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BST Herd Management

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With the possible FDA approval of bST use in the commercial dairy herd, many questions will be asked by dairy producers. Concerns and questions of dairy producers may include: What response can be expected in dairy herds? Will cows respond to bST for multiple lactations? What effect will bST have on body condition? Do high and low producing cows respond to bST? What effect will bST have on reproduction? Should all cows in the herd be injected? What effect will bST have on cow health? Do cows that receive bST need to be fed differently?

In an attempt to answer these questions, data from existing literature have been reviewed and summarized. To summarize data from different bST formulations, an average daily dosage rate was calculated by dividing injection dosage by injection frequency (days). Dosages were then grouped by 0, .1-9.9, 10-25.9, 26-44.9, and greater than 45 mg bST/d for analysis of FCM, energy intake, SCC, days open, services per conception, pregnancy rate, and mastitis. Day of initial bST administration ranged from 31 to 120 days postpartum and continued for a full lactation except for trials (15, 43, 73).

Fat corrected milk yield and energy intake

In a summary of 49 full lactation trials involving more than 5000 cows bST was effective in increasing 3.5% FCM (Table 1) from 5 to 23% of control cows. Energy intake increased from 6 to 15% for cows receiving the same bST doses. Both FCM yield and energy intake increased as bST dose increased. Efficiency of production (FCM/energy intake) was increased for bST treated cows because of dilution of the maintenance cost. Requirements for nutrients above maintenance to produce milk of the same composition is identical for bST treated and non bST treated cows.

Responses of primiparous cows to bST were lower than those of multiparous cows (Table 2) receiving less than 26 mg bST/d. Energy intake was 3-4% higher for primiparous cows receiving up to 45 mg bST/d as compared to multiparous cows. The lower FCM response at doses less than 26 mg bST/d for primiparous cows could be related to nutrient partitioning. Most first lactation cows are still growing and nutrients may be partitioned towards growth first, then lactation. Also younger cows have higher blood levels of bST than mature cows. Therefore, heifer size and maturity may affect response to bST.

Daily injected and sustained release formulations may both be available to the producer. Examination of reported literature (Table 3) reveals that FCM response of cows receiving bST daily was higher by 5 to 6% units than that of cows receiving sustained release at the same dose up to 45 mg bST/d. Therefore to obtain equal response a higher dosage of sustained release formulation will be needed for a response equal to that of a daily injected product.

Multiple lactations

Several multiple lactation studies have been reported with variable responses in FCM production in the second year. Responses of cows to bST during consecutive years are presented in Table 4. Average increases in production during the second year were 70% of observed responses during the first year. Gibson et al. (27) reported that FCM yield of cows given bST for two or three lactations was 9% less than control cows. Oldenbroek et al. (54) reported that cows which received 640 mg bST/28d for 4 consecutive lactations responded by producing an average of 3.5, 3.0, 2.2, and 2.2 kg more milk during lactations 1, 2, 3, and 4, respectively. Similar results were reported by Huber et al. (36) for cows which received 500 mg bST/14d for 4 consecutive lactations. Reasons for the lower response during multiple lactations for cows receiving bST could be related to insufficient energy stores for the following lactation. Brown et al. (9) reported decreased carcass energy density (1.999 vs 1.686 Mcal/kg) and fat (28.3 vs 45.7 kg) in cows receiving bST during week 11 through 18 of lactation. Soderholm et al. (65) reported a decrease in empty body fat for cows receiving 20.6 and 41.2 mg bST/d as compared to control cows. Several other studies (38, 43, 48, 61, 65) have also reported a decrease in body condition or a lag in regaining body condition for bST treated cows. Replacing body condition prior to the next lactation will have a major effect on how well cows produce in the subsequent lactation.

Genetics

Though most trials with bST have been conducted with Holstein cows, Jersey (38, 53, 54, 56, 71), Ayrshires (13), Brown Swiss (13), Red and Whites (53, 54), and other breeds have responded to bST in a similar manner. The response to bST of cows of different genotypes and phenotypes have been reported with conflicting results. McDaniel et al. (46) reported that phenotypically and genotypically higher yielding dairy cows increased yield more when bST was administered than did lower yielding cows. Gibson et al. (28) reported response of milk yield to bST may be negatively related to phenotypic yield and positively related to genetic potential. Nytes et al. (52) compared two genetic groups with a cow index difference of 470 kg of milk and reported similar responses to bST by the two genetic groups. In a study (32) at the University of Minnesota Southern Experiment Station (Waseca, MN) cows of two genetic lines, which differed in milk production by 3182 kg of milk, were treated with bST. Percent increase of FCM for high and low genetic cows receiving 10.3 mg bST/d above controls was similar (15.8, 13.9) but yield of FCM was higher for the high genetic cows (4.4 vs 2.9 kg).

Responses to bST by cows of different body sizes were studied at the Northwest Experiment Station (NWES), Crookston, MN (32). Cows at NWES have been selected for body size since 1966. Large multiparous and primiparous cows currently weigh 100 and 64 kg, respectively, more than cows selected for small body size. During bST treatment, large genetic cows given 10.3 mg bST/d increased FCM 2.63 kg/d (9.9%), whereas small genetic cows given the same dose produced 2.63 kg/d (9.4%) more than control cows within the respective genetic group. In the authors' opinion, cows of different yield potentials will have similar percentage changes in FCM as long as they are in good health and have no previous health related conditions which might affect milk yield.

Reproduction

Summarized data for pregnancy rate (number of cows pregnant/number of cows in treatment group) are listed in Tables 5, 6, and 7. Pregnancy rates for bST treated cows receiving greater than 10 mg bST/d was lower than those of control cows. This decrease in pregnancy rate could be related to the increase in milk production of bST treated cows. Ferguson and Skidmore (24) analyzed pregnancy rate according to production response and reported that when cows increased milk production in a predictable fashion to bST, then pregnancy rate was only slightly reduced and the reduction was consistent with increasing milk yields. But cows not responding to bST were less likely to become pregnant than their bST treated herd mates that did respond.

Days open averaged 16 d longer for all bST treated cows as compared to controls (Table 1). Cows given bST respond with higher milk yields within the first 2-3 days after injections begin, however energy intake does not generally increase until 4-6 weeks after the initial bST injection. Thus, energy balance usually decreases and may become negative in some cases. These changes in energy balance may adversely affect reproductive efficiency during the early period of bST administration. Results of Phipps (58) determined that days open were directly related to milk yield and not to bST ($P < .001$). An increase of 100 kg of milk during lactation has been associated with an increase of 1 extra day open (58). Services per conception for cows that conceived did not differ between bST and control cows (2.16 vs 2.08) (Table 1).

Cows treated with bST starting 1-45 or 45-90 days postpartum had pregnancy rates about 7% less than control cows in the same experimental groups. When bST injections were started 90 days postpartum or later, pregnancy rates did not differ between control and bST treated cows (Table 7). However, pregnancy rates of control cows in the experimental group which started 90-120 days postpartum were lower than the control cows which started the experiment at 1-45 or 45-90 d postpartum (Table 7).

Health

The effect of bST on udder health has been a major concern. Several studies have indicated that bST increased number of cows having mastitis and number of cases of mastitis. Combination of data from 16 lactation trials indicated that the number of cows affected with clinical mastitis increased ($P < .02$) from 20.0% for control cows to 25.3% for bST treated cows (Table 8). Cases of mastitis were similar for cows receiving bST and control cows (.572 vs .524 cases/cow). When cows receiving more than 45 mg bST/d were deleted from the data set, the percentages of cows affected with clinical mastitis were 20.0%, and 22.3% ($P > .18$) and cases of mastitis were .524 and .539/cow ($P > .67$) for control and bST cows, respectively. Somatic cell count, as indication of subclinical and clinical mastitis, suggested bST treated and control cows had similar udder health (Table 1). Thomas et al. (68) reported a 12 week trial which utilized 890 cows from 15 commercial herds. They reported no increase in mastitis ($P = .097$), but the number of treatment days per cow increased for cows receiving bST ($P = .027$).

Metabolic diseases such as ketosis and milk fever have not increased with use of bST. Lean et al. (42) reported a decreased risk of metabolic disorders associated with lipid mobilization postpartum following a previous lactation in which bST was used. In most studies, feet, leg (except for references 12 and 74) and digestive disorders do not appear to increase with bST treatment. Health, viability, and rate of gain of calves born to cows which had previously received bST were not compromised (3, 41).

Management

Bauman (8) suggested that the milk response observed with bST administration was an interaction of bST dose and management. Thus, responses to bST will be similar to the variability in production gained when artificial insemination of superior sires is used in herds with different management qualities (8). Management factors affecting response to bST are likely to include nutrition, herd health, milking procedures, and environment.

Although well managed herds respond to bST, there may be circumstances when use of bST should be delayed or not used. Obviously, earliest use of bST during a lactation will be determined by FDA upon bST approval. If a dairy producer wants to minimize any adverse effect on herd reproduction, then introducing bST at days 100 to 120 of lactation may allow more cows to become pregnant before the first bST injection. A cow that is not in good general health (locomotor problems or poor udder health,) should not be subjected to bST. Whether to treat first lactation cows with bST is still questionable because milk response is generally lower for first lactation cows and response to bST during a subsequent lactation may be lower than expected. Breed of cow or genetic potential should not limit the response to bST.

Studies have shown that apparent digestibilities of dry matter, energy and nitrogen are similar for bST treated and control cows (64, 69). Somatotropin shifts the partitioning of nutrients so more nutrients are used for milk synthesis (8, 64, 69). Therefore, current recommendations provided by NRC (51) are satisfactory for formulating rations for cows receiving bST. In the opinion of the authors, cows that are to be treated with bST, should be fed high energy diets. Cows should be changed to diets of lower energy densities on the basis of milk production and body condition. As discussed earlier, the increase in dry matter intake will occur 4-6 weeks after the increase in milk yield. Therefore, body reserves of treated cows will be utilized for production, and body condition will be less than that of nontreated herd mates. Body condition should be replenished prior to the next lactation or subsequent milk yield will be compromised. To accomplish this may require feeding higher energy diets longer than is currectly being practiced.

Conclusion

Efficiency and profitability of bST to dairy producers will ultimately determine product acceptance and use. If use of bST does not increase profits for a dairy, the producer should discontinue its use.

Table 1. Effect of bST daily dosage rates on percent change in FCM and energy intake during treatment, SCC, days open, services/conception.

	bST dosage, mg/d[1]						
	0	.1-9.9	10-25.9	26-44.9	>45	bST	P
FCM[4], %	100	105	113	119	123	115	.01
Energy[5], %	100	106	108	108	115	109	.0001
SCC[3,6]	149	149	181	190	159	179	.33
Days open[7]	99	114	116	116	116	115	.09
Services/conception[8]	2.08	1.71	2.12	2.59	2.12	2.16	.53

[1] Injection dosage/injection frequency (d).

[2] All bST treated cows.

[3] Somatic cell x 10^3.

[4] References 4, 5, 6, 7, 11, 13, 15, 16, 19, 20, 21, 22, 23, 25, 26, 27, 29, 30, 31, 32, 33, 34, 35, 37, 38, 39, 40, 43, 44, 47, 48, 49, 50, 53, 54, 55, 56, 57, 59, 60, 61, 62, 63, 65, 66, 67, 71, 72, 74.

[5] References 4, 6, 7, 11, 15, 20, 21, 22, 23, 27, 32, 34, 35, 40, 43, 44, 48, 53, 56, 65, 67, 71, 72, 74.

[6] References 4, 11, 20, 21, 23, 27, 30, 31, 32, 34, 38, 40, 43, 44, 48, 54, 56, 59, 61, 71.

[7] References 1, 4, 10, 14, 15, 16, 20, 21, 22, 23, 26, 29, 30, 31, 32, 37, 40, 43, 44, 47, 50, 57, 59, 61, 63, 66, 67, 72, 73, 74.

[8] References 1, 13, 15, 19, 20, 22, 23, 26, 30, 31, 40, 44, 48, 49, 50, 57, 59, 60, 61, 66, 72, 73, 74.

Table 2. Effect of bST and parity on percent change in FCM and energy intake, SCC, days open, services/conception.

	bST dosage, mg/d[1]					
	0	.1-9.9	10-25.9	26-44.9	>45	bST[2]
	Primiparous cows					
FCM, %[4]	100	100	110	117	118	110
Energy, %[5]	100	-	111	108	113	111
SCC[3,6]	105	116	135	121	103	123
Days Open[7]	107	100	105	118	117	106
Services/Conception[8]	1.94	1.73	2.03	2.20	2.32	2.00
	Multiparous cows					
FCM, %[9]	100	106	114	115	131	115
Energy,%[10]	100	-	107	105	114	107
SCC[3,11]	138	150	175	161	225	177
Days Open[12]	107	120	114	116	161	119
Services/Conception[13]	2.02	1.69	1.86	2.63	2.23	189

[1] Injection dosage/injection frequency (d).

[2] All bST treated cows.

[3] Somatic cell x 10^3.

[4] References 7, 16, 26, 30, 34, 40, 47, 49, 67, 74.

[5] References 7, 34, 40, 67, 74.

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[10] References 4, 7, 27, 34, 35, 40, 53, 65, 67, 74.

[11] References 4, 27, 30, 31, 32, 34, 40.

[12] References 4, 15, 29, 30, 31, 40, 47, 50, 66, 67.

[13] References 13, 19, 30, 31, 40, 50, 66.

Table 3. Effect of bST and injection type (daily or sustained-release) on percent change in FCM and energy intake, SCC, days open, services/conception.

	bST dosage, mg/d[1]					
	0	.1-9.9	10-25.9	26-44.9	>45	bST[2]
	Daily					
FCM, %[4]	100	105	116	126	123	114
Energy, %[5]	100	106	107	108	-	108
SCC[3,6]	173	154	212	373	-	183
Days Open[7]	108	117	120	176	-	121
Services/Conception[8]	2.08	1.65	1.99	2.35	-	1.98
	Sustained-release					
FCM, %[9]	100	104	111	119	123	116
Energy, %[10]	100	-	106	111	1.15	1.10
SCC[3,11]	166	-	176	196	162	171
Days Open[12]	90	100	100	97	116	103
Services/Conception[13]	2.08	1.90	2.43	2.57	2.17	2.38

[1] Injection dosage/injection frequency (d).

[2] All bST treated cows.

[3] Somatic cell x 10^3.

[4] References 4, 6, 11, 13, 16, 19, 20, 21, 23, 27, 30, 31, 32, 35, 38, 43, 44, 47, 49, 50.

[5] References 4, 6, 11, 20, 21, 23, 27, 32, 35, 43, 44, 65, 67, 71, 74.

[6] References 4, 11, 20, 21, 23, 27, 30, 31, 32, 38, 43, 44, 71.

[7] References 4, 14, 15, 16, 20, 21, 23, 30, 31, 32, 43, 44, 47, 50, 66, 67, 74.

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[10] References 7, 15, 22, 34, 40, 48, 53, 56, 59, 72, 74.

[11] References 34, 38, 40, 48, 54, 56, 59, 61, 62.

[12] References 1, 10, 15, 22, 26,29, 37, 40, 57, 59, 61, 63, 72, 73, 74.

[13] References 1, 15, 19, 22, 26, 40, 48, 57, 59, 61, 72, 73, 74.

Table 4. Response to bST in consecutive lactations.

Ref. no.	Days of treatment postpartum	Year 1	Year 2	Doses (mg)
		------- FCM (kg/d) ------		
4	31-305	5.3	3.5	10.3, 20.6/d
15	98-203	4.1	6.5	10.3, 20.6, 30.9/d
22	60-305	8.3	6.4	600, 1800, 3000/14d
31[2]	31-305	1.9	.4	5.15, 10.3, 16.5/d
31[3]	31-305	3.1	1.8	5.15, 10.3, 16.5/d
50	105-308	6.4	1.7	10.3, 20.6/d
59	60-305	4.3	3.1	500/14d

[1] Values represent average increase of all doses over controls.
[2] Cows were parity 1, during year 1.
[3] Cows were parity 2 or more, during year 1.

Table 5. Effect of bST on pregnancy.

	bST dosage, mg/d[1]					
	0	.1-9.9	10-25.9	26-44.9	>45	bST[2]
No. Cows	1520	383	1417	1119	138	3057
Pregnancy, %[3]	85.3	85.2	77.5[a]	81.7[a]	66.7[a]	79.5[a]

[1] Injection dosage/daily injection frequency.

[2] All bST treated cows.

[a] Significantly different from control ($P < .05$).

[3] References 1, 3, 4, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 23, 30, 32, 35, 37, 40, 43, 47, 48, 49, 55, 56, 59, 60, 61, 63, 66, 72, 73.

Table 6. Effect of daily or sustained release (SR) bST on pregnancy (PR).

	bST dosage, mg/d[1]					
	0	.1-9.9	10-25.9	26-44.9	>45	bST[2]
Daily, PR, %[3]	83.1	87.1	77.9	76.9	45.0	78.8
SR, PR, %[4]	86.9	78.6	76.2	82.9	73.0	80.3

[1] Injection dosage/daily injection frequency.

[2] All bST treated cows.

[3] References 4, 11, 13, 14, 15, 16, 19, 20, 21, 23, 30, 32, 35, 43, 47, 49, 55, 60, 66.

[4] References 1, 3, 15, 17, 18, 19, 37, 40, 48, 56, 59, 61, 63, 72, 73.

Table 7. Effect of days postpartum when receiving first bST injection was given on pregnancy (PR).

	Days postpartum when receiving first bST injection		
	1 - 45[1]	45 - 90[2]	90 - 120[3]
Control cows, PR, %	84.7	88.1	80.3
bST cows, PR, %	77.0[a]	81.7[a]	80.2

[a] Significantly different ($P < .01$) within column.

[1] References 1, 4, 11, 13, 21, 30, 35, 43, 47, 48, 49, 55, 60, 66

[2] References 3, 15, 17, 18, 37, 56, 59, 61, 63, 66, 72, 73.

[3] References 14, 15, 16, 19, 20, 23, 32, 40.

Table 8. Effect of bST on number of cows and cases of clinical mastitis during bST treatment.

	bST dosage, mg/d[1]					
	0	.1-9.9	10-25.9	26-44.9	>45	bST[2]
No. Cows	486	235	635	174	112	1156
Cows with mastitis, %[3]	20.0	12.3[a]	27.9[a]	19.5	46.4[a]	25.3[a]
	------------------------ Cases of mastitis ------------------------------					
No. Cows	294	193	511	22	24	750
Cases/cow[4]	.52	.23[a]	.66[a]	.50	1.58[a]	.57

[1] Injection dosage/injection frequency (d).

[2] All bST treated cows.

[a] Significantly different ($P < .05$) from control.

[3] References 4, 13, 15, 17, 18, 20, 21, 30, 31, 32, 38, 48, 57, 59, 66, 67.

[4] References 4, 12, 20, 21, 23, 30, 31, 32, 38, 40, 67, 74.

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