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Consumers' Desire for GM Labels: Is the Devil in the Details?

by William K. Hallman and Helen L. Aquino

The current U.S. policy regarding the labeling of GM foods is dictated by the Food and Drug Administration (FDA). In 1992, the FDA published a policy describing how foods made from GM plants would be regulated.

> FDA will require special labeling if the composition of food developed through GM differs significantly from its conventional counterpart. . . To date FDA is not aware of information that would distinguish GM food as a class from foods developed through other methods of plant breeding and thus, require such foods to be specially labeled to disclose the method of development (FDA, 1992).

The 1992 FDA policy *requires* special labeling of a GM food derived from new plant varieties under several circumstances. Specifically, labels are required to notify consumers if the GM food is no longer equivalent to its non-GM counterpart. In such cases, the food product also needs to be renamed. Labels are also required on a GM food product if its use or the consequences stemming from its use have changed, a new nutritional aspect was introduced that was not customary to the product, or a known allergen was introduced that was not implicit to the product. However, while these regulations require that consumers be alerted when the characteristics of a familiar food product have been substantially altered, the labels do not need to indicate that the change was produced through the process of genetic modification. As such, there are no current regulations mandating that GM foods be identified as such.

However, the FDA released draft voluntary guidelines for the food industry on 'positive' and 'negative' GM food labeling (FDA, 2001). In effect, food manufacturers can voluntarily label their products as containing these ingredients, but are not required to do so. Similarly, manufacturers can label their products as containing no GM ingredients if they choose to, as long as the statement does not express or imply that the non-GM food is superior.

In contrast, in July 2004, the European Union (E.U.) put into effect a labeling law that requires any food product that contains more than 0.9% GM material to be labeled as such (Alvarez, 2003). This move now allows the importation of GM material into the European Union, ending a defacto moratorium. Moon and Balasubramanian (2004), argue that the E.U. policy requiring mandatory labeling is the outcome of two regulatory principles. The first of these is the separation of scientific risk

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assessment from risk management, allowing E.U. regulatory agencies to take into consideration complex economic, political, and societal concerns. The second is the application of the precautionary principle, requiring continued scientific risk assessment to resolve any uncertainty about potential adverse effects of agrobiotechnology on health or the environment. This policy takes for granted that although no problems have yet been found with GM food products, they cannot be proven safe with absolute certainty. Mandatory labeling theoretically allows the assumed majority who would prefer to avoid GM foods the ability to do so, passing the additional costs involved onto those who seek to disturb the status quo by producing or consuming GM products.

According to Moon and Balasubramanian (2004), the current American policy of voluntary labeling represents a compromise between consumer demand to make informed choices and the avoidance of costs associated with over-regulation. This policy is grounded on rules established by the FDA governing the determination of substantial equivalence between GM and non-GM foods, and a tradition of minimal oversight of foods and ingredients that are generally regarded as safe (GRAS). The policy takes for granted that since GM foods are safe, voluntary labeling theoretically allows consumers who wish to avoid GM foods the power to do so, without imposing additional costs on the assumed majority who do not have such a preference (and based solely on scientific risk assessments, *should not* have such a preference).

Both of the current E.U. and U.S. labeling policies are based on the idea that ultimate acceptance (or rejection) of GM foods can be determined by market forces. That is, the fate of GM foods should be decided by the cumulative purchasing decisions of informed individuals.

However, despite the fact that an estimated 60 to 70% of processed foods on American shelves contain ingredients derived at least in part from GM Crops (GEO-PIE, 2003), major food manufacturers in the United States have decided not to label their products as containing GM ingredients. In part, this is because many in the food industry fear that consumers will interpret GM food labels as warnings implying that the products are of inferior quality or are unsafe and will reject products bearing them (GMA News, 2001; The U.S. Food Safety and Inspection Service, 2002). As a result, rather than providing more useful information to American consumers, The National Food Processors Association claims that labeling will only serve to confuse consumers and place importance on something that is not a health or safety issue (Pew Ag Biotech, 2003).

There is also reluctance to label GM foods because of the projected costs associated with crop segregation and other identity preservation methods required to ensure that GM and non-GM ingredients are kept separate. Without such a system at every stage of the supply chain, it would be impossible for manufacturers to ensure that their labels accurately reflect the GM or non-GM contents of their products. The added costs of these systems would ultimately be passed on to the consumer, yet it is unclear whether the majority of consumers would use the information for which they would ultimately be paying. Estimates of these costs vary greatly, ranging from a projected increase of between $0.23 and $3.89 annually in the cost of an average consumer's food purchases (Jaeger, 2002) to estimates that food prices would increase by approximately 5% (Houtman, 2002).

On the other side of the debate, labeling advocacy groups maintain that mandatory labeling of GM products would offer increased choices to consumers, the freedom to exercise religious or dietary preferences, and the ability to use market forces to express their political views in support or opposition to the use of GM technology. As such, arguing against food labeling is difficult politically, since doing so risks charges that government and industry are conspiring to deny consumers the right-to-know what they are eating (Hallman, 2000).

GM, What GM?

Consumer research conducted over the past several years at the Food Policy Institute (FPI) at Rutgers University finds that, despite being on American supermarket shelves for more than a decade, genetically modified food is an unfamiliar topic for most Americans. In the most recent national survey, less than half of the respondents (48%), were aware that GM foods are currently available in supermarkets, and only a third (31%) believed they had personally consumed GM food (Hallman, Hebden, Cuite, Aquino, & Lang, 2004). In the same survey, 28% (incorrectly) believed that GM foods are required to be labeled and 40% said they did not know. Only about one in three Americans (32%) were aware that there is no mandatory labeling policy in place in the United States.

Desire for Labels

Given the lack of awareness of GM foods and confusion about current labeling regulations in the United

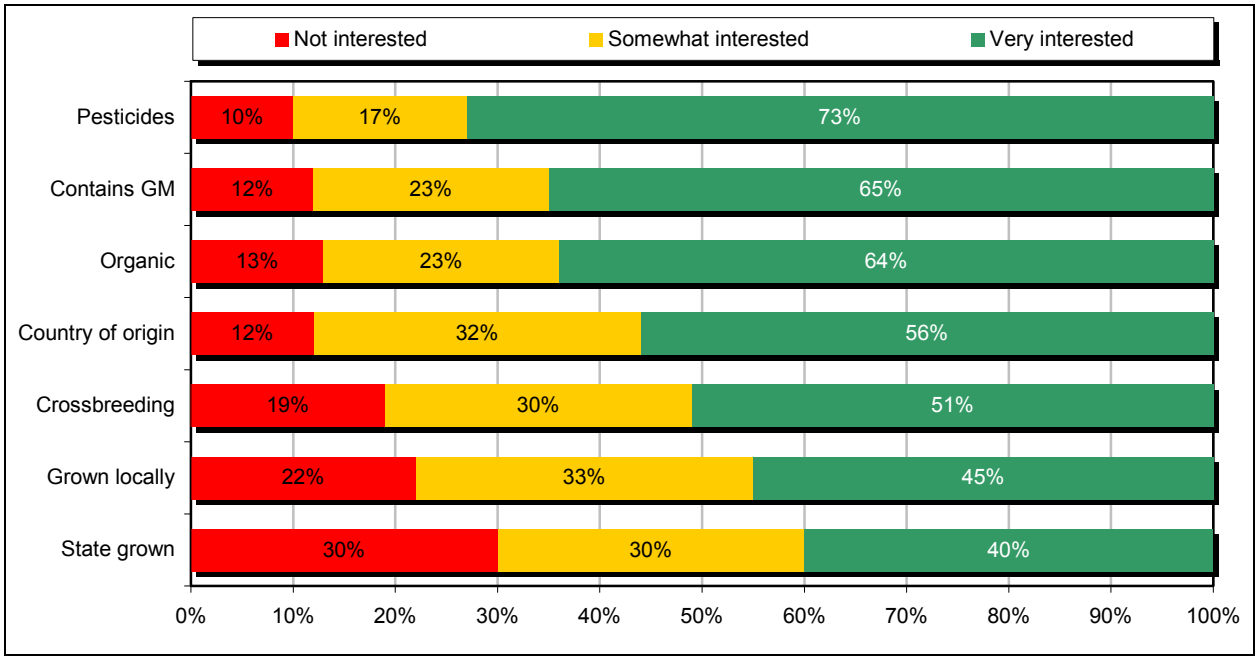

Figure 1. Consumer desire for additional information on food labels.

States, the issue does not seem to be a priority for most Americans. The topic of labeling was examined in detail as part of the 2003 National survey conducted by FPI (Hallman et al., 2003). Prior to any mention of GM foods, 600 Americans were asked how often they typically read food labels. More than half of the respondents (54%) said they read them "frequently" or "always," and 30% said they "sometimes" read food labels. Only 17% said they "rarely" or "never" read food labels. Despite this, more than three quarters (78%) of the respondents said that there was no additional information they were interested in seeing on food labels. In response to an open-ended question, of those who said there *was* additional information they wished to see on labels only six respondents (less than 1%) said that they would like labels to indicate whether the product contained genetically modified ingredients.

In contrast, after the issue of GM foods was introduced[1] and respondents were queried about how much they knew about the issues, whether GM foods were for sale in supermarkets, and whether they had eaten foods with GM ingredients, the respondents were asked directly whether or not they would like to see GM foods labeled as such. In response, 94% said they did favor such labels. Even among the respondents who said they never pay attention to food labels, 95% said they wanted this information. Further, more than three quarters (67%) of respondents said they would take the time to read food labels if this information was present, including 44% of those who said they rarely or never read food labels.

However, Americans' desire for more information about the foods they eat extends well beyond the issue of genetic modification. In the 2004 National Study, the respondents were asked how interested they were in having additional information on food labels concerning a number of attributes (Hallman et al., 2004). The results show that the majority of those surveyed were 'very interested' in seeing information on food product labels concerning nearly all of the attributes presented to them (See Figure 1). Of greatest interest is labeling information concerning whether pesticides were used in growing the food (73%), if the food contains GM ingredients (65%), and whether the food was grown or raised organically (64%). The message consumers are clearly sending suggests a strong preference for more information about the foods they are eating.

1. *The issue of genetic modification was introduced as follows: "Now I would like to ask you a question concerning another food production method. Genetic modification involves new methods that make it possible for scientists to create new plants and animals by taking parts of the genes of one plant or animal and inserting them into the cells of another plant or animal. This is sometimes called genetic engineering or biotechnology…"*

What is on the Label Matters

This apparent overwhelming support for additional information on food labels suggests that Americans wish to retain "consumer sovereignty;" the right to make food choices based on their own values (Thompson, 1997). However, those choices may confirm food manufacturers' fears. When asked how a GM food label would affect their purchasing decisions, more than half (52%) said it would make them less willing to purchase the product, 38% said it would make no difference, only 4% said they would be more willing to buy a product labeled as genetically modified, and 6% did not know (Hallman et al., 2003).

Focus groups conducted by the FPI to examine how consumers interpret information on food labels confirm consumers' wariness of purchasing foods labeled as containing GM ingredients (Hallman, Aquino, & Phillips 2003). Participants were segmented by their self-assessed awareness of food technologies and whether they shopped at conventional or 'natural' food stores. Several different label phrases and placement options were tested. In general, consumers who considered themselves to be more aware, were very skeptical of the claims on the food labels. They questioned the motivations of the food producers who labeled the products and wanted to know more details regarding the benefits and outcomes of genetic modification. In contrast, the less aware consumers were much more likely to perceive the labels as warnings. In the absence of more detailed information regarding the consequences of genetic modification, these consumers perceived the mere presence of a label as a signal that it was something about which they should be concerned. The shoppers at natural food stores, who were the most aware of GM foods, said that if they saw GM on a food label they would not buy the product because they did not want food that contained such ingredients. The shoppers at conventional food stores, who were generally less aware of GM, said that they wanted more information about the technology before they would buy a product labeled as such.

While these reactions seem to confirm the food industry's concerns about how GM food labels are likely to be interpreted by American consumers, data suggest that not all GM food labels may be off-putting. Americans say they would be more willing to purchase GM foods if the labels on such products included information certifying their safety. Safety certification from a variety of entities positively influenced reported willingness to purchase GM products. Respondents were asked how labels certifying food safety from various sources, including the USDA, FDA, EPA, the biotech industry, medical and scientific organizations, and environmental/consumer groups, would impact their willingness to purchase GM food. For every source presented, 40-50% of respondents indicated that the label would make them more willing to purchase the product (Hallman et al., 2004).

The strongest positive influences on respondent willingness to purchase were labels from the FDA (52% report increased willingness) and the USDA (52%), followed closely by medical/scientific organizations (44%), the EPA (43%), and consumer/environmental groups (42%). The biotech industry had the strongest negative impact, with one in-five respondents (20%) reporting a decrease in willingness to purchase GM products certified as safe by the biotech industry. When combined, about three quarters of the respondents (74%) reported an increase in willingness to consume GM foods with the inclusion of some form of safety certification.

But How Will Consumers *Really* React to GM Labels?

Of course, it is well known that what consumers *say* they will do in surveys and what they actually do often diverges. In our 2003 focus groups we asked the participants how often they read labels and, when they do read labels, what information they are seeking. Consistent with other research on how consumers use food labels, our focus group respondents told us they only read labels when they evaluate a new product or if they notice that something has changed on the label of a product they usually buy. They also told us when they do read labels they primarily look to the ingredients panel and to the nutritional panel for fat content, sodium content, or calorie information. In fact, none of the participants even noticed the addition of a GM food label on the products they were evaluating until it was pointed out to them. Once having been made aware of them, however, the participants had strong reactions to the labels, questioning the quality and safety of the food products to which they were affixed.

So, this is the conundrum for U.S. policy makers. When you ask Americans if they want GM food labels, nine-in-ten say they do. This is consistent with the views of those who favor mandatory labeling, arguing that consumers have a right to know and a right to choose. However, since most Americans know very little about the technology, even simple declarative sentences about

the presence of GM ingredients on a food label are likely to cause the product to be rejected by consumers. This is consistent with the position of opponents of mandatory labeling who argue that in the absence of any evidence that GM products are inferior or unsafe, any label that causes consumers to believe otherwise is misleading. The effect of such labels would be to cause consumers to reject foods made with GM ingredients, thereby reducing real consumer choice. They argue that without an informed consumer base, this is a case where providing *more* information doesn't necessarily translate into providing *good* information.

The paradox, of course, is that without GM labels, it is unlikely that American consumers will become much more aware of the presence of GM foods than they already are. Awareness of the availability of GM foods on supermarket shelves has changed little since our first survey focused on the issue in 2001 (Hallman, Adelaja, Schilling, & Lang, 2002). Yet, as already noted, consumers who are unaware of GM technology are likely to see such labels as warnings and reach conclusions that may not be warranted.

Enticing consumers to purchase products by making false or misleading statements is illegal in the United States. Indeed, the 2001 FDA draft labeling guidelines do not permit manufacturers to express or imply through labeling that a non-GM food is superior to that which contains GM ingredients. Ironically, given that the existing research suggesting that many American consumers are likely to interpret GM food labels as warnings, the adoption of mandatory labeling regulations in the United States might have the unintended effect of being a kind of government required 'false advertising.'

So, if labels are not the proper route to greater awareness about GM foods, and consumers do want to know more about the foods they are eating, whose responsibility is it to inform them and what should consumers be told? Indeed, the devil is in the details.

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William K. Hallman (hallman@aesop.rutgers.edu) is Director, and Helen L. Aquino is Research Analyst, Food Policy Institute, Rutgers, The State University of New Jersey, New Brunswick, NJ. *The research described here was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, the Food Policy Institute, or Rutgers University.*

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Consumer Willingness to Pay for GM Food Benefits: Pay-off or Empty Promise? Implications for the Food Industry

by Benjamin Onyango and Ramu Govindasamy

The Promise of Ag-Biotech

The biotechnology industry has spent substantial money researching and developing genetically modified (GM) products with tangible consumer benefits. The potential benefits include longer shelf stability, enhanced sensory appeal, reduced allergenicity, and nutritional or wellness attributes (Riley & Hoffman, 1999; Feldman et al., 2000). It is understandable that these distinct consumer GM food products' benefits (which are not available in the non-GM products) are likely to be critically important for broad consumer acceptance. However, as GM food products with enhanced and functional attributes appear in the marketplace, consumers will be faced with the choice between GM products bringing tangible benefits (but carrying unknown risks) and the traditional non-GM products that do not provide distinct and tangible consumer benefits.

It is important that researchers contribute to the ongoing discourse over benefits and risks of biotechnology by providing scientifically credible information on how consumers value various food attributes, including process attributes such as genetic modification. This is especially true given that food consumption in the United States and other developed countries is driven by factors other than physiological need. The majority of consumers in these countries want foods that are not only safe, but also promote good health and overall well being (Senauer, 2001). This study contributes to the ongoing debate over food biotechnology by explicitly modeling how consumers trade-off the potential or perceived risks of GM foods with the possibility of extracting significant benefits from GM foods.

In particular, this study analyzes (i) how consumers value the attributes embodied in food products (e.g., production technology, product benefit); (ii) how consumer valuation of these attributes vary across product types (e.g., whether it is consumed as a fresh product, a processed product, an animal-based product); and (iii) how the preferences over product attribute and product type combinations are influenced by the consumer demographics.

Understanding the values consumers place on individual product attributes may provide insights for the food industry in tailoring targeted marketing product strategies in line with changing consumer demands. The study results may also help policy makers decide which potential benefits of genetic modification are viable and acceptable to consumers.

Data and Modeling Framework

Data used in this analysis were obtained from mail interviews of respondents recruited at the end of a national telephone survey conducted and completed between February 27, 2003 and April 1, 2003. The mail survey elicited consumers' stated preference for the GM foods. Those participating in the mail survey received a five-dollar incentive for their effort. A total of 661 participated in the mail survey with 409 (61.9%) returning completed surveys distributed as follows: bananas: 137; cornflakes: 128; and ground beef: 144.

Before fielding the choice modeling mail survey, the experimental design was subjected to several lengthy discussions by various groups, comprised of life and social scientists. This facilitated decisions on the appropriateness of products that may appeal to the larger public, with potential and likely attributes and plausible genetic modification technologies through which the products could be

delivered. The products chosen were either whole (fresh), processed; or animal-based. In terms of benefits, care was taken to incorporate benefits that could broadly impact a consumer's health, have some type of consumer benefit, or provide a "societal" benefit. While in the case of technologies, the strategy was incorporating a wide range of existing and potential technologies such as plant or animal-based genes or microorganisms (bacterium).

Consumer preferences over food attributes are analyzed within the random utility discrete choice model framework (McFadden, 1978; Revelt and Train, 1998). Since market data from GM food products are not available, stated preferences (SP) choice modeling framework (Louviere, Hensher, & Swait, 2000) is used. The empirical model (i.e., the random parameter model) was estimated to obtain respondents' valuation of the benefits and the technologies jointly. The analysis involved examination of potential industry products in very specific details. Whose advantage was in terms of respondents' ability to relate to specific product characteristics based on carefully thought out answers. For example, corn flakes with longer shelf life versus corn flakes that stay crispy in milk longer or a banana that does not often bruise as quickly.

Consumer Stated Preferences

The willingness to pay/accept values was estimated by evaluating the ratio of the attribute coefficient (benefit or technology) to the coefficient of the monetary variable. Ceteris paribus, implicit prices were obtained that represent marginal rates of substitution between the attribute of interest (technology and benefit) and the monetary attribute. The positive values imply changes were beneficial (i.e., a consumer was willing to pay a positive amount for an increase of the attribute), while negative values implied reduction in utility (i.e., the consumer required compensation which may be in the form of a price discount for a unit increase in the attribute in this case the value may be taken to measure willingness to accept (WTA)). In reality, when consumers are presented with actual choices of GM products, stated preferences may be different from the actual buying behavior.

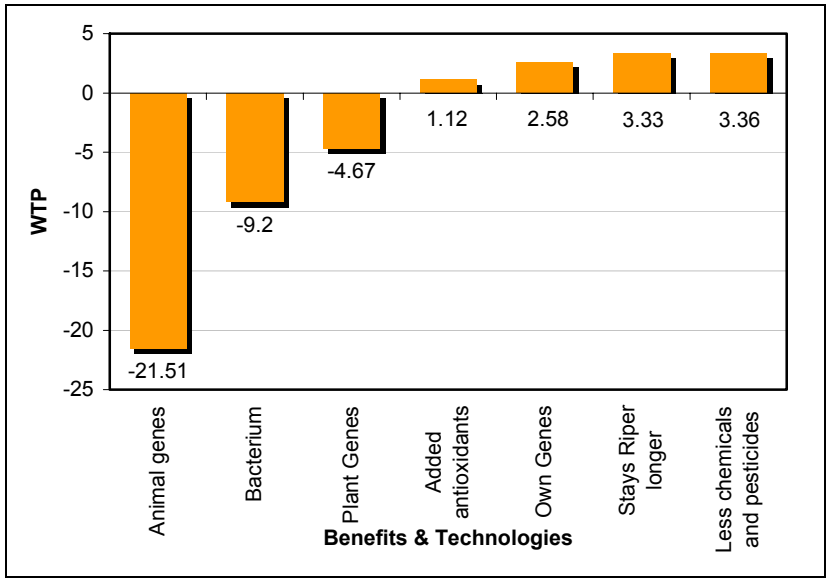

Figure 1. Willingness to pay: banana.

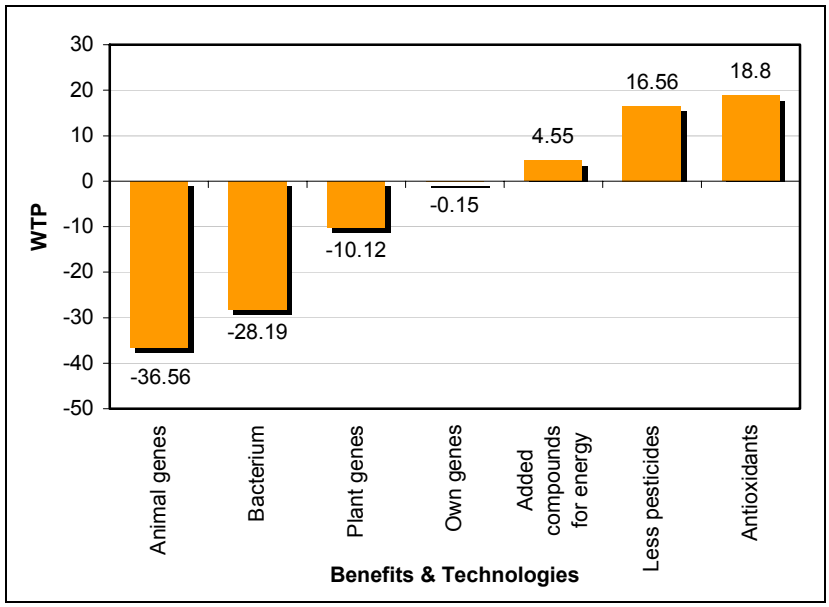

Figure 2. Willingness to pay: cornflakes.

Figures 1-3 present the mean willingness to pay for bananas, cornflakes, and ground beef. Most of the benefits across the three products have a positive effect on choice across the three products. The exception is antioxidants in the banana and added nutrients for stronger teeth and bones in ground beef that were insignificant. The significant and positive product benefits have a welfare

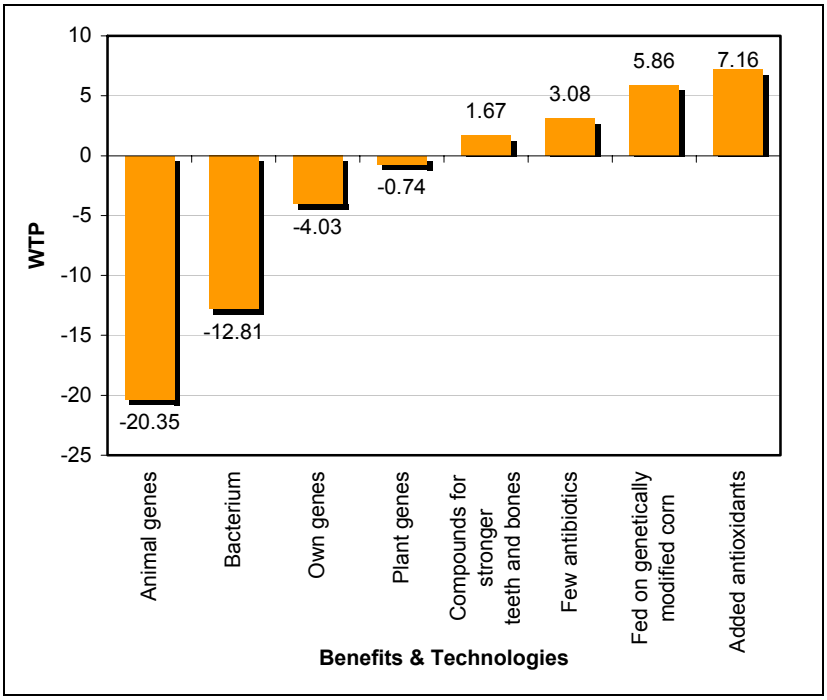

Figure 3. Willingness to pay: ground beef

improving effect on a genetically modified food choice. The negative coefficients on genetic modification technology imply that moving from the conventional food production technology reduces the probability of selection as that may lead to overall reduction in a consumer's utility. Conversely, a positive coefficient on a technology leads to an increase of utility. When ground beef was a product of cows fed on GM corn and a banana was modified using its own genes, in this case technology served to enhance consumer utility. Genetic modification involving animal genes, Bacterium, and plant genes has a negative effect on choice (i.e., reduces the probability of the GM alternative being selected).

Bananas

In the case of the banana (a fresh fruit or vegetable product), positively associated benefits were: use of less pesticides and chemicals to grow bananas, and increased shelf life (i.e., a banana that stays riper longer and reduces bruising). Respondents were willing to pay about 3% more compared to the current price in order to obtain such benefits. On the other hand, in case of technology; if the banana product is a result of genetic modification via plant, animal, or bacterium genes, the respondents needed to be compensated to accept it. The results show that more compensation is required to induce acceptance of processes involving animal, bacterium, and plant genes (22%, 9%, and 5%, respectively). Conversely, if the GM banana was a result of own gene transfer, consumers were willing to pay 3% more for the product. The results also show that respondents ranked technology from least to more acceptable (i.e., moving from a small to a larger negative and vice-versa). They ranked genetic modification via own genes top, followed by plant, with bacterium and animal-based technologies at the bottom. Given the normality assumption, at the same price, about 32-35% of the respondents would have placed a negative valuation of less pesticide use, added antioxidants, and a banana that ripens longer. Unlike the benefits, respondents largely placed negative valuation on technologies, ranging from 63-84%.

Cornflakes

In case of cornflakes (a processed product), respondents valued all the benefits positively. The benefits included: less chemicals/pesticides in corn production, added antioxidants to reduce aging, and added compounds for increased energy. However, given the normal distribution assumption, about 18-40% of the respondents could have valued these benefits negatively. Results indicate that respondents were willing to pay between 5% and 19% more to obtain the direct health and environmentally related benefit of corn produced with less pesticides and chemicals. Unlike the case of benefits, respondents largely placed a negative valuation on technologies ranging from 47-81%. As a result, if the cornflakes are genetically modified using plant, bacterium and animal genes, consumers need to be compensated by about 10-37% more to accept the cornflakes.

Ground Beef

For ground beef (animal-based product), with the exception of added compounds for stronger teeth and bones which turned out to be insignificant, consumers were willing to pay 2% more to obtain the benefits of less antibiotics in cow production and 3% more for antioxidants to slow down the aging process. In contrast, consumers required a compensation to accept ground beef, which was a product of genetic modification involving animal or bacterium genes (20% and 13%, respectively). However, if the ground beef was a

product of a cow fed on GM corn, consumers were willing to pay 6% more. With the normality assumption, at the same price, about 52-62% of the respondents placed a positive valuation on fewer antibiotics and antioxidants. On the other hand, compared to cornflakes and bananas, fewer respondents placed a positive coefficient on technology ranging from 19-60%.

Implications for Food Industry

The study results show that the use of choice modeling experiments provides a way of valuing non monetary attributes associated with consumption of GM food products and a way of identifying consumer preferences. The results indicate how different attributes of price, product benefits, and technology influence consumer demand for genetically modified food products. The results show how a consumer makes tradeoffs between the product attributes.

The results suggest that across the products, direct health, environmental and production-related benefits have a positive effect on choice. Also, the results generally show that genetic modification is viewed negatively. However, through the choice modeling experiments, respondents viewed own- and plant-based genetic modification less negatively than the use of bacterium and animal-based genetic modification. These results may suggest that attitudes may be somehow more promising for GM processes involving own- or plant-based gene technology. Respondents' willingness to pay for benefits embedded in the products suggests that there is potential for GM foods in the market.

Understanding the values consumers place on individual attributes can provide insights for the food industry in tailoring targeted marketing product strategies in line with changing consumer demands. The study results also provide information to policy makers on which direction to go in terms of genetic modification (i.e., what is viable and acceptable).

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Benjamin Onyango (onyango@aesop.rutgers.edu) is Research Associate, Food Policy Center, and Ramu Godvindasamy is Associate Professor, Department of Agricultural, Food, and Resource Economics and Associate Director, Food Policy Institute, Rutgers University, New Brunswick, New Jersey.

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Lies, Deep Fries, and Statistics!! The search for the truth between public attitudes and public behaviour towards genetically modified foods

by Craig Cormick

Which of these two statements do you think is true?

- About half of the Australian public will not eat genetically modified foods.
- About half of the Australian public will eat genetically modified foods.

The answer is, of course, that both are true, but which one you choose to accept will depend on your ideological perspective.

Consumer surveys are often quoted in the formation of government and industry policy relating to GM foods, but in addition to the common problem of selective use of data, it now also needs to be asked whether consumer surveys actually reveal the whole truth of consumer behaviours.

As has been shown by a study conducted for the European Commission (2001), policy decisions are too often based on perceptions of public perceptions, rather than a solid understanding of what public perceptions actually are.

The study listed ten common misassumptions that did not stand up to solid scrutiny. They included:

- The cause of the problem is that lay people are ignorant about scientific facts.
- The public thinks, wrongly, that GMOs are unnatural.
- The public demands zero risk, and this is not reasonable.
- It's the fault of the BSE crisis: as citizens no longer trust regulators.
- The public is a malleable victim of distorting sensationalist media.

Another study from the University of Illinois found that the assumptions that both opponents and proponents had towards the publics' attitudes towards GM foods were more often fallacies that actual (Wansink & Kim, 2001). They included:

- People need to be, and want to be, informed.
- Changing consumer attitudes will change their behaviour.
- The biotechnology controversy will be forgotten.
- People will become biotechnology advocates once they have the facts.

The reason is the sources that policy makers use to receive data, which is often opinion surveys, media coverage, and activist groups, which, when taken together, do not provide an accurate representation of actual public behaviours.

The accuracy of many surveys themselves need to be looked at as well. In a 2002 survey in Australia, Greenpeace asked: 'If you knew a product contained ingredients made from genetically engineered plants or animals, would that make you less likely to buy or not buy?' Sixty eight percent of the respondents agreed with the statement (Taylor Nelson Sofres, 2002). The reference to both GM foods and animals and the broadbanding of responses increases the response rate. Alternatively, a weighted question asked by Biotechnology Australia in 2001 to analyse the effect of weighting, and often quoted by pro-biotechnology advocates, was: 'Would you eat foods that had been genetically modified to be healthier?' Sixty percent of those surveyed said yes (Millward Brown [MB], 2001).

There have been many attitudinal polls towards GM foods conducted around the world that encompass the good, the bad, and the ugly, but as more and more data becomes available on consumer behaviours regarding GM foods, in countries where labelled GM foods are on supermarket shelves, the indication is that most attitudinal surveys might not be obtaining the full answers.

Trying to determine simple answers to consumer behaviours towards GM foods is a complex task, yet there are enough indicators to show that behaviours can be quite different to the findings obtained in most attitudinal surveys. This is very important when considering the amount of agricultural food policy decisions in government and industry that are based on available data.

The holy grail of all surveys into GM foods and the consumer is to best determine what percentage of the public would, or would not, eat GM foods. This is usually done through asking a variation of 'Would you eat GM foods?' or 'Do you have concerns about eating GM foods?' But are these the best relevant questions to ask?

First, let's look at the correlation of concerns and behaviours. Studies undertaken for Biotechnology Australia by the research company Millward Brown (2001, 2003) show that about 75% of consumers in Australia state they have concerns about eating GM foods – a statistic often quoted by anti-GM activists. Yet, the same studies show that about half the Australian population are willing to eat GM foods, despite concerns. This indicates that the relationship between concerns and behaviours is not necessarily a direct and comparable one.

Relativity of Concerns

Next, let's consider the relative ranking of concerns. A study conducted for Biotechnology Australia by the Market Attitude Research Services (2001) looking into food concerns, sought ratings across a five-fold scale of very concerned, quite concerned, little concern and not concerned. While 39% had high concerns about GM foods, it was the smallest high concern compared to 45% high concern about the uses of pesticides in food, 46% high concern about human tampering of foods, and 58% high concern about food poisoning. Similar results were obtained from similar studies conducted by the UK Food Standards Agency (2001), and by Wirthlin (2001) in the USA, yet relativity of concerns is rarely taken into account.

Biotechnology Australia updated this survey question in the study by Millward Brown (2003), asking about GM food concerns relative to environmental concerns and found again that GM food high concerns, at 11%, were lower than high concerns about Pollution at 35%, Nuclear Waste at 26%, the Greenhouse Effect at 17%, and Cloning at 12%. A study into GM food attitudes, undertaken by the Rural Industries Research and Development Corporation, found that there were five food concerns higher than GM foods (Owen, Louviere, & Clark, 2005):

1. Diseases in beef that could pass on to human.
2. Bacteria and disease in foods.
3. Hormones to accelerate growth in animals.
4. Antibiotics in meat.
5. Pesticide residue on fruits and vegetables.
6. **Fruits and vegetables that have been genetically engineered.**

Risk-Benefit Comparisons

Another indicator of consumer acceptance is gained from looking at risk-benefit comparisons, measuring the perceived benefits of GM foods to their perceived risks. Expressed as a ratio of benefits to risks, the Millward Brown (2001, 2003) studies showed that Australians have tended to see increased risks over benefits over the two years. In 2001 the ratio was risks rating 73% and benefits rating 57%, and in 2003 this had changed to 74% risk and 51% benefit.

However, it must be noted that during 2001 the concept of risk in society changed enormously. Following September 11, and the subsequent bombings in Bali, Madrid, and London, the world suddenly became a riskier place to live in and risk rankings rose on most surveys. Similarly, while perceptions of risk towards GM foods have risen in Australia, levels of concern have not risen.

Firstly, let's look at the impact of actual choice versus hypothetical choice. Before GM labelling came into force in Australia, in December 2001, a tracking study conducted by Quantum Market Research (2000) found that 46% of the population would not buy GM foods, even if they were labelled. But that figure dropped to 41% in a subsequent Quantum (2002) survey, indicating that the matter of choice and trust appeared to be influential in attitude formation, and that a labelling regime can have some impact on public attitudes.

While six different GM food types are approved for consumption in Australia: cotton oil, canola, corn, soy, sugar, and potato - the majority GM commodity is soy or canola. There have been about a dozen products on supermarket shelves that are

labelled as containing GM ingredients. These include donuts, chocolate cake, cake icing, and several types of chicken loaf and frozen chicken.

However, as highly-refined products that have no trace of novel DNA in the final food are exempt from labelling in Australia, most oils do not require labelling, and fast foods such as those deep-fried in these oils do not therefore need to be labelled either. This causes some over-heated debate about the accuracy of GM food labelling, but the changes in attitude do indicate a diminution in rejection of GM foods when they were labelled.

Understanding

Next, we should look at public understanding of GM foods. In the Millward Brown (2003) study, people were asked which of the following modifications were genetic modifications of food.

Modification	% Who View It as GM
The Change of Grain Crops to Make Them Pest Resistant	78%
Foods Produced Using Gene Technology Processes	74%
Food Made from Animals Fed with GM Stock Feed	66%
The Change of the Flavour in Food	52%
Flavour or Nutritional Enhancements in Food	52%
Colours in Food	35%
Food with Preservatives	32%
Food Grown with the Use of Pesticides	30%
Food Grown Using Fertilizers	26%

So a minimum of about 30% of the population believe that most any modification to foods makes them genetically modified. This is no surprise when we consider that we've never been at a time in our society when we have been so removed from agricultural production as we are now, with an increasingly urbanised society whose experience and understanding of food is restricted to supermarket shopping, and we have little knowledge of how food is actually produced.

It also raises the question, if so many people view these common modifications as genetic modifications, why isn't that being reflected in any adverse consumer behaviour towards these foods?

Let's look a little closer at those donuts and chocolate cakes and chicken loaf that really are genetically modified and are labelled as such. First, we need to look a little bit at the details of the labelling. A typical label might read, Ingredients: sugar, water, wheat flour, vegetable oil, egg, cocoa powder, fresh cream, thickener, milk solids, emulsifiers, salt, corn starch (genetically modified).

According to the supermarket chains, although they are often on the receiving end of anti-GM campaigns about their foods, there has been little to no diminution in sales of those foods that are labelled as containing GM ingredients.

Could this be explained by consumers simply not being able to find the fact that the food has GM ingredients on the label? Perhaps. But at the deli counter in Woolworths, all across Australia, there have usually been two or three types of sliced chicken loaf that have been clearly labelled 'contains genetically modified soy' on a plastic label, standing up by the meat. It is clear and prominent, and I have made it a habit of always asking the person in the deli, wherever I travel, whether anybody comments or complains about the GM ingredients. Invariably, I'm met with a blank look and the response that nobody seems very concerned about it.

So why is that – if so many people state that they are concerned about GM foods?

The Importance of Consumer Segments

An indication of why has been provided by Environics International (2000), a Canadian company who has done some cluster graphs on consumer attitudes to food, and whose research translates well into Australia. The general finding of its research showed that attitudes towards GM foods are more driven by general attitudes towards food than attitudes to gene technology.

They have defined six distinct consumer segments:

- *Food Elites* – who prefer to eat organics and the best foods and will pay for them (about 8% of the population).
- *Naturalists* – who prefer to buy from markets rather than supermarkets (about 16%).
- *Fearful Shoppers* – who have concerns about most foods – predominantly elder consumers (about 28%).
- *Nutrition Seekers* – who treat food as fuel for the body (about 20%).
- *Date Code Diligent* – who read labels, but generally only look at use by date and fat content – predominantly younger women – (about 13%).
- *The Unconcerned* – who don't really care too much what they eat – predominantly younger men – (about 13%).

Those top three are concerned about many food issues and also concerned about GM foods. The bottom three have specific concerns only, or aren't too concerned about foods and are not concerned about GM foods.

Focus group responses in a study conducted by Eureka Strategic Research (2005), showed that when people were served a cake that may contain some GM soy, typically responses were along the lines that since cakes weren't that good for you respondents wouldn't mind eating them. Or:

> "I think 2% [of the product being GM] isn't a whole lot that would do anything wrong."

If we look at those products that are labelled GM on supermarket shelves in Australia, it is apparent that they are the type of foods most consumed by the bottom three categories of consumers. If a GM soy milk was introduced to the market, which would have a higher appeal to the first three categories, I suspect consumer reaction would be very, very different.

Understanding the different nature of segments and understanding that there is not one single 'public' is vital to understanding consumer behaviours.

Focus Group Studies

A useful supplement to survey work is focus groups, which are often able to drill much deeper into drivers of attitudes. In a series of focus groups conducted by Millward Brown (2003), for instance, while acceptance and rejection of GM foods stood at about 50:50, as it had in 2001, there had been a major change in the cause of rejection. In 2001 the major stated cause was health and medical concerns, and yet in 2003 that had been replaced by no apparent benefit.

It can be argued, of course, as some anti-GM activists do argue, that people are eating GM foods only because they aren't aware they're eating them. But focus group respondents actually showed a drop in concerns when they were told they had been eating GM foods for several years.

Another major finding from focus groups is that there are five key factors of influence in determining acceptance or rejection of GM foods and crops. (MB, 2001, 2003; Eureka Strategic Research, 2005) They are:

- *Information* - a level of understanding of the technology and what it can and cannot do, which has to be provided from a credible source.
- *Regulation* - a level of confidence that effective regulation exists to protect humanity and the environment.
- *Consultation* - a feeling that the public has had some input to the development of the technology.
- *Consumer choice* - the ability for an individual to accept or reject each application of the technology.
- *Consumer benefit* - a clear individual and societal benefit from each application.

All five of these need to be met, however, and currently GM foods do not rate well on information and fall down on consumer benefits.

Some surveys, such as that conducted by the Rural Industry Research and Development Corporation, quoted earlier, have sought to capture a deeper level attitude and behaviour linkage (Owen, Louviere, & Clark, 2005). Its survey used quite a complex set of variables to quantify how much a person would pay for a GM or non-GM potato, potato chips, or milk. The study also found distinct consumer segments, definable by traits such as health, attitude to new products, and price sensitivity. It also found that if there were no benefits to the consumer, people would require between a 30 to 50% discount to purchase a GM product. Potential health benefits, however, increased acceptance of the GM foods, confirming the focus group findings above.

There are many more factors we could look at too, such as the impact of anti- and pro-GM misinformation on consumer behaviour, food safety scares and gender differences, all of which have some impact upon behaviours.

What Consumers Say Versus What They Do

Having looked at lots of survey results and the way that they are interpreted, and questioned the findings of many of them, we now have to ask: are we any closer to that holy grail? We know that what consumers say and what consumers do can be different things, such as the number of people who say they would prefer to eat organic foods far outweighs the numbers who actually do. It's not that consumers actively tell lies in surveys as much as they've often given an answer that is consistent with a preferred or idealised action, rather than an actual one.

Consumers are peculiar animals, and despite many concerted studies, we are still far from understanding them well. Yet, we know from animal behaviour studies that observing animals in zoos and laboratories can be different from how they behave in their natural environment.

Perhaps that's where we need to go next, into the natural habitats of consumers - the supermarkets - undertaking more ethnographic studies, based on our knowledge of existing consumer segments from attitudinal studies, watching behaviour rather than asking about it. How do consumers really behave, in super-

markets, when faced with GM foods that are labelled, and have price and product differences?

That is the question we need to be feeding into agricultural food policy formulation to ensure that decisions that are being made are in line with actual consumer behaviours.

The indications from Australia are that when asked in surveys consumers are only marginally supportive of GM foods - yet when in the supermarkets, considering the types of foods that are currently GM, there is only marginal rejection of those foods.

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Craig Cormick (Craig.cormick@biotechnology.gov.au) is Manager of Public Awareness, Biotechnology Australia, Canberra Australia. Biotechnology Australia, the Government agency responsible for co-ordinating biotechnology issues in Australia, has been conducting comprehensive surveys since its inception in 1999, tracking changing attitudes to GM foods and crops as well as health and medical applications in biotechnology. www.biotechnology.gov.au

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Testing Public Policy Concepts to Inform Consumers about Genetically Engineered Foods

by J. Lynne Brown and Wei Qin

Current Situation

Although U.S. farmers have rapidly adopted genetically engineered (GE) soybeans, corn, and cotton over the last decade, American consumers remain relatively unaware that ingredients derived from these GE crops are in over 70% of the processed foods they buy. Surveys indicate that consumers are more concerned about GE applications in animals than in plants and that presence of a consumer benefit is likely to increase acceptance (Hallman et al., 2003; PEW, 2002). Despite incidents (Monarch butterflies, Starlink, Prodigene) that reveal weaknesses in managing and regulating GE crops and the Food and Drug Administration's (FDA) use of voluntary rather than mandatory regulatory review of GE food products, the public seems open to more applications of genetic engineering entering the food system. A test case is on the horizon.

In 2000, AQUA Bounty (now called AQUA Bounty Technologies, Inc.) submitted a petition to the FDA to permit its GE fast growing Atlantic salmon to enter the U.S. food system. This salmon was genetically engineered to enable the continuous production of growth hormone, instead of seasonal production as in conventional salmon. The resulting GE Atlantic salmon reaches market weight in roughly half the time required for conventional Atlantic salmon used in fish farming. Using focus groups in 2003-2004, we discovered that consumers could envision a range of consequences resulting from approval of this 'animal' application. They expressed great concern about impacts on human health and the environment, indicating a situation where outrage could drive public opinion (Qin & Brown, submitted). Consumer response will determine the success or failure of this GE salmon if approved by the FDA. One antidote to opinions driven by outrage is balanced information, which might support more informed opinions.

However, most readily available information presents, at best, one perspective on the issue of use of GE foods in the U.S. food system. Information from the biotechnology industry offers arguments and data in support of adoption, while that from some environmental and consumer groups raises concerns and supports a ban until certain conditions are met. Information from scientific academies and organizations is harder to find and, once located, is often difficult to understand and represents only the scientific perspective, giving little recognition to the values and social norms that also contribute to opinions. Readily available media reports also tend to be biased to whatever view makes the story newsworthy. We sought a framework for presenting print information about GE fast growing Atlantic salmon that would provide a balanced view on the issue of FDA approval.

Public Policy Education

Alan Hahn (1988) pulled several decades of work into a model for educators interested in resolving public issues through policy education. Although the model emphasizes the process used by an educator to help a group inform itself, some key concepts could be applied to written communications about an issue. Once the issue is clearly identified, these include a) understanding the perspectives of all the stakeholders in the issue; b) considering alternative solutions to the issue including the 'do nothing' option; and c) examining the consequences of each solution. Only when this is worked through, would citizens have sufficient data with which to make an informed choice of solution to the issue in question. In particular, gathering information on stakeholder perspectives and generating all the

possible consequences of a solution are difficult for an individual to do. For that reason, most efforts at public policy education rely on working with a group of people over time. Indeed, Cooperative Extension has been involved in public policy education with groups for many years around issues of river basin management, farmland protection, land use planning, intensive livestock operations, water quality, and municipal governance.

However, the introduction and regulation of GE foods has primarily occurred at the national level. Less regulatory debate has occurred at the state, regional, or county level, although an Oregon initiative to introduce mandatory labeling failed, as have recent efforts to limit GE crop use in certain counties in California (Clapp, 2004). Concerned citizens may be unable to find or form groups to investigate the issues surrounding introduction of GE foods into the food system. We felt that print fact sheets were an economical method of providing information on GE foods for literate citizens. However, we wanted to organize the information in a manner reflecting the concepts of public policy education, but were unsure what format would have the most impact on understanding an issue. To resolve this, we decided to compare the effect of two ways of organizing print information about the impacts of introducing GE fast growing Atlantic salmon (called GE salmon hereafter) into the food system.

Information Format

As FDA reviews GE salmon, the major issue is whether to approve or disapprove its entry into the food system. For our study we chose to consider the solution of FDA approval. Our information sheets contained two sections, one of invariant background and the second that differed. In the invariant section, we presented factual data comparing traditional selective breeding and genetic engineering and then described how GE salmon was created, how fish farming is done, and the current status of FDA review of GE salmon. The second section presented either viewpoints of various stakeholders on or the consequences of FDA approval of GE salmon. We will use 'perspectives' and 'consequences' to distinguish these two approaches for the second section in the rest of this paper.

We developed the second section by gathering information about GE salmon provided by various stakeholder organizations. Using this, we wrote summaries that we felt represented the perspectives of regulatory agencies, AQUA Bounty, the fishing industry, scientific review panels, environmental groups, consumer groups, and international agencies on approval of this GE application. The stakeholder group, along with various members (regulatory agencies such as FDA, EPA, and USDA), was listed at the top of the summary and all the summaries linked together became the 'perspectives' approach. We then identified consequences that were embedded in these viewpoints and used verbatim sentences and paragraphs from the perspective summaries to organize explanations of each of the consequences. Stakeholders were not identified by name in these 'consequence' summaries. For instance, "Some government commissioned reports" was used in consequences while "the National Research Council" was cited in perspectives. This list of consequences and their explanations became the 'consequences' approach. An example of each approach is shown in Table 1. The resulting 'perspectives' and 'consequences' sections shared 96% of the same sentences and phrases, differing only in omission of agency names and addition of a consequence statement (for example, regulation of fish farming may change) to introduce each consequence's section. These information sheets were reviewed by an expert in fish genetics for accuracy and in policy education for bias. Little bias was detected and a few inaccuracies were corrected in both information sheets.

The reading level for both information sheets was twelfth grade.

Experimental Design

We tested each information sheet with a randomly assigned group of consumers. We developed two questionnaires, one containing the consequences and the other the perspectives information. In each, prior to reading the information sheet, the subject was asked a) how they felt about the use of fast growing GE salmon in fish farming to produce fish for human consumption using an approval/disapproval scale; b) how interested they were in information about GE salmon; and c) how much factual information they could tell someone wanting a verbal explanation of development and use of GE salmon in the food system. After reading the information sheet, they were asked these three questions again, as well as how confident they felt in their understanding of some of the questions surrounding the introduction of GE salmon into the food system (for example: How might GE salmon affect consumer choice?). They were also asked a series of questions about ability (readability, ease of understanding) and information quality (how interesting, factual, biased, and desirable length). Finally,

Table 1. Illustrations of perspectives and consequences.

Perspectives example	Related consequence example
The **National Fisheries Institute,** representing the fishing industry, feels that *farming of Atlantic salmon replaces a diminishing natural resource, helps conserve wild salmon populations and produces protein efficiently. It take less than two pounds of feed to produce one pound of farmed salmon compared to five pounds of wild feed to produce one pound of wild salmon.* They ***acknowledge that salmon do escape from ocean pens, and some escapees have spawned in nearby rivers and interbred with wild salmon. However, fish farmers are improving containment systems. In addition, farmers must protect the local environment or their fish will die. Advancements in technology have reduced the amount of salmon excrement and areas around farms are routinely monitored for pollution effects. Fish farmers keep the use of therapeutics (antibiotics) as low as possible.*** ***Environmental Defense*** (ED) *recognizes that aquaculture is the only available means to significantly supplement fish catches in a hungry worl,d but feels that aquaculture must be done in an environmentally sustainable manner. They recommend that EPA strengthen its oversight of fish farms and improve salmon farming practices.* Approval of GE fish for commercial sale should require evidence of ecological, as well as food safety, and the approval process should be open to the public (transparent).	**• Production of GE salmon may spare wild fish populations.** *Farming of Atlantic salmon replaces a diminishing natural resource, helps conserve wild salmon populations, and produces protein efficiently. It take less than two pounds of feed to produce one pound of farmed salmon compared to five pounds of wild feed to produce one pound of wild salmon.* **• Regulation of fish farming may change.** Fish farmers ***acknowledge that salmon do escape from ocean pens, and some escapees have spawned in nearby rivers and interbred with wild salmon. However, fish farmers are improving containment systems. In addition, farmers must protect the local environment or their fish will die. Advancements in technology have reduced the amount of salmon excrement and areas around farms are routinely monitored for pollution effects. Fish farmers keep the use of therapeutics (antibiotics) as low as possible.*** Other groups *recognize that aquaculture is the only available means to significantly supplement fish catches in a hungry world, but feel that aquaculture must be done in an environmentally sustainable manner. They recommend that EPA strengthen its oversight of fish farms and improve salmon farming practices.* Monitoring and enforcement actions to detect noncompliance should be increased to provide stronger environmental regulation of fish farming.

Note: Italic and bold italic text in the perspectives section matches the respective section in consequences. The remainder of the consequences text on regulation of fish farming came from other group perspectives and the remainder of the perspectives text for Environmental Defense became part of a different consequence not shown.

they rated the necessity of each section in the information sheet to be well informed on the issue.

Subjects were recruited at an art festival in a small college town who met the criteria a) being 21-65 years old; b) ate fish at least once a month; and c) not a college student from the local college. The sample was stratified by age and gender and assigned one version of the questionnaire to complete within two-hour time blocks. The questionnaires were alternated by time blocks so that half the sample completed the perspectives questionnaire and half the consequences questionnaire. Data checking, entry, and analysis followed.

Influence of Information Format on Knowledge and Perceptions

Participants reading either information sheet did not differ in demographic characteristics, except those who read the consequences sheet ate salmon significantly more often than those reading the perspectives sheet (32 vs. 23 times a year). They were middle-aged, Caucasian (90%), mostly college educated (74%), with median household incomes of $60,000. About two-thirds were not aware of GE salmon development.

The two groups of participants did not differ significantly in baseline measures (prior to reading either information sheet) of approval of GE salmon, self-assessed knowledge, or interest in learning about genetic engineering (See Table 2). There were also no significant differences in ratings of ability or information quality between groups. Both groups rated the information as moderately easy to read and understand. Both groups also found the information sheets moderately to rather interesting, rather factual, and just about right to provide the information necessary to reach an informed opinion. Both groups felt the information sheets exhibited little bias about introducing GE salmon into the food system.

Assessments of knowledge and interest after reading an information sheet did differ. Although both groups showed significant increases in knowledge and interest, those reading the consequences information reported greater gain in knowledge and more interest in learning about GE salmon than those reading the perspectives information.

The effect on approval was more complex. Prior to reading the information, both groups slightly disapproved of GE salmon. While the difference was not significant, those in the perspectives group were initially somewhat less negative about GE salmon than those in the consequences group. After reading the information, the assessment of both groups shifted upward slightly and significantly for the perspectives group. However, approval of both groups still hovered in the neutral range (half a unit on either side of zero in our scale). Further analysis revealed that the consequences group

Table 2. Effect of information on participants' views.

Viewpoint	Perspectives N= 103	Consequences N = 102
Approval of GE salmon[a]		
Pre-approval	-0.11[a]±1.60	-0.45[a]±1.75
Post-approval	0.16[b]±1.66	-0.36[a]±1.77
Self-assessed knowledge[b]		
Pre-knowledge	1.69[a]±1.03	1.96[a]±1.19
Post-knowledge	3.7[b]±1.18*	4.2[b]±1.17*
Interest in learning about GE salmon[c]		
Pre-interest	4.07[a]±1.48	4.39[a]±1.76
Post-interest	4.30[b]±1.28*	4.80[b]±1.59*
Confidence in understanding[d]		
How GE salmon are made	3.63±1.34	3.92±1.42
How they will be regulated	3.33±1.21	3.61±1.50
Effect on the environment	3.94±1.49	4.27±1.54
Effect on consumer choice	3.77±1.47*	4.29±1.39*
Effect on consumer health	2.87±1.43**	3.48±1.81**

Notes: Different superscripts indicate significant differences in pre vs. post values for each information sheet. Effect of information on approval, knowledge, and interest was compared when controlling for salmon consumption and respective pre-values. Effect on confidence was compared controlling for salmon consumption only. Significant differences between information formats is indicated as *p<0.05, ** p<0.01.

[a]7-point scale where -3 = strongly disapprove, 0 = neutral, and 3 = strongly approve

[b]7-point scale where 1 = nothing at all and 7 = a great deal

[c]7-point scale where 1 = not interested at all and 7 = extremely interested

[d]7-point scale where 1 = not at all confident and 7 = extremely confident

included a greater number who initially strongly disapproved of GE salmon than in the perspectives group (14 vs. 3, respectively). Despite these negative initial attitudes, exposure to the consequences information shifted their approval ratings the same degree of magnitude upward (toward approval) as those reading perspectives information. We interpret this finding to mean that neither consequences nor perspectives information changed approval ratings to any meaningful degree.

Participants indicated their degree of confidence in understanding some of the questions about introducing GE salmon into the food system (Table 2). Both groups indicated they were somewhat to moderately confident in understanding how GE salmon was made and will be regulated and they were moderately confident in understanding the effects on the environment. However, those reading consequences information were more confident than those reading perspectives information about understanding the effects on consumer health and consumer choice.

Finally participants rated the necessity of the components in both sections of the information sheet they read. Regardless of format read, participants felt that four of the five topics covered in the invariant background section were rather necessary (5 on a scale of 7). Selective breeding was considered moderately necessary (4 on a scale of 7). However, those reading consequences information rated background information on fish farming as more necessary than those reading perspectives information. Turning to the second section, both groups rated the various summaries presented in either the perspectives or consequences section as at least rather necessary (5 on a scale of 7) except for one section. Those reading perspectives information felt viewpoints of Canadian and British scientists were only moderately necessary (4 on a scale of 7).

Implications

If professionals want to encourage formation of informed opinions on an issue through the presentation of balanced information, the use of a consequences format would appear to help do this. Our experiment indicated that participants reading consequences information reported more interest in learning about GE salmon, as well as a higher self-assessment of their ability to verbally explain the development and use of GE salmon in the food system compared to those reading perspectives information. Participants viewed both formats as non-biased and factual, characteristics important for communicator credibility. However, each information sheet presented conflicting viewpoints or outcomes. Perhaps as a result, neither format led to changes in approval of GE salmon use in the food system that had much real life significance. Perhaps of most importance, participants reading the consequences information reported greater confidence in understanding some of the questions surrounding the entry of GE salmon into the food system.

One drawback to our information was the reading level. It was difficult to lower the level because a

breadth of topics was covered, from science to regulation. Plus, further simplification could easily result in bias. Although not intentional, our volunteer sample was well educated, which enabled them to understand the information. Perhaps only those who are better educated will form the informed citizenry needed for resolving public policy issues. This may be particularly true for issues that are not locally driven. Finally, our randomization process may not have evenly distributed all differences between the groups.

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J. Lynne Brown (f9a@psu.edu) is an Associate Professor, and Wei Qin is a Ph.D. student, respectively, Department of Food Science, Penn State University, University Park, PA.

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CHOICES
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American Opinions of GM Food: Awareness, Knowledge, and Implications for Education

by William K. Hallman and W. Carl Hebden

Agricultural biotechnology is a controversial science that typically involves removing the genes from one plant or animal and inserting them into the genes of another plant or animal to exploit beneficial characteristics of the donor organism (like pest resistance or increased productivity). Genetically modified crops have been adopted at an extraordinary rate over the past decade, and this proliferation of transgenic science, particularly genetically modified (GM) food, continues to rouse apprehension among many consumers around the globe. Public policy toward GM food tends to reflect consumer sentiment and those countries with strict regulation or bans tend to have constituencies that are against the adoption of such products. Where disputes over commodity trading are concerned, it is difficult to name an issue that has created a deeper international schism.

The United States is a powerhouse of GM productivity. The United States is the largest producer of food biotechnology products, harvesting about two-thirds (63%) of the world's GM crops. Most of the soy, canola, and cotton, and almost half of the corn produced in the United States and Canada consist of GM varieties (Pew, 2003a). Because these crops are the source of some of the most common ingredients used by American food processors (such as corn syrup, soy protein, canola, and cottonseed oil), and because GM varieties are often mixed with ordinary varieties during shipping, processing, and storage, most estimates suggest that between 60% and 70% of processed foods on American shelves contain ingredients derived at least in part from GM crops (GEO-PIE, 2003).

The American public, however, is unaware that we use these products every day. Funded by the United States Department of Agriculture (USDA) under its Initiative for Future Agriculture and Food Systems program, Rutgers University's Food Policy Institute conducted three public opinion surveys (Hallman, Adelaja, Schilling, & Lang, 2002; Hallman, Hebden, Aquino, Cuite, & Lang, 2003; Hallman, Hebden, Cuite, Aquino, & Lang, 2004) that found Americans are generally uninformed about GM food and largely unaware of its presence in the food system and their own diets. This did not prevent them from offering opinions and thoughts about the technology, however, and this article discusses several of these findings. Sampling methodology, sample sizes, and survey instruments for all three surveys can be found at www.foodpolicyinstitute.org.

Knowledge and Awareness

About three-quarters of Americans are indeed aware that methods of modifying genes exist (not necessarily in food). About half of Americans say they have heard or read some or a great deal about GM foods, but the majority of Americans have never had a discussion about it, suggesting that is a topic about which, most people are ill-equipped to converse.

While the American public may possess a rudimentary notion that the technology exists and a vague recollection that it has indeed been used in food, they are largely unaware of the prevalence of GM ingredients in everyday food products. Fewer than half of the respondents in the latest Food Policy Institute (Hallman et al., 2004) study realized that foods containing GM ingredients are available in supermarkets and fewer than one in three believed they had personally consumed GM foods. Though it is technically possible for one to have avoided eating GM foods, this would entail a level of specialized knowledge that the average consumer is unlikely to possess; Americans are eating GM foods in massive quantity without knowing it. There is evidence, however, that awareness has been slowly and steadily increasing since 2001, and despite their lack of awareness, U.S. consumers do seem to have a

vague understanding of how long these products have been available.

Those who were aware that some products in supermarkets contain GM ingredients (fewer than half of the sample) were confused as to which products are actually available. While the majority appropriately recognized the availability of either GM corn or GM soy products and a little more than half correctly acknowledged that both are currently on the market, many respondents incorrectly reported that GM rice or GM chicken are currently available.

Most striking was the widespread belief in the availability of GM tomatoes.

Though tomatoes were the GM food product most often identified by respondents as being available in the marketplace, no GM tomatoes are currently for sale in the United States.

It is quite possible that these respondents were exhibiting an indistinct recollection for the highly visible Flavr Savr tomato that was extensively marketed by Calgene and covered widely by the news media before being removed from the shelves in 1997 due to production and transportation problems (Martineau, 2001). Indeed, when respondents participated in a word association exercise in the 2003 study, tomatoes were often mentioned as one of the first thoughts or images they associated with the terms "genetic engineering" and "genetic modification."

It is clear from these studies that Americans are generally uninformed about the GM foods they consume every day, and most have only a vague understanding of the presence of GM products in the food system. This data paints a picture of a consumer who has heard of genetic modification in some form, understands that it may be used in foods, but has no clue as to how, where, why, or in what products they might find genetically modified material.

In addition, Americans do not appear to possess the tools needed to completely understand and evaluate the technology or its products. To assess consumer knowledge, respondents were asked to evaluate a series of true/false statements designed to gauge their comprehension of the basic scientific concepts underlying the science. These included such statements as "There are bacteria that live on wastewater," and "By eating a genetically modified food a person's genes could also become modified." In the most recent FPI study (Hallman et al., 2004) study, less than 50% of respondents could provide a correct answer to more than half of these questions, and nine out of ten "failed" the quiz (less than 70% correct answers). However, Americans do not overestimate their knowledge. The majority readily admit to knowing little or nothing at all about the science.

Media accounts of GM food do not appear to have had substantial impacts on American consumers. Only about one in five Americans can remember reading or seeing a news story about GM food and less than 1% could recall specific details about a story. When asked directly about seven stories that had been circulated in the media to some extent over the past decade, such as the Starlink corn incident (Kalaitzandonakes, Marks, & Vickner, 2004), none seemed to have caught the attention of many American consumers.

Americans also know little about the laws and regulations dealing with GM food. While most Americans understand which government bodies are responsible for regulating these products (FDA, USDA, EPA), only about a third knew that GM foods are not required to be labeled, and three out of four did not know these products were tested for human and environmental safety.

Opinions

Considering that American consumers know little about the science, laws, prevalence, or events surrounding GM food, it is no surprise that they also have uncrystallized and highly malleable opinions about the technology.

Although over the past three years American opinions toward plant-based GM food products seem split between the roughly half who approve, roughly two in five who disapprove, and the one in ten who have no opinion, the Food Policy Institute's study (Hallman et al., 2003) showed that consumers can easily be persuaded to change their opinions when presented with new information about benefits and risks. For example, many of those who said they are strongly opposed to the technology said they would buy GM food products if it reduced pesticide use (the most common application of the science).

Previous studies (Hossain & Onyango, 2004; Macnaghten, 2004; Pew, 2003b), as well as all three Food Policy Institute studies (Hallman et al., 2002; Hallman et al., 2003; Hebden et al., 2004) showed that Americans are far less approving of the use of genetic modification techniques that involve animals, though it should be noted that animal-based applications are not currently in use other than in an experimental context.

A Need for Education

Both proponents and opponents of the technology believe that there is a

need to educate consumers about GM food, and the good news is that Americans claim to be a receptive audience.

When asked to rate their interest in several hypothetical television shows related to GM food, Americans replied enthusiastically. These included such topics as "who regulates and monitors GM food," "how GM food might affect the environment," "whether GM food will affect world hunger," "the potential benefits of eating GM food on personal and family health," "which foods or brands of food contain GM ingredients," "whether genetic modification affects the cost of food for consumers," and "whether GM food affects the farmers' cost of producing food," among others. All of these topics received high ratings of interest from American consumers, particularly those topics related to human health. Respondents claimed to be most interested in whether there is a potential for GM foods to harm humans and whether anyone has ever fallen ill from eating it.

While American consumers are potentially receptive to passively watching television shows about these topics, most have never actively sought information about these issues. Nine out of ten respondents said they had never looked for information about GM food, suggesting that the remainder of those who said they had heard or read something about it (about one in five) probably did so as a result of their habitual media consumption. When asked where they might go for information, if they desired it, most respondents said they would search the Internet for information, while one in ten respondents said they would go to the library for information.

These results suggest that outreach via the Internet, where the majority of discourse about GM food seems to be contained, has missed the average American consumer. The nature of the Internet is such that one must actively search for information to find it, and American consumers typically have not searched for such information. Successful outreach therefore, must also be targeted at media such as television and newspapers where the information can be regularly digested within the context of consumers' normal media consumption.

In sum, Americans are unaware of the presence of GM foods in their lives and diets and uninformed about the science, regulation, and events surrounding it. Americans have not yet made up their minds about GM food largely because they have not yet thought about the issue. This doesn't mean that Americans lack opinions about the issues, or that they are unwilling to express them. However, as a whole, American opinions about the technology are weakly held, poorly formed, and highly malleable. Americans say they are highly interested in the topic of GM food, but to date it doesn't appear to have been a very high priority for most consumers. Few have actively sought information about it, and few have talked with anyone about the issues. As such, efforts to educate about GM foods are most likely to reach an uninformed and easily influenced audience: the American food consumer.

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William K. Hallman (hallman@aesop.rutgers.edu) is Director and W. Carl Hebden is Research Analyst, Food Policy Institute, Rutgers University, New Brunswick, New Jersey. *Research described here was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, The Food Policy Institute, or Rutgers University.*

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Consumer Responses to GM Foods: Why are Americans so Different?

by W. Carl Hebden, Hyun Kwan Shin, and William K. Hallman

While transgenic science remains a major source of controversy around the globe, genetically modified (GM) food is everywhere in the United States. From the high fructose corn syrup in our colas to the soy protein in our energy bars, almost every processed food contains a small quantity of ingredients derived from GM crops. And while many in the food industry are not keen to label products that contain GM food, they make no attempt to hide or disguise it either. GM food is here, it has been here for a long time, and Americans consume it in large quantity – even if we do not know it.

Where GM food is concerned, the two primary differences between America and most of the world might seem to contradict. On the one hand, we are the chief producers and consumers of GM crops, and on the other hand we seem to know less about its presence in our lives than many of our counterparts living in other nations.

While Americans perform better than European and Asian consumers on quizzes about the genetic concepts behind GM foods (Hallman, Hebden, et al., 2003; Hallman, Jang, Hebden, & Shin, 2005; Huang, Bai, Pray, & Tuan, 2004; Gaskell, Allum, & Stares, 2003), Americans remain relatively unaware of agricultural biotechnology itself (Pew Initiative on Food and Biotechnology, 2005). As is frequently pointed out, less than half of Americans realize that foods containing GM ingredients are sold in supermarkets and less than one in three believe that they have personally consumed GM foods. Those who know GM foods are sold in supermarkets are also confused as to which products are on the shelf. Many seem convinced that they are eating GM tomatoes and GM chicken, neither of which is for sale in the United States (Hallman, Hebden, Cuite, Aquino, & Lang, 2004).

It is also unlikely that many Americans are aware that there is a worldwide controversy surrounding the foods they eat every day. Little more than a third of Americans have heard of European demonstrations against GM foods, and less than a quarter were aware of the recent refusal of African nations to accept US GM food aid. (Hallman, et al., 2004).

Though Americans claim they are interested in various topics related to agricultural biotechnology, GM food has seemingly slipped from the pages of science fiction and onto our plates with little fanfare or controversy, and it remains there, largely unrecognized and unnoticed by those who consume it. Only about one in five Americans say they have discussed the topic more than once or twice with anyone (Hallman et al., 2004), a figure comparable to that of the United Kingdom, Greece, Portugal, Spain, and Belgium, though considerably less than Europe as a whole (where GM foods are conspicuously absent) and substantially less than such countries as Germany and Denmark where reported discussion is at its highest (Gaskell, Allum, & Stares, 2003).

Opinions about the application of biotechnology vary around the world, but the strongest opposition to the technology is concentrated within Europe and many Asian countries. The majority of Europeans believe GM foods are risky, not useful, and not to be encouraged (Gaskell, Allum, & Stares, 2003). Other research shows that European consumers are far less willing even to consume beef from cattle fed on GM corn (Lusk, Roosen, & Fox, 2002).

It has been suggested that European rejection of GM foods is related to fear of the unknown and avoidance of risk (Laros & Steenkamp, 2004), though Poortinga and Pidgeon (2005) have also suggested that European rejection of GM foods may be less due to risk perception and fear than the absence of tangible benefits. Indeed, Arvanitoyannis and Krystallis (2005) have found that while Greek consumer attitudes are overwhelmingly negative toward GM foods, this is not necessarily the final word on the matter, and that there are some market segments that

may be receptive to the potential benefits of GM foods. Korean consumers, who have proven to be strongly fearful of GM products, do show signs of bending under the promise of benefits (Hallman et al., 2005).

Consumer opinion is a powerful driver in governmental policy toward GM food around the globe. The response to GM foods (by both consumers and regulators) is very important for the US export market, which has lost millions of dollars due to European resistance (Pew Initiative on Food and Biotechnology, 2003). The manifestation of E.U. opposition began with an outright ban on the importation of these products and remains, opponents suggest, as a stifling labeling policy today. These policy decisions, it has been argued, may have also had a negative economic impact on the European Union (van Meijl & van Tongeren, 2004).

Similarly, U.S. agricultural exports to countries like South Korea have plummeted from several million tons of corn exported several years ago to virtually nothing today (Korean Ministry of Agriculture and Forestry, 2004) due to recently instituted GM labeling policies strongly influenced by consumer sentiment.

In addition to the European Union restrictions, countries including Australia, New Zealand, South Korea, China, Japan and others have introduced mandatory labeling policies that complicate trade with the United States which currently has no mechanisms in place to track genetically modified components from farm to fork. While it would be relatively easy to identify a shipment of grain, for instance, that is entirely composed of modified organisms, this becomes much more difficult when dealing with products that have been mixed during shipment, are so finely processed as to remove all traces of modified DNA, or processed food products that may have been "contaminated" as a result of one of the aforementioned scenarios. The stark difference in policy between the United States and its trading partners has caused a muddled trade situation that may only become more confusing with the increasing production of GM foods and shifting international policies (Phillips, 2003).

Explanation of Differences

Some literature suggests that cultural determinants play an important role in the consumer's approval of a specific technology, and that beliefs about its benefits and risks are rooted in more general knowledge and attitudes toward nature and technology and are therefore difficult to change (Bredahl, 2001). More specifically, Siegrist (1999) found that an individual's assessment of gene technology is affected by both their world view and by their perceptions of benefit and risk of the technology. Because these views are also culturally constrained, it is possible that international differences in opinion toward GM food are embedded in these cultural attitudes.

Another important influence may be related to the scale and structure of agriculture in the United States and Europe. Agriculture in the United States typically occurs on farms that are set apart both physically and psychologically from the urban centers where most of the population lives and also from the 'natural' parks and other recreational areas where those urban dwellers go 'to get away.' In the United States, farms are private property, often posted against trespass. In contrast, in many parts of Europe, farms are much smaller and situated closer to population centers and often adjacent to or in the midst of 'natural' areas. While still considered private property, many countries have laws that permit hikers to cross agricultural lands so long as they do no harm. This structural difference may help to explain why many in Europe see what happens on farms as occurring 'in nature' and why many in America see farming as quite separate from nature.

Another important factor may be the sources in which consumers place their trust. European public opinion polls suggest that Europeans, particularly those in the Northern regions of Europe, tend to trust consumer and environmental groups while investing relatively little trust in "established" institutions such as academia and government (Zechendorf, 1998). This is important because consumer and environmentally oriented action groups tend to frame agricultural biotechnology in a highly negative light. In contrast, Americans tend to trust scientific and academic sources of information while tending to have very little trust in consumer and environmental groups (Lang, & Hallman, 2005).

These cultural attitudes toward trust can play an important role in consumers' evaluation of risk. Research suggests, for instance, that while American consumers say they would like GM foods to be labeled, they remain confident in the current policy of the FDA that does not require such labeling (Loureiro & Hine, 2004). This is consistent with the historically high level of trust American consumers have had for regulatory agencies like the USDA and FDA. Moreover, Harrison, Boccaletti, & House (2004) found that trust in regulators plays an important

role in willingness to purchase GM food.

Finally, most consumers receive information about complex scientific concepts like agricultural biotechnology through the media (Hoban & Kendall, 1993). While *how* the information about such issues is presented can be important, the mere presence or absence of an issue within the media plays a large part in public awareness and participation in that topic (McCombs & Shaw, 1972). Perhaps American consumers seem apathetic toward GM foods simply because they have not been exposed to a great deal of information about it.

The American press has not covered this topic extensively with the exception of a few "spikes" in coverage revolving around specific events (McInerney, Bird, & Nucci, 2004). The European press, however, has covered the biotechnology issues rather extensively, and this has had an effect on public awareness, opinion and policy (Durant, Bauer & Gaskell, 1998), driving European consumers to be both cognizant of the technology and wary of it. Similarly, in South Korea, where consumers know less about the science behind GM foods than Americans, awareness of the technology's existence and the issues surrounding it are superior to that of the United States, quite possibly due to greater attention by the Korean media (Hallman, Jang, Hebden, & Shin, 2005).

Conclusion

Consumer opinion can be a powerful driver for public policy. Negative attitudes toward GM foods in Europe and Asia have caused a contentious and confusing trade situation and the loss of valuable export markets. Differences in culture, perceptions of nature and agriculture, trust and media treatment, and the interaction between these all seem to play influential roles in consumer opinion around the world. As such, international differences in public opinion about GM foods represent a clash of cultures, politics, and policies. As the gaps between these become narrowed with increasing internationalization of trade, communications, and culture, it is unclear how much longer Americans will be oblivious to the abundance of GM crops grown in fields across the Nation or to the appearance of GM foods on their plates.

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W. Carl Hebden is Research Analyst, Hyun Kwan Shin is Visiting Scholar, and William K. Hallman is Director, respectively, Food Policy Institute, Rutgers, the State University of New Jersey, New Brunswick, New Jersey. *The research described here was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, the Food Policy Institute, or Rutgers University.*

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What the Print Media Tell Us About Agricultural Biotechnology: Will We Remember?

by Joan Thomson and Laura Dininni

In contrast to our European counterparts, Americans have not demonstrated strong opinions about agricultural biotechnology. Nor has American awareness of agricultural biotechnology changed substantially over time (IFIC, 2001). Both the public's lack of familiarity with agricultural biotechnology and their limited perception of its relevance in daily living influence their perspectives toward the technology. This overall lack of public understanding creates an environment in which whatever information people are told is more likely to become what they believe.

Media agenda-setting theory posits that what is reported in the media sets the agenda for what public issues individuals consider to be important (McCombs & Shaw, 1972). Empirical evidence has shown that agenda-setting effects of media are minimal for obtrusive issues, issues with which individuals have direct experience. However, agenda-setting effects of the media are strong for unobtrusive, indirectly experienced issues because the public has a need for orientation to those issues, particularly when an issue is perceived as personally relevant to the reader. For most Americans, genetic modification through agricultural biotechnology is an unfamiliar and abstract concept, lacking any real context. In agenda-setting theory terms, it is an unobtrusive issue.

Studies of "second level" agenda-setting, or "attribute" agenda-setting, have shown that media presentations affect public perceptions not only regarding what issues are important, but also what aspects of those issues are important. Both what and how the media report on a topic is reflected in public understanding and opinion about that issue.

Space in the "daily news hole" is often event driven; that is, reporters will cover what is news today, increasing awareness of, in contrast to educating or informing the public on, an issue. Becoming aware of an issue is necessary, yet not sufficient, to become informed or take action on the topic. To do so also requires that an issue becomes salient. Media effects research shows that for an issue to become salient it must be covered with high frequency over a period of time. Coverage of peak events, that is, greater coverage of a topic over a period of time, increases the likelihood that the critical event that is covered will capture the public's attention, providing an opportunity for the issue to become salient for Americans. Thus, critical events which garner peak coverage can put the topic on the public's "radar screen."

Furthermore, peak events may provide an opportunity for information from a diversity of sources to reach decision-makers and the public (Abbott & Lucht, 2000). Controversy carries news value and often creates a media hoopla, or a peak in coverage, where journalists cover a topic with vigor. When an issue is seen as more controversial, journalists, guided by the norm of objectivity, may attempt to present opposing viewpoints. Because most newspaper stories are based on information provided by sources (Gandy, 1982; Soloski, 1989), print media sources for information on agricultural biotechnology have the potential to strongly influence what the public reads about this technology. Therefore, it is essential that those sources effectively frame information for the public's understanding so that information is what will be remembered.

Based on our knowledge of how media can influence public opinion, plus the American public's limited knowledge regarding biotechnology and GM foods, mass media coverage of agricultural biotechnology has the potential to strongly influence public opinion, particularly through

Table 1. Frequency of Agricultural Biotechnology Articles in 2001 and 2002 in *The New York Times*, *Washington Post,* and *Wall Street Journal*.

YEAR	N	NYT	POST	WSJ
2001	210	109	64	37
2002	173	59	56	58

critical event peak coverage. Therefore, we investigated what the media reports in overall and in peak coverage. Our analysis of news copy shows not only what topics garner coverage and who provides the relevant information, but also the extent to which a topic is covered and how.

The newspapers selected for our study, the *New York Times*, the *Washington Post* and the *Wall Street Journal,* have a combined national readership over 3.6 million (Editor & Publisher, 2000). Media studies have asserted that articles in the national newspapers tend to spread vertically through the news hierarchy, setting the national news agenda (Gitlin, 1980). These national papers, touted as "breakfast reading for congress," the "unofficial newspaper of record" (Ulrich, 2002), and "the publication of choice for capitalism's brightest stars" respectively, command attention. In fact, according to Herman and McChesney (1997:138), three national newspapers in the United States, the *New York Times*, the *Wall Street Journal*, and *USA Today*, along with the news agencies, "set the agenda for the rest of the press and for broadcasters as well." Because of this, the potential exists for articles carried in these nationals to travel not only through the news hierarchy to other newspapers published by the national firms, reaching a readership close to 12 million (Editor & Publisher, 2000), but also to other news outlets across the U.S. If so, coverage of agricultural biotechnology by local or regional papers is likely to follow the same pattern as that of the nationals.

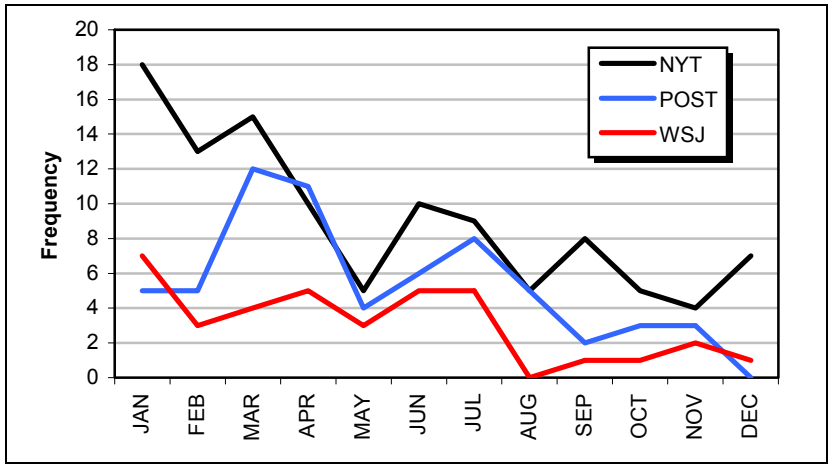

Figure 1. Agricultural biotechnology articles published monthly during 2001 in three national U.S. newspapers.

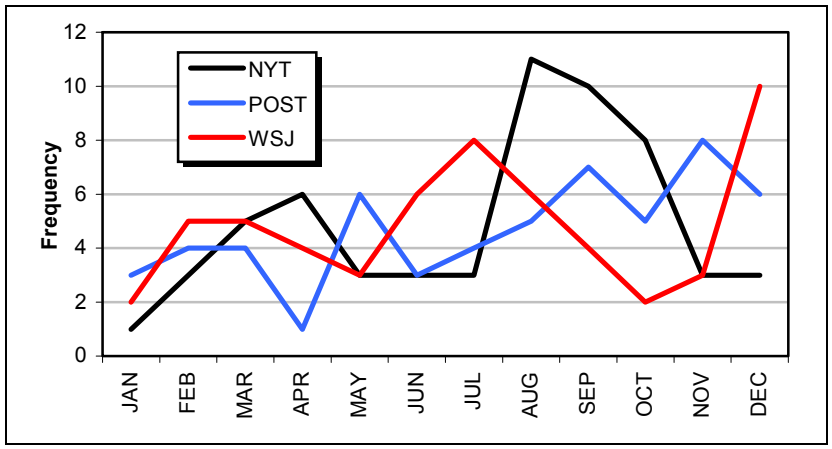

Figure 2. Agricultural biotechnology articles published monthly during 2002 in three national U.S. newspapers.

Our analysis of U.S. print media coverage of agricultural biotechnology in 2001 and 2002 indicates that national coverage of agricultural biotechnology is quite limited. A comprehensive key word search of articles published during these two years in the *New York Times*, *Washington Post*, and *Wall Street Journal* found just 210 articles were published in 2001 and 173 in 2002, see Table 1.

Peaks in Coverage

Across two years these three national papers published only 383 articles, or an average of 16 a month. This coverage was a mix of baseline and peak coverage. Such a peak is evident in early 2001 (see Figure 1). In 2002 (see Figure 2), elevated coverage is extended through several months. In both years, peak coverage is most clearly illustrated through the *New York Times*, also reflecting *The Times* more frequent coverage of agricultural biotechnology overall.

In 2001 and 2002, agricultural biotechnology coverage was most often found on page one of the section in which it appeared. Peak events were most often reported as breaking news, printed in the front section, and more often than not, on the first page. Further statistical anal-

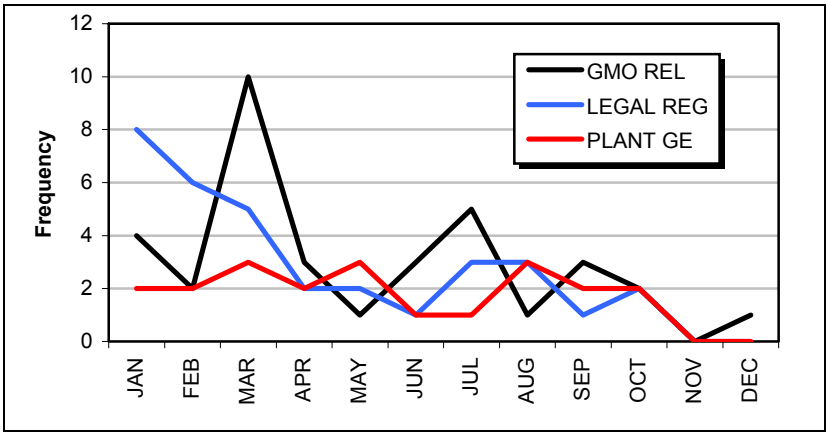

Figure 3. Coverage of three most frequent themes in agricultural biotechnology articles during 2001 in three national U.S. newspapers.

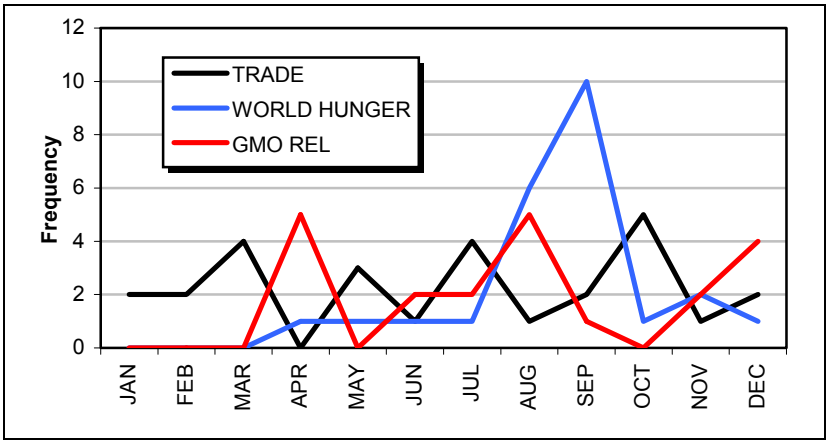

Figure 4. Coverage of three most frequent themes in agricultural biotechnology articles during 2002 in three national U.S. newspapers.

ysis revealed peaks in coverage for two of the most frequently reported themes, GMO release in 2001 and world hunger in 2002.

In 2001, GMO release, identified in 35 articles, was one of the three most frequent themes covered. Figure 3 shows a peak in coverage with 10 articles in March. Legal regulation and general articles about plant genetic engineering were the other two most frequent themes in 2001 with 33 and 21 articles, respectively. However, neither are representative of peak coverage, for this coverage occurred throughout the year.

In 2002, coverage discussing agricultural biotechnology's role in world hunger, the second most frequent theme for the year (N=24), peaked with six articles in August and ten in September (see Figure 4). Coverage of agricultural biotechnology in which trade was the primary theme, in 27 articles, occurred throughout the year. GMO release was again one of the three most frequent themes, appearing in 21 articles. However, in 2002 this theme showed no peak in coverage.

As the issue changes, what is pertinent to one topic may not be so for another. To further understand what is reported, we looked at sources cited in such coverage and how the risks and benefits of the issue are reported; that is, the tone.

Sources in Articles

Sources are not consistently used. Across all agricultural biotechnology articles in 2001, almost one-third cited none (61, 29% in 2001; 63, 36% in 2002). In 2001, U.S. government sources were most frequently cited in both overall coverage (39 articles, 19%) and within peak coverage of GMO release (10 articles, 29%). The next most frequently cited sources in overall coverage were industry affiliated (19 of 210, 9%). However, industry sources were cited in only 6% of peak GMO release articles. Activist groups were cited third most frequently in overall coverage, in 15 of 210 (7%) articles, whereas activist groups were cited second most frequently, 9% of the time, in GMO release articles.

Among the articles citing a source in 2002 (110 of 173, 64%), the most frequently cited sources were industry affiliated (21 of 173, 12%), comprising almost one-fifth (21 of 110, 19%) of all agricultural biotechnology sources of information. The next most frequently cited sources were U.S. government affiliated (16 of 173, 9%), followed by university-affiliated sources (12 of 173, 7%). Activists (all types) were cited 11 (6%) times. Farmers were only cited four (2%) times.

However, in the 2002 peak coverage of world hunger, U.N. affiliated and developing nation government sources were most frequently cited. This pattern is not consistent with the most frequently cited sources in overall coverage for 2002; the pattern changed. In the case of the world hunger peak, the topic being discussed allowed for a diversity of sources, thus far silent. It appears that sources cited reflect their relevance to the topic. A greater diversity of topic coverage provided public access to a

greater diversity of sources of information.

The use of acknowledged sources in agricultural biotechnology reporting is surprisingly limited. With few exceptions, U.S. government and industry are more often referenced than are other sources. However, as the world hunger theme illustrates, a controversial critical event garnering peak coverage may provide an opportunity to hear from a greater diversity of information sources.

Tone of Articles

Most often in both 2001 and 2002, articles emphasized neither the risks nor benefits of agricultural biotechnology (36% in 2001; 36% in 2002). Less often, both the risks and benefits were covered (29% in 2001; 20% in 2002). However, in peak GMO release coverage in 2001 risks were most often emphasized. In fact, in GMO release peak coverage in 2001 and in GMO release baseline coverage in 2002, risks were highlighted, 56% and 71%, respectively. Therefore, tone appears to reflect the topic, not type, of coverage.

As in 2001, articles published in 2002 most frequently mentioned neither risks nor benefits of the technology (36%). However, in peak coverage of world hunger, both risks and benefits were mentioned most often (45% of articles). Peak thematic coverage differs in tone from overall coverage. As the world hunger theme illustrates, a controversial critical event garnering peak coverage may also provide an opportunity to discuss the risks and benefits of this technology.

Given that overall coverage of agricultural biotechnology emphasized neither risks nor benefits, the public is provided little information with which to understand what, for many, is a critical question: Is agricultural biotechnology beneficial or not to the environment, our quality of life, and our economic welfare? Raising and discussing the risk/benefit question for the public is likely to encourage greater cognitive elaboration, or thinking, about agricultural biotechnology, particularly when the public is provided with the motivation to do so, for instance, through peak coverage of a "critical" event.

Crafting Effective Messages, Media Coverage to Remember

Our research indicates that how topics are covered varies across the issue, as well as within the issue. Even though print media coverage of agricultural biotechnology is limited—both in the extent of such coverage as well as what issues are covered and how—such information is essential to engage broader citizen awareness on a topic.

In a national survey by Hallman et al. (2004), respondents were asked if they recalled several agricultural biotechnology news stories. Almost one-quarter (24%) indicated that they remembered the world hunger peak event, the African refusal of GM grain food aid, even though this peak only occurred over two months in 2002. In contrast, only 7% remembered any Bt pollen/Monarch stories, categorized as a GMO release, that surfaced through a much longer peak in coverage, from June to December in 1999. Given the large media hoopla generated by this story, one might expect a much higher story recall. World hunger, a theme that emerged in 2002, is representative of peak coverage and is remembered. Although the Monarch peak occurred three years prior to the world hunger critical event, time may not be the only explanation for this difference in story recall.

Framing can provide a way to link the unfamiliar with the familiar, not only addressing one of the dimensions by which individuals assess risk, but also enhancing recall of a topic. The more often a schema and its connections are activated, the more those memories are reinforced, and the more likely they are to be retrieved. Much of the public of the developed world shares an inaccurate image of developing countries. Cate (1994) states that Adamson, founder and author of UNICEF's annual *State of the World's Children* report, argues that the public has "an impression that the developing world is a theater of tragedy in which poverty and human misery figure prominently in almost every scene." In addition, media often portray the West as a Samaritan figure providing aid in a time of need to countries in Africa. Accounts of suffering and relief fall, almost without exception, into "a pre-set narrative" that portrays helpless victims and "heroic saviors." When agricultural biotechnology is linked to this narrative it is not only more likely to be remembered, but it is also more likely to be perceived as less risky because it is paired with a more familiar concept, feeding the world's hungry.

As we know, consumers often voice concerns about agricultural biotechnology, viewing it as a risky technology. Risk assessment can also be influenced by framing a decision in terms of losses and gains (Tversky & Kahneman, 1986). Framing a decision in terms of loss makes the loss more salient to the decision maker. If a risk is framed in terms of loss, then the risk is seen as an opportunity to avoid loss and an individual will take more risk to avoid loss than

to chance a gain (Highhouse & Yuce, 1996).

In fact, when discussing the differences in consumer perceptions between medical and agricultural biotechnology, Wansink and Kim (2001) assert that medical biotechnology is often framed as avoiding a loss and agricultural biotechnology is framed as an improvement on a product that is already perceived to be sufficient by American consumers, a gain. When acceptance of agricultural biotechnology is framed as avoiding massive loss of human lives, as in the case for world hunger, we see that perceived risks of the technology are likely to be accepted to avoid a loss (of human life). The decision to accept a risk is simplified when it prevents such tragic loss. Acceptance of agricultural biotechnology is now linked with alleviation of starvation in the "Third World." What Americans have not sat guiltily munching down snacks as that nagging "Save the Children" imagery pops up on their television screens? The decision to accept a technology that is purported to avert the loss of human lives is easy. The Bt pollen/Monarch stories framed acceptance of agricultural biotechnology as potentially causing loss, ecological loss. However, unlike ecological concepts involving Monarch butterflies, images of starving children provide a link with an established schema, cultivated through media and culture. Although we may lament the loss of a species of butterfly, for most of us, it has little meaning to us directly, unlike the loss of human life.

Emotional imagery such as starving children portrays agricultural biotechnology as a beneficial solution to world hunger. Effective framing uses imagery to package the message in a form that is easily understood, minimizing issue complexity. Cues drawing on emotional imagery (Wansink & Kim, 2001) ease the cognitive burden of processing information, reducing the complex social implications of agricultural biotechnology to a scientific breakthrough to alleviate misery and reducing ambiguity through compelling emotional cues. Furthermore, emotion increases arousal, enhancing the chances of effective storage in memory.

When the media is essentially the sole provider of information on a topic, the public is apt to understand the issue in the same manner as the media portrayed it. Because of the complexity of agricultural biotechnology and its perceived lack of relevance for Americans, using cues such as emotional imagery can be more effective than scientific information in increasing the public's awareness of and comfort with agricultural biotechnology. Little direct experience with agricultural biotechnology leaves the public in the position of gaining understanding of this complex technology and the social and economic implications of its use through the media's coverage. Peak coverage can increase awareness of an issue, helping the public to remember, particularly when that coverage is framed as an event to remember.

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Dr. Joan Thomson (jthomson@psu.edu) is Professor of Agricultural Communications and Laura Dininni is a M.S. candidate, Department of Agricultural and Extension Education, The Pennsylvania State University, University Park, Pennsylvania. *This research was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS) grant #2002-52100-11203 'Evaluating Consumer Acceptance of Food Biotechnology in the United States,' Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, The Food Policy Institute, Rutgers University, or Penn State University.*

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Ag-Biotech: It's Not Just What's for Dinner Anymore, but the Future Contents of our Medicine Cabinets

by Jennifer Medlock and Edna Einsiedel

Forget about farm-to-fork when it comes to genetically modified (GM) crops. Think farm-to-pharmacy, or farm-to-factory. Produced through plant molecular farming (PMF), this new set of transgenic crops is being grown not for food, but to produce medicines and industrial products. For example, potatoes have been modified to produce a vaccine against the Norwalk virus, research that is currently in human clinical trials to determine efficacy (Tacket et al., 2000). On the industrial side, corn plants have been modified to produce trypsin, an enzyme used in the manufacturing process of insulin and vaccines, an application already on the market in the United States under the name TrypZean^{tm} (www.prodigene.com).

GM food production and PMF differ in one very significant way. In GM food, the product is the plant (to be consumed by humans or animals). In PMF, the product is the medical or industrial compound (the plant is not destined for the food chain). For GM food, the idea is to make crops easier to grow, for example through insect or herbicide resistance, or to enhance a crop's nutritional value, as in vitamin A enriched "Golden Rice." In PMF, the crop is used as a production vehicle or factory (Ma, Drake, & Christou, 2003). It is the ultimate product, the medical or industrial compound that is of interest, not the plant itself, which is considered a waste product after the compound is removed. PMF products can be grown in both food crops and nonfood crops (corn and tobacco are the most common platforms).

By uniting agricultural biotechnologies with medicinal and industrial processes, PMF has already aroused controversy. Those with a stake in this technology include conventional farmers, PMF companies, food processors and exporters, academic scientists, patient groups, policymakers, as well as members of the general public. And just as the number of stakeholders is large, so is the disparity in opinion. Prodigene, an early industry player in PMF, has this outlook for the technology on its website (www.prodigene.com):

> Imagine a day when taking children in for vaccinations will not involve a single tear being shed. Imagine that, in the place of a shot, the doctor gives your child a small bag of edible treats. This bag of treats will not be any ordinary snack—it will be an edible vaccine grown in corn and then made into an appealing snack.

Meanwhile, from the NGO perspective, a spokesperson from Friends of the Earth forecasts a very different future, saying that with "just one mistake by a biotech company, we'll be eating other people's prescription drugs in our cornflakes" (www.foe.org).

The diversity of stakeholders demonstrates the challenges for policy development around this emerging technology. In Canada, no commercial applications of PMF have yet been approved. Policy is still in the early stages of development, which provides a useful entry point for stakeholder and public assessment of the technology to be incorporated into policy development. Two studies conducted by the Genome Prairie GE^{3}LS (Genomics, Ethics, Environment, Economics, Law, and Society) research team, one on focus group discussions with the general public (Einsiedel & Medlock, 2005) and one on stakeholder interviews (Mistry, Einsiedel, Medlock, & Perraton, 2005), will be discussed in this article (along with their consequent policy implications), but first we will provide context on the regulatory situation in Canada.

While the Canadian government conducts its policy review (involving a number of departments including

Agriculture and Agri-Food Canada, Health Canada, and Industry Canada), the crops involved in PMF are regulated under the authority of the Canadian Food Inspection Agency (CFIA). Plants used for plant molecular farming are labelled as 'plants with novel traits' or PNTs, and broadly PNTs are defined as plants that have had a specific trait added to them through genetic engineering or other methods. PNTs can be developed using conventional breeding or through transgenic techniques. It is the resulting product that defines it as a PNT, and not the process of development.

The following appears on the CFIA's molecular farming web page: "**All PNTs in Canada are subject to the same strict science-based regulations.** However, since PNTs for molecular farming may present greater potential for environmental or human health risks, the Government of Canada may put even more stringent restrictions on the use of these novel plants than for other PNTs" (bold in original) (CFIA, 2005).

In the meantime, the CFIA has indicated that it is currently involved in a broad policy review of plant molecular farming. Until this consultation and analysis are complete, applications for confined research field trials for PNTs intended for plant molecular farming will be addressed on a **case-by-case** basis. The amendment lists a number of "interim recommendations" for PMF developers, the major one suggesting that use of major food or feed crop species for PMF is **not** recommended. Other recommendations include choosing host species that are "as amenable to confinement as possible" and encouragement to consider fibre crops, small-acreage specialty food or feed crops, or new crops as production platforms.

As policy development moves beyond the bounds of the CFIA's science-based safety assessments, assessments by stakeholder groups and the public are integral to developing socially sustainable policy.

Public Views

Focus groups were conducted in four cities across Canada (Toronto, Halifax, Vancouver and Montreal) (see Einsiedel & Medlock, 2005). Because of the unfamiliarity of PMF, participants received a 10-page briefing document in advance of the session that outlined the technology, its potential applications, and how it might be treated by the Canadian regulatory system. They were asked to read the document and bring with them three key questions and/or concerns with regards to the development of the technology.

Not surprisingly, awareness of PMF before being contacted for the study was very low, with only two of the 48 participants ever having heard of the technology, but none knowing of any specific applications. In contrast, participants revealed a high level of awareness of GM food and evaluated PMF within that reference, calling PMF a "cousin" of GM food.

Focus group participants discussed their concerns around four main themes: potential contamination of food crops; safety issues; appropriate regulation; and, long-term impacts.

The potential contamination of food crops was the most dominant issue raised. The main concern was that the 'modified' product would get into the food chain through direct cross-pollination, animals, or wind. As well, concern was raised that humans might contaminate food crops either by mistake (accidentally moving plant material from a greenhouse to a field) or by malicious intent (for example, through bioterrorism).

On the issues of safety and regulation, while participants were willing to accept a certain level of uncertainty with PMF, they were also concerned about the abilities of regulators to adequately manage the technology because resources to do so were seen to be inadequate. Concern was also expressed about the adequacy of standards to monitor longer-term impacts.

Concern over long-term side effects for human health and the environment was raised by those respondents with the highest level of trepidation about PMF. They wondered about whether enough time had been or would be allowed to effectively study these effects. Concern about proper balancing of commercial versus public interests was also expressed.

Ultimately, acceptance or rejection of PMF was dependent on the perceived "purpose" of the application. Whether a particular application had a "useful" or worthwhile purpose had a substantial influence on participants' perceptions. This purpose dimension was explored in more detail in the next stage of the session, where reactions to five specific applications of PMF (that are currently in or close to commercial production) were elicited from participants. The different applications were chosen strategically to incorporate different streams of PMF work; for example, are reactions different for products made in food crops versus nonfood crops? Or for industrial compounds versus medical compounds? After discussing the applications, participants rated each of them on a four-point "acceptability spec-

trum" (Fully Acceptable, More Acceptable, Less Acceptable, and Unacceptable). The five applications that were used in the discussion are:

1. ***Trypsin in corn:*** Trypsin, a protein derived from corn, is used in a variety of commercial applications including the processing of some biopharmaceuticals;
2. ***Interleukin in tobacco:*** Interleukin, a potential treatment for Crohn's disease, has been tested in field trials in Canada using tobacco as a platform;
3. ***Norwalk virus vaccine in potatoes:*** Norwalk virus capsid protein (NVCP), used as a test antigen, was able to trigger immune responses in healthy volunteers who ingested transgenic potatoes;
4. ***Gastric lipase in corn:*** Gastric lipase, used to treat cystic fibrosis, has been produced using corn as a production vehicle and is currently advancing through clinical trials; and
5. ***Bioplastics in corn:*** Still in the experimental stage, biodegradable molecules are derived from corn to produce bioplastics.

When judging the various applications, people assigned a higher level of acceptability if the purpose was seen to provide a significant benefit to human health (Norwalk virus vaccine in potatoes and gastric lipase in corn applications). If the purpose was seen to provide economic benefits, but not significant new benefits to human health (i.e., a new way of producing an existing treatment as in the Interleukin example), then the application was rated less highly. Finally, if the benefits were perceived to be entirely economic (i.e., lower cost industrial products), the value assigned was even lower.

In general, while medical applications were consistently preferred over industrial applications, members of the public appear to judge PMF on a case-by-case basis, assigning different levels of acceptability depending on context of the application. Distinctions were made also between producing compounds in food crops and nonfood crops, with food crops assigned a lower level of acceptability overall, though a significant level of risk was perceived in all applications.

PMF Stakeholder Views

To complement the public focus group work, the GE^{3}LS team conducted a set of surveys with other groups with an interest in PMF (farmers, academic and government scientists, and representatives from the food industry, PMF industry, patient groups and social/environmental groups) (see Mistry et al., 2005). The specific objectives of this work were: 1) To obtain a general assessment of plant molecular farming in terms of risk, benefits, and challenges; 2) To examine perceived risk, benefit, and acceptability of four PMF applications currently in development; and 3) To elicit views on how PMF should be regulated.

An interim report has been completed on this work. The applications tested were similar to those in the public focus groups (Interleukin in tomato, bioplastics in plants, trypsin in corn, and vaccine in tomato). An interim report has been completed on this work. In the study, there was conditional acceptance of PMF across all sectors, except for the social and environment groups who did not support going ahead with any applications.

A major caveat for support of PMF was the lack of a regulatory framework. This gap was mentioned by all sectors, but for different reasons. From the industry perspective, not having a regulatory framework was seen as a threat to investment in a burgeoning field. For social and environmental groups, if PMF were to proceed, a strong regulatory framework needed to be in place to control it. However, like members of the public, this group had doubts about the capacity of the government to adequately monitor the industry.

Also echoing the public groups, both food and nonfood crops were considered acceptable for PMF development (again across all sectors except for the social/environmental groups who did not support any applications), but there was a strong preference for nonfood crops as there was a sense of inevitability that contamination would occur at some point in the future (all sectors raised the risk of contamination to the food supply). A representative from the PMF industry preferred nonfood crops due to a perceptions issue, saying that "if it happens once, the industry is dead."

Another finding common across all sectors was support for regulation on a case-by-case basis. There is a recognition that the vast variety of protein products that can be produced from PMF should not be dealt with using blanket regulation. How an application should be regulated was dependent on a combination of the product (toxicity/stability, location of accumulation), production platform (i.e., food/non-food) and scale (how many acres?). Preferences for containment/confinement strategies were also application-specific, but generally followed a 'better safe-than-sorry' attitude where more containment is better.

Where the stakeholder groups diverged from the public sample was in the comparison between medical and industrial applications. The opinions of stakeholder interviewees were more nuanced, and there was cautious support of both as respon-

dents could see benefits and concerns raised in both cases. For example, concern was raised in the medical arena regarding whether there would be pharmacologically active drugs in the plants or whether they would be benign until purified and then combined with other elements. In the industrial arena, concerns were voiced about the potentially large acreages to be used to be profitable.

The issue of public involvement and public awareness was raised many times in the stakeholder interviews. Those in the PMF industry fear the "drugs in my cornflakes" view will take hold. An agriculture industry representative suggested that "the biggest risk (of PMF) is public perception of risk." Overall, there was general belief that public views on this technology will ultimately determine its future.

However, how to respond to the public perception issue differed among sectors, and fell into general spheres of thinking. Those in academia and the PMF and food industries felt that the public just needs objective information — educate them and they will understand and they will accept. Those in the government, social/environmental, and agricultural industry sector felt that yes, members of the public should receive information, but should also be engaged in discussion and their voices need to be heard in shaping policy.

Lessons from These Early Conversations

The importance of early understanding of public and stakeholder views is evident. This has been a major lesson from the experiences of the GM food debates. Public concerns revolve not just over why products are being made from a technology, but how they are produced and introduced into the marketplace. This involves the accompanying regulatory framework that can encourage confidence in their introduction and use.

Members of the public and stakeholders are clearly making trade-offs in their initial assessments. For members of the public, these include considerations of long-term impacts, not just to human health, but also to the environment. Expectations that regulatory systems similarly weigh different considerations, from economic and commercial gain to public interest considerations, are also evident. Members of the public, stakeholders, and regulators clearly have much to learn from each other.

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Jennifer Medlock (jemedloc@ucalgary.ca) is a PhD student and Edna Einsiedel is Professor, respectively, Faculty of Communication and Culture, University of Calgary, Alberta, Canada.

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I Will Not Eat It with a Fox; I Will Not Eat It in a Box: What Determines Acceptance of GM Food for American Consumers?

by Venkata Puduri, Ramu Govindasamy, John T. Lang, and Benjamin Onyango

Food biotechnology, also known as the genetic modification of plants and animals, is a scientific revolution with a potentially enormous impact on public life. Such technological advances rarely occur without public debate and these advances are no exception. Proponents view biotechnology in terms of its potential to improve food quality, enhance natural disease resistance, and reduce the use of chemical pesticides. Opponents cite ethical and moral concerns, as well as uncertain long-term impacts to the health of people and the environment.

Many in the food industry and government sector believe that public acceptance of biotechnology is critical for its future development. As a first step, therefore, increased consumer awareness through public education is desirable. Beyond educational efforts, however, it is important for industry and scholars to better understand which factors might influence consumer acceptance of biotechnology. Previous studies of American consumers suggest that acceptance is driven by knowledge and awareness of biotechnology and confidence and trust in the food system (Onyango & Nayga, 2004). Yet, it is not clear if there are any specific consumer benefits that Americans would readily accept.

Many American consumers support advances in biotechnology that result in food with beneficial traits. For example, American consumers would be interested in trying new varieties of fruits and vegetables that taste better or reduce the use of pesticides (Hoban, 1997; Hallman et al., 2002). Additionally, Americans generally support medical and crop biotechnology (Hoban, 1997; Hallman et al., 2002). However, Americans tend to support the use of biotechnology in plants more than in animals (Hallman et al., 2002, 2003, 2004). Furthermore, people with low trust in regulatory agencies have the highest concern about possible risks regarding food biotechnology (Frewer, Shepherd, & Sparks,, 1994). Researchers, policy makers, and food producers would be wise to heed consumers' preferences for particular traits, plant-based GM, and the concerns regarding regulatory support when implementing plant and animal genetic modifications.

Data and Modeling

In 2004, The Food Policy Institute at Rutgers University fielded a nationally representative telephone survey of 1,200 noninstitutionalized adult Americans, yielding a ±4 percent sampling error rate. This survey data is the basis for our examination of the factors influencing respondents' approval of plant and animal genetic modifications. A logistic model framework is used to explore the relationship between socio-economic, demographic, and value attributes and the factors influencing respondents' approval of plant and animal genetic modifications.

Consumer Perceptions about Plant and Animal-Based Genetically Modified (GM) Foods

This analysis examined the influence of demographic variables, value attributes, and socio-economic status on the approval of plant-and animal-based GM. Demographic variables included sex, race/ethnicity, age, and level of education. Value attributes included knowledge about biotechnology, religious service attendance, self-reported political leanings, trust in the government, confidence in scientific institutions, skepticism about biotechnology companies, and confidence in the competence of government regulators. Socio-economic status was measured by self-reported household income. In general, the results indicate higher consumer support for plant-based rather

than animal-based GM foods. Overall, twice as many respondents (55%) approve of plant-based genetically modified foods compared to approval (27%) of animal-based genetically modified foods. While this result is consistent with other surveys, a closer examination of the data reveals more detailed insights and allows us to further characterize American acceptance.

Basic demographic variables revealed interesting opinions. Men were 20% more likely than women to support plant-based genetic modification and 16% more likely to approve animal-based genetic modification. Among Caucasians, more than half (58%) approved of plant-based genetic modification and one-quarter (27%) approved of animal-based GM. Among other ethnicities, about half (46%) approved of plant-based GM and one-quarter (26%) approved of animal-based GM. The logistic regression estimates show that Caucasians were 30% more likely than other ethnicities to approve of plant-based GM. A similar percentage of Caucasians were more likely than other ethnicities to approve of animal-based GM.

Among younger respondents (35 years old or younger), half (52%) approved of plant-based GM and one-quarter (24%) approved of animal-based genetic modification. Fifty-eight percent of middle-aged (35-54 years old) respondents approved of plant-based genetic modification and 28% approved of animal-based genetic modification. Among older respondents (55 years old and older), about half (54%) approved of plant-based genetic modification and one-quarter (27%) approved of animal-based genetic modification. According to logistic regression estimates, younger respondents were 15% less likely to approve of animal-based genetic modification than the middle-aged respondents. The results suggest that non-Whites, the young, and women were less approving of either technology.

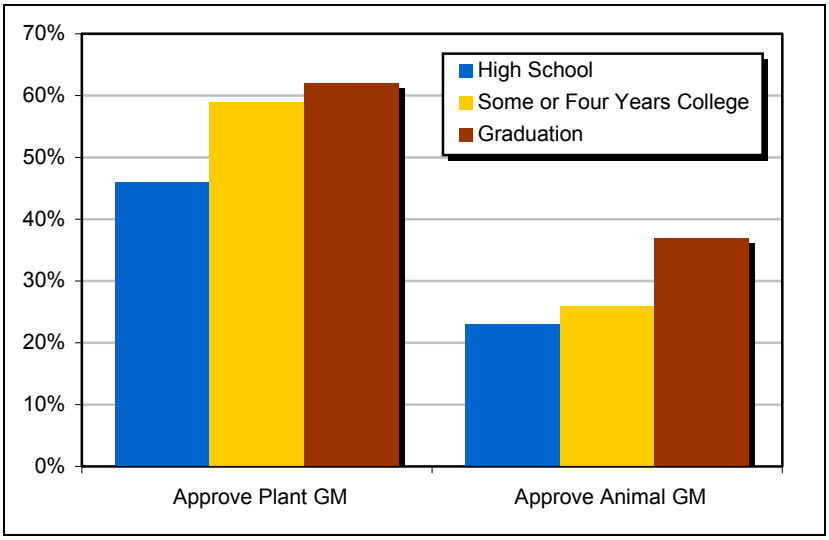

Figure 1. Respondents' opinion about approval of plant and animal-based GM food by their education.

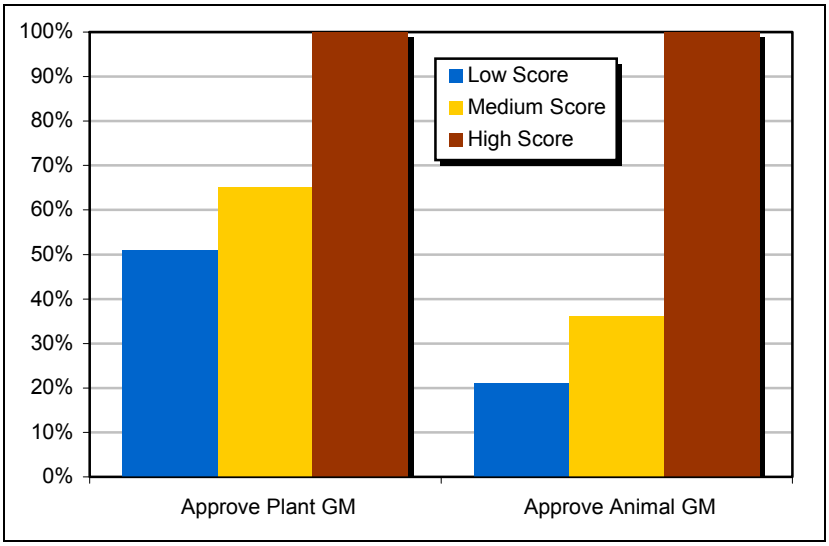

Figure 2. Respondents' opinion about approval of plant and animal-based GM food by their objective knowledge about genetically modified foods.

As seen in Figure 1, about two-thirds (62%) of college graduates approved of plant-based genetic modification and roughly one-third (37%) approved of animal-based genetic modification. Among those with at least some college education, 59% approved of plant-based genetic modification and 26% approved of animal-based genetic modification. Among those with a high school diploma or less education, 46% approved of plant-based genetic modification and 23% approved of animal-based genetic modification. According to logistic regression estimates, those who have some college education are 27% less likely than college graduates to approve of plant-based genetic modification. This suggests that increased formal education increases approval of plant-based genetic modification.

In terms of value attributes, respondents' knowledge of biotechnology was assessed by asking 12 questions relating to biotechnology. Those who answered 1 to 5 questions correctly were classified as low scorers; those who answered 6 to 9 questions correctly were classified as medium scorers; and those who answered 10 to 12 questions correctly were classified as high scorers. As seen in Figure 2, all high scorers approved of plant- and animal-based GM. Among medium scorers, two-thirds (65%) approved of plant-based genetic modification and one-third (36%) approved of animal-based genetic modification. Among low scorers, half (51%) approved of plant-based genetic modification and one-fifth (21%) approved of animal-based genetic modification. According to logistic model estimates, low scorers were 20% less likely to approve of plant-based GM than medium and high scorers and were 14% less likely to approve of animal-based GM than medium and high scorers. This suggests that knowledge of biotechnology positively influences the approval of plant- and animal-based GM. In other words, the more a respondent knew about GM, the more likely they were to approve of its use.

More than half of self-declared liberals, centrists, and conservatives approved of plant-based GM. In contrast, less than one-third of these respondents approved of animal-based GM. Yet, according to logistic regression estimates, liberals were 15% more likely to approve of animal-based genetic modification compared to centrists and conservatives.

As seen in Figure 3, among respondents who never attend religious services, two-thirds (66%) approved of plant-based genetic modification and one-third (32%) approved of animal-based genetic modification. Among people who attend services occasionally, more than half (57%) approved of plant-based genetic modification and one-quarter (27%) approved of animal-based genetic modification. Among respondents who attend religious services regularly, roughly half (49%) approved of plant-based genetic modification and one-quarter (24%) approved of animal-based genetic modification. Logistic regression estimates showed that those who never attend religious services were 37% more likely than those who attend services regularly to approve of plant-based genetic modification. The results suggest the less one visits a place of worship, the more approving of biotechnology.

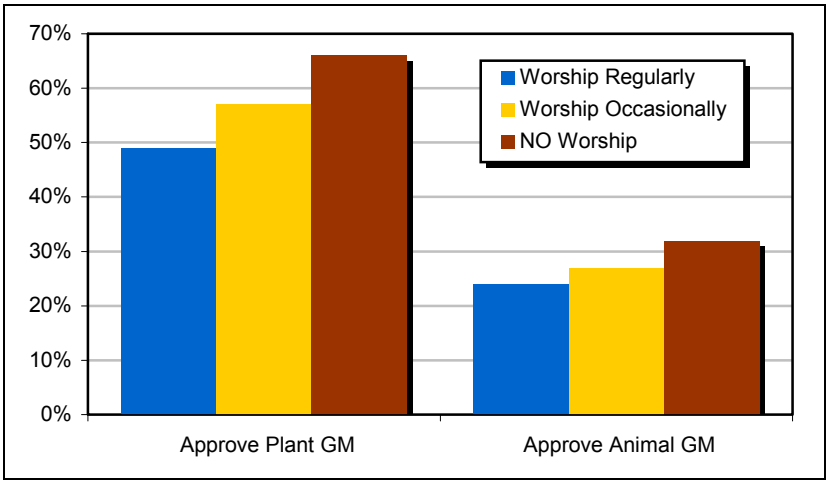

Figure 3. Respondents' opinion about approval of plant and animal-based GM food by those who attend church or other house of worship.

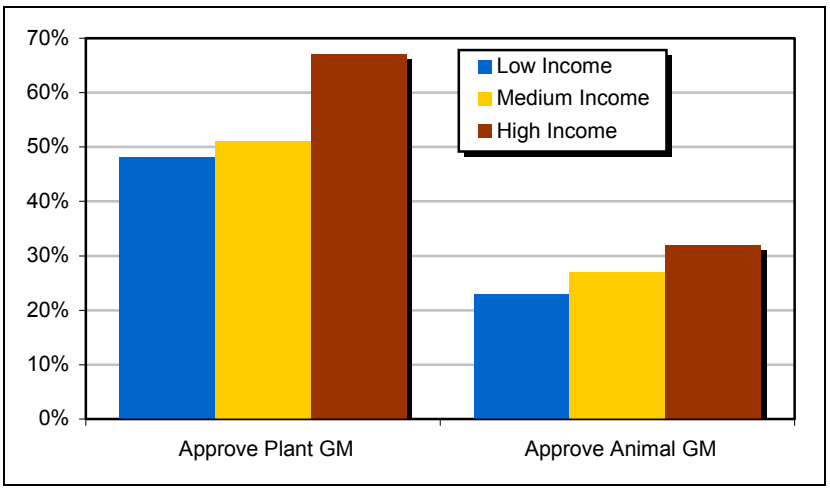

Figure 4. Respondents' opinion about approval of plant and animal-based GM food by their income.

Among respondents who say they trust scientific institutions, three-quarters (78%) approved of plant-based genetic modification and 39% approved of animal-based GM. Among respondents who say they trust the government, three-quarter (76%) approved of plant-based GM and 38% approved of animal-based GM. Among respondents who have confidence in regulators, less than two-thirds (63%) approved of plant-based GM and one-third (32%)

approved of animal-based GM. According to logistic model estimates, respondents who trust the government (29%), respondents who have confidence in scientific organizations (66%), and respondents who have confidence in the ability of regulators (28%), were more likely to approve the plant-based genetic modification. Respondents who trust scientific institutions were 30% more likely to approve of animal-based genetic modification. This suggests that those who trust key stakeholders are more likely to approve of plant-based genetic modification. Furthermore, those who trust science and its institutions are even more likely to extend that trust to animal-based GM.

As shown in Figure 4, among respondents with high household income (above $75,000), 67% approved of plant-based genetic modification and 32% approved of animal-based GM. Among respondents with a moderate household income ($35,000 - $75,000), 51% approved of plant-based genetic modification and 27% approved of animal-based genetic modification. Among respondents with low household income (below $35,000), 48% approved of plant-based GM and 23% approved of animal-based GM. Logistic regression estimates show that the low income group was 27% less likely, and the moderate income group was 25% less likely, to approve of plant-based genetic modification compared to the high income group. The low income group was 11% less likely than the moderate income group to approve of animal-based genetic modification. The results suggest the higher the household income, the more approving of biotechnology.

Concluding Remarks and Policy Implications

This article suggests differential acceptance and approval of genetic modification involving plant or animal genes. The results can contribute to our understanding of GM food acceptance and be used to derive marketing strategies and in policy formulation. Similar to previous studies, this article suggests that demographic, socio-economic, consumer value attributes, and trust in key stakeholders help drive acceptance of genetic modification (Onyango & Nayga, 2004). In general, the public is more approving of plant-based GM than animal-based GM. Furthermore, the results of this survey suggest that a better understanding of biotechnology, trust in the GM regulatory framework, and biotechnology corporations' motives are critical for the acceptance of genetic modification. A general outreach program to educate and inform consumers about biotechnology will not help the public make informed decisions about the desirability of this technology. Rather, a targeted communication strategy that takes all these differences between the consumer segments would be more effective. Additionally, the pursuit of a trustworthy corporate and industry-wide image would help assure consumers that biotechnology is, perhaps, a technology that is worth the risk.

For More Information

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Venkata Puduri is Post Doctoral Associate, Department of Agricultural, Food and Resource Economics at Rutgers, the State University of New Jersey, New Brunswick, New Jersey. Ramu Govindasamy is Associate Professor, Department of Agricultural, Food and Resource Economics, and Associate Director, Food Policy Institute, Rutgers, the State University of New Jersey. John T. Lang is a Doctoral Candidate, Department of Sociology and Research Assistant, Food Policy Institute and Department of Human Ecology, Rutgers, the State University of New Jersey, New Brunswick, New Jersey. Benjamin Onyango is Research Associate, Food Policy Institute, Rutgers, the State University of New Jersey, New Brunswick, New Jersey. *This research was supported by a grant provided to the Rutgers Food Policy Institute by the U.S. Department of Agriculture (USDA), under the Initiative for the Future of Agricultural Food Systems (IFAFS), grant #2002-52100-11203 "Evaluating Consumer Acceptance of Food Biotechnology in the United States," Dr. William K. Hallman, Principal Investigator. The opinions expressed in the article are those of the authors and do not necessarily reflect official positions or policies of the USDA, The Food Policy Institute, or Rutgers University.*