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J. Estrada

John E. Shirley

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THE USE OF BOVINE SOMATOTROPIN (BST) IN DAIRY CATTLE

Jorge Estrada and J. E. Shirley

General Information

We all have heard about the use of BST in lactating dairy cattle during the last 6 to 8 years, but what is BST? Bovine somatotropin is another dairy management tool developed to improve the efficiency and reduce the cost of producing milk. It is the newest in a list of technological advances in the dairy industry, such as genetic improvements, nutrition, health, housing, milking equipment and techniques, embryo transfer, and DHI records.

BST is a natural protein produced in the anterior pituitary gland of all cattle. Like other proteins, BST is composed of various amino acids (190-199). BST is bovine growth hormone, somatotropin. It helps to allocate energy from feed to meet the physical needs of the cows, such as growth in young animals, milk production in mature animals, and other functions in the body.

What does BST do? Supplemental BST stimulates cows to produce more milk from a proportionately smaller increase in feed consumption. Therefore, less feed is required to produce a pound of milk (Figure 1).

Peak milk production is normally reached in the second to third mo (50 to 65 days) of the 10-month lactation period, then it decreases until lactation finally ceases. Supplemental BST extends the duration of near-peak milk production consistent with the genetic and environmental potential of the cow (Figure 2).

How does BST work? Scientific research shows that BST is produced in the anterior pituitary, released to the bloodstream, and activates "BST receptors" for specific needs of the body. For example, "Growth receptors" in young animals direct food energy into normal growth; when the animal matures, the growth receptors shut down. In mature animals, "Mammary receptors" are activated as cows complete pregnancy. These receptors help direct energy in the feed into milk production.

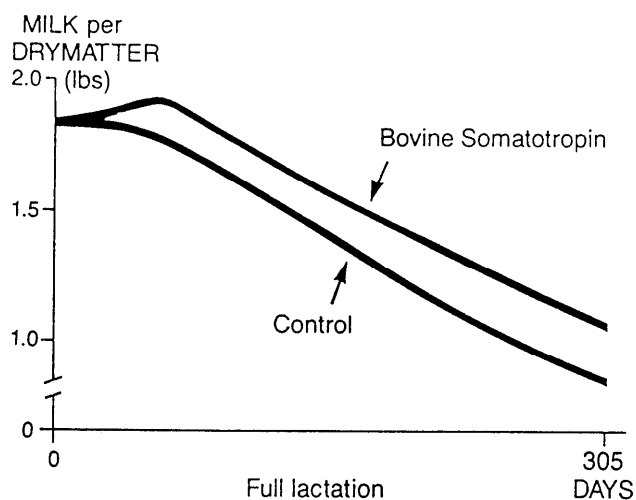


Figure 1. Feed efficiency improvement.

It is known that cows receiving supplemental BST consume more feed. Additional feed consumption and milk production are related to the amount of BST administered. Therefore, BST stimulates the cow to produce more milk, which results in increased intake to provide the extra energy required. More of that energy is directed into milk production rather than body maintenance.

How is BST made? BST can be produced in commercial quantity using recombinant DNA technology. The gene responsible for natural BST production in dairy cows has been isolated and can be transferred to ordinary bacterial cells. The bacteria are then used to produce large quantities of BST through fermentation techniques. After this process, the bacteria are killed, and BST is separated, highly purified, and formulated for use in cattle (Figure 3).

How safe is BST? Before a new animal drug such as BST may be marketed commercially, it must be found to be safe and effective in the target animal, safe from the standpoint of human food consumption, and safe for the environment. FDA's Center for Veterinary Medicine (CVM) is responsible for assuring that these standards are met prior to commercial marketing. With BST, the sponsors were able to demonstrate very early in the process that there were no changes in residues of BST in the milk from lactating dairy cows treated with BST and that even if there were, such residues would represent no risk

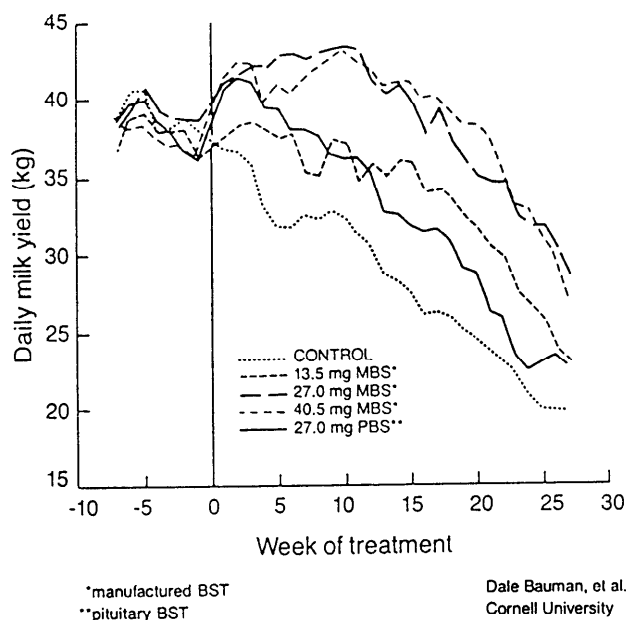


Figure 2. BST effectiveness.

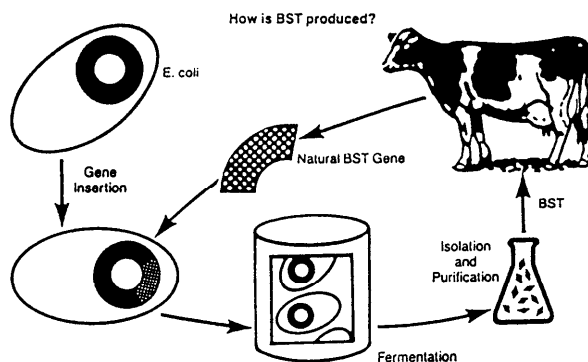


Figure 3. Production of BST.

no changes in residues of BST in the milk from lactating dairy cows treated with BST and that even if there were, such residues would represent no risk to humans consuming the milk. This finding by the FDA's Division of Human Food and Environmental Safety is based on four facts about BST:

- a. BST is a protein that, when ingested, is broken down or digested in the human gastrointestinal tract and thus inactivated. (BST is inactive even in cows when given orally.)
- b. BST is species specific. That is, even if BST is injected into humans, it is still inactive. The somatotropins from some species are fairly similar and may cross-react. However, that is not the case with respect to BST in humans. A number of years ago, BST was investigated as a drug for treatment of growth disorders in children and was found to be INACTIVE in humans even when injected.
- c. No difference has been detected in the milk from cows receiving supplemental BST and the milk from other cows or from the same cows before they received supplemental BST. Milk from cows treated with BST cannot be distinguished from milk from nontreated cows. Trace amounts of BST occur naturally in cows' milk at variable levels, generally less than two parts per billion but occasionally ranging up to 10 parts per billion. No increase in BST levels in milk has been observed in cows receiving supplemental BST at expected use levels.
- d. Humans consuming animal derived food products always have been exposed to small amounts of naturally produced BST in milk and meat.

The composition of milk (with respect to lactose, protein, and fat) obtained from BST-supplemented cows is not different than that of milk from cows that are not supplemented (Table 1).

Milk and meat from cows in a limited number of continuing BST trials conducted under Investigational New Animal Drug procedures have been authorized by FDA for sale and commercial use. Registration and commercial availability of BST are expected about 1990.

Table 1. Milk Composition

Measurement	Supplemental BST (mg/day)			
	0	12.5	25	50
Milk fat, %	3.65	4.00	3.65	4.00
Milk protein, %	3.00	3.04	3.03	2.98
Total solids, %	12.31	12.99	12.55	12.78

University of Pennsylvania
38 wk beginning at wk 4 to 5 of lactation

How safe is BST for the animals? BST used at anticipated commercial dosages has shown no undesirable effects on cows receiving it or on their calves. Long-term trials are continuing to confirm that supplemental BST used through multiple lactations is safe for cows. Researchers have found that cows receiving supplemental BST at the tested dosages showed no significant difference in:

- incidence of mastitis, milk fever, or ketosis;
- conception rates and services per conception;
- birth weights of calves and calf growth rates after birth;
- normal late-lactation weight gain;
- temperament or behavior of treated cows; or
- production of cows during the following lactation when they did not receive BST.

Studies at more than 20 universities, over 15 private herds, and other countries confirm many of these observations.

How will cows perform with respect to milk production and feed efficiency?

Supplemental BST is expected to lower the cost of milk production by increasing the milk produced per pound of feed consumed. Cows receiving supplemental BST produce an average of about 12% (range 10 to 25%) more milk. Increased milk response begins within 24 hr after BST administration and continues as long as BST is administered (Figure 4).

Results in different trials show that supplemental BST, with diets properly adjusted to provide the required nutrients, can improve feed efficiency or the amount of milk produced per pound of feed consumed by about 5 to 15% (Figure 5).

Feed consumption increases with the amount of additional milk produced, but it does not increase proportionately. Cows receiving supplemental BST must be fed according to their higher milk production level. Voluntary feed intake may increase sufficiently to support the increased milk production, allowing use of the same diet in greater quantities, but voluntary feed intake may be limited by stomach capacity, requiring ration reformulation at higher nutrient densities.

What are the economic effects and industry impact of BST? The economic effects of BST have been researched and are highly predictable. Cows on BST produce from 10 to 25% more milk and consume about 5 to 15% more feed to produce the additional milk. Thus, cows require about 5 to 10% less feed to produce a lb of milk, resulting in lower costs and a higher return for dairymen. BST will require little if any capital investment, unlike many dairy industry advances. It will be equally accessible to small herds and to larger, well capitalized operations. The cost of BST has not yet been established, but BST must be priced to yield a desirable profit to dairymen or they will not use it. The speed with which BST takes effect will offer dairymen an increased range of options to manage

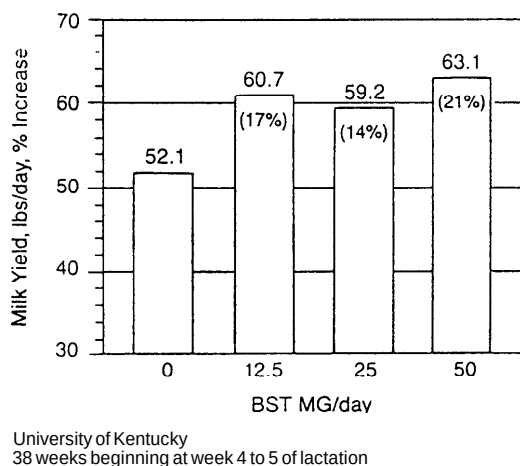


Figure 4. Milk production.

milk production and farm income. BST will provide the ability to increase herd average by producing the same amount of milk from fewer cows or more milk from the same cows; adjust milk production up or down to meet changing market or farm conditions within days; raise or maintain desired farm income without the need for more cows or farm facilities; and adjust farm operations to realize the same production/income with a reduced workload. Adoption of BST is expected to be gradual. It is unlikely that the maximum adoption rate will exceed 50 to 60% and even people that use it will not use BST immediately on their entire herds.

Conclusions

There is an important interaction between the dose of somatotropin, the time of the initiation of treatment, and the nutrition and management of the herd. The BST-treated cow is like the high-producing cow, and similarly, poor nutrition can restrict and superior nutrition can augment responses. BST can improve feed efficiency and milk performance, but it does not work alone. Improved performance and increased efficiency will be realized only when the level of management, nutrition, and herd health are concomitant with the management of our good and better-producing herds today. To be competitive in world and domestic markets, agricultural enterprises in the U.S. must strive for economic efficiency. Advances in nutrition, management, and sire-proofing programs have resulted in impressive increases in productivity and efficiency, and BST is the first product of biotechnology with potential to have a major impact upon productivity.

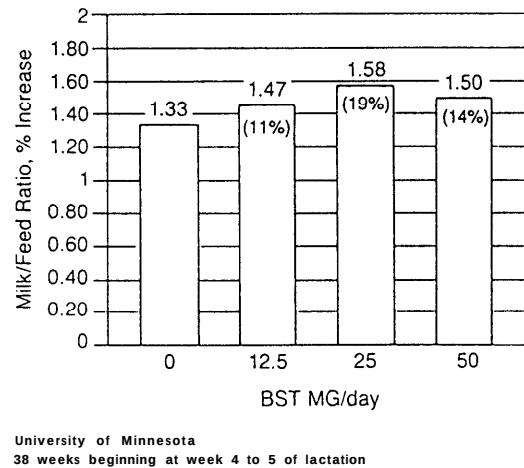


Figure 5. Feed efficiency.