of 38 and minimum of 24. The average age of participants was 45, with a minimum age of participation of 19 and maximum age of 77.

[1] *After the final trial in all experiments the participants were informed that the GMBLR potato sample was actually identical to the conventional bag of potatoes i.e. no GM material was used in the experiment.*

[2] *In 2013, women accounted for the majority of primary household shoppers in Ireland (Bord Bia, 2013). While the sample was not selected using a stratified random sampling procedure (due to budget constraints) the authors believe that the results provide a meaningful indicator of the types of responses that one might expect in a broader consumer study.*

Auction procedure

On arrival at the test centre, respondents were asked to sign a consumption clause form to ensure their full participation in the study. They then received an endowment (€40 per participant) for their participation. The subjects were randomly assigned identification numbers to use for the remainder of the study and were given a questionnaire to complete. It contained a range of questions about their knowledge, opinions and attitudes towards GM foods. The survey also contained a range of questions about the individual's values and lifestyles, and basic socio-demographic information. The range of questions asked in this pre auction questionnaire were expected to capture the different factors influencing the bidding results of the experimental auctions.

Because some consumers may be completely unaware of the process of genetic modification, a carefully balanced information statement was provided prior to completion of the survey (details of this statement are included in Appendix I). Other than this statement, the participants received no other information about GM foods prior to bidding in the auction.

The monitor then explained the experimental auction process via a PowerPoint presentation. Prior to participating in the GM potato experimental auction, the subjects first participated in an example non-hypothetical auction with a pen and a pencil to illustrate how the procedure worked. In addition to this, several examples of how the auction worked were provided. Also, the monitor explained why it was in the subject's best interests to reveal their true value for the product and to bid truthfully. The experimental auction proceeded as follows[3]:

Step 1. Participants received a 2.5kg paper bag of conventional potatoes. The participants were told that the price of the bag of potatoes was €2.50. They were then shown an identical bag of potatoes labelled "Contains GM ingredients". Participants were then shown the following statement in relation to GM potatoes:

The GM potatoes were genetically modified to be resistant to the fungal disease, Phytophthora infestans (Late Blight). Other than that, these potatoes are the same [in all other ways including texture and flavour] as the potatoes that you have been given. The genetically modified potatoes have been approved for human consumption.

Step 2. Participants then wrote on the bid sheets provided either the minimum amount they would be willing to accept in order to trade their conventional potatoes for the GM potatoes or the maximum they would be willing to pay in order to trade their conventional potatoes for the GM potatoes.

[3] The complete set of instructions given to participants is available from the authors upon request.

Step 3. When the bids were recorded the monitor ranked the bids in order from lowest to highest on a screen at the front of the room.

Step 4. The 2 highest bidders were displayed along with the 3rd highest bid price (the market price).

Step 5. Steps 2, 3 and 4 were repeated.

Step 6. After Step 5, an information shock was introduced to the experiment. Participants were given a scientific piece of information detailing the levels of fungicide applied to conventional potato plants during the growing season, followed by a piece of information detailing the potential benefits associated with a decrease in fungicide application to the environment or human health (See Appendix II for details of the information shock).

Step 7. After the completion of the 3rd round, a number was drawn randomly (1-3) to determine the binding round in the auction. The two highest bidders from the binding round then exchanged their bag of conventional potatoes for the GM potatoes and paid/received the third highest bid price (market price). All other participants kept their conventional potatoes.

Results

Consumer awareness and attitudes towards GM technology

To begin with all participants in the experiments were asked a range of questions relating to (i) their prior knowledge of GM and (ii) their general attitudes towards food safety issues. In relation to prior knowledge of GM, participants were asked:

'*On a scale of 1 to 10, where 1 is not at all knowledgeable and 10 is very knowledgeable how would you rate your level of knowledge about Genetically Modified Foods prior to participating in this experiment*'.

Figure 1 shows that the majority of respondents had a less than average (5 representing an average level of knowledge) self-disclosed prior knowledge of GM foods, with a mean value of 4.2. This result is consistent with previous research findings relating to Irish consumers awareness levels of GM technology (Eurobarometer, 2010).

Corresponding author: fiona.thorne@teagtasc.ie

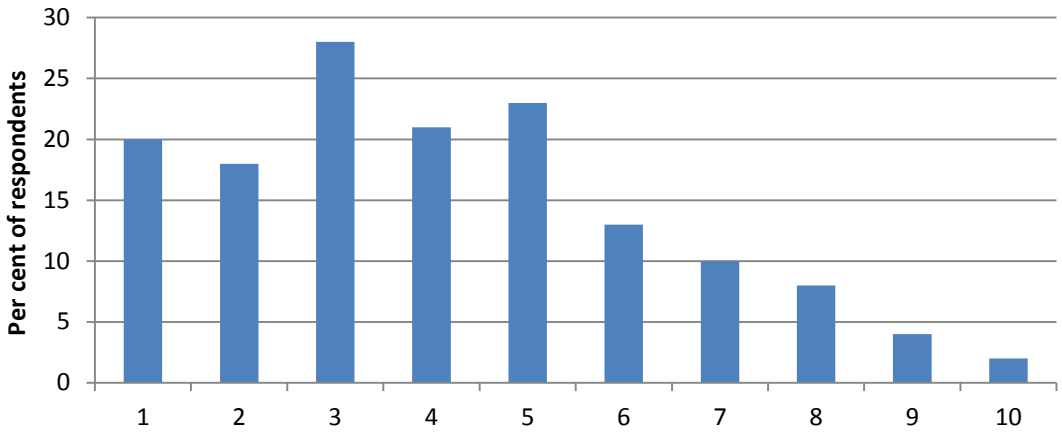

Figure 1: Participants Self-Disclosed Prior Knowledge of GM Foods

In relation to attitudes to GM foods, respondents were asked:
After reading the information above [brief scientific definition of GM foods – see Appendix 1] how would you have characterized your attitude toward genetically modified foods, with 1 been very negative, 3 neutral and 5 very positive?'

Figure 2 shows the distribution of self-reported attitudes towards GM foods, with a value of 1 representing a very negative attitude, 3 representing a neutral attitude and 5 representing a very positive attitude. The majority (mode) response category was 3, indicating a neutral attitude towards GM food technology. This score is perhaps not as negative as one might have expected based on previous research such as Veelei and Mcarthy (2001) which reported 66 per cent of consumers reporting a negative attitude towards gene technology, whilst the results from the current survey indicated that 50 per cent had a negative or very negative attitude towards the technology.

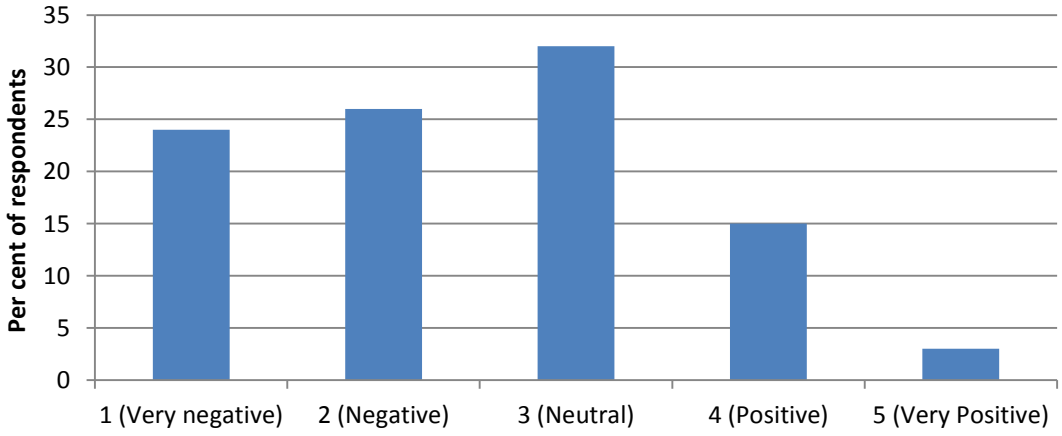

Figure 2: Distribution of Participants Self-Disclosed Attitude Towards GM Foods

Corresponding author: fiona.thorne@teagtasc.ie

Willingness to pay and willingness to accept GMLBR potatoes

Bid Distributions

Table 1 shows the mean bid of each trial in all five experiments (locations).

Table 1: Willingness of consumers to pay for GMBLT by location

	Dublin	**Galway**	**Dundalk**	**Offaly**	**Cork**
Trial 1	-€0.74	-€1.08	-€1.40	-€0.78	-€1.20
Trial 2	-€0.74	-€1.51	-€1.31	-€0.85	-€1.18
Trial 3	€0.39	-€0.45	-€1.06	-€0.40	-€0.54

The mean bid in the first and second trials was highest in Dublin at -€0.74 in both trials, meaning that participants in this location were willing to accept the GM product for a price of €.74 i.e. they would have to be paid €.74/2.5kg (€.30 per kg) to exchange their conventional product for the GM product.

As outlined by Fox *et al*., (1994) the first bidding trial in each experiment represents the respondents' initial preferences for the new technology given the 'compulsion to eat' clause. If we focused only on these initial preferences, our results would not reflect the effect of repeated market experience as a means of determining the value placed by participants on products.

In Trial 2 the mean bid (across locations) ranged from -€1.51 to -€0.74. The most negative mean bid for the GM product was in Galway followed by Dundalk. The mean bid in Galway decreased significantly between Trials 1 and 2. This indicates that the bidders in this location were quite vociferously opposed to the GM product. Interestingly, over half of the bidders in Galway and Dundalk stated in the pre-survey that they had a good level of knowledge on GM food production whilst also being the respondents that issued the most negative bids across all locations in bidding trials 1 and 2. There was also a small bid decrease in Offaly. The average bid in Dublin was highest and did not change between bidding trials 1 and 2.

After trial 3 the mean bid in all experiment locations became more positive. This increase was most likely the result of information provided after trial 2. Participants were given a scientific piece of information detailing the levels of fungicide applied to conventional potato plants during the growing season, followed by a piece of information detailing the potential benefits associated with a decrease in fungicide application to the environment or human health. The effect of this information on the average bid of Galway participants was in excess of €1.00. Their behaviour demonstrates both the sensitivity of consumers to the way in which information is presented and also the potential marketability of GM produce. The information

provided was designed to address the concerns of the participants in relation to GM and outline the potential benefits that could arise from GM production without touching on the potential negative. The information had a positive effect on bidding at all locations.

Bid Valuations

Valuation results for the GMLBR Potato are taken from the second bidding round of the auction. The second round captures the participants' initial perceptions of the product and also allows the participants to incorporate some market information into their purchase decision. In order to provide an appropriate market valuation for the [new] product, an extreme bid value was determined[4]. Based on the extreme bid valuation point there were 40 bids from a total of 147 bids which were categorized as extreme bids.

Figure 3 shows the frequency distribution of the bids for all five experiments (locations) at trial number 2 (to reflect initial preferences and some feedback of market information). Overall the results show that 28 per cent of respondents would not consume GM potatoes at a price that would make financial sense to the producer (i.e extreme bids) but nearly 60% of respondents would purchase the product if it were available at the same price or at a slightly lower price than conventionally grown potatoes. In addition, 14 per cent were willing to pay a premium for the GM potatoes.

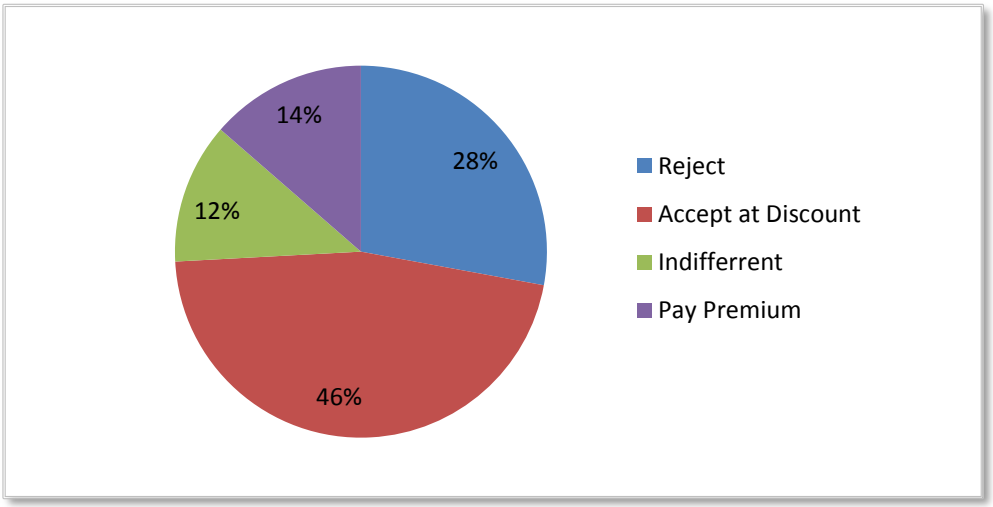

Figure 3: Frequency Distribution of Bids at Trial 2 ~ Acceptance of GM Potatoes in Ireland

Factors Affecting the Bid Values

[4] An extreme bid was defined as an overly negative bid or the point at which it would no longer be economically viable for the retailer to sell the product. This point was found by calculating the farm-fate price of 2.5kg bag of potatoes and adding a twenty per cent mark up to cover transaction costs to the retailer level. This cost was then subtracted from the average assumed retail price of€2.50 to obtain the point at which it would be no longer economically viable to sell the product. This was calculated as -€1.86 per 2.5 kg bag. Therefore, all bids that were more negative than -€1.84 were excluded from the valuation process.

Having established that bid values vary by participant, it is interesting to examine why such differences might exist. In the survey participants filled out before the auction, they were asked a variety of questions related to factors hypothesized to influence consumer willingness to purchase GM potatoes. This data was used in the estimation of an OLS linear regression equation to assess the influence of demographic and other characteristics on participants' WTP for GM potatoes. The basic form of the model was:

$Bid_i = f(AGE_i, EDUCATION_i, INCOME_i, POTATOES_i, KIDS_i, KnowGM_i, FARM_i)$

Where, Bid_i is the bid during the second round by the i^{th} auction participant for the GM potato product

All of the independent variables used in the OLS model are outlined in Table 1, with variable definitions and the mean values for the sample of farms.

Table 1: Variable Definitions and Descriptive Statistics

Variable	Description	Mean	St.Dev
Age	Age in years	44.43	(10.55)
dEducPrim	1 if the highest education level received was primary school education; 0 if otherwise	0.16	(0.37)
dEducSec	1 if the highest education level received was secondary school education; 0 if otherwise	0.45	(0.50)
dEducColl	1 if the highest education level received was third level education; 0 if otherwise	0.39	(0.49)
dIncLo	1 if participant is part of the low income bracket (<€30,000); 0 if otherwise	0.43	(0.50)
dIncMid	1 if participant is part of the middle income bracket (€30,000-€50,000); 0 if otherwise	0.23	(0.43)
dIncHi	1 if participant is part of the high income bracket (>€50,000); 0 if otherwise	0.34	(0.45)
Farm	1 if participant lives or has lived on a farm at some point; 0 if otherwise	0.40	(0.49)
Kids	1 indicates the presence of children in the participants household; 0 if otherwise	0.57	(0.50)
Potatoes	Continuous: Number of meals consumed in the household per week containing potatoes	4.08	(1.88)
KnowGM	1 if participant has good knowledge of GM food production; 0 if otherwise	0.41	(0.49)

The estimation results on Irish consumers' willingness to pay (WTP) for GMLBR potatoes are presented in Table 2. Three specifications of the model are shown in order to present the contributions of additional variables to the explanatory power of the model and also to recognise the apparent collinearity between income and education variables. Overall, the results in Table 2 suggest that willingness to pay for the GM potato product is significantly influenced by a number of socio-demographic characteristics. The overall goodness of fit statistics indicates that the model performed in a satisfactory manner. The adjusted R^2 of 0.197 (model 1) appears reasonable given that important yet idiosyncratic aspects of consumer preferences are not easily represented in a simple regression model.

The education dummy for college education is highly significant and negative for WTP for GMLBR potatoes, implying that the higher educated are less likely to consume GM potatoes. When household income of the participant is controlled for on its own (in a step wise regression) it appears to be negatively correlated with the willingness to purchase the GM product, whereby higher income participants were less willing to purchase the GM product. However, when the education level of the participant is controlled for in the model, education appears as a highly significant variable and the income variable no longer remains as a significant explanatory variable. Hence, one could consider that the income variable was not initially explaining a marginal ability to purchase; rather income level was a proxy for education level of the participant.

The presence of children under 18 years old in the household is also found to have a negative and significant effect (at the 1 per cent level) on willingness to pay for GM potatoes. This finding is consistent with a priori expectation and previous studies that show respondents with children are less likely to pay a premium for GM foods than those without children (Springer, 2002).

The number of meals containing potatoes consumed in respondents' households per week had a positive significant effect (at the 5 percent level) on willingness to pay for the GM product. Interestingly, this finding indicates that households that consume larger quantities of potatoes per week would be willing to pay more for GM potatoes. Respondents with lower incomes consumed the largest proportion of potatoes per week in our sample. This result suggests that the largest potato consumers would choose GM potatoes because of the potential for price savings.

Table 2: OLS Regression Results

	I	II	III	IV
Independent Variable				
Age	-.0045 (.012)	-.0114 (.012)	-0.0041 (.012)	-0.0102 (.012)
Farm	-.0634 (.247)	-.1732 (.236)	-0.1110 (.246)	-0.1842 (.238)
Kids	-.7424*** (.249)	-.844*** (.239)	-0.6710 (.253)	-0.8031 (.246)
Potatoes	.2380*** (.067)	.1700** (.068)	0.2230 (.067)	0.1716 (.068)
KnowGM	-.3816 (.239)	-.2404 (.230)	-0.3880 (.239)	-0.2417 (.233)
dEducSec		-.2091 (.340)		-0.1198 (.362)
dEducColl		-1.1648*** (.364)		-1.0344 (.407)
dIncMid			-0.3847 (.301)	-0.0949 (.304)
dIncHi			-0.5365 (.271)	-0.2235 (.288)
Adjusted R-squared				
Degrees of Freedom				

*** significance at the 1 per cent level

** significance at the 5 per cent level

* significance at the 10 per cent level

a Standard errors in parentheses

Knowledge of GM food production was found to have a negative effect in a step wise regression (significant at the 10 per cent level). Unexpectedly, this result indicates that those with a greater knowledge of GM food production would be willing to pay less than those with poor knowledge. However, in the final model specification identified this knowledge variable did not remain significant. This is more than likely due to the very significant and positive relationship identified between knowledge of GM food production and education.

The coefficient for age was negative but very small and did not have a significant effect on WTP, suggesting that consumers' age is not relevant in the decision to purchase GM potatoes. This result differs from a previous study conducted in Ireland by Vilei and McCarthy (2001) who found that younger age groups were more positive towards gene technology than older groups. Again the magnitude and significance of the education variable is probably responsible for the lack of significance of the age variable in the multiple regression model, due to the significant and negative relationship found between education and age in the step wise regression process. The coefficient for farm dwellers had a negative sign but was not statistically significant in the step wise or multiple regression models.

Overall, the results suggest that willingness to pay for the GM potato product is significantly influenced by a number of socio-demographic characteristics. The results of this analysis indicate that education level, presence of children in the household and frequency of potato purchases significantly affected the willingness to pay for the GM product.

Conclusions

The methods used in this study serve as a new departure in the experimental auctions literature, whereby willingness to purchase a new technology can have both positive and negative bids in the one experiment. This is a novel approach to examining the responsiveness of the consumers to a new technology which is not bound by truncation or censoring of data, which is the case with conventional WTP and WTA experimental auctions.

This study has demonstrated that the majority of consumers' that participated in the experiment derived a greater utility from the conventional potato product compared to the GM potato product. 3 out of 4 participants would require the GM product to be priced at a discount in order for the utility to be derived from the GM product to be the same as the utility derived from the conventional product. Assuming that GMLBR potatoes were to be offered to Irish consumers, the evidence from this experiment indicates that most consumers would be willing to purchase the GM product at a discount relative to the conventional product. Further investigation of the factors that influenced the participants' willingness to purchase the GMLBR potato indicated that education level, presence of children in the household and frequency of potato purchases significantly affected the willingness to pay for the GM potato product.

Corresponding author: fiona.thorne@teagtasc.ie

The implications of this study are notable given the ongoing debate both nationally and at an EU level regarding the introduction of GM crops Given that the European Commission proposed an overhaul of the EU policy in 2010 in relation to the cultivation of GM crops, it is possible that in the medium term there will be greater opportunities for GM crop production within member states. Hence, one of the first questions which must be addressed is whether or not there is potential consumer acceptance of the technology at a national level. The findings from this research would indicate that if the entry price point for the GMLBR potato product was correctly positioned, a market for this product could exist.

Corresponding author: fiona.thorne@teagtasc.ie

Appendix I – Definition of GM technology provided to participants prior to the Auction

Genetically Modified (GM) Foods

Genetically modified organisms (GMOs) can be defined as organisms in which the genetic material (DNA) has been altered in a way that does not occur naturally. The technology is often called "modern biotechnology" or "gene technology", sometimes also "recombinant DNA technology" or "genetic engineering". It allows selected individual genes to be transferred from one organism into another, also between non-related species.

Such methods are used to create GM plants – which are then used to grow GM food crops. GM foods are developed – and marketed – because there is some perceived advantage either to the producer or consumer of these foods. This is meant to translate into a product with a lower price, greater benefit (in terms of durability or nutritional value) or both.

- *World Health Organization, 20 Questions on Genetically Modified (GM) Foods*

http://www.who.int/foodsafety/publications/biotech/20questions/en/

Corresponding author: fiona.thorne@teagtasc.ie

Appendix II – Information Shock Provided Prior to Trial 3

Before bidding in the 3rd round please read the following information.

Economic Benefits

Summary from an article in the journal Potato Research discussing the economic cost of late blight to potato growers.

Title: Yield Losses caused by Late Blight (*Phytophthora infestans)* in potato crops in Ireland
Journal: Irish Journal of Agricultural and Food Research 47: 69–78, 2008
Authors: L.J. Dowley, J. Grant and D. Griffin

Potato growers have been able to control the fungus, Phytophthora infestans, that causes late blight with fungicides, but at an increasingly higher cost. A survey was conducted with thirteen experts to estimate the impact of late blight on potato yields, storage losses and fungicide use. It was estimated that combined late-blight fungicides and lost revenue costs for Irish growers was €11million. These total costs, which average €507 per hectare, do not include non-fungicide control practices.

Health Benefits

Irish potato growers sustain significant annual losses due to late blight. Blight control requires regular, high-rate fungicide applications at short intervals throughout the growing season. Conventional potato crops currently receive approximately 14 fungicide applications per season.

The GM potatoes that you are bidding on have been genetically modified to contain a blight disease resistant gene. This gene was taken from a blight-tolerant variety of potato found in the Andes and was then inserted into these potatoes using gene transfer methods.

Some consumer lobby groups argue that fungicides and pesticides are harmful to human health.

Genetic Modification can allow potato growers to reduce the level of fungicide applications by approximately 80%.

Corresponding author: fiona.thorne@teagtasc.ie

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