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Introduction/Related Literature

Biotechnology is often considered the catchall term for “any technological manipulation of a biological process, ranging from wine-making to the construction of mechanical prostheses” (Priest, 2001a, p. vii). A definition similar to this one offered by Nill (2001) is commonly used in the United States:

Usage of the word biotechnology has come to mean all parts of an industry that knowingly create, develop, and market a variety of products through the willful manipulation, on a

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molecular level, of life forms or utilization of knowledge pertaining to living systems (p. 3).

In the agriculture industry, the use of biotechnology is expected to grow, with some predictions stating that “genetically modified crops may surpass natural crops in acreage planted by 2020” (World Future Society, 2003, p. 2). In addition to increasing crop production through the use of Bt crops, herbicide-resistant crops, and virus-resistant crops, the science of agricultural biotechnology is forging new ground in *pharming* (the process of raising plants or animals for use as pharmaceutical or industrial substances) and *nutraceuticals* (foods that contain something beyond basic nutritional value) (Lalley & Vertefeuille, 2001).

Biotech is more controversial in the United States than has been generally assumed (Priest, 2001b). Nearly one third of the U.S. population believes that genetic engineering is likely to make the quality of life worse in the future, nearly the same proportion as believe that nuclear power generation is likely to do so (Priest, 2001b). While research is being conducted to explain public attitudes towards science (and biotechnology), the results are incomplete (Priest, 2001b).

Science Communication

News media have historically accorded science great importance (Weigold, 2001). At one time, the news media were seen as having the potential to create a country of science-literate citizens. However, many contemporary scholars believe that science is not communicated effectively to the general public (Treise & Weigold, 2002). Scientific knowledge and research generally make their way into popular literature when there are risk factors that might affect the general public or when controversies arise (McInerney, Bird, & Nucci, 2004).

The public perception of science is influenced by how the press chooses to represent scientific data (Schwartz, Woloshin, and Baczek, 2002). Priest (2001b) stated that “conventional wisdom relies on public information officers, public relation practitioners, and journalists to inform the nonscientist, or lay, public about the benefits (and sometimes the risks) of new technologies” (p. 97). Priest (2001b) commented that science communication has a crucial role to play in the generation and maintenance of public trust in science. She further stated that:

Science journalism is assumed to be an important determinant of science-related attitudes and opinions, primarily through its explanations of scientific results. Media research relevant to other questions about effects suggest that if this is true, the

important influences of science journalism are long term and indirect (Priest, 2001b, p. 105).

Treise and Weigold (2002) stated that a dominant theme that runs through current scholarship on science communication is that while the communication of science is important, it is not being done very well.

Journalist Training

Public knowledge about sciences and environmental issues, as with most information, comes primarily via mass media (Valenti & Tavarna, 2005). However, journalists report frustration with the difficulties of describing and understanding important scientific findings (Hartz & Chappell, 1997) and with the low levels of support provided by their news organizations for reporting on science news (Treise & Weigold, 2002). Modern news organizations are more likely to view science as a niche area; thus, in larger news organizations, science may be covered by a beat reporter, while in smaller organizations, science reporting is more typically handled by a general assignment reporter or by using wire services (Friedman, 1986).

Journalists almost always lack science training (Weigold, 2001). Research suggests that those who cover science frequently lack any but cursory backgrounds in the sciences and mathematics and that this lack of expertise may contribute to widespread error in reporting on science (Ankney, Heilman, & Kolff, 1996). Hartz and Chappell (1997) found that “journalists tend not to have a liberal-arts background in the sciences. Few understand the scientific method, the dictates of peer review, and the reasons for the caveats and linguistic precision scientists employ when speaking of their work” (p. 22). Sachsman, Simon, and Valenti (2004) surveyed science journalists and found that they were more likely than other journalists to have completed graduate-level education, though a majority felt that additional background knowledge in science is needed. However, Weigold (2001), in his review of the science communication literature, stated that one rationale used by those who oppose more science training is that it is “impractical for most people to receive enough training to serve as an expert across multiple disciplines of science, such as chemistry, biology, medicine, psychology, engineering, and physics” (p. 183).

Biotechnology

One of the difficulties involved with science reporting is the inherent complexity of the subject matter (Alley, 1996; Slovic, 2002). In addition, science reporting can be difficult because of the complexity of the language (Alley, 1996). For example, terms such as biotechnology and biotech foods

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are typically referred to as genetically modified foods or genetically modified organisms (GMOs) by the media (IFIC, 2002).

In a study by Vestal and Briers (2000), knowledge, attitudes and perceptions of newspaper journalists in the United States regarding food biotechnology were examined. Their findings indicated that newspaper journalists in the United States have a lack of knowledge about food biotechnology, when over 75% said they had an average to somewhat high knowledge level of food biotechnology. Gunter, Kinderlerer, and Beyleveld (1999) interviewed scientists and journalists about their perceptions and opinions about biotechnology. The two groups shared a concern about the quality of media coverage of complex subjects like biotechnology, with reporting often described as too sensational and risk oriented.

Literature Summary

As biotechnology moves forward and science enables more genetically modified crops and livestock, consumers are becoming more and more concerned with the potential risks of these new technologies. It is important to bridge the information gap between the consumer and the experts and provide unbiased information that will allow consumers to make informed decisions about these new technologies. Much of the time this "information gap" is filled by the media and media reports. Therefore, it is imperative that the media understand the science behind biotechnology and the complexities involved with this emerging science to effectively and accurately report the technology to their readers, viewers and/or listeners.

Studies have been done on journalistic or print media, but little is known at present about how radio and television broadcasters interpret and report on biotechnology, even those who regularly report on agriculture. The results will impact the preparation of future agricultural communicators as well as the future introductions of new agriculture biotechnologies to the media.

Purpose and Objectives

Because of the ever-increasing science of biotechnology and the complexity of the subject, this study sought to determine farm broadcasters' knowledge and beliefs about food biotechnology, specifically genetically modified organisms (GMOs). Three objectives were created for this study:

1. Describe current farm broadcasters in terms of their gender, age, marital status, and educational preparation; the broadcast market they currently work in; and how frequently they reported on genetically modified organisms (GMOs).

2. Determine the knowledge level of farm broadcasters on GMOs.
3. Determine the beliefs of farm broadcasters toward GMO and GMO risks.

Methods and Procedures

Population and Sample

The target population of this study was farm broadcasters. To develop the population frame, the online membership database of the National Association of Farm Broadcasters (NAFB) was utilized ($n = 565$). Those individuals who were listed in the membership database as downloaded on January 8, 2003 were used as the population for the study. Database entries were reviewed by position title and place of employment to determine which NAFB members were currently employed as farm broadcasters. This process reduced the farm broadcaster population frame to 141. All 141 were included in this study.

Instrumentation

A descriptive questionnaire was designed to collect information regarding farm broadcasters' knowledge and beliefs about biotechnology and additional demographic information. To construct the questionnaire, the researcher drew upon information gathered through a review of literature as well as GMO knowledge questions developed and used by Wingenbach, Rutherford, and Dunsford (2003).

The questionnaire consisted of five sections. Section One determined how important knowledge of biotechnology is for farm broadcasters. Section Two identified the current reporting practices of farm broadcasters. Section Three determined the broadcasters' perceptions of consumers and consumer behavior toward biotechnology. Section Four determined farm broadcasters' knowledge of specific biotechnology issues. This section included eight multiple choice questions from a study conducted by Wingenbach, Rutherford, and Dunsford (2003) to measure the biotechnology knowledge level of agricultural college students. The final section, Section Five, collected additional demographic information from the respondents.

The questionnaire was designed in both print and electronic formats and located at a specific Web site. A panel composed of professors at a major southern university, graduate students within that university's agricultural communications program, and area media professionals were asked to review the instrument to establish face and content validity. Based on feedback from the panel, the researcher made changes to the instrument before administering it to the study participants.

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Data Collection

A bimodal survey method (Brashears, Bullock & Akers, 2003) was used to collect data for this study. Each subject was mailed a letter on June 19, 2003, notifying them of their selection for this study and outlining the study and its importance. On July 7, 2003, a survey packet was sent via e-mail to all participants. Each questionnaire was coded to identify respondents. On July 14, 2003, a thank-you/reminder e-mail was sent to all the participants encouraging nonrespondents to participate. On July 22, 2003, a second survey packet with cover letter was sent via U.S. mail to all nonrespondents. A second thank-you/reminder postcard was mailed to the remaining nonrespondents on August 5, 2003. On August 19, 2003, the last and final round of surveys was mailed to the remaining participants. Those who had not responded to this final mailing were called on August 28-29, 2003, to further encourage their participation in the study. The final response was 63 (44.6%) participants. To examine potential nonresponse error, early and late respondents were compared on the major variables of the study to determine if any significant differences existed. With no significant differences present, nonrespondent answers will be assumed to be similar to late respondents (Lindner, Murphy & Briers, 2001).

Data Analysis

Questionnaire responses were coded and entered into a Microsoft Excel computer file for Windows XP, PC version. In individual questionnaire items when the participant chose not to provide a response, the coding was treated as missing data. A team of graduate students and professors performed a content analysis on the qualitative responses to determine if patterns existed in the responses. Numerical values were assigned to categories to permit statistical analysis. Data was analyzed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics were applied to demographic background and responses to quantitative answers of the subjects. *T*-tests and one-way ANOVAs were conducted to compare responses with demographic information.

Findings

Objective 1: Describe current farm broadcasters in terms of their gender, age, marital status, and educational preparation; the broadcast market they currently work in; and how frequently they reported on genetically modified organisms (GMOs).

Of the 63 respondents, 45 (73.8%) were male. The respondents ranged in age from 23 to 75. The median age was 43.5 years, the mean was 44.4 years, and 35% were more than 51 years old. Most (84.2%) farm broadcasters were

married, while a few (12.3%) were single. More than half (58.6%) of the respondents had a bachelor's degree, while 16 (27.6%) had some college training but had not completed a degree. A few (8.6%) had advanced degrees. The majority of bachelor's degrees were in journalism or agricultural communications. Few degrees were sought outside of the communication or agricultural fields.

Table 1 illustrates the types of broadcast markets that the respondents are employed in. The majority (86.2%) of respondents work only in radio, while a small number (13.8%) work in radio and another medium. The majority (57.6%) of respondents have an audience size of 50,000 or more, while 14 (23.7%) have audience sizes ranging from 20,001-50,000 listeners. About two thirds (65.4%) of the farm broadcasters defined their broadcast area as local, with the remainder describing their coverage as statewide, multistate or national. The majority (82.5%) of farm broadcasters report on genetically modified organisms or topics that relate to GMOs on at least a weekly basis. The largest group (56.1%) responded that they report on a weekly basis, while only three (5.3%) report on an annual basis.

Table 1. *Farm Broadcasters and Broadcast Market Demographics (n = 63)*

Variable	Number of responses	Percentage (%)
<i>Broadcast Medium</i>		
Multiple media (radio +)	8	13.8%
Radio only	50	86.2%
<i>Audience Size</i>		
<20,000	11	18.6%
20,000-50,000	14	23.7%
>50,000	34	57.6%
<i>Geographic Coverage</i>		
Local	34	65.4%
Statewide, multistate or national	18	34.6%
<i>How Often Stories Reported on Genetically Modified Organisms (GMOs)</i>		
Daily	6	10.5%
More than once a week	9	15.8%
Weekly	32	56.1%
Monthly	7	12.3%

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Objective 2: Determine the knowledge level of farm broadcasters on GMOs.

Most (71.7%) farm broadcasters believed it was extremely important to have a knowledge base of the subject before reporting on it, while 16 respondents (26.7%) believed it was somewhat important (Figure 1). When asked the reason for their response, most respondents believed that having a knowledge base made it easier to report. Other respondents felt that knowing the subject made them more credible to their audience, while others felt that a knowledge base would prevent any mistakes or misinformation on the subject. The few respondents who did not feel a knowledge base was important used objectivity as the reason for their response, believing that having background knowledge on a subject would interfere with being able to report objectively.

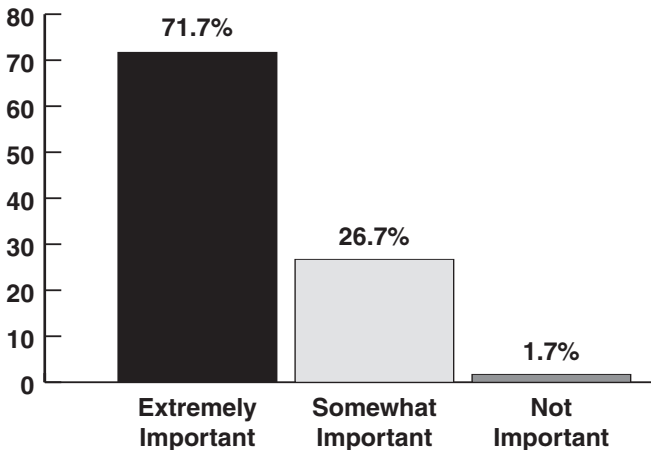


Figure 1. Farm Broadcasters' Belief in the Importance of Possessing a Knowledge Base of Genetically Modified Organisms

The survey instrument contained eight questions designed to determine the knowledge level of farm broadcasters on biotechnology. None of the respondents were able to answer all eight questions correctly. A third of the respondents (33.3%) answered five of eight questions correctly, while 22.2% answered four correctly and 27.8% answered three correctly (Table 2).

Table 2. Number of the Eight Biotechnology Knowledge Questions Answered Correctly by Farm Broadcasters^a

Number of Questions Answered Correctly	Number of Respondents	Percentage (%)
2	2	5.6%
3	10	27.8%
4	8	22.2%
5	12	33.3%
6	4	11.1%
Total	36 ^a	100.0%

Note. ^a 26 missing cases

Table 3 shows the number of respondents who answered each question correctly. The majority of respondents (96.4%) answered the question about Bt corn correctly, while only 27.7% answered the ripening of tomatoes question correctly.

Table 3. Test Questions Answered Correctly by Respondents

Questions	Number Who Responded	Number of Correct Responses	Percentage Answering Correctly
<i>Bacillus thuringiensis</i> (Bt), a naturally occurring bacteria found in the soil, is genetically engineered into corn to protect the plants from: European corn borers.	55	53	96.4%
The greatest known risk associated with genetically engineered insect corn is the possibility of: insects becoming resistant to the toxin	54	39	72.2%
Glyphosate herbicide (e.g. Roundup) has been found to be: effective and safe to use in and around water where fish and aquatic organisms thrive	50	35	70%
Season-long insect control using Bt cotton will expose two to three generations of insects to the toxin and will speed up the development of Bt-resistant insects	44	25	56.8%
Approximately, how many acres of genetically engineered crops were planted in the United States and worldwide in 2000? 75 million and 130 million.	48	19	39.6%

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Questions	Number Who Responded	Number of Correct Responses	Percentage Answering Correctly
Proteins produced by genes that have a toxic effect on specific insects are called insecticidal proteins	48	19	39.6%
Ripening of tomatoes is being modified by introducing genes of the tomato inserted in reverse form.	47	13	27.7%
Protecting cotton from pests accounts for about 40% of all agricultural pesticides used in the U.S.	45	10	22.2%

Objective 3: Determine the beliefs of farm broadcasters toward GMO and GMO risks.

Some questions focused on farm broadcasters' personal beliefs about genetically modified organisms (GMOs) and the potential risk involved with biotechnology (Table 4). On a scale of 1-5, with 5 = strongly agree, respondents agreed that the United States food supply was safe (4.28) and that the benefits of GMOs outweigh the risk (3.93). They did not believe that consumers find GMOs less acceptable than traditional crops (2.43). Farm broadcasters were undecided about the labeling of GMOs (3.20) and whether they were concerned about U.S. food production (2.79).

Table 4. Farm Broadcasters' Beliefs Toward Food Production and Genetically Modified Organisms

Belief Statements	<i>n</i>	<i>M</i>	<i>SD</i>
Our food supply is safe.	61	4.28	1.00
The benefits of genetically modified foods outweigh their risks.	61	3.93	0.87
Food containing genetically modified ingredients should be labeled.	61	3.20	0.96
I am concerned with the way food is produced in the United States.	61	2.79	1.37
Farm products are less acceptable to consumers when genetically modified seed is used.	61	2.43	1.07

Note. Scale used was 5 = Strongly Agree; 4 = Agree; 3 = Undecided, 2 = Disagree; 1 = Strongly Disagree

Farm broadcasters were asked their beliefs of how risky the use of GMOs was to future generations, using a Yes/No/No opinion scale. Forty-nine respondents (67.8%) believed that GMOs were not a risk to future

generations, while 12 (20.3%) did. On the other hand, 30 farm broadcasters (47.5%) perceived their audience as being more concerned with GMOs than they themselves were with the risk of GMO use (Figure 2).

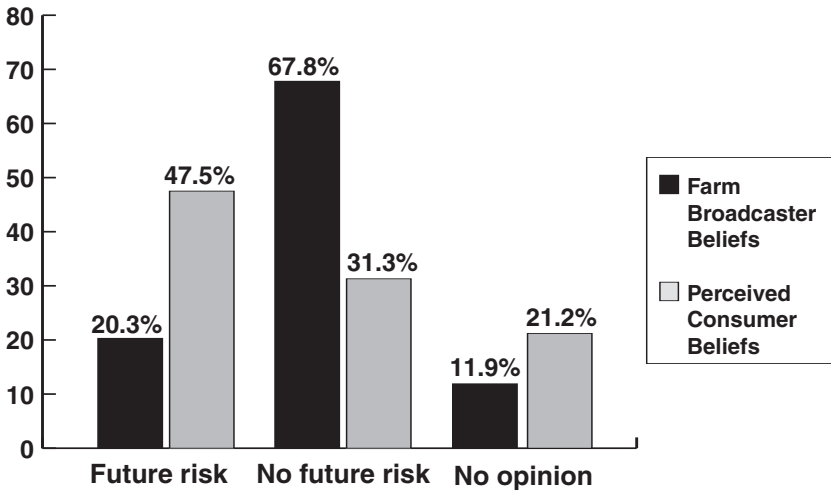


Figure 2. Farm Broadcasters' Beliefs About GMOs as a Risk to Future Generations and Their Opinion of Their Audience's Beliefs About GMO Risk to Future Generations

Analysis was conducted to determine if significant differences existed on any of the demographic characteristics and the knowledge level and personal beliefs of farm broadcasters. By using SPSS *t*-test and one-way ANOVA statistics at the $p = 0.05$ level, no significant differences were found on any of the demographic variables.

Conclusions and Recommendations

Farm broadcasters in this study were typically male, over 35 years of age, and married, with at least some college education. Most had an audience of more than 50,000 listeners, mostly local. In addition, most delivered a story about biotechnology and genetically modified organisms at least once a week.

Most farm broadcasters responding to this study believed it was extremely important to have a knowledge base on the subject they were reporting. In explaining this response, most believed that such knowledge made it easier to report while others felt that such knowledge made them more credible to their audiences. However, farm broadcasters did not know biotechnology-related content. This finding is supported by Vestal and Brier's study on journalists' knowledge of biotechnology (2000). None of the

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respondents answered all the knowledge questions correctly, yet almost 50% of respondents answered more than half the questions correctly. There were no significant differences between any demographic characteristics and the knowledge level of the farm broadcasters in this study.

For the most part, farm broadcasters' beliefs about biotechnology and genetically modified organisms were positive. Respondents believed that our current food supply is safe. In addition, the majority (67.8%) of respondents did not perceive GMOs as a risk for future generations.

From these findings, the researchers recommend that additional research should be conducted. Farm broadcasters' audiences should be studied to determine if their beliefs and attitudes toward genetically modified organisms match what broadcasters perceive those beliefs and attitudes to be. A low relationship between the beliefs of these two groups would indicate that farm broadcasters do not correctly understand their audiences.

This study should be replicated with other types of broadcasters. As farm broadcasters reach a unique segment of the listening public in the United States, it would be helpful to know whether mainstream broadcasters perceive biotechnology and report on it in the same ways or differently than agricultural broadcasters.

Based on the results of this study, the researchers are concerned that farm broadcasters may not be fully objective in their reporting. With a low average knowledge base and a generally positive attitude toward biotechnology, farm broadcasters may not be meeting their audience's information wants and needs. Research should be done to determine potential bias in farm broadcaster reporting.

There are numerous print and electronic information sources available on biotechnology, yet there is still a portion of the media that does not understand this technology. Studies should be conducted to determine who is using these materials and how these materials affect journalists' knowledge and reporting practices.

Because biotechnology is science-based agriculture, universities and their agricultural communications faculty should evaluate their academic programs to ensure their curricula are adequately preparing future farm broadcasters for success in the profession. With the dynamic nature of the agriculture industry and rapid advances in biotechnology, it would be difficult for agricultural communications curricula to remain current. As such, curricular evaluation should focus on the ability to produce graduates who possess strong science-reporting skills.

Keywords

biotechnology, science communication, farm broadcasters

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