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Factors Affecting the Adoption of Bovine Somatotropin by Kentucky Dairy Farmers

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Introduction

Over the next few years, dairy farmers will be offered an extensive array of new biotechnologies that could revolutionize milk production. Rapid adoption and use of new biotechnologies can have significant impacts on the market structure of the dairy industry as well as on the future location of milk production in the U.S. As a result, bovine somatotropin (BST), a biotechnology expected to be commercialized for use in the dairy industry in the near future, is receiving a great deal of attention.

BST is a natural protein produced in the pituitary gland of cattle (Baldwin and Middleton). Like other proteins, BST is composed of various amino acids. It is a growth hormone which helps allocate the energy from feed to meet cows' physical needs, such as growth in young animals, milk production in mature animals, and other bodily functions.

BST was first discovered by Soviet scientists in 1937 (Asimov and Krouze). When administered to lactating cows, milk production increased. However, until the advent of recombinant DNA technology, there was no cost-effective method of producing sufficient supplies of BST. Because of this scientific breakthrough, transfer of BST genes from animals to bacteria cells is possible and thus BST can be produced economically on a large scale at attractive market prices.

Current scientific thinking is that BST is generated in the cow's pituitary gland and released to the bloodstream, where it activates BST receptors for specific bodily functions. For example, BST activates growth receptors in young animals and directs food energy into normal growth. At maturity, the growth receptors shut down and mammary receptors are activated which direct food energy into milk production. Thus, supplemental BST administered to mature cows stimulates higher milk production as more food energy is directed to milk production rather than to body maintenance.

Supplemental BST extends the duration of near-peak milk production during the lactation period. Normally, production peaks in the second or third month of the 10-month lactation period and then tapers off until lactation ceases. Although cows receiving supplemental BST consume more feed, trial results show that feed efficiency—*i.e.*, the amount of milk produced per pound of feed—can improve by about 5 to 15%. While feed intake increases with the amount of additional milk produced, it does not increase proportionally.

BST can either be injected daily or administered in the form of a sustained-release implant. Use normally starts about 90 days into lactation. Experimental results have shown significant increases in milk production with the use of BST. Early experiments at Cornell University reported that milk production per cow increased up to 40% during the various stages of the lactation periods when BST was used (Bauman and McCutchen).

Recent farm trials have shown increases in milk production of 15 to 25%. Response rates to BST vary by dosages (Cleale; Huber). There is no doubt that BST increases milk production per cow although some trials have shown increases of only 5 to 10% (McDaniel; Boer). Studies have also indicated that the increased milk yields have resulted from greater feed intake. Feed efficiency, as such, was improved since the percentage of maintenance costs was reduced by producing more milk per cow.

BST has not yet been approved by FDA for commercial use. There is some indication that such approval could be forthcoming in 1993. The many uncertainties regarding BST and its effects on the dairy industry will only be resolved by long-term research studies and extended farm experience.

The question at this point is not whether BST (if approved by FDA for commercial use) will affect the dairy industry; the answer appears obvious. The more relevant question is, what will be the magnitude of the impact?

Adoption of BST will be a farm-level decision made on the basis of knowledge of BST and whether its use fits the individual operation. What factors enter into that decision? A recent survey (Appendix A) of Kentucky dairy farmers provides some insights into factors influencing the BST decision (Gong). The following is an *ex ante* analysis of the survey results focusing on the rate of adoption and factors influencing dairy farmers' adoption decision.

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Rate of Adoption of BST

The extent of the impact of BST on the dairy industry will depend on the proportion of dairy farmers adopting BST. In the survey, dairy farmers were asked to indicate their plans regarding the adoption and use of BST. Three adoption options were offered—adopt, not adopt, and uncertain.

The uncertain option provided an appropriate option for undecided dairy farmers so as to avoid biased responses. Based upon existing knowledge of BST, dairy farmers indicated relatively little interest. Only 5% indicated plans for adopting BST (Table 1). More than half, 57%, indicated an unqualified "not adopt" while 38% were uncertain.

Table 1—Responses of Dairy Farmers to Adoption of BST, Kentucky, 1989

	Daily Injection		Sustained-Release	
	No.	Percent	No.	Percent
Not Adopt	156	57	145	53
Uncertain	105	38	33	12
Adopt	14	5	97	35
Total	275	100	275	100

Source: Survey data.

Those responding "not adopt" and "uncertain" were asked to reconsider the question if a sustained-release implant were available. Given a sustained-release implant, 35% indicated adoption; 53% still would not adopt, and only 12% remained uncertain. The shift to adoption resulted primarily from a change within the uncertain category. Sixty-eight percent of the producers in the previous uncertain category indicated a willingness to use BST if a sustained-release implant becomes available.

Factors Influencing the Adoption Decision

In the adoption process, overall market environment, internal economic condition of an individual dairy operation, and dairy farmers' perception of BST will ultimately influence the adoption decision. The following provides some insights into the importance of both external and internal factors in reaching a decision.

External Factors

Dairy farmers were asked to identify external economic factors influencing their decision regarding adoption of BST. The major factors influencing non-adopters' decision were expected low milk prices, consumers' attitudes towards milk from BST-treated cows, potential risks to the health of BST-treated cows and daily injection (Table 2).

Table 2—Factors Considered—Non-Adopters, Kentucky, 1989

Factors	No.	Percent
Low milk prices	97	68
Consumer attitudes	82	58
Risks on cows' health	78	55
Daily injection	77	54
Costs > returns	46	32
More labor needed	32	22
Experimental results	31	22
Quit dairying	25	18
Risks on new investment	16	11
Balancing feed rations	17	12
Other	14	10

Source: Survey data.

Sixty-eight percent indicated that they do not plan to adopt BST because of expected lower milk prices, 58% were afraid that consumers may refuse to drink milk from BST-treated cows, 55% expressed concern about potential risks to the cows' health, and 54% did not like the daily injection method of administering BST. Eighteen percent of the non-adopters planned to quit dairying in the near future and thus were not considering adoption.

For the uncertain group, daily injection, the cost of BST, consumers' concern over milk from BST-treated cows, future milk prices, and impacts on the government price support program were factors affecting their decision (Table 3). Sixty-eight percent of the dairy farmers were uncertain because of administering BST by daily injections. Sixty-five percent were uncertain because of lack of information on the cost of BST. Dairy farmers in the uncertain group also indicated a concern for consumer reactions (60%) and the health of BST-treated cows (54%). More than half (58%) expressed concerns for the impacts on future milk prices and the price support program (51%).

Table 3—Factors Considered—Uncertain Group, Kentucky, 1989

Factors	No.	Percent
Daily injection	71	68
Cost of BST	68	65
Consumers' concern	62	60
Future milk prices	60	58
Concern for health of cows	56	54
Impacts on price support program	53	51
Experimental results not conclusive	39	38
Not economically feasible	23	22
Other	6	6

Source: Survey data.

The uncertain group was asked to further identify information needed for a more definite adoption decision. Their responses are recorded in Table 4. More than three-fourths indicated a need for more cost-return data from the use of BST. Other needed information included impacts on herd health and production. About two-thirds expressed an interest in results from herds using BST on a regular basis. The responses indicated that economic feasibility of BST, cow safety and the availability of field results would be important in reaching a final decision regarding the use of BST.

Although few in number, adopters were much more confident regarding the use and impacts of BST. Their reasons for planning to adopt centered primarily around expected response on productivity and expected returns over costs. Factors considered and their relative importance are shown in Table 5.

Internal Factors

The adoption decision is also influenced by factors internal to the dairy operation, such as: herd size, average milk production per cow, income levels, financial condition, management practices being used, and personal characteristics of the operator. These can all influence the adoption decision.

Herd Size. Adoption of BST is clearly associated with herd size (Table 6). At the .01 level of significance, association was found between adoption and size of herd. The proportion of dairy farmers planning to adopt BST increases as herd size increases. The proportion of dairy farms who were uncertain remained relatively constant among herd size groups.

Milk Production per Cow. A positive relationship between adoption of BST and average milk production per cow was found (Table 7). The percentage of adopters increased as average milk production per cow increased. A significant relationship was observed at the .05 level.

Income. In general, dairy farmers with larger total gross income are more likely to adopt BST (Table 8). At the .10 level of significance, no relationship was found relative to the percentage of total income from dairying.

Table 4—Information Needed—Uncertain Group, Kentucky, 1989

	No.	Percent
More results from experiments	38	41
Results from herds using BST regularly	60	64
More information on feeding systems needed	31	33
Wait for neighbor to use first	11	12
Need to know more about cost-return from its use	73	78
Need more information on herd health, production, etc.	70	75

Source: Survey data.

Table 5—Factors Considered—Adopters, Kentucky, 1989

Factors	No.	Percent
Returns > costs	13	93
Cost of BST	10	71
Feed efficiency	8	57
Expected milk prices	7	50
Response rates	7	50
No changes needed in labor and facility	5	36
Administration costs	4	29
Impact on price support program	4	29
Additional feed costs	3	21
Balancing feed ration	3	21
Results of experiments	2	14

Source: Survey data.

Table 6—Herd Size by Adoption Categories, Kentucky, 1989

	Not Adopt	Uncertain	Adopt
		Percent	
0-29 cows	67	11	22
30-49 cows	62	13	25
50-99 cows	40	13	47
100 or more	34	9	57
		cows	
Average Herd Size	48	56	67

Source: Survey data.
Chi-square, 6 df.—22.95, significant at $\alpha = .01$

Table 7—Milk Production Per Cow by Adoption Categories, Kentucky, 1989

	Not Adopt	Uncertain	Adopt
		Percent	
< 5,000 lb	100	0	0
5,000-9,999 lb	56	12	32
10,000-14,999 lb	47	15	38
> 15,000 lb	50	4	46
		lb	
Average milk production per cow (lb)	13,288	12,595	13,883

Source: Survey data.
Chi-square, 6 df.,—12.929, significant at $\alpha = .05$

Financial Status. The results show an inverse, but significant, relationship between adoption of BST and net worth (Table 9). Farmers with higher net worth are primarily small grade A producers and manufacturing milk producers. The inverse relationship may imply that large grade A dairy farmers with a high debt load are more aggressive in trying to improve their financial situation by using new technologies.

Personal Characteristics of Principal Operators. Two personal characteristics of operators, education and age, were analyzed (Table 10). The proportion of dairy farmers planning to adopt BST increases with the level of education. A significant relationship was observed statistically (.01 level). While adoption decreases with the age of the principal operator, no significant association was found between adoption and age of operator (.10 level).

Management Practices. No clearcut generalization emerged in the relationship of management practices and the adoption decision (Table 11). For example, at the .05 level, a significant relationship was found between the adoption decision and forage testing, computer feeding, artificial insemination, and the timing of feeding concentrates. No significant relationship was found with balanced rations, and DHIA or owner-sampler testing.

Table 8—Income by Adoption Categories, Kentucky, 1989

	Not Adopt	Uncertain	Adopt
		Percent	
Total Gross Income[a]			
< $20,000	74	7	19
$20,000-39,999	51	26	23
$40,000-59,999	68	17	15
$60,000-79,999	56	6	38
$80,000-99,999	36	7	57
$100,000-299,999	41	9	50
$300,000-499,999	44	0	56
> $500,000	25	25	50
Percentage of Total Income from Dairy[b]			
90-100	40	14	46
80-89	57	13	30
70-79	39	11	50
60-69	61	7	32
50-59	63	4	33
25-49	61	17	22
< 25	67	33	0

Source: Survey data.
[a]Chi-square, 14 df.—37.273, significant at $\alpha = .01$
[b]Chi-square, 14 df.—19.964, signficant at $\alpha = .10$

Table 9—Financial Situation by Adoption Categories, Kentucky, 1989

	Not Adopt	Uncertain	Adopt
		Percent	
100% Debt Free	63	11	26
75-99%	66	8	26
50-74%	39	16	45
25-49%	52	19	29
< 25%	37	10	53

Source: Survey data
Chi-square, 8 df.—19.177, significant at $\alpha = .05$

Table 10—Dairy Farmers' Personal Characteristics by Adoption Categories, Kentucky, 1989

	Not Adopt	Uncertain	Adopt
		Percent	
Education[a]			
< High school	74	13	13
Some high school	46	25	29
High school graduate	54	10	36
Some college	31	16	53
College graduate	33	0	66
Postgraduate	14	0	86
Age of Principal Operator[b]			
< 30 years	36	11	53
30-45 years	43	15	42
46-55 years	59	11	30
56-65 years	61	10	29
> 65 years	65	12	23

Source: Survey data.
[a]Chi-square, 10 df.—40.552, significant at $\alpha = .01$
[b]Chi-square, 8 df.—11.018, significant at $\alpha = .10$

Changes Needed to Adopt BST

Although BST is considered a low investment technology, adoption may require changes in existing facilities and management practices. Survey participants in the adopt and uncertain categories were asked to identify needed changes in their individual operation following adoption of BST. Responses are presented in Table 12.

The results indicated only a small proportion of farmers anticipating major changes in existing facilities. A somewhat larger proportion indicated either major or minor changes in some management practices such as labor, feeding, breeding, and record-keeping programs.

Table 11—Management Practices and Adoption Decisions, Kentucky, 1989

	Not Adopt	Uncertain	Adopt	Chi-Square[a]
		Percent		
Forage Testing				
Yes	43	8	49	13.058***
No	57	15	28	
Balanced Rations				
Yes	50	12	38	2.975
No	61	12	27	
Computer Feeding				
Yes	0	0	100	9.638***
No	55	12	33	
Artificial Insemination				
Yes	48	10	42	8.430**
No	58	16	26	
DHIA				
Yes	47	9	44	3.076
No	57	11	32	
Owner-Sampler				
Yes	48	10	42	.653
No	55	11	34	
Concentrates Fed				
Only when milking	57	12	31	11.018**
Part while milking	39	17	44	
Other	40	0	60	

Source: Survey data.

[a]Significant levels of .01 and .05 are indicated by *** and ** respectively.

Table 12—Changes Needed to Adopt BST—Uncertain and Adopt Categories, Kentucky, 1989

	NoChange	Minor	Major
		Percent	
Housing/holding facility	70	21	9
Milking facility	81	18	1
Milk storage capacity	68	22	10
Grain storage capacity	78	12	10
Silage storage capacity	75	19	6
Feed mixing capacity	80	14	6
Concentrate feeding system	62	28	10
Silage handling system	79	14	7
Waste disposal system	77	14	9
Land to grow more feed	65	26	9
Family labor	74	21	5
Non-family labor	66	23	11
Purchased forages	72	22	6
Purchased concentrates	48	44	8
Forage testing program	72	22	6
Balancing feed rations	48	44	8
Record programs (DHI/O-S)	67	24	9
Breeding program	73	25	2
Number of milkings per day	79	12	9

Source: Survey data.

Conclusions

Experimental results show that bovine somatotropin increases milk production per cow. The potential use of BST in milk production has attracted widespread attention from dairy farmers, organizations, government, and the consuming public. While it has not been approved by FDA for commercial use, there are indications that such approval could be forthcoming. However, its use will be determined by individual dairy farmers.

If approved, adoption will be a farm-level decision made on the basis of knowledge of BST and whether it fits the individual operation. This decision will be influenced by a number of factors, both internal and external. The objective of this study was to identify factors affecting that decision. The following conclusions can be drawn:

1. Based on existing knowledge of BST and assuming the method of administration would be daily injection, dairy farmers indicated a very low level of interest in adoption. Only 5% indicated plans to adopt. Given a sustained-release implant instead of daily injection, more than one-third (35%) indicated plans for adoption.

2. Major external economic factors influencing the non-adopter's decision were expected low milk prices, consumers' attitudes toward milk from BST-treated cows, potential health risks to BST-treated cows, and daily injections. Adopters were influenced by expected productivity responses and anticipated returns over cost.

3. Factors internal to the farm operation likewise influence the adoption decision. A positive relationship was found between adoption and the level of operator education, herd size, milk production per cow, and gross income. There was an inverse relationship between adoption and total net worth and age of operator.

APPENDIX A: SURVEY

A 20% random sample of Kentucky dairy farmers was surveyed using a mail questionnaire. The sample included 204 manufacturing milk producers and 616 grade A milk producers. A comprehensive questionnaire was mailed in May 1989. Two weeks later, a postcard was sent to those who had not yet responded. After a period of two weeks, a second reminder, including a blank questionnaire, was sent to those who had not responded to the two previous requests.

Usable questionnaires were received from 286 farmers for a 35% response (38% response from grade A milk producers and 26% response from manufacturing milk producers). This accounts for 7% of total Kentucky milk producers (8% grade A milk producers and 5% manufacturing milk producers).

The survey consisted of two major parts: (1) information on the dairy operation and the principal operator, and (2) plans for adopting BST. In the first part, specific information was collected on herd size, milk production, income, management practices, and personal characteristics of the principal operator.

In the second part, dairy farmers were asked to indicate their plans regarding the adoption and use of BST. They were also asked to identify the external factors affecting the decision. Three adoption options were offered: adopt, not adopt, and uncertain. The uncertain choice provided an appropriate option for undecided dairy farmers so as to avoid biased responses. Operational changes needed for use of BST and their opinions regarding some of the issues surrounding adoption of BST were also requested.

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