Adoption and Diffusion Potentials for Bovine Somatotropin in the Southeast Dairy Industry

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INTRODUCTION

BOVINE SOMATOTROPIN treatment, a new technology capable of enhancing a cow's ability to produce milk 7-23 percent (*18*), is expected to be available for commercial use sometime in late 1990 or early 1991. Because of the unprecedented yield-enhancing potential of this technology and the difficulties that the dairy industry has had with surpluses, BST is controversial.[3]

One aspect of that controversy is how BST will affect the organization and spatial distribution of dairy farming in the United States. The demand for dairy products is price inelastic, meaning that BST-induced declines in price will have minimal effect on consumption. With consumers unwilling to purchase the additional supply of milk made possible by BST, cow numbers will need to be reduced. But how and where will attrition occur? Will the egress of resources from dairying be concentrated among small farms or will the impact be spread more evenly? Will some regions of the country be affected more seriously than others?

Questions about how BST will affect the geographical and size dis-

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[2]Appreciation is expressed to Bill Lesser and his colleagues at Cornell University for sharing their survey instrument, to Jeff Gillespie for assistance with computer work and graphics, and to Conner Bailey, Keith Cummins, and Ray Huddleston for reviewing and commenting on an earlier draft of this report.
[3]Earlier references to bovine somatotropin use the terminology "bovine growth hormone," or bGH for short. "Bovine somatotropin" seems to be the preferred descriptor today, occasionally abbreviated bST. BST is the designation used in this publication. In any case, bGH, bST, and BST all refer to the same item.

tribution of dairy farms are important for several reasons. First, identifying regional impacts of BST will be useful to policymakers in allocating public resources designed to assist farm families and communities adversely affected by the technology. *Ex ante* information about regional adjustments also will be useful to industry in planning needed changes in milk handling and processing facilities. Second, identifying the size bias of BST (if any) *and the reasons for this size bias* will help policymakers anticipate the long-run effects of the technology. This information will improve the design of policies intended to mitigate or attenuate undesirable outcomes. For example, if BST tends to favor large farms, implying an acceleration of the trend toward fewer and larger dairies, policymakers will want to consider programs that help the smaller farmers adapt.

Adoption and diffusion rates are pivotal to understanding how BST will affect the average size and location of dairy farms. Accordingly, the main objectives of the research reported in this bulletin are: (1) to determine how rapidly BST likely will be adopted; (2) to describe the likely pattern of adoption; and (3) to define the rate in which the Southeastern dairy herd will be placed on the hormone (diffusion).[4] Secondary objectives include describing likely adjustments in herd size, feed acquisition, and land use. The Southeastern United States (Alabama, Florida, Georgia, and Mississippi) serves as the focus of analysis. Data were obtained using an *ex ante* survey procedure, an approach that elicits anticipated adoption decisions from a potential user group.

The research reported in this bulletin represents the first attempt to predict and describe the potential rate of adoption and diffusion of BST in the Southeast. Similar studies by Lesser et al. (*20*), Hammond (*11*), and Zepeda (29) provide adoption rate projections and related data for New York, Minnesota, and California. The New York and California studies suggest relatively rapid rates of adoption in these major milk-producing states, but differences exist regarding awareness, concerns about consumer and cow reaction to BST, and assessments of feasibility. For example, 37 percent of California producers indicated they would not use BST, compared to 13 percent for New York producers. Of the farms surveyed in Minnesota, 46 percent indicated nonadoption (*11*). These and other differences may be attributable to differences in the survey instrument and timing of the

[4]Defining diffusion as the rate at which BST is applied to the dairy herd differs somewhat from the traditional definition which implies the spread of an innovation from one locale or social group to another (3, p.1). But the definition used herein is consistent with the one used by Lesser et al. (*20*, p. 159), who define "adoption" as referring to individual decisions and "diffusion" as the aggregate impact of those individual decisions.

surveys, but they do provide a basis for determining how the Southeast may differ from other regions in terms of BST adoption and related issues.

The narrative has three basic parts: (1) a discussion of the survey methodology and summary statistics relating to adoption and diffusion; (2) development of a multivariate logit model to test hypotheses about factors affecting potential adoption rates; and (3) evaluation of the role of price in determining how rapidly farmers will purchase BST once it becomes available. Part (2) is more technical and narrow in focus than the other parts and can be skipped by the reader interested strictly in the descriptive aspects of the study.

SURVEY PROCEDURES

Data for this study were obtained through a mail survey of a random sample of dairy farmers in Alabama, Florida, Georgia, and Mississippi (see Appendix A for a copy of the instrument). The questionnaire was designed to assess farmers' attitudes toward BST. A "fact sheet" enclosed with the mail survey provided a description of the product, its mode of action, and means of administration (see Appendix B for more details about the "fact sheet"). Estimates were provided of projected additional feed requirements, gross returns, and profit associated with use of BST. In addition, the "fact sheet" provided information about the safety of BST to humans and animals.

Farmers were asked about their knowledge of the product, their opinion of its potential for profitable use on the farm, projection of their own relative speed and intensity of adoption, and willingness to pay. Several response categories were provided for each question. Socio-economic characteristics of the farm and its manager were also investigated.

An initial mailing of the survey instrument was made in October 1984 to 1,000 dairy farmers residing in the four-state region. Post card reminders and two additional mailings to nonrespondents resulted in a cumulative response rate of 32 percent.

The question of nonrespondent bias was examined by telephoning a random sample of 50 nonrespondents. Seven questions were asked concerning farm and personal characteristics. Comparison of sample means between telephone and mail surveys showed insignificant differences at the 5 percent level for six of the seven variables according to a t-test, table 1. The one significant factor (education) suggests that respondents have more schooling than nonrespondents. But the dif-

TABLE 1. SAMPLE MEANS OF SOCIO-ECONOMIC VARIABLES FROM MAIL VERSUS TELEPHONE SURVEYS OF SOUTHEASTERN DAIRY FARMERS, 1984-85

Source of data	Herd size	Herd productivity/ cow/day	Artificial insemination[1]	Dairy as income source[2]	Age of operator	Years of experience	Educational level[3]
		Lb.					
Mail survey	219.3	42.9	1.18	1.09	46.7	23.2	4.7
	(490.4)[4]	(7.8)	(.38)	(.29)	(11.7)	(14.5)	(1.3)
Telephone survey	154.4	43.9	1.28	1.12	49.9	26.6	4.3
	(202.8)	(8.4)	(.45)	(.38)	(11.3)	(14.7)	(1.2)
t-value[5]	–1.61	.78	1.48	.61	1.84	1.52	–2.1

[1]If the dairy farmers used AI, then the answer was coded 1; otherwise 2.
[2]If dairying is the most important source of household income, the answer was coded 1; otherwise 2.
[3]The number 4 corresponds to a high school education.
[4]Numbers in parenthesis are standard errors.
[5]Computed under the null hypothesis that sample means are equal. The critical value for rejecting the null hypothesis at the 5 percent level is 1.96.

TABLE 2. AGE DISTRIBUTION, CENSUS[1] VS. SAMPLE, SOUTHEASTERN DAIRY FARMERS, 1984[2]

Age group	Alabama		Florida		Georgia		Mississippi	
	Census	Sample	Census	Sample	Census	Sample	Census	Sample
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Under 25	1.6	0	0.9	0	1.6	4.1	1.5	1.7
25-34	10.8	19.1	9.4	15.3	10.0	15.8	10.8	11.7
35-44	19.7	28.1	20.0	30.6	20.7	26.3	18.7	31.7
45-54	23.6	23.6	24.4	29.2	23.0	23.7	22.3	28.3
55-64	24.5	24.7	25.6	18.1	24.4	23.7	24.8	25.0
Over 65	19.8	4.5	19.8	6.9	19.8	6.6	21.9	1.7

[1]1982 Census of Agriculture.
[2]Figures may not sum to 100 due to rounding.

ference is slight. Based on these results, nonrespondent bias is not considered a problem with these data.

The representativeness of the sample was checked by comparing the age distribution of respondents with 1982 census data. Results show that in each state the survey data tend to overrepresent younger farmers and underrepresent older farmers, table 2. But the data are representative of the age categories containing the largest number of commercial dairy farmers, age 45-65.

Survey respondents from each state are similar in most respects, table 3. They are on average 47 years of age, have about 23 years of experience dairying, and have some formal schooling beyond high school. Productivity of the sample dairy herds is about the same in each state, averaging 43 pounds of milk per cow per day.

Herd size is the one factor showing considerable differences across the states. Mississippi has the smallest average herd size, 95 head. Florida dairy farms, with an average herd size of 533 head, are the

TABLE 3. MEAN SOCIO-ECONOMIC AND PRODUCTION CHARACTERISTICS OF SOUTHEASTERN DAIRY FARMERS, 1984

State	Age of owner	Number of years dairying	Herd production/ day	Herd size[1]	Education level[2]	n
			Lb.			
Alabama	46	21	43	122	4.8	90
Florida	47	26	44	534	4.6	78
Georgia	46	22	44	127	4.6	80
Mississippi	47	24	41	95	4.7	65
All states	47	23	43	219	4.7	313

[1]This figure includes one farm of 7,000 head. Excluding this farm reduces the average herd size in Florida to 445.
[2]1 = some grade school; 2 = grade school graduate; 3 = some high school; 4 = high school graduate; 5 = some college; 6 = college graduate; and 7 = graduate school.

largest in the Southeast. The sample Alabama dairy herds are about the same size as those in Georgia, averaging 125 head.

RESULTS

This section provides a general overview of the survey results. Because preliminary analysis revealed few significant differences among states in terms of awareness, attitudes, adoption rate, and other factors discussed below, data are presented as sample averages rather than delineated by state. Unless otherwise indicated, conclusions drawn or inferences made about the Southeast are equally valid for Alabama.

Awareness of BST

Farmers' awareness of BST at the time of the survey (fall 1984) was relatively low. Awareness levels are as follows:

	Percent
Never heard of it	50
A little	33
Somewhat familiar	14
Very familiar	3

Only 50 percent of the respondents had heard of BST. Of these, only 3 percent indicated they were "very familiar" with the product. Awareness levels undoubtably have improved since 1984, given the publicity of BST in national and regional media.

Attitudes toward BST

Based on the information given in the survey packet about BST, respondents were asked to assess the feasibility and desirability of the product. The perceived feasibility of BST was rated as follows:

	Percent
Very	18
Somewhat	22
Possible	30
Questionable	28
Other	2
	(n=310)

While the majority of respondents saw potential for this new technology, 30 percent were skeptical.

The skepticism seems to be centered around the effects of daily injection on animals' long-term health and productivity, and labor costs.[5] Almost all respondents indicated that availability of an implant would enhance their opinion of feasibility.

Most respondents indicated a desire for more information about BST before assessing its feasibility. The recommendation of a veterinarian and experimental results covering a longer period of time were considered important factors influencing their final appraisal.

Adoption Rate

Respondents were asked how soon after availability they would try BST. Nine response categories were given. Results are:

Expected adoption rate	*Percent*
Immediately upon availability	41
3 months after availability	8
6 months after availability	11
1 year after availability	17
2 years after availability	7
3 years after availability	3
5 years after availability	3
Longer	2
Never	8
	(n = 297)

In total, 41 percent said they would adopt BST immediately upon availability, and another 41 percent would eventually adopt after a waiting period. Only 8 percent said they would never use BST. These results suggest a rapid adoption rate, with most farmers having at least experimented with BST within 3 years of availability.

Method of Adoption

Respondents were asked to indicate how many cows would be treated with BST and the criteria they would use to select trial animals. Approximately 19 percent indicated they would begin by treating the entire herd; 15 percent said they would initially treat half of the herd. The majority of respondents (66 percent) indicated they would begin using BST on only a few cows.

Criteria for selecting trial cows varied greatly. Many respondents indicated they would pick cows at random. Some would pick their best cows; others their worst. Still others proposed taking a cross-section of high, medium, and low-producing animals.

[5]Keith Cummins, Professor of Animal and Dairy Sciences at Auburn, states that a 30-day injectable form is now available.

Methods for Meeting Increased Feed Requirements

A treated cow requires more feed to compensate for increased milk output. The questionnaire probed how the farmer would meet additional feed requirements. Approximately 30 percent would purchase the additional feed. Of the remaining respondents, 27 percent would grow the additional feed and 43 percent would obtain it through a combination of purchases and cultivation of additional land.

Anticipated Adjustments in Herd Size

Respondents were asked to indicate current plans for changing herd size and to indicate adjustments in herd size following adoption of BST. Approximately 45 percent of the respondents indicated an intention to decrease herd size in the next year. The other 55 percent planned to increase herd size in 1 year.

When asked to indicate additional adjustments to milking herd size following adoption of the hormone, 10 percent said they would reduce the herd during the first year of treatment, while 31 percent indicated they would increase the herd. The remaining 59 percent indicated they would make no change in herd size following adoption. Approximately 9 percent of the respondents indicated they would decrease their herd size 5 years after beginning use of BST, while 30 percent indicated they would increase their herd size after 5 years. The remaining 61 percent indicated they would make no change in milking herd size 5 years after adopting BST.

The relatively large number of farmers who plan to increase herd size may reflect a perceived need "to get larger or get out." The perception is consistent with economic analysis showing larger dairies weathering BST more successfully than smaller dairies (*17*). The unwillingness to reduce herd size in the face of expanding supplies of milk suggests most of the adjustments will occur through attrition, i.e., farmers leaving dairying.

Diffusion

Diffusion in this study refers to the portion of the dairy herd treated with BST at selected time intervals from introduction of BST through market saturation. Diffusion differs from adoption in that interest is centered not on when the farmer plans to first use BST but on how rapidly BST is applied to the entire dairy herd. For example, farmers might plan to use BST immediately upon availability but then spend a long time experimenting using a small number of cows. In this case, adoption is rapid but diffusion slow.

Diffusion rates are especially relevant for policy analysis because the downward pressure on price following the introduction of new technology is more closely linked to diffusion than adoption (*15*). But adoption must occur before diffusion can be considered; therefore, the two concepts are related. In fact, when plotted against time, diffusion and adoption curves tend to be "S" shaped.

The potential diffusion of BST was assessed by asking the respondent to indicate the anticipated portion of the herd on hormone at selected time intervals following availability, table 4. The dairy farmer was to assume that the hormone would be administered via daily injections. Information was given indicating anticipated gross returns to hormone use for alternative levels of increased milk production, Appendix B.

TABLE 4. ADOPTION RATE OF BST IN THE SOUTHEASTERN UNITED STATES AS INDICATED IN A 1984 SURVEY OF DAIRY FARMERS

Time period after introduction of BST	Anticipated portion of herd on hormone[1]:				Adoption rate[2]
	None (1)	Some (2)	Half (3)	All (4)	
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*
6 months	28.4	39.0	16.3	16.3	71.6
1 year	17.7	29.1	24.8	28.4	82.3
2 years	12.1	22.0	19.8	46.1	87.9
3 years	11.3	14.2	22.0	52.5	88.7
10 years	10.6	11.4	13.5	64.5	89.4

[1]These numbers relate to those respondents (141) who completely specified an adoption path, i.e., gave some number for each of the time periods indicated. Similar tables were also constructed for (1) only the complete adopters (130), i.e., those who indicated that eventually *all* of the herd would be treated with hormone, and (2) all respondents who answered at least a part of the question (263). Diffusion curves implied by each group are presented in figure 1.

[2]Adoption rate is the sum of columns (2) - (4).

Respondents differed in the degree to which they answered the diffusion question. For this reason, responses were organized into three groups:

Group 1: Those who specified a complete diffusion path, i.e., gave some answer for each of time periods indicated (n= 141).

Group 2: Those who answered at least part of the question about the diffusion path (n = 263).

Group 3: Those who indicated that eventually all of the herd would be treated with the hormone (n = 130).

TABLE 5. POTENTIAL DIFFUSION OF BST, SOUTHEASTERN UNITED STATES, 1984

Time period after introduction of BST	Anticipated portion of herd on hormone[1]: Group 1	Group 2	Group 3
	Pct.	*Pct.*	*Pct.*
6 months	34	33	45
1 year	48	46	68
2 years	62	57	86
3 years	67	61	92
5 years	72	64	97
10 years	74	65	100

[1]Herd portions were computed using the formula $D = \sum_{i=1}^{3} w_i C_i \times 100$ where $w_1 = .25$, $w_2 = .50$, $w_3 = 1.0$.

C_1 = portion of sample indicating some cows on BST; C_2 = portion of sample indicating about half the herd on BST; and C_3 = portion of sample indicating all the herd on BST for the time period in question.

Following Lesser et al. (*20*), Group 3 is defined on the assumption that complete diffusion is the only viable option in the long run. That is, those intending to eventually treat the entire herd probably have the most realistic expectations about the technology. In any case, computing diffusion rates for each group provides a basis for determining how response rates and data treatment might affect results.

Results for all groups suggest a rapid rate of diffusion, table 5. At least one-third of the Southeastern dairy herd will be treated with BST within 6 months of commercial availability if these projections accurately reflect actual producer behavior. Within 3 years, 61-92 percent of the herd will be on BST. Beyond 3 years, diffusion continues but at a reduced rate. An asymptote of 65-74 percent appears to exist for Group 1 and 2 respondents, indicating a ceiling diffusion rate of about 70 percent for these groups. (The diffusion rate should not be confused with the *adoption rate* discussed previously. The percent of dairy farmers indicating eventual adoption of BST was 90 percent, greater than the Group 1 and 2 diffusion rate of 70 percent. This difference implies that although most farmers plan to use BST eventually, not all will treat the entire herd, i.e., some will remain "partial adopters.")

A histogram of the estimated diffusion paths for the alternative date groupings is shown in figure 1. Note that Group 1 and Group 2 have similar diffusion rates, implying minimal nonresponse bias. Group 3 exhibits about the same diffusion rate as the other groups; only the height of the curve is elevated. All three groups show rapid diffusion.

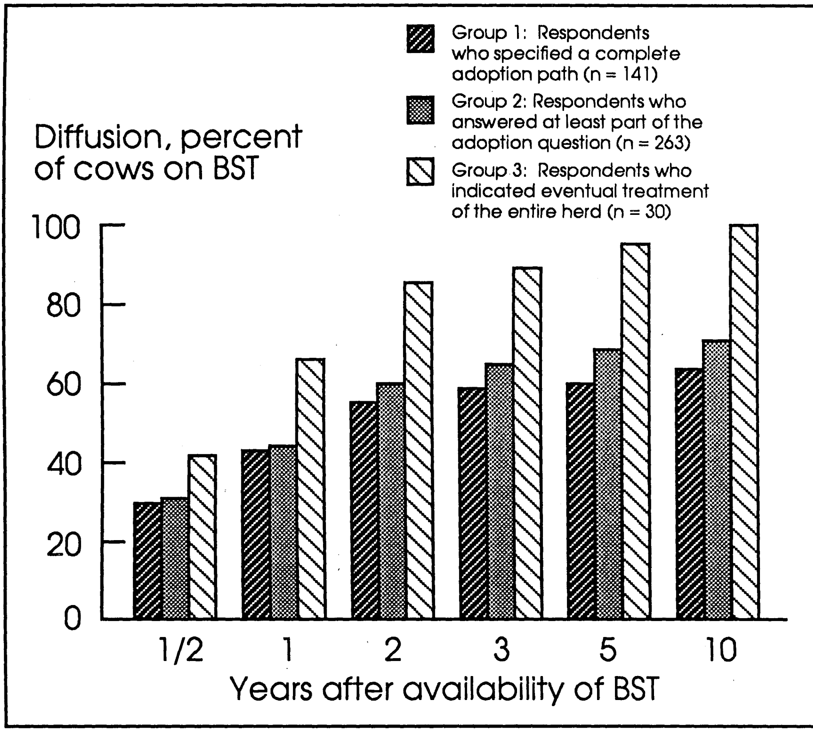


FIG. 1. Potential diffusion rate of BST for alternative groupings of Southeastern dairy farmers.

Influence of BST Price on Adoption

In an attempt to determine how the price of BST might affect the adoption decision, the respondents were asked to indicate the maximum price they would be willing to pay for the hormone and how alternative prices of BST would affect the adoption decision, figure 2. The fact sheet indicated a gross daily return to hormone use (net of feed costs) of $0.43-$1.29, depending on the production response of the treated cow.

The effect of price on the adoption decision was explored by asking the respondents to indicate how two price levels, 10¢ and 25¢ per dose, would affect adoption. Under the higher price, the percent of respondents indicating they would not use BST increased from 3 percent to 7 percent. Similarly, the percent who said they would apply BST to the entire herd decreased from 25 percent to 7 percent. Thus, the price of BST appears to be an important factor affecting its rate of adoption and use.

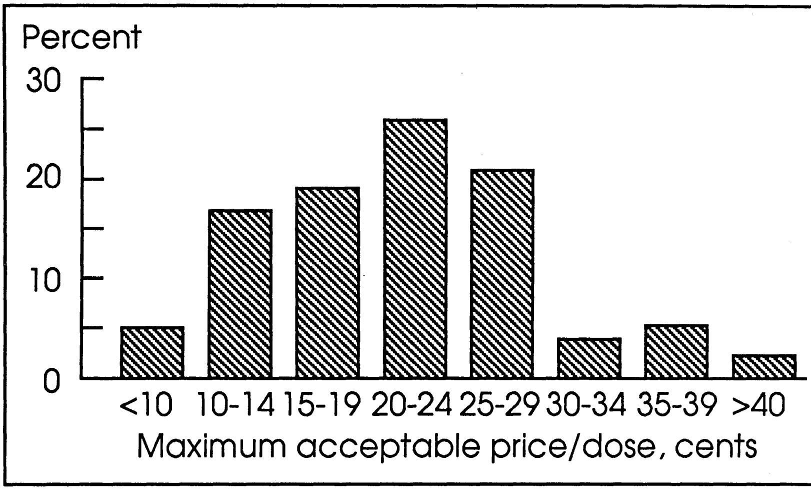


FIG. 2. Maximum acceptable price for BST, Southeastern dairy farmers, 1984.

Market sensitivity to the price of BST was determined by studying the cumulative distribution of maximum pay prices. Assuming that BST would not be purchased if the actual price exceeds the maximum pay price, the following shows the percentage of dairy farmers planning to use BST at different price levels:

Price/dose, cents	*Percent willing to purchase*
Less than 10	95
15	78
20	59
25	32
30	11
35	7
40 or more	2
	(n = 168)

These data highlight the dynamics between adoption and expected profitability of the technology. At the average maximum price of 21¢ per dose, BST achieves about 59 percent market penetration. However, if dairy farmers are required to pay 30¢ per daily dose, potential adoption declines from 59 percent to 11 percent. Conversely, lowering the price to 10¢, which would still yield a 17.6 percent gross manufacturing margin if BST could be produced and sold for 8.5¢, (*14*) increases the rate of adoption to 95 percent.[6]

[6]The apparent sensitivity to price even in a range that yields a positive return suggests a large implicit risk premium. The price of milk, therefore, could also significantly affect diffusion rates.

The relation between price and adoption was quantified further by estimating the following "demand" curve for BST (t-ratios in parenthesis):

$$(5)\ Q = \underset{(19.0)}{129.21} - \underset{(-13.1)}{3.33}\,P + u \qquad R^2 = .98$$

where Q = percent of dairy farmers willing to adopt BST, P = price of BST in cents per dose, and u is the regression residual. This equation has significant coefficients and provides a good fit to the data in the relevant range, figure 3.

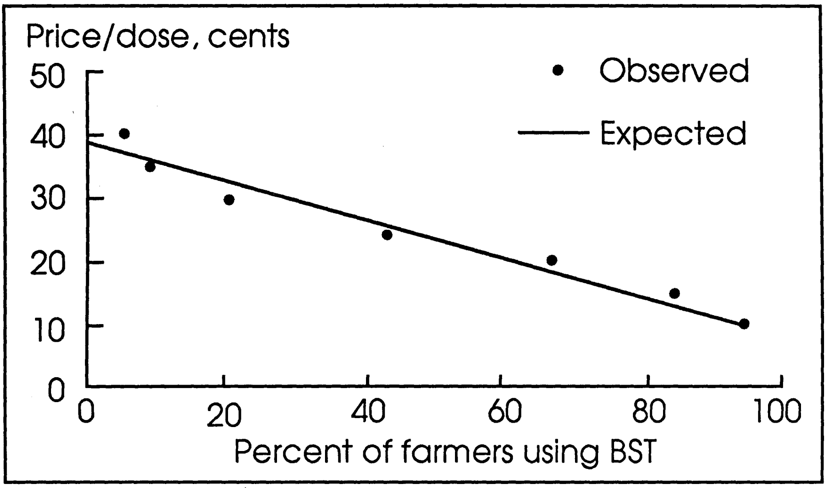


FIG. 3. Potential demand curve for BST, Southeastern dairy farmers, 1984.

The "price elasticity" for BST, evaluated at data means, is −1.8. (For comparison, when equation (5) is estimated in logarithmic form, the elasticity is −2.1.) The coefficient, being greater than one in absolute value, implies an elastic demand. With an elastic demand, percentage increases in the price of BST will result in greater than proportional percentage decreases in its rate of adoption. For example, increasing price 10 percent, say from 20 to 22 per dose, would reduce the rate of adoption an estimated 18 percent. Pricing of BST, it appears, will be pivotal in determining the rate of diffusion of BST in the Southeast. The key role of price in the adoption decision is consistent with technology-adoption literature emphasizing the importance of profitability (*10,22*).

LOGIT ANALYSIS OF FACTORS AFFECTING ADOPTION

The pattern emerging from the survey data indicates a relatively rapid rate of adoption and diffusion. But some farmers plan to adopt more quickly than others. Since prices decline in tandem with the rate of diffusion, "early bird" farmers capture most of the benefits from a new technology (*5*). Knowledge of the characteristics of early adopters provides a basis for identifying winners and losers.

This section presents an exploratory analysis of the factors affecting early adoption of BST. A brief review of the literature on technology adoption provides the background for developing hypotheses about determinants of early adoption. An empirical model of the adoption process is specified to test these hypotheses. The section concludes with a discussion of the empirical results.

Early studies on adoption of new technologies were undertaken chiefly by sociologists who focused on the importance of communication, interaction, and cultural resistance as determinants of adoption rates (*1,25*). Later studies by economists identified the importance of profitability and institutional arrangements. In a classic study of hybrid corn adoption, Griliches (*10*) attributed the more rapid adoption in the Corn Belt to the tendency of experiment stations and private seed companies to focus efforts on areas where corn is a more prominent crop. Other early studies by economists showed that innovation was induced by potential returns (*12,2*). More recent studies expand on the notion of profitability to include the education and skill level of the farm operator (*23,27,16,13*).

The relationship between adoption and farm structure is an issue that has received substantial attention. Farm size is often hypothesized as a determinant of adoption, but size may be capturing several effects, including fixed adoption costs, risk preferences, human capital, credit constraints, labor requirements, and tenure arrangements (*7*). Fundamentally, cost determines size bias. If a new technology represents a strictly fixed cost, a bias exists in favor of larger farms because the fixed cost can be spread over more units of production. New technologies representing strictly variable cost have no size bias per se because per unit cost is the same for all farmers regardless of size. Although many innovations, including use of BST, may seem to represent strictly variable costs, gathering information about the technology is a fixed cost (9). Consequently, even a technology representing primarily variable cost can work to the disadvantage of smaller farms.[7]

Empirical results for high-yielding varieties in less-developed countries tend to support the hypothesis that the larger treadmill theory is valid—early adopters will capture most of the benefits from a new technology. Ruttan (*26*) asserts that although many innovations initially are adopted by larger farmers, small farmers do eventually adopt. If the agricultural economic rents associated with biological innovations are large, then later adopters will be forced to use the improved technology to maintain solvency (*5,15*).

Recent studies characterize adoption as a Bayesian learning process in which current experience is added to previous opinion (*21,8*). Adoption occurs as a result of a dynamic information gathering process. In the Bayesian model, information acquisition is endogenous. In the theoretical model developed by Feder and Slade (9), three variables are considered central to the adoption process—farm size, human capital, and access to information.

Mansfield et al. (22) suggest a model to describe the speed of application of new industrial technologies that may have relevance to agriculture. The probability that a nonuser will adopt is a function of the proportion of the firms already using the technology, relative profitability, and required investment. The larger the proportion of firms already using the innovation and the more information that exists about the technology, the less the perceived risk of adoption. (Relative profitability is treated as a precondition in the Feder and Slade (9) model.) Required investment is specified as the percent of total average assets of the firm. Despite the complexity of the model, it has proven useful in forecasting adoption rates.

Conceptual Framework

The foregoing literature review identifies four sets of factors affecting adoption: (1) individual characteristics or personal traits of the farm operator (e.g. schooling, entrepreneurial ability, risk preferences, and innovativeness); (2) characteristics of the firm (e.g. location, input mix, and size); (3) characteristics of the institutional setting of the farm (e.g. availability of credit, labor, information, and extension services, tenure arrangements, and degree of crop or livestock specialization in the area); and (4) characteristics of the tech-

[7]The cost of acquiring information about BST arguably is negligible. Still, for the small producer the payoff to devoting substantial time researching the potential benefits (and risks) of this totally new technology may seem not worth the effort.

nology itself (e.g. its complexity, perceived efficacy, "lumpiness," and cost).

The most relevant of these four categories for explaining potential adoption of BST appears to be those relating to individual and firm characteristics. Specifically, factors relating to the human capital of the farm operator (schooling, experience, age, and innovativeness) and organization of the farm (size, specialization, and technical sophistication of production inputs) are hypothesized to be the most relevant variables for determining how rapidly a farm operator will adopt BST.

To test the hypothesis that human capital and firm characteristics adequately describe differential adoption rates, an examination was made of how these factors affect four dimensions of adoption: awareness of BST, assessment of its feasibility, speed of adoption, and intensity of adoption.

Potential users must be aware of the product. Awareness may be associated with human capital; for example, more educated or experienced farmers are expected to be more informed about a new technology. Larger herd size may be a surrogate factor for several effects, including access to information and credit, capacity to bear risk, and wealth. Also, indications of innovativeness in terms of current use of other new production techniques may be correlated with awareness of new biotechnologies.

Once a potential user is aware of an innovation, a calculation of feasibility is undertaken. Perceived feasibility will be based on expected profitability. These expectations will, in turn, be affected by experiences with other new technologies. The ability to manage a new technique should be associated with education and experience. Because the direct costs of BST are variable, no obvious advantage to size exists. Fixed costs associated with information acquisition should not affect feasibility. Thus, a relationship between size and feasibility is not expected.

With the initial steps of awareness and feasibility accomplished, the potential adopter is faced with whether to adopt. A positive outcome then requires a decision about how many cows to treat and how soon. Factors which affect adoption should be similar to those affecting awareness. Human capital, size, and innovativeness should all be useful in explaining adoption. Intensity of adoption is more difficult to understand, but likely has much in common with adoption itself. The same variables, therefore, are hypothesized to be applicable both to adoption and to intensity of adoption.

Empirical Model

A four-equation LOGIT model was specified to test the foregoing hypotheses. A brief description of these equations is as follows (see table 6 for a precise definition of variables):

Awareness Equation

$$(1)\ \text{Awareness} = A_0 + A_1\ \text{Age} + A^2\ \text{Experience} + A_3\ \text{Educ1} + A_4\ \text{Educ2} + A_5\ \text{Productivity} + A_6\ \text{Herd Size} + A_7\ \text{Art. Insem.} + A_8\ \text{Dairy Income} + A_9\ \text{Florida} + A_{10}\ \text{Georgia} + A_{11}\ \text{Mississippi} + E_1$$

Since human and physical capital are expected to improve awareness, A_1, A_2, A_3, A_4, A_5, A_6, and A_8 are expected to be positive in sign. The A_7 coefficient tests the relationship between innovativeness and awareness; the expected sign is positive. The signs of the coefficients on the three state variables will tell whether producers in these states are more aware of BST than Alabama producers. (A positive sign implies more awareness, a negative sign less awareness.)

Feasibility Equation

$$(2)\ \text{Feasibility} = B_0 + B_1\ \text{Age} + B_2\ \text{Experience} + B_3\ \text{Educ1} + B_4\ \text{Educ2} + B_5\ \text{Productivity} + B_6\ \text{Herd Size} + B_7\ \text{Art. Insem.} + B_8\ \text{Dairy Income} + B_9\ \text{Herbone} + B_{10}\ \text{Side Opening} + B_{11}\ \text{Free Stall} + B_{12}\ \text{Loose Housing} + B_{13}\ \text{Florida} + B_{14}\ \text{Georgia} + B_{15}\ \text{Mississippi} + E_2$$

Farmers possessing a higher level of human capital are hypothesized to make better use of innovative farming techniques. The coefficients pertaining to human capital variables (B_2, B_3, B_4, B_5), therefore, are expected to have positive signs. Innovativeness in the adoption of past technology is expected to improve perceptions about the potential for new technologies. Thus, B_7 is expected to have a positive sign. The sign of the herd size coefficient, B_6, tests the assumption about the scale neutrality of BST: a positive sign would indicate a bias in favor of larger farms. If B_6 is zero, BST could be considered scale neutral. A negative sign for B_6 would indicate a bias in favor of smaller dairy farms.

The coefficients of the binary variables for milking system, barn

TABLE 6. DEFINITION OF VARIABLES

Variable name	Definition	Coding
Awareness	Self-rated familiarity with the hormone	1 - if somewhat or very familiar 0 - otherwise
Feasibility	Perceived feasibility of the hormone	1 - if very or somewhat feasible 0 - otherwise
Adoption rate	Opinion as to speed of adoption of hormone	1 - if adopt immediately upon availability 0 - otherwise
Adoption intensity	Expected initial extent of adoption of hormone	1 - if use on half herd or more 0 - otherwise
Age	Age of farm owner	years
Experience	Number of years dairying	years
Educ 1	Educational level of farm operator	1 - high school graduate/some college 0 - otherwise
Educ 2	Educational level of farm operator	1 - college graduate or above 0 - otherwise
Productivity	Average production of herd in first half of 1984	pounds per cow per day
Herd size	Average milking herd size second half of 1983	number of cows
Art. insem.	Use of artificial insemination	1 - presently use 0 - otherwise
Dairy income	Importance of dairying as a source of household income	1 - most important source 0 - otherwise
Herbone	Herringbone parlor milking system	1 - use this system 0 - otherwise
Side opening	Side opening milking system	1 - use this system 0 - otherwise
Free stall	Free-stall type of barn	1 - have this type 0 - otherwise
Loose housing	Loose housing barn type	1 - have this type 0 - otherwise
Florida	State in which dairy operates	1 - if in Florida 0 - otherwise
Georgia	State in which dairy operates	1 - if in Georgia 0 - otherwise
Mississippi	State in which dairy operates	1 - if in Mississippi 0 - otherwise

type, and state tell how these factors affect perceptions of feasibility relative to the respective omitted categories. So, for example, if the coefficient of HERBONE is positive, this means that farmers using a herringbone parlor view BST more favorably than farmers using walk-through or other milking systems (the omitted category). Similar interpretations can be attached to the other coefficients of the binary variables.

Adoption Rate Equation

(3) Adoption rate = C_0 + C_1 Age + C_2 Experience + C_3 Educl + C_4 Educ2 + C_5 Productivity + C_6 Herd Size + C_7 Art. Insem. + C_8 Dairy Income + C_9 Herbone + C_{10} Side Opening + C_{11} Free Stall + C_{12} Loose Housing + C_{13} Florida + C_{14} Georgia + C_{15} Mississippi + E_3

The dependent variable in equation (3) assumes the value of one if the respondent said he would adopt BST immediately upon availability and zero otherwise. Human and physical capital factors such as age, experience, education, and farm size are expected to be positively related to willingness to adopt a new technology. Therefore, the coefficients C_1, C_2, C_3, C_4, C_5, C_6, and C_7 are expected to have positive signs. No *a priori* expectations are placed on the signs of the coefficients corresponding to the milking system, barn type, and state variables.

Adoption Intensity Equation

(4) Intensity = D_0 + D_1 Age + D_2 Experience + D_3 Educl + D_4 Educ2 + D_5 Productivity + D_6 Herd Size + D_7 Art. Insem. + D_8 Dairy Income + D_9 Herbone + D_{10} Side Opening + D_{11} Free Stall + D_{12} Loose Housing + D_{13} Florida + D_{14} Georgia + D_{15} Mississippi + E_4

The dependent variable of equation (4) assumes the value of one if the survey respondent would treat initially one-half or more of the herd and zero otherwise. Expected signs of the coefficients are as discussed for equation (3).

Empirical Results

LOGIT estimates of parameters for equations (1)-(4) are presented in table 7. The equations were estimated with 244 observations, the number of surveys having complete information for all variables. Mean values of the dependent variables, listed in the last row of the table, indicate that 16.7 percent of the sample were "somewhat or very familiar" with BST; 38.2 percent considered BST "somewhat" to "very" feasible; 37.5 percent would adopt BST immediately upon availability; and 31.9 percent would apply BST to one-half or more of the herd in the initial adoption period.

TABLE 7. FACTORS INFLUENCING AWARENESS, PERCEIVED FEASIBILITY, ADOPTION, AND ADOPTION INTENSITY OF BOVINE SOMATOTROPIN,[1] SOUTHEASTERN DAIRY FARMERS, 1984

Independent variable	Awareness		Feasibility		Adoption rate		Adoption intensity	
	Coef.	Stan. dev.	Coef.	Stan. dev.	Coef.	Stan. dev.	Coef.	Stan. dev.
Intercept	-8.265	2.11	.287	1.20	.378	1.23	-.668	1.27
Age	.044**	.02	-.018	.01	-.014	.02	.012	.02
Experience	-.001	.01	-.001	.01	.007	.01	.01	.01
Educ 1	.821	.85	-.557	.45	-.653	.45	.846	.53
Educ 2	1.938**	.84	.037	.48	.079	.48	.658	.58
Productivity	.048	.02	-.02	.02	-.037**	.01	-.047**	.02
Herd size	.002**	.001	.001	.001	.001*	.001	.001	.001
Art insem.	1.384	.79	.714*	.40	.763*	.40	.517	.41
Dairy income	-.366	.56	.083	.46	.658	.50	-1.06**	.47
Herbone	—	—	.406	.33	.125	.33	.286	.35
Side opening	—	—	-.196	.50	-.634	.52	-.367	.56
Free stall	—	—	-.725*	.43	-.799*	.43	-.151	.44
Loose housing	—	—	.542	.41	-.043	.42	.298	.43
Florida	-.012	.58	-.104	.46	-.232	.47	.369	.52
Georgia	.816	.61	.581	.40	.769*	.41	1.495***	.44
Mississippi	.393	.53	.475	.42	.479	.42	.733	.46
N[2]	244		244		244		244	
P[3]	.167		.382		.375		.319	

* = Statistical significance at the 10 percent level; ** = 5 percent level and *** = 1 percent level.

[1]LOGIT was used to estimate the regression equation. Standard deviations are asymptotic.

[2]N refers to number of observations.

[3]P is the mean value of the dependent variable.

Awareness

Signs of the coefficients of the awareness equation generally agree with *a priori* expectations. Age, education, herd size, productivity, and use of artificial insemination are all positively related to the level of awareness of BST. Experience has no correlation with awareness, nor does the importance of dairy farming as a source of income. The effect of these factors, however, may already be reflected in the age, productivity, and herd size variables. Dairy farmers in Alabama have the same average level of awareness of BST as other Southeastern dairy farmers.

Feasibility

Only two variables are significant in explaining differences in perceptions about the feasibility of BST. Farmers using artificial insemination have more favorable perceptions about feasibility of BST than do nonusers. Farmers using a free-stall milking system viewed BST less favorably. Other variables, such as herd size and herd productivity, had no significant effect on farmers' perceptions about the feasibility of BST. Florida, Georgia, and Mississippi producers rated BST no differently than Alabama producers.

Adoption Rate

Five variables are significantly related to rate of adoption: productivity, herd size, artificial insemination, free-stall milking system, and Georgia. Importantly, herd size is positively related to early adoption, meaning that "early bird" adopters will consist mostly of larger farmers. The finding that large dairies plan to adopt BST earlier than small dairies is consistent with assumptions made in various simulation studies designed to forecast the impacts of BST (see, e.g., *17*). It calls into question the assertion by Kuchler and McClelland (*19*) that "No documented evidence shows that farm size and innovation go hand-in-hand in U.S. agriculture."

The negative sign associated with the productivity variable, literally interpreted, means that farmers with more highly productive herds will be slower to adopt BST, *ceteris paribus*. The finding of a negative correlation between early adoption and productivity contradicts assumptions made in several studies that more productive farmers will be the first to adopt BST (*14*), but is consistent with the findings of Zepeda (29). The inverse relation between productivity and early adoption may reflect concern about Dairy Herd Improvement Association (DHIA) record keeping, as some respondents questioned the impact of BST on these records. (Dairy farmers with above average yields probably participate to a greater extent in the DHIA. Alternatively, below average producers might view BST as a means of overcoming deficiencies in management practices or genetic potential of the herd.)

The Georgia variable has a positive coefficient, meaning that Georgia producers anticipate adopting BST sooner than Alabama producers. The quantitative interpretation of the coefficient is that a Georgia producer has a 77 percent higher probability than an Alabama producer of adopting BST immediately upon availability. State appropriations for cooperative extension services were almost twice as large in Georgia as in the other three states, suggesting that the positive coefficient for Georgia may reflect a higher level of knowledge on the part of Georgia producers about the potential advantages of BST.

Artificial insemination positively influences adoption rate. This result conforms to expectations as artificial insemination serves as a proxy for the willingness of the producer to try new production techniques.

Adoption Intensity

Three variables are significantly related to the intensity of adoption: productivity (negative); dairy income (negative); and Georgia (positive). Again, the negative coefficients for productivity and dairy income variables probably reflect the cautious approach that more productive farmers will take toward experimentation with BST. The inverse relationship between dairy income and adoption intensity appears to be consistent with the Minnesota study showing farmers in financial difficulty have a greater probability of adopting BST than financially secure farmers (*11*).

The positive coefficient associated with Georgia is consistent with results for adoption rate: Georgia dairy farmers not only plan to adopt sooner than Alabama producers, they plan to apply BST to a greater number of cows in the trial period.

SUMMARY AND CONCLUSIONS

New technologies made possible by recent advances in the biological sciences promise to significantly impact agriculture and the food system. The potentially large increase in milk production associated with using BST illustrates the point. To minimize the potentially adverse social and economic impacts of these technologies, *ex ante* research is necessary to provide a basis for sound decisions.

This publication represents an attempt to explain a technology and the forces determining its acceptance before the technology actually appears in the marketplace. Southeastern dairy farmers were surveyed in 1984 to determine their attitudes toward a technology that could significantly impact them within 5 years. One-half of the respondents indicated no knowledge of the technology. Approximately one-third felt the product was unfeasible, possibly because of the need for daily injections. Forty percent indicated immediate adoption upon availability, although most (82 percent) would begin by administering the hormone to only a portion of the herd. Although 85 percent indicated adoption of the hormone within 3 years of availability, 8 percent said they would never use the product.

Dairy farmer concerns about BST centered on: (1) the effect on Dairy Herd Improvement Association record keeping, (2) the effect of daily injections on the animals' long-term milk output and well-being; and (3) the potential of the hormone to exacerbate the milk surplus problem. Farmers with larger herds tended to question the practicality of daily injections; an implant was viewed as highly desirable.

Logit analysis revealed that older, more educated dairymen, who were good managers, operated larger farms, and used artificial insemination, had a higher probability of being aware of the technology. Perceptions regarding feasibility of BST and the rate and intensity of adoption were found not to be well correlated with human capital factors. Factors positively correlated with fast adoption are herd size, use of artificial insemination, and a Georgia residence. Herd productivity and the use of free-stall milking systems have a net negative correlation with early adoption. Intensity of adoption, i.e., the portion of the herd initially treated with BST, is related to three factors: herd productivity, relative importance of dairying as a source of income, and Georgia residence. The first two of these factors have negative net correlations, suggesting an unwillingness by better managers to commit themselves to BST without an adequate period of on-farm experimentation. The negative correlation between herd productivity and early adoption contradicts assumptions made in several economic analyses of BST, but is consistent with survey results for California (*29*).

Pricing of BST is an important factor affecting adoption and diffusion. Most farmers preferred a price of 21¢ per dose based on the projected value of increased milk production. At this price, 59 percent of dairy farmers would purchase BST. A "demand elasticity" for BST was estimated to be −1.8, meaning that each percentage point increase (decrease) in the price of BST would lower (raise) the adoption rate 1.8 percentage points. Thus, a price of 19¢ per dose, for example, would increase the adoption rate from 59 percent to 77 percent in relation to the 21¢ price. The elastic demand for BST, if correct, suggests that price will be an important variable affecting the rate of adoption and diffusion.

Results of the survey suggest that adoption of BST in the Southeast will be relatively rapid. Thus, benefits from early adoption of BST may not be strictly the province of producers located in the prime milk production areas of California, Wisconsin, and New York. But the positive link between herd size and intended early adoption suggests a size-bias for BST that favors the larger dairy. Unless this apparent tendency for larger farmers to adopt first is offset by improved information, training, or other assistance for small and medium-sized dairies, adoption of BST can be expected to accelerate the trend toward fewer and larger dairies. One possibility for mitigating the apparent size-bias of BST is to lower its price to small producers, perhaps through a government rebate scheme.

Rapid adoption and diffusion of BST in the Southeast, coupled with an apparent unwillingness by existing producers to reduce herd size in the face of expanding supplies, suggest that most of the needed adjustments will take place by farmers leaving dairying altogether. For these individuals, education, training, and counseling programs can ease the transition. The one consolation for Southeast producers relative to their counterparts in other regions is that the Southeast is a milk-deficit region, meaning that adjustments will not be as severe here as in the milk-surplus regions, such as the upper Midwest *(6)*. Still, without targeted assistance, the adjustments in the Southeast necessary to accommodate BST likely will bear most heavily on smaller dairies.

LITERATURE CITED

(1) BEAL, G.M. AND J.M. BOHLEN. 1957. The Diffusion Process. Iowa State Agr. Exp. Sta. Spec. Rep. 18.

(2) BINSWANGER, HANS P. AND V.W. RUTTAN. 1978. Induced Innovation: Technology, Institutions and Development, Johns Hopkins Univ. Press.

(3) BROWN, L.A. 1981. Innovation Diffusion: A New Perspective. Methuen & Co., New York, N.Y.

(4) BUTTEL, FREDERICK H. 1984. Biotechnology and Agricultural Research Policy: Emergent Issues. Cornell Univ. Agr. Exp. Sta. Bull. No. 140.

(5) COCHRANE, WILLARD. 1979. The Development of American Agriculture, Univ. of Minn. Press.

(6) FALLERT, R., T. MCGUCKIN, C. BETTS, AND G. BRUNER. 1987. bST and the Dairy Industry. USDA/ERS. Agr. Econ. Rep. No. 579.

(7) FEDER, GERSHON, R. JUST, AND D. ZILBERMAN. 1985. Adoption of Agricultural Innovations in Developing Countries: A Survey. Economic Development and Cultural Change 33,2:255-198.

(8) FEDER, GERSHON AND G.T. O'MARA. 1982. On Information and Innovation Diffusion: A Bayesian Approach. American Jour. of Agr. Econ. 66:141-145.

(9) FEDER, GERSHON AND ROGER SLADE. 1984. The Acquisition of Information and the Adoption of New Technology. American Jour. of Agr. Econ. 66:312-320.

(10) GRILICHES, ZVI. 1957. Hybrid Corn An Exploration in the Economics of Technological Change. Econometrica. 25:501-522.

(11) HAMMOND, J.W. 1989. The Minnesota Dairy Farm Sector: Summary of the 1988 University of Minnesota Dairy Farm Survey. Minn. Rep. No. 216-1989, Minn. Agr. Exp. Sta.

(12) HAYAMI, YUJIRO AND VERNON W. RUTTAN. 1971. Agricultural Development: An International Perspective, Johns Hopkins Univ. Press.

(13) HUFFMAN, W.E. 1974. Decision Making: The Role of Education. Amer. Jour. of Agr. Econ. 56:85-97.

(14) KALTER, ROBERT J., ROBERT MILLIGAN, WILLIAM LESSER, WILLIAM MAGRATH, AND DALE BAUMAN. 1984. Biotechnology and the Dairy Industry: Production Costs and Commercial Potential of the Bovine Growth Hormone. Cornell Univ. Agr. Exp. Sta. A.E. Res. 84-22.

(15) KINNUCAN, H., J.J. MOLNAR, AND U. HATCH. 1989. Theories of Technical Change in Agriculture with Implications for Biotechnologies. *In* Biotechnology and the New Agricultural Revolution, Molnar, J.J. and H. Kinnucan (eds.), Amer. Assoc. for the Advancement of Science and Westview Press. Boulder, Colo. pp. 103-120.

(16) KISLEV, Y. AND N. SCHORI-BACHRACH. 1973. The Process of an Innovation Cycle. Amer. Jour. of Agr. Econ. 55:28-37.

(17) KNUTSON, R.D., R.D. YONKERS, AND J.W. RICHARDSON. 1989. The Impact of the Biotechnology and Information Revolutions on the Dairy Industry. *In* Biotechnology and the New Agricultural Revolution, Molnar, J.J. and H. Kinnucan (eds.). Amer. Assoc. for the Advancement of Science and Westview Press, Boulder, Colo. 121-136.

(18) KRONFIELD, D.S. 1988. Biological and Economic Risks Associated with Use of Bovine Somatotropin. Jour. of the Vet. Med. Assoc. 192:1693-1700.

(19) KUCHLER, F. AND J. MCCLELLAND. 1989. Issues Raised by New Agricultural Technologies: Livestock Growth Hormones. USDA/ERS. Agr. Econ. Rep. No. 608.

(20) LESSER, W., W. MAGRATH, AND R. KALTER. 1986. Projecting Adoption Rates: Application of an Ex Ante Procedure to Biotechnology Products. North Central J. Agr. Econ. 8:159-174.

(21) LINDNER, R.K., A.J. FISCHER, AND P. PARDEY. 1979. The Time to Adoption. Econ. Letters 2:187-190.

(22) MANSFIELD, EDWIN, JOHN RAPOPORT, ANTHONY ROMERO, EDMOND VILLANI, SAMUEL WAGNER, AND FRANK HUSIC. 1977. The Production and Application of New Industrial Technology. W.W. Norton.

(23) NELSON, R.R. AND E.S. PHELPS. 1966. Investment in Humans, Technological Diffusion, and Economic Growth. Amer. Econ. Rev. 56:69-75.

(24) PETERSON, WILLIS AND YUJIRO HAYAMI. 1977. Technical Change in Agriculture. *In*: A Survey of Agricultural Economics Literature, Lee R. Martin, ed. Univ. of Minn. Press.

(25) ROGERS, EVERETT M. 1983. Diffusion of Innovations, Third Edition. The Free Press, New York, N.Y.

(26) RUTTAN, V. 1977. The Green Revolution: Seven Generalizations. International Development Review 19:16-23.

(27) WELCH, FINIS. 1970. Education in Production. Jour. of Pol. Econ. 78:35-59.

(28) YASSOUR, J., D. ZILBERMAN AND G.C. RAUSSER. 1981. Optimal Choices Among Alternative Technologies with Stochastic Risk. Amer. Jour. of Agr. Econ. 63:718-723.

(29) ZEPEDA, L. 1988. A Survey of California Dairy Farmers: Potential Adoption of Bovine Somatotropin. Univ. of Calif. Agr. Issues Center Paper No. 88-1.

APPENDIX A: SURVEY INSTRUMENT

PRODUCER QUESTIONNAIRE

The enclosed yellow fact sheet describes a product which could be available on the market within a few years. Please read this material before answering the questionnaire. When the product is eventually sold, little additional information is likely to be available.

1. Before receiving this questionnaire did you have any knowledge of such a hormone or injection to increase milk production? (circle one number)

    1 NEVER HEARD OF IT

    2 A LITTLE

    3 SOMEWHAT FAMILIAR

    4 WAS VERY FAMILIAR

2. How feasible does this product look for your dairy operation for the immediate future if it were available today? (circle one number)

    1 VERY

    2 SOMEWHAT

    3 POSSIBLE

    4 QUESTIONABLE

    5 OTHER

Comments:

____

____

____

3. When do you think you would try it? (circle one number)

1 IMMEDIATELY UPON AVAILABILITY

2 3 MONTHS AFTER AVAILABILITY

3 6 MONTHS AFTER AVAILABILITY

4 1 YEAR AFTER AVAILABILITY

5 2 YEARS AFTER AVAILABILITY

6 3 YEARS AFTER AVAILABILITY

7 5 YEARS AFTER AVAILABILITY

8 LONGER

9 NEVER

4. If you did adopt, would you likely begin slowly with a few cows or with the entire herd?

1 few head at first

2 half my herd

3 entire herd

If you selected the first or second option, how would you select the trial cows?

____

____

____

5. If you need further information before trying the product, what information must you have? (check as many as apply)

( ) More experimental results

( ) a longer period of experimental results

( ) more specific information on feeding systems using the substance

( ) visit a herd on hormones

( ) recommendation of your vet

( ) wait for a neighbor to try it first and see how it works out for him

( ) other ____________________

Comments:____

____

____

6. What are your current plans for changes in your mixing herd size? (Please indicate number of cows.)

One year from now _____ Fewer cows OR______ more cows

Five years from now _____ Fewer cows OR_____ more cows

7. What additional adjustments would you expect to make in your milking herd numbers following the introduction of the hormone if it were available today? (Answer should be zero if you do not intend to adopt within the specified time period. If you do intend to use the product, please indicate number of cows.)

One year after beginning treatment +/- ______________

Five years after beginning treatment +/- ____________

Comments:____

____

____

8. If you adopt the hormone while holding your herd size constant or increase it, your feed requirements will rise. How will you supply the additional feed requirements for forage and concentrate?

____

____

____

9. What additional expenditures do you feel would be necessary during the first year of adopting the hormone? (Before answering this question you may wish to study the blue sheet?)

a) on feed production $________total or $__________per cow

b) on milking equipment $________total or $________per cow

c) on buildings $_______________total or $_________per cow

d) on labor (annual) $_________total or $__________per cow

e) on feed $______________total or $_______________per cow

f) on other $_________________total or $__________per cow

10. A possible market price for the hormone is 17¢ per cow per day. What difference would it make to your adoption decision and future plans if the daily dosage cost per cow was: (Use the information on the blue sheet as a basis for your answer.)

a) 10¢ ____

____

b) 25¢ ____

____

11. What is the maximum price you would pay for the hormone given the gross return figures discussed in the Fact Sheet? (Remember, the substance must be injected daily.)

_________ ¢ per cow per day

12. Preliminary work is under way on an implant which will release the compound in the proper daily dosage. Would having the implant available change your adoption decision and the price you are willing to pay? Please comment.

____

____

____

13. Overall, how many cows in your herd would you expect to be using the hormone in: (circle one number for each)

	None	Some	About Half	All
a. in 6 months	1	2	3	4
b. in 1 year	1	2	3	4
c. in 2 years	1	2	3	4
d. in 3 years	1	2	3	4
e. in 5 years	1	2	3	4
f. in 10 years	1	2	3	4

14. Farm characteristics:

a) Average milking herd size for the second half of 1983:

______cows

b) Milking system: (circle one)

1 HERRINGBONE PARLOR
2 SIDE OPENING
3 WALK THROUGH
4 FLAT BARN
5 OTHER PARLOR

c) type of barn: (circle one)

1 FREE STALL
2 LOOSE HOUSING
3 NO BARN FACILITY
4 OTHER

d) Average herd production for the first half of 1984: _____(lbs/day).

e) Do you presently use artificial insemination?

1 YES

2 NO

f) When did you begin artificially inseminating your herd? _________(month/year)

g) Age of owner_________(years)

h) Number of years dairying_________

i) Highest level of education attained: (circle one number)

1 some grade school

2 grade school graduate

3 some high school

4 high school graduate

5 some college

6 college graduate

7 graduate school

j) Is dairying the most important source of income in your household? (circle one number)

1 YES

2 NO

15. Have you had prior experience with growth hormones? (circle one)

1 NO

2 YES

If yes, please name the product_________________________.

16. Are there any other factors relating to the adoption decision which you have not yet expressed? You may wish to comment on other considerations or mention factors you find to be troubling or unclear.

____

____

____

APPENDIX B: GROWTH HORMONE "FACT SHEET"

*** Please read this Fact Sheet before you answer the questionnaire ***

GROWTH HORMONE FACT SHEET

Recent research on growth hormone in dairy cattle have raised considerable interest among dairymen. This Fact Sheet is a quick summary of the available information on this new product.

What is it?

Growth hormone is a naturally occurring protein which regulates the functions of animals. It has long been known that this hormone increases milk output, but only with recent developments in biotechnology has it been possible to produce it cheaply and in large quantities.

Is it safe for humans?

Yes. This hormone is a form of protein and is not accumulated in the body as it is broken down rapidly into amino acids. In fact, growth hormone must be injected into the cow to be effective because if consumed orally it is digested like any other dietary protein.

Is it safe for my herd?

Based on all experimental evidence the answer is yes. Experimental animals demonstrate normal reproduction and normal mammary health with no impairment to disease resistance. These results have been filed with and accepted by the Food and Drug Administration as a proof of safety. Information on the long term effects over multiple lactation cycles nevertheless is incomplete at this time.

How does it work?

This hormone coordinates body tissue metabolism to permit greater milk production. In this respect, it acts similarly to differences seen in genetically superior cows. More of the dietary energy and nutrients are directed to milk production.

How is it administered?

Growth hormones must be administered daily into the body. It is usually done with a hypodermic needle, but an injection "gun" is acceptable. The dosage is small - on the order of one cc. Missing a day or accidentally misdosing causes no harm and is easily corrected.

What does it do for milk production?

Results from experiment station research show test herd average production increases of 10 to 40 percent during treatment when injected on a daily basis after the first 12 weeks of lactation. Output increases almost immediately, and benefits over regular milk production levels persist throughout the remaining portion of the lactation cycle. Differences in response are due largely to amounts of hormone used (up to the maximum recommended dose). However, feeding practices and variation among individual cows will also influence results. Heavy producers respond at least as well as average or poorer producing cows.

Dosage begins following the peak of lactation, during the 13th week of the cycle. Butter fat and protein levels of the milk are unchanged.

How will my feed requirements change?

After beginning treatment, the cow will increase feed intake to levels needed to meet requirements. Thereafter, cows should be fed according to milk production as per typical management recommendations. There is no evidence that more exotic (and expensive) feed ingredients need to be used. However, the higher the level of milk production the more important is proper nutritional management to allow the cow to reach her potential. That is, the treated cow with a higher milk production should not be shifted to a lower energy diet as rapidly as would the untreated cow.

Is it profitable?

Experimental results using 20,000 pound second lactation cows suggests that the use of this product can be quite profitable, especially at the higher yield increase levels (see blue sheet). For example, the gross return (milk value less feed costs) from untreated cows showing a 10% increase in milk output is 43¢. Gross returns from cows showing a 20% (12 pounds per day) increase in milk output is 86¢ per day. Highly responsive cows, i.e., those showing a 30% increase in milk output in response to hormone treatment, provide a $1.29 per day gross return. (Gross return figures do not include the cost of purchasing the hormone.)

Compound use is especially attractive as no capital investment is needed and benefits are observed almost immediately. However, for your farm only you can determine the actual profitability by considering your own yield data, feed costs, and milk price figures.

When you calculate profitability it is important to remember that (a) production during the first 12 weeks of lactation is unaffected, and (b) first-calf heifers comprise about 20 percent of any commercial herd and hold down the herd average.

What else should I consider?

While the results to date are all very positive, it is important to remember that no long-term commercial herd applications have been tried.

As you consider using this new product on your farm, pause to consider the management impacts it will have on (a) the need to administer the compound daily to cows later in their lactation cycle, and (b) feed requirements of treated cows.

BLUE SHEET

Table 1. GROSS DAILY RETURNS PER COW FROM USE OF GROWTH HORMONE

Item	Untreated cow	Treated Cows: For daily milk output increases of:		
		10% (6 lbs.)	20% (12 lbs.)	30% (18 lbs.)
Milk Value [a/]	$6.72	+$.67	+$1.34	+$2.01
Feed Cost [b/]	$3.37	+$.24	+$.24	+$.72
Gross Return to Hormone Use [c/]		+$.43	+$.86	+$1.29

[a/] Based on milk at $11/cwt.

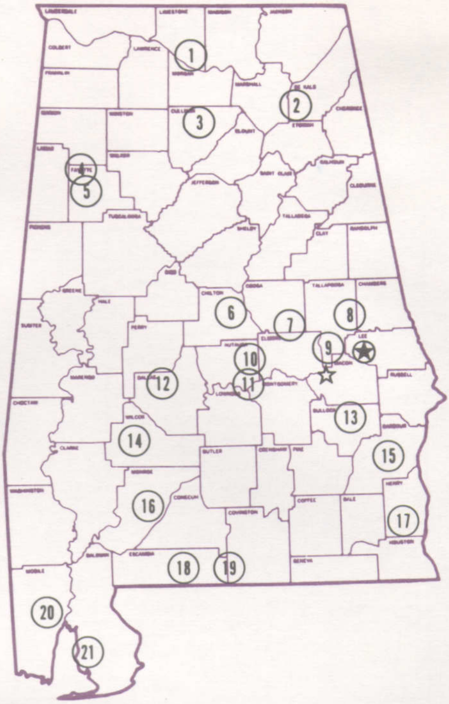
[b/] Feed at ration prices of 8 cents/lb. dry matter.

[c/] Gross return is prior to the purchase of the hormone.

Source: Experiment Station Research using 20,000 lbs. second lactation cows.

Alabama's Agricultural Experiment Station System
AUBURN UNIVERSITY

With an agricultural research unit in every major soil area, Auburn University serves the needs of field crop, livestock, forestry, and horticultural producers in each region in Alabama. Every citizen of the State has a stake in this research program, since any advantage from new and more economical ways of producing and handling farm products directly benefits the consuming public.



Research Unit Identification

⊛ Main Agricultural Experiment Station, Auburn.
☆ E. V. Smith Research Center, Shorter.

1. Tennessee Valley Substation, Belle Mina.
2. Sand Mountain Substation, Crossville.
3. North Alabama Horticulture Substation, Cullman.
4. Upper Coastal Plain Substation, Winfield.
5. Forestry Unit, Fayette County.
6. Chilton Area Horticulture Substation, Clanton.
7. Forestry Unit, Coosa County.
8. Piedmont Substation, Camp Hill.
9. Plant Breeding Unit, Tallassee.
10. Forestry Unit, Autauga County.
11. Prattville Experiment Field, Prattville.
12. Black Belt Substation, Marion Junction.
13. The Turnipseed-Ikenberry Place, Union Springs.
14. Lower Coastal Plain Substation, Camden.
15. Forestry Unit, Barbour County.
16. Monroeville Experiment Field, Monroeville.
17. Wiregrass Substation, Headland.
18. Brewton Experiment Field, Brewton.
19. Solon Dixon Forestry Education Center, Covington and Escambia counties.
20. Ornamental Horticulture Substation, Spring Hill.
21. Gulf Coast Substation, Fairhope.