The Impact of Product Attribute Wording on Consumer Acceptance of Biotechnology Applications in Produce

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A better understanding of consumer preferences for and behavior toward genetically modified (GM) foods is essential for designing new market strategies and information policies for GM products. A sample of Midwest consumers was administered one of two nearly identical conjoint questionnaires to identify the influence of attribute wording on consumer preferences. Respondents value "GM" negatively, while referring to the same attribute as "reduced environmental impact" (REI) results in a positive valuation. The inclusion of both the method of production (GM) and its specific benefits may provide consumers with more information with which to make choices among products.

According to recent studies on consumer attitudes toward biotechnology, consumers appear to favor the use of biotechnology to grow pest-resistant crops requiring fewer applications of chemicals (Kaye-Blake, Bicknell, and Saunders 2005; Loureiro and Bugbee 2005). Given documented consumer interest in locally grown produce, it is increasingly of interest to investigate consumer perceptions and trade offs for attributes such as locally grown, environmental impact, genetic modification, and price.

Like many fruits, apples are adapted to many regions but prosper in certain climates. Other climates promote the development of disease organisms which prey on apples. Apples are among the most pesticide-intensive crops, often requiring up to 16 sprays per year at ten- to 14-day intervals throughout the growing season, with additional applications sometimes required after rain (Merwin et al. 1994). The costs for the frequent treatments account for almost 13 percent of production costs. Korban et al. (2005) indicate that if effective control measures are not applied annually, apple yield losses might be up to 100 percent.

Apple scab is a particularly troublesome disease in much of the U.S. The successful use of biotechnology has resulted in the development of several disease-resistant apple varieties by isolating and cloning naturally occurring apple scab-resistance genes and transferring them into commercially grown apples. Thus there is potential for increasing local production of apples at reduced cost through biotechnology.

Consumer acceptance of GM foods has been investigated in a number of recent studies. However, Kolodinsky, DeSisto, and Narsana (2002) indicate results of these studies greatly vary. Their investigation into Vermont consumers' attitudes and responses to questions about genetic modification shows differences are attributable to wording of questions or phrasing which describes the technology.

Thus the complexity of questions surrounding consumer acceptance and trade-offs among attributes for locally grown produce, reduced pesticide applications, and genetic modification (GM; GMO) may depend upon phrasing of the attributes. Furthermore, if phrasing is important to acceptance, perhaps product labeling information may also impact purchase patterns. This study investigates the differences in consumer ratings of various apples and the trade-offs among the value of specific attributes when the products are described identically but labeled differently to separate sample groups, one as GM and the other as Reduced Environmental Impact.

Previous Studies

The effect of GM food labels on European consumer purchasing behavior was investigated by Noussair, Robin, and Ruffiex (2002). They found that the average bid submitted by study participants for appropriately labeled GM and non-GM chocolate bars was not statistically different. It is interesting to note that after labels indicating chocolate bars contain GM ingredients have been enlarged, bid amounts for the GM chocolate bars were 30 per-

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cent less than for the non-GM type, and 22 percent of study participants withdrew their bid entirely. However, the results indicated that about 78 percent of consumers offered a price at which they would purchase the genetically modified product.

Some European studies (Bredahl, Grunert, and Frewer 1998; Bredahl 2000) indicated that attitudes toward GM foods are not always based on evaluations of specific risks or benefits but rather on general socio-political attitudes. These studies found that negative reactions toward GM food were more likely to be common in cultures where these attitudes were well established. According to Bredahl, Grunert, and Frewer (1998), out of four European countries included in their study, consumers in Denmark and Germany had the most negative attitudes toward GM foods, followed by consumers in Britain and Italy. Burton et al. (2001) stated that consumers in the United Kingdom were willing to pay more money to avoid GM foods. In contrast to European countries, some consumers in developing countries were willing to pay a premium for GM foods (Li et al. 2002; Curtis, McCluskey, and Wahl 2004). According to Li et al. (2002), the market outlook for GM foods in China is optimistic, especially since younger members of the population were more willing to purchase GM foods having product-enhancing attributes.

It has also been found that consumers in the United States are more willing to accept GM foods than are consumers in Europe and Japan. An empirical study conducted by Hossain and Onyango (2004) on U.S. consumers' acceptance of GM foods suggest that American consumers are not decidedly opposed to food biotechnology if such foods provide additional nutritional benefits. Moreover, if GM foods offer significant benefits, these benefits can compensate for the perceived risks, resulting in a positive attitude toward GM food (Frewer et al. 1999). Other studies have indicated that when specific benefits are provided, some U.S. consumers may actually be willing to pay premiums for GM foods (Lusk et al. 2002; Lusk 2003). Lusk et al. (2001) found that 70 percent of their respondents were not willing to pay a premium to avoid GM foods.

According to Curtis, McCluskey, and Wahl (2004), differences between consumer attitudes toward GM foods were significant worldwide, ranging from price discounts of greater than 50 percent to a price premium of 38 percent. Baker and Burnhum (2001) point out that one strategy for increasing consumer acceptance of GM food products is to focus on products that have direct benefits for consumers. By studying consumer preferences for GM foods, they have found that those consumers who were most risk averse, most likely to believe that genetically modified organisms improve the quality or safety of food, and the most knowledgeable about biotechnology are more likely to accept GM foods. According to Baker and Mazzocco (2005), assuring consumers that GM food products are safe may require a multi-pronged strategy including such elements as additional research, education, certification, and branding.

In a study examining willingness to pay (accept) for GM foods, Moon, Balasabrumanian, and Rimal (2007) found a differential premium associated with perceived impact of the genetic modification. Consumers who perceived risks with GM foods required a larger price discount to accept the GM food than did consumers who perceived benefits from GM foods.

These studies and others, together with the development of disease-resistant apples, motivate an investigation into consumers' attitudes toward produce attributes and how these attitudes are affected by the phrasing of the product's description. Development of locally grown produce sources may be affected by consumers' preferences among product characteristics.

Methodology and Data

When examining consumer preferences, there are a number of available econometric techniques. Previous studies on new product development and identification of consumer preferences have mostly used such techniques as contingent valuation and conjoint analysis. In this study, conjoint analysis was applied as a survey-based modeling technique. Conjoint analysis is a useful approach for quantifying consumer preferences when there is a trade-off between different factors of potential importance. In so doing, researchers can identify the relative importance of each product attribute. This method has been widely used in many consumer research studies (Green and Rao 1971). The theoretical basis for conjoint analysis models is Lancaster's theory of consumer demand, which is based on the proposition that consumers value products because of the product's attributes, of which one may be price (Lancaster 1971).

Given that consumers may not be able to explicitly judge the importance of different attributes and how they may make trade-offs between different attributes, it is more appropriate to ask consumers to provide overall preference ratings of product profiles whose key attributes have been varied systematically, and then analyze these results statistically to understand the relative importance of the attributes. Using multiple ratings data for each respondent, the relationship between ratings and individual attributes can be estimated, and marginal rates of substitution between attributes can be evaluated. A general linear form of the rating-based conjoint model can be expressed by

$$(1)\quad P_i = a_{i0} + \sum_j a_{ij} Attribute_j + e_i,\ \ i = 1, \ldots, I,\ \ j = 1, \ldots, J,$$

where P_i is the utility or preference rating of the *i-th* individual, $Attribute_j$ represents the level of each of J attributes of the hypothetical product, and e_i is a random error term.

Generally, qualitative attributes in the model are represented by binary variables and quantitative attributes are represented by linear or quadratic specifications. The part-worth scores can be further analyzed to determine the relative importance of each attribute in the respondent's preference function:

$$(2)\quad RI_j = 100 \text{ x } \frac{UR_j}{\sum_{h=1}^{n} UR_h}$$

The relative factor importance score for each attribute (RI_j) is calculated by dividing the range of utility change estimates of different levels of the attribute j (UR_j) by the sum of such ranges for all product attributes ($\sum_{h=1}^{n} UR_h$). The sum of the relative factor importance scores of all attributes is 100 percent. After determining the contribution of each attribute to the consumer's overall evaluation, the researcher can then: (1) define the product profiles with the optimum combination of attributes and their levels; (2) indicate the relative contributions of attributes and each level to the overall evaluation of the product profile; (3) use consumers' estimates to predict market shares among product profiles with different combination of attribute levels; (4) aggregate potential customers who place similar importance on specific attributes into groups to define potential segments; and (5) identify marketing opportunities by exploring market potential for product profiles not currently available (Hair et al. 1992).

Selection of Attributes

Attributes are the key product characteristics that consumers consider when making purchase decisions. Given that products are treated as "bundles" of attributes in conjoint analysis, the first step in a conjoint experiment is selection of appropriate attributes and their levels. Previous studies indicate that consumers of food products are primarily concerned with price, quality, and safety attributes and are willing to pay a modest premium for chemical free or reduced-chemical produce (Baker and Crosbie 1994; Baker 1999; Kaye-Blake, Bicknell, and Saunders 2005; Kassardjian, Gamble, and Gunson 2005). These studies also suggest that quality factors such as color or taste would be of particular interest. Among other potential attributes are size, shape, consistency, texture, flavor, and brand appeal.

Based on the study objectives, findings from the literature review, results of a pilot study, and to insure that the number of hypothetical products is not overwhelming to the respondents, the following three attributes were selected for this study: price, place of production, and method of production.

Price and quality characteristics are attributes most commonly mentioned by consumers as major factors influencing their purchase decisions (Baker 1999). Thus price was included in the study as one of the most important trade-offs with other attributes. Price levels ($ per lb.) were selected to reflect a range paid by consumers in retail stores at the time of the study. Prices were defined as low ($1.39), medium ($1.59), and high ($1.79).

The second attribute, place of production, was included in the design because it was one of the main objectives of the study—to determine if place of production affects consumer preferences and purchase decisions. Place of production was introduced at two levels: locally grown, defined to participants as being grown within 150 miles of where it was purchased, and non-locally grown, defined as grown in other commercial apple growing areas of the United States.

The third selected attribute was method of production, with two attribute levels: conventional, meaning that apples were grown using common breeding techniques and normal chemical sprays, and genetically modified, meaning that apples were modified to include a gene cloned from a naturally occurring disease resistant apple, resulting in up to 60-percent less use of pesticide applications. This attribute was included in the study to investigate consumer preferences for GM products. To examine the effect of labeling language of GM food products on consumer preferences, two versions of the survey were designed (described in the "Data" section).

To fix levels of unobserved attributes, all hypothetical products were described to survey respondents as brightly colored, firm, fresh, appropriately sized, and blemish free. According to Orme (2006), fixing the levels of unobserved attributes increases the confidence in choices, and assures that differences in ratings are due to differences among manipulated attributes. All three attributes—place, method, and price—and their definitions were tested on a sample of undergraduate students for clarity.

Selection of Product Profile Presentation Form

There are three primary presentation methods of product profiles for conjoint analysis: paired comparison, trade-off method, and full-profile method. The trade-off method compares product attributes two at a time by ranking all level combinations. The major disadvantage of this method is that it requires respondents to make a large number of judgments for even a small number of levels, and prevents them from making realistic choices among product alternatives (Hair et al. 1992). The paired comparison method differs from the trade-off method by comparing product profiles instead of individual attributes. The full-profile method is a method of designing product profiles for evaluation by generating all possible combinations of attribute levels, and is the most popular method in conjoint analysis since it provides a more realistic description through defining levels of each attribute in a product profile. This method is recommended when the number of attributes is six or less (Hair et al. 1992). The full-profile method was implemented in this study. The selection of three attributes with the number of levels described above yields 12 product profiles.

Data

An online survey instrument was applied in this study to collect primary data. The survey was conducted in January, 2007 using Marketing Systems Group programming and services. The Marketing Systems Group (MSG) is a web-based survey hosting company recruiting survey participants from within their panel (http://www.m-s-g.com/). The qualified subjects for the survey were adult consumers 21 years of age and older with Illinois addresses. Selection of subjects was done from a random sample with no screening protocols. The surveys were posted to the panel until 400 surveys were completed. Anticipated time for taking and completing the survey was ten minutes. Two identical versions of the survey were offered to the targeted population, with identical descriptions of all products (see Figure 1). One version referred to the choice of the genetically modified apples as "reduced environmental impact" (REI), while the other version referred to it as "genetically modified" (GM). When collecting rating-based data, respondents were asked to rate product profiles on a scale of 1 to 10 (with 1 being the least desirable and 10 being the most desirable). A sample of the product profile presentations is shown in Figure 2.

Since the difference between the two versions was only in the language identifying the method of production, one subsample is referred to as the "GM group" and the other is referred to as the "REI group." The total number of completed surveys was 401, with 200 from GM group and 201 from REI group.

The descriptive statistics of respondents' socio-demographic characteristics are provided in Table 1. The category means and relative distribution of socio-demographic data are not statistically different between the two subsamples. Furthermore, the socio-demographic data is not statistically different from U.S. and Illinois population data, meaning that the two samples represent the population from which they are drawn. Thus any differences found in the respondents' preference functions and relative factor importance scores between the two groups can be attributed to referring to apple profiles as "GM" versus "REI."

APPLE PRODUCTION

Apples are among the most pesticide-intensive crops. Apple trees are annually treated for various diseases, insects, and other problems. Apple production requires up to 20 sprays per year at 10-to-14-day intervals throughout the growing season. If effective control measures are not applied regularly, up to 100 percent of the apple crop may be lost. As a result, apples are produced conventionally with normal pesticide application, or can be produced by applying new methods of production.

One alternative to pesticides is to develop apple varieties that are resistant to diseases. Apple scab is a disease that affects apples. Scab-resistant varieties have been developed. However, the disease-resistance genes are in apple varieties not normally grown for household use.

Through laboratory genetic modification, it is possible to transfer the disease resistant genes from the scab-resistant apple varieties into commonly grown apple varieties, resulting in a 60 percent reduction in pesticide use. These apples could be grown locally and with reduced environmental impact.

Figure 1. Description of Apple Production Method Included in Both Questionnaires.

Apple Description Locally Grown Reduced Environmental Impact $1.39 Your Rating: 1 2 3 4 5 6 7 8 9 10	Apple Description Locally Grown Genetically Modified $1.39 Your Rating: 1 2 3 4 5 6 7 8 9 10

Figure 2. Example of Product Profile Presentation.

It was assumed that the preference function can be presented by an additive model with no interaction effects, since a full factorial design was applied in this study, and part-worth values could be estimated using linear regression. Although not definitive proof of no interaction effects, Baker (1999) and Baker and Mazzocco (2005) have shown that tests for interaction effects among these and similar variables yield negative results. Under these assumptions and based on Equation 2, the preference function of *i-th* individual can be described as

$$(3)\quad P_i = a_{i1} + a_{i2}PLACE + a_{i3}METHOD + a_{i4}PRICE + e_i ,$$

where, $i = 1, 2, \ldots, I$; P_i is the preference rating for the *i-th* individual, on a scale of 1 to 10; PLACE is a binary variable representing the place of apple production, where PLACE = 0 if non-locally grown and 1 if locally grown; and METHOD is a binary variable representing the method of apple production, where METHOD = 0 if conventionally produced and 1 if genetically modified. PRICE is a continuous

Table 1. Socio-Demographic Characteristics of Respondents and Their Comparison, by Group.

Characteristic	GM Group	REI Group	Comparison of Means	p-value
Mean Age, years	40.90	42.23	t = 0.854	0.394
Gender, percent females	53.65	58.64	χ^2 = 0.969, df = 1	0.325
Marital Status, % married	57.89	56.02	χ^2 = 0.136, df = 1	0.712
Number of Respondents by Income Category			χ^2 = 7.603, df = 6	0.269
Less than $20,000	18	13		
$20,000–$40,000	37	48		
$40,000–$60,000	44	51		
$60,000–$80,000	41	26		
$80,000–$100,000	26	26		
$100,000–$120,000	13	18		
$120,000 and Over	8	5		
Missing	5	4		
Total	192	191		
Education Level			χ^2 = 3.847, df = 3	0.278
High School or Less	28	32		
Some College	67	69		
College	59	66		
Advanced	38	24		
Total	192	191		
Average Per Household				
Number of Adults	1.97	2.01	t = 0.454	0.650
Number of Children	0.80	0.83	t = 0.217	0.828

variable represented by the following levels: Low = $1.39, Medium = $1.59, and High = $1.79.

Based on the above-specified model, each respondent provided ratings for twelve products. These preference ratings (dependent variable) were then subjected to regression analysis on the variables price, place, and method (independent variables) for each individual using the conjoint analysis procedure in SPSS 15.0 for Windows. The results were converted into part-worth scores. For the continuous variable of price, this was accomplished by multiplying the estimated price coefficient for each individual by the difference between the minimum and maximum price. For the dummy variables place and method, the part-worth scores were respectively coefficients for the variables. The part-worth scores may be interpreted as the effect of each variable on an individual's preference for the product over the range of the variable.

Results and Discussion

The most common approach to interpreting part-worth or utility scores is to examine the aggregate preference function. The aggregate preference function is calculated based on Equation 3 by averaging the part-worth scores across all respondents. The regression estimates of the aggregate preference functions for the GM and REI groups are reported in Table 2.

Based on the aggregate preference functions specified in Table 2, the most and the least preferred product profiles can be identified and the accuracy of the conjoint model in predicting consumer preferences can be estimated. The average Pearson's R^2 statistic values for the GM and REI groups were 0.988 and 0.986, respectively, indicating a good fit of data.

On average, the highest rated apples by the GM group were apples that are locally grown, conventionally produced, and priced at $1.39 (with mean predicted rating of 7.57), as shown in Table 3. The lowest rated apples by the GM group were non-locally grown GM apples priced at $1.79 (with mean predicted rating of 4.53). Respondents in the REI group gave the highest rating to locally grown REI apples priced at $1.39 (with mean predicted rating of 7.93). Non-locally grown conventional apples priced at $1.79 were rated as the least preferred profile (with mean predicted rating of 4.73). This compares to a higher mean predicted rating of 5.44 for non-locally grown apples priced at $1.79 but grown with the genetic modification referred to as "REI."

Additional differences in the ratings due to the wording of the method attribute are noticeable. Conventional apples were preferred to genetically modified apples when genetically modified apples were referred as "GM". When the same genetically modified apples were referred as "REI", these apples were preferred to conventional apples.

Differences between predicted ratings of the two groups were found to be statistically significant at the ten-percent significance level for all product profiles except Profiles 1 and 9. Respondents of both groups rated locally grown conventional apples

Table 2. Aggregate Preference Functions by Group and Their Comparisons.

	GM Group		REI Group			
	Mean	St. Dev.	Mean	St. Dev.	t-test	p-value
Constant	12.050	0.305	12.372	0.351	0.373	0.709
Place						
Part-Worth: Local	0.466	0.032	0.484	0.036	0.246	0.806
Part-Worth: Non-local	–0.466	0.032	–0.484	0.036	0.246	0.806
Method						
Part-Worth: Conventional	0.296	0.032	–0.354	0.036	5.122	0.000
Part-Worth: GM/REI*	–0.296	0.032	0.354	0.036	5.122	0.000
Price						
Coefficient	–3.773	0.191	–3.799	0.219	0.049	0.961

* GM/REI means that apples were referred to as "GM" for GM group and as "REI" for REI group.

Table 3. Actual and Predicted Ratings by Group.

Product Description	Actual Ratings		Predicted Ratings	
	GM	REI	GM	REI
1. Local Conventional $1.39	7.64	7.23	7.57	7.22
2. Local Conventional $1.59	6.90	6.62	6.81	6.46
3. Local Conventional $1.79	6.14	5.76	6.06	5.70
4. Local GM/REI $1.39	6.89	7.81	6.98	7.93
5. Local GM/REI $1.59	6.21	7.20	6.22	7.17
6. Local GM/REI $1.79	5.33	6.28	5.47	6.41
7. Non-local Conventional $1.39	6.57	6.27	6.64	6.25
8. Non-local Conventional $1.59	5.84	5.42	5.88	5.49
9. Non-local Conventional $1.79	5.00	4.57	5.13	4.73
10. Non-local GM/REI $1.39	6.05	7.00	6.04	6.96
11. Non-local GM/REI $1.59	5.41	6.20	5.29	6.20
12. Non-local GM/REI $1.79	4.64	5.62	4.53	5.44

Note: GM/REI means that apples were referred to as "GM" for GM group and as "REI" for REI group.

priced at $1.39 (Profile 1) and non-locally grown conventional apples priced at $1.79 (Profile 9) not significantly differently. It is also important to note that out of all 12 apple profiles only one profile in each group was rated below 5.0 on a 1–10 rating scale. In both groups, these apples were non-locally grown and priced at $1.79. However, in the REI group, these apples were conventional while in the GM group, these apples were GM apples.

The aggregate preference function of the GM group indicates that the part-worth scores of locally grown and conventional apples have positive signs, while the estimated coefficient of price has a negative sign. This implies that on average the GM group has a higher preference for locally grown conventional apples at the low price compared to the other hypothetical apple profiles, which is not unexpected. The aggregate preference function of the REI group also indicates a higher preference for locally grown apples based on the positive sign of the part-worth score. However, conventional apples were less preferred than the REI apples.

The average part-worth scores of place and price attributes of the GM group were almost equal to the part-worth scores of the REI group (see Table 2). Both groups prefer locally grown apples to non-locally grown apples and lower prices to higher prices. However, there is some penalty associated with referring to genetically modified apples as "GM." The part-worth score of the method attribute has a negative sign for the GM apples and positive sign for the REI apples (−0.296 and 0.354 for GM and REI groups, respectively). To test the impact of the attribute wording on consumer preferences, the independent samples t-tests were computed with SPSS 15.0.

The comparison of the part-worth scores between the two aggregate preference functions resulted in t-statistic of 5.122, which was significant at the 0.001 probability level ($p = 0.000$). This result could be explained by the fact that referring to apples as GM causes consumers to become more negatively oriented towards apple products, while referring to apples as REI provides more positive association with the benefits of genetic modification technique, despite both groups having received the same explanation of the method immediately prior to conducting the profile ratings. This suggests that labeling language has to be carefully worded and should reflect both the method (GM) and the specific benefits (reduced environmental impact) it could provide. As a result, consumers would have more information to make a desirable and affordable choice of apples.

The results of the predicted ratings of various apple product combinations provided in Table 3 indicate that respondents of both groups rated locally grown GM and REI apples higher than non-locally grown conventional apples conditioned on equal prices. However, these differences in the ratings were found to be statistically significant only for the REI group ($t = 8.312$, $p = 0.000$). For the GM group, these differences in ratings were found to be not statistically significant ($t = 1.598$, $p = 0.112$). Given the aversion to the GM production method displayed by the GM group, the GM group appears to be willing to trade the conventional attribute for the local attribute.

Another way to evaluate various product attributes is by computing the monetary value of each attribute, as it was suggested by Baker and Mazzocco (2005). Following the methodology used in their study, the part-worth score of each product attribute was divided by the price coefficient, which represents the value of a $1.00 increase in the price per pound of apples. The computed monetary values of the method attribute shows that consumers would place a penalty of $0.08 per pound (−0.296/−3.773) when apples are referred to as "GM," compared to a premium of $0.09 per pound (0.354/−3.799) for "REI" apples. This $0.17 difference is additional evidence of the impact of attribute wording on consumers' preferences.

The penalties for the GM method of production may also be compared with the premiums for apples marketed as locally grown. The premiums associated with locally grown apples were $0.12 (0.466/−3.773) and $0.13 (0.484/−3.799) for the GM and REI groups, respectively. These results indicate that respondents in both groups were willing to pay a premium for locally grown apples, which is consistent with the previous findings by Brown (2003), and Schneider and Francis (2005). It is important to note that the GM group was willing to pay premiums for locally grown apples sufficient to offset the penalty associated with the GM method of production ($0.12 compared to −$0.08). These results indicate there is market potential for locally grown genetically modified apples.

Analysis of Relative Factor Importance Scores

In conjoint analysis, part-worth or utility scores provide only a rough estimate of how important each attribute level is in a consumer purchasing decision. Relative factor importance scores, as developed in Equation 2, allow the researcher to compare the importance of each attribute for either the individual consumer or to the aggregate group of consumers. In this study, the relative factor importance scores were

Table 4. Average Relative Factor Importance Scores and Their Comparisons by Group.

Attribute/Measure	GM Group	REI Group	t-test	p-value
Place	23.66	25.61	0.816	0.415
Method	39.17	33.76	2.073	0.039
Price	37.17	40.63	1.261	0.208

computed for each respondent and then averaged using the SPSS conjoint procedure. The averaged importance scores of all individuals are presented in Table 4.

The averages of the individual importance scores indicate that all three attributes were important to the consumers responding to the survey. For the GM group, the method attribute (39 percent) was almost as equally important as price (37 percent), followed by the place attribute (24 percent). These results support the findings of Baker and Burnham (2001) reporting that both attributes—price and GMO content—were approximately equal in their influence on consumer preferences. However, there were some differences in the attributes' importance scores between the GM and REI groups. For the REI group, price was the most important attribute, explaining 41 percent of variation in rating scores on average, followed by method (34 percent), and then place (26 percent).

Relative factor importance scores between the GM and REI groups were compared with the independent samples t-test procedure in SPSS 15.0. Statistically significant differences were found in the importance scores of the method attribute between the two groups (t = 2.073 with p = 0.039). It appears that respondents of the GM group place more importance on the method attribute than respondents of REI group. It suggests that when apples were referred to as "REI," consumers valued the benefit of genetic modification (reduced environmental impact) and were not as concerned with the method of production itself. As a result, they placed more value on price than on the other two attributes.

The comparison of the importance scores of the other two attributes between the GM and REI groups were found to be not statistically significant (t_{PLACE} = 0.816 with p = 0.415, and t_{PRICE} = 1.261 with p = 0.208), suggesting that respondents of both groups were similar to each other and valued both attributes (place and price) in the same way. Hence, the difference in their importance scores was due only to referring to genetically modified apples as "GM" versus "REI."

Impact of Socio-Demographic Characteristics

The influence of socio-demographic characteristics of respondents (age, gender, marital status, income category, and education level) on their preference functions was examined for each group using comparative analysis performed in SPSS with a one-way ANOVA procedure. First, the group variances were evaluated for homogeneity with Levene's test. Then the F-statistics were calculated to determine whether the means were significantly different from each other. To determine which pairs were significantly different, the pair-wise t-tests were computed. When more than two groups were compared, a Bonferroni multiple comparison test (assuming equal variances) or a Tamhane test (assuming unequal variances) was applied (SPSS n.d.).

Based on the ANOVA results, significant differences were found in the part-worth scores (F = 3.616, p = 0.007) and relative factor importance scores (F = 3.779, p = 0.006) of the method attribute among different age groups of the GM group respondents. Respondents' part-worth and relative factor importance scores of method attribute for both groups are presented in Table 5. Further post hoc tests indicated that respondents of age 65 and over show a much stronger preference for conventional apples than do respondents of all other age groups. The differences between part-worth scores of these age groups were found to be significant at the ten-percent probability level based on Tamhane test results. It was also found that respondents of age 65 and older place higher importance on method of production than do all other age groups. However, these differences in the REI group were found to be not statistically significant. Thus the reference to the benefit of the method of production (REI) negates the age effect commonly found by researchers of consumer acceptance of biotechnology.

Preference functions and relative factor importance scores for all three attributes were not influenced by the respondent's gender. It appears that the response of women and men to GM versus REI labeling were not significantly different. However, the comparisons of part-worth scores and relative factor importance scores based on the respondent's marital status resulted in some significant differences between married and unmarried respondents (see Table 6).

The part-worth scores for conventional and genetically modified apples were found to be significantly different between married and unmarried respondents at the five-percent level of probability (t = 4.458, p = 0.036 for the GM group, and t =

Table 5. Comparison of Part-Worth and Importance Scores of Method Attribute by Age.

	Age Group				
Attribute/Measure	21–25	26–34	35–49	50–64	65 & Over
Part-worth: GM	–0.193	–0.179	–0.111	–0.294	–1.522**
Part-worth: REI	–0.047	0.378	0.327	0.543	0.482
Importance scores, percent					
GM group	30.59	42.61	36.71	37.04	60.28*
REI group	37.79	38.44	29.55	29.84	32.73
Number of cases					
GM group	25	61	46	45	15
REI group	23	58	52	31	27

* Significant at 10% probability level.
* Significant at 1% probability level.

2.270, $p = 0.007$ for the REI group). This implies that unmarried respondents would pay a higher penalty to avoid GM method of production compared to married respondents.

According to their preference function, unmarried respondents in the GM group would pay a penalty of \$0.17 per pound (−0.546/−3.305) to avoid the GM method of production, compared to only a \$0.03 (−0.128/−4.085) penalty by married respondents. It is interesting to note that a \$0.13 premium that married respondents would be willing to pay for locally grown apples (0.517/−4.085) was sufficient to cover the \$0.10 penalty for GM method (\$0.13 − \$0.03). However, the \$0.12-per-pound premium unmarried respondents place on local production is not sufficient to cover the \$0.17 penalty for GM.

In the case of REI group, all respondents preferred REI apples to conventional apples. However, married respondents revealed a stronger preference for REI apples (part-worth score = 0.546) compared to unmarried respondents (part-worth score = 0.108).

The ANOVA results indicate no statistically significant differences between respondents' preference functions based on income and education. These results are consistent with previous studies results (Baker and Burnham 2001).

Research Implications

This study provides a number of contributions. It complements and extends in dimension the previous studies' results by analyzing consumer preferences specifically toward genetically modified products that are locally grown. The study results suggest that consumer preferences for apples are influenced by place and method of production. Although price is still one of the dominant attributes, it may play a different role for consumers who are willing to pay a premium for locally grown apples in conjunction with environmental benefits provided by the method of genetic modification.

The study contributes to the literature on the issues related to the labeling language of GM food. The study results suggest that labeling language has to be carefully worded. When apples are identified as "genetically modified," consumers value this attribute negatively. However, describing apples as "reduced environmental impact" results in a positive valuation of the same attribute. Therefore, when marketing GM products, providing consumers with more information, including both the method of production (GM) and the specific benefits of the genetic modification (less use of pesticides) allows consumers to make better purchase decisions among products. Of course, none of these results address

Table 6. Comparison of Part-Worths and Importance Scores of Respondents by Marital Status by Group.

Attribute/Measure	GM Group	REI Group
Part-Worth: Locally Grown		
Married	0.517	0.476
Unmarried	0.410	0.495
Difference	0.107	–0.019
Importance Scores of Place Attribute, percent		
Married	24.53	25.53
Unmarried	22.40	25.67
Difference	2.13	–0.86
Part-Worth: GM/REI		
Married	–0.128	0.546
Unmarried	–0.546	0.108
Difference	0.418*	0.438*
Importance Scores of Method Attribute, %		
Married	37.12	40.30
Unmarried	42.42	41.14
Difference	5.30	–0.84
Price Coefficient		
Married	–4.085	–3.884
Unmarried	–3.305	–3.691
Difference	–0.780	–0.193
Number of Cases	110	107

* Significant at 5% probability level.

the response to information compared to the silence on the issue of GM products, which is currently characteristic of U.S. produce markets.

The study also provides evidence of good market potential for locally grown produce, especially if is labeled as such. Coarse estimates of a $0.12–$0.13-per-pound premium for locally grown apples can be augmented by reduced production costs of disease-resistant varieties, providing more total value in the local supply chain. Furthermore, the results indicate that referring to the benefits of genetically modified products (reduced environmental impact, in this case) negates some of the common findings of other GM consumer response research, such as the age effect. The simple preference for the GM product when benefit-labeled should provoke further research in this area.

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