ECONOMIC IMPACTS ASSOCIATED WITH BOVINE SOMATOTROPIN (BST) USE BASED ON SURVEY OF US DAIRY HERDS

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Based on a 1996 United States Department of Agriculture (USDA) survey of 1,178 dairy producers and a milk price of $13 per hundredweight (cwt), optimal recombinant bovine somatotropin (rBST) use would be 73 percent of cows. Such a rate would increase herd-level milk production by 2,983 pounds per cow and herd-level net returns by $126 per cow.

Key words: milk production; profitability; recombinant bovine somatotropin; rBST.

Recombinant bovine somatotropin, a growth hormone that stimulates milk production has been approved for use in dairy cows since 1994. To date measurement of the impact of rBST use on milk production and herd profitability has been limited to regional studies and herds belonging to some type of farm record keeping service. A source of national rBST use is USDA National Animal Health Monitoring System's (NAHMS) 1996 dairy study (USDA/APHIS, 1996). Among the many questions asked of dairy producers was their use of rBST.

The objectives of this paper as follows,

- To estimate a national milk production response to rbST use, based on a random sample of dairy herds.
- For various combinations of rBST product cost and milk price, determine optimal rBST use and profitability at the national level (that is, assume all cows are aggregated into a single national herd).
- Compare optimal use of rBST with current use and project future impact on cow and herd numbers of continued acceptance of rBST.

Methodology

In January 1996, the first phase of the NAHMS study began with an interview of a stratified random sample of 2,542 dairy producers in the 20 top dairy states (USDA/APHIS, 1996). This survey represented producers who manage 83% of US dairy cows.

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Of these initial producers, 1,219 agreed to participate in phase two of the study. Although the 1996 Dairy '96 study was not designed to evaluate the effectiveness of recombinant bovine somatotropin (rBST), data were collected on percent rBST use, herd average milk production per cow, culling, calves born, and death loss. Such information made it possible to assess the productivity impact of rBST. Unfortunately, input costs such as feed, labor, or veterinary expenses were not collected. In order to estimate the economic impact of rBST we used published information for these input costs. A total of 1,178 producers provided usable information for economic analysis.

Milk production and non-milk productivity were estimated separately and are measured on a per cow basis. Estimating milk production separately allows us to determine optimal rBST use over a range of milk prices. Non-Milk Productivity (NMP) is as follows:

(1) = AVCB – ANRC
= AVCB + AVMCS + AVCC – AVRH.

where AVCB = Annual Value of Calves at Birth ($50/calf)
ANRC = Annual Net Replacement Cost
AVMCS = Annual Value of Milking Cows Sold (cows sold to other producers for $1,120/cow)
AVCC = Annual Value of Cull Cows (cows sold for slaughter at $383/cull average for culls in normal body condition and $234/cull average for culls in poor body condition)
AVRH = Annual Value of Replacement Heifer/Cows ($1,344/cow = $1,120 + 20%)

Values were based on 1996 prices received by producers (USDA/NASS, 1999a) except for cull cow values that were actual prices reported by producers. For cost of replacements, 20% was added to the price producers received for replacement cows in order to reflect transaction costs and that most replacements are heifers which generally have a higher value than cows.

To estimate the impact of rBST on milk production and non-milk productivity we used a multivariable regression model. The rBST explanatory variable was percent of cows in the herd receiving rBST and ranged in value from 0 to 100 percent. To measure a potential declining marginal physical product of milk production as rBST use increases, a quadratic term (squared percent rBST use) was also included. Other explanatory variables are as follows,

- Herd size and location.
- Percent Holsteins in the herd (as the Holstein breed usually produces more milk than other dairy breeds).
- Intensive grazing (as intensive grazers sometime sacrifice production for lower costs).
- Herd level bulk tank somatic cell counts (BTSCC) which is related to milk production (Hortet & Seegers, 1998).
- Number of days dry or not in milk (an increase in the number of days that a cow is dry lowers the proportion of cows in milk and, thus, lowers herd level production per cow inventory).
- Percent change in cow inventory (impacts cow replacements).
- Use of Dairy Herd Improvement Association (DHIA) records (as a proxy measure of management ability).

These variables were associated with either milk production or non-milk productivity at the $p < 0.01$ level. In addition, the model was tested for multicollinearity by measuring the variance inflation factor for each explanatory variable (Pedhazur, 1997). Maximum associated for any variable was less than 50 percent, thus, multicollinearity was assumed not to be a problem.

Recombinant BST is administered every 14 days starting in mid-lactation. We assumed 16 treatments (224 days) at a cost of $5.50 per dose (Bulter, 1999) or $88 per lactation. For feed, labor, veterinary, and medical costs we used estimates provided by others that were measured as cost per hundredweight of additional milk produced. Estimates by Marion and Wills (1990) include feed, $2.89 per cwt; milk hauling charges, $0.20 per cwt; and a return to management of $0.30 per cwt. Using published feed requirements and feeding values ("Feedstuff Reference Issue," 1997), a ration of 45% corn grain, 25% soybean meal, and 30% alfalfa hay would require 42.5 pounds of feed to produce an additional cwt of milk. At 1996 prices, this ration would cost $3.20 per cwt of additional milk. An analysis by Tauer and Knoblaugh (1997) found that labor costs and veterinary and medical expenses increased $14 per cow ($1.25 per cwt) for herds using rBST. Together these input costs sum to $4.95 per cwt. For analysis purposes we used $5 per cwt.

Results

In this analysis, 12.6 percent of the producers used rBST in their herds. Among producers using rBST, use ranged from less than one percent to 100 percent of the milk cows with a weighted average of 49 percent.

The linear coefficient per percentage point increase in rBST use was 70.6 pounds per cow while the quadratic coefficient was -0.407 pounds per cow (table 1). The marginal physical product of milk production with respect to rBST use is as follows,

(2) 70.6 pounds - 0.814 pounds * rBST percent use.

Maximum milk response would occur at an rBST application rate of 87 percent.

The impact in non-milk productivity was modeled by comparing any rBST use to non-use of rBST and that of linear and squared rBST percent use. The model based on any rBST use had a greater R^2 than the model based on percent use. Herds that administered any rBST to their cows experienced a reduction in non-milk productivity of $47.38 per cow (*SE*, 11.16). Four-fifths of this decline in non-milk productivity was attributed to an increase in culling rate of an additional 4.14 cows per 1000 cows (*SE*, 1.04).

Subtracting the $5 per cwt for other costs associated with rBST use has the effect of lowering the milk price by $5 per cwt. The median milk price during the Diary '96 study period was $13 per cwt. At the net milk price of $8 per cwt, optimal rBST use is to apply it to 73 percent of the cows. The resulting increase in herd milk production would be 2,983 pounds per cow and an increase in net returns of $126 per cow.

Varying rBST product costs from $0 to $10 per dose and milk prices from $10 per cwt to $18 per cwt results in optimal use ranging from a low of 47 percent to a high of 87 percent (figure 1, left-hand side). Associated increases in milk production then ranges from 2,429 to 3,058 pounds per cow, while net return ranges from -$2 to $350 per cow (figure 1, right-hand side). The negative returns were due to the $47.38 per cow cost caused by decreased non-milk productivity associated with rBST use.

Table 1: Model Regression and Standard Error (*SE*) Coefficients from Herd Milk Production and Herd Non-Milk Productivity.

	Herd Milk Production (Pounds/Cow)	Herd Non-Milk Productivity ($/Cow)
Percent rBST Use	70.56 (13.86)	n.a.
Percent rBST Use - Squared	-0.407 (0.160)	n.a.
Any rBST Use	n.a.	-47.38 (11.16)
Herd Size (log cow no.)	846.6 (151.5)	-5.05 (5.88)
Region		
Midwest	----	----
West	-440.7 (293.4)	12.38 (10.31)
Southeast	-2497.8 (429.2)	-3.65 (20.61)
Northeast	-520.5 (240.5)	18.00 (8.80)
DHIA Use (yes/no)	1839.1 (198.4)	-35.35 (7.54)

Note. n.a. denotes not applicable.

Discussion

The optimal rBST use of 73 percent is at the national level, that is, if all of the nations' cows were combined into a single herd. Optimal use for individual herds would vary depending on the individual productivity of the herds, but on average would be 73 percent.

Ex post economic analysis of rBST based on actual farm use began with two studies of New York dairy farms. Both studies were based on herds in the New York Dairy Farm Business Summary. Tauer and Knoblaugh (1997) estimated the financial impact of rBST for herds by comparing 1993 records with those from 1994. Stefanides and Tauer (1999) compared 1994 and 1995 users and non-users of rBST. Tauer and Knoblaugh found that herds using rBST produced 1,124 pounds more milk per cow and generated $120 per cow more income above operating expenses and $27 per cow more net farm income. Stefanides and Tauer (1999), however, found that herds using rBST experienced a reduction in net farm income of $39 per cow, though milk production increased by 1,130 pounds per cow. However, neither estimate of change in net farm income was statistically significant, though increases in milk production were statistically significant.

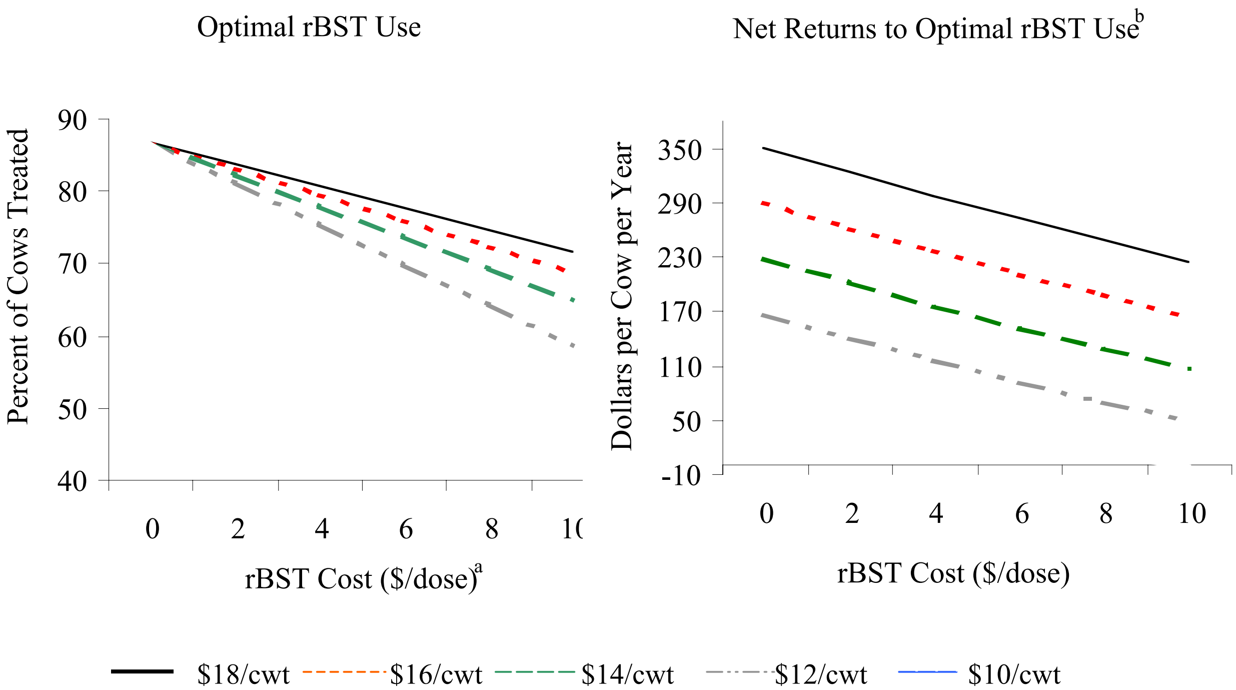
Table 1 cont'd: Model Regression and Standard Error (*SE*) Coefficients from Herd Milk Production and Herd Non-Milk Productivity.

	Herd Milk Production (Pounds/Cow)	Herd Non-Milk Productivity ($/Cow)
Intensive Pasture Grazing (yes/no)	-999.5 (272.8)	12.90 (10.66)
Bulk Tank Somatic Cell Count		
Low (< 200k cells/ml)	-----	----
Medium (200k-399k cells/ml)	-825.6 (212.9)	2.27 (7.68)
High (400k+ cells/ml)	-2127.7 (312.9)	-17.93 (13.74)
Holstein Breed (% cows that are Holstein)	54.2 (4.3)	-0.18 (0.18)
Registered Herd (≥ 90% cows registered, yes/no)	497.3 (335.5)	23.59 (11.93)
Days Dry - Not in Milk (70 days or greater, yes/no)	-719.4 (275.4)	7.79 (9.32)
Percent Change in Cow Inventory	-3.6 (4.7)	-10.16 (0.31)
Intercept	8909.6 (743.8)	-184.62 (33.07)
R-square	47.5%	78.1%

Note. n.a. denotes not applicable.

Lack of clear profitability in rBST use for these two New York studies could be related to the quantities of additional milk produced. The average increase in milk production for rBST in the two studies was 1,127 pounds per cow. Any use of rBST vs. non-use in our study increased milk production by 1,913 pounds per cow, and among herds in the northeast the milk production increase associated with rBST use was 2,601 pounds. Based on a milk price of $13.15/cwt, New York's average for 1994-95, an additional 1,474 (2,601-1,127) pounds of milk would have improved milk receipts associated with rBST use by an additional $194 per cow. Such an increase in milk receipts most likely would have greatly improved the profitability of rBST use in these New York dairy herds. Thus, a key to rBST profitability is to have a large enough increase in milk production.

Figure 1: Optimal rBST Use and Net Returns to Optimal rBST Use.



[a] 16 doses per lactation. [b] Includes $5/cwt other input costs $49/cow non-milk productivity impact.

We can use the study by Tauer and Knoblaugh (1997) to assess the reasonableness of our costs. They reported a $126/cow differential between milk receipts minus purchased feed and net farm income for rBST herds. They also reported $10 per cow increase in purchased feed costs that would result in an increase of total costs associated with rBST use of $136 per cow. Minimum rBST administration rate in the Tauer-Knoblaugh study was 25 percent. At a 25 percent administration rate and with 1,124 pound increase in milk production our costs would have increased $126 per cow and $148 per cow if one assumed a 50 percent rBST administration rate.

Another cost comparison is with a recent pro forma study by Fetrow (1999). Based on optimal use at 73 percent, our estimated 2,984 pound per cow increase in herd average milk production is equivalent to a 13 pound per day increase in production for a 305 day lactation per rBST treated cow. For a 13 pound per day increase in milk production, Fetrow (1999) estimated costs would increase $209 per rBST treated cow. On a treated cow basis our costs would have been $292, 40% greater than Fetrow's estimate. Thus, our profitability calculations appear to be reasonable and may be somewhat conservative.

Having established that rBST is profitable, we now turn our focus to the potential impact of increased adoption of this relatively new technology. While ideally such analysis would incorporate an endogenous milk price, such level of analysis is beyond the scope of this paper. Since increased milk production can reduce the farm price for milk we will assume a conservative milk price of $10 per cwt. At $10 per cwt and $88 per lactation rBST product cost, optimal rBST use would be 65%, generating an increase in herd milk production of 2,868 pounds per cow. Increase in herd level net income would be $39 per cow. This increase of 2,868 pounds represents a 17% increase in the 1996 milk production per cow of 16,433 pounds(USDA/NASS, 1999b). Alternatively, the number of cows needed to maintain 1996 milk production would need to decline by 1.4 million head or 15%. This reduction in cow numbers almost equals the inventory of milk cows on herds with less than 50 cows (USDA/NASS, 1997). Consequently, widespread adoption of rBST has the potential to greatly increase the national average of milk production per cow, which will put pressure on milk prices and cow numbers and, hence, the number of herds.

Conclusions

Based on data collected from 1,178 US dairy producers we found the following,

- The use of recombinant bovine somatotropin (rBST) substantially increases milk production. Herd-level milk production increases of 3,000 or more pounds per cow are possible.
- The marginal physical product of rBST declines as rBST use increases. Thus, while rBST use may be profitable on some cows, it may not be profitable on all cows. Producers should evaluate each cow or production group of cows before committing to rBST.
- Based on 1996 prices, the optimal application rate of rBST is approximately three-quarters (73%) of the cows in the herd.
- Recombinant BST use can be profitable. With milk prices at $13 per cwt an increase in herd-level net return from the use of rBST of at least $100 per cow should be readily obtainable and net returns remain positive even if milk prices were to fall to $10 per cwt.
- Strong possible increases in net returns should stimulate increased adoption of rBST over time which, in turn, will put pressure on milk prices and the number cows and, thus, herds needed to produce the nation's milk supply.

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