PRODUCER ATTITUDES TOWARD AGRICULTURAL BIOTECHNOLOGY: A FIVE STATE STUDY

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Abstract

Agricultural producers from Iowa, Minnesota, North Dakota, South Dakota, and Wisconsin were surveyed on their views toward agricultural biotechnology and their farming practices. The most divergent attitudes were North Dakota and South Dakota. Respondents from these two states differed on their attitudes toward crop preference, the regulation of genetically modified (GM) crops through moratoria, and their views toward GM crops and other genetically modified organisms (GMOs) as a positive scientific advancement.

INTRODUCTION

Technological advancements in agriculture have changed the face of the industry. Some of the most significant technological advancements in agriculture involve the development of crop and seed technologies. These technologies promise to bring many benefits, such as improved crop quality, greater overall yields, and resistance to chemicals, drought, and infestation. The adoption of these advancements, are viewed as a necessity by many conventional producers of agriculture in order to compete on a global scale. This article describes the results of a mail-out questionnaire that surveyed agricultural producers on their attitudes toward agricultural biotechnology and the planting of GM crops[1] with an overview of the topic of agricultural biotechnology and the controversy surrounding it, by addressing the views of those groups who support biotechnology as well as those groups who are opposed to biotechnology and its practices. In the subsequent sections, the mail-out questionnaire used to collect the survey data will be described. The study's sampling and data collection techniques will be discussed and the responses to selected survey items will be analyzed.

After summarizing the results for the survey items, a separate but related section will attempt to account for state-based differences in opinions toward agricultural biotechnology and the

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proposed benefits of planting GM summarizing the results for the survey items, a separate but related section will attempt to account for state-based differences in opinions toward agricultural biotechnology and the proposed benefits of planting GM crops, through the use of a six-item ranking index. Finally, a discussion of the state of agricultural biotechnology is presented along with concerns pertaining to the many challenges posed by biotechnology for agriculture and for the producers of agricultural products.

Support for GM Crops

Genetically modified crops, one of the chief products of agricultural biotechnology, became fully commercialized in 1996 (James 2005; Fernandez-Cornejo and Caswell 2006). Since their introduction to crop agriculture, a total of 25 countries have planted GM crops. In 2009, American producers dedicated over 158 million acres to the planting of GM crops, an amount accounting for 48 percent of all GM crops planted globally (James 2009).

These new crop varieties are viewed by many conventional producers as a technological advancement that has many potential benefits for farmers. Some of the proposed benefits include an increase in the nutritional value in food, improvements in the health of humans and animals, and the protection of the environment through reducing the use of insecticides and herbicides (USDA-Economic Research Service 2005). Some economic benefits include an increase in profits and the possibility of making farms less expensive to manage (Hillyer 1999). Further, biotechnology has been defended as a possible solution to world hunger and world food security in that it may help to promote sustainable small-farm agriculture in developing countries (Serageldin 1999).

Agricultural producers in the states of Iowa, Minnesota, North Dakota, South Dakota, and Wisconsin, have been among the quickest to adopt the practices of agricultural biotechnology through the planting of GM crops (Fernandez-Cornejo and Caswell 2006). For example, these five states accounted for more than 37 percent of the GM soybeans grown in the United States in 2004. Four of these states (all except North Dakota) accounted for over 45 percent of the GM corn grown in 2004 (National Agricultural Statistics Service 2004). More recent data show that on average 88 percent of corn and 93 percent of soybean acres planted in these states were sown with some type of GM crop variety. These numbers are both greater than the national average of 85 percent and 91 percent, respectively (National Agricultural Statistics Service 2009). These states are also among the strongest supporters for the research, development, and application of GM products (Pew Initiative of Food and Biotechnology 2004).

Opposition Toward GM Crops

Opposition toward GM crops stems from the criticism facing biotechnology and genetic engineering in general. Some opposition is based on consumer concerns surrounding the moral issues and the safety concerns this emerging technology raises. Early research on consumer opinion and opposition toward genetic engineering conducted by Hoban, Woodrum, and Czaja (1992) investi-

gated the factors that contributed to this opposition. The study found that consumer opposition toward the practices of genetic engineering was based heavily on moral grounds and the idea that consumers tend to steer clear from products they consider to be potentially unsafe or "unnatural" (Hoban et al. 1992:477). The same research by Hoban et al. (1992) stressed the importance of recognizing the role that a lack of awareness can play in influencing the public's attitude toward new technologies and practices. More recent research supports this argument. For example, McCluskey and Swinnen (2004: 1230) argue that this lack of public awareness and knowledge is a result of inadequate and biased information from the mass media, which has resulted in "consumers being poorly informed." Further, they criticized the media for failing to be objective or neutral when highlighting the risks of biotechnology.

Other research has shown that opposition and skepticism toward biotechnology and products that contain GM material varies by geographic location and country-to-country. Perhaps the most notable opposition toward GM food products comes from the European Union and Japan. Much of the opposition and concern stems from the emphasis European and Japanese consumers place on food safety (Kalaitzandonakes 2000). The inability to segregate foods containing GM material from those that do not is also a major concern for international consumers (Taylor, Tick, and Sherman 2004). The strength of European opposition toward the marketing of foods containing GM materials became apparent after a de facto moratorium was placed on such products by the European Union in the late 1990s (Rodemeyer 2002).

Finally, one of the sharpest criticisms of GM crops is their potential to perpetuate the inequality that exists between agricultural producers from developed countries and those from less developed countries (Altieri and Rosset 1999; Traxler 1999). The cost of research necessary to develop GM crop varieties puts less developed countries at a distinct disadvantage. This disadvantage has led to concern over the possibility that producers from less developed countries will find it increasingly difficult to compete in international markets and their populations will not be able to enjoy the proposed benefits of GM crops, most specifically the possibility of increased food security (Serageldin 1999).

Future Concerns

International opposition toward the use of GM material in food products is a serious concern to agricultural producers in the United States. Both Japan and Europe are large importers of agricultural products from the United States. The European Union and the United States also comprise the largest bilateral trade relationship in the world (Pew Initiative on Food and Biotechnology 2005). With the likelihood of more food products containing GM materials being introduced, international acceptance and access to international markets is vital for the economic success of GM crops (Taylor et al. 2004). Given the controversy surrounding GM products and their increased adoption, research on attitudes and values pertaining to these products seems especially relevant.

DATA COLLECTION

Data were collected through questionnaires seeking information from agricultural producers on a number of issues related to the planting of GM crops and their attitudes toward agricultural biotechnology. Specifically, producers were surveyed on their orientation to farming, their crop preference, and their opinions on issues dealing with agricultural biotechnology, its practices, its proposed benefits, and its regulation.

Using procedures described by Dillman (2000), the same questionnaire was sent to two different samples of respondents. First, the questionnaire was sent to a random sample of 2,550 farmers from the states of Iowa, Minnesota, North Dakota, South Dakota, and Wisconsin. The same questionnaire was then sent to a random sample of Certified Organic Farmers from the same five states (n= 194)[2].

Of the 2,550 questionnaires that were sent to the first random sample of producers, 837 were returned, yielding a response rate of less than 33 percent. A higher response rate was produced by the sample of Certified Organic Farmers. Out of a total of 194 mail-out questionnaires sent to Certified Organic Farmers, 94 were returned, yielding a response rate of over 48 percent.

A partial explanation for the relatively low response rate among the larger sample may have been due to the lack of salience some producers place on the topic. Another explanation for the lower response rate of the larger sample is that conventional producers of agricultural have been excessively surveyed, as opposed to the less surveyed sample of organic farmers. With a response rate that was 15 percent higher than the response rate of the random sample of farmers who were sent the same questionnaire, it would appear that organic farmers are more concerned about the issues and controversies related to GM crops. This may be due to the fact that many of the practices of agricultural biotechnology are in stark contrast to those of organic farming.

RESULTS

Presented in the following sections are summaries of the responses to selected survey items from agricultural producers from the five states involved in the survey. The items include those related to orientation to farming, the crop preferences of respondents, opinions concerning the potential moratoria that could be placed on GM crops, and the degree to which producers believe that the planting of GM crops can help solve common farm problems such as farm surplus. Information is also provided regarding the attitudes producers hold toward GMOs and technology's role in the promotion of family farming, and producers' views toward GMOs as a positive new technology.

Orientation to Farming

Assuming that their approach to farming might affect their attitudes toward biotechnology, producers were asked: "Which of the following best describes your orientation to farming?" This item provided respondents with three choices regarding their orientation to farming: conventional, organic, and sustainable.

The conventional orientation to agriculture is best described as agriculture that is based on the capitalistic practices of minimizing costs while attempting to maximize production and profits (Eicher 2003). Conventional producers are often viewed as being more open to the latest breakthroughs in technologies that promise higher yields and other benefits (Illinois River Decisions Support System 2005).

The other two farming orientations have official definitions. Producers of organic crops are those that satisfy the criteria necessary to be recognized as a Certified Organic Farmer typically committed to the planting of non-GM crops. The legal definition of "sustainable agriculture" involves an integrated system of plant and animal production practices. Some of the goals of sustainable agriculture are to pursue the economic viability of farm operations while also promoting land and environmental stewardship (CSREES 2006).

The majority of respondents from each of the five states reported that they conformed to conventional forms of agricultural production. North Dakota had the lowest percentage of conventional producers (70.9 percent), whereas Minnesota had the highest (82.8 percent). Respondents from Wisconsin (14.4 percent) and Iowa (14 percent) comprised the largest groups of sustainable producers of agriculture. Minnesota had the fewest number of farmers claiming to be sustainable farmers (5.7 percent). Finally, Wisconsin had the lowest percentage (8 percent) of farmers designating themselves as organic farmers, whereas North Dakota (20.3 percent) had the highest percentage of organic farmers (See Table 1).

Producer Crop Preferences

In order to survey respondents on their crop preference, producers were asked to rate their level of agreement (Agree, No Opinion, Disagree) with the following statement, "Naturally occurring crops are preferable to GM crops." There was a substantial range in the agreement with this item. Nearly 48 percent of producers from North Dakota were in agreement with this statement. Conversely, less than 30 percent of respondents from Iowa, and only about 33 percent of respondents from South Dakota agreed with this statement. Respondents from Iowa and South Dakota were also the most likely to disagree with this statement

Table 1. Percent distribution of Producer by orientation to farming, by state*

Orientation to Farming	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Conventional	77.3% (116)	82.8% (130)	70.9% (115)	75.9% (142)	77.6% (97)
Organic	8.6% (13)	11.5% (18)	20.3% (33)	12.2% (23)	8.0% (10)
Sustainable	14.0% (21)	5.7% (9)	8.6% (14)	11.7% (22)	14.4% (18)
Total	100% (150)	100% (157)	100% (162)	100% (187)	100% (125)

statement (35.9 percent and 31.3 percent, respectively) (See Table 2).

The Regulation of GM Crops

In order to gauge producers' perceptions toward the regulation of GM crops, respondents were asked about their level of agreement with two separate statements. Both statements pertained to the possible regulation of GM crops through a moratorium. The first item stated, "A moratorium should be placed on the use of GM crops until it is demonstrated that public health is safeguarded." Respondents from North Dakota and Wisconsin showed strong support for this statement, as over 58 percent of producers from North Dakota and nearly 49 percent of producers highest levels of disagreement with this statement. (See Table 3).

The second item pertaining to the regulation of GM crops stated, "A moratorium should be placed on the use of GM crops until it is demonstrated they can be kept segregated from non-GM crops." Again, producers from North Dakota (55.1 percent) were the most likely to agree with this statement. Producers from South Dakota were the least likely to indicate agreement with this statement, with only about 26 percent of respondents expressing agreement. (See Table 4).

Table 2. The extent to which Producers agreed that naturally occurring crops are preferable to GM crops, by state

Responses	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Agree	29.3% (44)	37.7% (60)	47.8% (78)	32.8% (62)	36.5% (46)
No Opinion	39.3% (59)	33.3% (53)	30.6% (50)	30.6% (58)	34.1% (43)
Disagree	31.3% (47)	28.9% (46)	21.4% (35)	35.9% (68)	29.3% (37)
Total	100% (150)	100% (159)	100% (163)	100% (189)	100% (126)

Table 3. The Extent to Which Producers Agreed that a Moratorium Should be Placed on the Use of GM Crops Until it is Demonstrated that Public Health is Safeguarded, by State

Responses	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Agree	42.4% (65)	37.1% (59)	58.8% (96)	35.7% (68)	48.8% (62)
No Opinion	15.0% (23)	23.2% (37)	14.5% (24)	23.6% (45)	12.5% (16)
Disagree	42.4% (65)	39.6% (63)	27.2% (45)	40.5% (77)	38.5% (49)
Total	100% (153)	100% (159)	100% (165)	100% (190)	100% (127)

Table 4. The extent to which Producers agreed that a moratorium should be placed on the use of GM Crops until it is demonstrated they can be kept Segregated from non-GM Crops, by state

Responses	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Agree	32.0% (49)	32.7% (52)	55.1% (91)	25.7% (49)	35.7% (45)
No Opinion	16.9% (26)	18.8% (30)	19.3% (32)	23.6% (45)	17.4% (22)
Disagree	50.9% (78)	48.4% (77)	25.4% (42)	50.5% (96)	35.7% (45)
Total	100% (153)	100% (159)	100% (165)	100% (190)	100% (126)

Table 5. The extent to which Producers agreed that GMOs are good because they are the latest scientific advancement made by humans, by state

Responses	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Agree	27.4% (42)	23.75% (38)	20.8% (34)	31.5% (60)	19.8% (25)
No Opinion	33.9% (52)	43.75% (70)	31.9% (52)	37.8% (72)	41.2% (52)
Disagree	38.5% (59)	32.5% (52)	47.2% (77)	30.5% (58)	38.8% (49)
Total	100% (153)	100% (160)	100% (163)	100% (190)	100% (126)

The Benefits of Agricultural Biotechnology

Proponents of agricultural biotechnology argue that their support for this emerging technology stems from the proposed benefits it can bring to producers (Hillyer 1999). In order to gain insight into how producers perceive the benefits of agricultural biotechnology, they were asked to rate their level of agreement to three separate statements. The first statement read: "Genetically Modified Organisms (or GMOs) are good because they are the latest scientific advancement made by humans." Respondents from South Dakota were the most likely to agree with this statement as 31.5 percent expressed agreement. Respondents from North Dakota and Wisconsin were the least likely to agree with this statement (20.8 percent and 19.8 percent, respectively). (See Table 5).

The second item in this series surveyed respondents on the extent to which they agreed or disagreed with the statement: "The use of GMOs will help solve the problem of farm surpluses by finding new uses for crops and livestock." Respondents from Minnesota were the most likely to agree with this statement, as nearly 38 percent expressed agreement, while producers from North Dakota displayed the lowest levels of agreement at about 26 percent. (See Table 6).

Table 6. The extent to which Producers agreed that GMOs will help solve the problem of farm surplus by finding new uses for crops and livestock, by state

Responses	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Agree	35.9% (55)	37.7% (60)	25.7% (42)	27.8% (52)	32.5% (41)
No Opinion	21.5% (33)	22.0% (35)	30.0% (49)	32.6% (61)	24.6% (31)
Disagree	42.4% (65)	40.25% (64)	44.1% (72)	39.5% (74)	42.8% (54)
Total	100% (153)	100% (159)	100% (163)	100% (187)	100% (126)

Table 7. The extent to which Producers agreed that GMOs promote family farming as much as they promote industrial agriculture, by state

Responses	Iowa	Minnesota	North Dakota	South Dakota	Wisconsin
Agree	31.3% (48)	28.1% (45)	27.3% (44)	31.5% (60)	30.1% (38)
No Opinion	28.1% (43)	31.25% (50)	29.8% (48)	32.1% (61)	34.1% (43)
Disagree	40.5% (62)	40.6% (65)	36.6% (59)	36.3% (69)	35.7% (45)
Total	100% (153)	100% (160)	100% (161)	100% (190)	100% (126)

Finally, respondents were asked about the level of agreement or disagreement to the statement: "GMOs promote family farming as much as they promote industrial agriculture." As with the previous survey item, producers from the five states varied in their extent of agreement. Producers from Iowa and South Dakota were the most likely to agree with this statement (31.3 percent and 31.5 percent, respectively). In contrast, producers from Minnesota and North Dakota recorded the lowest levels of agreement at less than 30 percent (28.1 percent from Minnesota and 27.3 percent from North Dakota). (See Table 7).

State Based Differences

Clearly, there were state-based differences among the respondents. In an effort to determine the reasons for these differences, an attempt was made to select and compare the two states in which the producers were most different through the development of a six-item index. The responses to the six selected items on the survey instrument were combined into one overall score. These items were:

(1) Scientists should be limited in the kinds of genetic manipulation they can do to crops.

(2) Scientists should be limited in the kinds of genetic manipulation they can do to animals.

(3) That which is natural is superior to that which is human made.
(4) Naturally occurring crops, along with hybridized crops, are preferable to genetically modified crops.
(5) GMOs are good because they are the latest scientific/technological advancement made by humans.
(6) GMOs are not inherently good or bad, but rather should be evaluated in terms of their consequences.

The responses to these items were coded 1 to 5. A score of "1" indicated the most negative attitude toward agricultural biotechnology and a score of "5" indicated the most positive attitude a respondent could display toward an item. The possible range of scores was from 6 to 30. This index allowed for a ranking of producers from each state based on their responses.

The mean index score of the entire sample was 20.8. When the mean index scores among the five states and organic farmers were compared, the results showed that South Dakota, with an index mean of 22.5, appears to be the most supportive of agricultural biotechnology and GMOs. In descending order, Iowa ranked second (21.9), Minnesota ranked third (21.6), and Wisconsin (21.2) and North Dakota (20.9) ranked fourth and fifth, respectively. Certified Organic Farmers recorded the lowest score with a mean index score of 14. (See Table 8). The numbers yielded by the six-item index were consistent with the views expressed by the producers in their responses to the selected survey items that were discussed earlier. As can be seen in Table 8, respondents from North Dakota appear to be the least supportive of agricultural biotechnology, while producers from South Dakota are the most supportive.

This divergence warranted a more detailed investigation. In order to explain the differences in attitudes between these two states, the data on respondents from North Dakota and South Dakota were separated from the rest of the sample. The attitudes of Certified Organic Farmers from these two states were also examined. The separation of organic farmers from the rest of the sample allowed for a comparison between the attitudes of non-organic farmers (both conventional and sustainable producers) from North Dakota and South Dakota and the attitudes of organic farmers from these two states. The original data in Tables 3 through 8 were re-examined to find where the levels of agreement were the most divergent. The responses that varied the greatest were for those items related to crop preferences and the regulation of bio-

Table 8. Index Score Means by Category of Producer

Producer Categories	Index Score Mean	N
South Dakota	22.5	172
Iowa	21.9	137
Minnesota	21.6	140
Wisconsin	21.2	122
North Dakota	20.9	128
Organic Farmers[3]	*14.0*	*93*
Total	20.8	792

[3] The category "Organic Farmers" indicates those respondents who were recognized as Certified Organic Farmers.

Table 9. The extent to which Producers agreed that naturally occurring crops are preferable to GM crops

Responses	North Dakota	South Dakota	Organic Farmers
Agree	39.3% (50)	24.5% (40)	82.4% (47)
No Opinion	34.6% (44)	33.7% (55)	14.0% (8)
Disagree	25.9% (33)	41.7% (68)	3.5% (2)
Total	100.0% (127)	100.0% (163)	100.0% (57)

Table 10. The extent to which Producers agreed that a moratorium should be placed on the use of GM crops until it is demonstrated that public health is safeguarded

Responses	North Dakota	South Dakota	Organic Farmers
Agree	48.4% (62)	29.2% (48)	92.9% (53)
No Opinion	17.9% (23)	25.6% (42)	5.2% (3)
Disagree	33.5% (43)	45.1% (74)	1.7% (1)
Total	100.0% (128)	100.0% (164)	100.0% (57)

Table 11. The extent to which Producers agreed that a moratorium should be placed on the use of GM crops until it is demonstrated they can be kept segregated from non-GM crops

Responses	North Dakota	South Dakota	Organic Farmers
Agree	46.0% (59)	17.6% (29)	89.8% (53)
No Opinion	23.4% (30)	25.6% (42)	6.7% (4)
Disagree	30.4% (39)	56.7% (93)	3.3% (2)
Total	100.0% (128)	100.0% (164)	100.0% (59)

technology and GM crops through moratoria (See Tables 2, 3, and 4). With respect to crop preference, the survey item asked respondents to rate their level of agreement to the following statement, "Naturally occurring crops are preferable to GM crops." Non-organic producers from North Dakota and South Dakota reported differing levels of agreement with this statement. More than 39 percent of non-organic producers from North Dakota agreed with this statement, compared to only about 25 percent of non-organic producers from South Dakota Organic farmers from North Dakota and South Dakota were the most likely to agree with this statement, as over 82 percent were in agreement (See Table 9).

A second disparity between non-organic producers from North Dakota and South Dakota was found in the two survey items that focused on the regulation of GM crops through

moratoria. The first item focusing on regulation through moratorium stated, "A moratorium should be placed on the use of GM crops until it is demonstrated that public health is safeguarded." Non-organic producers from North Dakota were far more likely than non-organic producers from South Dakota to agree with this statement as over 48 percent of non-organic producers from North Dakota were in agreement versus less than 30 percent of non-organic producers from South Dakota. Once again, organic farmers from these two states showed very high levels of agreement with this statement at nearly 93 percent (See Table 10).

The second item pertaining to the regulation of GM crops through moratoria stated, "A moratorium should be placed on the use of GM crops until it is demonstrated they can be kept segregated from non-GM crops." As with the previous statement dealing with potential moratoria, non-organic producers from North Dakota were more likely to express agreement toward this statement than those from South Dakota, as 46 percent of North Dakota respondents were in agreement compared to less than 18 percent of comparable South Dakota respondents. Remaining consistent with the other survey item that focused on the regulation of GM crops, organic farmers were in strong agreement with this statement, with over 89 percent of organic farmers in support of a moratorium (See Table 11).

DISCUSSION

The topic of biotechnology is one of great controversy that extends beyond agriculture. The potential outcomes of research conducted in the field of biotechnology, has been a topic of debate in many arenas, from the political to the economic to the religious. Consumer attitudes toward GM products in general are still quite skeptical (Curtis, McCluskey, and Wahl 2004). In contrast, the attitudes of agricultural producers are much more positive. Producers are attracted to the possibilities GM crops bring, especially in the way of producing larger yields that are easier to manage, less vulnerable to disease and infestation, and ultimately more financially profitable (Fernandez-Cornejo and Caswell 2006).

When looking at the adoption rates and the high percentage of acres being planted with some variety of GM crop, it is clear that, for the most part, the states in this region support the planting of GM crops and the practices of agricultural biotechnology. However, producers from this region are not uniform in their attitudes toward agricultural biotechnology. The divergence in opinion was most evident among producers from North Dakota and South Dakota. Producers from South Dakota are a prime example of those in support of agricultural biotechnology as they have shown the highest rates of adoption of GM crops (Pew Initiative on Food and Biotechnology 2004). And, among those surveyed, respondents from South Dakota showed the lowest levels of support for the regulation of GM crops through moratoria.

This topic is where the greatest divergence in attitudes existed between the surveyed producers of these two states. Producers and consumers alike in North Dakota have supported the regulation of new varieties of GM crops through moratoria to ensure the safety of GM products and to explore the

possibilities of GM foods being segregated from non-GM foods (Taylor et. al 2004). The support for the regulation of GM crops through moratoria was evident in the responses yielded by participants from North Dakota. Attitudes toward the regulation of GM crops and crop preference might account for the fundamental differences that exist between agricultural producers in these two states.

CONCLUSION

This article focused on the attitudes of agricultural producers toward agricultural biotechnology and the planting of GM crops. Results indicated that although all of these producers were from the same region, there was a surprising amount of disagreement among them. Clearly these producers are not monolithic in their attitudes toward this controversial topic.

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