Bovine Somatotropin (bST)

A Bibliography with Selected Annotations

Jeannine M. Kenney
Richard F. Fallert

PREFACE

This extensive literature review of bovine Somatotropin (bST) and related topics was carried out in conjunction with a USDA study requested by the Secretary of Agriculture. The study assesses the likely economic effects of the use of bST in dairy cattle. Information derived from this literature review, as well as direct and extensive communication with researchers at universities, in the industry, and in private companies was used to arrive at the underlying assumptions used in the analysis. The USDA study, bST and the Dairy Industry: A National, Regional, and Farm-level Analysis, is available from USDA-EMS Information, Room 237, 1301 New York Avenue, NW., Washington, DC 20005-4788. Phone: (202) 786-1512. A 16-page summary is also available.

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ABBREVIATIONS

bGH = bovine growth hormone
bST = bovine Somatotropin
bSTH = bovine Somatotropin hormone
BST = bovine Somatotropin
GH = growth hormone
GRF = growth hormone-releasing factor
hGRF = human growth hormone-releasing factor
hPGRF = human pancreatic growth hormone-releasing factor
IGF = insulin-like growth factors
MBS = methionly bovine Somatotropin
met-STH = methionly-Somatotropin
p-bgh = pituitary bovine growth hormone
pSTG = pituitary Somatotropin growth hormone
r-bgh = recombinant bovine growth hormone
rbGH = recombinant bovine Somatotropin hormone
rbST = recombinant bovine Somatotropin hormone
rbSTH = recombinant bovine Somatotropin hormone
rGH = recombinant growth hormone
SRV = sustained release vehicle
STH = Somatotropin hormone
ST = Somatotropin
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INTRODUCTION

This extensive review of bovine Somatotropin (bST) and related topics was carried out in conjunction with a USDA study requested by the Secretary of Agriculture. The study, bST and the Dairy Industry: A National, Regional, and Farm-level Analysis, assesses the likely economic effects of the use of bST in dairy cattle. Information derived from this literature review, as well as direct and extensive communication with researchers at universities, in the industry, and in private companies was used to arrive at the underlying assumptions used in the analysis.

A listing, Special Reference Briefs: Bovine Growth Hormone and the Dairy Industry (NAL SRB 86-03, Sept. 1986), compiled by Rita Bisaro and Jean L. Bellows at the National Agricultural Library (NAL), USDA, may be useful to you. Citations in this special publication are derived from manual and computerized searches of selected data bases. The individual citations include NAL call numbers. A copy of this bibliography is available from:

Reference Branch, Room 111
National Agricultural Library
U.S. Department of Agriculture
Beltsville, MD 20705
(301) 344-3704

Another source of information on bST is the proceedings of the National Invitational Workshop on Bovine Somatotropin, September 21-23, 1987, Westport Plaza, St. Louis, MO. The workshop was sponsored by the USDA Extension Service and officially sanctioned by the Extension Committee on Organization and Policy--Agriculture and Natural Resources. The proceedings appeared too late for each entry to be cited, but information regarding availability of copies may be obtained by writing or calling:

Basil R. Eastwood
Program Leader, Dairy Production
Extension Service, AP-LVS, Room 3334-S
U.S. Department of Agriculture
Washington, DC 20250
(202) 447-6486

Milk from bST-treated cows (50 mg/head/day) is the same as that produced by nontreated cows. There were no detectable levels of bST residues. Similar results were obtained from cows injected with 40 mg/head/day over two lactations. Because of the biological differences between humans and bovines, bST is inactive in humans. Any remaining bST residues in milk will be inactivated through the pasteurization process.


The complex process of lactation is regulated by several metabolic hormones, the most important of which is growth hormone (GH). Growth hormone secretion is regulated by a growth hormone-releasing factor (GRF) and somatostatin, a hormone-secretion inhibitor. Recent studies have been directed toward these two GH-regulators in an effort to indirectly stimulate GH secretion and, thereby, increase milk production. Injections of GRF have not resulted in milk yield increases comparable to those generated by injections of exogenous GH. Administration of GRF was expected to increase milk yields by 30 percent, but yields increased only 3-9 percent.


Metabolism during pregnancy and lactation is regulated by homeostasis and homeorhesis. The former maintains physiological equilibrium, while the latter controls the metabolism of body tissues to support a physical state such as pregnancy and lactation. Nutrients are partitioned during pregnancy to support growth of the fetus and development of the mammary gland. The metabolic and nutrient requirements of a pregnant animal are much higher than a nonpregnant animal. Cows unable to meet the demands of milk synthesis are susceptible to health and metabolic disorders. Endocrine control of homeorhesis is discussed although little is known about the endocrine control of pregnancy in dairy cows.

Five cows were injected with 51.3 IU of growth hormone (GH) daily for 11 days and five cows were injected with a placebo. Milk yields for GH-treated cows produced 9.5 percent more milk than controls. Fat percentages and yields in milk increased, while protein percentage decreased. Milk production increases resulted from GH, not greater feed intake. Yield increases were primarily due to a change in nutrient partitioning to the mammary gland and to improved ability of the mammary gland to synthesize fat and lactose.


The physiological mechanism of action for bGH is unknown. In an effort to determine whether bGH increases milk production by partitioning more nutrients to the mammary gland or if bGH merely increases absorption of nutrients, nine Holstein cows were injected with 9 IU of bGH/day. Milk yield, milk protein percent, and milk lactose yield all increased. Milk-energy secretion increased, while tissue energy balance decreased. The study concludes that bGH does not increase nutrient efficiency, but allows extra nutrients to be extracted from body reserves and partitioned to the mammary gland.


Nutrient partitioning in lactating animals is regulated by homeostasis and homeorhesis. The former is short-term control, while the latter is long-term control. Growth hormone appears to be a homeorhetic control during growth, pregnancy, and lactation. This process regulates nutrient partitioning although the mechanisms by which this is done are unknown. Because this process is complex, there is much work to be done in this area.

Thirty Holstein cows with an already high milk production potential were injected with varying doses of STH for 188 days beginning at 84 ± 10 days of lactation. The injected somatotropin was both recombinantly derived and extracted from the pituitary glands of culled cattle. Larger increases in production were seen from cows injected with rbSTH (23.3-41.2 percent) than from cows injected with pSTG (16 percent). Increases in production appeared to be dose-dependent. Milk content was similar across all cows as were body-weight changes. Lactational efficiency was improved by somatotropin injections. STH affects the metabolism of the animal's body tissues so that more nutrients are channeled to the mammary glands, which enhances the ability of the mammary gland to synthesize milk.


Productive efficiency can be increased through improved digestibility and nutrient absorption, decreased maintenance requirements, and more efficient use of metabolized energy for nutrient partitioning. The latter can be achieved only if scientists have a better understanding of the physiological controls involved in nutrient partitioning. Bovine growth hormone (bGH) is just one of several hormones that regulate nutrient partitioning. bGH increases milk yield by partitioning more nutrients to the mammary gland, and is probably the most effective option for increasing productive efficiency. Under bGH administration, maintenance costs are spread over higher levels of production.


bST, a naturally occurring hormone in dairy cows, is now available through genetic and biotechnological advances and has the potential to increase milk production by 10-40 percent per treated cow. This paper provides an overview of the fundamental political and economic issues surrounding bST, including the implications of the drug for the U.S. dairy surplus and the Government price-support system. The potential economic impact of bST is examined in terms of the cost of the drug and the profitability, viability, and efficiency of farms using bST under different price scenarios. A review of literature on these topics is provided throughout the analysis. The human and animal health and safety concerns are examined from both the perspective of bST proponents and opponents. bST cannot be approved for commercial sale until the U.S. Food and Drug Administration has adequate proof that the drug is safe and effective. The authors conclude their analysis with the broader sociological implications of bST and with suggestions of issues in need of further study.


The article outlines the various metabolites (such as glucose, amino acids, acetic acids, and long-chain fatty acids) that affect the ability of the mammary gland to synthesize milk. The effect of hormones (such as growth hormone, insulin, and glucagon) in partitioning nutrients to the mammary gland is also closely examined with respect to levels of these substances at different stages of lactation and their effect on milk yield, feed efficiency, and health and reproduction of lactating cows. While GH increases milk yield, insulin decreases milk yield. Insulin secretion is more difficult to regulate through diet than GH. The extended effects of changing partition are examined in detail.


An experiment was conducted with nine Holstein cows. They were injected with either a placebo or bovine growth hormone (bGH) during two 14-day injection periods. Both milk fat percentages and yields increased, as did triglycerides, diglycerides, and core lipids. Milk fat increases were caused by bGH injections, which mobilized adipose tissues. Fatty-acid composition of the extra milk-fat produced by bGH had less medium- and short-chain fatty acids, but more long-chain fatty acids. Because the cows tested were in negative energy balance, results may differ for cows in positive energy balance.


This paper provides a broad overview of bovine growth hormone (bGH) technology and the policy and marketing issues surrounding it. The market potential of bGH appears to be promising because of the high response rates of dairy cattle and the ease in producing bGH for marketing firms. Market estimates range from $300-$600 million per year. Methods of drug administration appear to be the major focus of research by marketing firms. Controlled- or sustained-release devices (such as capsules, nondegradable matrix devices, or implantable pumps) are methods researched. The large molecular weight of bGH and its poor
solubility may inhibit the development of these methods. Finally, the impact on the dairy industry and industries that service it is examined. The authors estimate that bGH will cause a reduction of 4 million dairy cows and could cause an increase in milk production of 25 percent.


bST has increased lactational responses from 10-40 percent. When treated with bST, cows become more feed efficient because nutrients are directed toward milk production. Milk from treated cows is the same as milk from nontreated cows, and the hormone is inactive in humans. Although the economic impact of bST is difficult to measure, the author is certain that bST will increase the efficiency of all farms.


Concern about excessive milk surpluses that may be generated by bST has been greatly exaggerated. Dairy farmers have been slow to adopt new technology, such as DHI testing and artificial insemination. There are several points to be considered before assuming that bST will cause a major upheaval in the industry. First, bST is still awaiting FDA approval. Second, milk yields will not be as great on the average dairy
farm as they were under controlled research conditions. Third, the price of bST for commercial sales has not yet been determined so realistic adoption rates cannot be determined. bST will probably be part of the structural changes that have been taking place in the dairy industry during the past 50 years.


Reports claiming bST will increase milk production per cow by 20-40 percent may be overestimating the impact of bST. A more realistic estimate (when one considers that field conditions and management strategies may be less than ideal) may be an increase of 10 percent. bST will merely raise an already increasing trend line for milk production. Claims that there will be regional advantages for the Southwest, Southeast, and Northwest dairies, because of their already high output and low-cost production, may be misleading. As feed requirements for bST-treated cows increase, smaller farms in the upper Midwest and the Northeast that produce their own feed may indeed have an advantage over those regions that purchase feed. Heat stress in the warmer regions (Northwest, Southwest, and Southeast) may put a constraint on milk production. The additional production generated by bST will cause current price levels to drop by $1.00 to $1.50, but this decline may occur regardless of bST adoption. Some small farmers may be forced out of the market if bST is approved by the FDA. Activist groups' concern about the safety of bST-treated milk may cause additional marketing problems for the dairy industry, even though milk and meat from bST-treated cows are safe for human consumption. This situation may create a need for an industry campaign to inform consumers about bST.


The article addresses the question as to what policy changes may be necessary in anticipation of the effect of bST technology. These policies may dictate adoption rates for bST, production increases, and market values of milk and feed. Different farm scenarios are set up in terms of average output per cow per farm. The effect of bST on each farm is examined. Existing dairy policies are examined in the context of bST and are found to be the most effective for dealing with bST.


bST, a naturally occurring protein in cows, can be produced through recombinant DNA technology in which the gene that codes for natural bST is inserted into a DNA vector, which is then transferred to E. Coli
bacteria. The bST is produced within the growing bacteria cells. The bacteria are destroyed, and the bST is purified. bST diverts nutrients to the mammary gland, resulting in a need for greater nutrients. bST is biologically inactive in humans, and consumption of milk or meat from bST-treated cows is safe because bST milk and non-bST milk are similar. Cows treated with bST appear to have no health problems. There are no environmental risks associated with E. Coli bacteria and the production of bST, as the bacteria are genetically altered so that they cannot survive in an external environment. Cows treated with bST experience a 10- to 25-percent increase in milk production and a 5- to 10-percent increase in feed efficiency. bST should return $2 for every $1 invested and requires no large capital outlays.


This paper outlines the results of three long-term studies involving bST treatment of dairy cows. Results from each study realized increased milk production per treated cow. The article examines in detail a Cornell/Monsanto study of 30 Holstein cows treated with 0, 13.5, 27, and 40.5 mg/day of recombinant and pituitary bST for 188 days. Milk yields increased 11.5 kg/day with injection of bST. The milk fat, protein, and lactose content of milk increased proportionately with milk production. Pituitary bST did not generate as great a response as r bST. The responses indicated that bST increases milk yield by partitioning nutrients to support the additional milk synthesis.


The milk from GH-treated cows was examined in an effort to determine the effects of varying doses of GH on tissues of lactating dairy cows. Lactalbumin and long-chain fatty acid (FA) concentration varied directly with changes in GH dosage. Short- and medium-chain FA increased from 0 to 50 IU/day bGH, but content leveled off between 50 and 100 IU/day. bGH concentration of other mineral elements was unchanged with varying doses of GH. These results are consistent with homeorhetic control of nutrient partitioning.


Six Holstein cows were injected daily with different doses (0, 5, 10, 25, 50, and 100 IU/day) of bGH beginning 192 days postpartum. Milk yield increased 32 percent, protein content increased 27 percent, and fat content increased 46 percent for the highest dosage. Lactose content was unaffected, but energy and nitrogen levels decreased as doses of bGH increased. Concentration of glucose and insulin in the
blood was unchanged. Increases in GH concentrations in plasma varied directly with bGH dosage. Somatic cell counts remained unchanged, and there were no observed problems with cow health or reproductive efficiency.


This article explores emerging technologies in milk production and processing: nutritional supplements, bovine growth hormone, farm computer application, embryo transfers, reverse osmosis, ultrafiltration, and freeze concentration. Nationwide adoption of these new technologies could result in fewer but larger dairy herds, with fewer cows needed to produce required milk supplies. This would require increased investment for the remaining herds and would provide a more storible milk supply with associated efficiencies in marketing and regional implications because of lower transportation costs among areas.


Compares and contrasts bGH with previous technologies affecting the dairy industry. Attempts to bring into perspective some commonly held beliefs and concerns about the likely effects of bGH on the dairy industry. Suggests that many questions remain before the likely effects of bGH on industry structure and performance can be reliably evaluated.


Three cows were treated with bGH through three different methods. One cow was treated with a placebo to act as a control. One test cow received an injection every 4 hours; a second received a daily injection of bGH; and a third received bGH through continuous infusion. All bGH-treated cows averaged a 31-percent increase in milk production. Intake of dry matter decreased by 9 percent, resulting in a 41-percent increase in feed efficiency. Milk content of fat and lactose was unaffected by method of administration.


"Biotechnologies promise to surpass all hitherto known technologies in agriculture in their direct, indirect, and cumulative social impacts. Though social data with which to perform cumulative impact assessment (CIA) on the diffusion of such biotechnologies are deficient, conceptual parameters guiding the research should be advanced for three reasons. First, the mapping of cumulative impact categories will stimulate the
generation of data and the specification of methods necessary for this comprehensive analysis. Second, the unprecedented pace of biotechnological change requires that social scientists act unhesitatingly to introduce CIA modeling referenced to biotechnological prototypes, thus allowing for refinement and development as the technology proliferates. Finally, acting early in the diffusion-production cycle will avert the pitfalls of post-hoc (Social Impact Assessment) SIA--commonplace in most SIAs of agricultural technologies. The present paper, using bovine somatotropin as a case study, attempts an initial 'scoping' of plausible social impacts associated with the technology's production and diffusion, suggests a CIA framework within which these impacts can be analyzed, and clarifies data opportunities and deficiencies relevant to the CIA of agricultural biotechnologies.


This article, written in highly complex terminology, discusses the physiology of bGH and insulin-like growth factors (IGF). The milk production-enhancing factors of GH can be manipulated through injection of rGH, by placing copies of GH gene into the zygote or by administering the growth hormone-releasing factor (GRF) rather than the actual GH. The authors review existing literature on both GRF and somatostatin, a GH-inhibiting peptide, and their effects on the somatotropic axis. The effects on malnutrition and environmental and metabolic factors on GH secretion are examined in detail. The effect of GH on lactation is discussed in detail in terms of feed efficiency, milk output, and the physiological mechanisms through which GH influences lactation. The effect of GH on lactation appears to be indirect and influenced by IGF.


Twelve cows were injected daily with either a low or medium dose of bGH during midlactation for three 21-day periods. Two cows were dropped from the experiment because of an illness unrelated to the experiment. The medium dosage of bGH had a significant impact on milk yield, which increased each consecutive week. Cows treated with the smaller doses showed no response in milk production. Milk fat content and milk protein concentration increased for the higher dosage, while lactose
concentrations remained the same. bGH was found in only one-third of milk serum samples. In a second experiment, four cows were infused daily with 30 mg bGH but measurement of exact amounts infused was difficult. Three cows experienced increased milk yield when infused with bGH, while one cow experienced a decline in milk yield.


The authors respond to a 1986 Office of Technology Assessment (OTA) report that suggested there will be a regional shift in dairying from the Northeast and Lake States to the West, Southwest, and Southeast. Some assumptions and conclusions of the report are disputed and are followed by arguments to reinforce the authors' position. The potential effects of emerging dairy technologies on Wisconsin dairy farms are examined. The impact of bGH has been overexaggerated, according to the authors, but overall milk production because of bGH use will likely increase 10 percent, not the 40 percent that some have predicted. The future of Wisconsin dairying is examined.


The author examines (through engineering cost designs and linear programming models) the cost of producing bGH for various plant sizes and the effect of bGH on costs of production, returns over variable costs (ROVC) and returns to land, capital, and cows. The cost of producing bGH is highly related to plant size, resulting in considerable economies of size. There is potential for a monopolistic situation to develop. The market price of bGH will be higher than production costs because of purification, marketing, and delivery costs. bGH appears to be commercially viable in that it is profitable for dairy farmers, even if onfarm milk prices fall to $9.50/cwt, feed prices rise, and milk yields increase by only 6.4 percent. ROVC varies directly with increasing response to bGH and is greatest for large farms with corn-grains sales and lowest for small farms with poor output. bGH will result in changes in crop rotation and management strategies as bGH changes nutritional requirements. Market prices for cows may increase, while land prices could remain stable.


This in-depth study examines the costs of production of the hormone on farm profitability because of changes in feed requirements and the potential for bGH on the commercial market. The authors conclude that bGH will be a marketable and commercially successful product once approved by FDA. Production costs are low, and potential drug use is high. Feed requirements will increase, resulting in different crop
rotation strategies. bGH use will increase returns over variable costs and marginal values for cows and buildings. Gains in returns will be short-lived, as milk prices will fall in response to increased production. Any changes in the numbers and demographics of dairy farmers are contingent on Government dairy policies. The viability of farms using bGH will depend on the feeding and management strategies of each farm.


The authors review the possibilities for major biotechnology-related advances in animals and plants, present hypotheses regarding the economic impact on agriculture, and discuss some implications for international trade. The authors suggest that the economic implications of these new technologies are still largely uncertain, but the lesson for agricultural economists should be clear: "We ignore developments and research in this area at the risk of missing major structural changes of critical importance for agriculture."


This research bulletin is essentially the same as the December 1984 version (entry 53, above), but a chapter on the economic effect of bGH on the New York dairy sector has been added. The chapter is based on articles by McGrath and Tauer (entry 69, below) and Tauer (entry 97, below).


This memo outlines bGH studies undertaken by researchers in the College of Agricultural and Life Sciences and the U.S. Dairy Forage Research Center. One study focuses on changes in milk yield and feed intake as a result of bGH injections. A second study examines the effectiveness of transferring genes into swine and cattle embryos to determine if the production of meat, milk, and wool can be enhanced without daily injections. A third study focuses on the effectiveness of bGH in enhancing milk output for cows of varying genetic production potential. A 2-year study is being conducted to determine the economic impacts of bGH on dairy production and marketing. The remainder of the
memo outlines the reasons the college markets milk produced from bST test herds.


Somatotropin-induced milk production may result in an increased incidence of lipolysis, subclinical ketosis, reproductive inefficiency, and a reduced resistance to disease in dairy cows. One study that began 120 days postpartum found that more fatty acids were being synthesized in the mammary gland and the lipolytic/lipogenic ratio increased for treated cows. STH administration may induce a hypermetabolic form of subclinical ketosis. Several studies have shown that heat tolerance and rectal temperatures of dairy cows increase as milk output increases. Heat tolerance has long been a concern with STH researchers. Others contend that STH reduces the output-inhibiting effects of hot and humid environments. More research is needed to study the possible health risks of STH-treated cows.


The author compares milk-output response to bST from nine different studies. Responses ranged from a 0.6-percent decrease to a 30.5-percent increase in milk yields. Responses varied with different doses and environmental conditions. Statistical predictions of profits over costs associated with bST may underestimate risks regarding the health of the animal and the low levels of response observed in some trials. Various simulation models for prediction of response and variation in gross margins are examined. Health problems for bST-treated cows may not appear in research trials as observations on the incidence of disease can only be made in trials with a large number of cows. Furthermore, STH may increase metabolic demands that may cause unobserved stress when trials focus only on changes in milk yield. Research trials must focus on health problems such as metabolic stress, immune competence, heat tolerance, and reproductive inefficiency. Some research trials have noticed an increase of disease in test herds compared with control herds. There is a need for more equitable reporting of good and bad test results.

This presentation outlines the health risks associated with the administration of methionyl-somatotropin. Met-STH, if administered at the wrong point in lactation or in an incorrect dosage, could cause heat stress, metabolic disease, and reproductive inefficiency, as some studies have indicated. GH may also induce subclinical ketosis, which could damage the immunity status of a cow. The economic impact of met-STH is examined. Profits may be overestimated as higher costs associated with health problems may result from using met-STH.


The physiology and biotechnological production processes of bST are examined in this paper, followed by an extensive review of the producer and consumer issues surrounding bST. bST increases milk production by 15 percent per cow according to different management and nutritional practices. In long-term treatments, protein, lactose, and mineral elements of bST-treated milk occur in the same proportions as in nontreated milk. In short-term treatments, milk fat increases and milk protein decreases. bST-treated cows experience both increased energy intake and increased heat production, but there is no long-term difference in body weight compared with nontreated cows. Decreases in the nitrogen content of urine and chromium concentration of fecal matter compensate for the increase of these elements in the bST-induced milk. bST does not appear to cause any increases in the incidence of mastitis, ketosis, foot and leg diseases, or milk fever, which is contrary to the claims of animal rights groups. Reproductive efficiency of cows and birth weights and growth rates of calves remain unchanged. Humans are unaffected by their consumption of bST-treated milk or meat as bST is biologically inactive in humans. bST has no environmental impact. bST use causes a decrease in milk production costs, but an increase in profits and feed requirements. Return over variable costs increases for all farms and herd sizes. The authors predict that adoption of bST technology will be rapid and that nonadopters may be forced out of the market, especially if Government support prices are reduced to compensate for an increase in milk production. The result will be fewer farms with greater milk production per cow.


Thirty-four Holstein cows were injected with varying doses of rbSTH (0, 12.5, 25, or 50 mg/day) for 266 days. The experiment was conducted to analyze the effect of phenotypic and genetic production potentials on rbSTH milk response. Milk yield increases ranged from 18.5 to 21.4 percent, according to dose. Both fat yield and FCM increased due to rbSTH. Phenotypic production potential was useful in predicting rbSTH output. Cows with low- and medium-phenotypic production potential responded better than high-producing cows. Genetic potential, however, was not a significant predictor of rbSTH-milk production. Following the analysis, the author makes suggestions for future studies on the relationship between bST-induced milk production and genetic and phenotypic production potentials.

A procedure for projecting ex ante the adoption rate of new biotechnology products is developed and applied to bGH. The projected adoption rate is rapid when using 1984 New York survey results, reaching 90 percent in 3 years. Predicting adoption and diffusion rates for a new product, such as bGH, is a speculative exercise. Dairymen are the most relevant source of information on bGH adoption because they are the potential users. The proposed adoption-predicting procedure provides a seemingly reliable forecast at low cost.


In a series of experiments, cows were injected with varying doses of GH, at different frequencies, and for different lengths of time. The studies were conducted to determine the effect of GH injections on milk production and feed efficiency. The short-term experiments showed little response in milk production, while long-term trials showed increased milk production without greater feed requirements. An experiment in which 60 mg bGH were injected every third day revealed that overall production response was the same as if 20 mg bGH had been injected daily. Finally, the longest study (10 weeks) showed a steady increase in milk production over controls until the hot weather of the eighth week caused production to decline.


This study examines the GH response of eight Holstein calves to injections of human pancreatic growth hormone-releasing factor (hpGRF) in an effort to determine if response of GH is related to a cow's genetic milk yield. Selected calves were bred from cows with high-production potential, while controls were bred from average-producing cows. Injections of hpGRF resulted in an immediate increase of GH concentrations, but the response was short-lived. Responses of control calves and selected calves were similar, leading authors to conclude that the magnitude of GH response of hpGRF does not reflect genetic ability for milk yield.

Different methods of administration of bGH were tested in relation to milk-output response. The treatment began 253 days postpartum. The methods of administration were injection of placebo for controls, injections of 25 IU of bGH every other day, daily injections of 25 IU of bGH, and continuous infusion of bGH. Output for cows injected daily and receiving continuous infusion was 28 percent above controls. Cows injected with 25 IU of bGH on alternating days experienced smaller increases in yields than those injected with 12.5 IU of bGH daily. Fat and protein content of milk produced by bGH-treated cows was similar to control cows. Overall, the response of cows injected every other day was similar to that of the controls.


Assesses the potential economic impact of bGH in terms of commercial costs of production, farm profitability, and the likelihood of adoption. Production costs of bGH should be relatively low with the possibility of economies of size in production. Effective use of bGH requires that feed rations per cow become more energy dense and, therefore, more costly. For all levels of response to bGH, rations and concentrate costs increase both per cow and per hundredweight. However, the return over feed costs and milk marketing also increases. Three representative farms are set up, each with a 16,000-pound per year per cow base. The author examines the farms in terms of the differences in feed management. One farm grows only forage, a second produces corn grain and forage, and a third has crop sales. For each farm, both the 12.5-percent and 25.6-percent response rate to bGH returns over variable costs increases and is highest for the 25.6-percent response rate. Marginal feed costs are highest for the farm producing forage only and lowest for the farm with crop sales. On the macro side, market production will increase by 10–15 percent, forcing a decline in both the number of cows and farms. The most adaptable farms will be those with good management and a low debt load.


If bGH is fully adopted, milk production per cow per year could reach 20,419 pounds by the year 2000. Milk production in each region will increase, but the greatest increase will occur in the Southern Plains, Mountain, and Pacific regions. Existing top dairy States will retain
their position regardless of BST technology. If all technology is adopted, herd sizes will increase 44 percent and the number of farms will decrease 51 percent. Farm-milk prices will likely decline as will cash receipts from marketing. Costs for land, buildings, equipment, and labor will increase. The combination of these effects will force out inefficient producers. By the year 2000, there will be greater enrollment in dairy herd improvement, improved breeding techniques, and fewer suppliers of feed. Dairy co-ops will consolidate as the number of producers falls. Farmers will need to develop more extensive marketing and advertising programs and increase the production of a more varied line of dairy products. There is likely to be less dependence on Government purchases by the year 2000 with fewer and larger Federal marketing orders.


Examines the effects of exogenous bGH on cows under heat stress because heat and humidity can adversely affect milk production and feed intake of dairy cows. Cows were tested under a controlled environment, two environments of heat and humidity, and an environment with heat, humidity, and bGH. Administration of GH seemed to alleviate the problem of suppressed milk production because of heat stress. Cows receiving GH increased productivity 3.8 percent and 12 percent, compared with cows in the same environment without bGH. Fat yield of milk also was higher for GH-treated cows than for control cows. GH may be useful in areas where milk production by dairy cows declines because of excess heat.


This paper gives a general background on the development and use of bovine somatotropin and its effects on milk production, stage of
lactation, milk composition, feed intake, animal health and reproduction, nutritional management, veterinary care, likely adoption by farmers, and the economic impact for Minnesota farmers. The authors conclude that, "Use of rbSTH by Minnesota dairy farmers will depend on approval by FDA, cost-benefit ratios, convenience for use and other factors. Production responses can be expected from rbSTH and additional feed will be required for the increased milk yield. Use of rbSTH will require management that is skilled and pays attention to detail."


Focuses on the concern over the mechanisms of action of growth hormone. If GH promotes lipolysis, then tissue reserves may be drawn upon for the mammary gland. This could hurt the cow's efficiency in the long run. Existing research does not support this theory. It is more likely that GH increases RNA synthesis in the mammary gland, which causes greater milk production. More research is needed in this area because very little is known about the physiology behind GH.


Five cows were injected with 51.5 IU/day of exogenous growth hormone for 11 days. Milk fat secretion and milk lactose yield increased, while protein yield was unchanged for controls. Milk yields increased by 3.3 kg/day. There was a 17.1-percent increase in milk energy output without any additional feed consumption. GH appears to act as a mechanism that coordinates the metabolism of body tissues in order to support the mammary needs for increased milk production. The physiological mechanisms of bGH are discussed, and the authors examine the results of similar studies in relation to their own results.


A short-term study (10 days) on milk yield response to GH glucose-sodium caseinate and a combination of GH and glucose-sodium caseinate was conducted. Milk production increased 15.2 percent because of GH injections, but only 3.9 percent for the glucose-sodium caseinate infusions. The combination of GH and glucose-sodium caseinate elicited no greater response in milk yield than did injections of pure GH.

This study was conducted to determine the effectiveness of exogenous growth hormone at different lactational stages. Four cows were injected with bGH during early lactation (12 weeks) and again during late lactation (35 weeks). The increase in milk production was 15 percent in early lactation and 31 percent in late lactation. Ad libitum intake of complete mixed ration declined during both treatment periods, resulting in increased feed efficiency. There were increases of fat, lactose, and protein yields during both periods.


Five sets of identical twin cows were injected daily with 39 IU of bGH/day for 22 weeks during midlactation. One member of each set of twins received an injection of bGH, while the other was injected with a placebo. Milk yields, fat content, and protein and lactose concentrations increased in cows receiving injections although milk composition was not significantly altered. Feed intake of bGH-treated cows increased after the eighth week of the experiment. There were no differences in live weight of controlled and injected cows. The results were followed by a discussion of the physiological action of bGH.


The authors review various studies on milk production responses to bST. Responses in short-term studies have been variable, but always positive. There was no increase in feed intake in these studies. Long-term studies have found larger increases in milk yields of 16-41 percent and in feed intake. bST appears to affect the mammary gland indirectly as no GH receptor in the mammary gland has been located. The effects of bST on blood flow; lipid, carbohydrate, and protein metabolism; and partitioning of minerals are examined in detail. The similarities between a genetically superior cow and a bST-treated cow are examined in terms of feed efficiency, live weights, and partitioning of nutrients. Consumer and animal safety concerns are addressed.


The authors discuss a study conducted on eight Holstein cows that received injections of 50 IU of GH for two 10-day periods, beginning 20 and 60 days postpartum. Control cows were injected with a placebo. Milk yields of GH-injected cows increased 6 percent and 12 percent over controls for the first and second period. Feed intake and protein content of milk from bGH-treated cows were unchanged. Fat content of milk increased by 25 percent over controls. The alternative explanations for low response to GH administered during early lactation are discussed. The authors conclude that the negative energy balance of dairy cows is not responsible for low GH-response, but rather, response is limited by an inadequate supply of glucose for lactose synthesis.
This paper outlines recent innovations in the dairy industry, including advances in bST biotechnology. A long-term bST study was conducted by Cornell dairy scientists. Cows were grouped by production potential and fed accordingly during treatment and pre-treatment periods. The high-producing cows were selected for daily injections of bST, beginning in the last two-thirds of lactation. Cows were injected for 188 days, causing an increase in milk production of 25 percent over control cows for the full lactation. The shape of the lactation curve changed (peaked at a higher level) for bST-treated cows. Energy and dry matter intake increased for bST-treated cows, while energy density of the ration remained the same. Milk composition, cow health, and reproductive efficiency were unaffected by bST. The authors attribute the success of bST to good nutritional management, allowing cows to consume a balanced ration consistent with higher milk production. Herd response in the field will likely be different than the response achieved under controlled experimental conditions.

Evaluates likely effects of bGH on the dairy industry and indicates the implications for dairy policy. An implication of bGH, like the technologies that came before, is the prospect of lower prices and perhaps fewer farmers. However, the potential benefits of bGH are greater efficiency, lower costs of production, the essential ability to compete with the U.S. dairy substitute market and in the world dairy market, and increased consumption at lower consumer prices.
Chapter 5 of this report (pp. 53-61), "Economic Impacts of Emerging Technologies and Selected Farm Policies for Various Size Dairy Farms," examines the state of the dairy industry in 1983-84, identifies the technologies most likely to affect the industry from 1983 to 1992, identifies policy options most likely to be considered in the 1985 farm bill, and analyzes the effects of these options on moderate, large, and very large dairy farms in major U.S. dairy production regions.


This report is the first step toward understanding the social and economic costs, as well as the benefits, of the emerging technologies for U.S. agriculture. It analyzes the dynamic forces influencing change in the structure of agriculture. Although technology was found to be an important force in such change, it is only one of several such forces. Public policy, institutions, and economics will continue to have important roles in shaping agriculture. The biotechnology and information technology revolution in agricultural production has the potential for creating a larger, safer, less expensive, more stable, and more nutritious food supply. Yet, it also has the potential to cause financial problems in the agricultural sector and in rural communities. Those financial problems can be minimized by careful analysis, planning, and implementing of farm programs.


106. ____________, Letter from John Taylor, Acting Associate Commissioner for Regulatory Affairs, to E. L. Rogersand, the Foundation on Economic Trends, Sept. 29, 1986.


This 12-page paper outlines data requirements from studies designed to demonstrate the effectiveness of bST and for collection of supplemental safety information. The outline lists the detailed needs on response claims, dose titration, herds tested, nutrition, reproduction, milk analysis, mastitis incidence, general cow health, experiment design and analysis, and format of data.


1987 ADSA ABSTRACT REFERENCES

The 82nd annual meeting of the American Dairy Science Association was held at the University of Missouri-Columbia, June 21-24, 1987. The following abstracts are from the Journal of Dairy Science, Vol. 70, Supp. 1, and they can be located in the journal supplement by the P-number at the end of each entry.


"Twenty-six cows received 0, 12.5, 25, or 40 mg BST/d from weeks 5 to 42 postpartum for a second consecutive lactation. Treatments during the previous year were 0, 12.5, 25, or 50 mg BST/d. Cows were fed ad libitum a diet with 55% concentrate and 45% forage. Cows injected with 25 and 40 mg BST produced more 3.5% fat-corrected milk (FCM) than controls (P < .10). Cows receiving 25 and 40 mg BST consumed more dry matter (DM) than controls and the 12.5 mg group (P < .10). Yield of FCM per kg DM intake was greater for cows receiving 40 mg BST than controls (P < .10). Milk composition was not affected by treatment. The data indicated that cows responded to BST treatment during a second consecutive lactation." (Table in original.)


"Records of 305-day milk yield were simulated with (2) and without (1) the effects of bovine somatotropin. Parameters were $h_1^2 = h_2^2 = 0.25$; $r_g = 1.0, 0.8$ or $0.6$; $r_p = 0.8$ or $0.6$; $X_1 = 5000$ kg and $X_2 = 6000$ kg, assuming 20 percent increase in yield associated with somatotropin administration from 90 days in milk to 305 days, and $0_1 = 900$ kg; $0_2 = 1080$ kg. Records for 100 sire progeny groups of 10 to 50 first lactation daughters in 200 herds were simulated. Means, standard deviations and distributions of within herd variances and accuracy and bias of ranking of sires were compared. Strategies included herd owners treating 100 percent or two-thirds of two-year-olds and allocation of somatotropin: (a) at random; (b) to two-thirds of the heifers with highest or lowest 90 day records; or (c) to daughters of the highest two-thirds or lowest two-thirds of the sires represented by..."
daughters in each herd. Variances increased with administration of somatotropin to 100 percent of the heifers in the herd. Sire rankings were not significantly affected by this or random allocation of somatotropin in some herds. Allocation on the basis of high 90 day records or high sire indexes, increased variances and sire mis-ranking."


"Following parturition, forty lactating Holstein cows were randomly assigned to one of four treatment levels of recombinant bovine somatotropin (BST). The hormone or saline was administered daily by subcutaneous injection for 266 days commencing between days 28 and 35 of lactation. Effects of the hormone on milk production, feed efficiency, weight gain (ADG) and reproduction are summarized in table in original abstract. BST injection resulted in a significant (P < .05) increase in milk production and feed efficiency and a decrease in ADG. There was no effect on days to 1st service and days open approached significance (P < .06)." (Table in original.)


"One hundred thirty six cows (116 Holsteins, 12 Jerseys, 4 Brown Swiss, 4 Ayshires) were assigned to 34 replications of 4 cows. Beginning at 28 to 35d of lactation, cows were injected with 0, 12.5, 25 or 50 mg/d recombinant somatotropin (BST). Diets with 16 to 17% CP and 1.65 to 1.70 kcal/kg NE were fed ad libitum. Nine cows (4 @0, 1 @12.5, 1 @25, 3@50 mg/d) did not complete the study and were removed from the production data base. At expected levels of use (12.5-25 mg/d), cows ate more feed (.5-1 kg/d), yielded an additional 3.3-4.4 kg/d FCM, and produced more FCM/DMI (.15-.17 kg). With 50 mg/d BST, fewer cows became pregnant but services/pregnancy were not affected by BST." (Table in original.)


"Our previous research demonstrated that hGRF(1-29)NH$_2$ is equipotent to hGRF(1-44)NH$_2$ in stimulating GH release of heifers and dairy cows. In this experiment, 21 dairy cows (98 ± 25 d in lactation and 609 ± 57 kg BW) received randomly at 1000 h on two consecutive days in the cervical area a sc injection of saline (group 1), [desamino-Tyr$^1$, D-Ala$^2$, Ala$^{15}$] hGRF(1-29)NH$_2$ (.12, .37, 1.11 or 3.33 ug.kg$^{-1}$ BW; groups 2 to 5) or hGRF(1-29)NH$_2$ (3.33 or 10.00 ug.kg$^{-1}$ BW; groups 6 and 7). Blood samples were collected at 20 min intervals from -2 h to 6 h after the injection plus additional samples at +10 and +30 min. Basal GH concentration averaged 1.8 ± .4 ng.ml$^{-1}$. After injection, GH reached peak levels of 3.2, 5.2, 12.8, 35.1, 44.4, 22.1 and 27.3 ng.ml$^{-1}$ (SEM = 6.4) and area under the GH curve were 19, 276, 828, 3823, 5333, 1521 and 2029 ng.min.ml$^{-1}$ (SEM = 911) for groups 1 to 7, respectively. There were significant linear and quadratic effects of
both hGRF peptides on GH release. In conclusion, the analog possesses a greater potency than hGRF(1-29)NH₂ to induce GH release of lactating dairy cows. Project supported by Hoffmann LaRoche Inc.


"Skeletal muscle O2 consumption, Na⁺,K⁺-ATPase-dependent respiration and energy expenditure on protein synthesis were measured for bovine somatotropin (BST; 50mg/hd/d) and saline (CONT) treated lactating cows. Milk production for the control and BST-treated cows at the time of sampling (131 to 151 days into lactation) was 28.4 kg/hd/d and 31.4 kg/hd/d, respectively. Dissected intercostal muscle bundles were used for in vitro measurements of O2 consumption and protein synthesis. Na⁺,K⁺-ATPase-dependent respiration was not significantly (P > 0.05) altered in intercostal muscle (0.40 ± 0.07 ul O2/mg/hr, CONT vs 0.53 ± 0.05 ulO2/mg/h BST) isolated from BST-treated cows. Similarly BST treatment did not significantly (P > 0.05) affect the energy cost devoted to protein synthesis in intercostal muscle (0.35 ± 0.09 ulO2/mg/hr, CONT vs 0.39 ± 0.07 ulO2/mg/hr BST). The proportion of the total muscle respiration directed toward Na⁺,K⁺-transport (18.0 ± 3.5 percent, CONT vs 22.9 ± 1.5%, BST) and protein synthesis (4.8 ± 3.3%, CONT vs 18.3 ± 2.6%, BST) was also not altered by BST-treatment. It was apparent that the skeletal muscle energy costs associated with Na⁺, K⁺-transport and protein synthesis are unaltered in BST-treated lactating cows."


"Bovine somatotropin (bST) was injected subcutaneously in a sustained release vehicle (SRV) in an 84 day experiment. Three amounts of BST (320, 640, 960 mg) were given at three injection (INJ) frequencies (14, 21, 28 days). A tenth group was a noninjected control. Each group initially contained at least 3 cows in early lactation and 2 heifers and 2 cows in midlactation. Interaction of dose of BST and frequencies of injection was not significant for any lactation parameter." (Table in original.)


"Sixteen lactating Holsteins were assigned to treatment groups of either control or 25 mg/d recombinant bovine somatotropin (BST) injected daily for 14 days. Milk production by cows receiving BST averaged 3.4 kg/d more than control cows. Eleven hematology parameters, six serum metabolites, four serum minerals, two serum enzymes and rectal temperature were not different between treatment groups at the end of the injection period. In a second experiment, 14 lactating Holsteins were used to determine lactation response to 960 mg BST mixed in a
sustained release vehicle (SRV) and injected subcutaneously on days 1, 29 and 57 of an 84 day experiment. Compared to control cows, daily yield of milk (kg, 22.9 vs 27.0), fat (g, 827 vs 924), protein (g, 744 vs 868), SCM (kg, 21.7 vs 25.0) and dry matter intake (kg, 20.2 vs 21.0) were greater for cows treated with BST. Body weight and somatic cell counts were not different between treatments. Results demonstrate that lactation is improved with daily injections of BST and that BST is efficacious when injected in a SRV.


"Our previous research showed that hGRF(1-29)NH$_2$ is equipotent to hGRF(1-44)NH$_2$ in stimulating milk production. In this experiment, milk production and feed intake of 16 cows (204 ± 34 d of lactation and 622 ± 51 kg BW) were recorded every day over three 10-d periods (pre-injection, injection and post-injection). Data from the last 5 d of each period were used for statistical analysis. During the injection period, cows received in the cervical area a daily sc injection of saline (group 1), hGRF(1-29)NH$_2$ (10 ug.kg$^{-1}$); (group 2) or [desamino-Tyr$^1$, D-Ala$^2$, Ala$^{15}$] hGRF(1-29)NH$_2$ (.6 or 1.8 ug.kg$^{-1}$; (groups 3-4). Blood samples were collected on days 1, 5 and 10 of the injection period from -2 to 8 h after injection. Averaging all days, area under the GH curve were 21, 2296, 3207 and 3941 ng.min.ml$^{-1}$ for groups 1 to 4, respectively (SEM = 476). During injection, milk production averaged 18.2 kg. d$^{-1}$ for group 1 and increased to 20.4, 20.4 and 21.3 kg.d$^{-1}$ for groups 2 to 4, respectively (SEM = .4). Feed intake was not affected by treatment. In conclusion, the analog is more potent than hGRF(1-29)NH$_2$ in stimulating milk production of dairy cows. Project supported by Hoffmann LaRoche Inc."


"Objectives were to evaluate interactions between recombinant bovine somatotropin (BST) and ruminally inert calcium salts of long chain fatty acids (Ca-LCFA; Megalac) in early lactation. Sixteen cows were randomly assigned to either a 0 or 50 mg/d BST group 4 weeks postpartum. Within each group cows received either 0 or .77 kg/d Ca-LCFA in a single reversal with 5 week periods. Cows receiving 50 mg/d BST produced more milk and 4% FCM, had higher gross efficiency and greater energy output into milk. There was no response to Ca-LCFA with 0 BST. Response to Ca-LCFA with 50 mg/d BST was greater than with 50 mg BST alone. Ruminally inert Ca-LCFA tended to help cows receiving BST in early lactation achieve increased production potential." (Table in original.)


"Ten Holstein cows, averaging 201 days in lactation, were used in a 30 day study during summer. No treatment was imposed during days 1-10 (P1) and 21-30 (P3). During days 11-20 (P2) cows were injected daily with
either saline or 50 IU of pituitary-derived bovine somatotropin (ST) in 30 ml solution. Dry matter intake and milk yield and composition were measured daily. Jugular blood samples, taken on days 10, 15, 19, 20, 21, 22, and 30, were analyzed for various constituents. Body temperatures and respiration rates were measured at 1400 h on 4 to 5 days during each 10 day period. Data were analyzed using orthogonal contrasts. The contrast of \((P1 + P3) vs P2\) for treatment x period interaction was significant for milk yield, respiration rate, and serum nonesterified fatty acids (NEFA). Under heat stress conditions, cows injected with ST for 10 days produced 8.5% more milk than control cows, but also had 6% higher respiration rates and 32% concentrations of serum NEFA's suggesting greater mobilization of energy from adipose tissue.


"Eighty Friesian cows were injected daily with either buffered saline or recombinant bovine somatotropin (bSTH) at 12.5, 25.0 and 50.0 mg/day over lactation weeks 5 to 42. They were fed either complete mixed rations (diet CD) over the whole period or a diet of forage and separate concentrate (9 kg/day) to week 29 and then grazed at pasture (diet FLR). Treatment with bSTH increased DM intake over weeks 5 to 29 by 1.5 kg/day (CD) and 1.1 kg/day (FLR) although the response was not apparent until 6 weeks after treatment. Milk yields over weeks 5 to 42 were 21.1, 24.6, 26.0 and 25.6 kg/day (CD) and 19.1, 23.6, 23.7 and 24.1 kg/day (FLR) for 0, 12.5, 25.0, 50.0 mg bSTH respectively with no significant effects on milk composition. Cows on FLR treated with bSTH tended to gain less weight (+23 kg) over weeks 5 to 29 than those on control (+43 kg), a trend not seen on CD. Progesterone analysis showed that treatment with bSTH did not influence the proportion of cows initially conceiving but those on 50.0 mg/day tended to have less established pregnancies, higher embryo loss and longer time between parturition and established pregnancy. There were no major effects of bSTH on health of cows and the birth weight of calves was unaffected by treatment. It is concluded that bSTH can increase yield of fat and protein by 20 to 28% over a single lactation."

1986 ADSA ABSTRACT REFERENCES

The 81st annual meeting of the American Dairy Science Association (ADSA) was held at the University of California-Davis, June 23-26, 1986. The following abstracts are from the Journal of Dairy Science, Vol. 69, Supp. 1, and they can be located in the journal supplement by the P-number at the end of each entry.


"The effect of recombinant bovine growth hormone (rbGH) on lactating dairy cows was measured with 28 Holstein cows and 4 Jersey cows. Beginning 28-35 days postpartum, subcutaneous injections were administered daily at one of four rotational neck sites. Treatment levels were 0, 12.5, 25.0 and 50.0 mg/head/d with 8 cows assigned per
treatment. The experimental period consisted of 266 days. Cows were fed ad libitum a mixture of corn silage and 18% C.P. concentrate (2:1) plus 1.36 kg alfalfa hay daily. Milk production and feed intake were measured daily throughout the experimental period. The average dry matter intakes were 21.3, 22.5, 22.4, and 22.6 kg/d respectively over the experiment. Average milk yields were 23.7, 27.6, 26.9 and 28.7 kg/d respectively. On a 3.5% FCM basis, milk production measured 25.7, 30.6, 30.4 and 30.3 kg/d respectively at a rate of 3.98, 4.20, 4.35 and 3.93% BF each. This trial showed a marked response to rbGH by lactating dairy cows.


"Beginning at 28 to 35 d of lactation, 32 cows (8/treatment) were injected daily until 294 d of lactation with 0, 12.5, 25 or 50 mg/d recombinant bovine somatotropin (BSTH). Cows were fed ad libitum a diet with 16.6% crude protein, 1.66 Mcal/kg NE, 22% ADF, .86% Ca and .65% P. Milk and FCM were similar (P > .20) in cows injected with BSTH. Cows injected with BSTH produced 24% more milk (P < .01) and 27% more FCM (P < .01). Daily output of energy in milk was increased 4.4 Mcal/d by BSTH (P < .01). Consumption of 1.5 kg/d more feed (P=.11) provide 2.5 Mcal. By diluting maintenance requirements and diverting energy from adipose tissue to milk, cows injected with BSTH produced .26 kg more FCM milk per kg feed (P < .01)." (Table in original.)


"In a randomized complete block design 29 Holstein cows (body weight 646 ± 14 kg) received intravenous infusions of 0 (sterile water), 3.125, 6.25, 12.5, 25.0 or 50.0 mg bovine growth hormone-releasing factor (Peninsula Lab)/cow for 24 h. Cows were blocked and assigned to dose (4 to 5 cows/dose) based on milk yield (28 ± kg/d) and day of lactation (203 ± 15). Infusions started at 1000 h and blood samples were collected at 20-min intervals for 1 h before and during the 24-h infusions. Pre-infusion growth hormone averaged 2 ± .5 ng/ml of serum and did not differ between treatments. Growth hormone during infusion averaged 1.8 ± .5, 9.3 ± 1.6, 6.8 ± .9, 10.8 ± 2.1, 7.2 ± 1.6 and 11.0 ± 1.2 ng/ml serum for increasing doses of releasing factor, respectively. Among doses of releasing factor, growth hormone release did not decline during infusion and was greater during the second (9.9 ± 7 ng/ml) than the first (8.3 ± .7 ng/ml) 12 h of infusion. Control cows had 0 to 3 pulses (maximum peak 12 ng/ml), whereas treated cows had 4 to 13 pulses (maximum peak 87 ng/ml) of growth hormone/24 h. We conclude that all infusions of bovine growth hormone-releasing factor for 24 h markedly increased concentrations and pulsatile release of serum growth hormone in lactating cows, but the increases were not related to dose (3 to 50 mg) of releasing factor."

4. ______. "Effects of 20-day Intravenous Infusions of Growth Hormone-Releasing Factor on Lactation in Dairy Cows." Michigan State Univ. and the Upjohn Co., Kalamazoo, MI. P80G.
In a randomized complete block design 15 primiparous Holstein cows (body weight 556 ± 17 kg) blocked (5 cows/dose) by milk yield and day of lactation (139 ± 7) received continuous intravenous infusions of 0 (sterile water), 1 or 3 mg bovine growth hormone-releasing factor (Bachem Lab)/cow/24 h for 20 d. Cows were fed ad libitum a complete mixed ration. Milk yield and feed intake were measured daily for five d before, during (d 1-20) and for ten d after infusions. Milk composition was determined on d 1-5 and 16-20 of infusions. Growth hormone was measured in blood collected every 20-min from 0800 to 2000 h on d 1, 10 and 19 of infusions. Growth hormone averaged 2.1 ± .3, 5.3 ± .5 and 6.8 ± .8 ng/ml serum for cows infused with 0, 1 and 3 mg of releasing factor, respectively. Releasing factor did not affect feed intake or body weight. Relative to controls (26.5 ± 1.7 kg milk) during d 6-20, 1 mg (29.4 ± 2.0 kg milk) and 3 mg releasing factor (32.7 ± 2.0 kg milk) increased daily yield of milk 11 and 23%, respectively. Between d 1-5 and d 16-20, solids-corrected milk yield (kg/d) decreased 2% for controls but increased 12 and 20% for cows given 1 and 3 mg releasing factor. Our results demonstrate that infusion of bovine growth hormone-releasing factor increases yield of milk and components in a dose-dependent manner.


"Twelve mature Holstein cows, averaging 104 days postpartum, were randomly allocated to two feeding regimes: concentrates fed in 12 equal portions at 2 h intervals or fed in 2 equal portions at 12 h intervals. All cows were fed 14 kg of barley/canola meal concentrate (87.6% DM; 17.3% CP), 3 kg chopped alfalfa hay (81.0% DM; 21.8% CP) and barley silage (43.6% DM; 9.7% CP) ad libitum. Four weeks later cows were randomly allocated within feeding regimes to two treatments: injection of 30 mg (1.8 IU/mg) bovine growth hormone (GH) or 10 mls of buffered saline for 8 days. Milk yield, milk composition and feed intake were recorded daily. Milk samples pooled for days 6, 7 and 8 were used for the determination of fatty acid composition. Blood samples were collected on day 7. Cows were given 7 days after the last injection before treatments were switched. Feeding frequency had no effect on any parameter measured. GH caused an increase in milk yield (27.9, 32.4 kg/day) and a trend for higher milk fat (3.6%, 3.8%) but had no effect on dry matter intake (24.1, 24.0 kg/day) or milk protein, lactose and fatty acid composition. GH (6.1, 21.2 ng/ml) and insulin (1.20, 1.68 ng/ml) concentrations were increased by GH injection. GH injection increased milk yield but feeding frequency had no effect."


"Thirty Holstein cows, 84 ± 10 days postpartum, were injected IM daily for 108 days with either (1) 0, (2) 13.5 (3) 27.0, (4) 40.5 mg r-bgh or (5) 27.0 mg p-bgh. Cows were individually fed a total mixed diet ad libitum twice daily. Mean feed and energy intakes were nonsignificant among treatments. Mean 3.5% FCM was (1) 26b, (2) 34b, (3) 33a, (4) 31ab and (5) 28ab kg (P < .05). Treatment (3) was higher for the relative parameters (% change between pretreatment and treatment
means) of milk production, feed efficiency, total fat and protein than the other treatments. Percent protein was higher (P < .05) for (5) as compared to (1) or (2). Percent fat was nonsignificant among treatments. Blood samples were taken from 2 cows per treatment on days -2, 1, 49, 98, 188 using indwelling cannulas. Blood samples were taken at -1, -0.5, -0.25, 0, 1, 2, 3, 4, 5, 6, 7, 8 and 24 h relative to injection each day. Plasma was analyzed for bgp, prolactin, insulin, glucose, free fatty acids, Beta-hydroxybutyrate and thyroxine (total and free) with significant differences among treatments in bgp and prolactin. Plasma concentrations of bgp (ng/ml) were (1) 2.67c, (2) 12.83bc, (3) 16.79ab, (4) 27.63a and (5) 26.52a (P < .05). Plasma levels of prolactin were (1) 15.25c, (2) 21.22ac, (3) 16.93bc, (4) 22.77a and (5) 17.86bc (P < .05).


"Sixteen Holstein cows were randomly assigned to receive one of four experimental concentrate mixtures: a base mixture consisting of 31% corn, 31% barley, 34% rice bran plus trace minerals and 6% sodium bicarbonate, the base mixture with whole cottonseed replacing 10% of other grains, the base mixture plus a live yeast culture additive, and a ration consisting of the whole cottonseed plus the yeast additive. All cows received alfalfa hay ad libitum, and were fed the base ration during a 2-wk adjustment period, followed by the respective experimental mixtures for an additional 12 wk. Blood samples were collected at the end of the trial via jugular cannulae. Samples were collected at 15-min intervals for 3 hr prior to concentrate feeding and 5 hr following concentrate feeding. Overall, growth hormone concentrations were negatively correlated with days postpartum, while positively related to average daily milk production during the preceding week. Plasma growth hormone concentrations were not affected by diet, but decreased following feeding averaging 4.6 and 3.7 ng/ml before and after feeding, respectively."


"Eight lactating Holstein cows (244 d postpartum) were used to study the effect of bGH (50 IU/day, n=4) or a placebo (n=4) on mammary lipid metabolism. Cows were on a 2 wk adjustment period followed by a 10 d period during which treatments were administered and milk production, milk composition, and lipoprotein lipase activity (LPL) of milk were determined. Cows were assigned to treatments based on milk production and means from the adjustment period were used for covariate analysis. On d 9 of the experimental period, serial blood samples were taken via jugular catheter from 2 to 5 hr post-injection for determination of plasma hormone and metabolite concentrations. Mammary tissue biopsies were taken on d 10 for determination of mammary metabolic activity. The following means for placebo and bGH respectively, were: milk production (21.5 and 24.8 kg/day); milk fat (3.80 and 4.00%); milk protein (3.42 and 3.18%); and 4% fat-corrected milk (20.7 and 25.1 kg/day). Milk production and fat-corrected milk production were significantly
increased while milk protein was significantly decreased by bGH. LPL in milk (32.6 and 28.8 umole/hr/ml) and mammary tissue (2.69 and 2.73 umole/hr/mg protein) were not significantly different. Administration of bGH did not alter lipid metabolism as measured by LPL in milk and mammary tissue."


"Thirteen Holstein cows (81-110 days postpartum) were assigned to a partially balanced incomplete block experiment to evaluate effects of Growth Hormone (GH; 25 mg/d) and environment (Shade-S or No Shade-NS) on milk yield, fat %, feed intake and some physiological responses. Two treatment periods were 28 d each, preceded by 10 d preliminary periods. Water and cottonseed hull-based diet were available ad libitum. Milk yield (MY) was measured twice daily, feed intake daily and fat %, body weight (BW), respiration rate (RR), rectal temperature (RT) and black globe temperature (BGT) 8-15 times during each period. Mathematical model included cow, period (P), treatment (T), environment (E), d and two-way interactions. BGT, RR and RT were higher in NS (P < .01) but no T X d interaction was detected. Overall, MY, fat % and fat yield, adjusted for dry matter (DM) intake, were increased 5.5%, 10.4% and 13.2% (P < .001) by GH during the 28-d period. MY was greatest for GH in both E, but difference was greatest in NS (8.6% vs 2.7% for S). DM intake was not different between T but was higher in S (P < .001)."


"Thirty lactating (2nd-5th lactation) Holstein cows (prior 305d lactation > 6800 kg, mature equivalent) were assigned to 5 treatment groups (6 cows/group). Treatments were as follows: Treatment 1=excipient, Treatment 2, 3 and 4=13.5, 27.0, and 40.5 mg methionyl bovine somatotropin (MBS), respectively, and Treatment 5=27.0 mg pituitary bovine growth hormone (b-GH). Treatments were initiated approximately at day 86 postpartum and continued for 27 wk. Treatments were administered daily by IM injection approximately 2h after the a.m. milking. Cattle were housed in a tie stall barn and fed a total mixed ration with feed and water available ad libitum. Responses to treatments were highly variable. Average daily milk production was not significantly different among treatments. Compared to daily milk production of each treatment group 2 wk pretreatment, daily milk production increased 12.6, 2.2, 4.4, and 4.3% in treatment 2-5, respectively. Milk composition, body weight and body composition did not vary among treatments. A protracted period of high ambient temperature and humidity and a concurrent reduction in feed intake during the experiment may have affected the magnitude of treatment responses."

Thirty-six cows received 0, 12.5, 25, and 50 mg/d rbSTH (supplied by American Cyanamid Co.) from weeks 5 to 42 of lactation. During weeks 4, 16, 28, and 40, circulating metabolites, hormones, and physiological parameters were measured on 28 of the 36 cows. Parameters measured did not differ among groups during week 4. Treatment did not affect blood concentrations of triglycerides, glucose, Ca, P, Cl, Na, K, urea, albumin, alkaline phosphatase, SGOT, creatinine, body temperature, or respiration. Increases in insulin and FFA with increased rbSTH appeared to be associated with increased milk production.” (Table in original.)

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Reports from recently completed trials shed more light on this advancing technology.


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Animal Health Institute campaign seeks to provide public and dairymen with information needed to make rational judgments about biotechnology, specifically somatotropin.


The president of the Foundation on Economic Trends is leading an effort to stop FDA approval of somatotropin.

CONGRESSIONAL TESTIMONY

Hearings on bovine Somatotropin (bST) were held June 11, 1986, before the Congressional Subcommittee on Livestock, Dairy, and Poultry, House Agriculture Committee, U.S. House of Representatives. The following testified before or submitted statements or materials to the subcommittee:


2. Chalupa, William. Professor of Nutrition, School of Veterinary Medicine, University of Pennsylvania.

3. Daniel, Ray. Member of the National Agricultural Research and Extension Users Board and Vice President for Agriculture, Chase Econometrics. "Review of the Status and Potential Impact of Bovine Growth Hormone."


5. Farmers Union Milk Marketing Cooperative.

6. Fox, Michael W. Scientific Director, The Humane Society of the United States.


8. Jorgensen, Neal. Associate Dean for Agricultural Research, College of Agricultural and Life Sciences, University of Wisconsin-Madison. "Bovine Growth Hormone Research at the University of Wisconsin-Madison."


11. Miller, Lee A. Vice President and General Manager, Animal Sciences Division, Monsanto Agricultural Co.


