THE EFFECTS OF BOVINE SOMATOTROPIN ON MILK PRODUCTION AND MILK COMPOSITION

A Senior Honors Thesis

By

MEREDITH DIANNE COOK

Submitted to the Office of Honors Programs
& Academic Scholarships
Texas A&M University
In partial fulfillment of the requirements of the

UNIVERSITY UNDERGRADUATE
RESEARCH FELLOWS

April 2000

Group: Economics and Political Science

THE EFFECTS OF BOVINE SOMATOTROPIN ON MILK PRODUCTION AND MILK COMPOSITION

A Senior Honors Thesis

By

MEREDITH DIANNE COOK

Submitted to the Office of Honors Programs
& Academic Scholarships
Texas A&M University
In partial fulfillment of the requirements of the

UNIVERSITY UNDERGRADUATE
RESEARCH FELLOWS

Approved as to style and content by:

Michael A. Tomaszewski
(Fellows Advisor)

Edward A. Funkhouser
(Executive Director)

April 2000

Group: Economics and Political Science

ABSTRACT

The Effects of Bovine Somatotropin on

Milk Production and Milk Composition. (April 2000)

Meredith Dianne Cook
Department of Animal Science
Texas A&M University

Fellows Advisor: Dr. Michael A. Tomaszewski
Department of Animal Science

Bovine Somatotropin is one of the first major biotechnological developments for agriculture, and it is hypothesized that it increases milk production in dairy cattle. It is apparent that Bovine Somatotropin has the potential to be a powerful new tool for the dairy farmer. This study was undertaken to determine the effects of Bovine Somatotropin on milk production and milk composition for dairy cattle. The results of this study indicate that Bovine Somatotropin does influence milk production and milk composition. However, parity and days in milk are also significant variables affecting milk. Treated cows did produce milk longer on average than non-treated cows. However, it is not certain whether the longer length of lactation was due to BST. Therefore, it cannot be determine whether Bovine Somatotropin is the primary variable influencing milk production and milk composition.

TABLE OF CONTENTS

LIST OF TABLES

INTRODUCTION

Since people first began domesticating animals thousands of years ago, they have been striving to improve the quality of the animals themselves in addition to the products they provided. For example, increasing the amount of milk a cow produces would increase the amount for her calf as well as the amount available for human consumption. The earliest history of animal improvements involved the mating of the "best to the best". The genetic recombination of mating superior animals usually results in improved progeny. However, the process of improving animals through breeding is slow. Decades may pass before superior animals are developed.

Genetic selection is still a valid and much needed tool for improving the quality of livestock. However, with the world population expected to reach 10 billion by the year 2030, all facets of the production system need to be evaluated (13). Farmers will need to produce more food with the same limited land and animal resources they currently have. Until genetic selection produces the ultimate dairy cow, innovation and improved management practices are needed to enhance the products produced by the cattle that farmers own today. Biotechnology is part of the strategy to produce more with less, right now. Recombinant Bovine Somatotropin (BST) is one of the first major biotechnological developments for agriculture, and it is hypothesized that it increases milk production in dairy cattle (11).

This study focuses on the effects of BST on milk production and its potential economic impact. Specifically, this study is being conducted to determine whether milk yield increases from BST use. Under the presumption that BST-treated cows actually do produce higher milk yields, an investigation of the causal effects of this increase needs to be conducted to determine whether or not the higher yields are due to BST. Finally, given the cost of BST injections and additional income from any increase in milk production, the economic feasibility of bovine somatotropin can be evaluated.

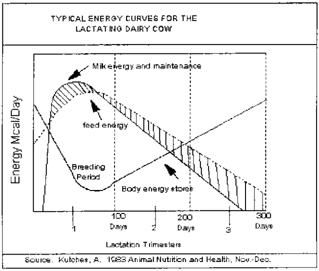
Previous research has been conducted regarding various aspects of Bovine Somatotropin usage. However, many of these reports are conflicting. When one reviews these reports, it is obvious that more research is needed to ascertain the exact effects of BST on dairy cattle.

History

Somatotropin, a hormone, was discovered about 50 years ago. Initial investigations showed that when rats were injected with a crude pituitary extract, growth rate was increased. Only later was it discovered that milk yield of lactating animals increased as well (13). This extract factor was called somatotropin from the Greek derivation meaning "tissue growth." Based on this derivation, somatotropin is sometimes referred to as growth hormone.

In the late 1970's scientists at the National Institute for Research in Dairying in England, and others at Cornell University, began further investigations on Bovine Somatotropin. Both groups concluded that the physiological basis for genetically superior cows (i.e., those more efficient in milk production) was better use of absorbed nutrients. Based on new concepts of how animals regulate the use of nutrients, both groups hypothesized that somatotropin could play a key role in nutrient regulation and that the previously proposed mechanism of action (acutely stimulated use of body fat) was wrong (13). Over the last decade, these concepts have been applied to research involving somatotropin and the biology of nutrient use during growth, pregnancy, and lactation for many species. Initial investigations with cows used pituitary-derived BST. In 1982, after landmark breakthroughs in biotechnology, the Cornell scientists conducted the first study with dairy cows using recombinantly derived BST produced by Monsanto Co. and Genetech Co (16). Since that time, the quality and scope of research with BST has increased exponentially.

Many researchers have credited increased Bovine Somatotropin levels in blood with increased milk production. The mechanism of action has been intensely studied. Bovine somatotropin is produced and excreted from the anterior pituitary. Like any hormone, it is transported through the bloodstream to the various body organs where it exerts its biological effects. In effect, it acts as a chemical link between different cells and organs of the body. Somatotropin regulates the use of absorbed nutrients (1). The graph below illustrates a typical lactation cycle. For a typical lactation, daily milk yield peaks during the first month after parturition and then progressively decreases through the remainder of the lactation cycle. Dairy cows are generally in negative energy balance during the first portion of the lactation cycle. During the first month of lactation for these cows, the body reserves being utilized were energetically equal to about one-third of the milk produced. When milk production is increased, extra nutrients are needed by the mammary glands to provide the raw materials and energy needed to make milk. Somatotropin coordinates the metabolism of various body organs and tissues in a manner that supports the increased nutrient use by the mammary glands. These coordinated adjustments in tissue metabolism involve all nutrient classes—carbohydrates, lipids, proteins and minerals, and are due to the direct action of somatotropin on tissues (13).



Courtesy Ministry of Agriculture, Food and Rural Affairs—Body Condition Scoring Factsheet. Queen's Printer for Ontario

Effects on Milk Production

Several studies have been conducted to determine the relationship between recombinant BST injections and increased milk production. According to most studies, milk yields can increase 10 to 20 percent when cows are injected with BST. These results are achieved gradually over the first few days of injection, and peak at about the sixth day (14). A maximum milk response is achieved at a BST dose (daily injection) of about 30 to 40 milligrams per day (4). No further increase occurs even at doses several-fold higher. Most production trials have used a BST dose between 10 and 50 milligrams per day (3, 4, 14). However, these findings conflict with other research which shows that while production does not decrease, there is no evidence that milk production will increase with BST injections (8). More research needs to be conducted to conclude what the effects of BST are on milk production.

Effects on Lactation

Another area of controversy is whether or not BST is more effective for primiparous cows or multiparous cows. One report states that primiparous cows responded identically to multiparous cows (1). Some research indicates that primiparous cows actually decreased milk production when administered BST (4). However, other findings suggest that response to BST vary according to the current lactation of the cow, with all lactations showing an increase in milk yield (8). According to Huber, the milk response is small or negligible when BST is administered early in lactation. The biological basis for this low response relates to the nutrition/endocrine status of the animal during this interval. In contrast, substantial increases in milk yield occur when BST is administered later in lactation and peak yield of milk is attained. There is no evidence that BST administered during a particular lactation will affect a cow's subsequent lactations in which BST injections are not given (4). Lactation responses to

BST have been reported for all dairy breeds examined. The response BST has according to lactation needs to be examined in more detail.

Effect on Milk Composition

Previous research contends that BST has no effect on the composition of milk. The percentages of fat, protein, lactose, and mineral content in milk produced by BST-treated cows are the same as those for naturally producing cows (4, 10, 14). However, other studies show that, while protein, lactose, and mineral content are not affected by BST, fat content is decreased (8). One possible explanation is that cows supplemented with BST are fed a higher density diet. Yet another study suggests that fat content increase with BST supplementation due to the cow's negative energy balance (17). The investigators of the first study admit that there may be minor changes, primarily in fat content of milk, during the first few weeks of BST supplementation as the cow's metabolism and voluntary feed intake adjusts. However, these changes are temporary and negligible when compared to the variations that normally occur over a lactation cycle. Whereas the lactose content of milk remains relatively constant, the content of fat, and to a lesser extent protein, normally varies widely due to many factors including genetics, breed, stage of lactation, age, diet, nutritional status, environment, and season. These factors affect the fat and protein content of milk in the same manner for BST supplemented and non-treated cows.

According to Otterby, the temporary shift in milk fat that can occur during the first few weeks of BST supplementation relates to nutritional status. Cows in negative energy balance produce milk with a higher fat content due to a greater reliance on lipids mobilized from body fat stores. Milk fat content is most likely to increase when BST supplementation is initiated in the first 100 days postpartum, during which time cows are typically in lower energy balance. However, the negative energy balance characteristic of this period is far in excess of that associated with BST supplementation. More studies should be conducted to determine the effect BST has on milk composition.

Effects on Cow Health

Catastrophic health effects have been postulated to occur with BST supplementation of dairy cows. Mastitis, ketosis, fatty liver, and chronic wasting all have been proposed as possible side effects. Crippling lameness, milk fever, infertility, sickness, and death are recent additions to the list of adverse health claims (15).

Subtle effects on the incidence and duration of mastitis are of special interest. Mastitis is an economically important disease to the dairy industry. The costs associated with clinical mastitis are estimated at approximately $100 per clinical case (9). The incidence of mastitis is directly impacted by management and herd health programs. However, the incidences of mastitis and elevated milk somatic cell counts are also positively correlated with increased milk yields regardless of BST use (15, 19). There is an overwhelming gap in the results of various studies regarding the use of BST and its role in the onset of mastitis. The reports are split equally among those that claim more mastitis, less mastitis, and no effect on mastitis as a result of BST use. Some studies show that the effects are negligible and claim that BST treated cows have the same incidence of mastitis as non-treated cows (6, 9, 14). If any occurrence were found, it could be attributed to the fact that higher producing cows naturally are more prone to udder disease. Thus, research on a very large sample of cows will be required to detect and evaluate whether subtle effects, independent of milk yield response, occur with the use of BST.

An equal number of studies report that the incidence of mastitis actually decreases in response to BST (5, 7). Finally, other scientists claim that the incidence of mastitis increases with BST use, which is evident by higher somatic cell counts. They attribute this increased incidence to milk overproduction, which in turn weakens the cow's immune system (4, 12). Another related report of interest concludes that, even though the incidence of mastitis increases with BST use, those cows will have a shorter duration of infection than non-BST cows (2).

Another concern that has been raised is the possibility that even a small increase in occurrence of mastitis from higher-producing animals will lead producers to increase the use of antibiotics in cows. The increased use of antibiotics has been a concern because of potential hazards to human health and the possibility of promoting bacterial resistance to antibiotics. It is obvious that more investigation needs to be done to form a definite conclusion regarding the use of BST and the incidence of mastitis.

Effects of Management

The milk response to BST on an individual farm will vary according to quality of management. Facets that contribute to the quality of the overall management program include the herd health program, milking practices, nutrition program, and environmental conditions. Inadequate nutrient management can result in a near-zero response to BST supplementation (18). Bovine Somatotropin is not magic. If cows are given an inadequate amount of feed or are fed a diet that is not nutrient-balanced, the magnitude of the response to BST will decrease accordingly (20).

Other Concerns Regarding the Use of Recombinant BST

A major concern with the adoption of BST is its potential side effects on human health. It is feared that BST obtained through consumption of milk will affect human growth rates. Research has been conducted to address this concern.

Somatotropin is species-limited. This means that there are differences in the ability of somatotropin from one species to elicit biological effects when injected into other species. Somatotropin is also a protein hormone. Like all proteins, it is composed of amino acids. The amino acid sequence of somatotropin is known for many species, including cattle. Bovine Somatotropin can be either 190 or 191 amino acids long and either of two different amino acids, leucine or valine, can occupy position number 126 in the sequence (13). Thus, four different variants of BST are produced naturally.

Typically, the pituitary produces equal amounts of the 190 and 191 amino acid BST. About two-thirds of the total BST produced has leucine at position 126, while the remaining one-third has valine at that position. To have a biological effect, a protein hormone must first bind to a specific receptor located on the cell surface. The amino acid sequence of somatotropin gives it a unique three-dimensional shape, which determines its ability to bind to receptors and elicit a biological response. The reason for BST's lack of effect in humans became clear when it was discovered that the three-dimensional shape of Bovine Somatotropin differs by about 35 percent from that of Human Somatotropin (6). Thus, BST is not able to bind to the somatotropin receptors of human tissues and, consequently, cannot affect human health.

Another concept that supports the idea that BST cannot affect human health is the mechanism of the human digestive tract. When a protein such as BST is ingested, digestive enzymes in the stomach break down the protein into individual amino acids. These amino acids are absorbed through the walls of the small intestine. Thus, whole, intact proteins cannot penetrate the lining of the stomach or small intestines, prohibiting any biological effect.

Emerging technologies will play a critical role in shaping the US dairy industry. Advances in health, reproduction, and information technology all will affect the industry. It is speculated that the most dramatic impact will be due to BST. Claims have been made that BST is unsafe to consumers, an unsafe product for cows, and a technology that will economically destroy many traditional farms. Others advocate that it poses no health risks to consumers or cows, and that it alone will not economically disadvantage the traditional farm operator. BST will merely accelerate an existing trend-- the pressure on the traditional farm to either grow or exit the industry. Changes in rate of technology adoption and perhaps dairy policy may be required to reverse this trend.

It is apparent that Bovine Somatotropin has the potential to be a powerful new tool for the dairy farmer. However, more research is needed to determine whether it is a miracle or a fluke. The purpose of this study is to determine the economic feasibility of the use of BST on a small farm. Once that is determined, this report can be used as a benchmark for dairy managers needing to decide whether BST is right for their farm.

METHODS

Texas A&M University owns and maintains the Dairy Center on F&B Road. The center represents an average dairy farm, with a mixed herd of Holstein and Jersey dairy cows. After 63 days in milk according to label recommendations, 50% of the cows were given a time-release BST injection every two weeks beginning March 1998. Cows were selected based on their ear tag number. Cows with odd numbered ear tags received the injection, while even numbered cows did not. This was done to insure random assignment of cows to the treatment group. These numbers are assigned sequentially at birth, thus ensuring random assignment. The dairy center has kept records of weekly milk weights for all cows during the duration of BST injections. Additionally, Texas A&M is a member of the Texas Dairy Herd Improvement program. This program provides the periodic collection of milk weights and a sample from which milk fat and protein values are calculated. These data, along with other pertinent management data are processed and maintained at a central database operated by the Dairy Records Management System (DRMS) in Raleigh, North Carolina.

The DRMS database was accessed and records were extracted on all cows currently in the herd and any cows that had left the herd since 1998. A total of 428 records were obtained (please see Appendix for complete data). Number of records refers to lactations, not cows. The 428 lactations represent 220 cows. For the purposes of this study, the period of BST injections begins March 1998 and ends February 2000.

It was then necessary to isolate only those cows that completed lactation during the period when BST injections were given. This was done in order to have complete lactation data to analyze. Therefore, any cow that was terminated from the herd was removed from the list. Next, any cow that calved prior to 1998 was also removed. This reduced the number of records to 177 lactations. Finally, any cow that calved after June 1999 was removed because it would not have been possible to complete a lactation prior to February 2000. The final data set consisted of 109 complete lactations within the time frame in which BST injections were given. The information obtained from DRMS consisted of three different measures for milk weight and milk composition. Milk 305 represents the projected ME milk weight and milk composition for a 305-day lactation. The measure is projected to remove lactation (maturity) effects. The actual 305-day milk weight (Act Milk) and milk composition is the actual value for milk produced in 305 days. If the lactation was less than 305 days, it is the actual milk produced for the less than 305-day lactation. Lactation to Date (LTD) milk weight and milk composition represent the amount of milk produced and the milk composition for the complete lactation.

The cows were then separated based on BST status. Non-BST treated cows were assigned to Group 0 and included 38 lactations. Cows receiving three or more BST injections were assigned to Group 2 and consisted of 49 lactations. A few cows were mistakenly given one or two injections of BST during the designated time frame. These cows were assigned to Group 1 and account for 22 lactations. Mean averages were calculated for 305-day ME Milk (Milk 305), Actual 305-day Milk (Act Milk) and

Lactation To Date Milk (LTD Milk) for Groups 0, 1 and 2. Based on these averages, it was determined from a mean test that Group 1, cows given only one or two injections of BST, was not significantly different from the control group, and were included in Group 0. Therefore, for the purposes of the study, lactations will be designated as either Group 0 or Group 2.

Lactations were next categorized based on parity within group. First lactations (38 cows in Group 0, 29 cows in Group 2) were designated Lac 1, second lactations (15 cows in Group 0, 7 cows in Group 2) were Lac 2 and three or more lactations (7 cows in Group 0, 13 cows in Group 2) were denoted Lac 3. Research has shown that after the second lactation, there is little difference in milk production based on parity. For this reason, cows with three or more lactations were grouped together. Using these data categories, statistical analysis was conducted utilizing the SAS ANOVA. A generalized linear model for Milk 305, Act Milk and LTD Milk and least squares means were calculated. The three categories of milk served as the dependent variables on which to test the effects of independent variables. The model was applied to the 109 cows to test the effects of BST, lactation, the interaction between BST and lactation, days in milk (DIM) and the interaction between BST and DIM on milk production. BST, lactation, DIM and the interactions of BST served as the independent variables whose effects were tested on the dependent variables. The model served to statistically compute which, if any, of the above variables significantly impacted the amount of milk produced. To be considered significant, the variable must have a $Pr < 0.05$ according to the model. Least squares means were calculated for each model according to BST group and lactation number. Least squares means represents a more accurate average. In other words, it represents the averages of dependent variables if the effects of independent variables are removed. It is a "true" average. Simple means are averages of dependent variables acted upon by independent variables.

Next, the factors affecting milk composition were determined. The model was applied and least squares means were calculated in the exact manner as stated above to statistically analyze projected 305-day protein and fat, actual 305-day protein and fat, and lactation to date protein and fat. To compare adjusted averages for milk components, simple means by BST and lactation group were calculated. Since one economic indicator for milk, fat and protein was desired, energy corrected milk (ECM) was calculated for each lactation. ECM was analyzed using the model, least squares means and simple means.

Income from milk sales was then computed for each of the three milk values and (ECM). The average milk and butterfat price for 1998 and 1999 for Dallas, Texas was used to calculate milk prices. The Dallas milk price was used since all regions use Dallas as the marker for any distance differentiates. The formula used was:

Income = (lbs. of milk / 100) x ($15.07 + (.1575 points for butterfat)).

Income was calculated per cow, and simple means were derived from the results. Cost was determined to be $6.50 per BST injection. Cost was calculated for each cow using the formula:

Cost = number BST injections x $6.50.

Net income was calculated using the following formula for each cow.

$$Net = Income - Cost$$

Simple means were calculated for all milk values for net income. Using statistical data computed to this point, it is possible to determine the effects of BST on milk production and milk composition, and the net income and additional income, if any, for BST-treated and non-BST-treated cows with complete lactations.

In order to thoroughly analyze the effects of BST use, cows that had not completed lactation or had been terminated needed to be observed. Using the original 428 lactation records, any cow that calved prior to 1998 and after June 1999 was removed from the data set. Next, any cow that did not have a termination code was deleted from the data set. This left 63 lactations remaining in the data set that would be used to statistically analyze cows that were terminated and may not have completed their lactation. The terminated cows were grouped in the same manner as the complete lactation cows with regard to BST status and lactation number. The exact calculations and models for milk production, milk composition, income and cost as stated above for complete lactation cows were also performed for the terminated cows so that the same results were available for terminated cows. Using this information in conjunction with data from complete lactation cows, a conclusion can be formulated regarding the economic use of BST for a small dairy farm.

ANALYSIS AND DISCUSSION

Effects on Milk Production

The first analysis included current cows with complete lactations. Means for Milk 305, Act 305 and LTD Milk by to BST group and lactation are shown in Table 1.

	BST									
	Group 0					Group 2				
	Milk 305		Act	LTD	DIM	Milk 305		Act	LTD	DIM
Lac	N	Mean	Mean	Mean	Mean	N	Mean	Mean	Mean	Mean
1	38	19582	15993	18719	360	29	21435	17517	20913	373
2	15	23316	20918	23318	354	7	21183	19531	24933	416
3	7	23750	22338	26235	365	13	22975	22914	26480	374
All	60	21002	17965	20746	359	49	21808	19237	22964	379

Table 1. Means for milk weights by lactation and BST group for complete lactation cows.

The means for all milk values were weighted by the number of cows in each lactation. The differences between Milk 305, Act Milk and LTD Milk averages are 806 lbs., 1272 lbs., and 2218 lbs., respectively. Cows with BST injections produced more milk than non-BST cows for all three categories of milk weights. Since Milk 305 is fixed at 305 days, and on average the cows produced more than 305 days, we anticipate this difference in production. However, in lactation 1, BST cows were in milk 13 more days than non-BST cows. Second lactation cows were in production for 62 days more than non-BST cows, while third lactation cows were 9 days different. On average, there was a 20-day difference between BST vs. non-BST cows. However, the model must be evaluated to determine if BST had a significant impact on milk production. The data from the model is presented in Table 2.

	Generalized Linear Model – Milk Weights								
	Milk 305			Act Milk			LTD Milk		
	df	MS	P <	df	MS	P <	df	MS	P <
BST	1	73201404	0.01	1	88007619	0.01	1	42265981	0.07
Lact	2	4160650	0.01	2	17537203	0.01	2	1592001061	0.01
BST x Lact	2	87234841	0.10	2	92464774	0.29	2	45305834	0.29
DIM	1	71127622	0.57	1	286559179	0.01	1	329147042	0.01
BST x DIM	1	30346736	0.01	1	13652897	0.06	1	15340909	0.06

Table 2. General model for milk weights for complete lactation cows.

General Linear Model—Significant Differences Between Lactations for Milk Prod.							
	Milk 305			Act Milk		LTD Milk	
	df	MS	Pr <	MS	Pr <	MS	Pr <
Lac 1 vs 2	1	56431359	0.01	194290903	0.01	189971243	0.01
Lac 1 vs 3	1	114125846	0.01	485811731	0.01	582334264	0.01
Lac 2 vs 3	1	6734126	0.47	43522041	0.01	70565472	0.01

Table 3. Model of contrast between lactations for milk for complete lactation cows.

According to the results of the generalized linear model for Milk 305, effects due to BST status, lactation number and the interaction between DIM and BST had a significant impact. The model for Act Milk was affected in the same manner. The factors affecting LTD Milk, however, were different than the other two milk values. According to the model, there were differences in milk production based on lactation and DIM only. In our model, BST use did not effect lactation yield significantly. We did not expect to see an effect from lactation for Milk 305 since it is a projected value, and the effects of lactation are supposed to be removed. However, a difference in milk production was still present in the first versus second and the first versus third lactations, but there was no difference between the second and third lactations. This could be due to the disproportionate number of first versus later lactation cows. The Milk 305 model showed there was a difference in milk production based on lactation, but it did not show which lactations were different. The three lactations were contrasted to observe which lactations differed. The results, shown in Table 3, showed that there was a difference in milk production between lactation 1 and lactation 2 and between lactation 1 and lactation 3. There was no difference in milk production between lactations 2 and lactation 3. Because there were differences between lactation 1 and the other lactations, it skewed the Milk 305 model for lactation to show that there was significance. The lactation contrast shows that there were differences between all lactation for Act Milk and LTD Milk. This was expected because those milk values were not adjusted for lactation, so a difference in production based on lactation should be seen.

Milk 305 is adjusted to a 305-day lactation and Act Milk is the actual value of milk produced to 305 days of lactation. Therefore, it is expected that DIM will not have a significant impact on Milk 305 or Act Milk production. This is shown to be true, as there is no differences in milk production based on DIM for Milk 305 or Act Milk. However, there is a significant interaction between BST and DIM. This means that there was an effect of BST present over the course of the lactation even though DIM is adjusted. DIM should have an impact on LTD Milk production because cows had varying lengths of lactation. Therefore, cows that lactate longer are likely to produce more milk. According to the model, there is a difference in milk production based on DIM.

Least Squares Means – Milk Production				
BST	**Lac**	**Milk 305**	**Act Milk**	**LTD Milk**
0	**1**	19691	16125	19167
2	**1**	21474	17546	20732
0	**2**	23511	21154	24117
2	**2**	21602	19843	23024
0	**3**	23798	22397	26436
2	**3**	23026	22951	26246

Table 4. Least squares means for milk complete lactation cows.

Least squares means were computed for all three milk values and are shown in Table 4. The means suggest that for all milk values, first lactation cows treated with BST produce more milk than naturally producing cows. However, in subsequent lactations, non-BST cows produce more milk than BST-treated cows. For the first lactation it appears that BST injections cause cows to produce more milk. However, for subsequent lactations, according to the LTD milk model, it appears that DIM and lactation number have the greatest impact on milk production, not BST. This makes sense because multiparous cows lactate longer than primiparous cows, thus enabling them to produce more milk. The least squares means conclusion is different from that of the simple means because the least squares means are adjusted for all the effects within the model. Thus, the data for milk production suggests that lactation number and DIM are the most important factors affecting milk production.

Effects on Fat Content

Means for Fat 305, Act Fat and LTD Fat are shown in Table 5. BST injected cows produced more pounds of fat than non-BST cows. The differences between Fat 305, Act Fat and LTD Fat averages are 38 lbs., 56 lbs., and 102 lbs., respectively.

	BST											
	Group 0						Group 2					
	Fat 305		Act Fat		LTD Fat		Fat 305		Act Fat		LTD Fat	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	38	748	38	621	38	739	29	805	29	671	29	822
2	15	841	15	769	15	863	7	814	7	765	7	983
3	7	880	7	836	7	1006	13	875	13	877	13	1039
All	60	787	60	683	60	801	49	825	49	739	49	903

Table 5. Means for milk fat by lactation and BST group for complete lactation cows.

	Generalized Linear Model – Fat Content								
	Fat 305			Act Fat			LTD Fat		
	df	**MS**	**P <**	**df**	**MS**	**P <**	**df**	**MS**	**P <**
BST	1	64945	0.01	1	15194	0.01	1	92435	0.24
Lact	2	80317	0.01	2	419056	0.01	2	361908	0.01
BST x Lact	2	14079	0.25	2	9089	0.59	2	4458	0.44
DIM	1	3918	0.53	1	3112780	0.10	1	22571	0.01
BST x DIM	1	66278	0.01	1	11242	0.01	1	83126	0.31

Table 6. General model for milk fat for complete lactation cows.

General Linear Model—Significant Differences Between Lactations for Fat Prod.							
	Fat 305			Act Fat		LTD Fat	
	df	**MS**	**Pr <**	**MS**	**Pr <**	**MS**	**Pr <**
Lac 1 vs 2	1	47313	0.01	230132	0.01	164359	0.01
Lac 1 vs 3	1	141420	0.01	624962	0.01	791436	0.01
Lac 2 vs 3	1	16573	0.20	63871	0.01	153285	0.01

Table 7. Model of contrast between lactations for fat for complete lactation cows.

The model for fat is shown in Table 6. According to the model, BST, lactation and the interaction between BST and DIM had a significant effect on fat production for Fat 305 and Act Fat. There were differences in milk production based on lactation and DIM for LTD Fat. BST was not significant for LTD Fat, according to the model, but was significant for Fat 305 and Act Fat. A difference in fat content due to lactation is not expected for Fat 305 since it is a projected value with effects due to lactation removed. However, according to the model shown in Table 7, a difference in fat content is still present in the first versus second and first versus third lactations. Act Fat and LTD Fat are not adjusted for lactation, so differences in fat content are anticipated. According to the model, there are differences in fat content based on lactation for Act Fat and LTD Fat. Differences are seen between all lactations for Act Fat and LTD Fat.

DIM does not have an impact on fat production for Fat 305 or Act Fat. This is expected since those fat values are adjusted to a 305-day lactation. However, there is a significant interaction between BST and DIM, meaning an effect of BST was present over the course of the lactation. DIM should and does have a significant impact on LTD Fat because the length of lactation differed for each cow. This is expected because the longer the DIM, the more likely the cow is to produce more fat.

Least Squares Means – Fat Content				
BST	**Lac**	**Fat 305**	**Act Fat**	**LTD Fat**
0	**1**	751	625	756
2	**1**	806	671	813
0	**2**	846	776	895
2	**2**	825	772	887
0	**3**	881	837	1014
2	**3**	875	878	1027

Table 8. Least squares means for fat for complete lactation cows.

The least squares means for all three fat values were computed and the results are shown in Table 8. The means suggest that first lactation BST-treated cows produce more fat than the control cows. However, for subsequent lactations, non-BST cows produce more fat than BST-treated cows. There is a discrepancy between least squares means and simple means. This is because the least squares means adjusts for all the effects within the model. Thus, the information for fat composition suggests that the most important factors affecting fat content are lactation and DIM.

Effects on Protein Content

Means for Protein 305, Act Protein and LTD Protein are shown in Table 9. The averages show that BST cows produced more protein content in milk than non-BST cows. The differences between Prot 305, Act Prot and LTD Prot averages are 32 lbs., 46 lbs., and 87lbs., respectively.

	BST											
	Group 0						Group 2					
	Prot 305		Act Prot		LTD Prot		Prot 305		Act Prot		LTD Prot	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	38	629	38	526	38	625	29	686	29	576	29	708
2	15	728	15	672	15	756	7	666	7	631	7	824
3	7	756	7	714	7	858	13	751	13	750	13	889
All	60	669	60	584	60	685	49	701	49	630	49	772

Table 9. Means for milk protein by lactation and BST group for complete lactation cows.

	Generalized Linear Model – Protein Content								
	Prot 305			Act Prot			LTD Prot		
	df	MS	P <	df	MS	P <	df	MS	P <
BST	1	45437	0.01	1	69936	0.01	1	10749	0.26
Lact	2	69600	0.01	2	265043	0.01	2	308777	0.01
BST x Lact	2	25147	0.01	2	13582	0.13	2	19110	0.11
DIM	1	1849	0.62	1	13558	0.15	1	2219500	0.01
BST x DIM	1	51172	0.01	1	68384	0.01	1	9257	0.30

Table 10. General model for milk protein for complete lactation cows.

General Linear Model—Significant Differences Between Lactations for Protein							
	Prot 305			Act Prot		LTD Prot	
	df	MS	Pr <	MS	Pr <	MS	Pr <
Lac 1 vs 2	1	29407	0.05	160784	0.01	126601	0.01
Lac 1 vs 3	1	130202	0.01	463348	0.01	579946	0.01
Lac 2 vs 3	1	23465	0.08	51637	0.01	107690	0.01

Table 11. Model of contrast between lactations for protein for complete lactation cows.

The model for protein is shown in Table 10. The model for Protein 305 shows that there are significant differences in protein content based on BST status, lactation, the interaction between lactation and BST and the interaction between lactation and DIM. The only variable that does not affect protein content for Protein 305 is DIM. This is expected because Protein 305 is adjusted for DIM. However, although DIM is adjusted for, there is still an effect of BST present over the course of the lactation. According to the model shown in Table 11, there is a difference in protein production present in the first versus third lactations, but there is no difference between the first versus second or second versus third lactations. Because there is a difference between the first and third lactations, it skews the model for lactation to show that there is significance. This is not what is expected because lactation is adjusted for in Protein 305. Although lactation was adjusted, an effect of BST was present based on parity.

The variables shown to affect Act Protein according to the model are BST, lactation and the interaction between BST and DIM. Differences in protein are seen in all three lactations for Act values, as expected. Effects of BST are still present over the course of lactation despite the fixed lactation length of 305 days. There are differences in protein content for LTD Protein based on lactation and DIM. According to the model, there is a significant difference in protein for all lactations of LTD values. This was anticipated because LTD is not adjusted for lactation number, therefore, variability should be present. Differences due to DIM are expected due to various lactation lengths. Cows that lactate longer are more likely to produce higher amounts of protein.

Least Squares Means – Protein Production				
BST	**Lac**	**Prot 305**	**Act Prot**	**LTD Prot**
0	**1**	631	529	640
2	**1**	687	576	700
0	**2**	732	678	783
2	**2**	676	638	743
0	**3**	757	715	865
2	**3**	752	751	878

Table 12. Least squares means for protein for complete lactation cows.

Least squares means were calculated and the results are shown in Table 12. According to the means, first lactation BST cows produce more protein content in milk than naturally producing cows. However, in subsequent lactations, non-BST cows produce higher protein content in milk than do BST cows. For the first lactation it appears that BST injections cause cows to produce more protein. For subsequent lactations, however, based on the LTD Protein model, it appears that DIM and lactation have the greatest impact on protein content, not BST. This is reasonable because multiparous cows usually lactate longer than primiparous cows, therefore, they are able to produce more protein.

Effects on ECM

Energy corrected milk (ECM = (.3246 x Milk) + (12.86 x Fat) + (7.04 x Protein)) data was evaluated for 305-Day, Actual 305-Day and LTD values. The means, shown in Table 13, reveal BST cows produced more energy corrected milk than non-BST cows. The gap between BST and non-BST ECM average values is very wide. The differences between ECM 305, Act ECM and LTD ECM averages are 975 lbs., 1451 lbs., and 2643 lbs., respectively.

	BST											
	Group 0						Group 2					
	ECM 305		Act ECM		LTD ECM		ECM 305		Act ECM		LTD ECM	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	38	20410	38	16886	38	19975	29	22146	29	18367	29	22347
2	15	23515	15	21405	15	23994	7	22032	7	20617	7	26539
3	7	24347	7	23026	7	27496	13	23995	13	24002	13	28209
All	60	21645	60	18732	60	21858	49	22620	49	20183	49	24501

Table 13. Means for energy corrected milk by lactation and BST group for complete lactation cows.

	Generalized Linear Model – ECM								
	ECM 305			Act ECM			LTD ECM		
	df	**MS**	**P <**	**df**	**MS**	**P <**	**df**	**MS**	**P <**
BST	1	57080229	0.01	1	77735219	0.01	1	19584338	0.13
Lact	2	67499727	0.01	2	284054774	0.01	2	327750101	0.01
BST x Lact	2	19508852	0.09	2	8205156	0.30	2	11963444	0.25
DIM	1	3132236	0.53	1	16901434	0.12	1	2127854906	0.01
BST x DIM	1	62965165	0.01	1	75170047	0.01	1	17856953	0.15

Table 14. General model for energy corrected milk for complete lactation cows.

The models for energy corrected milk are shown in Table 14. According to the results of the generalized linear model for ECM 305, effects due to BST, lactation and the interaction between BST and DIM had significance. The model for Act ECM was affected in the same manner. DIM was not, as expected, a factor influencing ECM 305. However, effects of BST are present over the course of lactation despite DIM adjustments. Lactation was not anticipated to affect ECM 305, because the values used are adjusted for lactation. However, an effect of lactation is still present. The only variables influencing LTD ECM are lactation and DIM. DIM should be significant because the lengths of lactation vary in this category. Because cows that lactate longer generally produce more milk, differences in production by DIM are expected. Lactation is a significant variable for Act ECM and LTD ECM, because these values do not adjust for the effects of lactation.

Least Squares Means –ECM				
BST	**Lac**	**ECM 305**	**Act ECM**	**LTD ECM**
0	1	20502	17008	20459
2	1	22179	18391	24857
0	2	23681	21624	27713
2	2	22386	20879	22118
0	3	24388	23080	24127
2	3	24038	24034	27914

Table 15. Least squares means for ECM for complete lactation cows.

Least squares means were calculated and are shown in Table 15. The means suggest that first lactation BST-treated cows produce more milk than naturally producing cows. However, non-BST cows produce more energy corrected milk than BST-treated cows in second and later lactations. Thus, the model and least squares means suggest that lactation number and DIM are the most important factors affecting energy corrected milk production.

Effects on Income, BST Costs and Net Income

Income, cost and net income were calculated for each of the three milk values, per individual cow. Figures are displayed in Tables 16, 17 and 18.

	BST											
	Group 0						Group 2					
	Price		BST Cost		Net		Price		BST Cost		Net	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	38	3050	38	0	38	3050	29	3317	29	115	29	3202
2	15	3554	15	0	15	3554	7	3307	7	118	7	3189
3	7	3655	7	0	7	3655	13	3573	13	94	13	3479
All	60	3247	60	0	60	3247	49	3384	49	110	49	3274

Table 16. Means for Milk 305 milk prices, BST cost and net income by lactation and BST group for complete lactation cows.

	BST											
	Group 0						Group 2					
	Price		BST Cost		Net		Price		BST Cost		Net	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	38	2507	38	0	38	2507	29	2731	29	115	29	2616
2	15	3210	15	0	15	3210	7	3072	7	118	7	2954
3	7	3451	7	0	7	3451	13	3572	13	94	13	3478
All	60	2793	60	0	60	2793	49	3003	49	110	49	2893

Table 17. Means for Act Milk prices, BST cost and net income by lactation and BST group for complete lactation cows.

	BST												
	Group 0						Group 2						
	Price		BST Cost		Net		Price		BST Cost		Net		
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	38	2952	38	0	38	2952	29	3294	29	115	29	3179
2	15	3588	15	0	15	3588	7	3931	7	118	7	3814
3	7	4092	7	0	7	4092	13	4167	13	94	13	4073
All	60	3244	60	0	60	3244	49	3617	49	110	49	3507

Table 18. Means for LTD milk price, BST cost and net income by lactation and BST group for complete lactation cows.

Using income and cost for Milk 305, cows supplemented with BST earn on average $27 more net income per lactation than cows not injected with BST. BST-treated cows earn an average of $100 more net income per lactation than non-BST cows if net income is computed using Act Milk. If net income is calculated using LTD Milk, cows injected with BST provide $263 additional net income per lactation over naturally producing cows.

TERMINATED COWS

Effects on Milk Production

The second analysis included the terminated cows. All calculations and models computed for complete lactation cows were also produced for terminated cows. Means for Milk 305, Act Milk and LTD Milk are shown in Table 19. Terminated BST-treated cows produced more milk than terminated non-BST cows. The means for all milk values were weighted by the number of cows in each lactation. The differences between Milk

305, Act Milk and LTD Milk averages are 1689 lbs., 2736 lbs., and 3734 lbs., respectively.

	BST									
	Group 0					Group 2				
	Milk 305		Act	LTD	DIM	Milk 305		Act	LTD	DIM
Lac	N	Mean	Mean	Mean	Mean	N	Mean	Mean	Mean	Mean
1	15	18876	12846	14698	285	14	20023	14489	17829	305
2	10	19436	14142	14953	243	11	23474	19095	20230	277
3	5	22444	20737	21274	267	8	20741	19871	21887	319
All	30	19658	14593	15879	268	33	21347	17329	19613	299

Table 19. Means for milk weights by lactation and BST group for terminated cows.

On average, cows produced more than 305 days, however, Milk 305 is fixed at 305 days, therefore, we expected that there would be a difference in production. However, in lactation 1, BST cows lactated 20 days longer than non-BST cows. Second lactation cows produced for 34 more days than non-BST cows, and third lactation cows were in milk 52 more days than non-BST cows. On average, there was a 31-day difference in production between BST and non-BST cows. The model, shown in Table 20, must be evaluated to determine the impact of BST.

	Generalized Linear Model – Milk Weights								
	Milk 305			Act Milk			LTD Milk		
	df	MS	P <	df	MS	P <	df	MS	P <
BST	1	1682107	0.73	1	22017131	0.19	1	3040133	0.56
Lact	2	50533684	0.01	2	231765564	0.01	2	146661136	0.01
BST x Lact	2	35290859	0.10	2	36370304	0.06	2	34755234	0.01
DIM	1	356918125	0.01	1	1068421192	0.01	1	2896918264	0.01
BST x DIM	1	560043	0.84	1	16769633	0.25	1	10693533	0.28

Table 20. General model for milk weights for terminated cows.

General Linear Model—Significant Differences Between Lactations for Milk Prod.							
		Milk 305		Act Milk		LTD Milk	
	df	MS	Pr <	MS	Pr <	MS	Pr <
Lac 1 vs 2	1	90051404	0.01	216053896	0.01	138110344	0.01
Lac 1 vs 3	1	41676861	0.10	396327218	0.01	249809144	0.01
Lac 2 vs 3	1	2316732	0.70	48921523	0.05	30105948	0.07

Table 21. Model of contrast between lactations for milk weights for terminated cows.

According to the results of the model, lactation and DIM are the only factors that had a significant effect on Milk 305 and Act Milk production for terminated cows. The model for LTD Milk was affected in the same manner, except a difference was present in milk production based on the interaction between BST and lactation. In our model, BST use did not significantly affect lactation yield for any milk value. An effect from lactation for Milk 305 was not expected since it is a projected value and the effects of lactation are supposed to be removed. However, a difference in milk production is still present in the first versus second lactations according to the mean contrasts shown in Table 21. There was no difference observed in the model between first and third or second and third lactation cows. This could be due to the disproportionate number of first lactation cows versus later lactation cows in the data set. The model results showed lactation was significant because of the difference in milk production between first and second lactations only. Act Milk and LTD Milk are expected to differ between all lactations. However, the results of the model do not reflect that to be true. There are significant differences between first versus second and first versus third lactation, but not between second versus third lactation. The model for LTD Milk shows a significant interaction between BST and lactation. This means there is an effect of BST present based on parity.

Milk 305 is adjusted for DIM, however, a difference based on DIM is shown according to the model. The results are the same for Act Milk. DIM is significant for LTD Milk. This is reasonable because cows varied in lactation length. Therefore, cows that have a longer lactation are likely to produce more milk.

Least Squares Means – Milk Production				
BST	**Lac**	**Milk 305**	**Act Milk**	**LTD Milk**
0	**1**	18866	12828	14673
2	**1**	19596	13816	16485
0	**2**	20342	15838	17284
2	**2**	23618	19322	20683
0	**3**	22819	21439	22239
2	**3**	20042	18770	19690

Table 22. Least squares means for milk weights for terminated cows.

Least squares means were computed and are shown in Table 22. The least squares means for terminated cows suggest that BST-treated cows produce more milk during first and second lactations. However, non-BST cows produce more milk than BST-treated cows after the second lactation. For the first two lactations, it appears that BST injections cause cows to produce more milk. For subsequent lactations, it appears that DIM and lactation number have the greatest impact on milk production, not BST. The least squares means suggests different results than the simple means because the least squares means are adjusted for all the effects within the model.

Effects on Fat Content

Means for Fat 305, Act Fat and LTD Fat are shown in Table 23. The means show that BST-treated cows produced more fat than non-BST cows. The differences between Fat 305, Act Fat and LTD Fat averages are 18 lbs., 70 lbs., and 111 lbs., respectively.

	BST											
	Group 0						Group 2					
	Fat 305		Act Fat		LTD Fat		Fat 305		Act Fat		LTD Fat	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	15	733	15	496	15	574	14	751	14	541	14	681
2	10	773	10	564	10	597	11	850	11	702	11	748
3	5	827	5	768	5	791	8	735	8	706	8	786
All	30	762	30	564	30	618	33	780	33	634	33	729

Table 23. Means for milk fat by lactation and BST group for terminated cows.

	Generalized Linear Model – Fat Content								
	Fat 305			Act Fat			LTD Fat		
	df	**MS**	**P <**	**df**	**MS**	**P <**	**df**	**MS**	**P <**
BST	1	381	0.87	1	30395	0.16	1	8836	0.35
Lact	2	50431	0.01	2	279292	0.01	2	155914	0.01
BST x Lact	2	30643	0.15	2	42665	0.07	2	46085	0.01
DIM	1	328889	0.01	1	1445838	0.01	1	4345389	0.01
BST x DIM	1	3073	0.66	1	39890	0.11	1	10900	0.30

Table 24. General model for milk fat for terminated cows.

General Linear Model—Significant Differences Between Lactations for Fat Prod.							
	Fat 305			Act Fat		LTD Fat	
	df	**MS**	**Pr <**	**MS**	**Pr <**	**MS**	**Pr <**
Lac 1 vs 2	1	100790	0.01	316345	0.01	189669	0.01
Lac 1 vs 3	1	14428	0.34	434366	0.01	231139	0.01
Lac 2 vs 3	1	19994	0.27	29137	0.17	10873	0.31

Table 25. Model of contrast between lactations for milk fat for terminated cows.

The model for fat production is shown in Table 24. The Fat 305 and Act Fat models suggest that there are significant effects on fat due to lactation and DIM. Lactation, DIM and the interaction between lactation and BST were significant variables affecting LTD Fat. None of the models showed a significant difference in fat production based on BST use. Effects of lactation were not expected for Fat 305 because those values are adjusted for lactation. However, there is a difference present between the first versus the second lactation, but there is no difference between the first versus third or second versus third lactations according to the model in Table 25. Effects of lactation are present, according to the model, for Act Fat and LTD Fat, as expected. However, the mean contrasts show there is only a difference in lactation for first versus second and first versus third, but not for second versus third lactations. There is an effect seen by the interaction between BST and lactation for LTD Fat. This means that effects of BST were observed by the model based on lactation.

Fat 305 is adjusted to a 305-day lactation and Act Fat is the actual fat value at 305 days. Therefore, differences in fat based on DIM are not expected. The results of the model, however, show there is a difference in fat content based on DIM. The effects of DIM should be present for LTD Fat. The model reveals that there are effects due to DIM. This makes sense because cows that lactate longer generally produce more fat than cows with shorter lactations.

		Least Squares Means – Fat Content		
BST	**Lac**	**Fat 305**	**Act Fat**	**LTD Fat**
0	**1**	732	495	572
2	**2**	739	517	629
0	**3**	801	628	688
2	**1**	853	709	765
0	**2**	838	794	828
2	**3**	714	666	701

Table 26. Least squares means for fat content for terminated cows.

Least squares means for fat values are shown in Table 26. The means suggest that BST-treated cows produce more fat content in milk than naturally producing cows for the first and second lactations. In subsequent lactations, non-BST cows produce more fat than BST-treated cows. The data suggest that lactation number and DIM are the most important variables affecting fat content in milk.

Effects on Protein Content

Means were calculated for Protein 305, Act Protein and LTD Protein and results are shown in Table 27. The averages show that BST-treated cows produced more protein content in milk than non-BST cows. The differences between Prot 305, Act Prot and LTD Prot are 58 lbs., 89 lbs., and 130 lbs., respectively.

	BST											
	Group 0						Group 2					
	Prot 305		Act Prot		LTD Prot		Prot 305		Act Prot		LTD Prot	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	15	594	15	411	15	481	14	643	14	467	14	599
2	10	640	10	475	10	504	11	734	11	606	11	647
3	5	661	5	610	5	629	8	668	8	639	8	714
All	30	621	30	466	30	513	33	679	33	555	33	643

Table 27. Means for milk protein by lactation and BST group for terminated cows.

	Generalized Linear Model – Protein Content								
	Prot 305			Act Prot			LTD Prot		
	df	**MS**	**P <**	**df**	**MS**	**P <**	**df**	**MS**	**P <**
BST	1	4300	0.56	1	31311	0.11	1	7138	0.36
Lact	2	46443	0.01	2	205564	0.01	2	106026	0.01
BST x Lact	2	8614	0.50	2	11980	0.37	2	12515	0.23
DIM	1	231053	0.01	1	1056683	0.01	1	3379558	0.01
BST x DIM	1	496	0.84	1	20131	0.20	1	25022	0.09

Table 28. General model for milk protein for terminated cows.

General Linear Model—Significant Differences Between Lactations for Protein							
	Prot 305			Act Prot		LTD Prot	
	df	**MS**	**Pr <**	**MS**	**Pr <**	**MS**	**Pr <**
Lac 1 vs 2	1	91672	0.01	241233	0.01	133971	0.01
Lac 1 vs 3	1	19465	0.22	312537	0.01	152618	0.01
Lac 2 vs 3	1	12385	0.32	17824	0.23	5624	0.67

Table 29. Model of contrast between lactations for protein for terminated cows.

Models were calculated for all protein values and are shown in Table 28. According to the model for all three protein values, the effects of lactation and DIM were the only two factors significantly affecting protein. BST did not significantly effect protein yield for any of the models. Differences between all lactations were expected for Act Protein and LTD Protein because those values were not adjusted for lactation. However, the mean contrasts, shown in Table 29, only observed differences between first versus second and first versus third lactations, but not for second versus third lactation. Differences by lactation were not expected for Protein 305 because this value was adjusted for lactation. However, the model reveals there was significance. When the lactation model is evaluated, there is only a difference between first and second lactations for Protein 305. Because of this difference, it skews the Protein 305 model for lactation to show that there is significance.

According to the results of the model, there is a difference in protein production based on DIM for all values. LTD protein is expected to differ by DIM because of the variation in lactation lengths. However, an effect is not expected for Protein 305 or Act Protein because the lactation for these values is fixed at 305-days.

Least Squares Means – Protein				
BST	**Lac**	**Prot 305**	**Act Prot**	**LTD Prot**
0	**1**	594	410	479
2	**2**	632	446	551
0	**3**	663	528	581
2	**1**	737	612	662
0	**2**	670	632	661
2	**3**	650	605	636

Table 30. Least squares means for protein for terminated cows.

Least squares means were computed and the results are shown in Table 30. The results suggest that cows supplemented with BST produce more protein than non-BST cows for the first and second lactations. Naturally producing cows produce more protein in subsequent lactation. There is no evidence in the model that can attribute these results to BST. Therefore, the data suggests that lactation number and DIM have the greatest impact on the protein composition of milk.

Effects on ECM

Means were calculated for ECM 305, Act ECM and LTD ECM. The results are shown in Table 31. The means show that BST cows produced more ECM than non-BST cows. The differences between BST versus non-BST cows for ECM 305, Act ECM and LTD ECM averages are 1195 lbs., 2427 lbs., and 3550 lbs., respectively.

	BST											
	Group 0						Group 2					
	ECM 305		Act ECM		LTD ECM		ECM 305		Act ECM		LTD ECM	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	15	19735	15	13441	15	15533	14	20685	14	14945	14	18758
2	10	20754	10	15180	10	16082	11	23715	11	19489	11	20742
3	5	22573	5	20900	5	21502	8	20881	8	20024	8	22229
All	30	20548	30	15264	30	16711	33	21743	33	17691	33	20261

Table 31. Means for energy corrected milk by lactation and BST group for terminated cows.

	Generalized Linear Model –ECM								
	ECM 305			Act ECM			LTD ECM		
	df	**MS**	**P <**	**df**	**MS**	**P <**	**df**	**MS**	**P <**
BST	1	1285362	0.74	1	25108997	0.15	1	5615248	0.40
Lact	2	44221330	0.01	2	222320385	0.01	2	127093268	0.01
BST x Lact	2	23083630	0.16	2	28749874	0.09	2	29499030	0.01
DIM	1	285322169	0.01	1	1102565216	0.01	1	3274177858	0.01
BST x DIM	1	1238072	0.75	1	23976768	0.16	1	12374317	0.21

Table 32. General model and least squares means for energy corrected milk for terminated cows.

ECM models were calculated for each of the three milk values and are shown in Table 32. According to the results of the generalized linear model for ECM 305, effects due to lactation and DIM were significant. The model for Act ECM was affected in the same manner. The LTD ECM model showed differences in production based on lactation, DIM and the interaction between BST and lactation. No model found BST to be a significant variable affecting ECM yields. An effect due to lactation was not expected for ECM 305 because the values are adjusted to correct the effects of lactation. However, the effects of lactation were expected for Act ECM and LTD ECM. The model for LTD ECM showed that the effects of BST were influenced by parity.

ECM 305 and Act ECM values are fixed at a 305-day lactation. Therefore, it was not expected that there would be a difference in ECM production based on DIM. However, a difference was present according to the model. LTD ECM was affected by DIM. This was expected because those values are not fixed for a standard lactation, and DIM vary widely.

Least Squares Means – ECM				
BST	**Lac**	**ECM 305**	**Act ECM**	**LTD ECM**
0	**1**	19726	13422	15507
2	**2**	20314	14276	17329
0	**3**	21584	16942	18559
2	**1**	23840	19714	21225
0	**2**	22916	21629	22528
2	**3**	20273	18930	19892

Table 33. Least squares means for ECM for terminated cows.

Least squares means, shown in Table 33, suggest that BST-treated cows produce more energy corrected milk than naturally producing cows for the first and second lactations. After the second lactation, non-BST cows produce more ECM than BST cows. There are no significant differences based on BST, according to the model. Therefore, the data suggests that ECM production is primarily influenced by lactation and DIM.

Effects on Income, BST Costs and Net Income

Income, cost and net income were calculated for each cow using all three milk values. Figures are shown in Tables 34, 35 and 36.

	BST											
	Group 0						Group 2					
	Price		BST Cost		Net		Price		BST Cost		Net	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	15	2958	15	0	15	2958	14	3097	14	75	14	3022
2	10	3075	10	0	10	3075	11	3582	11	83	11	3498
3	5	3447	5	0	5	3447	8	3139	8	89	8	3050
All	30	3079	30	0	30	3079	33	3269	33	81	33	3188

Table 34. Means for Milk 305 price, BST cost and net income by lactation and BST group for terminated cows.

	BST											
	Group 0						Group 2					
	Price		BST Cost		Net		Price		BST Cost		Net	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	15	2009	15	0	15	2009	14	2236	14	75	14	2162
2	10	2239	10	0	10	2239	11	2930	11	83	11	2847
3	5	3191	5	0	5	3191	8	3010	8	89	8	2921
All	30	2282	30	0	30	2282	33	2655	33	81	33	2574

Table 35. Means for Act Milk price, BST cost and net income by lactation and BST group for terminated cows.

	BST											
	Group 0						Group 2					
	Price		BST Cost		Net		Price		BST Cost		Net	
Lac	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**	**N**	**Mean**
1	15	2308	15	0	15	2308	14	2776	14	75	14	2701
2	10	2370	10	0	10	2370	11	3112	11	83	11	3029
3	5	3278	5	0	5	3278	8	3329	8	89	8	3240
All	30	2491	30	0	30	2491	33	3022	33	81	33	2941

Table 36. Means for LTD Milk price, BST cost and net income by lactation and BST group for terminated cows.

Terminated cows supplemented with BST earned an average of $109 per lactation more than non-BST cows when net income was calculated for 305-Day Milk weights. When Act Milk was used for net income, BST-treated cows produced an average of $292 more per lactation than naturally producing cows. Cows injected with BST earned on average $450 more than non-BST cows when LTD Milk was used for calculations.

CONCLUSION

This study shows that Bovine somatotropin does influence milk production, but also the longer days in milk for the treated cows, had a major influence. Although BST cows produced $263 additional income, part of that is due to the increased days in lactation. Our analysis indicates a significant influence on first lactation milk production. Any cows treated with Bovine Somatotropin after their first lactation did not appear to have a significant increase in milk production. This result could be due to the unequal distribution of cows within lactation groups.

There are some sources of error that may have contributed to an incorrect conclusion. Ideally, milk weights and milk composition samples taken for the DHI system are recorded monthly. However, this did not occur since the Texas A&M herd had results of only 8 tests, which resulted in larger lengths of time between milk evaluations. Another source of error was from cows that were mistakenly administered one or two injections of BST. While statistics reveal there was no difference between non-BST cows and cows injected a couple of times, other variables not accounted for may have been affected.

REFERENCES

1. Bauman, D.E. 1991. Bovine Somatotropin: Review of an Emerging Technology. J. Dairy Sci. 74:3913.

2. Burvenich, C., G. Vandeputte-Van Messom, E. Roets, J. Fabry, and A.M. Massart-Leen. 1989. Effect Of Bovine Somatotropin On Milk Yield And Milk Composition In Periparturient Cows Experimentally Injected With *Escherichia Coli*. Page 277 in Use of Somatotropin in Livestock Production. K. Sejrsen, M. Vestergaard and A. Neimann-Sorensen, ed. Elsevier Appl. Sci., New York, NY.

3. Cassell, B.G. 1992. Impact of Bovine Somatotropin on DHI and Genetic Evaluations. Dept. of Dairy Science. Virginia Polytechnic Institute and State Univ.

4. Chalupa, W., B. Vecchiarelli, D.T. Galligan, J.D. Ferguson, L.S. Baird, R.W. Hemken, R.J. Harmon, C.G. Soderholm, D.E. Otterby, R. J. Annexstad, J.G. Linn, W.P. Hansen, F.R. Ehle, D.L. Palmquist and R.G. Eggert. 1996. Responses of Dairy Cows Supplemented with Somatotropin During Weeks 5 Through 43 of Lactation. J. Dairy Sci. 73:800.

5. Eppard, P.J., J.J. Veenhuizen, W.J. Cole, P.G. Comens-Keller, G.F. Hartnell, R.L. Hintz, L. Munyakazi, P.K. Olsson, R.H. Sorbet, T.C. White, C.A. Baile, R.J. Collier, J.P. Goff, and R.L. Horst. 1996. Effect of Bovine Somatotropin Administered to Periparturient Dairy Cows on the Incidence of Metabolic Disease. J. Dairy Sci. 79:2170.

6. Gomes, W.R. 1992. Use of Bovine Somatotropin in Dairy Production. Dept. of Dairy Science. Univ. of Illinois.

7. Hoeben, D., C. Burvenich, P.J. Eppard, J.C. Byatt and D.L. Hard. 1999. Effect of Bovine Somatotropin on Neutrophil Functions and Clinical Symptoms During *Streptococcus uberis* Mastitis. J. Dairy Sci. 82:1465.

8. Huber, J.T., Z. Wu, C. Fontes, Jr., J.L. Sullivan, R.G. Hoffman, and G.F. Hartnell. 1997. Administration of Recombinant Bovine Somatotropin to Dairy Cows for Four Consecutive Lactations. J. Dairy Sci. 80:2355.

9. Judge, L.J., R.J. Erskine, and P.C. Bartlett. 1997. Recombinant Bovine Somatotropin and Clinical Mastitis: Incidence, Discarded Milk Following Therapy, and Culling. J. Dairy Sci. 80:3212.

10. Keys, J.E., J.P. Van Zyl, and H.M. Farrell, Jr. 1997. Effects of Somatotropin and Insulin-Like Growth Factor-I on Milk Lipid and Protein Synthesis In Vitro. J. Dairy Sci. 80:37.

11. Knoblauch, W.A. 1992. The Impact of BST on Dairy Farm Income and Survival. Dept. of Agricultural Economics. Cornell Univ.

12. Lescourret, F., J.B. Coulon, and B. Faye. 1995. Predictive Model of Mastitis Occurrence in the Dairy Cow. J. Dairy Sci. 78:2167.

13. McLaughlin, M. Bovine Somatotropin. Agbiotech Infosource. Westcross House Publications. Saskatchewan: Canada. July 1994.

14. Otterby, D.E. and R.J. Annexstad. 1992. BST- The Production Response. Dept. of Animal Science. Univ. of Minnesota.

15. Posilac and Mastitis. 1999. Monsanto Company.

16. Posilac and Reproduction. 1999. Monsanto Company.

17. Richard, A.L., S.N. McCutcheon, and D.E. Bauman. 1985. Responses Of Dairy Cows To Exogenous Bovine Growth Hormone Administered During Early Lactation. J. Dairy Sci. 68:2385.

18. Shearer, J.K. 1992. Herd Health Management Practices to Optimize the Response to BST. College of Veterinary Medicine. Univ. of Florida.

19. Stiles, R. 1984. Bulk Tank Somatic Cell Counts. Ministry of Agriculture, Food and Rural Affairs Factsheet.

20. Tauer, L.W. and W.A. Knoblauch. 1997. The Empirical Impact of Bovine Somatotropin on New York Dairy Farms. J. Dairy Sci. 80:1092.

APPENDIX

Current Cows

OBS	COWINDEX	CALVING	X	LACT	TERM	ACT_MILK	ACT_FAT	ACT_PRO	LTD_MILK	LTD_FAT	LTD_PRO	DIM	MILK_305	FAT_305	PRO_305	BST_INJ	MONTH	YEAR	BST
1	1044	12/16/98	.	5	0	24218	835	806	30184	1100	1031	421	23491	802	793	11	12	1998	2
2	1064	02/02/99	.	5	0	26177	953	807	28715	1042	890	373	25130	924	789	16	2	1999	2
3	1073	09/11/98	.	4	0	22133	792	666	26084	952	794	390	23240	816	689	3	9	1998	2
4	2021	03/30/98	.	4	0	21602	830	698	23888	907	782	351	20738	805	679	19	3	1998	2
5	2027	01/07/98	.	4	0	21013	860	679	21013	860	679	303	20673	847	668	9	1	1998	2
6	2047	02/13/99	.	5	0	25433	959	818	29391	1149	972	362	24416	921	790	16	2	1999	2
7	3029	01/19/98	.	3	0	20496	847	718	20496	847	718	291	21596	892	744	13	1	1998	2
8	3029	01/01/99	.	4	0	22830	876	808	25977	1010	930	354	22373	858	792	23	1	1999	2
9	3030	01/24/98	.	3	0	16558	598	521	16558	598	521	214	20164	730	641	2	1	1998	1
10	3053	02/18/99	.	4	0	26287	868	774	28761	995	871	357	25761	851	761	17	2	1999	2
11	3059	11/23/98	.	3	0	23930	963	740	28633	1196	914	393	24169	953	745	22	11	1998	2
12	3061	01/17/99	.	3	0	22259	992	787	26939	1255	1025	389	22036	972	771	19	1	1999	2
13	3064	11/21/98	.	3	0	30803	1091	897	40150	1452	1216	446	31111	1080	902	2	11	1998	1
14	3375	08/28/98	.	1	0	23057	870	773	23652	890	796	315	28130	1027	890	19	8	1998	2
15	3416	08/27/98	.	4	0	16282	678	621	26885	1149	1040	532	18073	739	677	5	8	1998	2
16	4002	09/24/98	.	3	0	20871	865	751	32645	1419	1202	504	22541	917	800	0	9	1998	0
17	4006	09/02/98	.	3	0	23484	879	739	26825	1026	874	406	25363	932	786	0	9	1998	0
18	4022	06/08/98	.	2	0	20562	721	664	24393	850	796	396	22207	779	707	1	6	1998	1
19	4031	10/22/98	.	3	0	25218	952	832	27275	1042	905	347	26983	990	870	15	10	1998	2
20	4036	01/01/98	.	2	0	19258	637	630	19427	643	635	309	20799	682	661	2	1	1998	1
21	4036	12/25/98	.	3	0	20791	726	655	20791	726	655	302	21119	730	668	0	12	1998	0
22	4044	02/23/98	.	2	0	19104	798	589	32592	1279	1051	512	20441	846	615	4	2	1998	2
23	4047	02/06/98	.	2	0	18815	761	586	29163	1160	951	518	20132	807	611	24	2	1998	2
24	4050	01/01/98	.	2	0	20093	779	640	20801	813	667	323	22102	841	676	2	1	1998	1
25	4050	01/29/99	.	3	0	21676	755	712	24495	884	819	377	22110	763	715	0	1	1999	0
26	4052	11/23/98	.	2	0	25815	852	762	31923	1101	977	444	27106	878	792	0	11	1998	0
27	4054	06/12/98	.	2	0	26545	779	752	32042	954	924	392	29465	857	810	1	6	1998	1
28	4060	08/31/98	.	2	0	21372	710	637	24564	818	743	376	24578	802	711	0	8	1998	0
29	4070	09/20/98	.	2	0	22325	899	737	22325	899	737	292	26212	1024	837	0	9	1998	0
30	4071	09/28/98	.	2	0	19476	768	621	19916	786	636	315	22203	852	685	16	9	1998	2
31	4074	09/11/98	.	2	0	20881	769	712	24003	916	823	365	24013	861	792	0	9	1998	0
32	4418	01/24/98	.	2	0	15182	710	571	18498	848	708	433	15941	731	588	2	1	1998	1
33	5003	03/05/98	.	1	0	17350	631	528	20487	761	632	365	18912	681	559	11	3	1998	2
34	5005	11/09/98	.	2	0	16354	662	602	17562	724	652	361	17499	688	629	19	11	1998	2
35	5006	11/12/98	.	2	0	19806	716	647	21377	779	702	335	21192	745	676	0	11	1998	0
36	5007	11/18/98	.	2	0	21721	774	657	27670	1066	870	449	23241	805	687	24	11	1998	2
37	5018	09/23/98	.	2	0	22756	823	711	24314	877	762	330	26852	938	799	0	9	1998	0
38	5024	01/18/98	.	1	0	19719	781	605	29407	1194	960	533	22874	890	687	2	1	1998	1
39	5025	03/04/98	.	1	0	16645	643	530	16645	643	530	269	21415	819	678	11	3	1998	2

40	5025	01/24/99	.	2	0	23842	891	791	27887	1071	962	382	25273	936	818	19	1	1999	2
41	5026	01/16/98	.	1	0	18490	671	543	23438	859	704	401	21633	772	623	2	1	1998	1
42	5031	01/09/98	.	1	0	16652	615	519	27814	1155	990	546	19649	713	600	22	1	1998	2
43	5035	11/20/98	.	2	0	17403	701	568	19744	796	647	378	19491	764	616	21	11	1998	2
44	5036	09/27/98	.	1	0	21045	752	703	24346	868	819	372	25254	880	807	0	9	1998	0
45	5040	01/24/98	.	1	0	16253	574	495	20196	756	643	393	19504	677	577	2	1	1998	1
46	5041	04/09/98	.	1	0	13748	498	456	16238	593	545	358	16360	588	536	11	4	1998	2
47	5044	05/25/98	.	1	0	19707	663	633	24896	855	814	406	23254	769	732	1	5	1998	1
48	5046	03/06/98	.	1	0	17767	712	584	17767	712	584	293	22031	873	710	2	3	1998	1
49	5046	02/10/99	.	2	0	22961	872	747	26789	1041	895	365	24798	933	785	0	2	1999	0
50	5048	01/16/98	.	1	0	16070	597	491	16605	620	508	316	19445	710	575	2	1	1998	1
51	5048	01/22/99	.	2	0	22984	805	711	23917	841	743	323	25282	869	751	0	1	1999	0
52	5052	11/15/98	.	1	0	20219	775	625	24735	961	785	401	23050	860	689	0	11	1998	0
53	5054	08/17/98	.	1	0	21111	710	642	22569	769	695	326	25967	845	749	0	8	1998	0
54	5055	04/03/98	.	1	0	16784	587	517	25484	939	820	491	20141	699	610	26	4	1998	2
55	5056	04/01/98	.	1	0	18865	709	599	28363	1099	927	475	22638	844	706	2	4	1998	1
56	5058	11/12/98	.	1	0	13507	558	436	13507	558	436	270	16981	696	535	0	11	1998	0
57	5059	01/19/98	.	1	0	19348	665	600	19744	681	613	313	23605	805	711	12	1	1998	2
58	5061	10/01/98	.	1	0	21651	824	707	22080	840	722	312	25765	948	806	16	10	1998	2
59	5062	01/14/98	.	1	0	18319	706	588	32936	1363	1130	660	22349	854	697	2	1	1998	1
60	5063	10/25/98	.	1	0	20076	749	622	20424	765	636	330	23690	861	706	14	10	1998	2
61	5064	02/21/98	.	1	0	15346	584	500	15346	584	500	285	19746	751	637	3	2	1998	2
62	5066	05/30/98	.	1	0	15645	555	494	16928	607	540	336	18774	655	582	0	5	1998	0
63	5067	09/02/98	.	1	0	20509	741	621	31619	1190	1018	526	25226	882	736	33	9	1998	2
64	5070	03/19/98	.	1	0	18702	660	569	18702	660	569	304	22872	801	681	1	3	1998	1
65	5406	02/19/98	.	1	0	12447	593	499	12447	593	499	267	15237	720	606	0	2	1998	0
66	5414	01/16/98	.	1	0	10649	524	394	10649	524	394	294	12677	621	466	1	1	1998	1
67	5416	01/18/98	.	1	0	13013	514	465	21791	902	797	533	15225	596	539	0	1	1998	0
68	5419	02/07/98	.	1	0	10442	549	382	11679	615	435	356	12426	642	447	4	2	1998	2
69	5420	09/21/98	.	1	0	10557	468	390	10557	468	390	291	13973	598	499	0	9	1998	0
70	5421	04/06/98	.	1	0	12816	607	517	28307	1472	1198	675	15379	722	615	34	4	1998	2
71	5422	03/22/98	.	1	0	12598	603	458	12598	603	458	276	15927	757	580	0	3	1998	0
72	5422	03/01/99	.	2	0	14948	636	521	14948	636	521	244	18895	774	659	0	3	1999	0
73	6001	08/22/98	.	1	0	21242	840	684	22231	875	716	321	26340	1016	824	18	8	1998	2
74	6003	08/23/98	.	1	0	19072	561	558	20030	593	590	320	23649	679	673	18	8	1998	2
75	6004	02/17/98	.	1	0	14501	588	453	14501	588	453	283	19177	765	582	2	2	1998	1
76	6004	01/26/99	.	2	0	18284	825	631	20444	931	713	380	20295	908	677	0	1	1999	0
77	6006	02/25/98	.	1	0	16134	594	528	16134	594	528	294	20633	747	654	1	2	1998	1
78	6009	01/17/98	.	1	0	17831	606	570	17831	606	570	293	22723	762	697	10	1	1998	2
79	6010	08/20/98	.	1	0	12605	446	392	13432	463	422	334	15756	544	477	0	8	1998	0
80	6013	03/13/98	.	1	0	18360	633	545	28407	1032	931	479	22766	772	653	24	3	1998	2
81	6019	09/12/98	.	1	0	23087	822	748	23087	822	748	300	29168	1018	926	16	9	1998	2
82	6022	10/17/98	.	1	0	15946	668	549	18410	782	635	384	19135	782	647	0	10	1998	0
83	6024	08/21/98	.	1	0	15530	543	498	18983	678	617	418	19878	673	613	0	8	1998	0
84	6025	09/22/98	.	1	0	18973	674	655	25036	878	886	436	23716	822	801	25	9	1998	2
85	6027	10/25/98	.	1	0	17449	747	606	18252	780	636	321	21288	889	727	20	10	1998	2
86	6034	11/12/98	.	1	0	14217	555	474	14217	555	474	303	17394	669	571	0	11	1998	0
87	6036	09/06/98	.	1	0	16853	660	571	19167	760	655	363	22246	845	717	1	9	1998	1
88	6037	12/29/98	.	1	0	22204	813	693	29915	1076	969	408	26645	959	823	25	12	1998	2
89	6038	12/02/98	.	1	0	21336	783	680	28578	1108	956	435	25817	932	811	0	12	1998	0
90	6042	02/26/99	.	1	0	20052	707	638	22611	826	731	349	23862	827	746	0	2	1999	0
91	6048	03/01/99	.	1	0	17521	681	572	19397	765	640	346	21200	810	674	0	3	1999	0

92	6051	03/02/99	.	1	0	17860	726	590	19775	804	655	345	21611	864	695	18	3	1999	2
93	6054	02/28/99	.	1	0	18205	672	600	20511	757	689	347	22028	800	708	0	2	1999	0
94	6402	05/01/98	.	1	0	13483	660	472	20148	988	728	465	16180	785	562	0	5	1998	0
95	6403	06/27/98	.	1	0	14912	643	555	18567	845	707	377	18044	765	660	17	6	1998	2
96	6404	06/11/98	.	1	0	9389	522	376	11997	661	483	389	11455	626	451	0	6	1998	0
97	6406	07/17/98	.	1	0	9778	444	362	9778	444	362	246	14516	633	531	0	7	1998	0
98	6409	09/14/98	.	1	0	16982	701	592	19027	813	669	355	22246	883	746	20	9	1998	2
99	6411	12/29/98	.	1	0	17600	723	634	17648	725	635	306	20064	803	704	18	12	1998	2
100	6412	01/06/99	.	1	0	13090	540	457	13090	540	457	287	15635	636	537	0	1	1999	0
101	6414	12/20/98	.	1	0	14375	621	527	14773	639	542	315	16819	714	606	0	12	1998	0
102	6415	11/09/98	.	1	0	9474	476	385	9474	476	385	273	12561	629	500	11	11	1998	2
103	6417	11/06/98	.	1	0	13844	690	526	20316	1060	815	461	17167	835	636	25	11	1998	2
104	7004	04/05/99	.	1	0	16415	558	541	16692	570	553	311	20683	692	654	0	4	1999	0
105	7005	02/15/99	.	1	0	16595	554	523	18779	631	600	360	20744	681	629	16	2	1999	2
106	7006	02/18/99	.	1	0	18190	568	532	20679	659	612	357	22738	699	640	1	2	1999	1
107	7007	04/02/99	.	1	0	18094	681	565	18585	704	582	314	22437	838	680	17	4	1999	2
108	7406	04/04/99	.	1	0	15443	681	549	15799	700	563	312	19304	844	681	0	4	1999	0
109	9038	09/05/98	.	6	0	22182	937	722	22182	937	722	303	23841	1006	782	1	9	1998	1

VITA

Meredith Dianne Cook

PERSONAL INFORMATION:

Born:	July 5, 1979 Austin, TX
Parents:	Mr. and Mrs. Ronald J. Cook
Address:	709 San Saba Drive College Station, TX 77845 (409) 696-5126

EDUCATION:

B.S. Animal Science, Texas A&M University, 2000

PROFESSIONAL ORGANIZATIONS:

American Society of Animal Science
American Society of Dairy Science
Golden Key National Honor Society

HONORS AND RECOGNITIONS:

Eisenhower Leadership Development Program Fellow
Dean's List Academic Achievement Award
Honor's Candidate