
Ohio and South Carolina Business Attitudes Toward Biotechnology¹

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ABSTRACT. Recent developments in biotechnology have resulted in an increased interest in the monitoring of public attitudes and perceptions of this area of science. The audiences of interest have broadened to include not only the general public, but also various public opinion leadership groups and groups involved in decision-making.

In general, leadership groups are more informed about biotechnology than the general public, and are more likely to see the benefits of biotechnology outweighing the risks. A special subgroup of the population that has not been polled previously is the business community. This is an important group whose opinions should be counted.

In July, 1985, Monsanto Company conducted a survey of 400 business executives, equally divided between Ohio and South Carolina, concerning their attitudes about the growing industry of biotechnology. South Carolina was chosen as a state representative of the South; Ohio was chosen as a state representative of the Midwest. Results indicated that the majority of business executives are not familiar with biotechnology. However, many in this group see biotechnology as a good financial investment. Results of the survey also reinforced the conclusion that most members of society are not very well informed about biotechnology. This produces a high "biotech illiteracy" rate among consumers that can greatly hamper the acceptance of biotechnology products by the public.

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INTRODUCTION

Over the past several years, interest has increased in monitoring public attitudes toward and perceptions of biotechnology. The audiences of interest have broadened to include not only the general public, but also various public opinion leadership groups and groups involved in decision-making.

Surveys of the general public (Powledge 1983) have concentrated on measuring the general awareness of biotechnology and such specific aspects as genetic engineering and gene splicing. A second focus has been the public's perception of whether the benefits of biotechnology outweigh the risks. The survey results indicate that, in general, the public is uninformed about biotechnology and its benefits to society.

Surveys of various leadership groups (Miller 1985) have not only concentrated on measuring awareness of biotechnology, but also measuring perceptions of its impact in various areas (e.g., medicine, agriculture). In general, leadership groups are more informed about biotechnology than the general public and are more likely to see the benefits of biotechnology outweighing the risks.

A special subgroup of the population that has not been polled has been the business community. How informed are business executives about biotechnology and its benefits? It stands to reason that this subgroup could play an important role in promoting the benefits of biotechnology. This is an important group whose opinions should be counted.

ATTITUDES OF THE GENERAL PUBLIC TOWARD BIOTECHNOLOGY. According to a Yankelovich, Skelly, and White survey in 1983 (Powledge 1983), 70% of the American public had heard of the term "genetic engineering." However, as the researchers point out, this does not indicate that people understand or know what biotechnology is. They also found that almost two-thirds of the sample felt that cautious steps should be taken in the development of genetic engineering. Even though almost 40% of the respondents felt that the benefits of biotechnology would outweigh any problems, another 30% could not voice an opinion on the subject. This is an indication of the number of people who do not know enough about biotechnology to make an intelligent decision concerning its risk/benefit ratio.

An area where the public does seem to support the use of biotechnology is in the diagnosis and cure of disease. A *Business Week*/Harris Poll (1985) indicated that the

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majority of Americans favor genetic testing and would even submit to it if it was used to diagnose or cure a fatal or genetic disease. The main fear seems to be that the government, insurance companies, or employers could use the information to discriminate against them in some way. They do not want the test results to be available to others.

A recent study by Cambridge Reports, Inc. (1985) indicated that 44% of the sample had never heard of the phrase "genetic engineering," or could not verbalize what they think of when they hear the phrase. Over one-half (54%) also had not heard of private companies getting into the field of biotechnology, with an additional 10% indicating that they were unsure if they had or not. It appears as if in the last few years the awareness level of biotechnology has not changed dramatically. People are still unaware of what it is.

ATTITUDES OF VARIOUS LEADERSHIP GROUPS TOWARD BIOTECHNOLOGY. In the last three years, more emphasis has been placed on measuring the attitudes of various subgroups of the population toward biotechnology; specifically, those aware of and interested in the scientific community and various leadership groups. Miller (1984) studied the attitudes of academic scientists and middle- and upper-level government employees toward biotechnology. All of these individuals were involved in some way with biotechnology policy. The scientists had more positive attitudes toward biotechnology and tended to be excited about its future. This group was not in favor of any federal regulations that might jeopardize scientific progress. In contrast, the federal civil servants were more cautious about biotechnology and advocated federal control over scientific advances.

These findings are consistent with those of the National Science Board (Powledge 1983). From 1979 to 1981, it surveyed individuals who were "knowledgeable" about, or "interested" in, science. The Board found that those with some knowledge about science tended to feel that the benefits of biotechnology would outweigh the risks. Those who were only "interested" in but not "knowledgeable" about science tended to be more pessimistic about the benefits. The study concluded that those with less education tend to be most concerned about the risk of genetic engineering.

Miller (1985) conducted a study of the attitudes of religious, environmental, and science policy leaders toward biotechnology. These leadership groups do not consider themselves very well informed about biotechnology (i.e., only 24% of science policy leaders, 21% of religious leaders, and 6% of environmental leaders were well informed). However, a majority of all groups felt that the benefits of biotechnology outweigh the risks.

As one moves from the general public to specific subgroups of the population, the level of awareness of biotechnology increases, as well as support for the belief that the benefits outweigh the risks. The question remaining is: Will this same pattern hold true for members of the business community?

METHODS

In July, 1985, the Monsanto Company retained the Opinion Research Division of Fleishmann-Hillard, Inc. to conduct a survey of 200 business executives in Ohio and another 200 in South Carolina concerning their attitudes about the growing industry of biotechnology. South Carolina was chosen as a state that was representa-

tive of the South; Ohio was chosen as a state that was representative of the Midwest. Co-sponsors of the survey were the Ohio Chamber of Commerce and the Chamber of Commerce of South Carolina. The study was exploratory in nature and designed to assess how cognizant the business sector was of the potential benefits of the biotechnology industry to the two states.

The list of business executives interviewed was purchased from Dun and Bradstreet's Marketing Services Division. Dun and Bradstreet computed the sampling intervals for the study and randomly selected Ohio companies with annual sales of at least \$70 million and South Carolina companies with annual sales of at least \$6 million for inclusion in the study. The list included the names of the chief executive officers of the companies. All of these individuals received an advance letter from their state's Chamber of Commerce explaining the study and asking the executives for their cooperation. The executives were then called by professional interviewers during business hours and interviewed. The average length of the interviews was 10 minutes.

Initially, the sample was to be drawn based on annual sales of over \$70 million. This sales level did not present a problem in Ohio because it has a large industrial base. However, in South Carolina, which is more rural and less industrialized, the sales level had to be lowered to \$6 million or more in order to have a large enough universe from which to draw a representative sample. The difference reported between the two states may be due to the size of companies participating and/or industry type. This should be kept in mind when reviewing the results.

Initially, all executives were read the following introductory paragraph concerning biotechnology:

"We'll be talking about biotechnology, a method of taking a specific gene from one type of plant or bacteria and transferring it to another. The result can include: heartier plants, more resistance to drought and disease, the creation of bacteria to neutralize hazardous waste, and new ways to produce medicine such as human insulin."

The executives were then asked questions designed to measure their level of awareness of the growing industry, their assessment of the caliber of their state's resources necessary to attract the industry to the state, and what they felt the future role of the United States would be in biotechnology.

For purposes of this study, sampling error was defined as the estimated variance between the observed results, and those that would be obtained in replicated samples of the same population using the same research methods. Given this definition and the total sample size of 400 respondents, the sampling error is ± 5 percentage points. This means that in 19 out of 20 surveys of the same population, using the same methods, we can expect that the true proportions are within 5 percentage points of the resulting estimates.

Response differences between Ohio and South Carolina executives were reported as statistically significant when there was only a 5% chance that an observed difference was not a true difference. The computation of significant differences between subgroups was based on the square root of the sum of the estimated variance for each subgroup.

RESULTS

AWARENESS OF BIOTECHNOLOGY. Fifty-three percent of Ohio business executives were at least somewhat familiar with biotechnology, whereas only 41% of South Carolina business executives were at least somewhat familiar with it (Table 1). South Carolina executives were more likely than Ohio executives to say that they were unfamiliar with biotechnology. Sixty percent of South Carolina executives indicated that they were unfamiliar with biotechnology; 48% of Ohio executives indicated that they were unfamiliar with it.

When asked about the involvement of their companies in the biotechnology industry, only 3 to 5% of all executives reported that their companies were involved in the research and development or commercialization of biotechnological products (Table 2). Most of the companies that are involved are engaged in research and development activities or the manufacturing of equipment for products related to biotechnology.

TABLE 1

Percentage of answers ($N = 400$) to the question: *Do you consider yourself to be very familiar, somewhat familiar, or unfamiliar with this new technology?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Very familiar	12	5
Somewhat familiar	41	36
Unfamiliar	48*	60*
Don't know	0	0

*Significantly different from each other at $P = 0.05$.

TABLE 2

Percentage of answers ($N = 400$) to the question: *Is your company involved in the research and development or commercialization of genetic engineering products?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Yes	5	3
No	95	97
Don't know	1	1

The business executives were also asked whether or not their company intended to move into the biotechnology industry within the next five years (Table 3). About 90% of the executives in both states said that their companies were not planning to do so, with less than 5% in either state indicating that their companies have plans to move into this industry.

Not only were the majority of the executives in companies not involved in biotechnology, but on the whole, they were also unaware of companies in their respective states who were involved in biotechnology (Table 4). South Carolina business executives (92%) were significantly more unaware of companies involved in genetic engineering in their state than Ohio business executives (81%).

Although executives were not very familiar with biotechnology, they were somewhat interested in purchasing stock in companies using this technology (Table 5). Executives in Ohio were more interested in purchasing stock in corporations using biotechnology than South Carolina executives. South Carolina executives tended to be uncertain whether they should purchase stock in these

TABLE 3

Percentage of answers ($N = 400$) to the question: *What about within the next five years? Is your company planning to move into this industry in this state?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Yes	4	1
No	88	94
Don't know	4	2
Currently involved in research	5	3

TABLE 4

Percentage of answers ($N = 400$) to the question: *Are you aware of any companies in your state that are now involved in genetic engineering?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Yes	17	8
No	81*	92*
Don't know	2	1

*Significantly different from each other at $P = 0.05$.

TABLE 5

Percentage of answers ($N = 400$) to the question: *How interested are you in buying stock in companies which use this technology for your own portfolio?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Very interested	16	7
Somewhat interested	36	34
Not very interested	43	46
Don't know	6	15

companies. However, more than 43% of executives in both states were not very interested in buying stock in these companies. As can be expected, executives who were the most knowledgeable about biotechnology were also the most likely to be interested in buying stock in these companies.

In general, executives in both states tended to be only somewhat familiar with biotechnology. The vast majority were not working in companies involved in biotechnology or that planned to be in the next five years. Executives tended to be unaware of companies in their respective states that are involved in biotechnology. Even though they were unaware of these factors, many were at least somewhat inclined to purchase stock in companies involved in biotechnology.

Executives in South Carolina were significantly more unfamiliar with biotechnology (Table 1), significantly more unaware of companies in their state involved in biotechnology (Table 4), and less likely to want to buy stock in biotechnology companies than executives in Ohio (Table 5).

THE POTENTIAL FOR BIOTECHNOLOGY IN OHIO AND SOUTH CAROLINA. Ohio executives were most likely to believe that biotechnology has enormous potential for their business sector than were South Carolina executives (Table 6). More than 25% of executives from both states did not know how much biotechnology would affect the business communities in their respective states. Overall, executives in both states felt that biotechnology offers at least some potential for their state's business sector.

South Carolina executives (32%) were significantly more likely to feel that their state is very competitive in attracting high technology industries than Ohio executives (22%). Conversely, Ohio executives (39%) were significantly more likely to feel Ohio is not very competitive in attracting high technology industries than were South Carolina executives (25%) (Table 7).

TABLE 6

Percentage of answers ($N = 400$) to the question: *How much potential do you think biotechnology (genetic engineering) has for the business sector in Ohio/South Carolina?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Very great potential	32	23
Some potential	36	43
Little potential	5	8
Don't know	28	27

TABLE 7

Percentage of answers ($N = 400$) to the question: *Compared to other states, do you consider Ohio/South Carolina very, somewhat, or not very competitive in attracting high technology industries of which genetic engineering is one?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Very competitive	22*	32*
Somewhat competitive	34	37
Not very competitive	39**	25**
Don't know	7	7

*Significantly different from each other at $P = 0.05$.

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Consistent with this last result, the vast majority (80%) of Ohio executives felt that Ohio should increase its efforts to encourage the development of biotechnology industries (Table 8). South Carolina executives were significantly more likely to indicate that they don't know if their state should increase its efforts to attract the biotechnology industry.

Respondents were asked how much their states would benefit from biotechnology in the areas of agriculture, business investments, pharmaceuticals for the state's health industry, and employment (Table 9). A majority of executives in both states believed that genetic engineering could benefit all these areas somewhat or a great deal. Biotechnology was seen as being most beneficial to the agricultural segment and business investments. There were no significant differences between Ohio and South Carolina executives on these questions.

Executives were also asked how much five different business sectors might benefit from the development of

TABLE 8

Percentage of answers ($N = 400$) to the question: *Do you believe Ohio/South Carolina state government should make a greater effort to encourage the development of the genetic engineering industry?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
Yes, make more effort	80*	69*
No, should not	12	9
Don't know	9**	23**

*Significantly different from each other at $P = 0.05$.

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TABLE 9

Percentage of answers ($N = 400$) to the question: *This new technology could potentially benefit Ohio/South Carolina in a number of ways. Do you see genetic engineering benefiting the state a great deal, somewhat, or very little in each of the following areas?*

	Responses (%)			
	Great deal	Somewhat	Very little	Don't know
Development of heartier plants and more productive animals for the state's agricultural industry?				
Ohio ($N = 200$)	53	35	5	8
South Carolina ($N = 200$)	51	33	4	13
New business investment in the state?				
Ohio ($N = 200$)	40	44	10	7
South Carolina ($N = 200$)	36	46	8	10
New pharmaceuticals for the state's health industry?				
Ohio ($N = 200$)	39	38	13	10
South Carolina ($N = 200$)	31	44	9	17
New jobs created as a result of the new technology?				
Ohio ($N = 200$)	33	51	10	7
South Carolina ($N = 200$)	35	46	10	10

biotechnology (Table 10). A majority of executives in both states thought that it will be very beneficial to agriculture. In Ohio, a similar majority felt that biotechnology will be very beneficial to Ohio's medicine and pharmaceutical sectors. Ohio executives were significantly more positive about the benefits to this sector than South Carolina executives.

Respondents did not see the banking/investment sector, computer/information system sector, or the construction sector benefiting a great deal from the introduction of biotechnology (Table 10). Ohio executives were sig-

TABLE 10

Percentage of answers ($N = 400$) to the question: *How much might each of the following Ohio/South Carolina business sectors benefit from the development of this new technology?*

Sectors	Responses (%)			
	Great deal	Somewhat	Very little	Don't know
Agricultural:				
Ohio ($N = 200$)	58	32	1	10
South Carolina ($N = 200$)	58	27	2	14
Medicine/pharmaceutical:				
Ohio ($N = 200$)	59*	26*	5	11
South Carolina ($N = 200$)	46*	36*	3	16
Banking/investment:				
Ohio ($N = 200$)	16	46	25*	14*
South Carolina ($N = 200$)	22	40	15*	24*
Computer/information systems:				
Ohio ($N = 200$)	14	36	33*	18*
South Carolina ($N = 200$)	18	33	22*	29*
Construction:				
Ohio ($N = 200$)	11	43	32	15*
South Carolina ($N = 200$)	12	37	26	25*

*Responses (Ohio vs. South Carolina) significantly different at $P = 0.05$.

nificantly more likely to feel that biotechnology will have very little effect on the banking and investment sector, and the computer and information sector. South Carolina executives were more likely to indicate that they did not know what effect biotechnology will have on these three sectors.

Executives were also asked to rate their respective state in terms of how strong it was in different resource areas (Table 11). Ohio and South Carolina executives differed significantly. Ohio executives felt they have very strong or strong resources in the area of science education. South Carolina executives viewed their science education as being not very strong, or they don't know how strong it is. On the other hand, South Carolina executives felt that their state was stronger in the area of offering tax breaks to companies involved in biotechnology.

Executives rated their states comparably in the areas of university research capabilities, industry research and development, and business expansion (Table 11). An important finding was that executives from both states view their state's weak points as being a lack of public and business awareness of biotechnology and its benefits. Overall, executives were divided as to the potential bio-

technology offers their state's business sectors (Table 6). The majority agree that biotechnology will benefit agriculture, business investments, pharmaceuticals, and employment, with the most benefit accruing to agriculture and business (Table 9).

Ohio executives were most likely to feel that biotechnology offers potential for the business sector (Table 10), and that Ohio should increase efforts to attract biotechnology industries. They felt that biotechnology will make more positive contributions to the pharmaceutical industry and have little affect on banking and investment (Table 10). They also viewed their state's educational resources as being a very strong attraction for biotechnology industries. On the other hand, South Carolina executives felt that their state was very strong in offering strong tax breaks to attract industry.

U.S. INVOLVEMENT IN BIOTECHNOLOGY. Finally, the executives were asked if they expected the United States to retain its lead in the field of biotechnology in the next decade (Table 12). More than 73% of the executives said that the United States will retain this lead. Twelve percent felt that another country will take the lead; slightly more than this said that they don't know who will be the leader.

TABLE 11

Percentage of answers ($N = 400$) to the question: *To promote the development of genetic engineering, states need various resources. Do you rate Ohio/South Carolina very strong, strong, or not very strong in each area?*

Resources	Responses (%)			
	Very strong	Strong	Not very strong	Don't know
Its university research capabilities:				
Ohio ($N = 200$)	42	52	5	2
South Carolina ($N = 200$)	35	46	13	7
Current amount of industrial research and development in areas like agriculture and medicine:				
Ohio ($N = 200$)	22	50	16	13
South Carolina ($N = 200$)	21	46	19	15
Sources of capital for business expansion:				
Ohio ($N = 200$)	23	55	19	4
South Carolina ($N = 200$)	20	48	18	15
Quality of science education in secondary public education:				
Ohio ($N = 200$)	22*	52*	20*	7
South Carolina ($N = 200$)	9*	39*	42*	11
Tax breaks/other incentives to attract genetic engineering businesses to the area:				
Ohio ($N = 200$)	10*	24	52*	15
South Carolina ($N = 200$)	22*	33	23*	23
Awareness among business and government leaders of genetic engineering and its benefits:				
Ohio ($N = 200$)	3	25	65	8
South Carolina ($N = 200$)	3	17	68	12
Public awareness of genetic engineering and its benefits:				
Ohio ($N = 200$)	0	7	87	6
South Carolina ($N = 200$)	1	4	90	6

*Responses (Ohio vs. South Carolina) significantly different at $P = 0.05$.

DISCUSSION

The majority of business executives surveyed in this study were not very familiar with biotechnology, and were not working for companies involved in or planning to become involved with biotechnology during the next five years. Business executives are more likely to be familiar with biotechnology than the general public, but they are not as well informed as science policy leaders or religious leaders. However, many executives see biotechnology as a good financial investment and are willing to purchase stock in these companies.

The results of this survey reinforce the conclusions reached by those involving the general public and specific leadership groups, namely that most members of society are not very well informed about biotechnology. This results in a high "biotech illiteracy" rate among consumers that can greatly hamper the acceptance of biotechnology products by the public. Recognition of the need for a public education program to enlighten consumers about the benefits of biotechnology have been voiced by members of the scientific community (Edwards 1983a, 1983b, Price 1985).

TABLE 12

Percentage of answers ($N = 400$) to the question: *The United States is now the world leader in genetic engineering, followed by Japan and some European countries. Do you expect the United States will continue to retain this lead during the next decade, or do you think another country will take the lead?*

Responses	Ohio ($N = 200$)	South Carolina ($N = 200$)
U.S. will retain the lead	74	73
Another country will take the lead	12	12
Don't know	15	16

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