

# **Considerations for the use of rBST in Commercial Dairy Herds**

Jessica Worobey Arrigan

Advisor: Dr. Daryl Nycham  
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## **Introduction**

The use of recombinant bovine somatotropin In the United States has been a hot button topic since its market debut as Posilac<sup>®</sup> by the Monsanto Company in 1994. More research than any other veterinary related drug surrounds the Posilac<sup>®</sup> product assuring its safety and efficacy as a lactational enhancement tool. This paper will attempt to clearly demonstrate the role rBST plays on commercial dairies, and the considerations for incorporating this tool into a herd's management scheme. It is of monumental importance that all veterinarians understand the technology and its use in animal agriculture in order to act as an accurate source of information for the consumer and dairyman alike.

## **Mechanism of Action and General Indications for Use**

The effects that bovine somatotropin (also known as bovine growth hormone (BGH) have on a cow's milk production been known since the 1930's when Russian scientists experimented with milk production enhancement by injecting crude bovine pituitary extracts into lactating dairy cattle. Work out of Cornell University with the availability of a recombinant product in the 1980's provided published data behind the lactational effects of rBST supplementation.

(1) Studies evaluating Posilac's efficacy and safety have been numerous and ongoing since the product's release in 1994.

Bovine somatotropin is a peptide hormone that is manufactured in and secreted from the anterior pituitary gland and consists of 190 or 191 amino acids.

The recombinant form of the molecule is virtually identical to the leucine variant of naturally circulating bovine somatotropin but has an added methionine at the NH<sub>2</sub> terminus. This small difference does not inhibit the protein from interacting correctly with the somatotropin receptor since the active end of the protein remains unchanged. (2,3) Additionally, milk from supplemented cows is not compositionally different than milk from cows not receiving rBST. (14)

Bovine somatotropin has no biological effect in humans and cannot bind to human somatotropin receptors. Additionally, when taken in orally, it is broken down in the gut like any other ingested protein. (2,3) Injections of bovine somatotropin given to children in the US in the 1950's as an experimental treatment for hypopituitary dwarfism failed to have any effect, showing the inherent receptor differences between bovines and humans. (1)

Posilac<sup>®</sup> is marketed as a subcutaneous injection in health dairy cattle of 500mg extended release semetrebove zinc with a 14 day dosing interval. The initiation of supplementation is recommended at the peak of the lactation curve, which is usually between 57-70 days in milk continuing through the end of lactation. (4)

#### *Homeorhesis vs. Homeostasis*

It is important to understand the interaction between homoerhesis and homeostasis in the bovine, the interactions between the two regulatory systems, and the effect that BST has on these systems resulting in increased milk yield.

Homeostasis is defined as “the maintenance of relatively stable internal physiological conditions (as body temperature or the pH of blood) in higher animals under fluctuating environmental conditions.” (5) Homeostasis acts to control the animal’s internal environment on a minute to minute basis. Homeorhetic control involves the coordination of metabolism, resulting in the directed partitioning of nutrient utilization for the processes of growth, pregnancy and lactation (6). In general, the major effect BST has on lactation is to partition more nutrients to the mammary gland for the increased production of milk through complex interactions with many target tissues. There is also a more minor somatotropic effect of mammary cell proliferation/cell maintenance that is implemented through BST’s effects on increasing circulating IGF-1. Additionally, rBST increases the metabolic capacity of mammary cells, increases the liver’s ability to convert propionate to glucose, and increases the rate of adipose lipolysis ( without causing ketosis), which all enhance milk production. (7,8,9)

There is a certain paradox that exists in relation to circulating somatotropin levels and milk yield that at first can be counterintuitive, as illustrated by the table below. (6)

**Table 1**

**Paradoxical relationship between circulating somatotropin concentrations  
and milk yield in lactating cows**

Physiological Situation	Circulating Somatotropin	Milk Yield
ST-Treatment	Up	Up
Genetically Superior	Up	Up
Inadequate nutrition	Up	Down
Poor Management	Up	Down

The above illustrates the effect that BST has on homeorhetic control of nutrient partitioning effecting metabolism without overriding the protective homeostatic controls a cow utilizes in times of adverse conditions. This prevents bST from having major detrimental effects on animal health. In the face of inadequate nutrient intake, elevated levels of circulating somatotropin will not divert essential nutrients towards milk production. Homeostatic control will partition these nutrients towards essential maintenance needs, and milk production will drop. It is therefore necessary to have good nutritional management on the dairy in order to economically benefit from BST use.

### **Economic Considerations**

#### *Direct Economic Benefits from BST use on 100 and 1000 cow dairy models*

It is obvious that cows supplemented with BST have the potential for increased milk production. Many factors determine the profitability of this tool on individual dairy farms. In a study of 15 dairy herds by Thomas et al. (9), the

average net increase of fat corrected milk/day was 10.78 lbs, with a wide variation from 6.38 to 16.72lbs. Another study conducted at Cornell by Bauman et. al. (10) analyzed test day records of over 27,000 cows in the Northeast US and concluded that there was an expected 8+lbs of milk/cow/day increase over the days supplemented, which equates to 1,968lbs of milk, 59lbs fat and 67lbs of protein per 305 day lactation.

To determine additional revenue from the use of bST on commercial dairy farms, there are assumptions and considerations that must be made and a partial budget performed.

1. Increased feed costs

Any additional milk production brought on by bST supplementation requires additional nutritional inputs. In general, a 10lb increase in milk production requires an additional 4lbs of dry matter (DM). Current feed costs can be estimated at approximately \$.09 per lb/DM.

2. Cost of the product.

Current price can be estimated at \$5.25 per dose.

3. Labor cost

Labor costs for bST administration differ from farm to farm depending on farm size and facility design. In general the added labor cost is minimal, and can be estimated at \$.01/cow/day

4. Other Assumptions

- Current milk price=\$17

- Days in Milk at the start of BST=63 days
- Average days supplemented= 287days/cow/lactation
- 8lb/cow/day response to bST

#### Cash Flow Improvement (Profit) 100 Cow Dairy

\$0.67     \$/cow/d

\$9.37     \$/cow/period

\$691.42   \$/period

20.50     BST Periods/year

\$14,174.08     \$/year

#### Cash Flow Improvement (Profit) 1000 Cow Dairy

\$0.67     \$/cow/d

\$9.37     \$/cow/period

\$6,914.18\$/period

20.50     BST Periods/year

\$141,740.78     \$/year

It is easy to see that the improved cash flow for dairies of all size would be monumental. The contribution of BST milk on overall dairy profits is likely to reach 25%. This extra profit potential may arguably impact more the way of life of a small farm family, than that of its larger farm neighbor.

Recently, the trend to increase the supply of rBST free milk to meet a proclaimed consumer demand has made processors change their policy on accepting milk from all dairies. Many dairies are asked to sign affidavits to attest

to their non-rbST use. Those farms may receive premiums ranging from \$.05-\$.25. Farms who decide to maintain the use of the technology may be forced to pay surcharges for added handling to keep milk containing rbST separate from milk that is deemed not to come from supplemented cows. It is important to keep in mind that milk labeled rbST free must include a disclaimer that informs the public there are no compositional differences between milk coming from supplemented cows and those that have not been supplemented with rbST, and there is no current commercial method developed to determine the difference. (11) The difference hinges on the signed affidavits and a good faith paper trail from farm to processor to the dairy case.

Due to premiums being paid to farmers who do not supplement their cows, dairies must evaluate the premium needed to compensate for the loss in revenue by not using Posilac. With the aforementioned data, and an average daily milk production prior to BST of 80lbs, it can be calculated that the breakeven premium milk processors must pay is \$.62/cwt for rbST free milk. Most of the processors that are offering premiums are providing \$.05-\$.25/cwt, far less than what is needed to forfeit using rbST technology.

### **Environmental Considerations for the Use of rbST**

With an increasing population and dairy product demand, and urban sprawl that is displacing land utilized for agriculture, efficiency of milk production is the key to sustainability. Consumers and dairy farmers alike are becoming

increasingly aware of the impact that dairy farms have on the environment, and implementation of nutrient management and air quality regulations are becoming large parts of the day to day operations of a dairy. With a projected milk demand of 180,000,000,000lbs annually (an increase of approximately 18% since 1998), these issues will remain key ones. (12) The benefit of rbST use is the increase in a cows productive efficiency, what can be termed marginal milk.

#### *Feed efficiency and Reduction in Manure-*

On average a cow requires 10Mcal of NEI for maintenance, and about .32Mcal to produce 1lb of milk. For example, cow A making 50lbs of milk would require 26 Mcal for maintenance and lactation (10Mcal+16Mcal), while cow B making 100lbs would require 42Mcal (10Mcal+32Mcal). Cow A's efficiency is .42Mcal/lb of milk, while cow B's efficiency is .52Mcal/lb. Essentially more efficient herds can better utilize cropland for milk production, and feed costs per pound of milk decreases leading to profitability. The effect of rbST, in regards to

Figure 1.  
Relationship between level of milk yield and the proportion of nutrients used for maintenance. Black =net energy White=crude protein. (6)

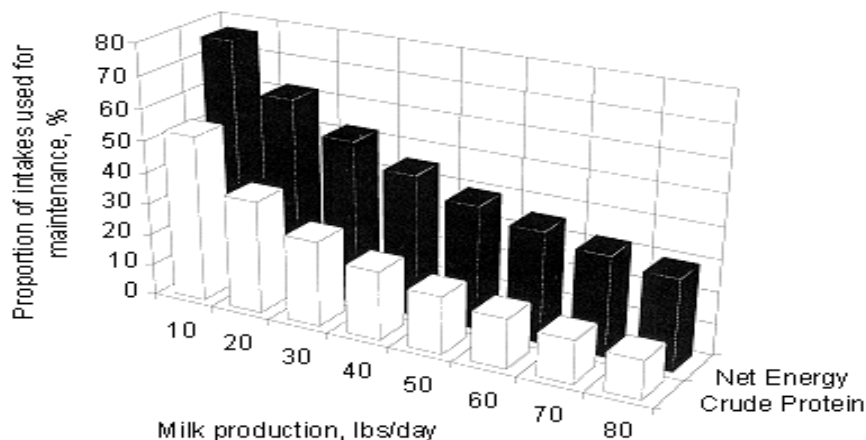


Figure 1 is to direct production to the right of the graph which equals higher milk yields and therefore greater production efficiency.

To illustrate, a 100 cow dairy can increase bulk tank milk by 590lbs/day while supplementing approximately 90% of the milking herd. The same dairy while not supplementing would have to add over 7 more cows, or increase their herd size by over 7% to make equivalent daily production. Feeding, housing, and getting rid of the manure for an additional 7 cows is costly, and not as environmentally friendly. When considering a large farm of 3000 cows, it would require an additional 222 cows to make up the production differences that bST could provide.

Good manure management is essential on any farm due to the impacts that dairy waste can have on the environment and human health, and currently is being strictly regulated especially for larger dairies. The less manure a dairy farm has to deal with decreases the risk for negative environmental impacts and the changes of negatively affecting human health. Additionally, less manure handling also means less expenses and increased revenue. A 1350lb lactating dairy cow can produce 108lbs of manure on a daily basis. (13) A 3000 cow dairy using bST making as much milk as a 3000 cow dairy not using bST would produce 23,976lbs less manure per day. That is 133 less pounds of nitrogen and 21 less pounds of phosphorus being created daily, while also decreasing environmental pathogen load.

At a time of an alternative energy revolution, more cropland is getting devoted for supply of these industries rather than for cattle consumption, and the dairy industry is feeling the squeeze as feed prices soar. Although the amount of cropland needed to supply the ethanol industry at the current time may be a bit unrealistic due to start-up inefficiencies, it would be advantageous to have a more compatible relationship between the agricultural sector and the alternative fuel industry. Through widespread bST use, generally less cows can fulfill the countries demands for milk and dairy products, while leaving landbase to feed an expanding population and an growing alternative energy industry.

### **Animal Health Considerations**

An enormous amount of data is available in respect to the effects that rBST supplementation has on the health of the dairy cow. Studies have looked at all aspects of cow health including reproduction, disease rates, longevity, and effects of calf health. Time after time the studies have concluded that there are no negative health effects directly related to the use of Posilac, with the exception of the correlation between superior production and increased risk for mastitis and obvious injection site lesions. Additionally, increased lipolysis at the beginning of supplementation puts a cow in a state that mimics early lactation and negative energy balance. However, cows will increase intake to meet demands, and BCS at the end of lactation are not different between supplemented and nonsupplemented cows. (7,8,9)

It has been concluded that the mastitis risk for supplemented cows is no different than cows at similar levels of production which are not supplemented with rbST. (7) Given this information proper management of facilities and implementation of strict mastitis control programs are keys to making rbST a profitable tool on the dairy. Strict adherence to injection site guidelines is necessary, as with all injectable agents, to prevent painful injection site lesions while complying with beef quality regulations.

### **Socioeconomic impact of milk price**

It has been long debated since its introduction the effect Posilac® has on mailbox milk prices. Historically, times of Posilac® production and supply problems and recently the push for rbST free milk demanding premium prices has coincided with times of high milk prices. This may lead to the idea that less bST use elevates milk prices and farmer profits. The threat of an oversupply of milk due to the widespread adoption of the technology and deflated milk prices keeps many anxious about widespread rBST use. However, milk price fluctuations are due to a complex interaction of many factors such as weather, crop yields, buyout programs, alternative energy demands, energy prices, global demand for weight products, and complex milk pricing schemes. (15) It must be noted that milk supply in the short term is inelastic (16) which means that an increase in demand is not immediately followed by an increased supply. It takes time, in general, to increase cow numbers to increase production, regardless of

rBST use. Additionally, the use of rBST on dairies, anecdotally, has declined very little in recent times, which again illustrates how other factors aside from rBST are bigger players in affecting milk supply and price.

### **Conclusions**

Food supply veterinarians are key advisors for their clients and aid in integral decision making impacting farm profitability and sustainability. It's clearly been demonstrated that recombinant bovine somatotropin, when used on well managed dairies, is a safe and proven product that is good for the financial health of all dairies independent of size and additionally proves to be an environmentally friendly technology. Research shows there are minimal effects on cow health, and good management can overcome few negative associations such as increased mastitis risk and injection site issues. Although rBST faces some public perception hurdles, it will without question remain an important production tool on well managed dairies across the nation.

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