All Around the (Genetically-Modified) Mulberry Bush: Information-seeking and Consumer Preferences for Genetically Modified Food Labeling in Vermont

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Abstract

Consumer demands for labeling of genetically modified (GM) food products have the potential to dramatically impact the way food crops are produced and distributed in the U.S. In May 2014 Vermont became the first U.S. state to legally require the labeling of GM foods. This study uses several waves of data from an annual survey of Vermont households to explore consumer preference heterogeneity surrounding GM foods as well as changes in demographic and attitudinal determinants of demand for GM food labels since the year 2000. Findings suggest women, some high-income respondents, and relatively educated respondents have consistently been more opposed to GM foods over time, but that opposition to GM foods has decreased over time in other demographic groups, especially women. But at the same time, since 2000 the demand for GM *labels* has steadily increased among all demographic groups in Vermont, including both pro-GM and anti-GM respondents, reaching 96% support for labeling in 2013.

Key words: genetically modified organisms, food labeling, consumer preferences, willingness to pay

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Consumers are increasingly seeking information about the contents and origins of the foods they eat. This rising trend has coincided with a recent resurgence in demand for food labels indicating whether or not a food contains ingredients produced through genetic engineering. Genetically-modified (GM) crops have been commercially-available in the United States since 1996, and are now present in the majority of staple crops and as much as 75% of processed foods produced and sold. However, a significant proportion of the general population has continued to express uneasiness with the technology (Harmon & Pollack, 2012; Plumer, 2012), either because of perceived health threats, perceived environmental threats, or simply because of a belief in consumers' "right to know" what is in their food. In spite of increasingly vocal demands from consumer groups, the United States today remains one of the few developed countries in which labeling of food products containing GM ingredients is not required by national policy.

GM crops occupy a special place in U.S. food and labeling policy. At the federal level, the U.S. federal government has consistently voiced support for GM foods since the late 1990s (U.S. Department of Agriculture, 2002; Löfstedt & Vogel, 2001; Lynch & Vogel, 2001). This support has taken the form of continued investment and subsidization of GM crop research, development and dissemination in the public and private sectors, as well as relatively restrained regulation (when compared to other industrialized countries) of new GM food crop varieties in the US market (CBD, 1992). Industry opponents of GM labeling in the U.S. have long argued that FDA-approved GM foods have not been conclusively shown to pose a health risk to consumers above and beyond that of conventionally-produced foods, hence mandatory GM labeling is unwarranted under existing federal standards. Within this favorable policy environment, labelling of GM foods has never been required in the U.S. – and indeed labeling was hardly even discussed publicly until GM crops were already a major part of the U.S. food supply.

While federal-level institutions have resisted labeling GM crops, at the state level, there have been several recent attempts to introduce mandatory GM labeling in response to outspoken consumer demands for such information. State-level efforts to instate GM labeling policies have been largely unsuccessful in the past, with the failure in early 2013 of California Proposition 37 (which would have mandated labels for most GM foods in California) highlighting the barriers to state-level GM labeling efforts. Nevertheless, pro-labeling consumer groups have remainined active in recent years. In May 2014 Vermont became the first U.S. state to legally require the labeling of GM foods, a policy scheduled to go into effect in 2016, and Connecticut and Maine already have legislation in place that will require GM labeling once several other states in the region do so. Altogether, between January and June 2014 there were 25 states proposing 67 pieces of legislation related to GM labeling (Washington Post, 2104; Slate, 2014; Huffington Post, 2014).

This study examines consumer perceptions of GM and labeling of GM food products while accounting for media attention to GM crops in the small state of Vermont between 2000 and 2013. GM labeling has been debated in the Vermont state legislature in several sessions since the state's first forays into labeling regulations in the 1990s surrounding recombinant growth hormones used in milk production (Gad, 2013; Hirsch, 2013). There has also been a wealth of media attention to GM crops over this time period, focusing at times on the debate over GM crop risks, and at other times on Vermonters' rights to information over where and how their food is produced. Our analysis is based on several waves of data from an annual household survey which allow us to directly measure changes in demographic and attitudinal determinants of demand for GM food labels in Vermont since the year 2000. Specifically, we examine the roles of gender, age, education, income, family size, and knowledge of GM crops – including an original dataset on media coverage of GM issues in local news outlets over time – in increasing or decreasing demand for GM labels in Vermont.

Binary logistic regression and ordinal logistic regression are employed to investigate the degree to which different demographic and knowledge factors influence support for GM food technologies and (separately) support for GM food labels over time. To our knowledge this study represents the first to empirically examine consumer preferences for GM labeling using a similar survey instrument over a 13-year time period. The specific geographic focus and time period for this study are particularly interesting given the very recent passage of Vermont's new first-in-the-nation mandatory GM labeling law. This study was designed to provide insights into how demographic, attitudinal, and knowledge-based factors shape consumers' understanding of GM technologies, their search behavior for information about GM food, their demand for GM labeling and their willingness to pay to obtain the information that GM labels might provide.

Prior Research on Food Information Search and Labeling

There is now a substantial literature examining consumers' willingness to pay to obtain or avoid different food attributes (Burton et al., 2001; Grannis and Thilmany, 2002; McCluskey et al., 2003; Roosen et al., 2003; Lusk et al., 2003; Alfnes, 2004; Tonsor et al., 2005). There is also an established literature exploring consumer attitudes towards GM foods in particular (Caswell, 1998; Kolodinsky et al., 2004; Kalaitzandonakes et al., 2005; Brossard et al., 2007; Esposito & Kolodinsky, 2007; Premanandh, 2010) including country- and region-specific studies in Europe (Davison & Bertheau, 2008; Font, 2011; Rousselière & Rousselière, 2013; Sarno & Ardeleanu, 2014) in Asia (Hama, 2010; Lee & Yoo, 2011; Alam et al., 2012; Ebata et al., 2013) and in developing countries (González et al., 2009; Pellegrini, 2013; Tironi et al., 2013). A burgenoning recent literature further explores determinants of GM food attitutudes and purchase behaviors amongst population subsegments such as youth (Aasen & Vatn, 2013; Jurkiewicz et al., 2014) and further explores the roles of factors such as trust, public confidence, and emotions on the acceptance of GM foods in the U.S. (Siegrist et al., 2012; Šorgo et al., 2012; Vàzquez-Salat, 2013). We are not aware of any past studies exploring U.S. consumer support for GM foods and demand for GM food labels over an extended period of time.

GM crops occupy a peculiar place in U.S. federal law (Keatley, 2000) – for commercial and licensing purposes, GM crops are deemed sufficiently distinct from non-GM crops that patents can be issued (something that is not possible for any non-GM crop). For marketing purposes, however, GM crops are deemed substantially equivalent to their non-GM counterparts – a classification which has allowed GM crop producers and processors to introduce the technology rapidly and ubiquitously without providing additional information to consumers. In 1990 the first successful field trial of a genetically modified crop was completed (Teitel and Wilson, 1999). The earliest commercialized forms of genetic modification in the U.S. consisted of herbicide tolerance and insect resistance, introduced into field crops through the use of biotechnology techniques developed in the 1980s and 1990s (World Food Prize, 2013). These genetic traits sought to increase per-acre crop production and reduce expected production costs to farmers (Fernandez-Cornejo and McBride, 2002, FAO, 2004). The direct benefit of GM crops to consumers, however, was less immediately clear – a fact that some scholars cite as a key driver underlying widespread public aversion to the technology (Chern and Rickertsen, 2004).

The roots of public aversion to GM crops are varied, but have broadly included concerns over potential health risks associated with new biotechnologies, concerns over the potential for environmental impacts due to the new technologies, more general normative or ethical beliefs opposing GM crops as “un-natural.” More recently, additional opposition has grown in response to perceived secretive and monopolistic behavior on the part of agro-chemical industries producing and promoting GM crops - leading to additional opposition to GM crops for reasons not directly associated with the technology itself. GM labeling advocates claim GM labeling represents a strategy enabling consumers to internalize the nonmarket costs associated with GM crops.

Labeling is part of a larger collaborative risk communication strategy (Hadfield & Thomson, 1998; Kolodinsky, 2007; Weldon & Laycock, 2009). It establishes this individual control over consumption (Caswell & Mojduszka, 1996; Kolodinsky, 2007), increasing consumer control and allowing the marketplace to be the playing field for decision making (Hadfield & Thomson, 1998; Kolodinsky, 2007).On the other hand, proponents of labeling point to consumers’ right to know (Streiffer and Rubel, 2003), equity issues related to small scale agriculture (Marion and Willis, 1990), “interference” in the natural order of things (Douthitt, 1991; Fallert et al., 1987; Marion et al. 1989; Marion and Willis, 1990), fairness about who derives the benefits from purchase of these goods, business or consumers (Busch, 1992), and values concerning food and its social significance (Busch, 1992; Thompson, 1997; Conner and Kolodinsky, 1998).

On the other hand, labeling critics argue that the practice will stigmatize their products in the marketplace. Opponents of labeling have asserted that providing more information either destructive or useless. They claim that the information limits consumer choice in the long run because consumers may be led to believe that biotechnology is “bad” (Browning, 1993; Carter and Gruère, 2003). If two products are substantially the same, they argue, a negative label (e.g., rBST-free) or a positive label (e.g., contains rBST) could imply that the presence of rBST in milk is harmful (Smith, 2000), or that the absence of rBST makes the milk better (McClure, 2001). Such concerns (and fears of food industry groups) appear supported by national polls: in a 2013 ABC News poll of 1,024 U.S. adults found 93 percent of respondents believed the federal government should require labels on food containing GM ingredients (or "bio-engineered", the poll used both terms). Fifty-seven percent also said they would be less likely to buy foods labeled as genetically modified, while only five percent said they would be *more* likely to buy a food labeled as GM. Kolodinsky (2007) concluded that rBST free labels on milk did not convey emotion and communicated the information they were intended to: that the milk was not produced using rBST.

The ABC poll mentioned above also found that only a third of the public believes GM foods are safe to eat, and that 52 percent believe such foods are unsafe (an additional 13 percent are unsure). In the presence of such doubt, and in the absence of any formal GM food labeling policy, both pro- and anti-GMO interests have used the media to advocate their positions regarding GM risk and information provision (Harmon & Pollack, 2012; Plumer, 2012; Silk, Weiner, & Parrott, 2005; Reynolds, 2004; Hellsten, 2003). Researchers have observed such publi arguments are often emotional or uninformative (Pechan et al., 2011; Weldon & Laycock, 2009; Kolodinsky, 2007), and also susceptible to influence by one side or the other of the debate (Pechan et al., 2011; Irwin & Wynne, 1996). The recent Proposition 37 debate in California in 2012 revealed the scale of the stakes in providing or withholding information from consumers: the prominent GM labeling bill was struck down in a public vote, but only after seeing more than $35 million in advertising expenditures by food industry stakeholders opposed to labeling. Pro-labeling advocates themselves expended some $9 million. Labeling has emerged as the latest battleground upon which the information war over GM food is being waged.

Research Design: Data Collection

This study uses data from Vermont's state-wide annual Vermonter Poll, including questions on GM attitudes, labeling preferences, and WTP between 2000 and 2013. Vermont is a unique place to investigate GM labeling policy. The state is the second-most rural state in the U.S. by population, and has a rich agricultural identity (Council on the Future of Vermont, 2009; U.S. Census Bureau, 2010). The state also has a long history with the GM labeling debate, beginning with the promulgation and ultimate repeal of the nation's first mandatory labeling of milk produced using rBST (Kolodinsky, 2007; Kolodinsky et al., 1998). As such, the selection of this case for further study over time is both applicable and timely as GM labeling debates remain far from settled.

The Vermonter Poll is a statistically representative, statewide telephone poll conducted annually by the University of Vermont Center for Rural Studies. The poll usually takes place in February or March, with households selected randomly using a list of telephone numbers generated from Vermont telephone directories.[1] The survey was designed to collect three types of data: socio-economic information including age, residence and household income. GM food related characteristics include: awareness and knowledge about GM products; attitude towards GM products, and concerns regarding GM products; and information acquisition characteristics, such as information search behavior, trust, source, and satisfaction with available food labeling information; and willingness to pay for additioanl food labels Each year, the results of the poll have at least a 95/5 percent level of confidence and error. Summary statistics of selected demographic attributes of survey respondents are provided in Table 1.

[1] The Vermonter Poll is a statistically representative of Vermonter households with landline telephones. According to the most recent estimates, only 5.1 percent of Vermont households have at least one wireless cellular phone, but no landline telephone. As a state, Vermont has the lowest level of "wireless-only" households in the country. Blumberg et al. (2009).

Table 1. Description of the Sample: 2000-2013 Vermonter Poll.

Year	N	Percent Female	Mean Age	Mean HHsize	College Degree	Income >$50K	Heard of GM	Support GM Use	Support GM Labels
2000	667	53%	50.9	2.7	44%	68%	78%	-	97%
2001	720	53%	48.4	2.8	47%	67%	76%	-	-
2002	191	83%	-	-	100%	100%	-	2%	-
2003	641	55%	50.0	2.6	51%	67%	68%	17%	95%
2004	630	55%	54.1	2.8	47%	69%	67%	12%	94%
2005	618	54%	53.3	2.6	46%	70%	-	-	-
2006	608	56%	53.5	2.6	53%	72%	81%	16%	-
2007	-	-	-	-	-	-	-	-	-
2008	614	52%	56.3	2.5	51%	61%	78%	10%	96%
2009	615	51%	56.6	2.5	53%	60%	-	10%	-
2010	661	58%	58.6	2.3	51%	50%	-	8%	-
2011	611	58%	60.5	2.3	53%	56%	85%	16%	-
2012	699	57%	58.7	2.4	51%	58%	82%	22%	-
2013	777	52%	57.6	2.5	52%	57%	88%	16%	96%

Poll numbers fluctuated between 500 and 800 participants annually. Female respondents slightly outnumbered male respondents and the average respondant in any given year was 50-60 years of age and had 2-3 children in the household. The income and education distribution is slightly above average. Respondents who are aware of GM food topped 88 percent in 2013. The overwhelming majority support GM labels (94-97 percent).

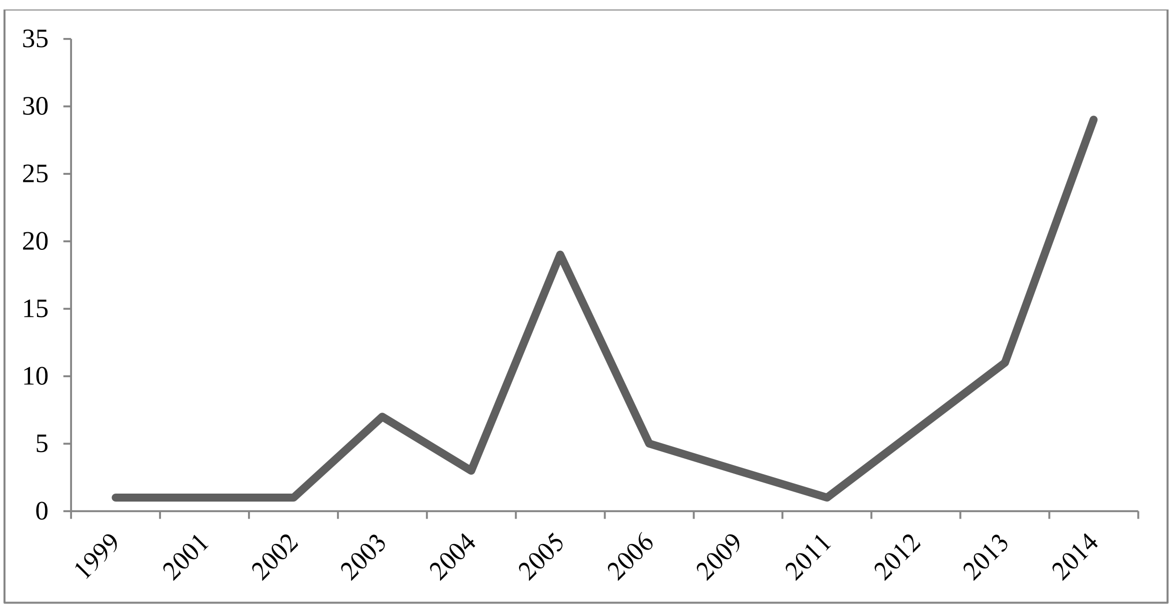

Figure XX. Articles containing "GMO" mentions in the Burlington Free Press ProQuest Archive.

Analyis

We grouped questions into five distinct themes for analysis: awareness of GM foods, attitudes towards GM foods, information seeking behavior, labeling preferences, and willingness to pay for

GM-related information. All variables were recoded for scale consistency and comparability over the full 2000-2013 time period. For example, in 2000 and 2013 respondents could identify a neutral position vis à vis GM labeling, whereas in 2003, 2004 and 2008, they were given choices which did not include "neutral." Consequently neutral responses have been removed from this analysis. All respondents who identified "do not know" or "refused" were also not included in the analysis.

In 2000, the labeling question was asked as a Likert scale, from strongly disagree to strongly agree, for the question "*Should chips containing GM ingredients be labeled for the consumer?*" In 2003, 2004 and 2008 the statement was a choice across labeling and non-labeling options, reading "*Choose the one of the following statements that summarizes your view best:*

- *Products containing GMOs should be labeled.*
- *Products not containing GMOs should be labeled.*
- *All products should be labeled.*
- *No products should be labeled.*"

In 2013, the labeling question was again read as a Likert scale: "*Are you very supportive, supportive, neutral, opposed, or very opposed to GM labeling?*" The 2013 poll also included a more specific question about then-pending GM labeling legislation in Vermont: "Are you very supportive, supportive, neutral, opposed, or very opposed to the Vermont "GMO labeling Bill" H-112?

For use in binary logistic regression all scale variables pertaining to GM labeling were converted to binary yes/no variables. In 2003, 2004, and 2008 "yes" responses include "all products should be labeled, products not containing GMOs should be labeled, and products containing GMOs should be labeled against no product should be labeled.

We estimated a series of independent reqressions, either logit or ordinal probit depending the on the level of measurement of the dependent variable. Individual characteristics hypothesized to impact biotechnology support were drawn from the existing literature of technology adoption and biotechnology in particular (Herath, 2013; Legge & Durant, 2010; Lyndhurst, 2009; Rogers, 2003). Rogers (2003) finds younger, wealthier, and more educated and socially-connected individuals are more likely to adopt new technology in its earliest stages, partly due to greater access to information regarding the risks and benefits of new technology. They also have a higher tolerance for potential risks, given the resources at their disposal. Legge & Durant (2010) corroborate this relationship in regards to GM technology, finding that older individuals are less likely to consume and purchase GM foods while scientific literacy (education) positively impacts the degree and consistency of support for GMO technology.

Gender also plays a role in biotechnology support. Women are more averse toward biotechnology (Herath, 2013; Legge & Durant, 2010; Lyndhurst, 2009). Legge & Durant (2010) attribute this aversion to women's greater attention to health and the environment, including the presence of GMOs in baby formulae and children's foods. Herath (2013) finds that Canadian women were 1.9% less likely to strongly support and 2.9% more likely to strongly oppose GM foods in 2001. This gender divide decreased by 2011, likely due to the increased role of the internet and social media in disseminating information across all demographic groups (Herath, 2013).

We further control for regional variation (population density of the county in which the respondent was located) and time (year of the survey).

To estimate these models we use several years of cross-sectional survey data from a representative sample of Vermont consumers.

Results

Results of bivariate and multivariate analyses of predictors of GM food awareness, support for GM food use, information-seeking behavior on GM ingredients, support for GM labeling, and willingness to pay for GM-related information over time are summarized below.

Awareness

Awareness of GM foods has increased from 75% to over 85% of the Vermont population between 2000 and 2013. There are significant differences in awareness among below-medium and above-medium income households from 2010 onward. There are highly significant ($p<0.01$) differences in awareness by education level, with awareness increasing as education level increases (Figure 1).

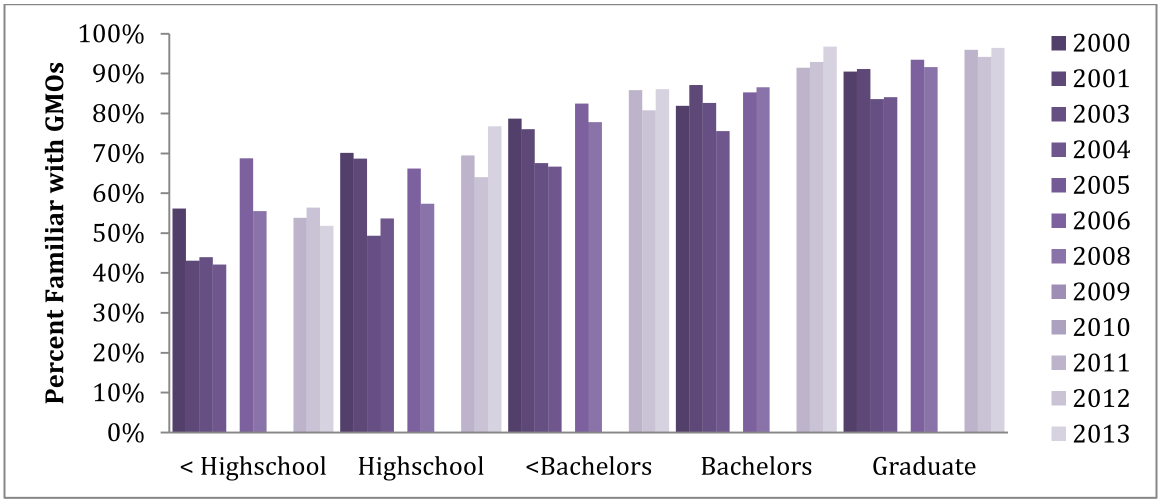

Figure 1. Awareness of the term "genetically-modified organism" by education level (χ^2=80.57, p<0.01 in 2013).

There are also significant bivariate differences in awareness of GM foods between men and women, with women generally more aware of the presence of GM indredients in the U.S. food supply in recent years (χ^2=8.53, p<0.01 in 2012) but no differences between the sexes in some years (χ^2=0.097, p<0.76 in 2013) and men more likely than women to be aware of GM foods in earlier years in the sample (75.4% of men versus 69.4% of women before 2005; χ^2=11.76, p<0.01). There are also significant differences in awareness of GM foods by age, with older respondents less likely to know about GM foods in the U.S. especially in later years (t=3.01, p<0.01). There are no significant differences in awareness based on the number of children in a household or urban/rural location. (See Appendix 1 for details on this analysis).

Table 2. Binary logit predicting familiarity with GM foods over time.

	Coef.	Std. Err.	z	P>z	[95% CI]	
Female (=1)	-0.265	0.084	-3.150	0.002	-0.430	-0.100
Age	-0.004	0.003	-1.090	0.276	-0.010	0.003
Education (HS omitted)						
Some College	0.813	0.102	8.000	0.000	0.614	1.013
Bachelors Degree	1.308	0.118	11.110	0.000	1.077	1.539
Graduate School	1.885	0.144	13.070	0.000	1.602	2.168
Household Size	-0.050	0.035	-1.420	0.157	-0.119	0.019
Income > $50K	0.220	0.090	2.450	0.014	0.044	0.396
Population Density	-0.001	0.000	-1.800	0.072	-0.002	0.000
Year (base 2000)						
2001	0.145	0.190	0.760	0.446	-0.227	0.517
2003	-0.500	0.177	-2.820	0.005	-0.848	-0.153
2004	-0.391	0.185	-2.120	0.034	-0.754	-0.029
2006	0.231	0.200	1.160	0.247	-0.160	0.623
2008	-0.092	0.176	-0.530	0.599	-0.436	0.252
2011	0.449	0.193	2.330	0.020	0.071	0.828
2012	0.250	0.181	1.380	0.167	-0.105	0.604
2013	0.818	0.191	4.280	0.000	0.443	1.192
Constant	1.013	0.329	3.080	0.002	0.368	1.659

N = 4376
LR χ^2 (16) = 388.06
Prob > χ^2 = 0.00
Log likelihood = -1875.32

Table 2 presents results of logit estimates to predict familiarity with GM over time. Overall, women and older adults have been less aware of GM over time, while more highly educated and higher income people are more aware. Respondents from more rural counties have been slightly more likely to be familiar with GM foods than their more urban counterparts. There is a trend towards increased awareness over time since the early 2000s, as evidenced by the more recent poll year variables.

Attitudes towards GM Food

A majority of Vermonters are opposed to the use of GM ingredients in food products, a majority that has remained large over time. As few as 10-15% of Vermonters explicitly support GM foods in any given year, while around 25% are neutral on the issue. As seen in Figure 2 the trend in support versus opposition to GM foods has ebbed and flowed over time, with opposition reaching a peak in 2009-2010.

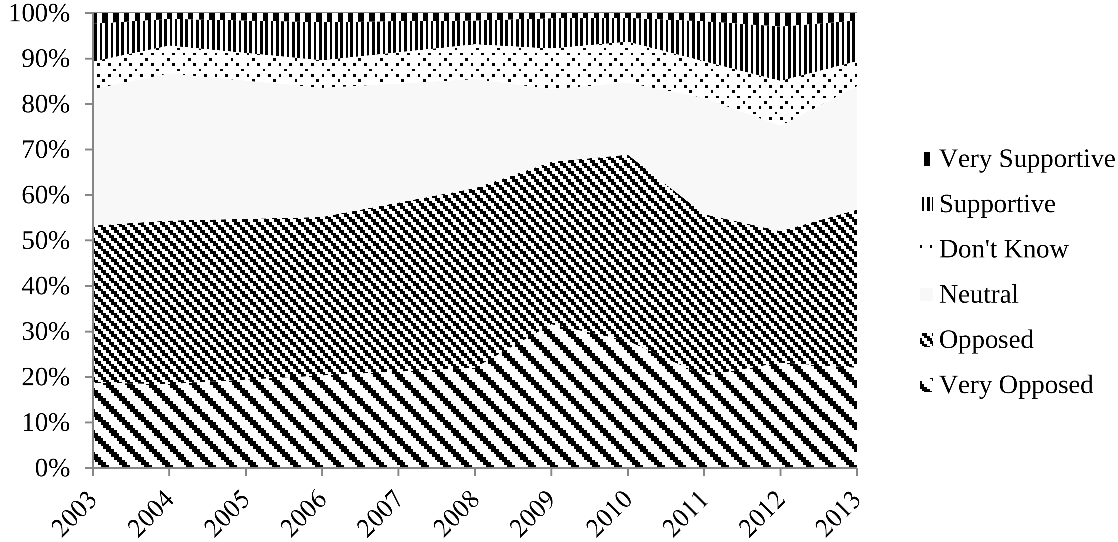

Figure 2. Support and opposition to the use of GM foods over time.

There are significant differences in support for GM foods among below-medium and above-medium income households in 2010 ($p<0.01$) and 2013 ($p<0.05$). There are also significant differences in support by education level in several years, including 2013 ($\chi^2=15.10$, $p<0.01$). There are also highly significant ($p<0.01$) differences in support between men and women over the study period (Figure 3). There are no differences in support based on the number of children in a household or residential environment. (See Appendix 1).

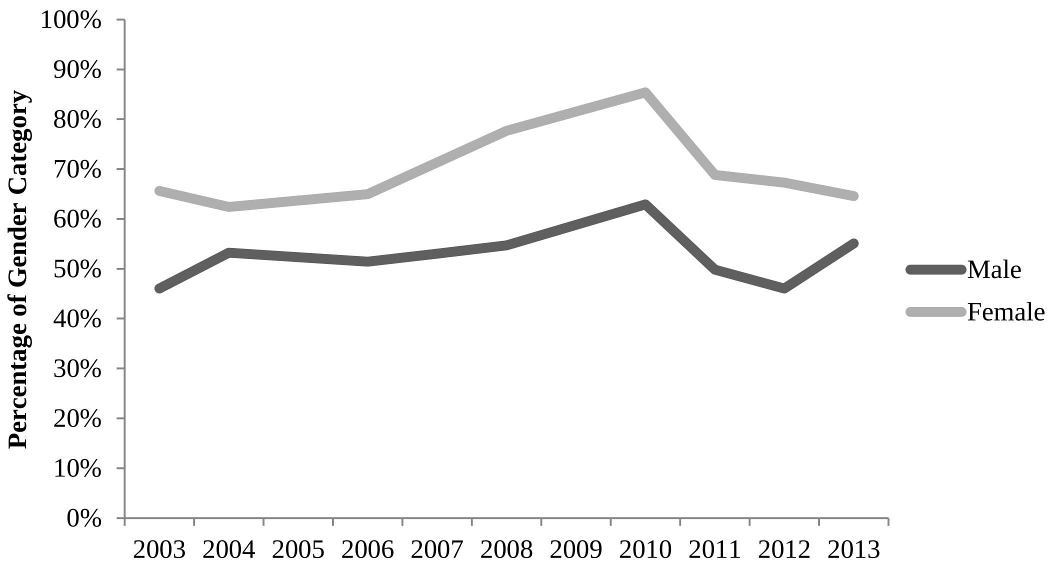

Figure 3. Males, females "opposed" or "strongly opposed" to GM foods.

Table 3. Binary logit predicting support for GM in food production in Vermont over time.

	Coef.	Std. Err.	z	P>z	[95% CI}	
Female (=1)	-1.080	0.110	-9.780	0.000	-1.297	-0.864
Age	0.008	0.004	1.850	0.065	-0.001	0.017
Education (HS omitted)						
Some College	0.174	0.156	1.110	0.266	-0.132	0.480
Bachelors Degree	0.091	0.160	0.570	0.571	-0.223	0.405
Graduate School	0.232	0.160	1.450	0.147	-0.082	0.545
Household Size	-0.004	0.048	-0.080	0.937	-0.099	0.091
Income > $50K	0.061	0.121	0.510	0.612	-0.175	0.298
Population Density	0.002	0.001	4.270	0.000	0.001	0.004
Year (base 2003)						
2004	-0.416	0.280	-1.480	0.138	-0.965	0.133
2006	0.046	0.249	0.180	0.854	-0.443	0.534
2008	-0.506	0.247	-2.050	0.040	-0.989	-0.022
2009	-0.590	0.248	-2.380	0.017	-1.076	-0.104
2010	-0.612	0.250	-2.450	0.014	-1.101	-0.122
2011	0.009	0.235	0.040	0.970	-0.452	0.470
2012	0.491	0.216	2.270	0.023	0.067	0.914
2013	0.001	0.221	0.000	0.997	-0.432	0.433
Constant	-1.069	0.436	-2.450	0.014	-1.923	-0.215

N = 3221
LR χ^2 (16) = 175.67
Prob > χ^2 = 0.00
Log likelihood = -1189.14

Table 3 presents logit estimates predicting support for GM in food production over time. Overall, women are less supportive of GM in food production, while older respondents and more urban respondents are more likely to be supportive or neutral towards GM foods. With the exception of poll year 2012, support for GM in food production has declined almost every year since 2003.

Information Seeking Behavior

More than 60% of Vermonters actively seek or pay attention to information regarding GM foods, and there has been no significant change in this level of information-seeking behavior across the different years in the sample.

In preliminary bivariate tests several demographic characteristics emerged as related to GM information-seeking behavior. There are significant differences in seeking among lower-income (<$50K) and higher-income (>$50K) households, particularly since 2008. There are highly significant ($p<0.01$) differences in information-seeking by education level in all years, with highly educated respondents vastly more likely to seek out information on GM foods (χ^2>366.96, $p<0.01$ across all polling years). There are also significant ($p<0.05$) differences in information seeking by age in most years (with older respondents less likely to seek information) as well as by gender, with women more likely to seek out information across all years (χ^2=34.59, p<0.01). (See Appendix 1 for details).

Table 4. Ordinal logistic regression predicting information-seeking behavior for GM foods over time (outcome is more aggressive information seeking on a 1-3 scale).

	Coef.	Std. Err.	z	P>z	[95% CI]	
Female (=1)	0.269	0.073	3.670	0.000	0.125	0.412
Age	-0.014	0.003	-4.770	0.000	-0.020	-0.008
Education (HS omitted)						
Some College	0.302	0.110	2.740	0.006	0.086	0.517
Bachelors Degree	0.633	0.112	5.630	0.000	0.413	0.853
Graduate School	0.996	0.115	8.690	0.000	0.772	1.221
Household Size	-0.008	0.032	-0.230	0.816	-0.071	0.056
Income > $50K	-0.257	0.083	-3.110	0.002	-0.419	-0.095
Population Density	-0.001	0.000	-2.520	0.012	-0.002	0.000
Year (base 2003)						
2004	0.031	0.166	0.190	0.851	-0.295	0.358
2006	-0.033	0.157	-0.210	0.831	-0.341	0.274
2008	0.228	0.148	1.540	0.124	-0.063	0.518
2009	0.306	0.152	2.010	0.044	0.008	0.603
2010	0.575	0.148	3.880	0.000	0.284	0.866
2011	0.424	0.143	2.960	0.003	0.143	0.705
/cut1	-1.246	0.295			-1.825	-0.668
/cut2	1.504	0.296			0.924	2.083

N = 2947
LR χ^2 (14) = 153.81
Prob > χ^2 = 0.00
Log likelihood = -2786.74

Table 4 presents ordinal logit results predicting information seeking behavior over time. Overall, women and those with higher levels of education are more likely to seek out information about GM food. Holding other variables constant, higher-income respondents and more urban respondents are less-likely to engage in extensive information-seeking. There is a trend toward increased information seeking starting in 2009 and continuing to 2013.

Labeling

There has long been overwhelming public support for labeling GM food products in Vermont. The trend has ranged from a low of 94% support for labeling in 2004 to a high of 96% support for labeling in 2013 (Figure 4). There are significant bivariate differences in labeling support across education level, with people with graduate degrees slightly less supportive of labeling than the general population (94% versus 97%; χ^2>10.18, p<0.02). As statewide support for labeling increases to near-universal in 2008 and 2013, there are less significant relationships between labeling support and demographic characteristics. (See Appendix 1 for details).

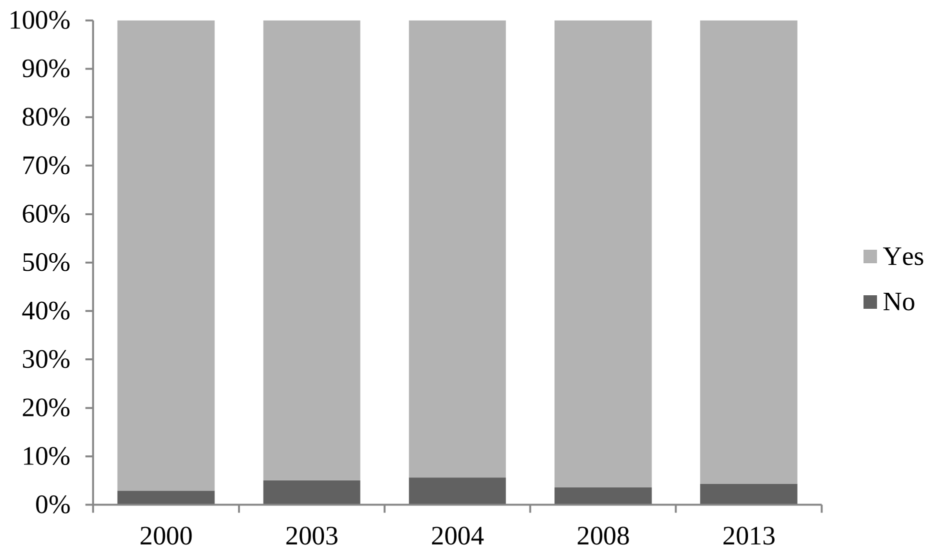

Figure 4. Support for labeling of GM foods over time.

Table 5. Binary logit predicting support for GM food labels in Vermont over time.

	Coef.	Std. Err.	z	P>z	[95% CI]	
Female (=1)	1.032	0.234	4.410	0.000	0.574	1.491
Age	-0.009	0.009	-1.040	0.300	-0.027	0.008
Education (HS omitted)						
Some College	-1.081	0.395	-2.730	0.006	-1.855	-0.306
Bachelors Degree	-1.103	0.403	-2.740	0.006	-1.892	-0.314
Graduate School	-1.319	0.399	-3.310	0.001	-2.101	-0.538
Household Size	-0.095	0.088	-1.070	0.283	-0.268	0.078
Income > $50K	0.067	0.253	0.260	0.792	-0.428	0.561
Population Density	0.000	0.001	-0.410	0.679	-0.003	0.002
Year (base 2000)						
2003	-0.478	0.414	-1.150	0.248	-1.288	0.333
2004	-1.013	0.396	-2.560	0.010	-1.789	-0.238
2008	-0.411	0.402	-1.020	0.306	-1.199	0.377
2013	-0.318	0.400	-0.790	0.427	-1.101	0.466
Constant	3.838	0.899	4.270	0.000	2.077	5.600

N = 1911
LR χ^2 (11) = 42.37
Prob > χ^2 = 0.00
Log likelihood = -320.32

Table 5 presents logit results predicint support for GM food labels over time. Overall women are most supportive of labeling, while respondents with higher levels of education are less supportive (though as previously noted, this difference is on the order of 94% support versus 97% support). Support for labeling has historically been consistently high and while coefficients on poll year are negative in all years (and statistically significant in 2004), label support has not significantly decreased; it has remained higher than 90 percent.

Willingness to Pay

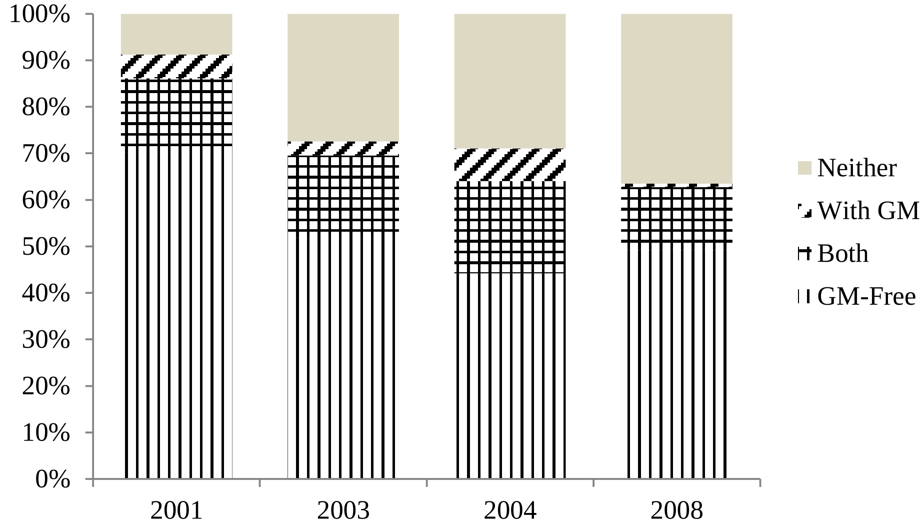

Figure 5. Willingness to pay price premium for different label attributes over time.

There are highly significant ($p<0.01$) differences in willingness to pay for foods labeled GM-free between men and women in all years, with women consistently more willing to pay some premium for GM labeling information (Figure 6). In 2008, there were significant ($p<0.05$) differences in willingness to pay based on education (with more educated respondents generally more willing to pay for more information; χ^2=9.58, $p<0.02$). There are no data on willingnesss to pay beyond 2008. (See Appendix 1 for details).

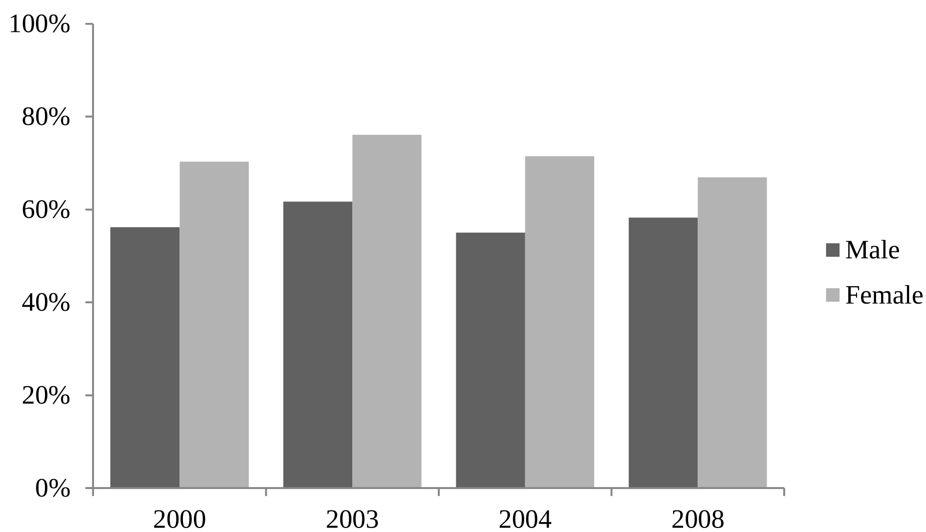

Figure 6. Males, females willing to pay more for foods labeled "GMO-free"

Table 6. Binary logit predicting WTP any price premium for GMO-free labels in Vermont over time.

	Coef.	Std. Err.	z	P>z	[95% CI]	
Female (=1)	0.663	0.127	5.240	0.000	0.415	0.911
Age	-0.006	0.005	-1.250	0.211	-0.016	0.003
Education (HS omitted)						
Some College	-0.034	0.173	-0.200	0.844	-0.372	0.304
Bachelors Degree	-0.081	0.179	-0.450	0.650	-0.433	0.270
Graduate School	0.187	0.192	0.980	0.329	-0.189	0.563
Household Size	0.095	0.054	1.760	0.078	-0.011	0.202
Income > $50K	0.039	0.140	0.270	0.783	-0.237	0.314
Population Density	-0.001	0.001	-0.820	0.410	-0.002	0.001
Year (base 2001)						
2003	-2.598	0.329	-7.900	0.000	-3.242	-1.954
2004	-2.626	0.332	-7.910	0.000	-3.276	-1.975
2008	-3.053	0.324	-9.430	0.000	-3.688	-2.419
Constant	2.692	0.533	5.050	0.000	1.647	3.737

N = 1661
LR χ^2 (11) = 230.16
Prob > χ^2 = 0.00
Log likelihood = -787.81

Table 6 presents logit results predicting WTP any premium for GM free labels over time. Women emerge as the most supportive of labeling (including willingness to pay a premium based on labels). Larger households are also more willing to pay a premium for a GM-free label. As can be clearly seen in Figure 5 self-reported willingness to pay a premium for GM-related labels has declined since 2001.

Discussion

There are consistently significant differences between men and women with regard to awareness, support, and willingness to pay for GM-free foods. This corroborates previous findings (Herath, 2013; Legge & Durant, 2010; Lyndhurst, 2009). There are also significant differences in awareness and information seeking behavior based on demographic characteristics such as income, age, and rural/urban (population density).

There are consistently significant differences among education levels when it comes to awareness and information seeking behavior. These relationships coincide with the theory of innovation diffusion, in which more educated individuals have increased information access regarding new technologies (Rogers, 2003). Meanwhile some of the unexpected findings among demographic variables in the “support labels” regression (including more educated respondents being less supportive of labels) may suggest that as labeling support approaches 100% small subpopulations – such as scientists and other well-educated elites who are also often pro-technology – are strongly influencing findings.

Conclusions

Since their introduction, GM seeds have become the most widely and most rapidly adopted technology in the history of modern agriculture (Conway, 2012). The United States remains one of the few developed countries in which labeling of food products containing genetically modified (GM) ingredients is not required by national policy. Industry opponents of GM labeling long argued in federal courts that FDA-approved GM foods have not been conclusively shown to pose a health risk to consumers beyond that of conventionally-produced foods, hence mandatory GM labeling is unwarranted under existing federal standards. At the state level, however, there have been several attempts to introduce mandatory GM labeling in response to outspoken consumer demands for such information.

Appendix

Appendix 1: Significance Levels between Themes and Demographics

Awareness

	Income	Education	Age	# Children	RSU	Gender
2000	.056*	.000***	.832	.222		.021**
2001						
2003	.075*	.000***	.928	.327		.370
2004	.603	.000***	.905	.838		.209
2006	.810	.000***	.554	.634	.723	.025**
2008	.032**	.000***	.119	.335	.473	.589
2010						
2011	.000***	.000***	.000***	.152	.622	.452
2012	.000***	.000***	.020***	.969	.844	.004***
2013	.000***	.000***	.462	.533	.422	.738

Support

	Income	Education	Age	# Children	RSU	Gender
2000						
2001						
2003	.167	.181	.684	.945		.000***
2004	.303	.948	.048	.511		.048**
2006	.178	.038**	.324	.892	.427	.006***
2008	.198	.389	.433	.071*	.140	.000***
2010	.041**	.040**	.420	.258	1.000	.000***
2011	.472	.842	.035**	.364	.386	.000***
2012	.408	.348	.100*	.121	.419	.000***
2013	.021**	.053*	.268	.757	.044**	.045**

Information Seeking

	Income	Education	Age	# Children	RSU	Gender
2000						
2001						
2003	.704	.004***	.013**	.135		.521
2004	.167	.275	.039**	.089*		.877
2006	.414	.000***	.807	.805	.540	.034**
2008	.011**	.000***	.146	.058*	.619	.372
2010						
2011	.000***	.000***	.000***	.106	.318	.144
2012	.000***	.000***	.006***	.774	.296	.416
2013	.000***	.000***	.020**	.235	.467	.327

Labeling

	Income	Education	Age	# Children	RSU	Gender
2000						
2001						
2003	.108	.001***	.000***	.254		.000***
2004	.000***	.008***	.043**	.797		.027**
2006						
2008	.005***	.383	.407	.122	.586	.109
2010						
2011						
2012						
2013	.127	.934	.721	.772	.239	.109

Willingness to pay

	Income	Education	Age	# Children	RSU	Gender
2000	.643	.933	.405	.661		.000***
2001						
2003	.672	.750	.231	.303		.000***
2004	.813	.528	.292	.763		.000***
2006						
2008	.414	.013**	.819	.538	.546	.023**
2010						
2011						
2012						
2013						

*Income, Education, RSU, and Gender categories utilized Pearson Chi-Squared Test. Age and # Children utilized ANOVA. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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