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THE PROFITABILITY OF rBST ON U.S. DAIRY FARMS

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This brief paper addresses some of the issues that surround rBST use on United States (U.S.) dairy farms 5 years after its commercial availability. Specifically, the focus of our inquiry is on two fundamental issues. First, has this technology been profitable and productive at the farm level? And, second, has it changed the competitive position of adopters vis-à-vis non-adopters? While it would appear that rBST is an effective technology for increasing milk production and would also appear to be an economically feasible technology, the conclusions of the few ex post studies available seem to give mixed results. Is profitability truly lacking for this technology, and if so why? How do we reconcile this potentially lackluster performance at the farm level with all the accumulated experimental evidence and our economic models? Is Monsanto extracting all of the innovation rents and, if so, is this optimal (even for Monsanto)? These are some key questions that beg for further economic analysis.

Key words: recombinant bovine somatotropin, adoption, profitability, economic feasibility.

Bovine somatotropin is a naturally occurring (peptide) hormone produced in the pituitary gland of cows. It was discovered in the 1920s, and originally called "bovine growth hormone" or BGH. Experiments in the 1930s revealed that BGH, when extracted from the pituitary gland of a cow and injected into another cow, could increase milk production in the recipient cow. In the late 1970s, Dr. Dale Bauman, an animal scientist at Cornell University, successfully transferred the gene responsible for BGH production to a bacterium. The resulting product was called recombinant bovine growth hormone, or rBGH. Simple multiplication of the bacterium meant that rBGH could easily be produced in commercial quantities at reasonable cost. Several pharmaceutical and non-pharmaceutical companies became interested in the product in the early 1980s. Though rBGH is a peptide hormone and not a (much-maligned) steroidal hormone, to avoid the stigma associated with hormones, the industry agreed to change its name to bovine somatotropin. Thus, it's synthetic analog would be called recombinant bovine somatotropin, or rBST. Today, both names (rBGH and rBST) are still used.

Four companies involved in rBST research applied for patents for their particular brand of rBST in the early 1980s, which resulted in many misstatements, exaggerations, and misunderstandings. Congressional Hearings were held in June 1986. From these hearings emerged the alleged last word on rBST. The basic findings were as follows:

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- Recombinant bovine somatotropin, when injected into a cow, could cause a 10 to 25 percent increase in milk production.
- There was also a 10-15 percent increase in feed efficiency. This means that there is an effective decrease in feed costs per unit of milk produced, and therefore a lower average cost of production.
- Recombinant bovine somatotropin appeared to be safe for both human milk consumption and for cows.

It took until November of 1993 to gain Food and Drug Administration (FDA) approval, and it was not released commercially until February of 1994. However, the controversy surrounding rBST that has existed since 1983, continued. Specifically, questions were raised about adverse health effects on animals treated with rBST, the appropriateness of the technology for an industry plagued with surpluses, the effects of increased milk production on milk prices, and the plight of the family farm in the United States. Media hype about the impacts of rBST has been intermittent since 1983, but increased substantially from 1988 - 1993.

Recombinant bovine somatotropin has been commercially available now for 5 years. Amazingly, we still do not know a lot about its impact, profitability, or effect on the competitiveness of dairy producers. This brief paper addresses some of the reasons why we still do not know a lot about rBST, and what we do know about this new technology. Ultimately, our inquiry attempts to address two fundamental questions:

- Has this technology been profitable and productive at the farm level?
- Has it changed the competitive position of adopters vis-à-vis non-adopters?

Production Responses To rBST

In theory, as the famous saying goes, rBST should increase the profitability of dairying. Numerous papers in the animal science literature show that, with a few exceptions, use of rBST should increase milk production by 5 – 15 pounds per cow per day of usage. In a recent paper by Bauman *et al*. (1999), 340 Dairy Herd Improvement (DHI) herds were used to compare production responses to rBST. One hundred and seventy-six herds were control herds (non-rBST users), and 164 were rBST herds. After correcting for management improvements, feed supply, seasonal variation, and so on, in both control and rBST herds, the study concluded that milk, fat, and protein production increased significantly in response to rBST. Over the four years since commercial availability, these cows showed an average of 6-plus pounds of milk per cow per day for each cow milking on a test day. An average of 8-plus pounds of milk per cow per day was achieved for each cow milking on a test day over the last two-thirds of lactation (mid- and late-lactation). These represent at least 1,968 pounds of milk, 59 pounds of fat, and 62 pounds of protein per 305-day lactation. As Bauman *et.al*. (1999) point out, these are presumably minimum responses to rBST treatment, because it was assumed that 100 percent of the cows in each herd were treated with rBST. Since most producers do not treat 100 percent of cows, average response rates are much higher than these results indicate.

These results, along with several hundred other controlled experiments and studies, indicate that rBST does appear to significantly increase milk production in treated cows. To really appreciate the results of the Bauman *et. al*. (1999) paper, the reader should understand that this study was carried out on entire herds in the field – as opposed to controlled experimental results on individual cows which often exaggerate the response rate.

The Theoretical Economics Of rBST

The second step in assessing any technology is to examine the economic feasibility of adopting it. The logic is simple. A new technology may increase milk production, but its cost may outweigh its benefits or returns, thereby making it less attractive to dairy producers. There are a number of ways for increasing milk production efficiency and profitability. A new technology must not only be economically feasible, but it must also be shown to be at least as feasible as other methods of increasing efficiency and profitability.

The economics of rBST can be as simple or as complicated as you want to make it. To estimate the additional profit from using rBST, a dairy producer may simply estimate the additional revenues realized from rBST use, and subtract from that the additional costs associated with supplementing cows with rBST. Let us take a simple, but typical, example.

If a dairy producer expects 8 pounds of additional milk per cow per day, and the average mailbox price of milk is $12.00 per hundredweight (cwt.), then the additional revenues from using rBST are $0.96 per cow per day. If the producer expects to supplement the cow for the recommended 245 days (from 60 DIM to the end of the lactation), then total additional revenue from the extra milk generated by supplementing the cows with rBST would be $235.20 per cow per lactation.

Now, rBST costs $5.50 per 14-day treatment. That is about $0.42 per cow per day. In addition, there will be extra feed costs of about $0.05 per pound of extra milk. If we assume 8 pounds of extra milk per cow per day, then the total extra feed costs will be $0.40 per cow per day. Therefore, the producer will incur extra costs of $0.82 per cow per day ($0.42 for the rBST and $0.40 for the extra feed).

Subtracting costs from additional revenues, this dairy producer will increase profits by $0.14 per cow per day, or $34.30 per cow per lactation. Let us go one step further to put this in perspective. Let us assume that this producer is netting about $1.50 per cwt. on cows that are averaging 20,000 pounds of milk. Therefore, profit per cow per year, without rBST, is $300, from milk alone. Additional revenues from rBST then will increase profits from $300 to $334.30 – an 11.4 percent increase in profit. Obviously, it would be higher with a higher response rate.

While these are not stunning figures, they are probably sufficient to convince a dairy producer that rBST is quite a good investment. And, it must be remembered that our example is a very conservative one. No, we have not accounted for potentially extra costs associated with rBST use such as extra labor, administering and keeping records, increased days open, mastitis, lameness, and heat stress. These additional costs may, or may not be significant. Few studies have reported them as significant. In addition, we have not accounted for the increase in feeding efficiencies associated with rBST use that many studies have reported. And our assumptions about response rate and milk prices are very conservative. We might assume that these additional possible revenues offset the additional possible costs. Obviously, if mailbox prices are higher, and feed costs are lower, then returns to rBST would be higher. The opposite is also true. In fact, the prudent producer might adopt a simple rule of thumb that would indicate when rBST use was no longer feasible. The following would probably work in most situations:

$$NR = (MP * RR) – cBST – (FC * RR)$$

Where: NR = net revenues or profit from using rBST
MP = milk price or mailbox price in $/cwt.
RR = response rate in lbs/cow/day
cBST = cost of rBST = $0.42/cow/day.
FC = feed costs in $/cwt. of milk produced.

Collecting terms and rearranging, we get:

$$NR = RR [(MP – FC)/100] – 0.42$$

Let MP – FC (the difference between current milk price and current feed costs per cwt. of milk produced) = D, then, when NR = 0 (the break-even point):

$$D = 42/RR$$

Thus, for example, if you are expecting a response rate (RR) of 10 pounds per cow per day, then the difference between current milk price and current feed costs needs to be more than 42/10 = $4.20 for rBST to remain economically feasible. If current milk prices are, say, $13.50 per cwt., then feed costs need to be less than $13.50 - $4.20 = $9.30 per cwt. for rBST to be economically feasible. Monsanto offers a discount of $5.25 per 14-day treatment to purchasers of rBST if they agree to treat more than 50 percent of their herds. In this case, the daily cost of rBST would decrease to $0.375, and our rule of thumb would then become:

$$D = 37.5/RR$$

This would have the effect of lowering the breakeven point. The proposed rule of thumb can also be reversed. That is, it could be:

$$RR = 42/D$$

In this case, the producer would compute a minimum response rate (RR) given the difference (D) in current mailbox milk price and current average feed costs. If average milk price is $13.50 per cwt. and current average feed costs are $6.50 per cwt., then D would be 7 ($13.50 - $6.50). The minimum response rate (RR) for rBST to remain feasible would be 42/7 = 6 lbs of extra milk per day, or 5.35 lbs per day for discounted rBST.

Actual Adoption And Profitability Rates

So far, we have shown that rBST is an effective technology for increasing milk production, and that it would appear to be an economically feasible technology in the sense that most reasonable assumptions generate an increase in the profitability of milk production from rBST supplemented cows. The third, and final, step in our assessment of this new technology is to examine the rate of adoption and profitability of rBST on dairy farms. Again, the reasoning is simple. If rBST is efficacious and is economically feasible, then we would expect relatively widespread adoption. Moreover, it is only after relatively widespread adoption that we may observe the true profitability of rBST, and its impact on the competitive position of users versus non-users.

Ex Ante Adoption Studies

A number of studies have been carried out over the last 10 – 15 years (mostly before rBST was commercially available). Most studies involved asking dairy producers their opinions and attitudes toward rBST, and whether or not, and to what to extent, they plan to adopt rBST. The objectives of these studies were, among other things, to determine the socio-economic characteristics of producers, and relate theses to their intentions to adopt, The data were then used to predict aggregate adoption rates, which in turn could be used to asses the potential social and economic impacts of rBST.

It is impossible to neatly summarize, and do justice, to the many studies that have been done on rBST. Centner and Lathrop (1996) report that more than 1,500 articles have been written on rBST. Several articles have attempted to summarize the results of many of these studies (Caswell, Fuglie & Klotz, 1994; Raboy & Simpson, 1993; Lesser, Bernard & Billah, 1999)

Overall, the predicted aggregate adoption rates range from 8% to 41% for early adopters, and from 33% to 92% for eventual adopters. Factors associated with early adoption in most studies identified producers who were younger, better educated, with larger farms and a stronger than average asset base, who were skilled managers and managed herds with higher than average herd productivity. At the same time, most surveys also identified a significant proportion of dairy producers who were committed non-adopters because of the socio-economic issues surrounding rBST. Predicted rates of profitability from rBST use range from negative values on poorly managed dairy farms with low herd productivity, to $250 per cow on farms with higher production bases and elevated response rates (Fallert *et. al*., 1987; Schmidt, 1989; Butler, 1992; Marion & Wills, 1990; Jarvis, 1996).

Actual Adoption Rates And Ex Post Studies

Actual adoption of rBST is quite difficult to determine. As Lesser, Bernard, and Billah (1999) report, Monsanto, the only company that currently sells rBST (sold as Posilac) were reporting in August, 1998 that 30% of cows nationally were "in herds that are supplemented" with rBST, and that the average dairy producer treated at least 50% of the herd. Monsanto also reports that sales of rBST were up 45% for 1995, and an additional 30% in 1997 (presumably these figures refer to sales compared to year before sales). Monsanto also claims that "approximately 300 dairy producers per month have been joining the Posilac program". Lesser, Bernard, and Billah (1999) interpret these data to mean that approximately 24,000 dairy farms nationally (21%) used rBST on at least some cows. Other than this information, Monsanto have not been forthcoming in reporting adoption rates by state, or any other useful information that would be helpful in assessing the current adoption rate of rBST.

Very few ex post studies of rBST adoption have been carried out. Lesser, Bernard, and Billah (1999), Tauer and Knoblauch (1997), and Lyson, Tauer, and Welsh (1995) report on studies carried out on rBST use on New York dairies. Overall adoption rates in New York were 33% - 39% after one year, and 37% by the end of 1996. Barham (1996) and Barham *et al*. (1995) report on early adoption rates in Wisconsin. According to these studies, 6.6% of dairy producers had adopted rBST after one year of availability, while 50% of producers reported no planned use, and a further 36% were classified as unlikely users. Butler (1998a) reports on adoption rates in California. By the spring of 1995, one year after commercial availability, about 20% of California producers were using rBST on an average of 25% of their cows. Another 5 percent of producers reported having used it in the past on about 23% of their herd. Thus, about 10% of all cows in the sample were treated with rBST within a year of release. By 1996, the percentage of current users had not changed, but the number of past users had increased slightly, the number of prospective users had increased, and the number of committed non-users had dropped from 59% in 1994 to 44% in 1996. Preliminary data from a survey of California dairy producers in 1998 suggest that 25% are current users, and about 15% are past users. Average percentage of the herd treated increased slightly to 30%, suggesting that less than 10% of all cows in California are currently treated with rBST.

Profitability

To date, only two studies have been published on the profitability of rBST use on dairy farms. These studies, carried out by Tauer and Knoblauch (1997) and Stephanides and Tauer (1999) on New York dairy farms, found that the use of rBST significantly increased milk production per cow, but the impact on profits was not statistically different from zero. Stephanides and Tauer (1999) conclude

that the use of rBST was not profitable, on average, for these farms, and that two years may simply be too short a time period for a thorough understanding of the new technology. Alternatively, they suggest, "rBST use equilibrium may have been reached such that all adoption rent has been extracted" (Stephanides & Tauer, 1999). Lesser, Bernard, and Billah (1999) suggest much the same, and raise the possibility that Monsanto is "extracting much of the rent created by Posilac".

Similar results are suggested in analyzing the comments of producers participating in the California survey (Butler, 1998b). Many producers admit that while the response rate to rBST treatment produces significantly more milk, it is not clear that there is any significant increase in profits. One major problem is that most producers do not have the time, or the technologies, to monitor individual cow feed intake and, therefore, do not have any way of calculating profits from rBST use. For most producers, it is pure guesswork. One producer said, "It's difficult to determine the exact response on each cow without daily monitoring…so without computerized daily records, you guess at individual profitability on each cow…while costs continue to increase." One must naturally ask, however, if the results are general then why are farmers using rBST if it is not generating a profit for them? Maybe the fact that rBST increases milk production is sufficient for many producers to conclude that they are achieving what was intended. This is particularly true if there are no noticeable losses associated with rBST use. Maybe the margin is much smaller than our theoretical models would indicate. But since there are other ways of increasing profits, it is indeed puzzling why producers would continue to use rBST if it was not generating a significant profit.

Concluding Comments

This brief paper has addressed some of the issues that surround rBST use on U.S. dairy farms 5 years after its commercial availability. Specifically, we have tried to focus our inquiry on two fundamental issues:

- Has this technology been profitable and productive at the farm level?
- Has it changed the competitive position of adopters vis-à-vis non-adopters?

It would appear that rBST is certainly an effective technology for increasing milk production. It would also appear to be an economically feasible technology, since most reasonable assumptions generate an increase in profitability from rBST use. Yet the conclusions of the few ex post studies seem to give mixed results. Is profitability truly lacking for this technology, and if so why? How do we reconcile this potentially lackluster performance at the farm level with all the accumulated experimental evidence and our economic models? Is Monsanto extracting all of the innovation rents and, if so, is this optimal (even for Monsanto)? These are some key questions that beg for further economic analysis.

Dairy producers who are using rBST are a fairly stable minority, some of who are not at all sure whether they are making a profit on rBST. Since the profitability of rBST is still uncertain and, in any case, not startlingly spectacular, and since the adoption of this new technology has been slow to moderate, and appears to have reached a plateau for the time being, then we must conclude that it has probably had very little impact on the competitive position of adopters vis-à-vis non-adopters.

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