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Analysis of consumer perceptions toward biotechnology and their preferences for biotech food labels

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ANALYSIS OF CONSUMER PERCEPTIONS TOWARD BIOTECHNOLOGY AND THEIR PREFERENCES FOR BIOTECH FOOD LABELS

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ABSTRACT

Using a sample from the seven largest metropolitan areas in the United States, (Denver, Chicago, Los Angeles, Atlanta, New Orleans, New York, and Houston), consumer attitudes concerning agricultural biotechnology is examined. Conjoint analysis is used to examine consumer preferences for the labeling of biotech foods. The study examines the relationship between the consumer's knowledge and attitudes regarding biotech foods and their preferences for food labels. Consumers' attitudes regarding a healthy diet, and their risk perceptions regarding biotech foods were found to have a significant effect on the general use of food labels and preferences for labeling of biotech foods. The most significant finding of the study is that consumers prefer mandatory labeling of biotech foods, rather than FDA's current voluntary labeling policy.

The conjoint results show that the most important attribute regarding a biotech label was the presence of a logo, contributing 48.7 % to the preference rating. A text disclosure describing the benefits of the biotech ingredient was determined to be the second most relevant attribute, accounting for 40.87% of the respondent's preference rating. The third most important attribute (contributing 10.43%) was the location of the logo on the principal display panel (PDP) of the product package.

CHAPTER 1

INTRODUCTION

The growth and development of agricultural biotechnology have resulted in many new crops, along with changes in production practices and marketing activities of crops and livestock products. A number of factors have combined to stimulate interest and investment in agricultural biotechnology by farmers, processors and consumers. The changing needs and preferences of consumers have created opportunities and markets for new products that farmers and food processors are willing to produce and market. An increasingly discriminating consumer who has an expanded interest in food safety, labeling, nutrition and value-added enhanced qualities, also creates opportunities for agricultural biotechnology expansion. Profit maximization, a dominant market share, and control of the vertical integration system caused food processors to invest heavily in research and development of agricultural biotechnology. Many agribusinesses, including large food processors, have been able to develop and market field crops with qualities and attributes that end-users desire and are willing to pay for. The major agribusinesses involved in biotechnology are, Archer Daniels Midland, Advanta Seeds, American Cyanamid, Cargil, Cebeco, Dekalb, Monsanto, Pfizer Incorporated and Zeneca. Farmers were responsive to, and quickly embraced genetically engineered products because they anticipated the benefits of reduced production costs, enhanced yields and increase profits.

Biotechnology is defined as the use of biological systems to produce a product, the use of a biological system as a product, or the use of the techniques of biotechnology to provide a product, process or service (Wiegele, 1991 p 21). Genetic engineering,

which is a subset of biotechnology, is defined as the manipulation and alteration of the genetic material (constitution) of an organism in such a way as to allow it to produce endogenous proteins with properties different from those of the normal organism, or to produce entirely different (foreign) proteins altogether (Nill, 1998). The terms biotechnology, genetically engineered (GE) and genetically modified (GM) are often used interchangeably throughout the scientific community, an approach that will be adopted in this study.

Biotechnology reduces pesticide use, which helps protect the environment from potential harmful effects of pesticides use. It allows production of crops with increased resistance to pests, animals with increased resistance to diseases, and increase crop yields. Biotechnology also has the potential to boost the nutritional value of foods. Consumers, the end-users of all agricultural crops, benefit from biotechnology as they obtain food products that are innovative, nutritious, and have enhanced traits or qualities.

The production and distribution of GE foods may also lead to changes in trade patterns, because agricultural biotechnology increases the scope for substitution of one commodity for another (Junne, 1997). Problems arise when one country is able to introduce the new technology at a faster pace than others. The early adopters will be able to increase their market share and will displace other countries as exporters. (Junne 1997). Less developed countries in Latin America, Africa, and the Caribbean will suffer more as they lack the necessary infrastructure to be competitive in the production and distribution of GE foods. Other concerns among trading countries are the health risks associated with GM foods. The European Union has already banned some GE foods from the U.S. for health reasons, putting a strain on US-EU trade relations. For instance, there

is heightened interest in food safety and a greater distrust from European consumers toward their government because of the recent technology crisis, associated with Bovine Spongiform Encephalopathy (BSE). The influence of GE foods on international trade is also affected by each country's economic and political climate. Political persuasions can retard or boost acceptance, substitution and distribution of GE foods

Biotechnology has produced numerous crops and products that satisfy both producers need for lower cost and increased profits, and consumers need for more product diversity and consumer specific traits. For example, bioengineered cotton and soybean seeds are two of the major crops that farmers welcomed because of their great potential. Bacillus thuringiensis (Bt) technology has been developed for cotton to resist damage from bollworm1, tobacco, budworm, and pink bollworm. With Bt corn, the plant produces the insecticide throughout its life cycle, which eliminates the need for post emergent pesticides spraying. (McBridge et al., 1999). These changes in production practices avoid the possible contamination of water supplies and harm to the environment that occurs during water run-offs.

One of the first major agricultural animal products from biotechnology is Bovine Somatotropin (BST). BST, also known as bovine growth hormone (BGH), is a protein made in the pituitary gland of cows (Schacter, 1999). Recombinant bovine somatotropin (rbST) is BST produced by genetically altered bacteria in the laboratory. Laboratory produced rbST, when injected in cows, increases their milk production (Aldrich et al., 1998). The milk from cows given rBGH has the same product characteristic as the milk from untreated cows (Grobe et al., 1997). In the U.S., BST was thoroughly tested and studied before it was approved for commercial distribution. The Food and Drug

Administration (FDA), an agency of the U.S. Department of Health and Human Services (HHS) approved BST for U.S. sale and use on November 5, 1993 (Monsanto 1994).

Stefanides and Tauer (1999) found that adoption rates of bST by farmers were consistent with previous ex ante bST adoption studies. The predicted aggregate adoption rates ranges from 8% to 41 % for early adopters, and from 33% to 92% for eventual adopters. In terms of production, adoption of bST, when viewed at the national level, simply reinforces the trend toward increased milk production per cow and declining dairy farms numbers. When viewed at the farm level, bST use could prove profitable for almost all commercial dairy farms (Fallert et al., 1994)

On the other hand, consumer acceptance of products produced from biotechnology has been slow despite their excellent prospects. New technologies in food supply and increased knowledge of the link between diet and health have resulted in consumers having a greater interest in food qualities and safety issues (Caswell et al 1997). This is due largely to fears that GE foods are unsafe and could cause long-term health problems giving rise to public debate over the potential risk associated with GE foods. For biotechnology to be successful it has to be accepted by consumers who first must understand the science behind the process. It becomes imperative for farmers, processors, the private industry, government and the media to join resources and educate the public about the benefits and safety of genetically engineered products.

Labeling of genetically engineered foods has caused concerns among food processors. According to Economic Research Service (ERS), labeling of food in the United States is geared toward solving problems of asymmetric information, where content and nutrition disclosures are not typically used as a standard tool to alert

consumers about possible unsafe foods. The Food and Drug Administration (FDA), the leading authority on food labeling, requires genetically engineered foods to be labeled only if they differ significantly from their conventional counterparts. The question remains though, what are the effects of separating and labeling of GM foods and non-GM foods? Is there a direct relationship between labeling and success of GM foods? Food labeling regulation can hinder trade and distribution of GM foods and results in increased cost (marketing cost) to consumers. The challenge facing the agriculture industry is the stimulation and education of consumers. While the market will always adjust to changes in consumer needs, the marketplace must also help to shape consumers preferences and choices by providing information that is credible and readily available.

The introduction of any new product for public consumption will undergo scrutiny and potential consumer resistance due to lack of awareness and misunderstanding. Animal food products in particular raise concerns because consumer surveys seem to document less acceptance of genetic modification of animals than of plants (Aldrich and Blisard, 1998). However, consumer views toward biotechnology are generally positive. Sixty-seven percent of consumers in a national sample agreed that biotechnology would personally benefit them in the next five years (Hoban and Kendall, 1992). Milk sales remained steady after rbST became available to farmers, even though a multitude of public opinions surveys documented widespread concern about food safety. The rbST experience suggests that, while scientific evidence of food safety will not prevent controversy over biotech foods, controversy will not necessary inhibit consumer demand for the food.

Problem Statement

The introduction of biotech foods and the debate over food safety and labeling has led to U.S. policy makers to make some difficult choices, often trying to appease both farmers and consumers. The problem is compounded because policymakers, who often base policy decisions on the results of scientific studies, frequently do not understand the seemingly irrational concerns held by consumers (Baker and Crosbie, 1993). New technologies in food supply and increased knowledge of the link between diet and health have resulted in consumers having a greater interest in food qualities and safety issues. (Caswell et al., 1997). This is due largely to fears that GE foods are unsafe and could cause health problems giving rise to public debates over potential risk associated with GE foods. Labeling biotech and non-biotech foods has caused some concern as advocates argue for the right to know by consumers. However, the Food and Drug Administration (FDA), the leading authority on food labeling requires genetically engineered foods to be labeled only if they differ significantly from their conventional counterparts. Public concerns over GM are strong despite a library of scientific evidence of its safety (Aldrich and Blisard 1998). Notwithstanding, resistance to GMOs still exists due largely to consumers in general having little comprehension of all facets of GE products. When this happens consumers will naturally perceive more risk to be associated with the product, when in actuality, it is not. Thus, the problem addressed in this study is to conduct a detailed analysis of individual consumer preference for GM foods and the labeling of these products.

Statement of Research Objectives and Questions

Potential consumer resistance to animal food products produced from biotechnology continues to raise uncertainty among analysts of the food system. The production of GMOs such as bt corn and rbST has come under continued scrutiny. There are groups demanding that products produced from biotechnology be labeled as such. However, the guiding principle of Federal regulation of food products from biotechnology is that the product, not the process, be regulated (Caswell et al., 1997). In the case of rbST, the milk was determined to be safe and was not different from other milk and therefore no special handling or labeling is required. Given this, it becomes necessary to determine whether knowledge of the production method will influence consumer evaluation of the biotech products. The overall goal of this study therefore is to examine the adoption of GMOs by US consumers and their preference for products labeled biotech compared to products made from the tradition production processes. The study encompassed three specific objectives:

Specific Objective1:

To measure consumer attitudes and perceptions towards foods produced using biotechnology. It is hypothesized that consumer acceptance of genetically engineered foods is influenced by concerns for more healthy diets and the potentially harmful effects of biotechnology on the environment. The nature of this relationship will be examined through the use of a questionnaire.

Specific Objective 2:

Quantify labeling preferences regarding genetically engineered foods and to examine consumer attitudes toward a mandatory versus a voluntary labeling policy for biotech foods. The process of estimating consumers' labeling preferences will be

accomplished using conjoint analysis. This model will be used to determine the value that consumers place on particular combination of labeling attributes, such as nature of information disclosure, use of a biotech logo, and the position of biotech information on the label. Also, consumers' choice between a mandatory or voluntary labeling policy will be analyzed.

Specific Objective 3:

To determine the frequency of consumers' use of food labels in general. Unless products are labeled, consumer may be unaware of the nutrients or ingredients they contain. Labels serve as a source of information and reduce uncertainty. A questionnaire will be use to identify consumers' propensity to use food labels.

Organization of Study

In the next chapter, previous research and relevant literature is reviewed and summarized. Chapter three describes the methods used in the study, which includes the experimental design, empirical methods, questionnaire design and attributes used in the conjoint analysis. Chapter IV focuses on the discussion of empirical results and interpretation. This study concludes with chapter V which offers the summary, conclusion, limitations, and suggestion for further research.

CHAPTER 2

LITERATURE REVIEW

The production and marketing of genetically modified food products has caused many concerns, particularly from an increasingly discriminating consumer. Consumers are concerned, not only about the price of GMP's, but also the long-term impacts of GMP's on the environment, the moral, ethical and religious implication of both manufacturing and consuming the product, and most importantly, human health. The acceptance and success of genetically engineered food products will be greatly influenced by an expanded set of consumer interests. Today's consumers are placing increasing importance on food quality, food safety and environmental quality now more than ever. The results of surveys of consumer attitudes toward food biotechnology conducted since the introduction of the technology found that issues related to biotechnology and its acceptance can be grouped into three major categories: (1) credibility issues related to industry and its government regulators, (2) safety issues relevant to individual consumers as well as the environment, and (3) the right to know by consumers, the matter of labeling.

Several studies have analyzed the more general relationship between socioeconomic factors, the perceived risk associated with genetically modified food products, and in general food safety concerns (Baker et al 1993, Grobe et al 1997, Caswell 1994, Holland and Wessells 1998). Results indicated that there are substantial differences between consumer segments in terms of their willingness to pay for food products certified as safe. Social and cultural factors such as gender, education, age,

household size, ethnicity, environment and animal rights contributed to consumers having different risk perceptions.

Baker et al., (1993) identified consumer segments based on a detailed analysis of individual consumer preferences for food safety attributes in respect to apples. Consumer segments were constructed by using cluster analysis to form groups, which were homogenous with respect to preferences regarding food safety. Conjoint analysis was then used to estimate individual preference function for food safety attributes. Market simulation was conducted in San Jose, California, where shoppers were asked to participate in a survey for a $10 incentive payment.

Price and quality attributes were considered for each product. The products and their attributes provided a consumption service. An indirect utility function was derived which indicated consumer's purchase decision for a product. This function was based on product attributes, price of the product, and attributes and prices of other products as well as each consumer's income level.

The utility function for each respondent was specified in terms of a combination rule W and a set of function forms W_K as *W (w1 (z1),…, wk (zk*). Where Z_K is a set of characteristics for a product. Hypothetical products were presented in a manner that describes the products fully in terms of their attributes levels. Four factors, price, damage certification program, and pesticides regulation (each with three levels) were used to evaluate preferences for fresh apples. Results indicated that there were substantial differences between consumer segments in terms of their willingness to pay for certified products. However, individuals in three different segments were willing to pay a substantial price premium to ensure that produce meets safety standards.

Grobe et al., (1997) also studied consumer risk perception. The qualitative multinomial logit model (LIMDEP econometric software) approach was used to measure consumer risk perceptions and provide understandings of how individual differences affected or contributed to their overall treatment of risk. The risk perceptions of food-related biotechnology, recombinant bovine growth hormone, (rbGH) was examined in the analysis. A survey was conducted nationwide and lasted from March 1, through June 27, 1995 with 1,910 interviews. A sub-sample was created which grouped respondents into two major groups, those who were aware of rbGH and those who had no prior knowledge of rbGH. These two groups was further divided into seven categories depending on the respondent's perceived risk and their resulting behavior. Respondents were further divided on variables such as personal health influences, which is affected by heredity, personal concern and lactose tolerance. Gender, education, age, household size, ethnicity, environment, animal rights and "poor" defined social and cultural influences. The "poor" category was based on the USDA's poverty guidelines, February 9, 1995.

The study found that groups of consumers with shared information on rbGH had variable beliefs and displayed roles relating to their personal preferences. For example, there were consumers who were unaware of rbGH's use, but were provided the same brief description of rbGH, still exhibited different risk perception responses that ranged from believing that product was safe to perceiving personal susceptibility. The study also found that those who engaged in protective actions were highly correlated with environmentalist concerns. This suggests that food safety concerns were just as important as rbGH and the environment**.** No one public policy would likely satisfy all consumers. It is therefore important for policy makers to understand that consumers differ in their

behavioral response to perceived risk and in so doing, only then will risk communication strategies be successful.

Caswell et al., (1994) took a more holistic approach. Biotechnology was looked at from an economic perspective. The study found that factors such as public policies, producers' expectation and consumers demand for new products have affected the supply of agricultural biotechnology products. An expected increase on profitability by farmers and processors create a demand for biotechnology applications. However, the market (sellers and buyers) for biotech products sectors will depend on consumer demand for biotech-derived agricultural products.

Another survey analyzed consumers' perception about food safety and biotechnology in developed countries such as the United States, Australia, United Kingdom and Japan. Hoban (1999) studied consumer awareness and acceptance of biotechnology and willingness to purchase GM foods. Telephone surveys were conducted in both Japan and the United States from 1995 to 1998. Results indicated that an increasing number of consumers were willing to purchase genetically modified food products. The study also found that consumers in the United States were more aware and had a greater understanding of biotechnology compared to their Japanese counterparts.

In terms of adoption and use by farmers, various studies have been conducted, and all studies have shown similar results. "The empirical Impact of Bovine Somatotropin on a group of New York Dairy Farms" by Zdenko and Tauer (1995) showed increased milk production per cow, however the impact on profits was not statistically different from zero. Data from 211 New York dairy farms were used to estimate *ex post* rbST adoption function and to measure the impact of rbST on milk

output and profitability. They found that rbST was not profitable on average. They concluded that a learning phase is needed for farmers to understand how to make optimal use of the new product. This study was done in 1994, the first year of rbST availability which impacted the findings greatly.

Two other studies on farmers' adoption were done in California and Wisconsin. The Wisconsin study by Barham (1996) showed that adoption in this state is consistent with a politicized constrained path, and farmers adoption rates were very low. Barham argued that bST's diffusion and adoption in Wisconsin has not followed the classic sigmoid growth of rapid acceleration. Zepeda (1990) used an ex ante adoption model to predict adoption of rbST by California dairy farmers. Five categories of respondents were analyzed. They included user, non-user, waiter, don't know, and haven't heard. There were significant differences between all five categories of respondents. Potential farmer adoption of bST, based on the waiter and use categories, were 44%, a rate lower, compared to results from other studies for other regions. This can be attributed to other research that indicates that diffusion rates of highly concentrated industries are lower than less concentrated industries.

While some of the studies in the United States found that Americans favor the technology, such support is not always universal. In Australia, a national government survey of 1,378 people showed that 89% of respondents said that genetically engineered tomatoes should be labeled so that people could decide whether they wanted to eat these tomatoes or not. Only 4% percent were against labeling. About 65% percent said that labeling engineered tomatoes would be a good idea, while 65% percent said that

unlabeled engineered tomato would be a bad idea (www. consumersinternational.org/ campaigns/surveys.html)

The effect of biotechnology on agricultural production and profitability will depend on the demand characteristics of the products to which the technology is being applied. As previously mentioned, acceptance and success of biotechnology will be greatly influenced by an expanded set of consumer interests. Today's consumers are placing increasing importance on food quality, food safety, and environmental quality. Additional information in the form of product labeling is one proposed way to provide information consistent with public concerns. According to Caswell et al., (1999), the uncertainty of consumer reactions is the largest impediment to assessing the future potential of biotechnology in U.S. agriculture.

For GMOs to be successful there must be full market access and market acceptance of the product. Isaac and Phillips (1996) said that consumer concerns and acceptance are impeded by two factors. These include the perception of the primary benefits of GMPs and the perception of control over GMPs. Presently, most consumers see producers as the major beneficiaries of GMPs. Issac and Phillips (1996) concluded that until the advantage seen in productivity is translated into significant decrease in prices, or until the new applications target attributes desired by consumers, consumers will continue to believe that they don't receive any benefits from biotechnology adaptations. Since consumer acceptance is a function of the consumer's understanding of perceived risk and benefits, more transparent information is needed to enhance these consumer's understanding of the risk and benefits.

Market acceptance and product regulations are correlated, as consumers cannot be offered products without government approval, and governments who are sensitive to public interest, will not approve products unless consumers are confident genetically engineered foods (GE) are safe. The type of government regulation employed to address consumer concerns will affect market access and consequently the development and commercialization of agricultural biotechnology. Approval by regulatory agencies for biotech products, however, does not always equal acceptance by consumers. Producers must therefore take a proactive role in disseminating information about the benefits and risks of biotech products, and not rely on regulatory agencies (Isaac and Phillips, 1996).

One of the most challenging issues surrounding genetically engineered foods involves labeling and the consumer right to know. The general issue of food labeling has been debated in many forums. Food labels provide many benefits. They allow producers and marketers to communicate to potential buyers information about their product offerings. This information is then used by consumers for product evaluation and selection. Food labeling has become a policy issue for Americans (policy makers and consumers) because more emphasis is now being placed on nutrition. Subsequently, the Nutrition Labeling and Education Act (NLEA) of 1990 replaced the voluntary system of labeling established by the FDA in 1973. The act requires mandatory nutrition labeling for packaged food and strict regulation of nutrition content and health claims. The characteristics of GE food labels will have a significant effect on consumers' understanding and acceptance of biotechnology. In general, informational labeling is being used as a means of (a) shaping consumers' knowledge, purchasing patterns and use practices, and (b) manufacturers' product offering and marketing practices (Caswell and

Mojduszka, 1996). The right to know by consumers of ingredients used to produced food products, the matter of labeling has received considerable attention and study

One study relating to the labeling of GE foods was conducted by the Wirthlin Group Quorum Survey. Approximately 1000 telephone interviews were conducted in March 1997, February 1999, and October 1999. When asked how informed they are about biotechnology, less than 20 percent of consumers felt they were very well informed about the technology. The study found that on average, 78% of Americans support the current FDA labeling policy for biotech foods. The present policy of the FDA is that labeling of biotech foods should be voluntary, since it has been determined these foods have the same safety and nutritional contents as other foods. According to the study, consumers were still likely to agree with the labeling position of the FDA's even after they were told of the mandatory labeling policy as argued by critics of the FDA. Critics of the policy say that any food produced through biotechnology should be labeled, even if the safety aspect of the food has not been altered.

According to Hallman et al., (1995), 84% of the 604 residents surveyed wanted mandatory labeling on engineered fruits and vegetables. Sixty percent of the population would consider buying fresh vegetables if they were labeled as having been produced by genetic engineering. Also, 58% would not specifically look for biotech labels while shopping. Forty-two percent of the people who said they would look for produce labeled as not genetically engineered, also said they would buy produce that was genetically engineered if the label gave this information. Other studies by Hoban and Kendall (1992), Maki (1995), Douthitt (1990), and Novartis (1997) found that most Americans want foods that are genetically modified to be clearly identified with labels.

Economics of Labeling

Since the introduction of agricultural biotechnology, issues associated with food labeling are having a significant impact on the food industry. The widespread use of labeling and the emphasis the legislature places on labeling requirement suggests that it is an effective way of altering the behavior of both producers and consumers. Over the years, labeling was thought of as a direct shopping aid for consumers. However, Caswell and Padberg (1992) argued that the roles of labeling should include; influencing product design, advertising, promoting consumer confidence in food quality, and contributing to consumer education regarding diet and health. Evaluating the effectiveness of labeling programs requires understanding how information affects market behavior and the benefits and costs of these programs. That is, what characteristics of the interaction between the label, the consumer, and the product affect the impact of information (Teisl 1999). The effectiveness and utilization of different labels will vary across consumer groups, and depends on various socioeconomic and demographic criteria such as education, ethnic background, and income levels. These characteristics may be associated with the benefits and costs of consumer information usage (Wang et al., 1995)

When asked if labeling is an effective policy tool for providing information about food products, consumers usually answer yes, indicating that labels improve their information set and guide their buying decisions. They also may make the market work more efficiently as competition among firms, in an improved information environment, awards success to products with the best attributes, as argued by Caswell and Padberg (1992). From these viewpoints, it can be said that food labels are successful. However

Variyam, Blaylock, and Smallwood, (1995 and 1997) and Mooran (1996) have found labels to be unsuccessful in educating consumers and changing consumption behavior. These studies found that consumers often make hasty food choices in grocery stores and usually do not examine food labels.

Labeling will generate some benefits and also some cost. Policy makers must weight the benefits and cost to determine whether labeling is an appropriate policy option. The primary benefits of any governmental labeling program are changes in social behavior and informed consumption of food products. Labeling could also result in higher per-unit cost for producers and manufacturers. As a result, consumers will pay higher prices for the same food products and small firms may be placed at a competitive disadvantage.

Americans are becoming increasingly aware of the importance of nutrition, and the linkage between diet and health. Coupled with the introduction of genetically modified foods, informational labeling and food labels have become the focus of increasing attention and research. Labels therefore become a primary information set used by consumers in making product selections. Previous studies have indicated that consumers desire labels to indicate the presence of genetically modified ingredients (Huffman et al., 2000). Presently, no study has been done on the labeling characteristics preferred by consumers for biotech foods, or the effects of consumer attitudes regarding the safety of biotech foods and labeling preferences. These issues are important because US consumers have different risk perceptions regarding the safety of biotech foods, and posses varying demographic characteristics.

This study attempts to determine label characteristics for genetically modified foods, preferred by different groups of consumers. The study contributes to previous literature because it further explores consumer understanding and usage of labels in general, and how these factors affect their use and understanding of biotech labels. Since the introduction of biotech foods, a lot of information (from scientists, industry leaders and government) debate, media scrutiny, and views from the general public have become known. These actions will have a major influence on the present and long-term viability of the biotechnology industry. The influence will no doubt be lead from consumers. How has views and perceptions changed since these major studies were done? To further understand present and future preference of consumers regarding genetically modified food products is one of the objectives of this study.

CHAPTER 3

REVIEW OF CONJOINT ANALYSIS THEORY

Introduction

This chapter discusses the steps involved in the implementation of conjoint analysis (CA), and the theoretical and practical reasons for using conjoint analysis as a measurement technique for this study. The first part of this chapter begins with a discussion of the history of conjoint analysis. Also included in the first section, is a review of consumer utility as the foundation on which conjoint analysis is built. The second part of this chapter covers the steps in the conjoint analysis process, including attribute selection, experimental design, survey design, data collection, and model specification.

Previous researches on new product development and identification of buyer preferences have focused on techniques such as contingent valuation (CV) and conjoint analysis. The accelerated growth of biotechnology and its applications may be considered a new product to consumers. As a result, an understanding of how consumers evaluate products based on various attributes is necessary for maximum buyer acceptance of products produced from biotechnology. Empirical estimation of the importance of attributes for biotech labels will be accomplished using conjoint analysis.

Conjoint Analysis

Conjoint analysis is a multivariate technique used to estimate or determine how respondents develop preferences for products or services (Hair et al., 1998). It is widely used in marketing research and is based on the premise that consumers evaluate the value of a product by combining the separate amounts of value provided by each attribute of

the particular product or services. According to a survey by Cattin and Wittink (1982), approximately sixty percent of all conjoint studies are related to consumer goods, twenty percent to industrial goods, and the remaining 20 percent are performed for transportation and financial services. These applications were used primarily for new product/concept evaluation and pricing decisions. Conjoint analysis has also proven very successful in market segmentation. (Green and Srinvasan 1978). Heterogeneous groups of consumers are divided into homogeneous segments so different marketing strategies can be tailored to each segment.

Conjoint analysis provides valuable information about bundles of attributes that represent potential products or services for consumers. CA therefore provides researchers with insight into the composition of consumer preferences by examining the attributes that are most or least important to the consumers. These attributes form the basis for a decision criteria that a respondent uses to choose products or services**.** In CA, products or services are referred to as profiles, treatments, or a stimulus. Consumer preferences, needs, and attitudes are reflected in their choices among product profiles. A profile is defined as a hypothetical product consisting of different attribute - levels as shown by diagram 2.1 below.

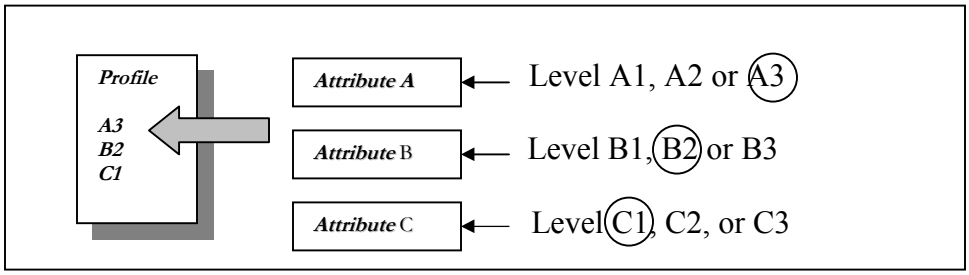

Figure 3.1 Relationship Among Profile, Attributes and Levels.

CA is the tool used in this study because it allows researchers to determine which attributes of a product are liked or disliked. Thus, the tradeoffs consumers make among attributes will be determined. Attributes are the key product characteristics that buyers consider in their assessment of products. Because of their importance in decision-making, each attribute must be distinct and represent a single concept and should include the features most relevant to the potential buyer. Factors that must be considered in choosing attributes include: (1) the number of attributes, where too many increases the number of profiles a subject must evaluate (Hair et al., 1998), and (2) attribute multicollinearity which implies there is a high correlation between two attributes. Examining the correlation matrix is one way of detecting multicollinearity. Multicollinearity is present when the correlation coefficient is greater than or equal to 0.80 (Kennedy, 1998). Combining the two related variables to form one variable, or eliminating one attribute altogether will solve this problem. CA allows for assessment of the relative importance of each attribute by determining a person's part worth utility for each attribute-level. Having estimated part worth utility, total utility of individuals can then be estimated for any combination of attributes. A relatively large range between part worth values associated with an attribute-level suggests it is of relatively high importance**.** Various combination of part worth values provides a utility index that is a function of attribute-level combination.

Preferences and Utility

Utility, which is subjective and unique to each individual, is the conceptual basis for measuring consumer demand in economic theory. Economic theory states that utility is interpreted as a numerical measurement of the satisfaction derived from the

consumption of alternative bundles of commodities. In recent years, the theory of consumer utility has gone beyond the traditional economic theory of consumer demand. According to Lancaster's model of consumer behavior, the theory of brand preferences states that good are valued for the attributes they possess, and that differentiated products are merely different bundles of attributes.

Marketers are interested in the characteristics of products or services that are important to consumers. This is very important because they are better able to design their products and position them to achieve a competitive advantage. Individuals in their decision making process evaluate the benefits and costs of competing products before a final choice is made. This process is a complex one. Consumers use judgements, impressions, and evaluation of all competing products attributes before they make their final choice. In this process, consumers combine (integrate) information about different determinant attributes to form overall impressions of product profiles, a process that conjoint analysis is built upon, and is known as information integration theory (IIT), (Louviere, 1988). ITT has three stages, which includes valuation, (psychophysical judgement formation) integration, and response formation (Ozayan, 1997). The final choice is the one that provides the individual with the highest level of total utility. The utility index provides a framework for evaluating consumer preferences for the labeling of biotech food products**.**

The Composition Rule

A composition rule is used in conjoint analysis to explain an individual's preference structure. It explains how respondents combine part worth values to form total utility. There are two models often used to demonstrate the composition rule. One

approach to the composition rule utilizes interaction effects which allow for certain combinations of levels to be greater or less than their individual sums. The second, the additive model uses only the main effect of the attribute. The additive model which is the primary form used in CA allows respondents to add up the values for each attribute to attain a total value for the bundle. The additive model, is the most common because it accounts for most of the variation in respondents preferences (Green and Srinvasan, 1978). However, the interactive form may be a more complex representation of how respondents value products and services. The additive rule is used to describe how consumers combine part worths. In the additive model, each respondent's total utility is the sum of the part worth of each attribute. This means that the attribute impact on utility is independent of the levels of other attributes.

The multiplicative model on the other hand indicates that response difference corresponding to the levels of attributes can grow closer together or farther apart as the levels of another attribute are present or not. In this case differences between responses for the good-good and good-bad levels are not equal to the bad-good and bad-bad levels. (Stringer, 1999). Use of an interactive model decreases the predictive power of the model because an increased number of part worth estimates reduce the statistical efficiency. This increase in the number of parameters increases the burden of rating or ranking on the part of the respondents and will most likely decrease the reliability and validity of responses. Moreover, several studies cite that interaction effects are negligible on model results (Hildreth et al.,1998, Harrison et Al., 1997). For this reason, a main effect additive model is used in this study.

Data Collection

The next step in CA involves the method of data collection. The issues of data collection for this study were the questionnaire design, the selection of a technique for survey administration, and the method of presentation for conjoint data collection. The aim is to present to respondents various attribute combinations i.e., product profiles that facilitate effective preference evaluation. Presentations can either be in a written or pictorial format. There are three main presentation methods. They include the trade-off, full-profile and pair-wise comparison methods. These methods will be discussed in the next section of this study.

Methodology

This section outlines the steps used to evaluate consumer attitudes concerning agricultural biotechnology and labeling formats for food products made using biotechnology. Steps of CA include: 1) attribute selection, 2) experimental design, 3) Questionnaire/survey construction, and 4) selection of an empirical model. Attribute selection plays an important role in CA because it affects the accuracy of the results and the relevance of the stimuli to real managerial decisions. Once the attribute and attribute levels have been selected, they must be combined into hypothetical products for respondents to rate or rank. This forms the basis for the experimental design, where respondents are shown various forms of a product and then asked to evaluate the different hypothetical products. In effect, the experimental design allows researchers to assess the effect of one or more independent variables (the attribute-level) on the dependent variable (product rating). To administer conjoint analysis, surveys are used as the data collection

method. The empirical model was designed based on the theory of complex decision making described in Louviere (1988, pages 12 -13).

Attribute and Level Generation

CA assumes that individuals evaluate product attributes in forming their preference for alternative products or services. It is critical to have a carefully thought out list of attributes. A list of too many attributes can greatly increase the burden on respondents since many attributes require evaluation of numerous product profiles. A list with too few attributes can reduce the predictive capabilities of the model because key pieces of information are missing from the model. The critical factor in specifying attributes and attribute levels is that a product cannot be accurately simulated if the product is not adequately defined. Attributes included in a conjoint study should be those most relevant to potential customers. An attribute is relevant to a product or conjoint survey if overlooking its existence leads to different predictions about the choice or ordering of the goods by the consumer. If the attribute does not positively or negatively influence a consumer's preference function, it is considered irrelevant. (Lancaster, 1971). Attributes should represent a single concept, and be able to be used in the model so that any perceptual differences among individual are minimized. For example, an attribute such as quality should not be included and be specified by levels such as high, medium or low, because quality is relative and individuals will perceive quality differently. It is equally important when selecting attributes, to select their relevant levels, an important factor to consider because a balanced number of levels protects against attribute bias (Stringer, 1999).

A number of methods exist to identify attributes of interest. These include literature review, focus group discussions, and individual interviews. In the initial phase, identification of the appropriate attributes and their relevant levels, a focus group session was used. Since this study deals with consumers' attitudes toward agricultural biotechnology and the labeling of these types products, focus group interviews would provide the attributes that are most important and those that most influenced the respondent preference toward labeling preferences.

Focus Group Discussion

Researchers often use qualitative research methods to gain insight into consumers' preferences (Teague et al 1995). One frequently used qualitative research method are focus groups research. Focus groups are very important, not only because they aid in developing questions for the questionnaire, but in providing the researcher with the forum where individuals' beliefs, opinions, and perceptions can be explored. Focus group interviews consist of between six and twelve participants in which the researcher moderates a group discussion on the topic of interest (Harrison et al., 1998). Although small in numbers, focus groups uncover attitudes and opinions found in the general population. Small groups are preferred to large group because interaction among group members is increased, which facilitates discussion in greater depth**.** Advantages of focus group research includes an increased interaction between all participants and the researcher, visual aids and tangible products can be circulated, and areas of specific interest can be covered in greater depth. Some disadvantages of focus groups include, the need for experienced researches, the complexity to organizing, and the procedure is expensive when compared to other methods.

The focus group for this study consisted of a heterogeneous mix of people who were primary shoppers for their household. The focus group discussion was conducted on October 17, 2001 and was attended by six participants, five females and one male from the Baton Rouge area who were recruited randomly from the phone book. The purpose of the focus group was to, (1) obtain information regarding the consumers' general knowledge about biotechnology, (2) identify labeling characteristics that are most likely to contribute to the consumer's preferences and understanding of GMOs, and (3) better understand why consumers may have concerns or fears of GMOs. The focus group session follows the following outline: first, the moderator introduced the general topic of biotechnology and its applications in the food system. Participants were asked to briefly describe what they knew about biotechnology. The moderator then guided them through a discussion about biotechnology and labeling issues in general. Handouts with information on biotechnology were distributed to each participant. Information included (a) a scientific definition of biotechnology, (b) examples of food that contained genetically modified ingredients, (c) agencies that are responsible for food labeling and food label requirements in the U.S., and (d) information provided by food labels.

The second part of the focus group focused on labeling of products using biotechnology. Participants were presented with twelve different examples of biotech food labeling. The labels differed in terms of (1) the use of a biotech logo, (2) text disclosure of biotech ingredients, (3) agencies which inspect and approve food products for human consumption. Participants were asked to rank their choices from one to twelve in terms of the label presentations they deem most useful in providing information about biotechnology. Participants then were asked to discuss their preferences with group

members. The following is a brief description of the labels formats presented to the participants.

- Label A - simple disclosure, " contains genetically modified ingredients"
- Label B - "GE" logo, plus inspected and approved by the FDA
- Label C - "GE" logo plus inspected and approved by the FSIS
- Label D - "GE" logo, plus contains genetically modified ingredients
- Label E - the presence of a logo "GE"
- Label F - text disclosure, "genetically modified to increase vitamin A content"
- Label G – text disclosure, contains genetically modified ingredients, long term effect not known
- Label H - Less than 5% of ingredients are genetically modified.
- Label I - "GE" logo, plus "less than 5% of ingredients are genetically modified"
- Label J - "GMO FREE"
- Label K - text disclosure "Genetically modified to reduce pesticides use"

When asked how knowledgeable they were about biotechnology, most participants demonstrated some awareness of what biotechnology involves or is associated with. One participant said " It's the way they are changing food in a scientific way." Another participant made reference to "breeding chickens to have a desired trait" as what comes to mind when biotechnology is used. When asked if terms such as genetically engineered, genetically modified, genetically modified organism (GMO) or

biotechnology were the same in meaning, participants thought they meant the same, although one participant thought biotechnology sounded safer. When asked if they could presently identify any biotech foods in their supermarkets, most respondents said they could not. However, one participant said that tomatoes she had seen in the market could possibly have been genetically engineered. In general, participants were surprised to learn about the number of consumer food products that contain genetically modified ingredients. When asked where on the package should a biotech disclosure label be placed, 83% of the participants said on the Principal Display Panel (PDP) and the disclosure should be a logo only.

After collecting the ranking responses, the moderator facilitated participants' discussion of the preferred attributes, and those that were not chosen. Label E received the largest total number of first or second place rankings. Participants thought this format was simple and short and is more likely to be seen relative to longer messages. Based on the discussion, participants believed that before Label E can be effectively used, there must be a nationwide education program to provide more information to consumers about biotechnology and labeling. Label D, which was a combination of a logo and a text disclosure, was the participants' second choice. Label D was chosen because participants said it presented a lot of information. Label G, (caution statement) received very low rankings because participants believed it focused on health and risk, and tells of some inherent danger or risk in using the product. Labels B and C also received low rankings because participant say most times they don't trust regulatory agencies.

In term of the type of disclosure, participant rankings varied widely. Sixty seven percent of the participants believed that food products should be labeled GMO if contents

contain any trace of genetically modified ingredients. One participant believed that food products should be labeled GMO only if contents contain more than 50% of genetically modified ingredients. Another believed that labeling should not be required regardless of the amount of genetically modified ingredients. When asked specifically if they would buy products with a GMO label, most participants said yes. Most participants said, that as consumers they have the right to know about the production process of the food they eat, and as a result, products produced by biotechnology should be labeled as such. In addition, participants believed that biotechnology is beneficial, and is a process, that once they have more information about, would more readily embrace. The focus group discussion indicated that both logo and text disclosure were important attributes. Location of the disclosure was also important, and the respondents thought that any easily identifiable logo would aid their shopping and purchase decisions. Based on these results, the attributes selected for the mail survey are presented in table 3.1.

Table 3.1 Attributes and Their Levels Used in Survey

Attribute	**Levels**
Text disclosure of biotech Ingredients	Simple text disclosure Text disclosure with benefits of the technology No text
Biotech logo	Present Absent
Location of a Biotech logo	Principal Display Panel Informational Panel

The Experimental Design

The focus-group discussion identified three important attributes and levels, which were combined to form hypothetical biotech labels. Levels were based on results from the focus group discussion, and FDA's labeling requirement guidelines were used to ensure that realistic scenarios were presented. Respondents' evaluation and measurement of

potential products takes either a metric scale, used for rating, or a non-metric scale used for ranking.

When rating scales are used, respondents normally grade perceived benefits on metric scales (Gustafsson et al., 2000). On the other hand, ranking scales only present an order of preference (i.e. ordinal relationship). Consumers find the rank order approach easier when only a few products are evaluated. This is because respondents are only required to say which alternative is preferred over another (Green and Srinivasan, 1978). The disadvantages of using ranking scales include the inability of respondents to express indifferences between alternatives, and the difficulty of the ranking task with a large number of product profiles.

By contrast, rating scales require respondents to provide the intensity of their choices for competing alternatives (Green and Srinivasan 1978). The main advantage of using rating scales is the increased information they may contain. Unlike rank scales, rating scale provide ordinal measures of preferences as well as relative measures. The absolute measures of preference are contained within the rating scores of each alternative, while the relative measures can be determined by comparing responses among various alternatives. Respondents are able to express indifference among alternatives by giving them identical rating. For this reason, the rating method offers more benefits to the research, and is likely to be more reliable than the ranking method (Green and Srinivasan, 1978). Boyle et al., (2001) evaluated a comparison of the response formats used in conjoint analysis. The study found that respondents who used a rating scale provided ties for their responses, while people who answered the ranking format did not use ties. For these reasons, the rating format was used in this study.

After the preference model and measuring scale has been selected, the next step is to determine the presentation methods. The two-factor at a time, full profile, and pairwise comparison methods are most frequently used in conjoint analysis. The two-factor at a time approach requires respondents to compare two attributes at a time and rank the various combinations of attributes from the most to the least preferred. This approach is the simplest for respondents, since only two attributes are considered at one time. It has the advantage of reducing information overload, but its principal disadvantage is it is limited to ranking data only (Gustafsson, 2000). This approach also prevents respondents from making realistic choices most commonly used for verbal descriptions of factor combinations, rather than pictures. (Green and Srinivasan 1978). Another disadvantage to this approach is its inability to use fractional factorial stimuli to reduce the number of comparisons (Hair et al., 1998)

An alternative approach, the full-profile method, more closely represents real buying situations because it utilizes the complete set of attributes. However, this procedure lends itself to information overload and reduces the accuracy of respondents' preference evaluation. The number of profiles respondents have to evaluate can be reduced through the use of fractional factorial designs. For this reason, it is used most frequently in conjoint analysis. For example, assume you wish to evaluate three attributes, each with three levels, a total of 27 different product profiles can be evaluated. This is too large a number of profiles for respondents to effectively rate or rank. Because of this problem, the full profile procedure is used for relatively small numbers of factors such as five or six. In many marketing studies, products and services are defined by many more attributes each a with corresponding large number of levels. The use of a full-

factorial design becomes impractical since respondents cannot provide meaningful evaluations when presented with large numbers of treatments. However, various forms of a fractional factorial designs (split-plot design and confounded factorial design) can be used to limit the total number of profiles in the analysis.

The third presentation method, the pair-wise comparison method is a combination of the full factor and the trade-off methods. In this method, profiles normally do not contain all the attributes as the full-profile, but involve the evaluation of pairs of stimulus at a time. The pair-wise method is similar to the two factor- at- a-time method except the pair-wise comparison method compares product profiles and the two factor- at- a- time method compares individual attributes. A fractional factorial design as prescribed by the conjoint designer will be used in this study.

Data Collection

Survey Design and Implementation

Methods of data collection are important because they increase the interpretability and reliability of the study, and strengthen the statistical analysis of the study. Surveys can be administered by mail, or in person or by telephone. Each has it advantages and disadvantages. Telephone interviews allow the interviewer to clarify questions that a respondent may misunderstand, and they have the ability to randomly sample using random-digit dialing. Telephone interviews are relatively more expensive, compared to other forms of data collection methods. Another disadvantage of telephone surveys is the potential for interviewer bias. Interviewer's bias occurs from the variability in the way different interviewers communicate with respondents. Another disadvantage of telephone

interviews is the difficulty for interviewers to hold the attention of respondents for more than 15 minutes.

The advantages of mail surveys include their relatively low cost, ease of administration, and geographical flexibility. Pictures and diagrams can also be included in the questionnaire. The disadvantages of using mail surveys are their characteristically low response rates, and the need for follow-up surveys to increase response rates. Also, respondents may interpret some questions incorrectly and as a result, provide incorrect answers. For this study, a mail survey was used because the conjoint section of the study required respondents to rank different biotech labeling characteristics.

Questionnaire

A questionnaire was developed which was divided into six sections. They included a section on consumer awareness and perceptions of biotech foods, (2) questions on mandatory or voluntary labeling, (3) a conjoint experimental design on labeling formats, (4) questions on the purchasing of biotech foods, (5) questions regarding the consumer's use of food labels, and (6) questions on consumer demographics. A copy of the questionnaire appears in appendix A.

The first part of the questionnaire provided background information on biotechnology. It included a definition, the present and future uses (benefits), and examples of present applications of the technology. This was followed by 12 questions regarding the respondent's general knowledge of, and their attitudes toward biotechnology. Following this introductory section, respondents were asked to choose between a mandatory labeling or a voluntary labeling policy for biotech foods. A second question asked respondents to choose the minimum percentage of genetically modified

ingredients necessary for a product to be labeled. Section six collected information regarding the demographic and socio-economic characteristics of the respondents. Questions were asked about age, income, marital status and education.

The conjoint section of the questionnaire was a two-page layout of 7 hypothetical biotech label formats as prescribed by the fractional design. Respondents were asked to rate each example of a product with a biotech label. The instructions required respondents to rate each example (product profile) on a scale from 0 (least preferred) to 10 (most preferred). Ties were allowed. The labels differ in terms of (1) the use of a biotech label, (2) location of the biotech label on the package, and (3) the text disclosure on biotech ingredients.

The survey was administered by mail during the month of July 2002. A modified version (due to cost considerations) of Dillman's Mail and Telephone Surveys: *The Total Design Method* (1978), was used to guide the survey and the data collection procedures. Three thousand four hundred and fifty (3450) surveys were mailed to randomly selected household individuals in Denver, Chicago, Atlanta, Los Angeles, New Orleans, New York, and Houston.

During the first week of July 2002, each individual was mailed a questionnaire. The questionnaire was accompanied with a cover letter[A], which provided information about the study. It included a short background introduction to biotechnology and food labeling, the reason why the study is being conducted, and the importance of the subject's response to the success and usefulness of the study. Since a modified version of Dillman's Mail and Telephone Surveys: *The Total Design Method* (1978) was used, the postcard reminder normally sent during the second week was omitted. Instead, a reminder

[A] **See Appendix A**

letter[A] and a follow-up questionnaire were sent two weeks after the initial mailings. The letter served two purposes, (1) it thanked the individuals who had responded, and (2) reminded those who had not responded to do so as soon as possible because their participation are important for success of the study.

One difficulty with mail questionnaires, is that not all respondents will answer all questions. Sections will be left unanswered resulting in incomplete questionnaires that cannot be used in the analysis. In addition, surveys will be " not deliverable" because of "incorrect addresses". Responses were received from 524 (15 % of sample) individuals. However, not all of the returned surveys were completed. Only 509 respondents returned a completed questionnaire for a 14.75 % useable response rate. Of the initial sample of 3450 surveys, nine were undelivered.

Model Specification

Evaluation and measurement of product profiles in conjoint studies usually involves using either a metric scale or a non-metric scale to elicit consumer preferences. Methods that assume the dependent variable is of an ordinal scale are ranked ordered because they provide a non-metric ordering of respondents' preferences. The interval rating method is used when metric measures of respondents' preferences are obtained. The ranking format allows respondents to rank product profiles from most preferred to least preferred. The rating format asks respondents to indicate their preferences for several hypothetical products, which could results in two or more products receiving the same score. This ability to express order, indifference and intensity for different product profiles, allows for both cardinal and ordinal properties of utility to be examined.

(Harrison et. al., 2002). The type of coding such as ranking or rating also plays an important part in model selection used for estimation of part-worth values.

Most CA studies use Ordinary Least Square (OLS) or ordered regression models such as ordered probit and two-limit tobit to measure respondent part worth values. rating of product profiles. Studies by Harrison et al., 1998, Baker and Crosbie 1993, Halbrendt, et al., 1991 have used the rating scale method and OLS to estimate respondents' part worth values. When analyzing rating preferences in CA, the dependent variable is usually limited and censored on both ends. If these bounded ratings are estimated using OLS, the residuals will be truncated and the parameters will be asymptotically biased (Harrison et al., 2002). The ordered probit and two-limit tobit models are more appropriate than the OLS in estimating limited dependent variables. The ordered logit model differs from the ordered probit model only in the cumulative distribution function that is used to define choice probabilities (Griffiths et al., 1993). Results from the probit and logit models are usually similar and therefore, there is little basis for choosing between either model. For this study, because the dependent variable in the conjoint model is censored and discrete (0 …10,) an ordered probit model is used to analyze consumers ratings.

Model I

Respondents were presented with 7 hypothetical labeling formats and were asked to rate each using a interval rating scale from 0 to 10. The label formats had three attributes; (1) use of biotech logo with three levels, (2) location of the biotech logo on the package with two level, and (3) the text disclosure of biotech ingredients with two levels. It was hypothesized that individual preferences for biotech labels may be related to

demographic characteristics such as education, age income, ethnic origin, and gender. An ordered probit model is used to estimate consumer preferences for these labeling attributes which included the demographic variables. The following empirical model was used:

$$R_{n,i} = \beta_0 + \beta_1 X_1 + \beta_2 X2 + \beta_3 X3 + \beta_4 X_4 + \beta_5 EDU_{ij} + \beta_6 Age_{ij} + \beta_7 INC_{ij} + \beta_8 RACE_{ij} + \beta_9 GEN_{ij} + \varepsilon_n$$

where, $R_{n,i}$ is the n^{th} respondent's rating (0 –10 scale) of the i^{th} labeling format, β_o is the constant term, and β_i represents the part-worth estimates for each of the attributes-levels. The right hand variables are coded as follows: X1= 1, X2 = 0, if the text disclosure describes the benefits of biotech ingredients contained in the product; X1= 0, X2= 1 for simple text disclosure, which states the product contains biotech ingredients, and X1= -1, X2 = -1 if no text disclosure is present. The logo's location attribute is coded as follows; X3 = 1 if the logo appears on the primary display panel (PDP), X3 = -1 if the biotech logo appears on the information panel (IP); and, X4= 1 if a logo is present and X4= -1 in if there no logo. EDU_{ij} denotes the education levels of the ith individual, where j = 1,2, …6 for 6 education categories, and EDU_{ij} = 1 if respondent ith indicated their education level falls in the jth category, otherwise EDU_{ij} = 0. INC_{ij} reflects the annual yearly income of the ith individual, where j = 1,2, 3…9 for 9 income categories. INC_{ij} = 1 if the ith respondent indicated their income is in the jth category, otherwise INC_{ij} = 0. $RACE_{ij}$ represents the ethnic background of the ith individual, where j = 1,2, …6 for 6 ethnic background. $RACE_{ij}$ = 1 if the ith respondent indicated their race is in the jth category, otherwise, $RACE_{ij}$ = 0. AGE_{ij} represents the age group of the $_i$th individual, where j = 1,2, …6 for 6 ages groups, and AGE_{ij} = 1 if ith respondent indicated their age is in the jth

category, otherwise AGE_{ij} = 0 and GEN_{ij} represents the gender of the $_i$th individual, where j = 1 for two gender categories, and GEN_{ij} = 1 if the ith respondent is in the jth category, other wise GEN_{ij} = 0.

Model II

It is hypothesized that choices between a mandatory versus a voluntary labeling policy may be affected by respondents' general perception of biotechnology. The explanatory variables used in this model were questions 6 through 12 from the mail survey. The dependent variable was in the binary form, where 1 represents respondents who agreed with FDA's voluntary labeling policy and 0 if respondents supported a mandatory labeling policy. The binary probit model used in the estimation was

$$Voluntary/Mandatory_i = \beta 0+\beta q6_i+\beta q7_i+\beta q8_i+\beta q9_i+\beta q10_i+\beta q11_i+ \beta q12_i$$

Where $Voluntary/Mandatory_i$ is the previously defined dependent variable, $q6_i$ = response by the ith individual to question 6 from the questionnaire; $q7_i$ = response by the ith individual to question 7 from the questionnaire; $q8_i$ = response by the ith individual to question 8 from the questionnaire; $q9_i$ = response by the ith individual to question 9 from the questionnaire; $q10_i$ = response by the ith individual to question 10 from the questionnaire; $q11_i$ = response by the ith individual to question 11 from the questionnaire; and $q12_i$ = response by the ith individual to question 12 from the questionnaire. Responses to questions 6 through 12 are coded as follows: 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree and 1= strongly disagree.

CHAPTER 4

RESULTS

Introduction

This chapter reports and discusses the results from the mail survey that was used to collect quantitative and descriptive data. The analysis also presents the part-worth estimates used to determine the attributes' relative importance in selecting biotech labels. The general reporting format is as follows: (1) descriptive data, which includes a discussion of socioeconomic and demographic characteristics of the sample, (2) summarized respondents' responses to attitude statements in the survey, (3) results from the empirical ordered probit and binary models presented in chapter 3 and (4), discussion and interpretation of model results.

Survey Response Rate

Questionnaires were mailed to 3,450 households in Atlanta, Chicago, Denver, Los Angeles, New Orleans, New York, and Houston. A total of 509 usable surveys were returned for an overall response rate of 14.75%. Table 4.1 presents each region's response rate, plus the response rate for the overall survey. Denver, Colorado provided the highest response rate of 20%, followed by New Orleans (18%) and Chicago (17%). Respondents from New York returned the lowest response rate of 8.6%.

Table 4.1 Response Rates of Survey Respondents for the Seven Metropolitan Regions Used in the Study.

Region	Number of Surveys Mail	Number of Surveys Returned	Response Rate
Denver	500	100	20.0
New Orleans	500	92	18.40
Chicago	500	85	17.00
Los Angeles	500	71	14.20
Atlanta	450	61	13.56
Houston	500	57	11.40
New York	500	43	8.60
Total	3450	509	14.75

Descriptive Statistics of Sample

Table 4.2 presents summary statistics for demographic information about respondents. Of the 509 respondents, 274 or (54%) were males and 235 (46%) were females. All age groups were represented in the sample, with the 45-54 age group accounting for the most responses, 27% of sample. Hence, the median age of the sample was between age group 45-54. Respondents were well educated as over three quarters (8o%) had completed some college courses, graduated with a bachelor degree, or had done post graduate work. The median annual income of respondents was between $30,000-$44,999, which accounts for 20% of the sample. Six percent had annual income of less than $15,000, and 10% of respondents made in excess of $120,000 in yearly earnings.

Consumer Awareness and Perceptions of Biotech Foods

The study found that awareness i.e, having read or heard of biotechnology foods was higher among U.S. consumers when compared to previous studies. For instance, Hoban and Kendall (1992) conducted a survey on consumer awareness of biotechnology and found that 48 % of respondents were aware of biotechnology. The Wirthlin Group Quorum Survey (1999) also did a study on awareness and reported a 20% awareness level by respondents. Table 4.3 and figure 4.1 summarizes the percentage of awareness of respondents, and their levels of awareness. Eighty four percent of the respondents have heard about biotech foods, while only 16 % said they have not read or heard anything about biotech foods. Of the 84 % of respondents who indicated they are aware of biotech food, 60 % indicated they believed themselves to be either very informed (3.5%), moderately informed (23.8 %) or somewhat (32.4%) informed about

biotechnology (figure 4.1). The remaining 36% having heard of biotech foods said they believed themselves to be only minimally informed about biotechnology.

Table 4.2 Frequency Distribution of Socio-Demographic Characteristics of Survey Respondents of Biotech Labeling Survey

Demographic Characteristics Sample (n= 509)	Number	Percentage
Gender		
Male	274	54.0
Female	235	46.0
Age (years)		
18-24	12	2.36
25-34	56	11.00
35-44	99	19.45
45-54	135	26.52
55-65	93	18.27
65 or older	114	22.40
Education		
Less than high school	2	0.39
Completed High school	58	11.39
Technical school	37	7.27
Some college	119	23.88
Completed bachelor degree	150	29.47
Post graduate work	143	28.09
Income		
Less than $15,000	33	6.48
$15,000 -$29,000	47	9.23
$30,000 - $44,999	101	19.84
$45,000 - $59,999	99	19.45
$60,000 -$74,999	76	14.93
$75,000 -$89,999	53	10.41
$90,000 -$104,999	32	6.29
$105,000 -$119,999	19	3.73
More than $120,000	49	9.63

Table 4.3 Respondents' Awareness Level of Biotechnology

	Number of Respondents	Percentage of Respondents
Aware of biotechnology	429	84 %
Not aware of biotechnology	80	16 %

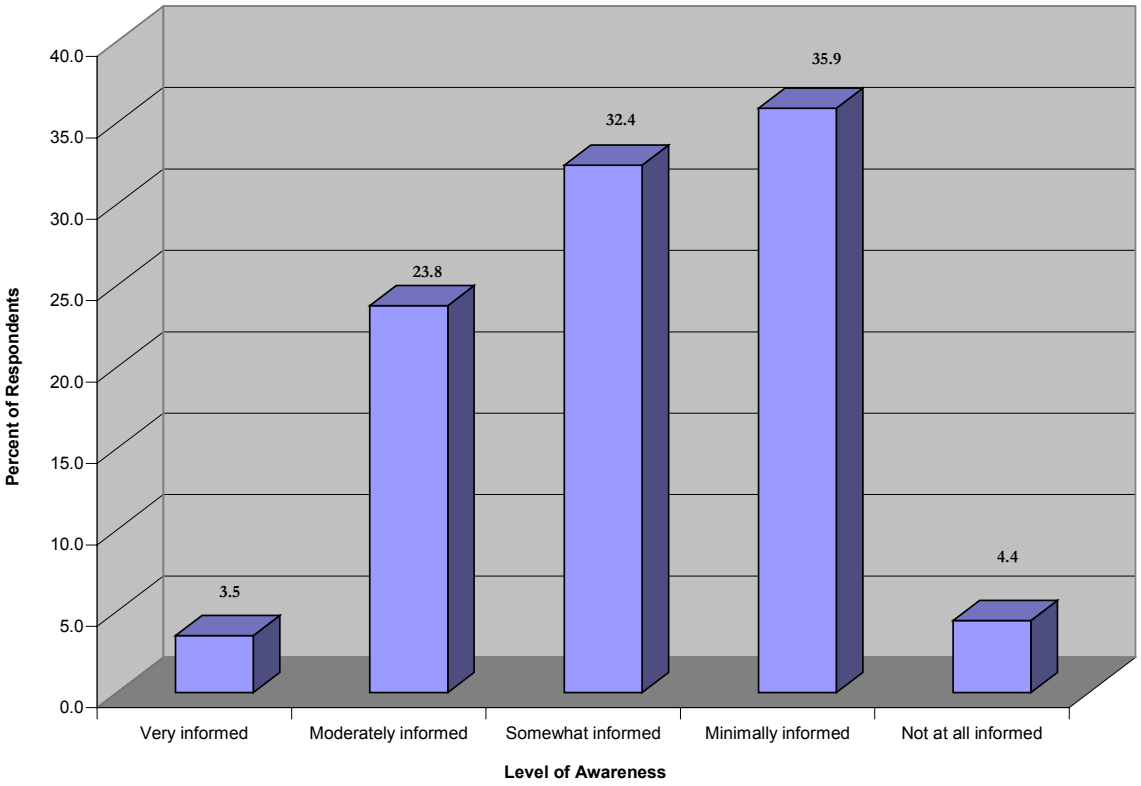

Figure 4.1 Percentage of Respondents indicating levels of Awareness.

Before looking at the ordered probit model presented in chapter 3, table 4.4 provides cross-tabulations of the relationship between general consumer awareness and demographic factors. Of the 84 % of respondents who are aware of biotechnology, 58% were male and 42% were females. Further analysis of the data showed that respondents within the age groups 35-44, 45-54 and the 65s and older, were more aware of biotechnology than other age groups. Respondents in these age groups indicated a 21.21%, 27.51% and 21.68% level of awareness respectively. The demographic variable

education showed more of an influence than any other variable. Respondents who had a bachelor degree (31%), or those who had completed postgraduate work (31.93%), indicated greater awareness of biotechnology than other respondents. Hence, more educated individuals considered themselves to be more informed about biotechnology than less educated respondents. The effect of gender on awareness was also interesting. In general, men considered themselves more aware about biotechnology than females. Fifty eight percent of males said they were aware of biotechnology compared to forty two percent of females.

Table 4.4 Cross Tabulation of Awareness Level and Socio-Economic Demographic Make-up of Sample.

	% Total Response	Percentage Level of Awareness				
	Aware	Very Informed	Moderately Informed	Somewhat Informed	Minimally Informed	Not at all
Gender						
Male	58.04[a]	1.63[b]	20.75	18.18	15.15	2.33
Female	41.96	3.03	15.15	13.99	8.62	1.17
Age (years)						
18-24	2.10	0.00	1.17	0.70	0.23	0.00
25-34	9.32	0.93	2.10	3.73	2.10	0.47
35-44	21.21	0.70	10.49	4.43	5.13	0.47
45-54	27.51	0.70	8.39	10.49	6.99	1.17
55-65	18.18	0.93	5.83	7.23	3.26	0.93
65 or older	21.68	1.40	7.93	5.83	6.06	0.47
Education						
Less than high school	0.00	0.00	0.00	0.00	0.00	0.00
High school	8.86	1.86	3.96	1.17	1.63	0.23
Technical school	7.69	0.23	3.03	4.20	0.23	0.00
Some college	20.51	1.17	10.49	4.90	3.50	0.47
Bachelor degree	31.00	0.93	11.19	10.02	8.16	0.70
Post graduate work	31.93	0.47	7.23	12.12	10.26	2.10

[a] - Vales in the table are the percentage of total responses for awareness of the sample.
[b]- Values in the tables are the percentage of total responses indicating each level of biotech awareness

Figure 4.2 shows the percent of respondents indicating the most familiar biotechnology term. Fifty two percent of those surveyed indicated that genetically

engineered foods was the most familiar term associated with biotechnology while the least familiar term was bioengineered food, (6%). Genetically modified foods (22%) and biotech foods (13%), were the second and third most familiar terms respectively. Of the 429 respondents who said they were aware of biotechnology, 37 % said they know that foods produced through biotechnology are presently in their local supermarket or grocery store. Moreover, of the respondents who considered themselves more informed, all answered yes when asked if there are any foods produced through biotechnology in their local supermarket. They identified vegetables (114), tomatoes (100), corn (98), and cereal/grains (86) as the leading foods in supermarkets known to be made from biotechnology. See Figure 4.3 for the complete list.

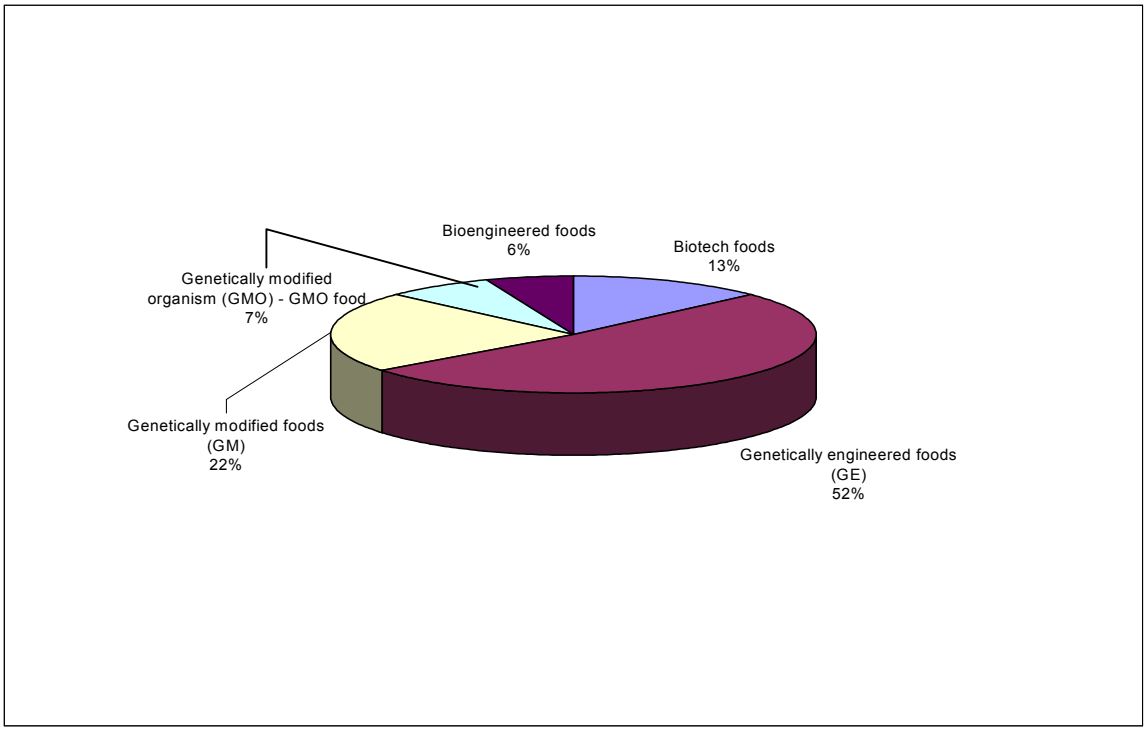

Figure 4.2 Percent of Respondents Indicating the Most Familiar Biotechnology Term

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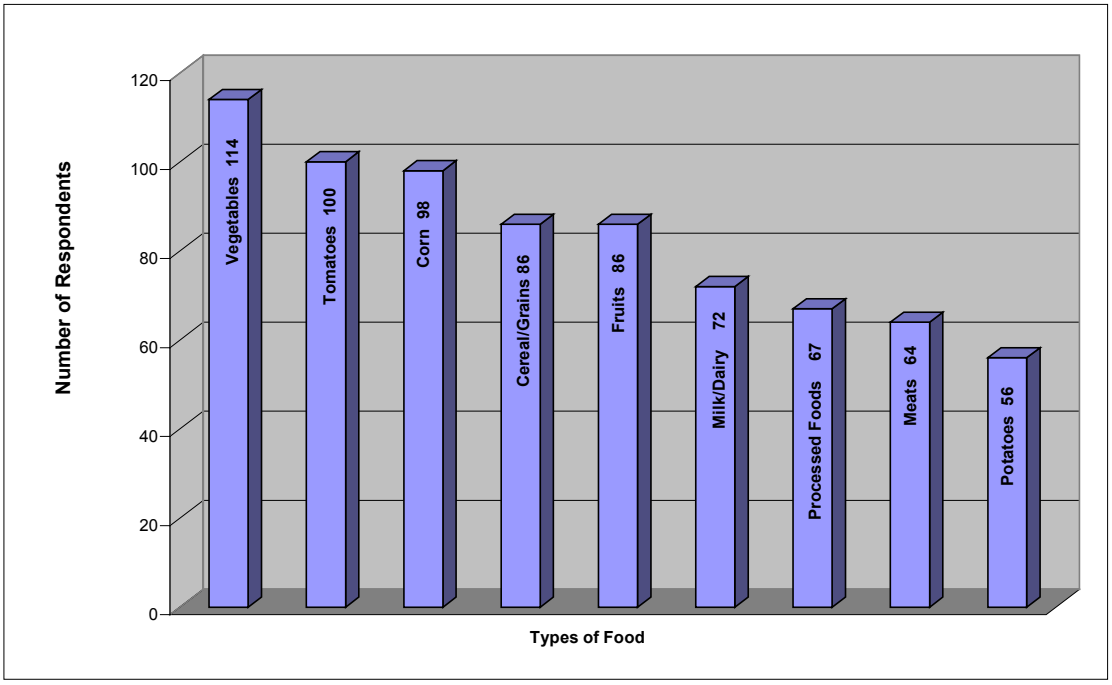

Figure 4.3 Number and Kinds of Food Identified by Respondents As Being Produced By Biotechnology in Their Local Supermarket.

Consumer Perception of Biotechnology

As table 4.5 shows, 41.25% of respondents either strongly agree (7.07%) or agree (34.18%) that biotech foods are reasonably safe for human consumption. On the other hand, 17.28% of respondents think that genetically engineered food products are not reasonably safe for human consumption. Forty one percent of the respondents remained neutral when answering this question. In terms of the effect of biotech crops on wildlife and the environment, 40% agreed that these type crops may have an adverse effect. Eighteen percent disagreed. A quarter (25%) of the survey respondents thought that meat products produced from biotechnology pose more health risks than foods made from biotech crops. Half of the respondents remained neutral in answering this question. There was support for biotechnology from respondents as more than 50% thought biotechnology benefits society because it allows farmers to produce food more efficiently. Only 16% thought there were no benefits from biotechnology to society. However, concerns about food products still exist. Labeling of these types products is the major issue. To respondents, food labels indicating the presence of biotech ingredients are very important because 81 % indicated that food products should have biotech labels, whereas only 6% weren't in favor of biotech labels. According to this sample of respondents, the approval of biotech food products by the FDA for consumption, does not necessarily mean the consumers will accept the product. Fifty six percent indicated that FDA's approval of biotech foods does not equate to biotech food products being safe.

Mandatory or Voluntary Labeling

The present policy of the FDA is that labeling of biotech foods should be voluntary since it has been determined these foods have the same safety and nutritional

Table 4.5 Respondents' Perceptions and Attitudes Of Biotechnology

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
				percent		
Question 6.	Biotech Foods are reasonably safe for human consumption.	7.07	34.18	41.45	11.39	5.89
Question 7.	Biotech crops may have adverse effects on wildlife and the environment.	10.81	29.08	41.85	15.32	2.75
Question 8.	Meat products produced using biotechnology are more likely to pose health risks than foods made from biotech crops.	4.13	20.43	53.05	19.06	3.34
Question 9.	Biotechnology benefits society because it allows farmers to produce food more efficiently.	11.00	42.63	30.45	10.81	5.11
Question 10.	There is no need to be concerned about the safety of biotech foods because the U.S. Food and Drug Administration (FDA) would not let these products be sold in supermarket if they were not safe.	3.34	19.45	20.83	31.04	24.75
Question 11.	Foods labels are needed to show the presence of biotech ingredients, since consumers could face unknown health risks.	40.86	40.67	12.57	4.91	0.98
Question 12.	It is unethical to produce a food using biotechnology.	4.72	8.45	36.54	29.86	20.24

content as other foods. FDA argues that mandatory labeling of biotech foods could unnecessarily raise the health concerns about biotech foods. However, critics of this policy say that any food produced through biotechnology should be labeled, even if the safety aspect of the food has not changed. Survey respondents were asked to choose between the present FDA's policy of voluntary labeling or the mandatory labeling of biotech foods as argued by critics of the FDA's policy. Of the 509 respondents, 409 or 80% of the sample were in favor of a mandatory labeling policy for biotech food products. Only 20% of the respondents indicated they agreed with FDA's voluntary labeling policy, despite being informed of FDA's concern that mandatory labeling would unnecessarily raise heath concerns among consumers, (Table 4.6).

Table 4.6 Respondent's Responses to a Mandatory or Voluntary Labeling Policy.

	Number of Respondents	Percentage of Respondents
Voluntary Labeling	103	20
Mandatory Labeling	406	80

If respondents were in agreement with the critics' mandatory labeling policy, a follow-up question was asked to determine what levels of biotech ingredient contents warrants labeling. The categories by percentages of biotech ingredients that must be present were set at the following levels: 50%, 25%, 10%, 5% and any trace. Of the 80 % of respondents who said that mandatory labeling was preferred to voluntary labeling, 67.5 % indicated that labeling should be mandatory if a food product contained any trace of ingredients produced with biotechnology. Another 13.8% said that mandatory labeling should be required only if more than five percent of the product's ingredients are produced with biotechnology. 6.2 % said mandatory labeling of a biotech product is only

necessary when either 25% or 50% of the product has been genetically modified (figure 4.4)

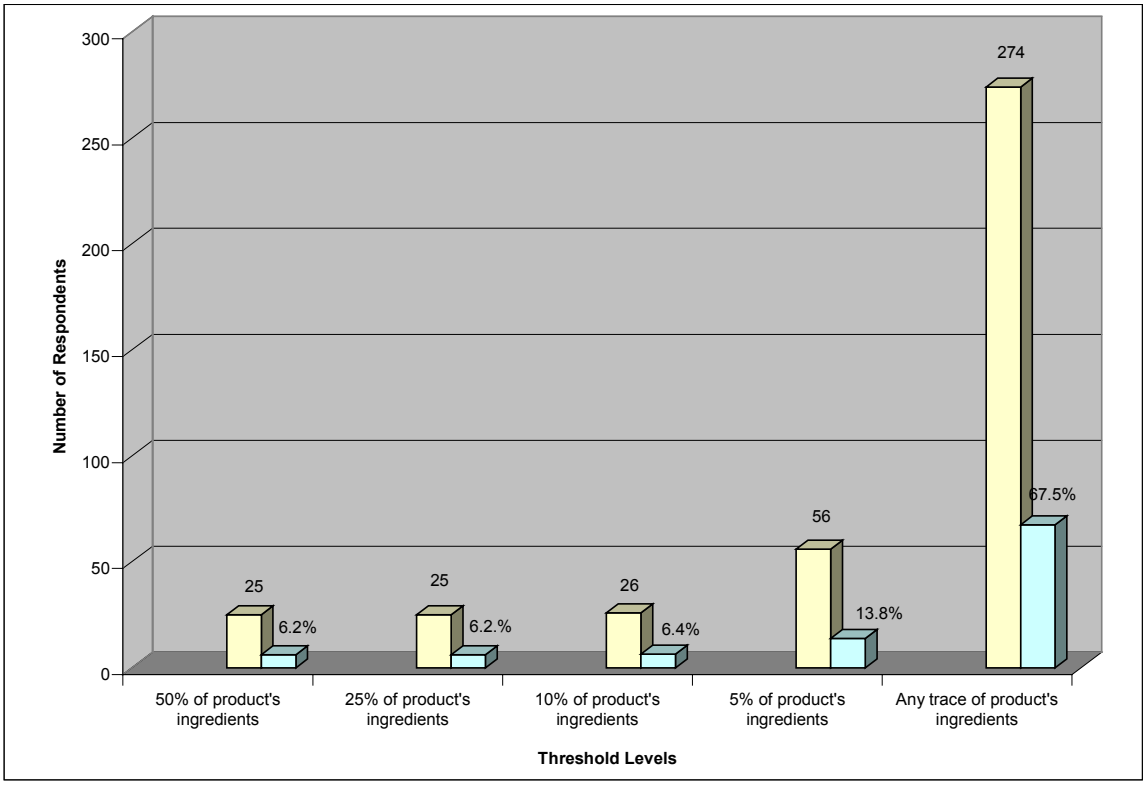

Figure 4.4 Number and Percentage of Respondents Indicating the Minimum Levels of Biotech Ingredients that Warrant Mandatory Labeling.

Purchase of Biotech Foods

Differences existed between consumers who are willing to purchase a meat product made from biotechnology compared to a non-meat food product. Respondents were asked, would you purchase a non-meat food product that has been produced using biotechnology? The responses to this question fell into three categories; yes (46%), no (16%) and those that were uncertain (38%). However, when the same question was asked in regards to a meat product, the responses changed to; yes (24%), no (32%), and uncertain (44%). A combined 54% would not or were uncertain about purchasing a non-

meat bioengineered food product, while more than three quarters (76%) of the sample would not or were uncertain about purchasing a meat product made from biotechnology. Figure 4.5 displays the percentage responses of survey participants on purchasing both types of biotech foods products.

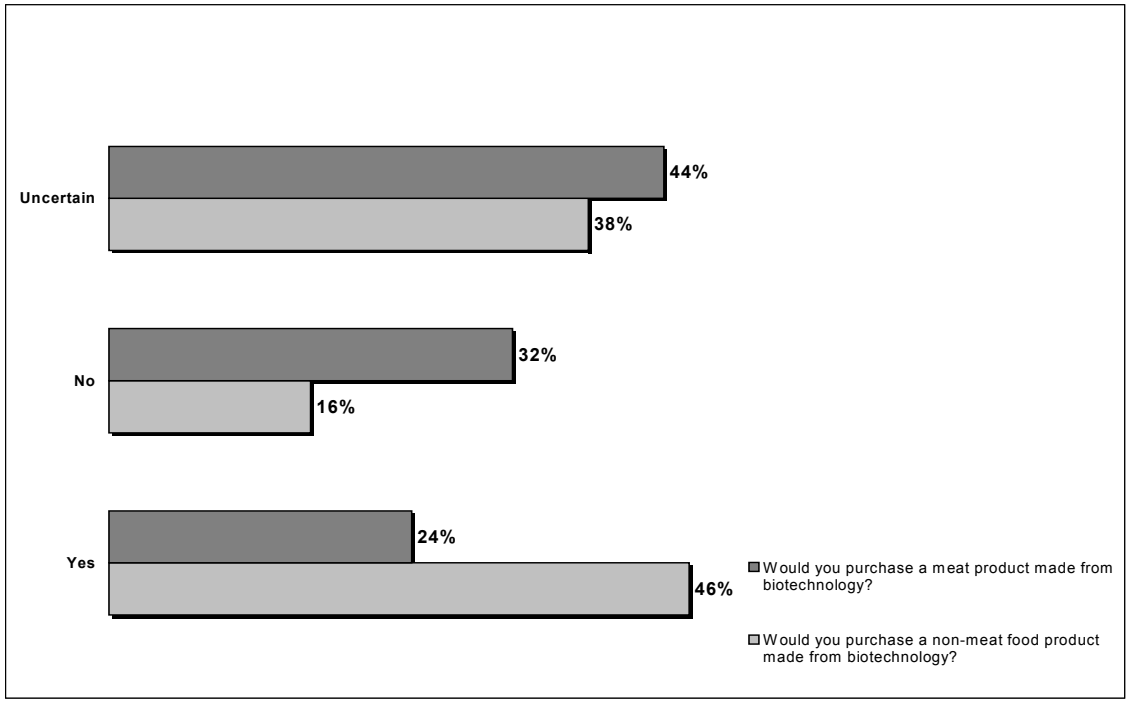

Figure 4.5 Respondent's Choices on Purchasing a Non-meat versus Meat Product Made From Biotechnology.

Consumer Use of Food Labels

This section of the questionnaire contained four questions pertaining to the frequency with which consumers read food labels when buying a product. Table 4.7 shows that consumers on average read both nutritional information and ingredients lists when buying either familiar or new products. The first two questions asked if respondents read the nutritional and ingredients sections of food labels before buying a familiar product. Thirty seven percent of the respondents indicated they read the nutritional section of food labels often, and 31% indicated they sometimes read the nutritional

section of food labels before buying a familiar product. Only 14% said they always read the nutritional section of food labels when buying a familiar product. Results were almost similar for consumers when asked how often they read the ingredients section of food labels of familiar products.

The next two questions asked if respondents read the nutritional and ingredient sections of food labels before purchasing a new product. Forty percent of the respondents indicated that they always read both nutrition and ingredients labels when purchasing a product for the first time, while 55% said they either sometimes or often read nutrition labels the first time they buy a new food product. Also, 53 % of the respondents said they read the ingredient section of food labels either often or sometimes when buying a new product. Only 2% of respondents said they never read foods labels before purchasing new food products. Two important findings emerge from the analysis of consumer use of food labels. The first is that that consumers place equal importance on the knowledge gained, or information provided by both the nutritional and ingredients lists. The second and most significant is that consumers place greater emphasis on labeling when purchasing new food products.

Table 4.7 Percentage of Respondents Indicating their Use of Food Labels

	Always	Often	Sometimes	Rarely	Never
			Percent		
Quest 17. How often do you read the *nutritional* section of food labels before buying a **familiar** product.	14	37	31	16	2
Quest.18. How often do you read the *ingredients* section of food labels before buying a **familiar** product.	11	33	32	21	3
Quest. 19. How often do you read the *nutritional* section of food labels before buying a **new** product.	40	41	14	4	1
Quest. 20. How often do you read the *ingredients* section of food labels before buying a **new** product.	40	38	15	6	1

Conjoint Model Results

Conjoint analysis begins with the estimation of the part-worth utilities for the total sample. This entails examining the part-worth coefficients, as the size and sign indicate the degree and direction in which respondents prefer a particular level of an attribute. The constant term in the model is the overall mean preference rating of biotech labeling formats. The part-worth values for the attribute levels of a given label are then added to the constant term to determine total utility for a particular label format.

Recall from chapter 3 that each attribute level has a dummy code associated with it to determine the part-worth utility. For example, the attribute logo location is coded as 1, and –1. The coefficients obtained for these variables are then multiplied by the coding variables to yield the part-worth estimate. Table 4.8 presents the results of the ordered probit part worth estimates for conjoint analysis of biotech labeling formats.

The chi-square test showed that the overall model was significant at the 1% level. A t-test was used to test the null hypothesis that the part-worth estimates are equal to zero. The estimated coefficients for all attribute levels were significant at the 1% level of confidence. The relatively large positive coefficient for the "text disclosure that describes the benefits of the biotech ingredients" suggests that this type of disclosure increases the average respondent's preferences for biotech labels. The presence of this attribute will increase utility with a part-worth value of 0.58. A "simple biotech text disclosure" causes a reduction in part-worth utility as indicated by the negative 0.22 coefficient. This suggests that consumers in general want more information, and even a simple text disclosure would not add to consumer utility. The attribute, "presence of a biotech tech logo" had the second largest positive coefficient of 0.56. In general, the presence of a

biotech logo increases the average consumer's overall preference for biotech labeling. The location of the logo had the lowest effect on respondents' utility. However, when the logo appears on the Principal Display Panel (PDP), as opposed to the Informational Panel (IP), the average consumer's preference for labeling increased as indicated by the positive 0.12. The 'no text' attribute decreased overall preference and utility by .36 which suggests that absence of a text disclosure decreases the average respondent preference for biotech labels.

To aid in the interpretation of the effects of individual characteristics on biotech label preferences, several demographic variables were included in the model. The socio-demograhic characteristics used were age, education, annual income, gender, and race.

The estimates for the education variables are positive but not significant at either the 1% or 5% levels of confidence. However, respondents having a bachelor degree were significantly different from the post graduate category at the 10 percent level, which indicates that these individuals have greater preferences for biotech labels compared to individuals with the highest education in the sample. Two of the age dummy variables are significant at the 10 percent level. The coefficient for the 65 and older is positive and significant at the 5% level. Similarly, the 55-65 age group is positive and significant at the 10% level. The results imply that respondents older than 55 years of age have a greater preference for biotech labeling relative to the omitted age group (45-54). Most of the income dummy variables are not significant. However the $15,000 - $29,000 group, and the more than $120,000 group, coefficients are negative and significant at the 5% or better level. This means that each of these categories preferences, for biotech labels is lower relative to the $30,000 to $44,999 income level.

Table 4.8 Ordered Probit Part Worth Estimates for Conjoint Analysis of Biotech Labeling Formats in Combination with Demographic.

Variable	Coefficient	Standard Error	(t-ratio)	P-Value
Constant	1.207***	0.151	7.961	0.000
Text disclosure that describes the benefits of biotech ingredients	0.575***	0.037	15.255	0.000
Simple biotech text disclosure	-0.218***	0.039	-5.522	0.000
No Text	-0.357***	0.049	-7.262	0.000
Biotech logo appears on the PDP	0.122***	0.030	4.029	0.001
Presence or absence of a biotech logo	0.557***	0.033	17.074	0.000
Gender[a]				
Female	0.012	0.051	0.241	0.809
Education[b]				
Completed high school	0.083	0.097	0.856	0.392
Technical college	0.042	0.099	0.422	0.673
Some college	0.064	0.073	0.886	0.376
Bachelor degree	0.119*	0.071	1.684	0.092
Income[c]				
Less than $15,000	-0.191	0.127	-1.510	0.131
$15,000 - $29,999	-0.258***	0.094	-2.746	0.006
$45,000 - $59,999	-0.244***	0.081	-3.019	0.003
$60,000 -$74,999	-0.121	0.088	-1.383	0.167
$75,000 -$89,999	-0.041	0.094	-0.441	0.659
$90,000 -$104,999	-0.074	0.113	-0.657	0.511
$105,000 -$119,999	-0.014	0.133	-0.104	0.917
More than $120,000	-0.282**	0.119	-2.364	0.018
Age[d]				
18-24	0.135	0.161	0.834	0.405
25-34	0.026	0.096	0.271	0.786
35-44	0.101	0.075	1.396	0.163
55-65	0.124*	0.069	1.813	0.069
65 or older	0.172**	0.078	2.197	0.028
Race[e]				
White	-0.229*	0.132	-1.743	0.081
African American	-0.255	0.176	-1.447	0.148
American Indian	-0.139	0.394	-0.353	0.724
Hispanic	-0.237	0.167	-1.415	0.157
Other	-0.203	0.180	-1.125	0.260

*** Indicates estimated coefficient is significant at the .01 level ; χ^2 Log-L -4150.94

** Indicates estimated coefficient is significant at the .05 level; Chi-square = 777.28, p-v. 0.00

* Indicates estimated coefficient is significant at the .10 level ; N=509*7= 3,563

[a] Excludes the gender male.

[b] Excludes the post graduate work category ; the less than high school group was omitted from the analysis because only two responses were in this education category.

[c] Excludes the $30,000 - $44,999 income category

[d] Excludes the 45 –54 age group category

[e] Excludes the Asian category.

In regard to ethnic background, all estimated coefficients were negative and are not significant except for the category for whites, which was significant at the 10% levels. Results would suggest that Asians (the omitted category) are more likely to prefer labeling of food products produced from biotechnology relative to whites. Gender had no effect on respondents' preferences for a biotech labels.

Relative Importance of Attributes

The relative importance of product attributes was calculated using the part-worth utility values from the ordered probit model. To determine the relative importance of an attribute, each attribute's highest and lowest part-worth utilities are utilized. The difference between the highest and lowest part-worth values establishes the utility range for the given attribute. Once the utility range for all attributes is determined, the relative importance of each attribute is calculated by dividing the utility range for the attribute by the sum of all attributes. (Harrison et al., 1998). The equation used is,

$$RI_i = \left[\text{Utility Range}_i \div \sum \text{utility ranges } \forall \text{attributes}\right] \times 100$$

where RI_I is the relative importance for the *i*th attribute. The results presented in table 4.9 indicate that the most important attribute was the presence of a logo, contributing 48.7 % to the preference rating. The text disclosure that describes the benefits of the biotech ingredient was determined to be the second most relevant attribute, accounting for 40.87% of the preference rating. The third most important attribute contributing 10.43%, was the location of the logo on the product package.

Table 4.9 Relative Importance of Attributes For Biotech Label

Attribute	Relative Importance (%)
Text disclosure	40.87
Location of logo	10.43
Presence of a biotech logo	48.70

Model II

It is hypothesized that choices between a mandatory versus a voluntary labeling policy may be affected by respondents' general perceptions and attitudes of biotechnology. In addition, respondents' perceived level of risks and benefits associated with biotechnology, may also influence acceptance of either labeling policy. Recall from chapter 3 that the explanatory variables used in this model were questions 6 through 12 from the mail questionnaire. Resulting opinions for these questions were expressed as ranging from 5 (strongly agree) to 1 (strongly disagree). A key assumption is that a 5 to 1 coding represents an ordered scale of respondent's opinion regarding each statement. The dependent variable was in binary form, where 1, represents respondents who agreed with FDA's voluntary labeling policy, and 0, if respondents supported a mandatory labeling policy. The index function coefficients and marginal probabilities for mandatory versus voluntary biotech labeling are presented in table 4.10.

The chi-square test showed that the overall model was significant at the 1 significance level. Coefficients on questions 7, 10 and 11 are significant at the 1 significance level. All other coefficients are not significant. Question 7 has a negative coefficient indicating that as respondents' level of agreement with the statement that biotech crops may harm the environment and wildlife increases, they are more likely to

support a mandatory labeling policy. The marginal effect on this variable indicates as respondents' perception that biotechnology is harmful to the environment and wildlife increases, the probability of them supporting a voluntary labeling policy, decreases by .052. Question 10, which ask respondents if approval of biotech food products by the FDA as an inspection and regulatory agency means the product is safe for consumption, has a positive coefficient. Hence, if consumers believe this to be true, they are more likely to support a voluntary labeling policy. The marginal effect indicates that if respondents trust the FDA inspection and safeguard regulations regarding biotech foods, the probability of them agreeing with FDA's voluntary labeling policy increases by 0.059. Question 11 has a negative coefficient, which indicates that as a respondent's perception of unknown health risks associated with biotech foods increases, they are more likely to support a mandatory labeling policy. The marginal effect show that the probability of these respondents agreeing with a mandatory labeling policy will increase by .095.

Table 4.10 Binary Probit Coefficients and Marginal Probabilities For Mandatory Versus Voluntary Biotech labeling.

Variable	Equation				Marginal Effects			
	Coefficient	Standard Error	(t-ratio)	P-Value	Coefficient	Standard Error	(t-ratio)	P-Value
Constant Term	-.1042	0.693	-0.021	0. 983	-0.003	0.157	-0.021	0.983
Q6. Biotech Foods are reasonably safe for human consumption.	0.199	0.129	1.545	0.122	0.045	0.029	1.535	0.119
Q7. Biotech crops may have adverse effects on wildlife and the environment.	-0.230**	0.093	-2.486	0.012	-0.052**	0.020	-2.535	0.011
Q8. Meat products produced using biotechnology are more likely to pose health risks than foods made from biotech crops.	0.131	0.103	1.265	0.206	0.029	0.023	1.276	0.202
Q9. Biotechnology benefits society because it allows farmers to produce food more efficiently.	-0.022	0.118	-0.186	0.852	-0.005	0.027	-0.186	0.852
Q10. There is no need to be concerned about the safety of biotech foods because the U.S. Food and Drug Administration (FDA) would not let these products be sold in supermarket if they were not safe.	0.259***	0.071	3.669	0.002	0.059***	0.016	3.749	0.000
Q11. Foods labels are needed to show the presence of biotech ingredients, since consumers could face unknown health risks.	-0.418***	0.085	-4.902	0.000	-0.095***	0.019	-4.816	0.000
Q12. It is unethical to produce a food using biotechnology.	-0.061	0.093	-0.656	0.5111	-0.014	0.021	-0.658	0.510

* Indicates estimated coefficient is significant at the .10 level
** Indicates estimated coefficient is significant at the .05 level
*** Indicates estimated coefficient is significant at the .01 level
N = 507
Chi-square = 101.6740; χ^2 Log-L-205.522

CHAPTER 5

SUMMARY AND CONCLUSIONS

Today's consumers are placing increasing importance on food quality, food safety and the environment. As a result, the production and marketing of genetically modified foods have caused some concern among certain consumer groups. Consumer acceptance of genetically modified foods has varied because of different attitudes toward the health and environmental risks associated with these products.

Intricately linked to the debate on agriculture food biotechnology is the matter of labeling and information. Economics and marketing studies on the value of information have characterized information on food labels as reducing consumer's uncertainty regarding safety and nutritional qualities of food. Labels serve as a source of information, and for labels to achieve their objectives, consumers must understand the information provided by labels. This study has explored the relationship between information and labels, and consumers' perceptions of agricultural biotechnology.

The overall objectives were to: (1) measure consumer attitudes and perceptions toward foods produced using biotechnology, (2) quantify labeling preferences regarding biotech foods, and (3) determine the frequency of consumers' use of food labels in general to accomplish these objectives a questionnaire was developed.

The survey consisted of questions on respondents' perceptions and attitudes to biotechnology, consumer use of food labels, and conjoint analysis questions. The first section asked respondents to indicate their level of awareness and perceptions on biotech foods. Eighty four percent of the respondents indicated they have heard about biotech foods, while 16% said they have not read or heard anything about biotech foods. Previous

researche conducted in 1997 and 1999 found awareness levels to be 20 and 40%, respectively. Fifty two percent of those surveyed indicated that genetically engineered foods was the most familiar term associated with biotechnology, while the least familiar term was bioengineered food, (6%). One primary reason for this increased level of awareness is media coverage. In recent years, the media has focused a lot on biotechnology, even sensationalizing some stories as "dolly" the sheep, the Bovine Spongiform Encephalopathy (BSE) crisis in England, and the genetically modified "STARLINK corn" found in Kraft's taco shells which contamination the food supply, and its subsequent recall in the U.S.

Respondents were asked about their general perception about biotechnology, 41.25% of the respondents thought that biotech foods were reasonably safe for human consumption. More than half of the respondents viewed biotechnology as beneficial because it allows farmers to produce food more efficiently. Respondents, although supportive of biotechnology, still exhibited some concerns about the technology. Eighty one percent were strongly in favor of biotech labeling. More than three-quarters of the surveyed respondents indicated that they supported a mandatory labeling policy for biotech foods. In addition, 67% indicated that labeling should be mandatory if a food product contained any trace of ingredients produced with biotechnology. Despite consumers' concerns about the risks associated with genetically modified food products, respondents were still willing to purchase these type products. The only notable differences in respondents' willingness to purchase biotech foods, is that respondents were more likely to purchase a non-meat biotech food compared to a meat product produced from biotechnology.

In terms of consumer usage of food labels, an important finding was that consumers place greater emphasis on labels of new products compared to those of familiar products. They were twice as likely to read both the ingredients list and nutrition information on new product labels. This is an significant finding since biotech foods are considered new products by many consumers. There was no substantial evidence from the study to show that differences in socio-demographic factors contribute to consumer usage of food labels.

Statistical Results

In order to estimate the relative empirical importance of labeling of biotech foods, conjoint analysis was used to determine how respondents with different demographic characteristics rate different labeling formats. Conjoint analysis provides the means to determine which labeling characteristics contribute positively or negatively to respondents' total preferences of biotech labels.

An ordered probit regression analysis was used to estimate the rating on the 7 hypothetical biotech labeled products. The product profiles receiving the highest rating was "product A" (appendix A) which had the attributes, text disclosure with benefits and a biotech logo located on the PDP. The attribute found to be more significant in providing utility to respondents was a text disclosure with benefits and the presence of a biotech logo. This was evident in the significance of the parameter estimates. The relative importance of both attributes were 40.87% and 48.70%, respectively. Results suggest that respondents have definitive preferences for biotech labels, and in general need more information on food labels. The results of the conjoint analysis indicates that on the

whole, differences in education, age, income and race weren't significant determinants in determining respondents preferences for biotech labels.

The second model in the study examined consumers' choice for a mandatory versus a voluntary labeling policy of biotech foods. Respondents who have significant food safety concerns, or thought there unknown health risk associate with biotechnology, or believe that genetically modified products may harm the environment, were in favor of a mandatory labeling policy. Dissatisfaction with a voluntary labeling policy was also a function of respondents' lack of confidence in FDA's assurances that biotech food products are safe consequently, respondents were more likely to support a mandatory labeling policy. Moreover, potential support for biotech foods is substantial as almost half (46%) of the respondents indicated that they would be willing to buy these types products. Perhaps the most significant finding of this study is that consumers are genetically receptive of biotechnology, given they are informed about the presence of biotech ingredients in their foods.

Implications

Several important findings emerge from the analysis of the determinants of consumer attitudes towards biotechnology and the labeling of these type products. Consumers in general do use food labels as a source of information when purchasing food products, and labels play even greater roles when consumers are buying new products. Therefore, biotech foods, which essentially are new products, need to be labeled for consumers to willingly purchase them. Results from the focus groups, surveys questions and respondents comments would suggest some level of uncertainty about biotechnology. Uncertainties that will no doubt influence respondents' choice for a

mandatory labeling policy. Labeling therefore plays a very useful role in reducing some of this uncertainty. Educational program could also play n important role in consumer acceptance of biotech food. Promotional efforts from food processors should also focus on the beneficial aspects of biotech food products. Consumers appeared to have low levels of confidence in FDA's food inspection and approval programs. As a result, the FDA could provide more information to the public on their inspection and approval procedures, which may help to alleviate some uncertainty and increase consumer confidence.

Limitations and Future Research

Although a national survey was conducted, only the 7 largest metropolitan regions were surveyed. The attitudes and perceptions of these respondents may not be the same for other regions. Another limitation of this study was that most respondents had high levels of education, a demographic factor that may influence respondents' choices. Future research could focus on using larger samples of a more diverse section of the population. Future extension to this research could also focus on measuring consumers' willingness to pay for biotech labels.

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APPENDIX A

QUESTIONNAIRE AND COVER LETTERS

A Survey of

Consumer Attitudes Concerning Agricultural Biotechnology

Louisiana State University

- **Please complete the questionnaire and return it in the postage-paid return envelope.**
- **Your answers are completely confidential. <u>Do not write</u> your name on the questionnaire.**

LSU AgCenter Research & Extension

Thank you for your help. We hope you will take part and let your views be represented.

BACKGROUND

Certain food products are being developed or modified by new scientific techniques such as biotechnology or genetic engineering. Biotechnology involves taking the genes from one species and inserting them in another to transfer a desired trait or characteristic. Biotech crops can resist diseases, are protected from insect damage, and require less pesticide use, all of which potentially aid farmers and consumers. Biotech foods also provide consumers with improved nutritional qualities, or other specialty traits, such as shape, size, freshness and wholesomeness. The purpose of this survey is to determine your preferences regarding the labeling of these types of products.

Section I: Consumer Awareness and Perceptions of Biotech Foods

1. Have you read or heard about the use of biotechnology, genetically engineered (GE), genetically modified (GM), genetically modified organism (GMO) or bioengineered ingredients in the production of food?

   a) Yes, I have read or heard about biotech foods.
   b) No, I have not read or heard **anythin**g about biotech foods.

   If your answer to question 1 was (a), please answer questions 2 through 5. Otherwise go to question 6.

2. Using a 5 point scale, how well informed would you say you are about biotechnology, where ***one means you are not at all informed*** and ***5 means you are very informed.*** (Please circle your response)

   a) 5 - very informed
   b) 4 - moderately informed
   c) 3 - somewhat informed
   d) 2 - minimally informed
   e) 1 - not at all informed

3. Which of the following terms are you most familiar with? (Circle one)

   a) Biotech foods
   b) Genetically engineered foods (GE)
   c) Genetically modified foods (GM)
   d) Genetically modified organism (GMO) – GMO foods
   e) Bioengineered foods

4. Are there any foods produced through biotechnology in your local supermarket or grocery store? (Circle one)

   a) Yes b) No c) Don't know

5. If answered yes, which foods? (Circle all you know)

   a) Vegetables
   b) Tomatoes
   c) Fruits
   d) Meats
   e) Milk/Dairy
   f) Cereals/Grains
   g) Corn
   h) Potatoes
   i) Processed foods

Please read the following statements carefully, then circle the response that most nearly reflects your opinion.

SA = Strongly Agree, **A** = Agree, **N** = Neutral, **D** = Disagree, **SD** = Strongly Disagree

6. Biotech foods are reasonably safe for human consumption…….…….. **SA A N D SD**

7. Biotech crops may have adverse effects on wildlife and the environment……..…….….. **SA A N D SD**

8. Meat products produced using biotechnology are more likely to pose health risks than foods made from biotech crops……..……..……..…**SA A N D SD**

9. Biotechnology benefits society because it allows farmers to produce food more efficiently……. **SA A N D SD**

10. There is no need to be concerned about the safety of biotech foods because the U.S. Food and Drug Administration (FDA) would not let these products be sold in supermarkets if they were not safe……...……...… **SA A N D SD**

11. Food labels are needed to show the presence of biotech ingredients, since consumers could face unknown health risks……..……**SA A N D SD**

12. It is unethical to produce a food using biotechnology…….**SA A N D SD**

SECTION II: Mandatory or Voluntary Labeling

The present policy of the U.S. Food and Drug Administration (FDA) is that labeling of biotech foods should be voluntary, since it has been determined these foods have the same safety and nutritional contents as other foods. FDA argues that mandatory labeling of biotech foods could unnecessarily raise the health concerns about biotech foods. However, critics of this policy say that any food produced through biotechnology should be labeled, even if the safety aspect of the food has not been altered. They argue it is the consumer's right to know.

13. Which labeling policy are you most likely to agree with, the FDA's or its critics?

a) FDA- voluntary labeling of biotech foods
b) Critics – mandatory labeling of biotech foods

*If your answer to question 13 was **(b)**, please answer question 14. Otherwise, go directly to section* **III**

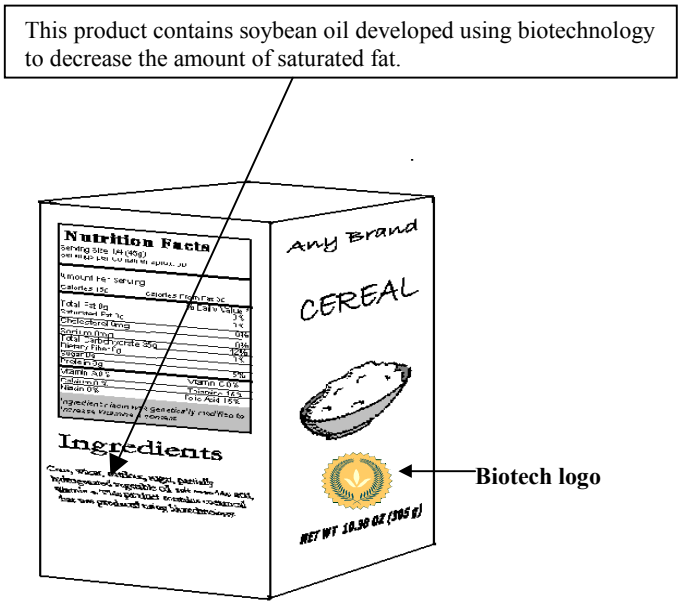
14. Mandatory labeling of biotech foods should be

a) required only if more than 50% of the product's ingredients are produced with biotechnology.
b) required only if more than 25% of the product's ingredients are produced with biotechnology.
c) required only if more than 10% of the product's ingredients are produced with biotechnology.
d) required only if more than 5% of the product's ingredients are produced with biotechnology.
e) required if they contain any <u>trace</u> of ingredients produced with biotechnology.

SECTION III: Labeling Formats

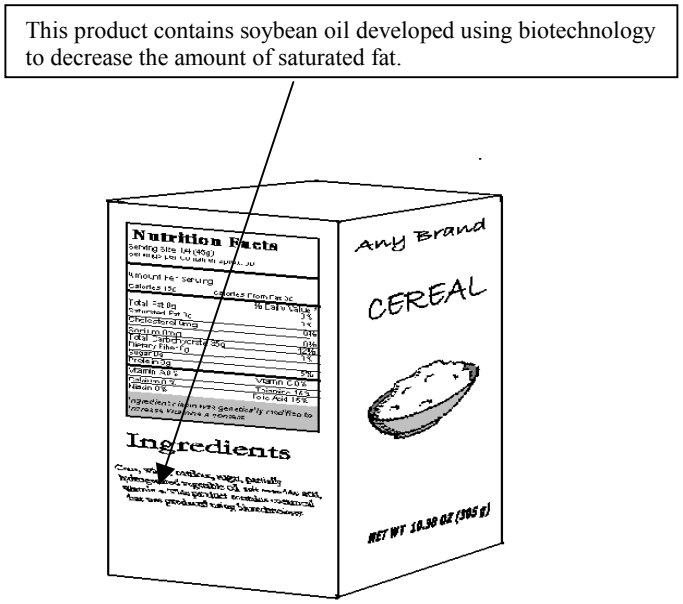
The following diagrams show different labeling formats for labeling biotech foods. The labels differ in terms of (1) the use of a biotech logo, (2) location of the biotech label on the package, and (3) the text disclosure of biotech ingredients. Please rate each example, where 10 is the most preferred and 0 the least preferred. Ties are okay.

(A) Logo on the front and the following text inserted in the ingredients list.



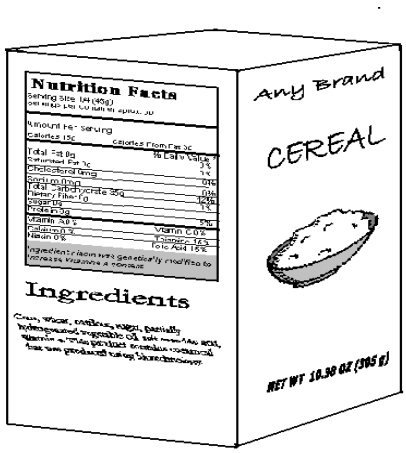
Rating_____

(B) No logo, but the following inserted in the ingredients list



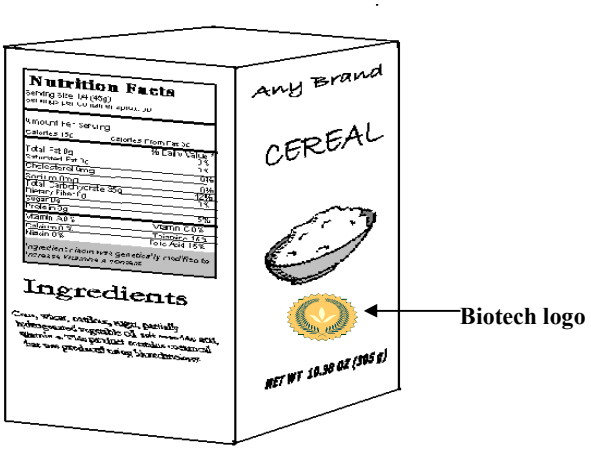
Rating_____

(C) No Biotech Label



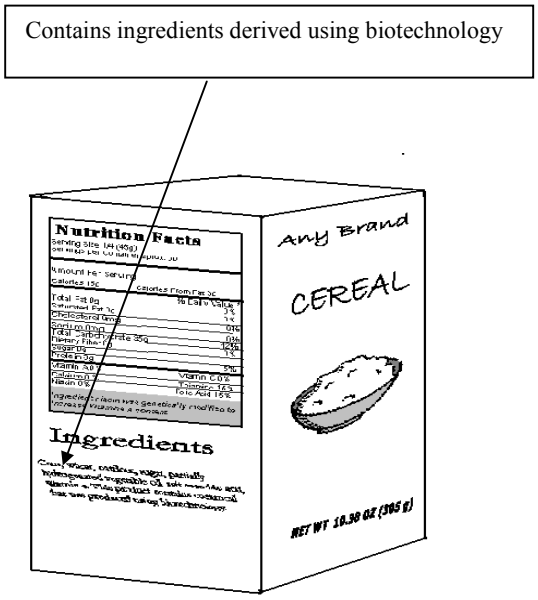
Rating_____

(D) Logo on the front only



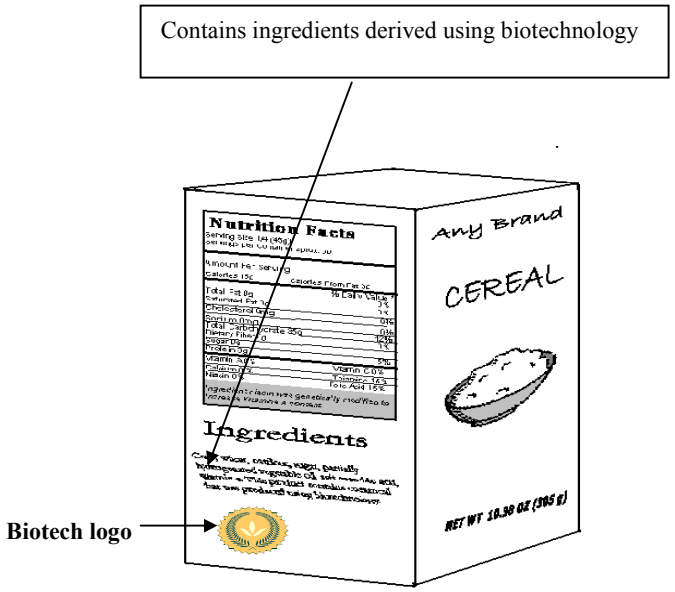
Rating_____

(E) No logo but the following inserted in the ingredient's list.



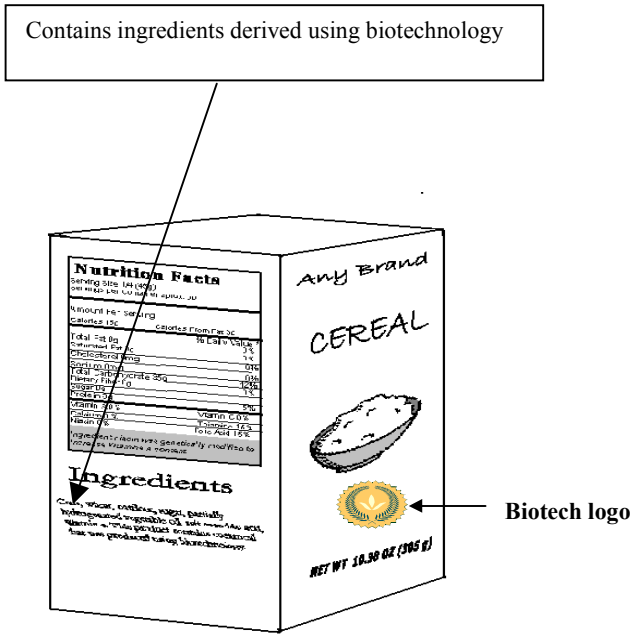
Rating_____

(F) logo on the side and the following inserted in the ingredient's list.



Rating_____

(G) logo on the front and the following inserted in the ingredient's list.



Rating_____

SECTION IV: Purchase of Biotech foods

15. Would you purchase a non-meat food product (example slow-ripening tomato or corn chips) that has been produced using biotechnology?

    a) Yes b) No c) Uncertain

16. Would you purchase a meat product (example bST milk) that has been produced using biotechnology?

    a) Yes b) No c) Uncertain

SECTION V: Consumer Use of Food labels

17. How often do you read the **nutritional** section of food labels before buying a **familiar** food product? (Circle one)

    a) Always b) Often c) Sometimes d) Rarely e) Never

18. How often do you read the **ingredients** section of food labels before buying a **familiar** food product? (Circle one)

    a) Always b) Often c) Sometimes d) Rarely e) Never

19. How often do you read the **nutritional** section of food labels before buying a **new** food product? (Circle one)

    a) Always b) Often c) Sometimes d) Rarely e) Never

20. How often do you read the **ingredients** section of food labels before buying a **new** food product? (Circle one)

    a) Always b) Often c) Sometimes d) Rarely e) Never

Section VI: Demographics

All information is confidential

1. Gender (Circle one)

    a) Male b) Female

2. Which of the following best describes your age category in years? (Circle one)

    a) 18 – 24
    b) 25 – 34
    c) 35 – 44
    d) 45 – 54
    e) 55 – 64
    f) 65 or older

3. How many members of your household are in the following age groups? (List all that apply)

a) Infants 0-24 months_____
b) Children 2-17 years _____
c) Adults 18 or older _____

4. Which of the following best describes your ethnic background? (Circle one)

a) African American
b) American Indian
c) Asian
d) Hispanic
e) Caucasian (white)
f) Other _____

5. Please indicate the highest education attained. (Circle one)

a) Less than High school
b) High school
c) Technical college
d) Some college
e) Bachelor degree
f) Post graduate work

6. What is your marital status? (Circle one)

a) Married
b) Single

7. Which of the following categories best describes your annual 2001 income? (Circle one)

a) Less than $15,000
b) $15,000 - $29,999
c) $30,000 - $44,999
d) $45,000 - $59,999
e) $60,000 - $74,999
f) $75,000 - $89,999
g) $90,000 - $104, 999
h) $105,000 - $119,999
i) More than $120,000

8. Please chose the **one** category that **most closely** describes your occupation? (Circle one)

a) Business
b) Agriculture and Natural Resources
c) Engineering
d) Education
e) Government
f) Healthcare
g) Housewife
h) Student
i) Retired
j) Self-employed
k) Unemployed
l) Other _____

Please use the space below to make any additional comments or questions

Thank you for your time and cooperation in helping to make this a successful study

Department of Agricultural Economics an
101 Agricultural Administration Building
Louisiana State University
Baton Rouge, LA 70803-5604
(225) 578-3282
FAX: (225) 578-2716

June 5, 2002

Dear Sir or Madam:

As you may or may not know, biotechnology is being used more often in the production of certain food products. Biotechnology is the use of scientific techniques to make new or better products. It has the potential to make crop more nutritious, taste better, last longer, and naturally resist insects, viruses and herbicides. It is also being used in the pharmaceutical, manufacturing, food processing and environmental industries.

The department of Agricultural Economics and Agribusiness at Louisiana State University is conducting a study of biotechnology and labeling of foods made from biotechnology. The enclosed survey is intended to collect information about your knowledge of biotechnology, and the types of labeling formats you would prefer for food products made using biotechnology.

The survey will help us and the food industry better understand how consumers use food labels. The results will also help the food industry better understand how consumers view biotechnology. Consequently, your participation is very important to the success of this study.

All of your responses are **strictly confidential** and will not be used for any purposes other than this study. Please take a few minutes to fill out the questionnaire and return it in the postage-paid envelope.

If you have any questions regarding the survey please contact Dr. Wes Harrison at wharrison@agctr.lsu.edu,or Mr. Everald Mclennon at smclen1@lsu.edu. Or call us at 225-578-2595.

Thank you for you participation.

Sincerely,

R. Wes Harrison, Ph. D.
Associate Professor
Food Marketing

Department of Agricultural Economics an
101 Agricultural Administration Building
Louisiana State University
Baton Rouge, LA 70803-5604
(225) 578-3282
FAX: (225) 578-2716

June 19, 2002

Dear Sir or Madam:

About two weeks ago, a questionnaire seeking information about agricultural food production and biotechnology was sent to you. The survey deals with the consumer=s knowledge of biotechnology and labeling formats you would prefer for food products made using biotechnology. You were selected as an important participant in this study.

As of today, we have not yet received your completed questionnaire. I am writing to convey the importance of your response to this study. The survey provides an opportunity for your input into the labeling of these type foods.

If you have recently completed and returned the survey, please accept our sincere thanks. If not, I have enclosed another copy for your convenience. I urge you to please take a few minutes, fill out the questionnaire and return it in the postage-paid envelope.

Please be assured that all responses are **strictly confidential** and will not be used for any purposes other than this study.

If you have any questions regarding the survey please contact Dr. Wes Harrison at wharrison@agctr.lsu.edu,or Mr. Everald Mclennon at smclen1@lsu.edu. Or call us at 225-578-2595.

Thank you for you participation, your cooperation is greatly appreciated.

Sincerely,

R. Wes Harrison, Ph. D.
Associate Professor
Food Marketing

VITA

St. Everald A Mclennon was born in St. Catherine, Jamaica, to the proud parents of Noel and Neita Mclennon. The eldest of five children, he showed great athletic ability at an early age. He excelled in high school athletics becoming the champion boy and schools' record holder for both the 100m and 200m at St. Catherine High School. He also represented his high school in volleyball.

He came to the United States in 1997 and completed his Bachelor of Science degree in agribusiness from Louisiana State University in fall 1999. In August 2000, he enrolled in the Agricultural Economics program at Louisiana State University, and will receive the degree of Master of Science at the December 2002 commencement.