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CONCERN ABOUT EATING GENETICALLY ENGINEERED FOOD

By Glenn D. Israel And Thomas J. Hoban

ABSTRACT

Concern about eating genetically engineered food is explored for a sample of residents from Florida and North Carolina. Previous research on consumers' food safety concerns and perceived risk associated with food production suggests that concern about genetically engineered food is influenced by three factors. Concern is influenced by how well informed consumers are about food technology, their capacity to understand that information, and the compatibility of genetic engineering with consumers' moral beliefs. Utilizing logistic regression, women and persons who viewed genetic engineering to be morally wrong were found to have greater concern about eating genetically engineered foods. Awareness and educational attainment also decreased concern about among North Carolina residents. For the Florida sample, awareness had no effect on concern, and education decreased concern for only one of two types of food. Although addressing concerns based on moral beliefs may be problematic, efforts to better inform consumers, especially women, might reduce their concern.

CONCERN ABOUT GENETIC ENGINEERING

The view that genetic engineering in agriculture has the potential to solve many problems related to production of food and fiber is widely accepted. Indeed, the development of agricultural biotechnology research has become a priority at many state universities and land-grant colleges. The decision making process about what research to conduct and which specific technologies to apply commercially will be influenced by public policies derived, in part, from input from consumer and other interest groups. So far, however, the research agenda for genetic engineering at land grant universities has been defined by those inside the institutions — researchers, administrators and decision-makers in the private sector

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(Bonanno, 1989; Buttel, 1989). The broader public has had little interest in or chance to help shape this agenda.¹

With the exception of the survey sponsored by the Office of Technology Assessment (1987), there appears to have been little effort to learn how consumers perceive the need for or desirability of specific genetic engineering technologies. To date, much of the research appears to be motivated more by the threat of rejection of specific biotechnologies by the public than an attempt to incorporate consumer needs and values in setting research priorities. A history of using experts and peer reviewers, rather than the broader public, to identify research priorities at land-grant universities may account, in part, for the limited number of consumer surveys. Consumers also do not comprise a monolithic group from which problems are communicated via Cooperative Extension Service personnel to researchers in the way that agricultural commodity groups do. Furthermore, many researchers in "production agriculture" departments may not view consumers as relevant to identifying research priorities when the focus of their research is on increasing output or reducing the costs of production for farmers.

As Lacy et al. (1991) assert, however, the public has a right and an obligation to shape the development of genetic engineering. This assumes that participation by an informed public in policy debates on genetic engineering is desirable in a democratic society. Moreover, public input should occur prior to spending public funds rather than after technologies have been developed. At that point, only questions of how, when and where to implement remain.

Nuclear power generation serves to illustrate the point. Large-scale government expenditures for research and development have left a legacy of halted plant construction, sporadic but intense public opposition, and widespread concern about radioactive waste and emissions (Office of Technology Assessment, 1987). Public concern and opposition are likely to arise with the perception or occurrence of negative consequences from genetically engineered products (Office of Technology Assessment, 1984; Pimentel et al., 1989; Slovic, 1987).

To date, few surveys about the public's views concerning genetic engineering have been conducted and detailed analysis has been limited (Lacy et al., 1991). Sufficient detail is not available to develop appropriate

¹For a thorough discussion of the development of agricultural biotechnology research as a priority at many state universities and land-grant colleges, see the annual progress reports, **Emerging Biotechnologies in Agriculture: Issues and Policies** (National Association of State Universities and Land-Grant Colleges, 1982-1990).

educational programs for different segments of the public. Such information is important to identifying content and target audiences for educational programs to fill gaps in the public's knowledge. This, in turn, will be important to fostering a better informed public policy debate on genetic engineering research.

Building on earlier studies (Hoban, 1989a; Office of Technology Assessment, 1987), this paper examines concern expressed by residents of two southern states, Florida and North Carolina, about eating genetically engineered food. Previous research on consumers' food safety concerns and perceived risk associated with food production can be applied to examine the case of genetic engineering. Food safety concerns are influenced by how well informed consumers are about food technology and how capable they are of understanding that information. Another important influence is how compatible a technology, such as genetic engineering, is with consumers' moral beliefs and ethical values (Busch, 1991; Hoban, 1989a). The analysis focuses on identifying segments of the public with differing concerns and examines the basis for those differences.

CONCERN ABOUT FOOD SAFETY

Consumers' concern about eating genetically engineered food likely will reflect broader concerns about food safety. One reason for concern involves potential health effects of eating genetically engineered food (Lacy et al., 1991). The public's previous exposure to substances intentionally added to food or remaining from food production and processing could provide a basis for consumers to suspect that genetically engineered food products might have similar effects. Concern about additives and residues also are related to the broader concern about the nutritional value of genetically engineered food. Consumers will want to know if such foods are as nutritionally adequate as non-engineered foods (Busch, 1991).

Recent surveys indicate the extent of consumers' food safety concerns.

Three out of four respondents to a national telephone survey said they avoided buying certain foods because of safety concerns (Opinion Research Corporation, 1988). In a 1989 Gallup Poll, most people said they would favor fewer chemicals even if this meant higher food prices. In general, people claim they would be willing to pay more for food they perceive to be processed less and more "natural."

Similar concerns were found during Opinion Research Corporation's series of telephone surveys around the time of the Alar scare (the controversy revolving around a "60 Minutes" report on the use of potentially hazardous chemicals on apple crops). A baseline survey in

January 1989 (before the Alar incident) found that more than 80 percent of the consumers expressed confidence in the safety of food supply. A follow-up survey on April 14 (following the "60 Minutes" story on Alar) found that consumer confidence had dropped to 67 percent. When they repeated the survey on April 28, confidence had rebounded slightly to 73 percent. Consumer perceptions of food safety appear to be significantly affected by public controversies and a series of such controversies could lead to a significant erosion of public confidence.²

Lee (1989) provides a detailed discussion of consumers' fears about food safety, especially as related to new food technologies. Lee describes the major causes of these fears, which he terms "food neophobia." Most of these causes involve deficiencies in educational and communication systems. One reason for consumer food safety fears involves the fact very few people grow and process their own food. Less than two percent of the American population is directly involved in agricultural production and less than one-fifth are indirectly involved in the food and fiber industry. As a consequence, large segments of the public have a poor understanding of the entire food production and processing system. This leads many to view new food technology, especially food chemicals, as artificial and risky.

Another cause of food neophobia, according to Lee (1989), is the related fact that most consumers are not "science observant" (Office of Technology Assessment, 1987). This means that consumers know very little about many areas of science (e. g., chemistry). The list of ingredients on processed food can be alarming to consumers. Even ingredients as benign as vitamins are viewed with suspicion if only the chemical terms are given on the label. This phenomenon has been termed "chemophobia" (Lee, 1989).

Because many consumers have a limited understanding of science, they can become confused by scientific debates. People get mixed messages about food safety. For example, they are being told on one hand to eat more fruit and vegetables. Then, on the other hand, they are told to watch out for pesticide residues. Some people have the impression that any "chemical residue" is bad. However, scientists are now able to detect such low levels of pesticide that people may become unnecessarily concerned. Many will say, "if it has any chemicals in it, it must be bad." This is a dramatic shift from the 1950s when advertizing slogans talked

²Some consequences of public confidence being eroded are illustrated by the Alar scare. Consumers shifted purchases to "Alar-free" apples and other fruits which were perceived to be safer (in some cases paying a premium for these foods). Many apples growers who could not document that their apples were not sprayed with Alar could not sell their produce at normal market prices and suffered financially.

about better living through chemistry.

Media coverage also influences consumer attitudes about food safety (Lee, 1989). The mass media play a dominant role in shaping public understanding and perception of risks. This is best exemplified by the coverage given to negative impacts associated with intentional use of chemicals (e. g., Alar or DDT) and accidental releases (e. g., the Bhopal, India tragedy). Consumers often accept news, documentaries and even entertainment programs without question as solid fact. On a related point, food advertising and packaging also perpetuate consumer confusion and fear by the use of terms such as "no artificial ingredients added" or the poorly defined term "natural." Food advertising repeatedly insists that by leaving something out, the food is somehow safer or more nutritious. Media reports of recent action by the FDA against the use of "fresh" on labels of orange juice concentrate cans only serve to raise consumer suspicions about nutrition and health claims made by the food industry. It is clear that what people read and hear about new food production technologies will influence consumers' concern about genetically engineered food.

PERCEPTION OF RISK

The extent of concern about eating genetically engineered food also will be influenced by their perceived risk of experiencing negative impacts (Hoban, 1989a; Lacy et al., 1991). Sometimes, there is a sound scientific basis for these concerns. For others, there may be little scientific support. Much of the concern expressed for food safety is related to the fact that many people feel agricultural chemicals pose risks for their own health and well-being. As a consequence, consumers expect government and industry to minimize these risks. Risk management, however, is very complex because of inherent uncertainty and the need to make difficult tradeoffs between the benefits associated with risks and overriding moral, economic, or social constraints (Wilson and Crouch, 1987). Moreover, the public often resists making tradeoffs, particularly between the economy and the environment, to reduce risks (Sandman, 1986).

Lewis (1990) notes that widespread public concern over technological risks appears to be a relatively recent phenomenon (as are many of the technologies themselves). Risk perception must be considered in its social and cultural context. In fact, he argues that people in affluent societies are preoccupied with safety, while risk is recognized as a normal part of life for the less fortunate. The idea that people deserve a risk-free life is a relatively localized and recent phenomenon (i. e., confined to the Western industrialized world) (Lewis, 1990).

The public's perception and acceptance of risk have their roots in social and cultural factors (National Research Council, 1989). Responses to risk are affected by social influences and communication with friends, family members, fellow workers and respected public officials. Psychological studies have uncovered a number of biases that people employ to make sense out of uncertain risks (Heimer, 1988). Most people base their risk assessments on intuition, emotion, and selective perception of uncertain information (Slovic, 1987).

Several criteria influence how the lay public determines if a particular risk is acceptable or unacceptable (National Research Council, 1989). Some criteria will make the risks of genetically engineered food appear more serious and therefore less acceptable to the public. One criterion that makes a risk unacceptable is whether people are made to bear a risk involuntarily. This is because risk perceptions tend to be very personal (Lewis, 1990). Food production technologies will be perceived as particularly risky because they will be considered an involuntary risk. Consumers' influence is limited to purchasing decisions for foods available in grocery stores and supermarkets. Most people have little direct control over food production and, hence, food safety (Lee, 1989).

Unfair risks are also considered to be less acceptable. For example, people who feel they are being asked to bear potential risks of food production technologies may feel they are not receiving the benefits from use of these technologies. Public concern over food safety risks will also be perceived as more serious if they are associated with artificial chemicals (e.g., pesticides), rather than something found in nature (e.g., bacteria). This may be because natural risks are perceived to be less avoidable than are man-made or anthropogenic ones (Freudenburg and Jones, 1991).

People also find known risks (i.e., those that are understood) generally to be more acceptable than those which are unknown. The public finds little comfort in the fact that the government and scientific community do not know the extent of safety risks for many foods. Consumer food safety fear involves the desire for absolute certainty (Lee, 1989). However, because the public's understanding of very low probability events is poor, people tend to be conservative, especially when the risk involves food or the environment. A lack of familiarity with genetically engineered products and lack of knowledge about associated risks also can cause consumers to view such products as riskier than foods produced by more traditional methods.

According to Lee (1989), public concern about food technology is increased by the fact that scientists "chase zeros." This is related to the desire for zero risk in that it reflects poor understanding of statistics and mathematics. Some of the terms that scientists use in risk assessment

(e.g., parts per billion) have little meaning for most people. Extremely small quantities of hazardous chemicals cause fear just because they are there (Lee, 1989). In fact, the ability to detect smaller and smaller quantities is outpacing explanation of what the numbers mean. For these and other reasons it is not surprising that some consumers have lost confidence in the safety of the food supply.

Public perception of risk is also influenced by attitudes toward science and technology in general. Public confidence in science and technology has diminished in recent years (Office of Technology Assessment, 1987). Large segments of society have become distrustful of some new and unfamiliar technologies, such as food irradiation (Schutz et al., 1989). This problem is particularly serious as related to agriculture, because most people have little understanding of or appreciation for how food is produced. Thus, as Slovic (1987) asserts, "difficulties in understanding probabilistic processes, biased media coverage, misleading personal experiences, and the anxieties generated by life's gambles cause uncertainty to be denied, risks to be misjudged (sometimes overestimated and sometimes underestimated), and judgments of fact to be held with unwarranted confidence." Such factors make analysis of public attitudes about genetic engineering challenging, but increasingly important.

CONCERN ABOUT GENETICALLY ENGINEERED FOOD

If concern about food safety risks are applicable to this case, similar factors may influence concern about the safety and perceived risks of genetically engineered food products. Awareness and use of information on genetic engineering is one key factor. Although several studies of public perceptions about agricultural biotechnology have been conducted, information is sparse on how well informed consumers are about genetically engineered food. This is because most of these studies included a broad range of topics and few questions have focused specifically on food issues.

A survey conducted by Louis Harris & Associates for the Office of Technology Assessment in October 1986 found that slightly more than a third of Americans had read or heard about genetic engineering (Office of Technology Assessment, 1987). Youth, higher educational attainment, a good understanding of science, and being scientifically observant were factors related to awareness of genetic engineering (Office of Technology Assessment, 1987). Increased awareness of genetic engineering was found to be associated with greater public acceptance, which suggests that awareness of genetic engineering also might reduce concern about eating genetically engineered foods.

Higher levels of educational attainment imply a greater capacity to understand food safety and nutritional issues related to genetically engineered food. This, in turn, is likely to be reflected in lower levels of concern about new food technologies among well educated consumers (Bord and O'Conner, 1989).

As Lewis (1990) noted, risk is of great personal relevance. This suggests that gender may have a particularly important influence on concern about food related technologies (Schutz et al., 1989). The greater involvement of women in the purchase and preparation of food suggests that issues of food safety and nutrition should be more salient to women.

Similarly, safety concerns about genetically engineered food may be heightened among parents. While adults tolerate some risks for themselves, they may be less tolerant in subjecting their children to the same risk (Bord and O'Conner, 1989; Hamilton, 1985a; 1985b). Hamilton (1985a; 1985b) found parents, especially mothers, to be more concerned about the safety of chemically contaminated drinking water than nonparents. Exposure to unknown risks associated with genetically engineered foods may elicit greater concern among consumers with children than among those who do not have children.

An extension of Lewis' (1990) idea that affluent societies emphasize safety suggests that affluence (e. g., income) may effect perceptions of risk and expressions of concern over food safety. Although income was not a significant factor in concern about irradiated foods (Schutz et al., 1989), more affluent households were found to be more concerned about pollution of their local water supply (Hamilton, 1985b). More affluent segments of U. S. society might place greater emphasis (and be better able to afford) low-risk foods than would people who are less affluent. Thus, consumers with higher income might express greater concern about eating genetically engineer foods that those with lower incomes.³

People hold particular moral and ethical beliefs based on such factors as early experiences, education, circumstances and personality. For some people, modifying or manipulating living organisms through genetic engineering constitutes "playing God" (Lacy et al., 1991; Office of Technology Assessment, 1987). This also may be contrary to certain religious beliefs and practices. For others, genetic engineering is viewed as a potential source of social inequality or injustice by which some people benefit more than others from the use of specific biotechnologies (Lacy et

³Income and education are viewed to have distinct effects for the purposes of this analysis. Most research suggests, however, that these factors are so highly interrelated that their effects will not be easily distinguished.

al., 1991). In either case, these moral and ethical beliefs are likely to raise consumers' concern about eating genetically engineered foods.

Finally, residence might serve as a basis for differences in consumers' attitudes about eating genetically engineered food. The sociocultural milieu surrounding residence, measured as rural/urban or metro/nonmetro, has long been a factor differentiating attitudes (Willets et al., 1982). Historical diffusion patterns of new technologies from center to periphery (Brown, 1981) suggest that metropolitan residents might show higher levels of acceptance and less concern about eating genetically engineered foods than nonmetropolitan residents.

DATA

The data used for the analysis are from telephone surveys of a random sample of Florida adults conducted in March 1991 and a random sample of rural and urban North Carolina adults conducted in Winter 1988. Respondents (18 years of age or older) were contacted by telephone through random digit dialing. The Florida data is from the Florida Consumer Attitude Survey. The primary purpose of the survey is to calculate a monthly index of consumer confidence. Additional questions on selected topics, in this case genetic engineering, are included periodically. Respondents for this study were not given a definition of genetic engineering and were told only that "The next few questions are about genetic engineering." The number of respondents for the Florida sample was 632.

The data for North Carolina is from a telephone survey of residents living in the state's three largest metropolitan areas and five most rural counties. The random sample was drawn by Survey Sampling, Inc. The survey of North Carolinians focused specifically on genetic engineering and early in the interview, respondents were read the following definition: "Scientists have new knowledge about biology that they can use as tools to solve problems. Genetic engineering is one of these new tools. In genetic engineering, genes are taken from one kind of plant or animal and put into another kind." The number of respondents for the North Carolina sample was 332.

MEASURES AND METHOD OF ANALYSIS

The data are analyzed in several steps. The extent of awareness about genetic engineering is examined, followed by concern about eating genetically engineered fruits and vegetables and meats and dairy products.

These variables were measured with ordered response categories. Data on the awareness about genetic engineering were obtained by asking "How much have you read or heard about genetic engineering?" The response options included: nothing, a little, some and a lot (coded 0 through 3, respectively). The few "Don't Know" responses were considered missing data for this analysis. Data on concern about eating genetically engineered food were obtained from two questions, "How do you feel about eating genetically engineered fruits and vegetables?" and "How do you feel about eating genetically engineered meats and dairy products?" The response options included: very concerned, somewhat concerned and not concerned (coded 0, 1 and 2, respectively).

For the independent variables, age was measured in years; gender was coded 0 for females and 1 for males; incomes was coded 0 for less than \$20,000, 1 for \$20,000 to \$99,999 and 2 for \$100,000 or more; educational attainment was categorized with grade 11 or lower coded 0, high school graduate coded 1, 2 for some college, 3 for college graduate and 4 for graduate work; having children was coded as 1 and 0 otherwise; metro residence was coded 1 and nonmetro 0.

Along with the extent of awareness about genetic engineering, two items measuring attitudes toward the morality of genetic engineering were included in the analysis of concern about eating genetically engineered foods. Respondents were asked: "Do you think that genetic engineering of plants to solve agricultural problems is morally wrong or not, or do you not know?" and "Do you think that genetic engineering of animals to solve agricultural problems is morally wrong or not, or do you not know?" "Yes" responses were coded as 1 and all others (i. e., No, Don't Know, Depends) as 0.

The analysis was conducted with SAS's multiple logistic regression procedure. Multiple logistic regression is the preferred method for estimating the probability of a certain event occurring. A major advantage of logistic regression is that the independent variables can be discrete, ordered, continuous, or a mixture of all three. Multiple logistic regression estimates coefficients which are similar to those of multiple linear regression. A coefficient estimates the change in the logit for a unit change in the independent variable. Unlike multiple linear regression and logistic regression models using a dichotomous variable, logistic regression with ordered dependent variables generate multiple intercept terms (ALPHAs). These intercept coefficients estimate the "break point" in the logistic response distribution for moving from one category to the next. Thus a dependent variable with three categories will have two intercepts. Asymptotic standard errors and corresponding Wald statistics (Chi-squares) are used to assess the significance of the estimated coefficient for

each variable. The overall fit of the model is indicated by the model chi-square, degrees of freedom, and probability levels. A large model chi-square and small probability level indicate that the model is a significant improvement over an intercept-only model.

FINDINGS

The data indicate that most people are not well informed about genetic engineering. At least 60 percent of the respondents said they had read or heard little or nothing about genetic engineering (Figure 1). Despite increasing mass media references to research involving biotechnology and genetic engineering, the majority of Florida residents reported they have not read or heard anything about the topic. Higher percentages in both the Office of Technology Assessment study and the North Carolina sample reported having read or heard a little or some about genetic engineering than did residents in Florida. Those who said they had heard a lot were nearly equal among the samples.

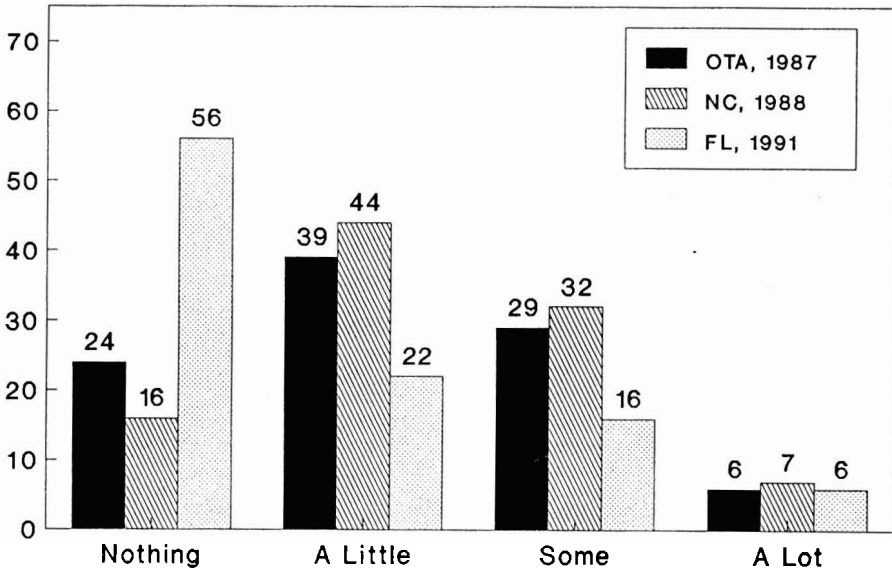


Figure 1. Amount respondents had read or heard about genetic engineering.

Although fewer Floridians said that they had read or heard about genetic engineering than did those from North Carolina, several factors were found to be related to awareness in both samples. Men and respondents with higher educational attainment had read or heard more

about genetic engineering in both the Florida and North Carolina samples (Table 1). On the other hand, higher income had a positive affect on awareness for Floridians only. Metro residence was a significant, positive factor in North Carolina.⁴

Given that Florida residents were less aware of genetic engineering than those from North Carolina, it is not surprising that a larger percentage of Floridians said that they did not know how concerned they would be about eating genetically engineered foods (see Figures 2 and 3).⁵ A higher percentage of Floridians said that they would not be concerned about eating genetically engineered food than were North Carolinians. Most striking is the pattern of increase in those who are very concerned

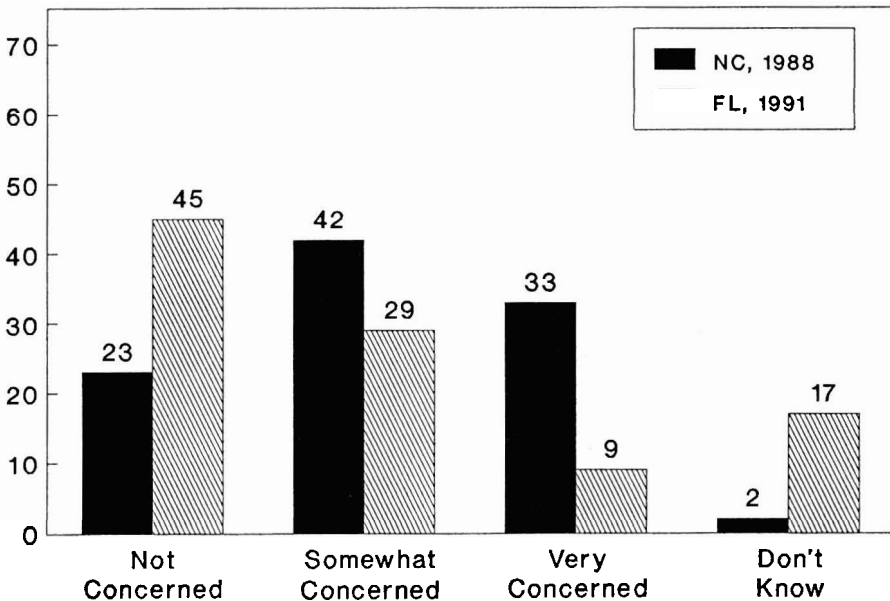


Figure 2. Concern about eating genetically engineered fruits and vegetables.

⁴The effect of metro residence in North Carolina may be exaggerated by the sample selection procedures. The sample is derived from three urban and five rural counties in the state and does not include residents from smaller metro counties.

⁵"Don't Know" was not among the response options offered to respondents for these items on questionnaires for the two states. "Don't Know" responses were excluded from the later steps of the analysis.

Table 1. Logistic regression of having read or heard about genetic engineering on selected variables for samples of Florida and North Carolina residents.

Variable	Florida				North Carolina			
	Estimated Coefficient	Standard Error	Chi-Square	Prob.	Estimated Coefficient	Standard Error	Chi-Square	Prob.
ALPHA1	-1.531	.426	12.90	.000	.303	.406	.56	.455
ALPHA2	-2.586	.439	34.64	.000	-2.102	.419	25.13	.000
ALPHA3	-4.124	.471	76.57	.000	-4.455	.484	84.58	.000
Age	-.001	.006	.06	.799	-.007	.007	.89	.345
Educational Attainment	.252	.086	8.53	.004	.431	.101	18.30	.000
Income	.597	.206	8.43	.004	.222	.217	1.05	.305
Gender	.379	.182	4.33	.038	.602	.217	7.67	.006
Have Children	.036	.204	.03	.858	.388	.264	2.17	.141
Metro Residence	.276	.226	1.49	.223	.819	.225	13.25	.000
-2 Log Likelihood (Intercepts only model) =			1090.37		798.17			
Model Chi-Square =			36.87		63.96			
Degrees of Freedom =			6		6			
Probability =			.000		.000			

Israel and Hoban

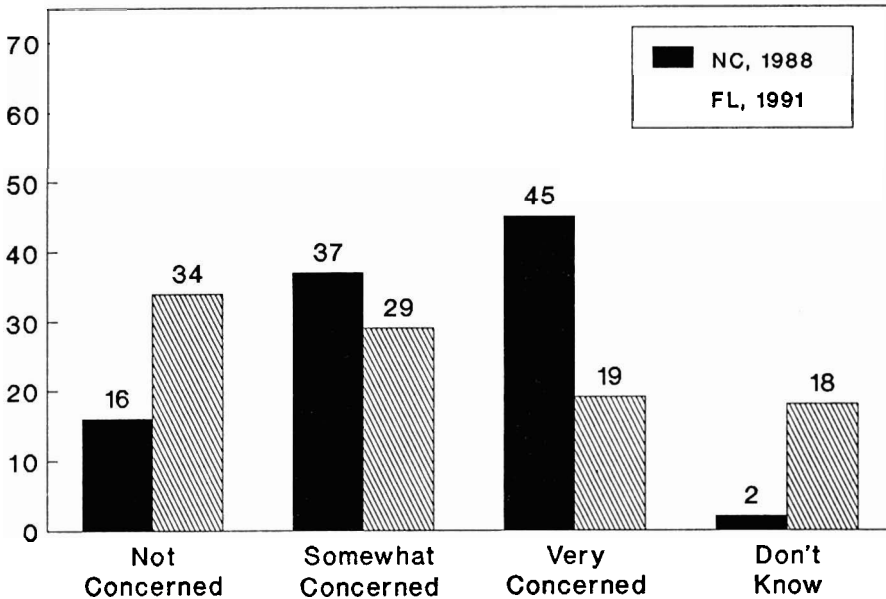


Figure 3. Concern about eating genetically engineered meat and dairy products.

(10 percentage points for Floridians and 12 points for North Carolinians) when comparing concern about eating genetically engineered fruits and vegetables with concern about eating meats and dairy products (compare Figures 2 and 3). Animal-related products likely will be less acceptable than plant-related food products.

Despite differences between residents of Florida and North Carolina in concern about eating genetically engineered foods, several factors influencing the level of concern were found in common. As shown in Table 2, higher levels of concern about eating genetically engineered fruits and vegetables was influenced most by the view that genetic engineering of plants is morally wrong. In addition, men, older persons, and those with more education were less concerned in both of the Florida and North Carolina samples. The amount that people read or heard about genetic engineering appears to reduce substantially the concern about eating genetically engineered fruits and vegetables for North Carolinians but not for Floridians.

The belief that genetic engineering of animals is morally wrong has a similar affect on concern about eating genetically engineered meats and dairy products (see Table 3). Like concern about eating genetically engineered fruits and vegetables, men expressed lower levels of concern

Table 2. Logistic regression of the extent of concern about eating genetically engineered fruits and vegetables on selected variables for samples of Florida and North Carolina residents.

Variable	Florida				North Carolina			
	Estimated Coefficient	Standard Error	Chi-Square	Prob.	Estimated Coefficient	Standard Error	Chi-Square	Prob.
ALPHA1	1.206	.452	7.13	.008	3.331	.473	49.54	.000
ALPHA2	-.799	.455	3.08	.079	1.079	.434	6.17	.013
Age	-.014	.007	4.31	.038	-.014	.007	3.74	.053
Educational Attainment	-.213	.099	4.63	.031	-.343	.105	10.60	.001
Income	-.094	.239	.16	.692	-.107	.226	.23	.635
Gender	-.394	.208	3.59	.058	-.581	.225	6.67	.010
Have Children	-.037	.223	.03	.870	.401	.267	2.26	.133
Metro Residence	-.067	.244	.07	.785	-.026	.232	.01	.909
Amount Heard About Genetic Eng.	-.106	.107	.99	.320	-.592	.148	15.98	.000
Feel Gen. Eng. Is Morally Wrong	1.670	.427	15.30	.000	1.069	.332	10.40	.001
-2 Log Likelihood (Intercepts only model) =			740.81		694.10			
Model Chi-Square =			37.53		77.06			
Degrees of Freedom =			8		8			
Probability =			.000		.000			

Israel and Hoban

37

Table 3. Logistic regression of the extent of concern about eating genetically engineered meat and dairy products on selected variables for samples of Florida and North Carolina residents.

Variable	Florida				North Carolina			
	Estimated Coefficient	Standard Error	Chi-Square	Prob.	Estimated Coefficient	Standard Error	Chi-Square	Prob.
ALPHA1	.377	.462	.66	.415	2.997	.512	34.21	.000
ALPHA2	-1.285	.468	7.54	.006	.781	.477	2.68	.101
Age	-.003	.007	.15	.698	-.012	.008	2.35	.125
Educational Attainment	-.104	.095	1.21	.272	-.262	.108	5.92	.015
Income	-.221	.233	.90	.342	-.001	.235	.00	.995
Gender	-.469	.203	5.35	.021	-.520	.233	4.98	.026
Have Children	.352	.219	2.58	.108	-.009	.274	.00	.972
Metro Residence	.433	.245	3.12	.077	-.155	.343	.41	.524
Amount Heard About Genetic Eng.	-.101	.104	.94	.333	-.334	.152	4.82	.028
Feel Gen. Eng. Is Morally Wrong	1.416	.243	33.83	.000	1.570	.243	41.68	.000
-2 Log Likelihood (Intercepts only model) =			815.27		665.32			
Model Chi-Square =			61.08		89.38			
Degrees of Freedom =			8		8			
Probability =			.000		.000			

about eating engineered meats and dairy products. In this case, however, age had no effect on concern about eating genetically engineered meats and dairy products for either Floridians or North Carolinians. Higher educational attainment and greater awareness of genetic engineering significantly reduced concern about eating genetically engineered meats and dairy products among North Carolina consumers, but not for those from Florida. These factors show only slightly smaller estimated coefficients for meats and dairy products than for fruits and vegetables. In contrast to concern about eating genetically engineered fruits and vegetables, educational attainment showed no significant affect on concern about eating engineered meats and dairy products for Florida consumers.

As anticipated, women and persons who viewed genetic engineering to be morally wrong were found to have greater concern about eating genetically engineered foods. Awareness of genetic engineering and educational attainment decreased concern substantially among North Carolina residents but only education did (and only for concern about eating fruits and vegetables and not meats and dairy products) for those in the Florida sample.

DISCUSSION AND CONCLUSIONS

The data suggest that many consumers are not yet well informed about genetically engineered foods. Many respondents did express concern with consuming genetically engineered foods. A similar level of concern among consumers is evident for food irradiation technology (Bord and O'Conner, 1989). These fears should not be dismissed as irrational. As Slovic (1987:285) notes, not only do consumers' perceptions include both error and wisdom, but lay people's "basic conceptualization of risk is much richer than that of the experts and reflects legitimate concerns that are typically omitted from expert risk assessments."

Although varying perceptions of risk may be one basis for concern about eating genetically engineered food, moral and ethical beliefs also will be important. While reasons for saying genetic engineering of plants and animals is morally wrong have been suggested (Lacy et al., 1991), the extent that consumers hold one view or another have not been established. It also is not clear whether educational efforts could or should be aimed at changing deeply held beliefs.

The findings do suggest that more effective and better targeted educational programs can be developed to help consumers make more informed decisions about genetically engineered food. Increasing knowledge can reduce food technology concerns (Bord and O'Conner, 1989). Educational programs might be directed toward women because these results suggest

they have read or heard less about genetic engineering. Women also were more concerned about eating genetically engineered food products. Given the current division of labor in most households, it would seem particularly appropriate that women receive more information about genetically engineered food. Well written lay articles for journals such as *Good Housekeeping*, coupled with community-based educational programs by Cooperative Extension and other organizations, can help inform consumers. The Cooperative Extension Service is well placed to implement programs to educate the public about the effects of genetic engineering on food safety and nutritional adequacy, food costs and availability, and environmental quality (Hoban, 1989b).

Not only will educational efforts be important in addressing consumers' concerns, but the manner and content of the food industry's advertising also will influence consumer perceptions about genetically engineered foods. Advertising and label statements will need to be written carefully to avoid confusion or misunderstanding among consumers trying to purchase safe and nutritious food (Busch, 1991; Lee, 1989). Given the limited awareness and understanding of genetically engineered foods by the public, one would expect that the food industry will want to avoid any reference to such production techniques.

While many consumers need information about genetic engineering to make well-informed choices, administrators of land-grant institutions involved in genetic engineering research also need more information about public awareness and attitudes. Such information is not only useful for developing educational programs for the public but also can be used to identify research goals and priorities which explicitly reflect public needs and concerns. Surveys like this one are a way to obtain information from the public about their preferences and concerns.

Limiting public input to research goals maintains the autonomy that agricultural experiment stations and other research units of land-grant institutions have historically enjoyed. But it also leaves land-grant institutions vulnerable to a backlash when negative impacts (either acute or chronic) occur. Such a backlash is likely to erode the credibility of and long-term public support for land-grant institutions.

An incomplete understanding of consumers' concern also means that conducting public policy debates between pro- and anti-genetic engineering groups may be both difficult and risky for administrators of genetic engineering programs. Reaching agreement about public policy may become more difficult if the debate becomes polarized and groups prove to be as intransigent as some appear in the animal rights and other movements. Thus, the threat of an animal rights type of conflict has created apprehension about public support for genetic engineering

research among private and public sector administrators and scientists.

The findings of this research may be influenced by differences between the South and other regions of the country. Given the lower levels of educational attainment in the South (Beaulieu, 1989), concern about eating genetically engineered foods might be more widely expressed among consumers in this region than among those in other regions of the country. Likewise, the widely accepted view that the South encompasses much of the Nation's "Bible Belt" suggests that concerns based on the morality of genetic engineering may be less pervasive outside of the South or might have other bases. These factors indicate the need for additional research of regional and national scope to provide further information about this topic.

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