An Examination of Agricultural and Science Educators' Attitudes Towards the Use of Biotechnology

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Abstract

Agriculture has benefited from the use of biotechnology for hundreds of years; however, recent advancements in recombinant DNA and cloning have brought about much ethical debate. Public concerns range from the disapproval of genetic manipulation for moral reasons to potential dangers and risks of the use of the science (Kloppenburg & Burrows, 1995). To address these concerns and to overcome resistance to innovation, research indicates a need to identify sources of information most trusted by the public as well as to determine the most effective means of disseminating information about biotechnology. As is frequently the case, educators play a critical role. However, even though many high school agriculture education programs have infused instruction about biotechnology into their curriculum, national studies indicate that the instruction is not keeping up with the technological advances in biotechnology.

Given that agricultural and science educators are such an important and trusted source of biotechnological information, this study explored the attitudes of high school agricultural and science educators about the use of biotechnology. Like any other adopters of innovation, educators go through a process that involves first becoming aware of the innovation, forming an attitude about the innovation, deciding to adopt or reject the innovation, implementing the idea, and then confirming they made the right decision to adopt the innovation. The objectives of this study were to investigate whether participation in biotechnology training affected their awareness level of the uses biotechnology (awareness of innovation), and their attitudes about the use of biotechnology (forming an attitude). By describing the awareness and attitudes of high school agricultural and science educators about biotechnology, we can then describe where they are in the innovation-decision process and be better able to design training that will be inductive to biotechnology curriculum adoption.

Introduction

Over the last 150 years, the agricultural industry as well as the education of and about agriculture has experienced metamorphic change. Scientific research has led to major advancements in the production and marketing of agricultural commodities. Since the mid 1800's, major discoveries such as the development of fertilizers and pesticides–in addition to recent biotechnology discoveries-have dramatically increased agricultural production in United States.

Carlson (2000) reported that, since 1887, the agricultural industry has progressed through a biological revolution in which the content knowledge base and agricultural productivity have both increased exponentially. New hybrids, oil-seed crops, fertilizer and herbicide manufacturing and genetically altered crops in the field of biotechnology are just a few of the key discoveries that accelerated this revolution. The biotechnology phase of the agricultural biological revolution that emerged in the 1980s and 1990s became commercialized when the genetically transformed tomato, *Flavor-Savor*, was introduced to consumers in grocery stores in 1994. This biotechnological commercialization continued apace: by the late 1990s, four major crops produced by North American farmers-70% of canola, 60% of soybeans and cotton, and 30% percent of corn-were genetically modified.

Exactly what is biotechnology? And why is the topic so controversial? The Committee on Fundamentals of Science (1995) defined biotechnology as "a powerful set of tools that employ living organisms or parts of organisms to make or modify microorganisms for specific uses"(p.1). Agriculture has benefited from the use of biotechnology for hundreds of years; however, recent advancements in recombinant DNA and cloning have brought about much ethical debate.

Smith (2000) suggested that some consumers are opposed to the use of genetically modified crops and animals. Public concerns range from the disapproval of genetic manipulation for moral reasons to potential dangers and risks of the use of the science (Kloppenburg & Burrows, 1995). Some people are concerned that genetically modified organisms will be detrimental to other organisms in the environment or that genetically modified foods are unsafe to consume. Others fear that a few multinational firms that have invested in the majority of the biotechnology product development will monopolize the agricultural economy.

In order to address these concerns, educators should be aware of the confidence the public has in the integrity of different groups. Hoban and Kendall (1992) found that government and private companies are not trusted as much as university professionals, nutritionists, and environmental groups.

Theoretical/Conceptual Framework

Even though many high school agriculture education programs have infused instruction about biotechnology into their curriculum, national studies indicate that the changes in instruction are not keeping up with the technological advances in biotechnology. In 1999, the National FFA Organization commissioned the ABG Strategic Consulting firm to conduct survey

research related to the status of high school agricultural education. In the student analysis, most students who completed the survey responded that they had not heard of the word "biotechnology." After given the definition, they responded they had not been taught any concepts related to biotechnology in agricultural education.

As is frequently the case, education is the most powerful change agent for effecting changes of attitude and modification of behavior. Accordingly, teachers play a critical role. Finch, Schmidt & Faulkner (1992) hypothesized that teachers are a key element of educational change because they oversee what occurs in their classrooms. According to Fullan (1991), if teachers do not support the implementation of innovation, it may be doomed to failure.

On a similar note, Ross, Cornett & McCutchion (1992) suggested that a teacher's personal values and beliefs could determine what is taught in the classroom, including new curriculum. Interventions such as staff development should provide teachers with "internalization," which may lead to a desired change of attitude and modification of behavior as suggested by Fitch & Kopp (1990). However, Schommer (1988) hypothesized that adult learners may not respond to training because it does not reflect their epistemological beliefs. Certain beliefs and values can lead to a teacher's refusal to accept or use new technology.

An innovation was defined by Rogers (1995) as "an idea, practice or object that is perceived as new by an individual or other unit adoption" (p.11). In his innovation-decision process theory, Rogers (1995) hypothesized that an individual must first become aware of the innovation, form an attitude about the innovation, decide to adopt or reject the innovation, implement the idea and then confirm having made the right decision by adopting the innovation. He also believed that this entire process could be influenced by how the adopters perceive the innovation and their prior experiences dealing with the innovation.

Roger's (1995) innovative-decision process theory provides a conceptual framework for the need and purpose of this study. By describing the awareness and attitudes of high school agricultural and science educators about biotechnology, we can then describe where they are in the innovation-decision process and be better able to design training that will be inductive to biotechnology curriculum adoption.

Purpose and Objectives

The purpose of the study was to explore the attitudes of high school agricultural and science educators who had attended training and had not attended training about the use of biotechnology. The objectives of this study were to describe their awareness level of the uses biotechnology (awareness of innovation), and their attitudes about the use of biotechnology (forming an attitude).

Procedures

This was a descriptive study using responses from randomly selected teachers who had not attended biotechnology training and teachers who had self selected themselves to receive intensive technical training in agricultural biotechnology techniques.

The instrument was derived from Hoban and Kendall's (1992) "Consumer Attitudes about the Use of Biotechnology in Agriculture and Food Production," a USDA-Extension Service instrument that was reviewed by a national panel of experts for content validity and pilot tested twice by forty different randomly sampled consumers. Items were analyzed and subscales were created during the pilot analysis.

To control for history effect, thirty-six randomly selected teachers who had not attended training were surveyed twice over a two-week period. The stability of the questions related to teachers' attitudes was measured using the Product-Moment Correlation Coefficient (Pearson r). The initial pilot responses and the responses received two weeks later resulted in a coefficient of stability of r = .72, reflecting a high stability rate. At the conclusion of an intensive biotechnology training, fifty-six teachers were surveyed. Forty-eight of the respondents completed the entire survey instrument for a final response rate of 86%.

Limitations of the study included self-selection by the participants in the survey by the subjects attending the intensive biotechnology training. It is also recognized that the subjects who attended the training were there because of their interest and prior experiences with biotechnology. Therefore this study can not be generalized to all agricultural and science teachers.

The statistical analysis used to interpret the data included descriptive statistics to determine the mean, measure of variance (standard deviation) and frequencies of the items.

Findings

Respondents were asked " How much have you heard about biotechnology?' to determine how aware they were of biotechnology. Both groups of agricultural and science educators, those who attended training and those who had not attended training, possessed some awareness about biotechnology. Those that had attended training were very aware of biotechnology as shown in Figure 1. NOTE: In all of the following tables and charts, "Control" refers to educators who had had not attended training; "Treatment" refers to those who had attended training.

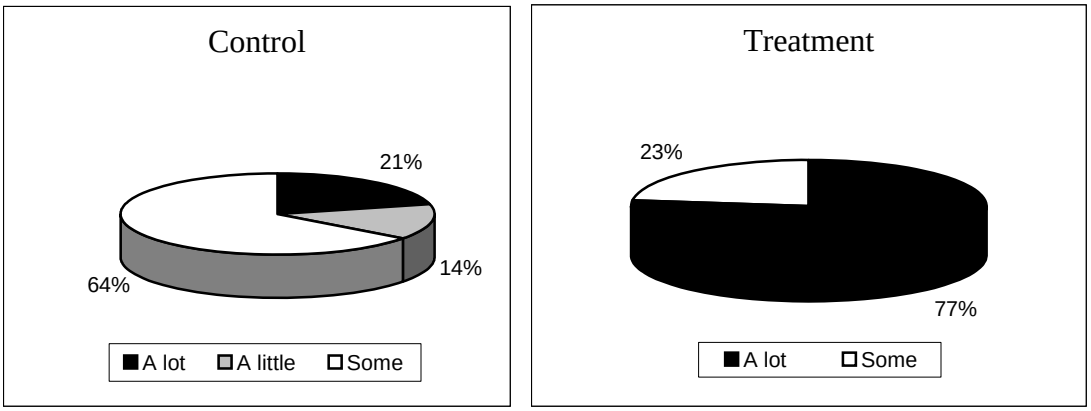

Figure 1. *Awareness of agricultural and science educators about biotechnology.*

As seen in Table 1, agricultural and science educator's attitudes toward the use of genetic engineering varied according to the reason the plant or animal product had been altered. A Likert scale of 1 (unacceptable) to 5 (acceptable) was used to survey the respondents. Both groups were accepting (a rating of 4 to 5) of genetic engineering to improve the production of plants and animals in agriculture. Some in both groups reflected neutral (a rating of 3) attitudes about the acceptance of the use of genetic engineering for the enhancement of food products. Overall, however, both groups were less accepting of the use of genetic engineering for the enhancement of food products.

Table 1:
Agricultural and science educators acceptance of the use of biotechnology to make different products.

	Control		Treatment	
	χ	SD	χ	SD
Plant Production				
ood crops that resist insect damage	4.50	.73	4.51	.71
otton plants that resist damage from the use of weed control chemicals	4.69	.60	4.53	.84
acteria that prevent frost damage to crops	4.44	.73	4.51	.89
Animal Production				
arm animals that resist disease	4.50	.73	4.43	.71
ompounds that increase milk production when given dairy cows	4.00	1.03	4.14	.98
Enhancement				
ompounds that produce less fatty meat when given to farm animals	4.00	.73	4.22	1.01
ood ingredients, such as flavorings	3.81	1.11	4.16	.85
ort fish that grow larger	3.50	1.10	4.16	.85

Scale: 1=Unacceptable to 5=Acceptable

The majority of agricultural and science educators in both groups believe the use of biotechnology will have a positive effect on food quality, fish and wildlife, the reduced use of pesticides, farmers' economic conditions, and environmental quality as seen in Figure 2. Both groups were most confident in the use of biotechnology to improve food and environmental

quality including a reduction in the use of pesticides and the least confident in the use of biotechnology to enhance fish and wildlife recreation.

The majority of participants who had not attended training did not believe genetic engineering would help improve the control of world population growth. The majority of those that attended training did feel biotechnology could improve the control of world population growth but this group had the least amount of confidence in this particular use of biotechnology.

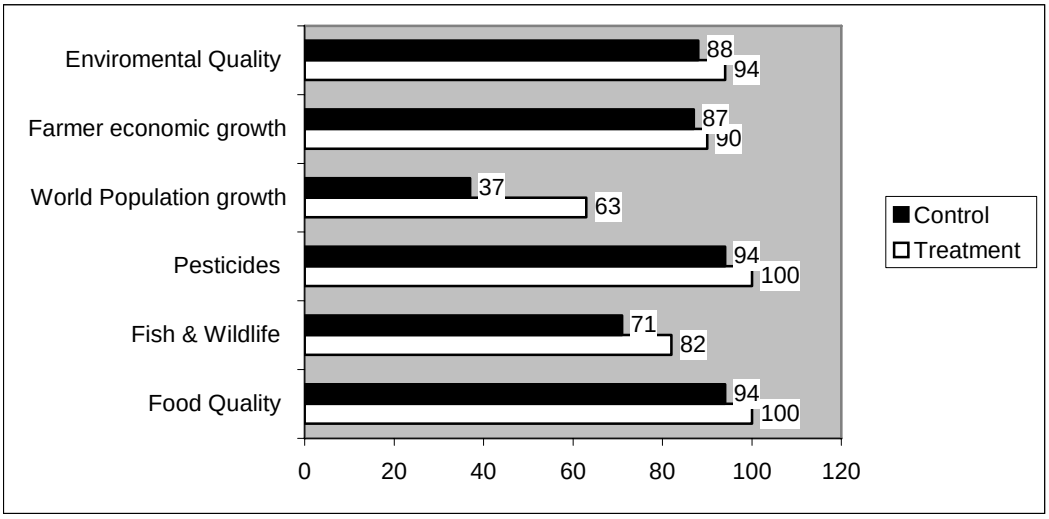

Figure 2. *Percentage of agricultural and science educators who responded positively toward the uses of biotechnology.*

Agricultural and science educators in both groups were accepting of the use of biotechnology to move genes from one plant to another, from animals to plants, and from animal to animal. Neither group was accepting of the transfer of genes from humans to animals. Those that had attended training were more accepting of the human to animal gene transfer. See Figure 3.

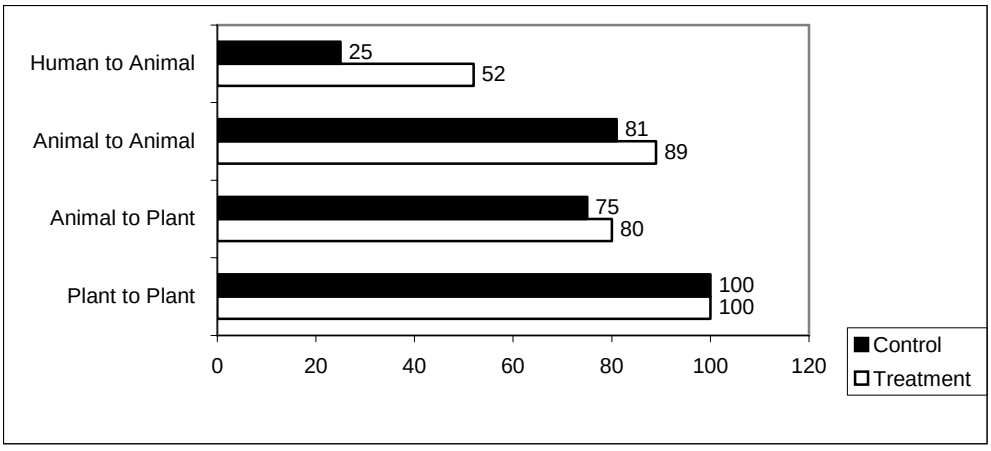

Figure 3. *Percentage of agricultural and science educators who responded positively toward the different types of transgenic biotechnology.*

The majority of agricultural and science educators who had received training and those who had not received training felt that the use of biotechnology to change plants and animals was morally acceptable. In both groups, more respondents were more morally accepting of the use of biotechnology to change plants than to change animals. See Figure 4.

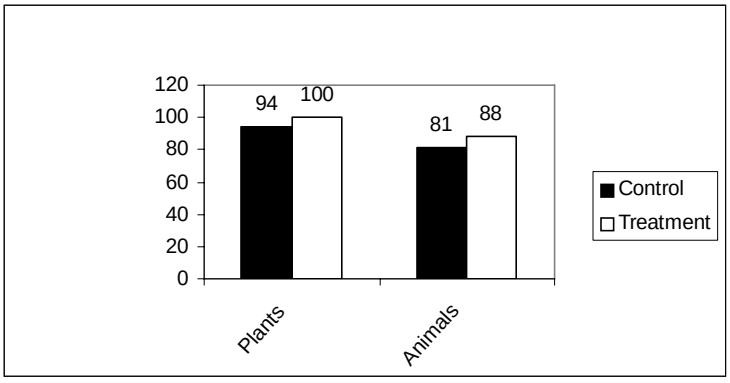

Figure 4. *Percentage of agricultural and science educators who responded they felt the use of technology to genetically engineer plants and animals was morally acceptable.*

Most agricultural and science educators in both groups thought that all types of information about biotechnology were very or somewhat important to them. Both groups placed high importance on information about the risks and benefits of biotechnology. Those who had attended training placed a higher importance on information about the new uses of biotechnology in food production and the basic science of biotechnology. See Table 2.

Table 2:
Agricultural and science educator's attitudes toward the importance of different types of information.

	Control		Treatment	
	χ	SD	χ	SD
otential risks or negative effects of biotechnology	3.00	.00	2.92	.27
otential benefits or positive effects of biotechnology	2.88	.34	2.96	.20
ow government regulates biotechnology	2.88	.34	2.80	.45
ew uses of biotechnology in food production	2.56	.63	2.82	.39
asic science behind biotechnology	2.06	.68	2.76	.43

Scale: 3=Very Important, 2=Somewhat Important, 1=Not Important

For these educators, university professors, county extension agents, and farmers were the most trusted sources of biotechnology information by both groups. Environmental groups and companies making biotechnology products were the least trusted sources of information. See Table 3.

Table 3*: Agricultural and science educator's attitudes toward their trust in sources of biotechnology information.*

	Control		Treatment	
	Mean	SD	Mean	SD
University professors	2.69	.48	2.60	.49
County Extension Agents	2.56	.51	2.42	.50
Farmers or farm groups	2.50	.52	2.32	.51
Federal government agencies	2.13	.72	2.24	.52
State government agencies	2.06	.68	2.24	.48
ompanies making biotechnology products	2.00	.52	2.08	.49
ood processors and manufacturers	1.88	.50	2.06	.42
Environmental groups	1.69	.60	1.78	.47

Scale: 3=A Lot, 2=Some, 1=None

Conclusions

Conclusions in this study should only be generalized to those participating in the study.

1. Those educators who had attended training were very aware of biotechnology, whereas those who had not attended training indicated some awareness about biotechnology. To raise the awareness of biotechnology, it is recommended that agricultural and science educators continue to receive intensive technical training in agricultural biotechnology techniques.
2. Both the Control and Treatment groups indicated their acceptance of genetic engineering to improve the production of plants and animals in agriculture but both groups were less accepting of the use of genetic engineering for the enhancement of food products and recreational wildlife. Technical training for agricultural and science educators should include the applications of biotechnology in agriculture to improve plant and animal production as both groups are more accepting of this technology.
3. Both groups believe the use of biotechnology will have a positive effect on food and environmental quality including reductions in the use of pesticides. Technical training for agricultural and science educators should include the applications of biotechnology in agriculture to increase the quality of food and the environment as both groups are more accepting of this technology.
4. Both groups were accepting of the use of biotechnology to move genes from one plant to another, from animals to plants, and from animal to animal. Neither group was accepting of the transfer of genes from humans to animals but it is interesting to note that those who received training were twice as likely to approve such transfers. More research should be conducted to determine if there is a correlation between the scientific training of agricultural and science teachers and their acceptance of the use of human genes in the genetic engineering of agricultural products.
5. Neither group felt the use of biotechnology to change plants and animals to be morally wrong. In both groups, more respondents were more accepting of the use of biotechnology to change plants than to change animals. Both groups thought that all types

of information about biotechnology were very or somewhat important to them. And both groups placed high importance on information about the risks and benefits of biotechnology. Interestingly, those who had attended training placed a higher importance on information about the new uses of biotechnology in food production and the basic science of biotechnology, suggesting that training might make a difference in attitude. Both groups identified university professors, county extension agents, and farmers as the most trusted sources of biotechnology information. This finding suggests that training designed and conducted by these sources might find the most accepting audiences among agricultural and science educators.

Implications

Biotechnology training for agricultural and science teachers should continue to focus on the awareness of individuals of the innovation as well as the development of their attitudes about the innovation. If technical training is provided, agricultural and science teachers are more likely to possess a higher level of awareness and more positive attitudes about non-conventional uses of biotechnology, such as food enhancement and human to animal gene transfer. As more biotechnology advances are made in agriculture, future training should be considered to promote acceptance of this new technology.

Teachers who already possess awareness of technology are more interested in new research and the basic science of the technology. Future training efforts should include new research in biotechnology and the scientific tools used in this technology. Training should also include the use of biotechnology to improve plant production, animal production, food quality and environmental quality as teachers are more accepting of these uses of biotechnology and may be more willing to adopt related curriculum.

Land grant universities and their extension services should consider providing biotechnology teacher training as part of their outreach programs. Agricultural and science teachers trust professors and extension agents and are most likely to attend training sponsored by these groups. Biotechnology has and will continue to change agriculture. If agricultural and science teachers are to prepare the next generation for a career in agriculture, they must be willing to adopt biotechnology curriculum. Agricultural and extension education can serve as an effective change agent in this innovation adoption process.

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