

Consumer Perceptions and Attitudes towards Bovine Somatotropin

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This article investigates the possible negative effects of bovine somatotropin (bST) and antibiotic use in cows on fluid-milk consumption in New York State. Based on data from a consumer survey, the potential change in milk consumption due to bST and antibiotic use is estimated. In addition, the current perceptions of consumers about bST and antibiotics are measured, and the significant socioeconomic, demographic, and attitudinal characteristics of consumers that are related to their milk-consumption response to bST are identified. Depending upon consumer awareness of bST, the results indicate that milk consumption in New York State could decrease by 5.5% to 15.6% if bST is approved. The results also suggest that antibiotic use in cows could decrease milk consumption by 1.6% to 7%, depending upon consumer awareness. A major implication is that education will likely play an important role in influencing consumers' attitudes and perceptions about both bST and antibiotics.

One of the first major commercial applications of biotechnology to agriculture will likely be the use of bovine somatotropin in the dairy sector. Bovine somatotropin (bST), or bovine growth hormone, as it is sometimes called, is a naturally occurring protein in the dairy cow that regulates nutrient partitioning for milk production and other functions (Sechen, Bauman, Tyrell, and Reynolds). It has long been known and consistently observed that injecting additional bST into cows boosts milk yields (Hutton; Peel, Bauman, Gorswit, and Sniffen; Bauman, Eppard, DeGeeter, and Lanza; Bauman et al. 1989). However, the costs of extracting bST from the pituitary gland of slaughtered cows were too high to make this practice an economically viable management option for dairy farmers (Becker and Taylor).

It is now possible, through recombinant DNA technology, to produce synthetic bST. Moreover, it is projected that the costs of manufacturing this product are low enough to make the use of synthetic bST in dairy cows economically viable for many farmers (Becker and Taylor). When given to cows in well-managed herds, synthetic bST has increased milk yields from 10% to 25% and increased feed efficiency from 5% to 15% (Animal Health Institute). Synthetic bST (hereafter referred

to simply as bST) is not yet available commercially, but the Food and Drug Administration (FDA) has authorized the sale of milk and meat from cows supplemented with bST in herds that are participating in FDA-approved field trials (Juskevich and Guyer). In December 1990, an independent panel of scientists organized by the National Institute of Health reaffirmed the FDA's findings, concluding that milk and meat from cows supplemented with bST were safe for human consumption (National Institute of Health). Scientists have concluded that there are no differences (outside the normal range of biological variation) in milk composition between milk from cows given bST and from cows not receiving bST (Daughaday and Barbano). The Council on Scientific Affairs of the American Medical Association concluded that "animal safety studies complete to date indicate that daily injections of lactating cows with bST do not appear to cause severe adverse health reactions in animals or in calves born to cows receiving bST." The FDA, however, is still investigating whether bST poses any short- and long-term health threats for dairy cows or their offspring (National Institute of Health).

Although the FDA—and virtually all of the scientific community—has repeatedly concluded that milk produced by cows supplemented with bST is safe, there is some opposition to bST approval (e.g., Foundation for Economic Trends) and some calls for further study on its safety (e.g., Consumers' Union). Opponents have argued against bST on a number of grounds, including animal welfare,

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its possible impact on involuntary farm attrition as a result of increased milk production and reduced milk prices, opposition to biotechnology in general, and animal and human safety concerns. Regardless of scientists' assurances of its safety for humans, some researchers are predicting a negative backlash in milk consumption if bST is approved (Smith; McGuirk, Preston, and Jones). Some consumers may perceive milk from cows supplemented with bST as different and less safe than "natural" milk and may adjust their consumption patterns accordingly.

The possible negative impacts of bST on milk demand is of great concern to the dairy industry. Questions such as the following need to be addressed: What might be the magnitude of this backlash? Which consumers will be more likely to react negatively to bST? What types of consumer education programs need to be conducted to allow consumers to make informed decisions about product safety? The majority of research on bST, however, has focused on its potential impacts on milk production (e.g., Kalter et al.; Fallert et al.; Kaiser and Tauer; Marion and Wills) or on the composition and quality of milk (e.g., Baer et al.; Barbano and Lynch). Only the recent studies by Smith, and by McGuirk, Preston, and Jones have begun to address the important demand-side questions.

To offer insight into these questions, this paper has three objectives: (1) to estimate the potential change in milk consumption in New York State if bST is approved; (2) to examine consumers' perceptions and attitudes about bST; and (3) to identify significant socioeconomic, demographic, and attitudinal characteristics of consumers that are related to their estimated milk-consumption response to bST.

Methodology

To obtain data on consumers' perceptions and attitudes about bST, a systematic, stratified random sample of 2,000 New York State households was drawn. The sample was randomly drawn from a population of New York residents based on telephone directories and Department of Motor Vehicle information. In addition, the sample was stratified to obtain 25% of respondents ($n = 500$) from the metropolitan New York City area, with the remaining 1,500 households from upstate New York. While approximately 41% of the population of the state of New York lives in the metro New York City area (Brown), we wanted to obtain a significant representation from both rural and upstate urban areas. Consequently, upstate New York was oversampled.

The data were collected using a 12-page booklet-type questionnaire that was pretested on a random sample of 100 households prior to the full study. Data collection was conducted by the Survey Research Facility of the Cornell Institute for Social and Economic Research in May and June of 1990. A three-wave mailing procedure was used in order to maximize the response rate. Personalized, individually signed letters and a questionnaire were mailed to each respondent, followed ten days later by a postcard reminder. Ten days after the postcard, a second personal letter and replacement questionnaire were mailed to nonrespondents. A total of 716 households completed and returned the questionnaire, which gave an overall response rate of 40.4% (228 out of the 2,000 questionnaires were undeliverable).¹

The survey questionnaire included a description of what bST is, what its current status at the FDA is, and a brief description of the claims for and against it (see Exhibit 1 for a complete description). To assess whether there is a negative feeling towards other dairy technologies or whether it is specific to bST, a description of another dairy-farming technology was included (antibiotic use in cows; see Exhibit 1 for description), along with questions parallel to the bST perception questions. Two versions of the questionnaire guaranteed that the order of the description and questions about bST and antibiotics did not influence the results. The first version presented the bST section first, while the second version presented the antibiotics section first. One-half of the sample received the first version, while the other half received the second version. No systematic differences between the two versions of the questionnaire were found in any variable means.

Comparing the sample responses with the most recently available population data (Gaines) indicated that the sample is skewed in favor of those with higher education and higher income, and has a greater representation of males than females. To test whether this bias would impact the results, a procedure that assigned different "weights" to each observation was used. Observations in the sample were weighted so that they reflected the same proportions of respondents with different income, gender, and education levels as the population statistics. In terms of income, the weighting procedure produced only marginally different results than the unweighted results. However, this was not the case for gender and education. Thus,

¹ Unknown to the authors at the time, the same households received a mail questionnaire on a different topic in February–May 1990. This overlap of respondents most likely depressed the response rate. However, no unexpected systematic bias was detected.

Exhibit 1. Survey Questionnaire Descriptions of bST and Antibiotic Use in Cows

About bST

Dairy cows naturally produce a protein hormone called **bovine somatotropin** or **bST** (sometimes called bovine growth hormone). Recently, it has become technically feasible to manufacture bST outside of the dairy cow. When man-made bST is injected into cows, milk production will increase an average of 10% to 15%.

Based on an extensive review of information related to the safety of bST, the Food and Drug Administration (FDA) concluded that milk and meat from bST-supplemented cows are safe for human consumption. The FDA may approve the commercial use of bST by dairy farmers in 1991.

Those in favor of giving man-made bST to cows say that this practice is safe and will benefit consumers by lowering prices they have to pay for dairy products. They also say that research studies have shown that giving man-made bST to dairy cows does not hurt the cows and that the milk and meat are safe.

Those against giving cows man-made bST say that increased milk production will create milk surpluses. This may hurt farmers by decreasing milk prices and farm income. They also think that injecting bST into cows is cruel and question whether meat and milk from these cows are safe.

About ANTIBIOTICS

Antibiotics such as penicillin are used for treating various infections in cows. For example, if a dairy cow with an infected milk-producing gland is not given antibiotics, she may become sick. Sick cows usually produce less milk and the quality of the milk they produce is poor.

While the cow is receiving antibiotics, and for a time after her last treatment, her milk is not sold. This is done to prevent any contaminated milk from reaching the consumer. Milk is frequently tested for antibiotic residue, but some milk containing low levels of antibiotics occasionally reaches consumers.

Those in favor of using antibiotics to treat infected cows say that this practice is safe and benefits consumers by keeping milk prices lower. Farmers are also benefited by making sure that they have healthy cows that produce large quantities of good milk.

Those against farmers using antibiotics argue that the leftover antibiotics in dairy products may be unsafe for humans.

all of the results reported here use a weighting procedure that reflects the population statistics for both gender and education level (see Table 1 for unweighted sample, population data, and weighted sample).

Potential Impact on Milk Consumption

Of the 716 respondents completing the questionnaire, only 26.7% indicated they had read or heard something about bST, while 43% said they had read or heard something about antibiotics in milk. Consequently, a significant percentage of the respondents relied on the survey's description of the technologies and the issues concerning them in responding to questions about bST and antibiotic use.

Respondents were asked how much milk their households buy during an average week. The 716 households in the sample purchased an average of 11.0 pints of milk weekly. This translates to an annual per capita measure of 26.3 gallons per person per year, which is just slightly lower than the U.S. average for 1989 of 27.6 gallons per person per year (Milk Industry Foundation, p. 32). This average, however, included 101 respondents who either did not answer this question or indicated that they do not buy milk. Because we are interested in the potential bST-induced consumption response, these 101 respondents were deleted from the rest of the analysis. The average weekly milk purchases for the 615 remaining households in the sample that indicated they buy milk was 12.8 pints.

Survey participants were asked how their weekly household purchases of milk would change if the government approved bST and the price of milk remained the same. The frequency distribution of the 615 responses to this question is given in Table 2. The majority of respondents (82.2%) indicated that their purchases would remain unchanged under this scenario. The remaining 17.8% indicated that they would decrease their purchases of milk if bST was approved and there was no change in milk price. This is much lower than a comparable Pennsylvania study in which almost twice as many (32.1%) consumers in that state indicated they would decrease their milk consumption because of bST approval (Smith).

The response to our question regarding effects on consumption was used to estimate weekly purchases of milk under bST approval, assuming consumer perceptions at the time of the survey. A weighted-average decrease in milk consumption due to bST approval was calculated on the basis of each respondent's proclaimed change in milk consumption, weighted by the household's weekly

Table 1. Gender and Education Levels of Raw Sample, Population, and Weighted Sample of New York State^a

Education	Raw Sample		Population		Weighted Sample	
	Male	Female	Male	Female	Male	Female
Percentage.....					
Elementary	1.0	1.1	5.5	7.0	5.4	7.3
Some high school	4.7	2.6	4.3	6.1	4.3	6.1
High school graduate	17.9	10.9	16.0	21.0	16.0	21.1
Some college	13.6	10.0	7.5	9.3	7.5	9.3
College graduate	11.8	7.1	6.3	6.0	6.3	5.9
Post college	12.0	7.3	5.9	4.9	5.9	4.9
Totals	61.0	39.0	45.7	54.3	45.4	54.6

Sources: Mail survey of New York State households. Population estimate is from L.M. Gaines.

^aThe small difference between the population and the weighted results is due to rounding error.

milk purchases. It was estimated that average household milk purchases would fall from 12.8 pints to 10.8 pints per week if bST was approved at that time. In other words, if bST was approved at the time this survey was conducted and the price of milk remained unchanged, there would be a 15.6% decline in milk consumption. This compares quite closely with the results of a similar survey of Virginia consumers, which indicated a 14.1% decrease in milk consumption if bST was approved and there was no price change (McGuirk, Preston, and Jones).

To compare consumers' perceptions of bST with another dairy practice, respondents were asked how their weekly household purchases of milk would change if farmers continued treating cows with antibiotics and the price of milk remained the same. The frequency distribution of the 615 households' responses to this question is given in Table 3. A larger proportion of consumers indicated that their purchases would not change under this sce-

nario compared with the bST scenario (87.0% compared to 82.2% for bST). Consumers have more of a negative reaction to bST than they have to antibiotics. If the response to the antibiotics question is used to adjust weekly purchases of milk, then average household milk purchases were estimated to fall from 12.8 pints to 11.9 pints per week. That is, the respondents indicated that if farmers continued the practice of treating cows with antibiotics and the price of milk remained unchanged, they would decrease their milk consumption by 7%, on average. This result suggests that there are also some negative perceptions on the part of some consumers concerning antibiotic use in cows.

Our estimated 15.6% decrease in milk consumption due to bST approval is based on the responses of survey participants who, as a result of the survey and its technology description, became 100%

Table 2. Frequency Distribution on Respondents' Expected Decrease in Milk Consumption Due to Government Approval of bST

Percentage Decrease in Milk Consumption Due to Government Approval of bST	Percent of Sample
0%	82.2%
1-10%	1.2%
11-20%	0.9%
21-30%	0.7%
31-40%	0.4%
41-50%	5.5%
51-60%	0.5%
61-70%	0.1%
71-80%	0.6%
81-90%	0.9%
91-100%	7.0%

Source: Mail survey of New York State households. Results are weighted to correct for sample gender and education biases.

Table 3. Frequency Distribution on Respondents' Expected Decrease in Milk Consumption Due to Continued Use of Treating Cows with Antibiotics

Percentage Decrease in Milk Consumption Due to Continued Use of Antibiotics in Cows	Percent of Sample
0%	87.0%
1-10%	1.6%
11-20%	1.6%
21-30%	1.0%
31-40%	0.2%
41-50%	3.7%
51-60%	0.0%
61-70%	0.0%
71-80%	0.1%
81-90%	0.0%
91-100%	4.8%

Source: Mail survey of New York State households. Results are weighted to correct for sample gender and education biases.

aware of bST. This may overestimate response because it is possible that many consumers will never become aware of bST after its introduction. To adjust for this possible overestimation, we used the following procedures. The sample of consumers was divided into two groups based on whether or not they had previously read or heard about bST. If a respondent was not previously aware of bST, then her/his milk-consumption response to bST was assumed to be zero. The rationale is that if a consumer does not know about bST, then that consumer's milk consumption would not change. On the other hand, if a consumer was previously aware of bST, then her/his indicated percentage change in consumption was used to estimate the average milk-consumption response to bST. This still assumes that the stated intentions of people aware of bST are the same as their ultimate actions.

Based on these adjustment procedures and a 26.7% consumer awareness of bST, average household purchases of milk were estimated to decrease from 12.8 pints per week without bST approval to 12.1 pints per week under bST approval, a decrease of 5.5%. While substantially lower than the unadjusted 15.6% estimate, this 5.5% adjusted estimate is still a significant reduction in milk consumption that would represent a tremendous shock to the dairy industry.

Similar procedures were used to estimate an adjusted milk-consumption response to antibiotic use in cows, assigning a zero consumption response to consumers that were previously unaware of antibiotics (57%). In this case, weekly purchases of milk were projected to fall from 12.8 pints per household to 12.6 pints, which represents a 1.9% decrease in milk purchases.

To summarize, the unadjusted estimate of decreased milk purchases due to bST was 15.6%, while the adjusted estimate, based on a 26.7% consumer awareness of bST, was 5.5%. The results also suggest a negative, but not as substantial, decrease in milk consumption due to antibiotic use in cows. The unadjusted and antibiotic-awareness-adjusted estimates of decreased milk purchases due to antibiotics were 7% and 1.9%, respectively. Even the awareness-adjusted results indicate a large potential decrease in milk consumption due to bST.

Attitudes and Perceptions about bST and Antibiotic Use

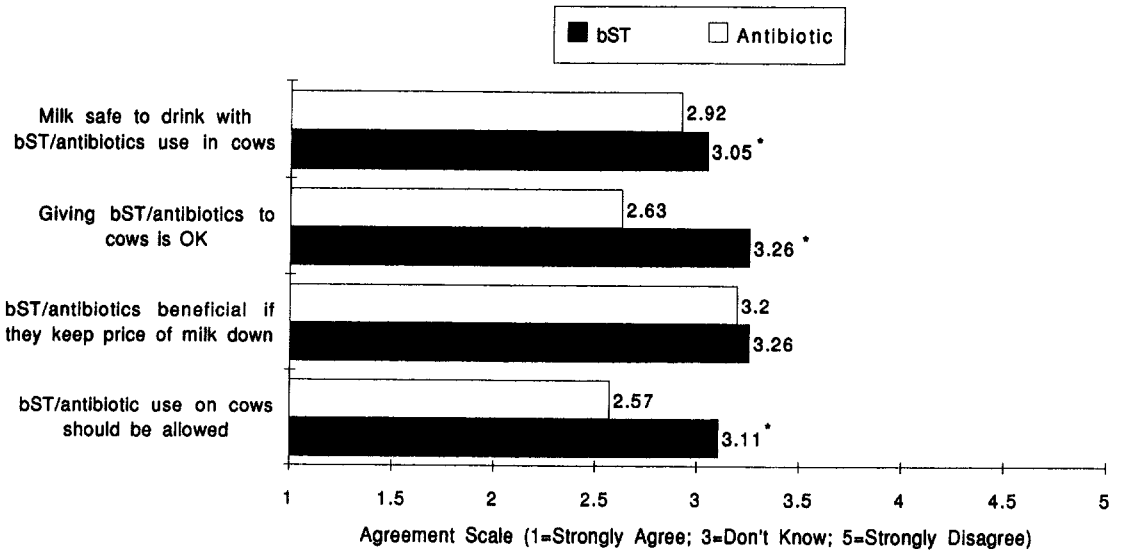
Respondents were provided with several attitudinal statements about bST and, for comparison, equiv-

alent statements regarding antibiotic use in cows. These questions were designed to determine the relative levels of concern that consumers felt about bST and antibiotics. To quantify their responses, an "agreement" scale ranging from 1 to 5 was constructed, where 1 indicated strong agreement, 3 indicated that the respondent did not know, and 5 indicated strong disagreement. The average scores by the respondents for the four statements concerning bST and antibiotic use are displayed in Figure 1.

On average, most consumers do not appear to have strong feelings regarding either bST or antibiotic use. This is illustrated in Figure 1, which shows that the average responses tend to be close to the middle of the agreement scale. The findings indicate that there is more concern about bST supplements than there is about antibiotic use. The differences between responses for bST and antibiotics, for all but one statement, are statistically significant ($p < .001$).

It appears that consumers do not have enough knowledge about bST and antibiotic use to form definite conclusions about their safety. For instance, the average response to the statement that "milk will be safe to drink if the FDA approves bST" was 3.05 (3 = do not know). Most people simply do not know enough about bST to make a judgment about its safety. In fact, only 3.1% strongly agreed and 7.2% strongly disagreed with this statement, while 40.6% did not know enough about bST to make a judgment concerning its safety. Consumers tended to agree slightly more to the parallel statement about the use of antibiotics in cows. The average response to the statement that "milk is safe to drink even though farmers use antibiotics" was 2.92. More people strongly agreed (4.2%) and fewer people strongly disagreed (4.6%) with this statement compared to the bST response. While the average of 2.92 is significantly different from the average response about bST (3.05), an average near 3 for both indicates that consumers have little information about antibiotics and bST.

In terms of animal-welfare perceptions, survey respondents were more inclined to agree that giving antibiotics to cows was more acceptable than giving cows supplemental bST. The average response to the statement "giving antibiotics to cows is OK" was 2.63. This is significantly different from the average response of 3.26 for the parallel bST statement that "giving bST to cows is OK." With respect to bST, this statement drew the largest strongly disagree response (11.3% of the sample) of all statements in the questionnaire. Con-



* The * indicates that the mean response for bST is statistically different from the mean response for antibiotics at the .001 significance level. The source for this is a mail survey of New York State households conducted in May-June 1990. Results are weighted to correct for sample gender and education biases.

Figure 1. Average Consumer Responses to Attitudinal Statements About bST and Antibiotics^a

sumers may view antibiotics as being more beneficial for cows relative to bST since they cure illness. On the other hand, bST might not be viewed this way by consumers because, unlike antibiotics, bST is not a product perceived to be beneficial to cows.

The major benefit to consumers of new technology is its restraining influence on price increases. Interestingly, consumers disagreed the most with the statements that the use of bST and antibiotics was beneficial "if it keeps down the price of milk." The average responses to this statement were 3.26 for bST and 3.20 for antibiotics, which are not significantly different from one another. The average response to this statement may suggest that the negative effect of the uncertainty consumers feel about the safety of bST and antibiotics outweighs the positive effect of a lower milk price. This result may also be due to the relative price inelasticity of demand for fluid milk. A somewhat similar result was obtained by Preston, McGuirk, and Jones in a consumer study in Virginia. Their study found that a milk price decrease of \$0.40 per gallon due to bST was not enough to offset reductions in milk consumption due to the introduction of bST.

In terms of approved use, respondents were more inclined to agree that antibiotic use should be allowed than to agree that bST should be approved. The average response to the statement that "antibiotic use on dairy cows should be allowed" was

2.57. This is significantly different from the average response of 3.11 to the statement that "bST use on dairy cows should be approved." However, as was true for other responses, an average of 3.11 indicates there was no strong reaction for or against bST. For instance, only 11.2% strongly disagreed and 7% strongly agreed that bST should be allowed, while 37.4% were simply uncertain. There was more certainty and agreement over the view that antibiotic use should continue to be allowed compared to the opinion that bST should be approved. That is, only 5.2% of the sample strongly disagreed and 7.9% strongly agreed that antibiotics should be allowed, while 29.2% did not know. Again it appears that consumers need more information about bST and antibiotic use in cows before more definite conclusions can be made.

In the absence of strongly negative or positive responses to questions about the safety and the approval of bST use, the major implication of these results is that education will likely play a major role in determining consumers' attitudes and perceptions about both bST and antibiotics. The typical consumer needs to better understand what bST is, as well as be apprised of the scientific community's findings about the safety of milk and meat from cows given bST. This suggests that a proactive educational strategy should be pursued by the dairy industry to deliver explanations and facts about these technologies to consumers. If such a strategy is not followed by the industry,

then a backlash against bST in terms of reduced milk consumption may occur.

Factors Associated with Milk-Consumption Response Due to bST

The results indicate a potential reduction in milk consumption if bST is approved, assuming similar consumer perceptions at the time of approval as those at the time this survey was conducted (i.e., May and June 1990). In order to better understand the reasons for the potential negative impacts of bST on milk consumption, it may be helpful to know if consumers have any characteristics that are significantly related to their proclaimed consumption response. Various socioeconomic, demographic, and attitudinal factors may be correlated with how consumers respond to the introduction of bST in terms of decreasing their milk consumption. Consumers' milk-consumption response to bST, in this context, was measured by their declared intended decrease in milk consumption following the introduction of bST (see Table 2).

Hypotheses

It was hypothesized that households with children would decrease their milk purchases by more than households without children if the FDA approved bST. The rationale is that families with children are more concerned about the safety of bST in milk than households without children (Scherer). This factor was measured by a binary variable, *CHILD1*, which was equal to 1 if the household had any children who were 12 years old or younger, and zero otherwise.

The educational level of consumers may also influence expected consumption response to bST. It was hypothesized that as the level of formal education increases, the reduction in milk consumption would increase. The rationale for this hypothesis is that more highly educated individuals tend to be most aware of safety concerns and most likely to act on those concerns. This hypothesis is consistent with previous empirical results (e.g., McGuirk, Preston, and McCormick). Information from the survey on the highest level of education completed by the consumer (*EDUCAT*) was used to measure this factor. This variable is a categorical variable where the categories are: 1 = elementary school, 2 = some high school, 3 = high school graduate, 4 = some college or technical/vocational school, 5 = college graduate, and 6 = graduate or professional studies.

Another factor that might be related to change in milk consumption is the amount of effort that con-

sumers exert in obtaining information on current issues. Consumers who spend more time obtaining information on events may be better informed than consumers who spend little or no time gathering information. Consequently, the more informed consumer is more likely to be aware of the scientific community's opinions that bST is safe. To measure this factor, the variable *EFFORT* was constructed, which is based on information from a question about how respondents prefer to receive information. This categorical variable has the following values: 1 = television, 2 = face-to-face, 3 = print, and 4 = multiple ways. It is assumed that the least amount of effort exerted in obtaining information is related to television and the most is related to multiple sources.

The gender and age of consumers may influence bST milk-consumption response. It was hypothesized that females would have a larger negative milk-consumption response to bST than would males. This hypothesis is based on the empirical results of others (e.g., McGuirk, Preston, and Jones; Smith). The binary variable *GENDER* (1 = male, 2 = female) is used to test this hypothesis. The age of consumers was hypothesized to be negatively related to bST consumption response. That is, the older the consumer the less severe the consumption reduction to bST. The rationale is that older people are less likely to change their consumption patterns than younger people. The variable *AGE* was used to measure this effect, which gives the age of the consumer on her/his last birthday.

It was hypothesized that previous knowledge about bST would be related to consumption response. However, no a priori direction was assigned to this hypothesis. If previous information received by consumers about bST was negative, then one should expect a direct relationship between awareness and milk-consumption declines. This factor was measured as a binary variable, *HEARD*, which equals 1 if consumers were previously not aware of bST and 2 if consumers were previously aware of bST.

The level of household consumption of milk was hypothesized to be positively related to milk-consumption response to bST. Specifically, it was hypothesized that households that consume more milk would have larger reductions in milk consumption in response to bST than households consuming less milk. The rationale for this hypothesis is that households consuming high levels of milk are more sensitive to issues affecting milk than households consuming lower levels. This factor was measured by the variable *CONSUME*, which is constructed from information on respondents'

weekly milk purchases. This variable was measured in pints of milk purchased per week.

In addition to these socioeconomic and demographic variables, five attitudinal factors were hypothesized to be correlated with consumers' milk-consumption response to bST. Consumer belief about the safety of bST was hypothesized to be positively related to consumption response. The more unsafe one feels bST is, the more severe the milk-consumption response will be. This factor was measured by a categorical variable, *SAFE*, which is based on consumers' response to the statement "milk will be safe to drink if FDA approves bST" (1 = strongly agree, . . . , 5 = strongly disagree). Consumers' attitudes regarding the potential benefits of bST in keeping the price of milk down were hypothesized to be positively related to consumption response. The rationale is that if consumers feel that keeping the price of milk down is not a benefit of bST, then they will be more likely to decrease milk purchases due to bST than consumers who do believe this is a benefit. This factor was measured by a categorical variable, *PRICE*, which is based on consumers' response to the statement "approving bST will be beneficial if it keeps down the price of milk" (1 = strongly agree, . . . , 5 = strongly disagree). Consumers' perceptions about animal welfare and bST were hypothesized to be positively correlated with consumption response. For example, animal-rights groups might boycott milk if bST is approved because they believe it is cruel to cows. This factor was measured by the categorical variable *HUMANE*, which is based on consumers' response to the statement "giving bST to cows is OK" (1 = strongly agree, . . . , 5 = strongly disagree). Consumer attitudes towards labeling milk from cows given bST were hypothesized to be negatively related to consumption response. That is, the stronger one feels that milk from cows given bST should be labeled, the greater one's consumption response will be. This factor was measured by the categorical variable *LABEL*, which is based on consumers' response to the statement "milk from bST-treated cows should be labeled" (1 = strongly agree, . . . , 5 = strongly disagree). Finally, consumers' beliefs about whether bST should be approved was hypothesized to be positively related to consumption response. All things equal, the stronger one feels that bST should not be approved, the greater the consumption response. This factor was measured by a categorical variable, *ALLOW*, which is based on consumers' response to the statement "bST use on dairy cows should be approved" (1 = strongly agree, . . . , 5 = strongly disagree).

Empirical Results

To test the above hypotheses, milk-consumption response due to bST (*RESPONSE*) was regressed on the set of socioeconomic, demographic, and attitudinal independent variables described above. Because the dependent variable *RESPONSE* is measured as a percentage, it is restricted to the [0, 100] interval. Since there are many observations at both endpoints of this interval, a censored regression technique is more appropriate than ordinary least squares for estimating the consumption-response equation. In this application, a two-limit tobit censored regression model is used (Maddala, p. 161) that has the following form:

$$RESPONSE_i = \begin{cases} L_i, & \text{if } X_i\beta + \epsilon_i \leq L_i \\ X_i\beta + \epsilon_i, & \text{if } L_i \leq X_i\beta + \epsilon_i \leq U_i \\ U_i, & \text{if } X_i\beta + \epsilon_i \geq U_i, \end{cases}$$

where L_i and U_i represent lower and upper limits of the dependent variable for observation i respectively, X_i is a matrix of independent variables, β is a vector of coefficients for the independent variables, and ϵ_i is a vector of error terms. The software package LIMDEP was used to estimate the two-limit tobit milk-consumption-response equation. This package uses the Newton maximum-likelihood estimation method.

The results of the two-limit tobit regression model of milk-consumption response to bST are presented in Table 4. Since this is a nonlinear model, the interpretation of the coefficients for testing the hypotheses is given in terms of directional relationships (i.e., signs of the coefficients) rather than magnitudes. The overall model was significant at the .005 level, which implies that the model does a reasonable job of explaining much of the milk-consumption response to bST. The coefficient of variation cannot be computed with this type of model. However, the coefficient of variation for the equivalent model estimated using ordinary least squares is 0.28. Some of the results support the hypotheses above, while others do not.

Interestingly, the first two hypotheses were not supported by the empirical results. The coefficient for the number of children in the household 12 years old and under (*CHILD1*) had the expected positive sign but was not statistically significant. The coefficient on the level of education of consumers (*EDUCAT*) had the expected positive sign but was not statistically significant. These results suggest that targeting families with children and higher levels of formal education to mitigate consumption response to bST may not be an effective strategy.

Table 4. Two-Limit Tobit Regression Results for the Milk-Consumption-Response Equation

Variable	Tobit Coefficient	Asymptotic T-Value
CONSTANT	-3.05	-0.66
CHILD1	0.48	0.18
EDUCAT	1.74	0.96
EFFORT	-3.99*	-5.25
GENDER	-0.95	-0.40
AGE	-0.21*	-4.14
HEARD	3.44*	2.81
CONSUME	0.21*	2.13
SAFE	5.22*	3.06
PRICE	3.39*	2.94
HUMANE	-2.14	-1.15
LABEL	-2.58*	-2.02
ALLOW	2.67*	2.12
Sigma	21.51*	31.40
Log likelihood	-2,212.3	
Observations	493	
Regression chi-square	159.2	

Source: Mail survey of New York State households. Results are weighted to correct for sample gender and education biases.

*Statistically significant at the .05 level.

One of the next two hypotheses was supported by the results while the other was not. The level of effort exerted by consumers in obtaining information (*EFFORT*) was negatively related to consumption response, as expected. The estimated coefficient for this variable was statistically significant at the .0001 level. Consequently, individuals who obtain their information primarily from television should be a target for strategies designed to mitigate negative milk-consumption responses to bST. While the gender (*GENDER*) of consumers had the hypothesized negative relationship with consumption response, its coefficient was not statistically significant. This result differs from findings of McGuirk, Preston, and Jones, as well as Smith, who found that females had a significantly larger milk-consumption response than males to bST.

The next three hypotheses were confirmed by the findings. The estimated coefficient of the age of the consumer (*AGE*) was negatively related to consumption response, as was hypothesized. This supports the notion that older consumers are less likely to change their consumption patterns than younger consumers. Previous information about bST (*HEARD*), as measured by whether or not the respondent had previously read or heard of bST, was positively related to consumption response and statistically significant. It appears that much of the media information about bST has provided consumers with an overall negative message. It was also found that households that consume more

milk had a significantly larger consumption response to bST than families that did not drink as much milk. These households appear to be more sensitive to safety issues regarding milk than families that have lower milk-consumption levels.

Four of the five hypotheses relating to attitudinal factors and milk consumption response to bST were not rejected by the results. Not surprisingly, consumers' perceptions of the safety of bST (*SAFE*) was an important explanatory variable of consumption response. The estimated coefficient for the variable *SAFE* was the largest of all variables in the model and was statistically significant at the .001 level. If many consumers question the safety of bST, there could be a tremendous decrease in milk consumption if it is approved for widespread use. This suggests that a main theme of educational strategies designed to lessen consumption response should emphasize safety. The potential price benefit of bST (*PRICE*) was also positively related to consumption response and statistically significant at the .0016 level.

On the other hand, consumers' attitudes of how humane bST is for cows (*HUMANE*) was not found to be significantly related to consumption response. In fact, the coefficient for this variable had the opposite sign (albeit not significant) than what was hypothesized. Consumers may in fact consider giving bST to cows cruel, but the results imply that consumers are not concerned enough to reduce milk consumption. There was a relationship between respondents' attitudes towards labeling milk from cows given bST (*LABEL*) and their potential consumption response to bST. Respondents who strongly believed in bST labeling reported a larger potential milk-consumption response to bST than consumers who disagreed that bST should be labeled. The coefficient on the labeling variable was statistically significant at the .02 level. Respondents' feelings about whether or not bST should be approved were also significantly related to potential consumption response. Consumers who held strong beliefs that bST should not be approved reported a larger potential milk-consumption response than those who did not hold such beliefs.

Summary

This paper examined the potential impact of bovine somatotropin on milk consumption. Significant socioeconomic, demographic, and attitudinal characteristics of consumers related to potential milk-consumption response to bST were also identified. Data were obtained from a systematic, strat-

ified random sample of 2,000 New York State households. The questionnaire presented respondents with descriptions of bST and the use of antibiotics in cows. These were followed by a set of questions on bST and antibiotics, other food-safety issues, and socioeconomic and demographic characteristics. The analysis reported here was based on an overall response rate of 40.4%.

The results show that there is likely to be a decrease in milk consumption if bST is approved, based on current media coverage and consumer perceptions. The unadjusted estimate of decreased milk purchases due to bST was 15.6% while the adjusted estimate, based on a current 26.7% consumer awareness of bST, was 5.5%. The results also suggest a negative impact on milk consumption due to antibiotic use in cows. The unadjusted and adjusted estimates for decreased milk purchases due to antibiotics were 7% and 1.6%, respectively. It appears a large proportion of consumers do not have sufficient information about either bST or antibiotics to form strong judgments about their safety. In the absence of a strongly negative response to questions about the safety and to the possible approval of bST use, a major implication of this study is that education will likely play an important role in influencing consumers' attitudes and perceptions about both bST and antibiotics. The typical consumer needs to know a lot more about what bST is and what the facts are about milk safety. This suggests that a proactive educational strategy should be pursued by the dairy industry to deliver explanations and facts about these technologies to consumers. If such a strategy is not followed by the industry, and if bST opponents launch a strong campaign against bST, then a backlash against bST in terms of milk consumption will likely occur.

If bST is approved, the consumption of milk is expected to decrease the most among those people who (1) exert the least effort in obtaining information, (2) are younger, (3) have previously read or heard something about bST, (4) consume larger quantities of milk, (5) question the safety of bST, (6) do not care about the potential milk price decreases due to bST, (7) feel that milk from cows given bST should be labeled, and (8) believe bST should not be allowed. This information should be useful to dairy-industry-supported educational campaigns regarding bST.

References

- Animal Health Institute. *Bovine Somatotropin (BST)*. Alexandria, VA, 1988.
- Baer, R.J., K.M. Tieszen, D.J. Schingoethe, D.P. Casper, W.A. Eisenbeisz, R.D. Shaver, and R.M. Cleale. "Composition and Flavor of Milk Produced by Cows Injected with Recombinant Bovine Somatotropin." *Journal of Dairy Science* 72(1989):1424-34.
- Barbano, D.M., and J.M. Lynch. "Milk from bST-Treated Cows: Composition and Manufacturing Properties." In *Proceedings of Conference on Advanced Technologies Facing the Dairy Industry: bST*, 9-19. Cornell University, Animal Science Mimeograph Series no. 133. Ithaca, NY, November 1989.
- Bauman, D.E., D.L. Hard, B.A. Crooker, M.S. Partridge, K. Garrick, L.D. Sandles, H.N. Erb, S.E. Franson, G.F. Hartnell, and R.L. Hintz. "Long-Term Evaluation of a Prolonged-Release Formulation of n-Methionyl Bovine Somatotropin in Lactating Dairy Cows." *Journal of Dairy Science* 72(1989):642-51.
- Bauman, D.E., P.J. Eppard, M.J. DeGeeter, and G.M. Lanza. "Responses of High Producing Dairy Cows to Long-Term Treatment with Pituitary Somatotropin and Recombinant Somatotropin." *Journal of Dairy Science* 68(1985):1352-62.
- Becker, G.S., and S. Taylor. "Bovine Growth Hormone (Somatotropin): Agricultural and Regulatory Issues." Washington, DC: Congressional Research Service, 20 November 1986.
- Brown, W. "1990 Census Preliminary Counts." Paper presented at the New York State Data Center Meeting, Troy, NY, 1 November 1990.
- Council on Scientific Affairs of the American Medical Association. "Biotechnology and the American Agricultural Industry." *Journal of the American Medical Association* 265(1991):1429-36.
- Daughaday, W.H., and D.M. Barbano. "Bovine Somatotropin Supplementation of Dairy Cows: Is the Milk Safe?" *Journal of the American Medical Association* 264(1990):1003-5.
- Fallert, R.T., T. McGuckin, C. Betts, and G. Bruner. "bST and the Dairy Industry: A National, Regional, and Farm Level Analysis." U.S. Department of Agriculture, October 1987.
- Gaines, L.M. "Tabulations from the Current Population Survey for New York State." New York State Department of Economic Development, 1990.
- Hutton, J.B. "The Effect of Growth Hormone on the Yield and Composition of Cows' Milk." *Journal of Endocrinology* 16(1957):115-25.
- Juskevich, J.C., and C.G. Guyer. "Bovine Growth Hormone: Human Food Safety Evaluation." *Science* 249(1990):875-84.
- Kaiser, H.M., and L.W. Tauer. "Potential Impacts of Bovine Somatotropin on the U.S. Dairy Sector." *North Central Journal of Agricultural Economics* 11(1989):59-73.
- Kalter, R.J., R. Milligan, W. Lesser, W. Magrath, L. Tauer, D. Bauman, A. McGuiirk, E. Andrysick, and M. Grosh. "Biotechnology and the Dairy Industry: Production Costs, Commercial Potential, and the Economic Impact of Bovine Growth Hormone." A.E. Research 85-20. Department of Agricultural Economics, Cornell University, December 1985.

- Maddala, G.S. *Limited-Dependent and Qualitative Variables in Econometrics*. Cambridge University Press, 1983.
- Marion, B.W., and R.L. Wills. "A Prospective Assessment of the Impacts of Bovine Somatotropin: A Case Study of Wisconsin." *American Journal of Agricultural Economics* 72(1990):326-36.
- McGuirk, A.M., W.P. Preston, and A. McCormick. "Toward the Development of Marketing Strategies for Food Safety Attributes." *Agribusiness: An International Journal* 6(1990):297-308.
- McGuirk, A.M., W.P. Preston, and G.M. Jones. "Biotechnology and the Consumer: The Case of Bovine Somatotropin." Staff Paper 90-60. Department of Agricultural Economics, Virginia Polytechnic Institute and State University, 1991.
- Milk Industry Foundation. *1990 Milk Facts*. Washington, DC, 1990.
- National Institute of Health. "NIH Technology Assessment Conference Statement on Bovine Somatotropin." *Journal of the American Medical Association* 265(1991):1423-25.
- Peel, C.J., D.E. Bauman, R.C. Gorswit, and C.J. Sniffen. "Effect of Exogenous Growth Hormone on Lactational Performance in High Yielding Dairy Cows." *Journal of Nutrition* 111(1981):1662-71.
- Preston, W.P., A.M. McGuirk, and G.M. Jones. "Consumer Response to the Introduction of Bovine Somatotropin." In *Economics of Food Safety*, edited by J.A. Caswell. New York: Elsevier Science Publishing Co., Inc., 1991.
- Scherer, C.W. "Adoption of Health Risk Reduction Behaviors: The Case of Geologic Radon." Department of Communication, Cornell University, 1989.
- Sechen, S.J., D.E. Bauman, H.F. Tyrell, and P.J. Reynolds. "Effect of Somatotropin on Kinetics of Nonesterified Fatty Acids and Partition of Energy, Carbon and Nitrogen in Lactating Dairy Cows." *Journal of Dairy Science* 72(1989):59-67.
- Smith, Blair. "Consumer and Public School Perceptions on the bST Issue in Pennsylvania." In *Farm Economics*. Cooperative Extension Service, U.S. Department of Agriculture, The Pennsylvania State University, March/April 1991.