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Consumer Preferences and Trade-Offs for Locally Grown and Genetically Modified Apples: A Conjoint Analysis Approach

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Abstract

Using conjoint analysis methodology, this study used an online survey to measure consumers' preferences for the apple attributes as place of production, method of production, and price. The results of the conjoint analysis indicate that consumers are willing to make trade offs between the studied attributes. Segment analysis indicates Place-oriented consumers may be willing to pay 60% to 70% premiums for locally grown apples. The high consumer preferences for locally grown products combined with environmental benefits transferred through genetic modification provide an opportunity for producers to capture and build their markets, especially within certain market segments.

Keywords: conjoint analysis, consumer preferences, GM, locally grown

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Introduction

Midwestern U.S. fruit production is increasingly characterized by two contrasting dimensions. There is growing interest in locally grown food, suggesting growing demand. However, climate conditions in the Midwestern U.S. often favor the support of pests and diseases (such as apple scab), which thrive on fruit, requiring costly and intensive management and chemical applications to combat these challenges. Recently the successful use of biotechnology has resulted in the development of new disease-resistant commercial apple varieties by isolating and cloning the apple scab-resistance genes and transferring them into commercially grown apples. Thus, the increasing production of apples with less pesticide application (up to 60% less) using apple-to-apple gene technology is a feasible approach for the Midwestern apple sector. However, growers need to understand consumer perception of GM apples that provide for both reduced pesticide application and local production.

The main objective of this study is to investigate consumer preferences for scab-resistant genetically modified (GM) apples that are locally grown and the trade-offs among these attributes. A secondary objective is to develop consumer segments reflecting these preferences. Market participants will then be better positioned to make decisions regarding technology adoption, market segmentation, and product positioning.

Previous studies have indicated that GM food products are more acceptable if they are produced with reduced use of pesticides (Richardson-Harman et al., 1998; Kaye-Blake et al., 2005; Laureiro and Bugbee, 2005). On the other hand, results of many consumer surveys indicate that consumers are willing to pay a premium for locally grown products (Brown, 2003; Schneider and Francis, 2005). This begs the question as to whether these two findings hold there if the two attributes, environmental benefit through genetic modification and local production, are combined. That is, if GM products are produced locally, would it increase the level of consumer acceptance of such products? As far as we know, none of the previous studies have investigated the benefits of genetic modification with respect to local production. This study is the first attempt to investigate consumers' preferences for a combination of two product attributes–place and method of production. The results will elucidate whether consumers make distinctions between locally grown and non-locally grown products, and conventionally produced versus genetically modified products with environmental benefits such as reduced use of pesticides. By stressing specific local product characteristics, small farms and orchards may find significant growth opportunities that are available through product differentiation. For the Midwestern apple sector as well as for other small and midsize farmers, it would be valuable to have a better understanding of consumer preferences and behavior toward locally grown agricultural products. The results would provide producers information that would aid in production and marketing decisions.

Previous Studies

Biotechnology claims to have a great potential for farmers and ultimately for consumers. However, consumer acceptance of this technology is still not well understood. According to Curtis et al. (2004), differences between consumer attitudes towards GM foods are significant worldwide. Studies of consumers' price response to GM foods have results ranging from price discounts of greater than 50% to price premiums of 38%. Some studies have shown that genetic modification has been found to be more acceptable by consumers when it provides specific benefits. The empirical study conducted by Hossain and Onyango (2004) on U.S. consumers' acceptance of GM foods suggests 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 towards 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). It has also been found that acceptance of GM products is greater if the gene introduced into a variety is derived from the same plant (Gamble and Gunson, 2002).

A few recent studies have used apples as a genetically modified experimental product. Taking into account that close to 100% of apples sold in New Zealand were sprayed with pesticides, Richardson-Harman et al. (1998) found lack of awareness of the use of pesticides on apples among New Zealand consumers. Thirty-six percent of their respondents indicated that they would like to see genetic engineering used to reduce pest damage of apples. A majority of their respondents also stated that they would eat an apple that had been genetically engineered to increase size, improve flavor, and reduce chemical residues. Kassardjian et al. (2005) evaluated consumer willingness to purchase GM apples using experimental auctions on 80 New Zealand consumers. The apples were introduced to consumers as resistant to pests, eliminating any need for any chemical sprays, and as GM apples with a gene coming from another apple. Results showed that a majority of participants were ready to pay a premium for these GM apples. However, generalizability of these results to Midwestern U.S consumers is not certain. Furthermore, the added attribute of "local" production and the trade offs among these attributes remains unknown.

Brown (2003) indicated that marketing local products should stress quality, freshness, and price competitiveness, and must appeal to environmentalists and consumers supporting family farms. It was reported that 16% of their study respondents would pay a 5% premium, and 5% of respondents would pay a 10% premium for local foods. Similarly, Schneider and Francis (2005) found that consumers were willing to pay a 10% price premium for locally grown foods.

Loureiro and Hine (2001) assessed consumer's willingness to pay for a labeled value-added potato that could be marketed as organic, GMO-free, or Colorado-Grown. They found that consumers were willing to pay a higher premium for local Colorado-Grown potatoes.

Results of the above studies are used herein to focus on hypothetical GM apples requiring reduced pesticide applications while providing a basis for serving an expanding market for local production. The emphasis is on the trade-offs among these attributes by Midwestern U.S. consumers in the context of price premiums and discounts to value the attributes. Would consumers accept GM products resulting in less use of pesticides and reduced environmental impact in combination with being locally grown as a high quality product? Would any price penalty for being GM be offset by a price premium for being locally grown? These types of questions are addressed in this study.

Method

There are few available econometric techniques to model consumer preferences. Previous studies on new product development and identification of consumer preferences have mostly focused on such techniques as contingent valuation and conjoint analysis. Contingent valuation techniques are usually used when determining consumer willingness-to-pay for a product or service (Loureiro and Hine, 2001; Louriero and Bugbee, 2005). The willingness-to-pay approach frequently employs a questionnaire asking survey respondents to choose a price point at which they would purchase a hypothetical product.

In contrast, conjoint analysis is a multivariate technique applied to estimate how respondents develop preferences for products and services (Hair et al., 1992). The conceptual 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 products' characteristics (Lancaster, 1971), one of which may be price. Therefore, in conjoint analysis a series of products is described to survey participants in terms of the products' attributes and the level of each attribute. Respondents score (rank or rate) each product given its combination of attributes and the relative scores are compared to identify preferences for attribute levels and the trade-offs among the attribute levels. Lancaster characteristics models have been used in a number of recent studies of GM foods (Baker, 1999; Baker and Burnham, 2001; Baker and Mazzocco, 2005) and are applied in this study because they directly yield answers to the research questions. The major steps of applying Lancaster characteristic models are the following: (1) construction of product profiles; (2) data collection; and (3) model specification and estimation.

Construction of Product Profiles

Attributes are the key product characteristics consumers consider when making a purchase decision. 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 chemical reduced produce (Baker and Crosbie, 1994; Baker, 1999; Kaye-Blake et al., 2005; Kassardjian et al., 2005). Among other potential attributes are size, shape, color, consistency, texture, flavor, and brand appeal. Due to the large number of attributes and possible levels representing each attribute, the number of hypothetical product profiles could be very high. As Quester and Smart (1998) indicated, a key to the reliability of conjoint output is to select the appropriate product attributes with realistic attribute levels. Based on the study objectives, findings from the previous studies, and to insure that the number of hypothetical products is not overwhelming to the respondents, the following three attributes were selected for the purpose of this study: price, place of production, and method of production (Table 1).

Table 1: Attributes and Their Levels Used in the Study

Attribute	Levels
Place of production	Locally grown
	Non-locally grown
Method of production	Conventional
	Genetically modified (GM)
Price, per pound (USD)	$1.39
	$1.59
	$1.79

Price and quality characteristics are attributes usually 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 tradeoffs with other attributes. Price levels were selected to reflect a range paid by consumers in retail stores at the time of the study. These 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 one of the main objectives of the study is to determine whether place of production affects consumer preferences and their purchase decisions. Place of production was introduced at two levels: (1) locally grown, defined for this study as apples grown within 150 miles of the place of purchase, and (2) non-locally grown, defined as being grown in other commercial apple growing areas of the U.S.

The third attribute was method of production, with two attribute levels: (1) conventional, meaning that apples were grown using common breeding techniques and normal chemical sprays; and (2) genetically modified, meaning that apples were modified to include a gene cloned from a naturally occurring disease resistant apple, resulting in up to 60% less use of pesticide applications. This attribute was included in the study to investigate consumer preferences for GM products.

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.

The full-profile method, as a method of designing product profiles for evaluation, was used in this study by generating all possible combinations of attribute levels. This method is the most popular method in conjoint analysis because it provides more realistic descriptions through defining levels of each attribute in a product profile, and is recommended when the number of attributes is six or less (Hair et al., 1992). The selection of three attributes with two or three levels each (see Table 1) yielded 12 product profiles (2 x 2 x 3 = 12). 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). Figure 1 is an example of a product profile presentation.

Apple Description:
Locally Grown
Genetically Modified
$1.39

Your Rating: 1 2 3 4 5 6 7 8 9 10

Figure 1: Example of Rating-Based Product Presentation

Data Collection

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/). Although early adoption rates of internet usage may cause some researchers to believe that web-based surveys have an inherent sample bias, Sethuraman et al. have recently shown that “no practical differences in attribute preferences were observed between …” online and traditional rating-based conjoint surveys and that the use of online data collection was “superior to … a traditional … method on the basis of internal consistency and predictive validity (p. 602).”

Conjoint analysis surveys are typically designed to present consumers with realistic product choices. In this study consumers were asked to express their preferences for the introduced products by rating alternative products. Multiple observations for each subject permit the estimation of a preference function (regression) for each individual and an estimate of how each attribute is valued.

While traditional conjoint analysis has no sample size requirements and could be utilized for a single respondent (Hair et al., 1992), the larger sample size enhances the reliability of the results and allows the researcher to make some generalizations. To provide reliable estimates, Green and Srinavasan (1978) suggest a minimum sample of 100 respondents. Some studies suggest using the ratio of the number of parameters to the number of respondents when identifying the sample size (Xu and Yuan, 2001). The rule of thumb for the ratio is between 5 and 10. With two attributes with two levels and one attribute with three levels, we would have a total of 5 parameters (the total number of levels minus the total number of attributes plus one). Then we need at least 25 respondents (5 parameters x 5) to complete the study. The target sample size for this study is 200, which is large enough to provide reliable data.

The number of observations per respondent is the number of product profiles each respondent rates. The minimum number of product profiles depends on the number of attributes and attribute levels. In general, it is suggested that the number of profiles is at least 1.5 times the number of parameters (Xu and Yuan, 2001). With five parameters to be estimated, this guidance indicates a minimum number of product profiles per respondent of approximately eight. In this study, a full factorial design resulted in twelve product profiles, which is a sufficient number to keep the measurement error small. Previous similar studies have used eight to twelve product profiles (Baker, 1999; Baker and Burnham, 2001; Baker and Mazzocco, 2005).

The qualified subjects for our 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. Marketing System Groups identifyed respondents only based on their age and residency. The surveys were posted until 200 surveys were completed.

The survey assessed two types of information: (a) information about individual consumer preferences for hypothetical apples based on the combinations of different attributes and their levels; and (b) information about consumer socio-demographic characteristics.

Each survey included a letter with an instruction sheet, a description of product attributes, product rating form, and a consent statement form. Comparisons of socio-demographic characteristics among U.S. population, Illinois population, and survey respondents are presented in Table 2.

The results indicated that survey participants were more highly educated compared to the U.S. and Illinois populations. However, other socio-demographic characteristics of respondents, such as median age and income category, proportion of women, and proportion married were roughly similar to the socio-demographic characteristics of the U.S. and Illinois populations. Thus, the sample appears to provide good representation of the Illinois population within the dimensions of these characteristics.

Table 2: Socio-Demographic Characteristics of the U.S. and Illinois Populations, and Survey Participants

Characteristics	U.S. Population[a]	Illinois Population[a]	Survey Sample
Gender, % female	51.01	51.04	53.65
Median Age, years	36.40	35.60	37.0
Marital Status, % married	53.40	52.90	57.89
Median Income, $	46,242	50,260	40,000-60,000
Education Level[b], %			
High School or Less	45.3	42.4	14.44
Some College	27.5	28.3	34.76
College	17.2	18.3	31.02
Advanced	10.0	10.9	19.79

[a] Source: U.S. Census Bureau, 2005 American Community Survey.
[b] The distribution of the U.S. and Illinois populations by level of education includes only people of age 25 and over.

Model Specification

The general model is introduced in the form of a consumer's utility function, which provides a convenient framework for evaluating consumers' preferences for alternative products. It assumes that a rational consumer will always maximize his/her utility by selecting the most preferred product from the set of alternative products based on the product's attributes, subject to the budget constraints.

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 attributes have been varied systematically, and then analyze these results statistically to understand the importance of the attributes. A general linear form of the rating-based conjoint model following Lancaster (1971) can be expressed by the following equation:

$$1)\ P_i = a_{i0} + \sum_j a_{ij} Attribute_j + e_i, \qquad i = 1, \ldots, I,$$

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 $(j = 1, \ldots, J)$, and e_i is a random error term. 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 can be estimated using linear regression. Under these assumptions, the preference function of *i-th* individual can be described as the following:

$$2)\ P_i = a_{i0} + a_{i1}PLACE + a_{i2}METHOD + a_{i3}PRICE + e_i \qquad i = 1, 2, \ldots, I$$

where P_i is a 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 (0 if non-locally grown, 1 if locally-grown); *METHOD* is a binary variable representing the method of apple production (0 if conventionally produced, 1 if genetically modified); *PRICE* is a continuous variable represented by three levels (low - \$1.39 per pound, medium - \$1.59 per pound, and high - \$1.79 per pound).

Applied conjoint analysis often includes interaction variables to identify interaction effects among the principle attributes. Baker (1999), Baker and Burnham (2001) and Baker and Mazzocco (2005) have shown the absence of interaction affects among the attributes used in this study. Therefore, we assume no interaction effects in the specified model. Furthermore, interaction affects cannot be estimated in a full factorial design with a small number of product profiles, especially when two of the three attributes are binary, having an end-point design and no intermediate values.

Based on the above specified model, each respondent provided twelve product ratings on a scale of one to ten. These product ratings (dependent variable) were then subjected to regression analysis on the price and binary variables (place and method) for each individual. The survey data were analyzed using the conjoint analysis procedure in SPSS 15.0 for Windows, which uses OLS. The regression results then were converted into part-worth scores. For the continuous variable price, this was accomplished by multiplying the price coefficient by the difference between the minimum and maximum price. For the binary variables place and method, the part-worth scores were coefficients for the respective variables. The part-worth or utility scores may be interpreted as the impact of each variable on an individual's preference for the product over the range of the variable. For example, for the price variable the part-worth indicates the estimated change in the product rating for each individual based on the difference between the maximum and minimum price levels.

Results

Invalid data resulted in the elimination of eight observations, reducing the sample size to 192. To estimate the accuracy of conjoint models in predicting consumer preferences for products, the Pearson's *R* and Kendall's tau statistics were computed as two measurements of correlation between the observed and estimated preferences. Both indicate how well the conjoint models fit the data for the overall sample and for each individual for validity purposes.

In our conjoint study, the Pearson's *R* statistic value for the overall model was equal to 0.994, indicating a good fit of data. The Pearson's R statistic was found to be significant for all individual cases having a Pearson's R greater than or equal to 0.50 ($p<0.05$). More than 80% of all cases had Pearson's R higher than 0.75 ($p<0.001$). However, 8 % had Pearson's R values less than 0.50, indicating poor correlations between observed and predicted ratings. These respondents were found to be "inconsistent" in their rating task. The analyses were rerun with these respondents excluded as suggested by Moskowitz et al. (2002). This adjustment made no difference to the findings. Therefore, the data were analyzed with these cases included. Table 3 reports the regression estimates of the aggregate preference function, which are the mean coefficient estimates and part-worths of the 192 individual regressions.

As expected, the signs of the part-worth scores of locally grown and conventionally produced apples have positive values, while the estimated coefficient of price has a negative value. This implies that, on average, respondents give a higher rating to

Table 3: Regression Estimates of Aggregate Preference Function

	Mean	St. Dev.
Constant	12.050	0.305
Place:		
Part-Worth: Local	0.466	0.032
Part-Worth: Non-local	-0.466	0.032
Method:		
Part-Worth: Conventional	0.296	0.032
Part-Worth: GM	-0.296	0.032
Price:		
Coefficient	-3.773	0.191
Part-Worth: $1.39	-5.244	0.265
Part-Worth: $1.59	-5.999	0.304
Part-Worth: $1.79	-6.753	0.342

locally grown, conventionally produced apples at the low price compared to the other hypothetical apple profiles.

Based on the aggregate preference function, the preference rating of any combination of attributes and their levels (1 to 10) can be calculated (see Table 4). For example, the highest rated apples (locally grown, conventionally produced, and priced at the lowest price) have a mean predicted rating of 7.57. The lowest rated apples (non-locally grown, GM, and priced at the highest price level) have a mean predicted rating of 4.53.

Table 4: Actual and Predicted Ratings of Apple Profiles

	Actual Ratings		Predicted Ratings	
Product Profile	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**
1. Locally Grown Conventional $1.39	7.64	2.171	7.57	2.022
2. Locally Grown Conventional $1.59	6.90	2.069	6.81	1.866
3. Locally Grown Conventional $1.79	6.14	2.518	6.06	2.219
4. Locally Grown GM $1.39	6.89	2.615	6.98	2.410
5. Locally Grown GM $1.59	6.21	2.251	6.22	2.088
6. Locally Grown GM $1.79	5.33	2.311	5.47	2.225
7. Non-locally Grown Conventional $1.39	6.57	2.238	6.64	2.123
8. Non-locally Grown Conventional $1.59	5.84	2.106	5.88	2.020
9. Non-locally Grown Conventional $1.79	5.00	2.463	5.13	2.387
10. Non-locally Grown GM $1.39	6.05	2.439	6.04	2.635
11. Non-locally Grown GM $1.59	5.41	2.106	5.29	2.380
12. Non-locally Grown GM $1.79	4.64	2.311	4.53	2.538
Pearson's R statistic = 0.994, p = 0.000; Kendall's tau statistic = 0.939, p = 0.000				

From Table 4 it is clear that conventional production is preferred to GM production when other variables are held constant. A pair-wise t-test shows the differences in product ratings is significant at the 1% probability level (t =3.208, p=0.003). This finding is consistent with expectations and the literature cited earlier.
To determine if the differences in ratings of locally grown and non-locally apples were statistically significant, pair-wise t-tests were performed. The t-test results indicated that differences in mean ratings of locally grown and non-locally grown apples (with all other variables held constant) were statistically significant at 0.001 probability level (t = 9.189 with p = 0.000). The study results were consistent with the findings of Gallons et al. (1997), Brown (2003), Schneider and Francis (2005), which report a high level of consumer interest in purchasing locally grown/produced food from farmers' markets, local grocery stores, local restaurants, and directly from farms and are willing to pay a premium for locally grown products.

However, it is particularly noteworthy that respondents indicated no statistically significant difference in product ratings for locally grown GM apples compared to non-locally grown conventional apples when prices are held constant (t=1.598, p=0.112) As indicated in Table 4, any leaning one might have toward accepting a t-value in this range would point toward apparent higher ratings for the locally grown GM product over the non-locally grown conventional product.

Another way to evaluate various product attributes is by computing the monetary value of each attribute, as was suggested by Baker and Mazzocco (2005). By 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 divided by -3.773) on GM apples. However, it was found that the premium associated with marketing apples as locally grown was $0.12 (0.466 divided by -3.773), sufficient to offset the penalty associated with the GM method of production ($0.12 + (-$0.08) = $0.04).

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, calculated by dividing variation in the preference rating due to each individual attribute by total variation in the preference rating due to all attributes, allow the researcher to compare the importance of each attribute to either the individual consumer or to the aggregate group of consumers. Relative factor importance scores for an overall sample can be computed in SPSS in two different ways. One way of computation is to average all individual relative factor importance scores. Another way is to compute relative factor importance scores from average part-worth scores. Orme (2002) suggests that when summarizing attribute importance scores it is better to compute importance scores for respondents individually first and then average them. This way of computation indicates that method attribute (39%) was almost equally important as price (37%), followed by place attribute (24%). 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 product ratings.

Table 5: Relative Factor Importance Scores

Attribute/ Relative Factor Importance Score	Average of Individual Importance Scores, %
Place	23.66
Method	39.17
Price	37.17

Comparison of Demographic Characteristics

The study also examines the relationships between consumer preferences and consumer socio-demographic characteristics, such as gender, age, marital status, income category, level of education, number of adults and children in household. Previously, no consistent findings were observed on the influence of socio-demographic characteristics on consumer acceptance of GM foods. Some studies (Schaffner et al., 1998; Engel et al., 1995; Barton and Pearse, 2003; Baker and Mazzocco, 2005) reported that socio-economic factors affect consumer preferences due to their influence on consumer behavior; while others did not (Kolodinsky et al., 2002; Baker and Burnham, 2001).

One advantage of traditional conjoint analysis is the ability of the researcher to evaluate each respondent's preference function. Using the conjoint analysis procedure in SPSS 15.0, individual part-worth scores for each of the 192 respondents were computed and examined, and then compared with respect to age group, gender, marital status, income category, and education level of respondents 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, 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) were used as more appropriate tests, since the probability of Type I error can be guaranteed not to exceed a certain level of significance only individually or for each pair-wise comparison separately, but not for the whole family of comparisons (http://www.spss.com/complex_samples/data_analysis.htm).

The analysis of individual preference functions of respondents by gender, income category and level of education revealed no significant differences, which is consistent with previous results of Baker and Burnham (2001). However, some differences were noted with respect to age and marital status. Respondents' part-worth and relative factor importance scores by age group are presented in Table 6. Based on the ANOVA results, significant differences were found in the part-worth scores and relative factor importance scores of the method attribute among different age groups of respondents. Further *post hoc* tests indicated that respondents of age 65 and over show much stronger preferences for conventional apples than respondents of all other age groups, except of the age group of 50-64. The differences between part-worth scores of these groups were found to be significant at 10% probability level based on Tamhane test results. It was also found that respondents of age 65 and older value the importance of method of production significantly higher than all other age groups except the age group of 26-34 (Tamhane test results were significant at 5% probability level). Statistically significant differences were also found in the relative factor importance scores of the price attribute between respondents of age of 35-49 and 65 and older. Respondents of age 35-49 were almost doubly influenced by price compared to respondents of age 65 and older (Tamhane test result was significant at 5% probability level).

Table 6: Part-worth and Importance Scores of Respondents by Age

	Age				
Attribute/Measure	**21-25**	**26-34**	**35-49**	**50-64**	**65 & Over**
Number of Cases	25	61	46	45	15
Constant	11.805	10.805	13.174	13.432	9.935
Place:					
Locally Grown	0.540	0.460	0.390	0.472	0.578
Non-locally Grown	-0.540	-0.460	-0.390	-0.472	-0.578
Importance Score,%	29.33	22.74	19.65	28.23	16.54
Method:					
Conventional**	0.193	0.179	0.111	0.294	1.522
GM**	-0.193	-0.179	-0.111	-0.294	-1.522
Importance Score, %*	30.59	42.61	36.71	37.04	60.28
Price:					
Coefficient	-3.550	-2.992	-4.484	-4.444	-3.125
Importance Score, %**	40.08	34.65	43.64	37.04	23.18

* Tamhane test result is significant at 5% probability level
**Tamhane test result is significant at 10% probability level

Table 7: Part-worth and Importance Scores of Respondents by Marital Status

	Part-Worth Score		
Attribute/Measure	**Married**	**Unmarried**	**Difference**
Constant	12.566	11.255	
Place			
Locally Grown	0.517	0.410	0.107
Non-locally Grown	-0.517	-0.410	-0.107
Importance Score, %	24.53	22.40	2.13
Method			
Conventional	0.128	0.546	-0.418*
GM	-0.128	-0.546	0.418*
Importance Score, %	37.12	42.42	5.30
Price			
Coefficient	-4.085	-3.305	-0.780
Importance Score, %	38.35	35.17	3.18
Number of Cases	110	80	

* Significant at 5% probability level

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, as shown in Tables 7. The part-worth scores for conventional and GM apples were found to be significantly different between married and unmarried respondents at the 5% of probability level (t =4.458, p = 0.036). 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 would pay a penalty of $0.17 per pound (-0.546 divided by -3.305) to avoid GM method of production compared to only the $0.03 (0.108 divided by -3.691) 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 divided by -4.085= $0.13) was sufficient enough to cover the penalty for the GM method ($0.13 - $0.03 = $0.10). However, it would not be sufficient for unmarried respondents ($0.12 - $0.17 = -$0.05).

Consumer Segmentation

The results of the conjoint analysis on the individual level were also used to determine the existence of groups of respondents who were different from each other based on their relative factor importance scores. Cluster analysis was performed to classify consumers into homogeneous groups based on their relative factor importance scores. The data were analyzed in SPSS 15.0 using the K-means clustering algorithm. In this study, three-cluster and four-cluster solutions were evaluated. It revealed that there were many respondents in the sample (73 out of 192) to whom all three attributes were roughly equally important. Therefore, it was important to group these respondents into a separate market segment so that their preference functions and socio-demographic characteristics can be analyzed separately. As a result, a four-cluster solution with 36 respondents in the first cluster, 44 respondents in the second cluster, 39 respondents in the third cluster, and 73 respondents in the forth cluster was chosen for further examination.

The first market segment, referred to as "Place-oriented", was defined by consumers who consider place as the most important attribute. The second and third segments were labeled as "Method-oriented" and "Price-oriented", since consumers of these segments were influenced the most by method of production and price, respectively. The forth segment was represented by consumers who show relatively the same importance scores across all three attributes and was labeled as "Balanced." The results of the segment analysis are presented in Table 8.

To identify if there were any statistically significant differences in the preference functions and socio-demographic characteristics of respondents among the segments, the appropriate statistical tests were performed and are reported in Table 9. Statistically significant differences were found in the age (p=0.033) and apple consumption (p=0.053) of respondents among the market segments based on the ANOVA test results. Further analysis implies that statistically significant differences in respondent's age were only confirmed between the Price-oriented segment and the Balanced segment (Bonferroni test was significant at 10% probability level with p=0.058). It appears that, on average, the Price-oriented consumer is older than the Balanced consumer. The Balanced consumer also consumes more apples per week than the Price-oriented consumer (Bonferroni test was significant at 10% probability level, p=0.099).

Table 8: Average Utility Scores, Importance Scores, and Socio-Demographic Characteristics of Respondents by Market Segment

Variable/Measure	Segment 1 Place-Oriented (N=36)[a]	Segment 2 Method-Oriented (N=44)	Segment 3 Price-Oriented (N=39)	Segment 4 Balanced (N=73)
Constant	8.08 (4.21)[b]	7.16 (3.31)	20.56(10.67)	12.41(6.16)
Place:				
Locally Grown	1.23 (1.10)	0.28 (0.40)	0.20 (0.38)	0.34 (0.44)
Non-locally Grown	-1.23 (1.10)	-0.28 (0.40)	-0.20 (0.38)	-0.34(0.44)
Importance Score, %	62.78	10.38	10.70	19.30
Method:				
Conventional	0.25 (0.77)	1.13 (2.11)	-0.03 (0.36)	-0.01(0.13)
GM	-0.25 (0.77)	-1.13 (2.11)	0.03 (0.36)	0.01 (0.13)
Importance Score, %	22.98	77.93	9.00	39.90
Price:				
Coefficient	-1.27 (2.46)	-0.91 (1.96)	-8.86 (6.90)	-4.02 (3.90)
Importance Score, %	14.25	11.69	80.30	40.80
Socio-Demographics:				
Age	39.14	43.52	45.26	37.90
Females, %	63.89	59.09	53.85	45.21
Married, %	61.11	47.73	60.53	61.11
Income Category	2.32	2.79	2.41	2.57
Education Level	2.42	2.57	2.49	2.66
Per Household:				
Number of Adults	1.97	2.02	1.92	1.97
Number of Children	0.94	0.76	0.64	0.81
Weekly Apple Consumption	5.46	7.16	4.08	6.90

[a] N is the number of respondents in the segment
[b] Standard deviations are shown in parentheses

Table 9: ANOVA and Chi-Square Test Results of Utility Scores and Socio-Demographic Characteristics of Respondents among Market Segments

Variables/Measure	*F-values*	*p-values*
Attribute's Part-Worth Score:		
Place	24.124	0.000
Method	8.517	0.000
Price	30.559	0.000
Age	2.973	0.033
Per Household:		
Number of Adults	0.115	0.951
Number of Children	0.459	0.711
Weekly Apple Consumption	2.605	0.053
	Pearson χ^2	*p (2- tailed)*
Gender	4.135	0.247
Marital Status	2.409	0.492
Income Category	13.749	0.317
Education Level	11.025	0.274

The Place-Oriented Segment

The apple preferences of the Place-oriented consumers were mainly determined by the place attribute, with an average importance score for place of 62.78%.The second most important attribute for these consumers was method of production (22.97%) followed by price (14.25%). The results (Table 8) indicate that there is a high premium associated with marketing apples as locally grown to the Place-oriented consumer segment. On average, the Place-oriented consumer would pay a $0.97 premium per pound for locally grown apples (1.23 / -1.27). This amount compares to a $0.20 penalty these consumers would place on GM versus conventional (-0.25/ -1.27 = $0.20). This 60% to 70% premium (over $1.59 or $1.39, respectively) should be attractive to marketers of locally grown produce.

The Method-Oriented Segment

The preferences of the Method-oriented respondents were primarily determined by the method attribute, with an average importance score of 77.93%. Place and price attributes were almost equally important for this market segment (10.38% and 11.69%, respectively). The results indicate that there was a strong penalty associated with genetic modification. The average part-worth score of the method attribute for this segment was -1.13 resulting in a relative factor importance score of 77.93%. The Method-oriented respondents would impose a $1.24 penalty on GM apples (1.13/ -0.91). In this case, a premium of $0.31 (0.28/ -0.91) associated with marketing apples as locally grown would not be enough to cover the penalty associated with GM method. It suggests that these consumers would not buy GM apples at any reasonable market price.

The Price-Oriented Segment

The Price-oriented respondents were consumers who were more influenced by the price attribute. As a result, the price attribute accounted for about 80% of variation in their preference function. Place was the second most important attribute (10.70%) followed by method (9%). It is interesting to note that the Price-oriented consumers place almost no penalty ($0.003) to avoid GM apples, meaning that they would most likely purchase GM apples if these apples are priced low.

The Balanced Segment

The Balanced consumers do not exhibit strong preferences for any single product attribute. They placed almost equal (about 40%) values on the relative factor importance of price and method attributes, and 20% on place. On average, the part-worth score for GM apples was close to zero (-0.01), indicating that there was almost no penalty for GM method of production among Balanced consumers.

In spite of the fact that most of the differences in personal consumers' characteristics among the market segments were found to be not statistically significant, it can be suggested for the future research to identify what other factors might influence consumer behavior so that they value the attribute with such difference.

Simulation Analysis Results

As a final stage of the conjoint analysis, the part-worth scores were used as an input for predicting expected preference shares of commercially feasible products. To compute expected preference shares for apple profiles, the conjoint procedure in SPSS 15.0 was used with application of the following three methods: maximum utility, Bradley-Terry-Luce, and logit. The results of all three simulation models have shown a high consumer preference share for locally grown GM apples priced at the low price level. Based on the maximum utility model, the highest expected preference shares were given to locally grown conventionally produced apples priced at the low price (product profile 1) and locally grown GM apples priced at the low price (product profile 4), as shown in Figure 2 (profiles are described in Table 4). As expected, conventional apples were given a little higher preference share compared to GM apples (about 34% compared to 30%). It is important to point out that the results of all three simulation models have reported a high consumer preference share for locally grown GM apples priced at the low price. Thus, it can be concluded that there is a good potential for this hypothetical new product to succeed in the market place if it carries a low price.

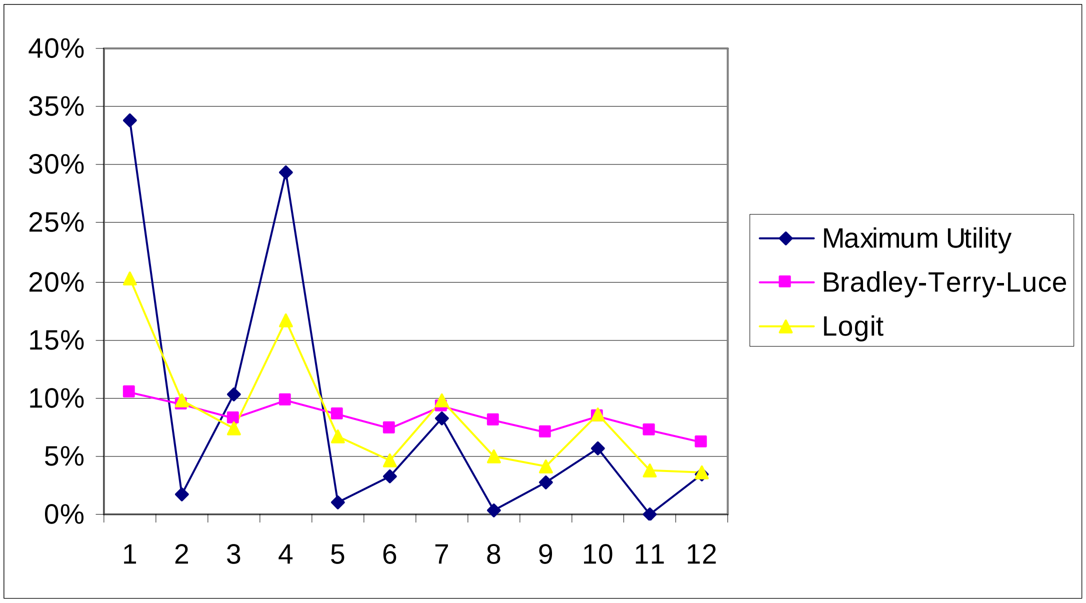

Figure 2: Expected Preference Shares of Apple Profiles (See Table 4)

Conclusions and Implications

This study complements and extends previous studies' results by analyzing consumer preferences and purchasing decisions specifically toward genetically modified products that are locally grown. The study results show that consumer preferences for apples are influenced by place and method of production attributes. Respondents were willing to make trade-offs between these attributes. While price is still one of the most important attributes, it may play a lesser role for consumers who are willing to pay a premium for locally grown apples with the combination of environmental benefits provided by genetic modification.

The high consumer preferences for locally grown products combined with the benefits of genetic modification provide a great opportunity for Illinois producers, as well as for other producers, to expand their production. Apple producers could take advantage of planting and growing new GM apple varieties resistant to the scab disease to increase production, to reduce labor and pesticides application costs, and to expand market potential.

The results also clearly indicated the need for a targeted approach to consumer markets. Although the differences in socio-demographic characteristics of respondents among the market segments were found to be not statistically significant, segmenting consumers into four well-defined market segments on the basis of product attribute importance is a valuable contribution of this research. Results indicate there is potential growth in local production by aligning product offerings with targeted segments.

Limitations and Directions for Future Research

The conclusions developed herein must be considered in light of the limitations of the study. The nature of the hypothetical products used to evaluate consumer preferences is one such limitation. Another limitation is that only one product (apples) was used in this research. Thus, it is possible that influence of method of production and place of production on consumer preference for GM foods might not be generalizable to a broad array of products. It is also important to consider that although the conjoint analysis method is a useful and effective method to assess consumer preferences for GM foods, this research approach has some limitations. One such limitation, which is typical for all stated preference research approaches, is to decide which attributes to include in the study design. In this study, the levels of unobserved attributes were fixed by describing hypothetical apples as brightly colored, firm, fresh, appropriately sized, and blemish free. However, it is still possible that there are other attributes of apples that are important to some consumers beyond those considered in this study.

Nonetheless, this study expands on the limited research relating to the combination of place and method of production as product attributes. Identifying the socio-demographic or other markers indicating segment membership can have significant value for managers pursuing markets. Factors to consider may include consumer knowledge, beliefs, and attitudes, such as trust.

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References

Baker, G.A. "Consumer Preferences for Food Safety Attributes in Fresh Apples: Market Segments, Consumer Characteristics, and Marketing Opportunities." *Journal of Agricultural and Resource Economics*, 24(July 1999): 80-97.

Baker, G.A. and T.A. Burnham. "Consumer Response to Genetically Modified Foods: Market Segment Analysis and Implications for Producers and Policy Makers." *Journal of Agricultural and Resource Economics*, 26(July 2001): 387-403.

Baker, G.A. and P.J. Crosbie. "Consumer Preferences for Food Safety Attributes: A Market Segment Approach." *Agribusiness,* 10(April 1994): 319-324.

Baker, G.A. and M.A. Mazzocco. "Consumer Response to GMO Foods: Branding Versus Government Certification." *International Food and Agribusiness Management Review*, 8(2005): 1-20.

Burton, M., & Pearse, D. (2002). "Consumer Attitudes towards Genetic Modification, Functional Foods, and microorganisms: a Choice Modeling Experiment for Beer." *AgBioForum*, 5: 51-58.

Brown, C. "Consumers' preferences for locally produced food: A study in southeast Missouri." *American Journal of Alternative Agriculture,* 18(2003): 213-224.

Curtis, K.R., J.J. McCluskey, and T.I. Wahl. "Consumer Acceptance of Genetically Modified Food Products in the Developing World." *AgBioForum,* 7(2004): 70-75.

Engel, J.F., Blackwell R.D., & Miniard P.W. "Consumer Behavior." Fort Worth TX: The Dryden Press (1995).

Frewer, L., D. Hedderley, C. Howard, and R. Shepherd. "Reactions to information about genetic engineering: Impact of source characteristics, perceived personal relevance, and persuasiveness content." *Public Understanding of Science*, 8(1999): 35-50.

Gallons, J., U.C Toensmeyer, J.R. Bacon, and C.L. German. "An Analysis of Consumer Characteristics Concerning Direct Marketing of Fresh Produce in Delaware: A Case Study." *Journal of Food Distribution Research,* 28(1997): 98-106.

Gamble, J., and A. Gunson. "The New Zealand Public's Attitudes regarding Genetically-modified Foods: May and October 2001- Full Report." *HortResearch*, (2002).

Green, P.E., and V. Srinivasan. "Conjoint Analysis in Consumer Research: Issues and Outlook." *The Journal of Consumer Research*, 5(1978): 103-123.

Hair, J.F., R.E. Anderson, R.L Tatham, and W.C. Black. "Multivariate Data Analysis." 3rd Ed., New York: Macmillan Publishing Co., 1992.

Hossain, F., and B. Onyango. "Product Attributes and Consumer Acceptance of Nutritionally Enhanced Genetically Modified Foods." *International Journal of Consumer Studies,* 28(2004): 255- 268.

Kassardjian, E., J. Gamble, and A. Gunson. "A New Approach to Elicit Consumers' Willingness to Purchase Genetically Modified Apples." *British Food Journal,* 107(2005): 541-555.

Kaye-Blake, W. K. Bicknell, and C. Saunders. "Process versus Product: Which Determines Consumer Demand for Genetically Modified Apples?" *The Australian Journal of Agricultural and Consumer Economics*, 49(2005): 413-427.

Lancaster, K. "Consumer Demand: A New Approach." New York: Columbia University Press, 1971.

Loureiro, M.L., and M. Bugbee. "Enhanced GM Foods: Are Consumer Ready to Pay for the Potential Benefits of Biotechnology?" *The Journal of Consumer Affairs,* 39(2005): 52-70.

Loureiro, M.L., and S. Hine. "Discovering Niche Markets: A Comparison of Consumer Willingness to Pay for a Local (Colorado-Grown), Organic, and GMO-free product." *Selected Paper, American Agricultural Economics Association Meetings,* (2001).

Lusk, J.L. "Effect of Cheap Talk on Consumer Willingness-to-Pay for Golden Rice." *American Journal of Agricultural Economics,* 85(2003): 840-856.

Lusk, J.L., M. Moore, L. House, and B. Morrow. "Influence of Brand Name and Type of Modification on Consumer Acceptance of Genetically Engineered Corn Chips: A Preliminary Analysis." *International Food and Agribusiness Management Review*, 4(2002): 373-383.

Moskowitz, H., J. Beckley, T. Mascuch, J. Adams, J., A. Sendors, and C. Keeling. "Establishing Data Validity in Conjoint: Experiences with Internet-Based Mega-Studies." *Journal of Online Research*, (2002): 1-11.

Orme, B. "Getting Started with Conjoint Analysis: Strategies for Product Design and Pricing Research." *Madison, WI: Research Publishers LLC*, (2006): 49-57.

Quester, P.G., and J. Smart. "The Influence of Consumption Situation and Product Involvement over Consumers' Use of Product Attribute." *Journal of Consumer Marketing,* 15(1998): 220-238.

Richardson-Harman, N., T. Phelps, P. Mooney, and R. Ball. "Consumer Perceptions of Fruit Production Technologies." *New Zealand Journal of Crop and Horticultural Science,* 26(1998): 181-192.

Sethuraman, Raj, Roger A. Kerin, and William L. Cron. "A Field Study Comparing Online and Offline Data Collection Methods for Identifying Product Attribute Preferences Using Conjoint Analysis." *Journal of Business Research*, 58(2005): 602-610.

Schaffner, D.J., Schroder, W.R., & Earle, M.D. *Food Marketing: An International Perspective.* New York: The McGraw-Hill Companies, Inc. (1998).

Schneider, M.L., and C.A. Francis. "Marketing locally produced foods: Consumer and farmer opinions in Washington County, Nebraska." *Renewable Agriculture and Food Systems*, 20(2005): 252-269.

SPSS Complex Samples: http://www.spss.com/complex_samples/data_analysis.htm

U.S. Census Bureau, 2005 American Community Survey.

Xu, G., and Y. Yuan. "Conjoint Analysis in Pharmaceutical Marketing Research." *Quirk's Marketing Research Review,* June (2001): 1-10.

