Consumer Benefits and Acceptance of Genetically Modified Food

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- Widespread consumer resistance towards genetically modified (GM), particularly as expressed in the news media, has led to slow adoption of this technology outside of North America.
- Much of the resistance appears to stem from public perceptions that GM crops benefit large multinational corporations, food producers, and typically have no apparent consumer benefits.
- In order to test whether clearly defined consumer benefits would change consumer preferences, a purchasing experiment has been conducted in New Zealand where the GM issue has been highly politicized, with cherries labelled as spray free-GM, organic or conventional. These were offered for sale in a roadside stall, with price levels manipulated to test price sensitivity of the different options.
- Approximately 27 percent of consumers proved willing to purchase GM labelled cherries at the prevailing market price and this percentage increased as the price dropped.

Introduction

Genetic modification refers to alteration of the genetic makeup of an organism so that the modification is transmitted to the organism's offspring. Strictly speaking, it includes processes such as selective breeding that have been practiced for thousands of years (Tester,2001). Traditional methods of GM include:

- Selection for desirable characteristics within existing populations – most modern crops and domestic livestock have been so altered by this process that they bear little resemblance to their wild ancestors.
- Crossing closely-related species – e.g. modern wheat has arisen from two sequential crossings of three separate species.
- Selecting mutants – e.g. herbicide-resistant canola (oilseed rape) developed from plants that appeared spontaneously in Canadian canola fields.

However, the controversy about GM usually concerns the modern techniques which have come to be known as genetic engineering (GE). These techniques involve:

- Deletion, change or moving of genes within an organism
- Transfer of genes from one species to another
- Modification of existing genes or construction of new genes and their incorporation into any organism (Eichelbaum, et al.,2001)

Traditional techniques for genetic modification were limited to those occurring between closely-related organisms, whereas GE enables transference between any two organisms, no matter how distantly related in evolutionary terms. For the rest of this paper, the terms GM and GE will be taken to be synonymous, and to exclude the less-contentious traditional forms of genetic modification involving hybridisation and selection.

In 2004, approximately 8.25 million farmers in 17 countries planted genetically modified crops, with the USA, Argentina, Canada, Brazil, China, Paraguay, India and South Africa accounting for approximately 99% of the global biotech crop area (James,2005). Despite this evidence that farmers in numerous countries are adopting GM technology, activist groups in many countries – particularly in Europe – have

continued to fight the introduction of GM foods. In most poor countries, governments have still not given permission to plant GM food or feed crops. The main reason is fear that the EU and Japan will shun imports from countries that grow GM crops (Paarlberg,2002).

The United Kingdom GM Science Review Panel Report (King,2003) states: "To date world-wide there have been no verifiable untoward toxic or nutritionally deleterious effects resulting from the cultivation and consumption of GM crops. However, absence of readily observable adverse effects does not mean that these can be completely ruled out … Some (people) reason that the absence of evidence of harm should not be treated as evidence of the absence of harm." As has been pointed out (Scully,2003): "Beliefs rather than information appear to be at the heart of the non-acceptance of genetic engineering." Grave concerns have been expressed by some authors: e.g. "The bio-revolution does not just tamper with the fabric of life, but also aspires to restructure fundamental perceptions and values. Environment, human values and relationships, and intellectual property rights are all drastically reconfigured under the spell of biotechnology" (Pottier,1999).

Consumer attitudes in Europe

Consumer attitudes in Europe, particularly Northern Europe, towards GM foods have been reported in many studies to be strongly negative (Bredahl,2001, Frewer, et al.,1995, Grunert, et al.,2000). Negative opinions of GM foods have also been reported from other countries including Singapore (Subrahmanyan and Cheng,2000) and New Zealand (Campbell, et al.,2000, Gamble and Gunson,2002). Consumer concerns regarding GM foods have been categorised as: concern for public safety,

moral concerns, and fear of loss of individual life (Bredahl, et al.,1998). Consumers in the UK have been found to be most concerned by health issues, animal welfare and the environment, and by lack of consumer control over what was happening (Miles and Frewer,2003).

The role of the mass media

Controversial reports in the mass media have undoubtedly played an important role in magnifying widespread fear of GM food and GM crops (Laros and Steenkamp,2004). Use of terms such as "Frankenfoods", "unreliable", "disaster", "environmental risks", "risks of cancer", and "food health fears" are examples of fear appeals in relation to GM foods that have appeared in the mass media in British, Canadian, Dutch and even US media (Laros and Steenkamp,2004). This role of the media, termed "social amplification" in psychology (Slovic,2000), intensifies public perception of risk and leads non-experts to greatly over-estimate the likelihood of rare or dramatic risk events. "It has long been known that compared to expert risk assessors, the public tends to overestimate risks associated with 'technological' hazards e.g. food additives and genetic engineering and also to underestimate risks associated with 'lifestyle' hazards e.g. high-fat diet and smoking" (Pattison, et al.,1996).

Provision of information about GM foods has been found to have little effect on consumers' attitudes towards such foods, and the extent to which people trusted the information source appeared to be determined by existing attitudes towards GM foods (Frewer, et al.,2003). Public opposition to this technology has been widely interpreted as stemming from misperception of the risks on the part of the public. However, recent work questions this interpretation, and indicates that the more important reason

for public opposition is the absence of perceived benefits to consumers (Gaskell, et al.,2004).

A need was identified a decade ago for research to determine whether benefits to health and the environment represent more acceptable reasons for GM than reduced cost or increased shelf-life (Frewer, et al.,1995). A study conducted in New Zealand (Fortin and Renton,2003) found that consumer resistance to GM foods was unlikely to be offset by the attribute of "increased shelf life", but the authors point out that this may not be seen as a positive attribute – and may be viewed with suspicion as "unnatural". A conjoint study of consumers in four Scandinavian countries (Bech-Larsen and Grunert,2000), manipulated a set of benefits associated with cheese consumption. They reported that if certain benefits were made apparent, and consumers could actually sample the product before forming an opinion, then resistance to such products could be lessened. A contingent valuation study in Italy (Boccaletti and Moro,2000) found that 'lower pesticide use', 'products with improved nutritional characteristics', and 'products with improved organoleptic characteristics' all increased the willingness of consumers to pay a premium for GM food products, but this was not so for 'longer shelf life' nor for 'generic GM foods.'

Do attitudes translate into purchasing behaviour?

Although consumer attitudes towards the concept of GM have been widely reported to be negative, it is possible that these attitudes will not translate directly into negative purchasing behaviour of GM foods by consumers (Gaskell, et al.,2003). Even in the UK, where antagonism towards GM foods has been intense and highly vocal, several million tins of clearly labelled tomato paste have been sold since introduction of this

product in 1996 (Halford and Shewry,2000). This product, made from GM slow-ripening tomatoes, has a clear consumer benefit in that it is cheaper than its non-GM competitors and is of a thicker consistency (Halford and Shewry,2000).

These findings are supported by comments from interviewees in our study of gatekeepers of the European food distribution channel (Knight, et al.,2003). In particular, distributors in Germany indicated that consumers in that market were extremely price conscious and would be likely to purchase GM products if there was a price advantage, especially if there was an additional consumer benefit. These views provided the impetus for the research reported here. Two recent studies indicate that in both France and the UK a significant proportion (up to 50%) of consumers may in fact be willing to buy GM foods if they are sufficiently discounted (Moon and Balasubramanian,2003, Noussair, et al.,2004). Research recently conducted in the UK found that in a "topic-blind" sample of 100 individuals, 93% willingly tasted and ate what they believed to be GM food in an experimental setting (Townsend and Campbell,2004). Furthermore, 48% said they would buy GM food in the future – results which the researchers found "surprising in the context of other reports about attitudes and intentions toward GM food" (Townsend and Campbell,2004), p.1385.

"GE-Free New Zealand"?

In New Zealand, the GM issue has reached heights of controversy as great as anywhere. In 2000, the New Zealand government set up a Royal Commission on Genetic Modification costing approximately NZ$6.5 million. The Royal Commission was directed to "receive representations upon, inquire into, investigate and report upon:

(1) the strategic options available to New Zealand to address, now and in the future, genetic modification, genetically modified organisms and products, and

(2) any changes considered desirable to the current legislative, regulatory, policy, or institutional arrangements for addressing, in New Zealand, genetic modification, genetically modified organisms, and products", p.6 (Eichelbaum, et al.,2001).

The major conclusion was that "New Zealand should keep its options open. It would be unwise to turn our back on the potential advantages on offer, but we should proceed carefully, minimising and managing risks", p.2 (Eichelbaum, et al.,2001). This measured conclusion has done little to defuse the controversy and there is still a very active anti-GM movement in New Zealand which, with a slogan of "GE-Free New Zealand", opposes all forms of application based on genetically modified organisms (GMOs).

Much of the debate has centred on potential harm to New Zealand's country image in foreign markets for food products – particularly European markets (Eichelbaum, et al.,2001). A common view in New Zealand appears to be that consumers in foreign markets are either 'for' or 'against' GMOs – mostly 'against'. The extensive study of Public Perceptions of Agricultural Biotechnologies in Europe reveals that this 'for' or 'against' view is a fallacy, and the issue should not be seen in terms of black and white, nor in terms of the intensity of debate in the news media (Marris, et al.,2001). Until October 2003, New Zealand had a moratorium on the commercial release of GMOs (whether food crops or any other application of GM technology) into the environment. Since the lifting of this moratorium, each application is to be dealt with on a case-by-case basis. In this evolving climate, it becomes important for a food exporting country such as New Zealand to know the likely impact of these moves on

perceptions in foreign markets of food products from their country once they introduce GMOs of various kinds (Knight, et al.,In Press). Also, it becomes important to know whether a proportion of consumers will accept GM food products when consumer benefits are made explicit.

Research Objectives

The question is: how should these issues be tested? It has long been known that consumer attitudes, and even consumer behavioural intentions, can fail to consistently predict consumer behaviour (Belk,1985). The aim of the present study is to determine whether actual purchasing behaviour reflects the stated attitudes which consumers in general appear to have towards GM foods, in a situation where consumer benefits are made explicit. As already indicated, the research reported here was inspired by insights provided by food distributors in Europe, who were interviewed in the course of a study of gatekeeper attitudes towards GM food, and towards countries that produce GM crops (Knight, et al.,2003, Knight, et al.,In Press). Some of the respondents in this earlier study considered that a proportion of European consumers would accept GM food products that were cheaper or had a well-defined consumer benefit other than lower price.

Revealed versus stated preferences

In a rare example of research into actual purchasing behaviour, Powell and colleagues placed GM sweet corn (insecticide-free) on sale along side conventional non-GM sweet corn at a farm and market in Ontario, Canada. The GM version outsold the regular version, and "the majority of consumers interviewed said they were more concerned about pesticides than about genetic engineering" (Powell, et al.,2003),

p.700. The current study, carried out before we were aware of either the Townsend and Campbell study (Townsend and Campbell,2004) or the Powell et al study (above) set out to test directly how consumers in New Zealand react to food labelled as genetically engineered, and having a clearly stated consumer benefit, when these consumers are placed in a real purchasing situation. In addition, the study set out to determine the price sensitivity of a GM label when compared to organic or ordinary. This study was intended as a pilot for research to be carried out in the near future in various European countries. This subsequent research will aim to estimate the likely impact on New Zealand's major export markets of applying GM technology in food production.

Methodology

A fruit stall was set up in New Zealand alongside a major highway frequented by domestic and overseas tourists. Cherries were offered for sale with the label conveying price and method of production manipulated experimentally. In order to conduct an experiment in an existing market with a new product, the customers were temporarily guided prior to the sale transaction by the labels on the produce. On sale in this fruit stall were cherries labelled in three ways: (a) "**ORGANIC**, Biogrow certified", (b) "**LOW RESIDUE,** Cromwell cherries" (Cromwell being a nearby locality well-known for cherry-growing), and (c) "**100% SPRAY-FREE**, genetically engineered cherries." The fruit stall was situated several kilometres from any existing orchard or fruit retailer in order to minimise the risk of upsetting other operators or of causing any transference of adverse reaction to such retailers.

Once customers had made their selection, but before money changed hands, they were made fully aware that this was a university-run experiment, that it had received approval from the University of Otago Ethics Committee, and that all cherries were in fact the same local, low-spray-residue type. The nature of the fruit stall, the purpose of the experiment, and the fact that all the cherries displayed were the same locally grown cherries was communicated verbally or by show-card to avoid contaminating other shoppers if these were present. Shoppers were then given the opportunity of purchasing cherries at the lowest price shown. All 414 customers who had made a choice took advantage of this offer.

The labels were carefully chosen to reflect plausible selling propositions that were considered to be likely to accompany the introduction of GM fruit into the marketplace. The words "genetically modified" would be required on the label in New Zealand under current regulations. However, it is the consumer benefit, rather than the words "genetically modified", that would be likely to be given prominence on the label in a real market. Pre-testing of these labels was carried out on academics and graduate students to ensure that the labels communicated the respective consumer benefit and gave a clear indication of the production method in a manner that the test respondents found credible. The term "genetically engineered" (GE) was used rather than GM on the labels because the former term appears to be more widely used and understood by members of the New Zealand public, and has been given particular prominence by the "GE-Free New Zealand" movement.

While this research might be viewed in the context of false and misleading advertising, an important research topic in its own right, that is beyond the scope of

this work which was designed to record consumers' preferences for experimentally manipulated product attributes, in a realistic market setting. False and misleading advertising is governed by legislation introduced by governments internationally to prohibit *unfair or deceptive acts or practices in or affecting commerce* (Federal Trade Commission Act 5 U.A.C. 45 1994, with its equivalent in New Zealand the Fair Trading Act 1986 and amendments.) Case law has established what is misrepresentation in particular instances (Preston,1992, Richards and Preston,2001). No attempt was made in our experiment to deceive customers making their final purchase as, prior to an actual transaction taking place, they were informed that all cherries offered for sale were the same. The transmission of corrective information, either orally or by means of a show-card, had no bearing on the initial choice that shoppers made, because that information was recorded prior to their being informed about the true nature of the experiment.

Prices were set at three levels: (1) prevailing or average market price (PMP) advertised in that region, which changed from day to day as a function of supply and demand, (2) PMP plus 15 percent, and (3) PMP minus 15 percent. The $\pm$ 15% variation covered typical seasonal and product variety price fluctuations observed prior to the research being undertaken in the local fruit market. The different prices were assigned to each fruit category using a balanced fractional factorial experimental design, with price design points (runs) changing every fifty customers. Repeat customers were identified and, although they were allowed to buy fruit at the displayed price, their data observations were specifically excluded from the analysis to prevent contamination of the experiment. It is possible that one or two new customers had in fact been pre-alerted by prior customers that this was an experiment

and all the fruit was identical. However, it seems unlikely that there were many such shoppers, because they would have had to display considerable acting ability for this not to be obvious. Furthermore, there is no clear reason for such non-naïve shoppers to choose one category of fruit over the other two, except by way of choosing whatever was cheapest at the time. A particular merit of the drive-in nature of this experimental situation is that, once customers had made their choice and subsequent purchase, they would drive away and thus be less likely to contaminate the behaviour of the next lot of customers than would be likely in a street market, for example.

The fruit stall was staffed by carefully briefed and trained postgraduate marketing students employed as research assistants. If shoppers asked about the genetic modification that led to the 100% spray-free designation, then they were told that the cherries were from trees that incorporated the *Bacillus thuringiensis* toxin (Bt) gene so that they made their own natural insecticide and so did not require spraying. If shoppers asked about the spray status of organic fruit, they were advised that Bt natural insecticide could have been sprayed onto the organic cherries to minimise insect damage. Currently in the New Zealand market GM cherries are not available, and organic cherries are rarely on sale. However, market knowledge on availability may be imperfect, especially with visitors. Surprisingly few consumers expressed surprise at these categories of fruit being on sale, and those that did were told that the GM fruit may have come from "an experimental orchard." Further details of the experimental approach are provided elsewhere (Mather, et al.,In Press).

Research findings

The data were analysed with a conditional multinomial logit (or discrete choice) regression model. The part-worths for each cherry category and the three category-specific price coefficients were identified (see Table 1).

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All produce and price parameter estimates were significantly different from 0 at the 99.98% confidence level or better. The overall fit of the model can be summarised by the unadjusted Psuedo-R-squared statistic 0.10, which is considered within the acceptable range.

From these results, an increasing value gradient in the aggregate market can be seen, from organic through ordinary to spray-free genetically engineered produce, controlling for, or taking out, the effect of price. Increasing price sensitivity in that same direction can also be seen, making it difficult to qualitatively judge the combined impact on relative value at market prices for the three alternatives without further numerical calculations. The differences between organic and ordinary parameters are the least significant, around 60% to 80% confidence levels; the differences between ordinary and GM parameters are more significant, around 88%-89% confidence level; and the differences between organic and GM parameters are highly significant, around 99.5% to 99.8% confidence levels. Demographic variables were tested but no significant effects were observed. Results were not significantly different for overseas visitors as opposed to domestic consumers.

Simulations of market share were calculated using the above model parameters and the multinomial logit form as follows:

$$\hat{M}s_{jk} = \frac{e^{\hat{\alpha}_j + \hat{\beta}_j x_{jk}}}{\sum_i e^{\hat{\alpha}_i + \hat{\beta}_i x_{ik}}} \quad \text{where}$$

i is the index over all the alternative fruit types, varying from 1 to 3.

j is the index for the jth. alternative for which the market share is to be simulated.

k is the index over the four pricing scenarios simulated varying from 1 to 4. Each scenario is defined by a vector of 3 given prices for each of the three alternative cherry types.

$\hat{M}s_{jk}$ is the estimated market share for the jth. alternative of fruit type for the kth. scenario to be simulated.

$\hat{\alpha}_j$ ($\hat{\alpha}_i$) is the fruit type intercept estimate for the jth. (ith.) alternative, or fruit type,

$\hat{\beta}_j$ ($\hat{\beta}_i$) is the price sensitivity parameter estimate for the jth. (ith.) alternative or fruit type,

x_{jk} (x_{ik}) is the level of price, in dollars, simulated for the jth. (ith.) alternative or fruit type, defining part of the kth. scenario.

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Market simulations for categories ("Organic", "Low residue" or "100% Spray-free") show that when all three were offered at the prevailing market price then **ORGANIC Biogrow certified** was the most preferred followed by **LOW RESIDUE Cromwell cherries**, while **100% SPRAY-FREE genetically engineered cherries** gain a moderate but not dominant market share (Table II). However, these preferences

changed markedly with differing prices regimes. Where all three categories are offered at a premium price, i.e. 15% more than the prevailing market price, the pattern of preferences outlined above becomes more marked. But the market simulations also show that when all three cherry categories were offered at the low price, i.e. 15% below the market average for the study period, this preference order changed markedly and "100% spray free – genetically modified" would be the most preferred choice compared to "Organic – Biogrow certified" and "Low Residue – Cromwell cherries" (Table II).

This price-preference relationship is a function of Spray free-GM having the most negative price coefficient estimate, indicating that it is the most price elastic, gaining market share faster than the other categories as all prices fall. In fact the 100% Spray-free (GM) cherries gain the most market share, and achieve a dominant market share, i.e. greater than 50%, when they are offered at a moderate (15%) price discount relative to Low residue cherries while Organic is offered at the price premium.

Discussion

This fruit stall experiment adds an important dimension to other studies of the GM issue by testing consumer behaviour in an actual purchasing situation when there is a clearly-stated consumer benefit in addition to price. This approach overcomes the problem of behavioural intentions failing to adequately predict behaviour in some markets (Belk,1985).

The results of the fruit stall experiment reported here provide direct evidence that a sizeable segment of domestic and visiting consumers in New Zealand, a country where the GM issue has been particularly politicized, will buy GM products provided there is a clearly-defined consumer benefit. Whether these are consumers with a propensity to try new and innovative products, whether they are consumers who are pro-GM, or whether they are largely consumers who simply do not care about the issue needs exploring in further research.

More research also needs to be conducted to determine whether a significant subset of European consumers will accept GM foods that have defined consumer benefits including lower price. The 2003 Eurobarometer Report (Gaskell, et al.,2003) found that "support for GM foods and crops has stabilised across Europe as a whole between 1999 and 2002." It is possible that resistance to GM foods could melt away quite quickly provided adequate attention is paid towards providing, and emphasising, the consumer benefits of such products.

Conclusion

Important public policy implications for food exporting countries resulting from this research can be summarized as follows:

- Survey-based approaches to determining attitudes and willingness of consumers to purchase GM foods may seriously over-estimate the strength of public opposition to such foods
- Identifying a defined consumer benefit associated with a GM food may well strike an accord with a sizeable consumer segment

- Even in a country where the GM issue has been highly politicized, a considerable number of consumers may be willing to purchase GM food products when there is a price advantage.

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Biographical Notes

John Knight is a Lecturer in Marketing at Otago University, New Zealand. His current research interests concern public acceptance of biotechnology, international marketing, and technical trade barriers.

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Table I

Multinomial Logit Parameter Estimates for Cherry Type and Price Sensitivity.

Parameter	**Estimate**	**Std Error**	**Chi-Square**	**P(ChiSq>0 by chance)**
Organic Type	4.01712	0.75064	28.6394	<0.0001
Ordinary Type	4.90652	0.88467	30.7601	<0.0001
Spray-Free GE Type	6.81226	0.82164	68.742	<0.0001
Price Organic	-0.50451	0.13748	13.4666	0.0002
Price Ordinary	-0.76204	0.16151	22.2614	<0.0001
Price Spray-free GE	-1.1112	0.15742	49.825	<0.0001

Table II. Market share simulation estimates at different price levels derived from the results of the fruit stall purchasing experiment.

Price level	**ORGANIC Biogrow certified**	**LOW RESIDUE Cromwell cherries**	**100% SPRAY-FREE Genetically engineered cherries**
Prevailing market price for all types	46%	27%	27%
All at 15% discount to market price	35%	27%	38%
All at 15% premium to market price	56%	26%	18%
15% discount for spray-free GM, prevailing market price for "Cromwell", 15% premium for organic	20%	20%	60%

All rows have significantly different market share estimates at the 90% confidence level

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