Bovine Somatotropin: Effects On Reproduction

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Reproductive efficiency effects profit in dairy herds by influencing milk produced per day, calves born per year, and replacement losses from forced culling[4,7,9,13]. Since rates of return are 3/1 in early lactation compared to 1/1 in late lactation, and 50% of profit from milk production is realized in the first 100 days of lactation, profit and cash flow are potentially maximized when cows calve every 12 months, given typical lactation profiles. The optimal time period between successive calvings (calving interval (CI)) is a function of the shape of the lactation curve, replacement calf value and future potential survival in the herd[4]. Altering the lactation function by using bovine somatotropin may alter the optimal CI.

Bovine somatotropin (BST) increases milk production post peak lactation and has a slightly negative effect on conception rate (CR)[1,5,6,17,18,19]. Due to the lower CR, CI has been longer and fewer cows have become pregnant when given BST and voluntary waiting period has not been altered (Table 1). Since BST increases milk production post lactation peak, it has been speculated that it may be more profitable to have a longer CI in cows receiving BST. In addition, although fewer cows may become pregnant, BST may be used to extend lactation in open cows, thus reducing the negative effects of fewer pregnant cows on milk produced per day. However, extended CI and fewer pregnant cows may decrease returns if these are bad decisions economically. Many studies have examined the economic aspects of using BST based on milk yield response and cost of BST[8], but few studies have examined the interaction of BST use with reproductive management on farm profit. This paper will explorer those issues.

Calving Interval And BST

Calving interval is a function of conception rate (CR), heat detection rate (HDR), voluntary waiting period (VWP) and breeding period (days following the VWP which cows will still be inseminated). Conception rate influences semen usage. Heat detection and conception rate determine pregnancy rate (PR, the proportion of cows which become pregnant every 21 days). Pregnancy rate is the parameter that determines CI and calves born per year. Combined with the PR, the breeding period will determine the total pregnant animals. Decreasing CR and/or HDR and extending the VWP increase the CI. This reduces milk/day and calves born/year, thereby reducing herd profit. Pregnancy rate (PR) captures the effects of HDR and CR in one variable. In dairy herds it is profitable to achieve 85% pregnancy or higher in cows which are in the breeding pool, and profit is maximized when 80% of cows become pregnant prior to 120 days postcalving at a PR of 35%.

Using lactation data from a 400-cow dairy, we examined production responses through two lactations for cows with VWP of 50, 80, 110, 140 days and 100% PR. We modeled production for 50 cows, 35% first lactation, 20% second lactation, and 45% third and greater lactation, through two sequential lactations. Initially, we did not consider replacement, but were interested reproductive factors which resulted in maximum production in this cohort of cows over this time period. Voluntary waiting period could be varied, as could PR and breeding period. Initial breeding period was set to 270 days from the VWP and could be extended to 420 days from the VWP.

As days open increase from 50 through 140 days, milk declines by .06 lbs/day (Figure 1). Thus, it is most profitable to get cows pregnant early. To investigate the effects of BST on this relationship we then examined injections from the ninth week of lactation.

Posilac® (Monsanto) is approved for use in lactating dairy cows from the ninth week of lactation[5]. Typical production responses have been 8-15 lbs. of milk. Injections must be given every 14 days to maintain the production response. Production response declines slightly in cows over 200 days in milk[5]. Production oscillates with the 14-day injection schedule, peaking 7-10 days post injection. We examined production responses of 5, 10, and 15 lbs. with varying VWP and PR to examine the effect of BST on milk/day over two sequential lactations. Injection was given beginning the 9th week of lac-

TABLE I. Summary of studies examining bST effects on milk production, conception rate and total pregnant animals.

Increase in from controls Milk (kg)	0	0-2.5	2.5-5.0	5.0-10.0	>10
Number cows,	66	40	404	338	848

Mean increase, kg 4.78 .13 (10.5 lb .29)
(summary of 27 trials)

bST and Pregnancy, number of cows

BST	OPEN	PREGNANT	%
0	123	1043	89.5
YES	158	690	81.4

MANTEL HAENSZEL CHI SQ 64.51 p<.000
(summary of 27 studies)

BST - CR and DAYS OPEN

	Control	bST
CR,%	48.4	47.2
Days Open	0[a]	17.2[b]

(summary of 14 - 19 trials)

tation and response could be varied to exam the interaction of BST with days open.

Again, PR was set to 100%, VWP was varied from 50 to 140 days and BST response was 0, 5, 10 or 15 lb. (Figure 1). In this case the VWP would represent days open. Milk produced per day decreased .060 lbs/day from 58.82 lbs/day as days open increased from 50 to 140 days. If BST caused a 5 lb. increase in milk, baseline milk increased to 61.99 lbs/day, but increasing days open was still associated with a .055 lb/day decline in milk produced per day. If BST increased milk 10 lb., then baseline production was 65.22 lbs/day and the decline in production per day was .051 lbs/day. With a fifteen pound increase in milk from BST injections, baseline milk was 68.47 lbs/day, but still declined at .046 lbs/day with increasing days open (Figure 1). The decline in milk with extended days open was reduced with increasing BST response but not abolished. Using BST minimized losses in milk/day with extended days open, but highest production was associated with 50 days open.

However, dairy herds do not have PR of 100%. The average herd has a PR of 25%, and most herds range from a low of 15 to a high of 35%. Therefore herds have cows with varying distributions of days open as a function of PR. At very low PR (<=30%) milk/day declines steeply (Figure 2). Extending the VWP to 80 days across all PR reduces milk/day, but the decrease is not as great at PR below 35% (Figure 2). Injections of BST, resulting in 5, 10, or 15 lb. of milk response, increase milk/day above baseline rates across all PR, but production is maximal when PR is above 35% (Figure 3). Low PR extend CI, lower milk produced per day and calves born per year. Injections of BST increase milk/day at any given level of PR. However, milk/day is maximized with VWP of 50 days and PR equal to and above 35%. Thus, it does not appear that extending CI is the best decision to maximize milk production with BST. It would appear to be optimal to maintain short CI with BST.

Interactions with Periparturient Problems

Cows with periparturient problems may have reduced fertility and reduced production. It has been suggested that extending CI would decrease the yearly costs associated with periparturient problems, and by using BST, lactations could be profitably extended to offset the losses associated with extended CI. To investigate these interactions, incidence of periparturient problems was varied from 10 to 50% with reduction in fertility of from 25 to 90% and production declines of 10 to 30% in cows with problems.

If the incidence of periparturient problems ranges from 10 to 30% and milk production declines by 10% in these cows, milk/day is reduced at all PR (Figure 4). The horizontal lines in figure 4 represent the minimum and maximum milk/day if the incidence of periparturient problems is 0% at PR is <20% (minimum) and PR>70% (maximum). Increasing PR above 40% increases milk/day within ranges observed with no periparturient problems, but not to levels of 0% disorders. Extending VWP at typical PR of .25 in herds would be a costly decision. To delay breeding 30 days because of periparturient problems would reduce milk 2.1 lbs/day, at a PR of .25. It would only be profitable to make this decision if the cost of health interventions was more than the milk loss. However, to delay because of problems also reduces production/day in normal cows. Thus, this appears to be a bad decisions.

If BST increases milk 5, 10, or 15 pounds, then it can mitigate the production losses with periparturient problems (Figure 4). However, only BST in combination with short VWP and high PR can restore

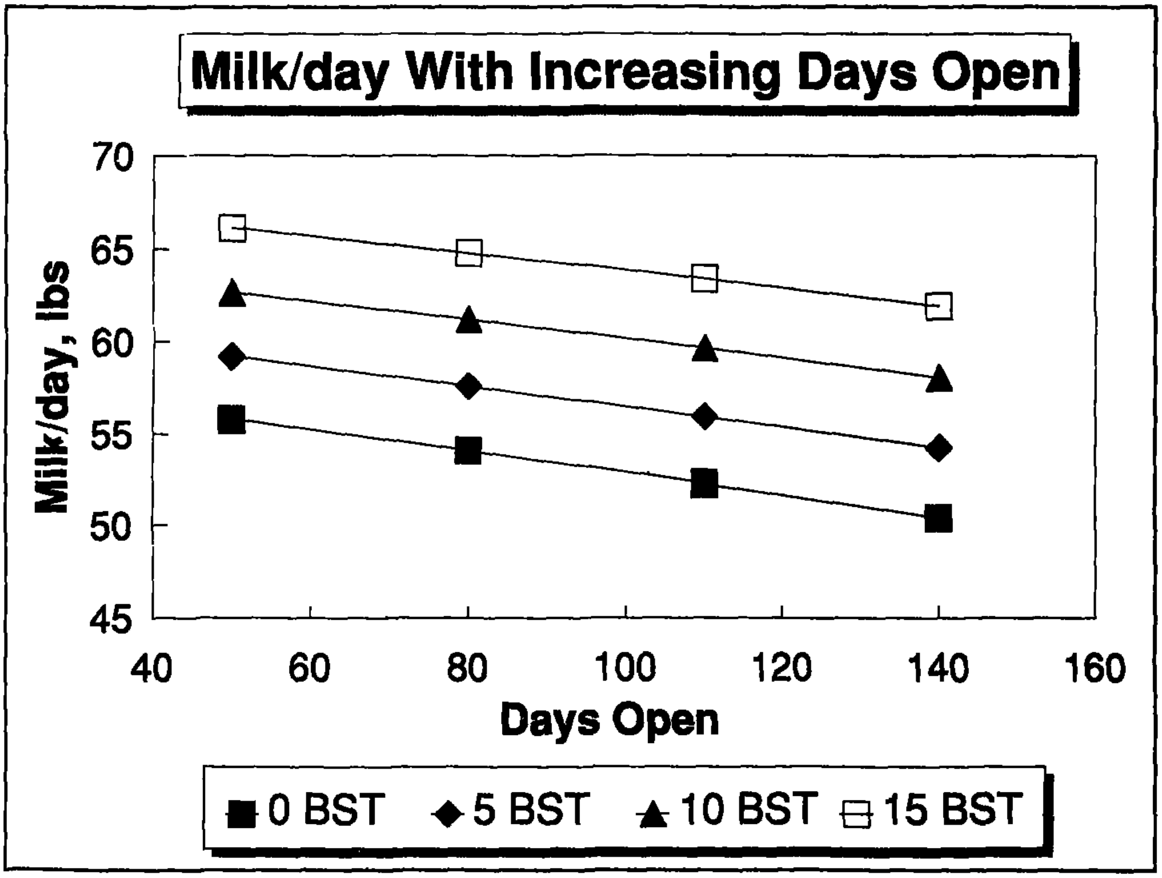
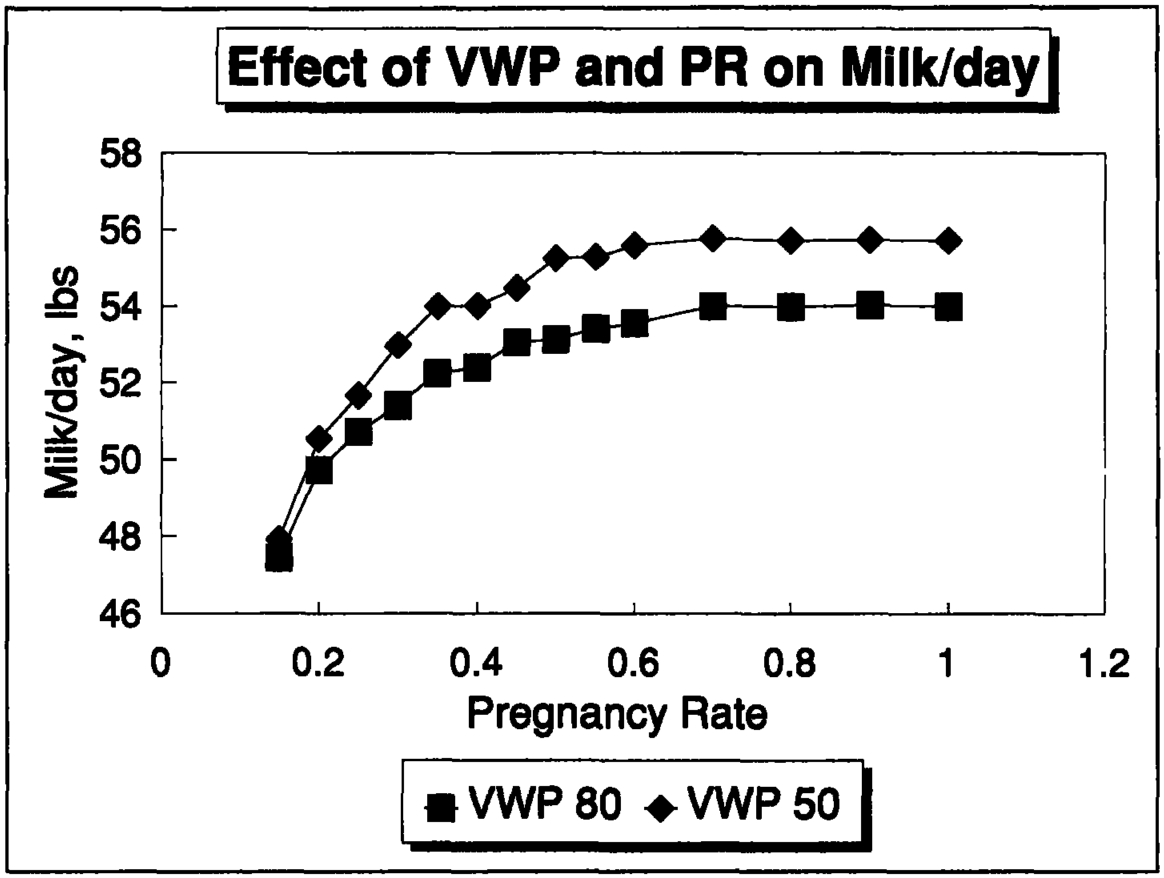


Figure 1.

Figure 2.



milk/day to levels achievable with no periparturient problems and high reproductive efficiency. If BST response were 10 lb. or more and milk losses with periparturient problems were 10%, then milk produced/day would approach baseline values if PR were 30% or higher. However, it should be noted that these levels don't approach maximum yields if periparturient problems were 0%.

Management Conclusions

Thus it appears reproductive efficiency and strategies should not be altered with BST. BST may offset some of the negative effects of low PR (<35%) common in most herds by increasing milk/day.

Reproductive Effects – Overview

Pregnancy Prevalence. Presented in Table 1 is PP for control and BST treated cows summarized from literature reports (3,5,10,17,18). PP was significantly reduced in BST treated cows. Pregnancy was most effected in primiparous cows in data summarized by Cole et al. (3). Older cows, the effects of BST on pregnancy seemed to be largely a function of milk yield (3). If milk yield increased in a predictable fashion to BST injection, then PP was slightly reduced, and the reduction was consistent with increased milk yield (3).

Conception Rate and Days Open. Overall, cows receiving BST had slightly lower CR (5) to no significant reduction in CR (3,5 and Table 1). Days open increased (Table 1). Under current management schemes, with voluntary wait periods of 50-60 days, BST use will lower PP, but in a manner consistent with increased milk yield. CR in the fertile population will be similar to current CR, but total semen use may increase due to an increase in cows failing to become pregnant earlier. This early depression in CR may be related to energy balance and initial losses in body condition just after initiation of BST (14-16,19). Feeding management will interact with reproductive management and influence the CR response seen in individual herds.

Cows failing to become pregnant may actually stay in the herd longer, due to BST injection prolonging lactation yields. Thus although increasing forced replacement, herd turnover per year may decrease, as cull cows may be milked longer due to BST injection.

Physiologic Effects On Reproduction

Changes in endocrine pattern in BST treated cows have been slight. Several studies have shown BST treatment is associated with increased plasma progesterone[11 12]. GnRH induced luteinizing hormone (LH) output from the pituitary was higher in BST treated cows, and LH pulse frequency increased in BST treated cows[12]. These slight changes in progesterone and LH are difficult to interpret relative to their potential impact on reproductive function.

Most studies have reported no effect of low to average doses of BST on expression of estrous or estrous cycling. High doses of BST have been reported to increase estrous cycle length and decrease estrous expression. Most studies suggest little effect on first ovulation, estrous cycle length and estrus expression.

High doses of BST (>= 50 mg/d) have been reported to increase early embryonic death. Initiation of BST in cows during early pregnancy (25 to 40 d postbreeding) should probably be avoided. This may explain why PP decreases with no change in CR in the cows which become pregnant. Cows which fail to maintain pregnancy may fail to become pregnant, whereas cows which maintain pregnancy due so in a fashion consistent with herd performance.

Extrapolating from field studies and based on the time postpartum of initiation of BST injection, the effects of BST on the physiology of reproduction appear to be minor and will not present major problems to dairy producers.

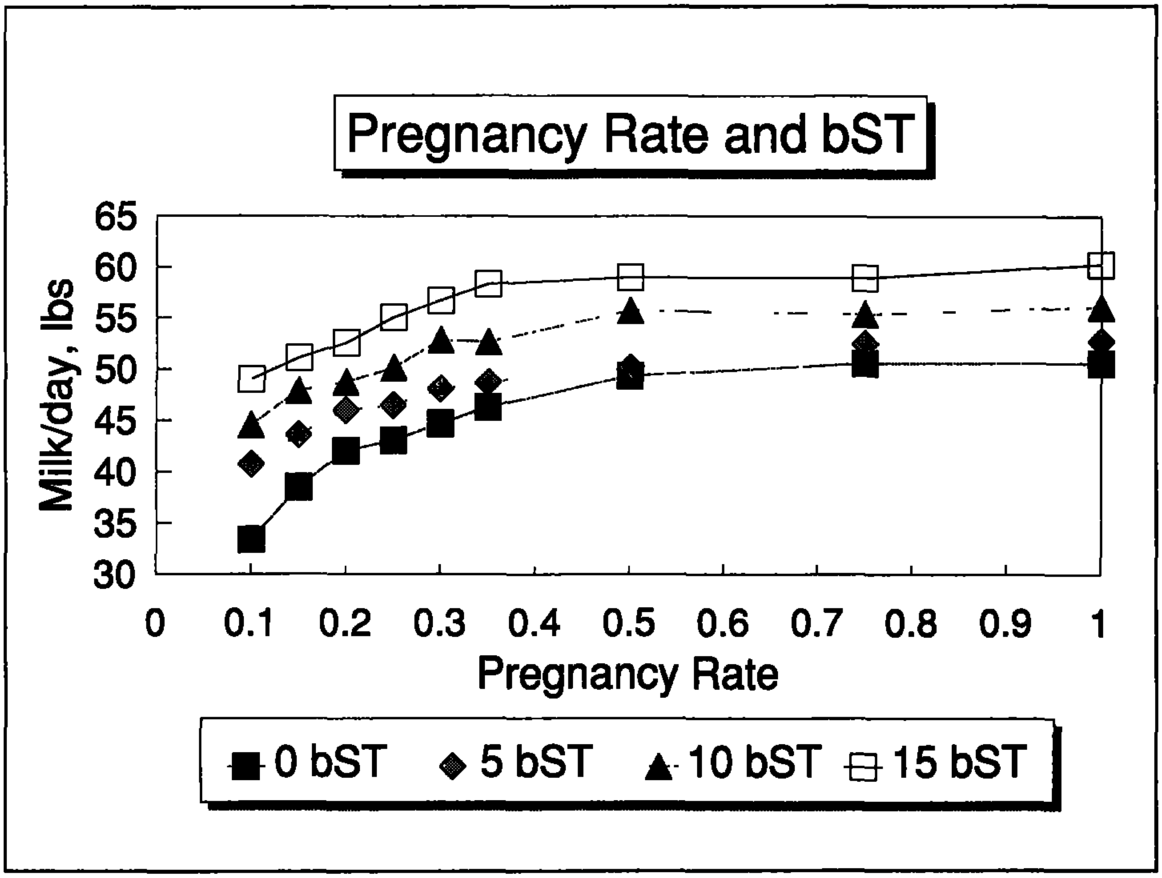
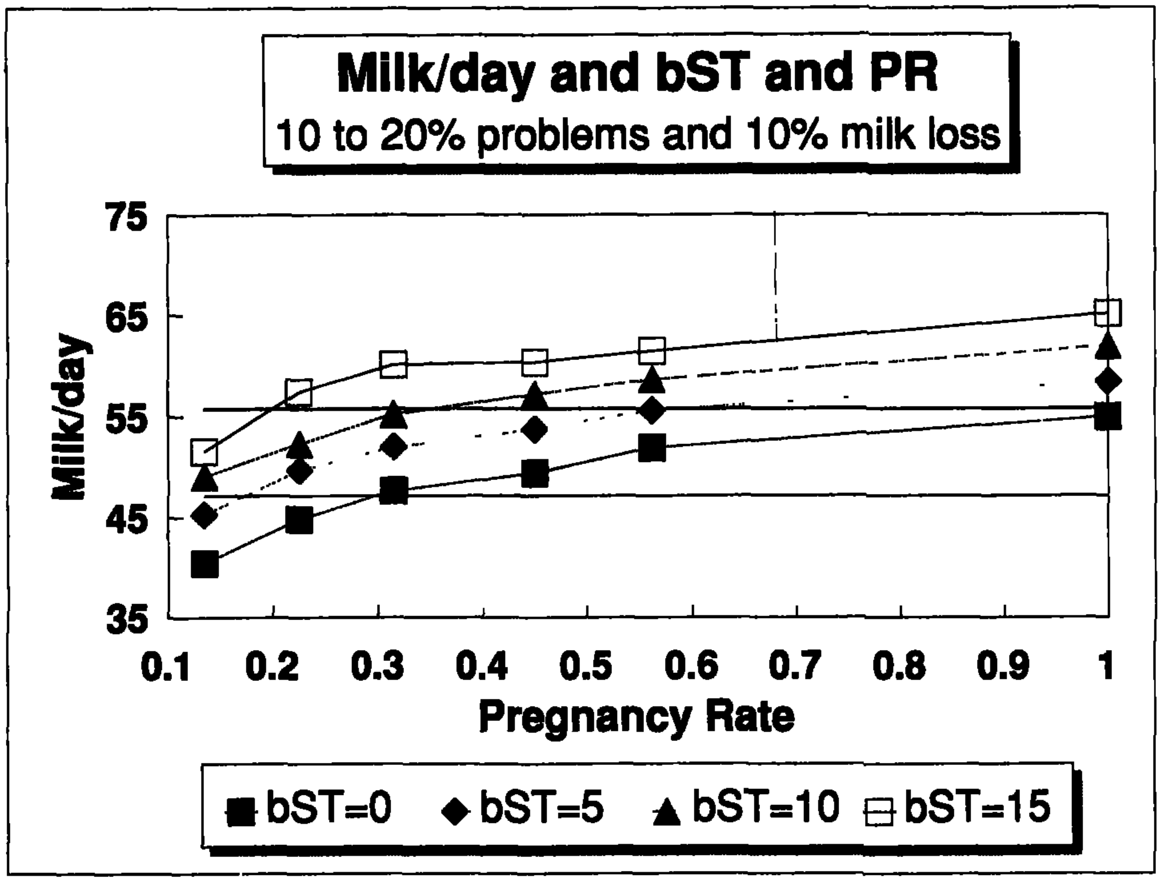


Figure 3.

Figure 4.



Weight Change And Body Condition

Most studies have reported less weight and body condition gain in BST-treated cows[1,2,5,15,16,18,19]. Initiation of BST treatment decreases energy balance. Dry matter intake increases, usually 4 to 8 weeks after BST initiation (5). A decrease in energy balance does not mean cows are returning to negative energy balance. They may only be less positive, particularly with BST initiation at 60 days postpartum. BST partitions nutrients from body tissue to milk, so it is not surprising that BST cows gain body weight and body condition slower than nontreated cows. In most studies, condition by next calving was not different in the BST cows. Thus body repletion occurs, but producers will have to monitor condition change in late lactation to ensure adequate body reserves for next lactation. This does not appear to be different than current practices used to manage body reserves in high producing herds.

Managing rations to minimize change in body condition with initiation of BST should aid in preventing reduction in CR in the first month after BST treatment.

Milk yield responses to BST injection in cows treated for two and three successive lactations have shown responses equal to the first year response (26,28,46). With proper management of body reserves, cows will respond equally well to BST in subsequent lactations.

Conclusion

Bovine somatotropin is a management tool which can be used to alter production within a herd of cows. Maintaining reproductive efficiency with BST is important to optimizing herd production, just as it is without BST use.

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