June 1996 Staff Paper No. 397

The BST Case

By

William D. Dobson

Department of Agricultural & Applied Economics
University of Wisconsin-Madison

Copyright © 1996 byWilliam D. Dobson. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.

THE BST CASE

W.D. Dobson

Recombinant Bovine Somatotropin (rBST) is a milk production enhancer, a product of industrial microbiology. First approved for commercial sale in the United States (U.S.) by the Food and Drug Administration (FDA) in 1994, rBST has been immersed in controversy since the early 1980s. Conflicts among major players with interests in rBST have shaped the product's image and influenced its use. Players with interests in the product include government agencies, Monsanto Corporation (the first firm approved to sell rBST), other firms seeking commercial approval to sell rBST, dairy farmers, and consumers.

The product rBST is similar to other ground-breaking technologies in that its introduction and use have been politicized. FDA commercial approval of rBST was delayed for two reasons: (1) FDA failed to develop policies for reviewing new biotechnologies in a timely fashion, and (2) strong opposition of rBST-use focused debate on should the government approve a product that wasn't wanted by consumers, that could cause some (smaller) dairy farmers to go bankrupt, and that would mostly benefit four large drug companies? Opponents additionally took the offense in the labeling game by gaining approval to use "rBST-Free" labels on products that did not contain rBST.

While the rBST story continues to unfold, it already provides strategic marketing lessons for people involved with the product itself, other new biotechnologies and

government. The product rBST is one of the first major U.S. test-case biotechnologies. How government agencies and market participants react to rBST is setting a precedent for how those agencies and participants will react to similar technologies already available or yet to be introduced. While other countries (Mexico, Brazil, India, Russia and at least ten others) have approved rBST for commercial use, this story focuses heavily on U.S. experience with the product. Hence, most of the implications drawn in this case relate to developed country experience with rBST.

The following presents background and information relating to the introduction and use of rBST, consumer and producer reactions to rBST, impacts of conflicts among players affected by the new technology, and lessons gleaned from experiences with the product. Economic concepts offered by von Witzke and Hanf (see References) proved valuable for developing the key sections dealing with consumer and producer reactions to rBST. Hereafter, in the text, both rBST (also known as rBGH), the synthetic product made by recombinant DNA technology, and naturally occurring BST will be referred to as BST.

BACKGROUND AND HISTORY

What is BST and How Does It Work?

BST is a naturally occurring growth hormone that stimulates milk production in dairy cows. Use of BST to increase milk production is not new. It was discovered in the 1920s that injecting dairy cows with BST would substantially increase milk production.

However, it was not feasible to consider using BST on commercial dairy farms until the hormone could be produced economically and in quantity using industrial microbiology techniques.

Many studies show that BST can boost milk production per dairy cow by 10–20 percent and can raise feed efficiency of that cow by 5–15 percent under “on-farm” conditions. The hormone must be present in the cow's bloodstream each day to maintain an increased production response. BST is administered to the cow by daily injections or through prolonged release formulations requiring injections at two to four week intervals. Milk yields generally increase within a few days after the BST is administered and achieve a higher level relative to a normal lactation curve. Part of this increase can be maintained over the remainder of the lactation period. The gain in production efficiency occurs in part because the proportion of feed nutrients used by the cow for maintenance is reduced.

Quality of management and nutrition affect the size and duration of milk yield response to BST. Poorly managed dairy farms can expect to achieve little or no benefit from BST because other factors constrain the ability of cows on these farms to produce milk. Maximum response is expected from herds with excellent overall management.

BST has been referred to as a size neutral technology. This characterization fails to take management differences into account. For example, while it is true that the equipment and training needed to administer BST are such that small, medium-size and large dairy managers could avail themselves of the technology, it is also true that operators of larger farms have made greatest use of BST because they have management systems that allow them to gain and maintain profitable production responses from BST.

Numerous studies have examined the effects on milk composition of administering BST. These studies show that the composition of milk in terms of fat, protein, lactose, minerals, cholesterol and vitamins is not substantially changed by BST supplementation, and is within the range of milk composition found in untreated cows. Meat obtained from BST-treated cows has a lower fat content but is otherwise similar to that of untreated cows.

Who Produces and Distributes BST in the U.S.?

Monsanto Corporation, a U.S.-based chemical company, was the first firm to gain approval from the FDA to sell BST in the U.S. in February 1994. This company, ranked among the top 100–200 firms in the *Fortune* 500 list of largest U.S. industrial firms during the 1990s, had total 1995 revenues of nearly U.S.$9 billion in 1995. Monsanto sells BST under the brand name, *Posilac*. *Posilac* is a prolonged release product, normally injected into dairy cows every two weeks during the last two-thirds to three-fourths of the cow's lactation period.

Monsanto uses express package delivery companies to ship *Posilac* directly to farmers rather than sell it through wholesalers, farm supply stores or veterinary supply stores. (The delivery companies also pick up, for disposal, the needles used to inject BST into cows.) Monsanto finds direct delivery feasible because BST is a high valued product. Secondly, it permits the company to maintain product quality which could be damaged by heat or storage. Finally, direct sales prevent price competition among wholesalers from driving down the price of the product.

Thomas Elam, an economist employed by Eli Lilly (a company seeking approval to sell its version of BST), estimates that the U.S. market for BST could amount to $200–$300 million per year if 65 percent of U.S. dairy farmers adopted the product. According to Christopher Willis, a chemistry industry analyst, 1995 sales of *Posilac* reached about U.S.$100 million, equivalent to about one percent of the company's recent annual sales. Willis reported that at the $100 million sales level, *Posilac* still does not cover operating costs associated with the product. Further, in 1995, Monsanto was still not generating enough profits from *Posilac* to defray development costs for the product which analysts estimate totaled several hundred million dollars.

In addition to Eli Lilly, two other firms, American Cyanamid (acquired by American Home Products on December 1, 1994) and Upjohn (which merged with Pharmacia Corporation on November 2, 1995) have requested approval from the FDA to sell BST commercially in the U.S. American Home Products, Eli Lilly, and Pharmacia & Upjohn had total revenues of U.S.$13.4 billion, U.S.$7.5 billion, and U.S.$7.1 billion respectively, in 1995. At this writing, these three companies have not yet gained FDA approval to sell BST in the U.S. However, they have gained experience selling BST in Mexico, Brazil and other countries that have approved their BST products for commercial sale.

Government Roles Regarding the Introduction and Use of BST

Government has played three important roles affecting the introduction and use of BST in the U.S. First, the federal FDA must approve a manufacturer's BST product for

efficacy (e.g., power to produce claimed effects on milk production) and safety for humans and animals prior to giving the nod which allows its commercial sales. Second, some state governments in the U.S. have approved labeling laws specifying that a product is "BST Free" or variations of this claim. Finally, the U.S. Department of Agriculture (USDA) operates a national dairy price support program which is affected by BST since it is based on subsidies per unit of milk (or milk component) produced.

The FDA. Efficacy and safety studies required by FDA of each BST manufacturer are carried out by the manufacturer and independent investigators at different locations in the country. Sponsoring companies maintain tight control over test materials used in the independent studies. Investigators conducting the independent studies can publish results of their investigations. They also can report to the FDA any misrepresentation that they believe the sponsoring company has made regarding the product.

With regard to the safety of BST for humans, FDA addresses practical questions such as: Is the milk from cows treated with BST safe to drink? Is the beef from cull dairy cows treated with BST safe to eat? In 1985, the FDA concluded, on the basis of an evaluation of toxicological data, that both milk and meat obtained from BST-supplemented cows were safe to consume. Daughaday and Barbano, professors of Medicine at Washington University in St. Louis and Food Science at Cornell University, respectively, characterized the FDA's findings regarding the safety of BST for humans as follows:

- The FDA has answered all questions and concerns about the safety of milk obtained from BST-supplemented cows for human consumption and has authorized the commingling of milk from the BST-supplemented investigational herds with the rest of the

commercial milk supply.

- BST has no biological activity when ingested orally or when given by intramuscular injection.

- Insulin-like growth factor I (IGF-I) is not orally active. Any changes in IGF-I levels in milk obtained from BST-supplemented cows are well within normal variation and lower than those reported in human milk.

- All cow's milk contains BST, and no significant change in milk composition occurs as a result of giving cows supplemental BST.

With one possible exception, these findings remain largely unchallenged. In 1996, questions were still being raised about possible effects of IGF-I on human health.

Studies designed to measure the impact of BST on the health of dairy cows receiving the hormone generally showed no difference between BST-treated cows and controls. Possible effects of BST on incidence of mastitis (one of the economically most important diseases of dairy cows), pneumonia and other infectious diseases, lameness, and reproductive performance were considered in the studies. They revealed no difference between controls and BST-treated cows. Some negative effects on fertility (conception rates) were noted for dairy cows injected with BST early in the lactation period. For obvious reasons, when BST is administered after pregnancy is confirmed, or after the first 100 days of lactation, this problem disappears or becomes less important.

Eppard, Vicini, Cole, and Collier characterized the impact of BST on animal health as follows: "The single best indicator of overall health of a lactating dairy cow is milk production. When cows are in poor health or under stress, they produce less milk."

Administration of BST has resulted in consistently high milk yields across studies suggesting that severe health problems are rare (Moore and Hutchinson).

State Government Product Labeling Laws. The state legislatures of Wisconsin and Minnesota have passed laws allowing processors to voluntarily label milk and dairy products as being BST-Free. State agencies in at least six other states have provided guidelines to processors regarding BST-Free product labeling. The exact labeling varies by state.

In Wisconsin many fluid milk containers carry the label "Farmer-Certified BST Free." Impetus for BST-Free labeling increased in early 1994 when BST was first approved for commercial use in the U.S. Both consumer groups, fearing possible adverse health effects of BST, and farmers, fearing that BST might produce lower milk prices as a result of consumer perceived negative effects, pressured retailers to offer fluid milk products and other dairy items for sale which originated from cows that had not received supplemental BST; these products were to be labeled as being BST-Free. These two pressure groups were sufficiently strong that most companies selling fluid milk in Wisconsin opted to use such labeling. Fearing stigmatization of products made with BST-milk, Monsanto brought suit against one processor and threatened court actions against others who proposed to use some variation of a BST-Free label. Wisconsin state government regulators also questioned the appropriateness of such labels.

In response to these developments, Wisconsin's legislature passed a voluntary labeling law in June 1994 permitting processors to indicate on the package that milk used to make a dairy product came from dairy herds not treated with BST. The FDA (federal

oversight) permitted use of such labels provided they included a disclaimer stating that the FDA found that there was no significant difference between milk obtained from cows treated with BST and those not receiving supplemental BST. Among other things, the FDA did not wish to allow labels which implied a health benefit for non-BST milk.

The USDA's Dairy Price Support Program. BST affects the environment in which the USDA's dairy price support program operates. In 1996, the USDA supported farm level milk prices at U.S.$10.35 per hundredweight ($.23 per kg). To operate the program, the USDA purchases butter, cheese and nonfat dry milk at prices that take into account processing costs, and still returns to farmers the $10.35 support price. During the past decade, the program's cost to the U.S. government has ranged from $2.3 billion in fiscal 1986 to about $43 million in fiscal 1996.

Although U.S. government budget outlays for dairy price supports have been relatively small in recent years, the program has received scrutiny as pressures to balance the U.S. federal budget have intensified. Changes adopted in the Federal Agricultural Improvement and Reform Act of 1996 (the so-called 1996 "Farm Bill") would gradually lower and then eliminate price supports for all dairy products on December 31, 1999.

BST and other developments influence budget costs for the U.S. dairy price-support program since they affect volume of milk produced. In 1987, USDA analysts forecast that BST would, under a probable scenario, increase U.S. milk production by 6 percent over levels that would exist without BST. This could necessitate a reduction in dairy price supports if government were to keep costs at politically acceptable levels. Because the FDA didn't approve BST for commercial use as soon as expected, and a larger than

expected percentage of farmers opted not to use the product, the anticipated impacts of BST on U.S. milk production have failed to materialize fully. However, if BST use by farmers eventually rises to levels predicted in those early studies, then impacts forecast by USDA analysts could materialize. This development could possibly generate calls for reinstatement of dairy price supports after the scheduled 1999 termination date for the measures if dairy incomes slump "too much."

CONSUMER AND PRODUCER REACTIONS TO BST

Consumer Reaction to BST

Von Witzke and Hanf describe some economic concepts affecting the use of growth hormones for producing dairy products and beef. These concepts provide an economic framework for analyzing consumer reactions to BST.

1. Food quality is a luxury good. Significant groups of consumers in high income countries consider dairy products made by using BST milk to be of inferior quality. Since the demand for food quality is low at low levels of economic development, consumers in low income countries tend to favor use of BST because it reduces food costs.

2. Dairy products made with BST milk have indeterminable quality attributes associated with the method of production used. Consumers can't determine from product texture, taste, or other product characteristics whether a dairy product was produced with BST milk. Moreover, if properly used, the quality of dairy products produced with BST milk cannot be distinguished by known scientific testing methods from similar

conventional milk-based goods. Von Witzke and Hanf note a parallel between items produced with BST milk and meat obtained from livestock produced under conditions (e.g., in crowded confinement facilities) that are objectionable to certain animal rights groups. Both products may be safe but are produced by means that are objectionable to some consumers.

3. Market failure (price not related to specific product quality) may occur when goods have indeterminable quality attributes. As long as some consumers prefer lower-priced items produced with BST over conventional dairy products while others are willing to pay a higher price for conventional dairy products, social welfare may be positively affected when both qualities are produced. However, because BST goods possess indeterminable quality attributes, consumers may believe that they receive dairy products made with BST while paying for the higher priced conventional product. In such cases, markets will fail to supply non-BST milk and government intervention (labeling and compliance enforcement) may be called for to encourage both qualities of the product to be offered.

For reasons noted later relating to BST adoption rates, it is unlikely that market failure associated with indeterminable product quality would ever drive non-BST milk completely out of the market. However, this phenomenon could increase the percentage of milk containing supplemental BST beyond levels that would exist absent any question in consumers' minds about whether they were receiving BST or non-BST milk products.

Consumers have responded to BST partly as a food quality matter. Few, if any, consumers regarded BST as producing an improvement in milk quality. Consumer

concerns have been heightened because of the importance of milk in the diets of children and the use of a hormone to produce it.

Barham, Buttel, Jackson-Smith, McNichol and Wood, Agricultural Technology and Family Farm Institute (ATFFI) researchers, summarized the studies on consumer attitudes toward BST. Studies completed in the early 1990s show rather consistently that although more than half of U.S. consumers would be unlikely to change milk consumption patterns following the introduction of BST into dairy herds, about 10 percent of consumers reported that they would stop or reduce milk consumption unless milk from untreated herds was available to them. A residual group of between 10 percent and 40 percent said they would reduce their consumption to some degree if BST was introduced into dairy herds. In view of the inelastic price elasticity of demand for milk at the farm level in the U.S., if BST caused even a small (2–3 percent) decline in milk consumption it would reduce farm milk prices substantially (by about 15 percent) or increase dairy price support purchases.

Douthitt, a University of Wisconsin consumer scientist, completed a national survey of consumer attitudes toward BST during the second quarter of 1995. Her survey revealed that: (1) 10 percent of U.S. milk drinkers buy milk from cows not treated with BST; (2) 94 percent believe milk from untreated cows should be labeled as BST-free; and (3) that fewer than 1 percent of consumers have stopped buying milk because some farmers use BST. Douthitt and her colleagues expressed surprise at the level of consumers' concern about BST which persisted for over a year since most concerns about a new food technology typically decline fairly rapidly.

Questions arise about whether various "Farmer Certified BST-Free" labels address

the market failure problem associated with the milk's indeterminable quality. Ensuring the validity of farmer certification may be simpler than imagined. Because Monsanto delivers BST to farmers in highly visible Federal Express trucks, a farmer who used *Posilac* but made false certifications could be identified. Neighboring farmers could report such behavior to the milk processor buying the farmer's milk. The processor in turn could ensure that the farmer actually delivered milk produced without supplemental BST. However, monitoring whether processors always used conventional milk to produce items labeled as BST-Free would be costly and difficult. Hence, the BST labeling practices may be only partially effective for preventing market failure associated with indeterminable quality. Moreover, if other companies gain approval to sell BST in the U.S. and employ less visible BST sales and delivery methods, the compliance problem will become more difficult to address. In the latter situation, needed monitoring of the entire process of milk production could be cost prohibitive.

Farmer Reaction to BST

Von Witzke and Hanf also listed the following economic concepts describing milk producer incentives to be either adopters or non-adopters of BST:

1. In developed countries which have little involvement in international dairy product trade, the demand for milk at the producer level tends to be inelastic. Hence, in these countries producer income would decline as output expands with BST use (other things being equal). This is sometimes referred to as the "technology treadmill" phenomenon. In many low-income countries the demand for milk at the producer level

is elastic. Consequently, use of BST would lead to higher milk production and higher producer incomes on efficiently managed farms in these countries.

2. In an open economy framework, many farmers would tend to favor BST use as long as they expect other countries to approve it. They might feel the need to use BST to remain competitive and push for early approval of BST to capture rents associated with being an early adopter.

3. In developed countries, the influential minority of agricultural producers seeking protection from foreign competition may find it profitable to enter into coalitions with consumers seeking protection from perceived food-related health risks via food quality standards. Political demands of both farmers and consumers on government could be met by using domestic food quality regulation as a nontariff (nonprice) barrier to trade.

Early studies predicted that competitive pressures associated with the "technology treadmill" would force most U.S. dairy farmers to adopt BST in the long run. In short, the treadmill effect predicts that early adopters of cost-effective, supply-increasing new technologies will profit from using the technology. As use of the technology spreads in a competitive, largely closed economy, supply pressures exerted on inelastic demands force down product prices, reducing profits of early adopters. As prices of products produced with the new technology fall, farmers who have not yet adopted the technology must do so to avoid losses. Farmers who fail to adopt the technology may sustain losses and be forced out of business. Ultimately, prices may be reduced to levels below those existing prior to the introduction of the technology and consumers emerge as the main beneficiaries of the increased supplies and lower prices thus produced.

Many early studies predicted that farmers would adopt BST following the pattern generated by a logistic curve (below) used for studying technological change.

$$P = \frac{K}{1+e^{-(a+bt)}}$$

where P = the level of diffusion

K = the maximum level of diffusion (asymptote)

a = a constant

b = the rate of acceptance

t = time in years.

This function, which traces out an S-shaped curve, predicts that farmer adoption of new technologies proceeds slowly at first as innovators and some early adopters experiment with it. Next, other early adopters and the "early majority" try the product, producing adoption at an increasing rate. Finally, farmers in the "late majority" and some laggards try the product. Farmer adoption practices in the later stages slow the adoption rate and ultimately cause the curve to approach the asymptote. As indicated later, such farmer adoption patterns for BST have been short circuited in some areas.

ATFFI analysts compiled a list of variables used in *ex ante* studies to explain adoption and non-adoption of BST. Surveys and anecdotal information about BST adoption suggest that the direction of causality indicated for the variables is generally correct. However, the percentage of farmers who adopted or plan to adopt BST is smaller than *ex ante* studies suggested. Yonkers summarized *ex ante* survey data from studies completed during 1984 which indicated that 61–77 percent of farmers in major U.S. dairy

states would adopt the technology. Similar studies, completed in 1986-88 after more research had been done, revealed more concerns on the part of farmers about the impact of BST on herd health and possible adverse consumer reaction to BST milk. These studies suggested that only 42–62 percent of farmers would use BST technology. Relatedtrends were identified in California (the largest milk producing state in the U.S.). Repeated surveys of dairy farmers in the late 1980s and early 1990s detected a steady decline in intent to adopt BST as the possibility of adverse consumer reaction increased. A decline in *ex ante* use intentions also was evident in responses obtained by *Hoard's Dairymen* (a leading dairy farmer magazine) in annual reader surveys. According to these surveys, farmers' planned adoption of BST during the first six months after release of the technology for commercial sale fell from 33 percent in 1985 to 18 percent in 1993.

Wisconsin farmers surveyed by ATFFI analysts during November–December 1994 revealed that only 5.5 percent of dairy farmers in this second largest milk producing state were using BST. An additional 1 percent of survey respondents anticipated using BST within the next six months, while 3.6 percent said they would wait at least 6 months before deciding whether to use the technology. The remaining 90 percent of respondents said they either were unlikely to use BST or would not use it under any circumstances.

Monsanto reported that 13,000 (about 10 percent) of U.S. dairy farmers were using *Posilac* on January 31, 1995, one year after the product's commercial introduction. According to Monsanto, these farmers accounted for about 30 percent of the dairy cows in the U.S., further indication that use of the product initially was concentrated on farms of larger producers.

ATFFI analysts explained that *ex ante* producer surveys may overestimate the BST adoption rate because producer surveys fail to directly account for the potentially negative effect of consumer response on adoption outcomes. Drawing upon Wisconsin's experience, they report that adoption appears to be strongly affected by regionally-specific institutions—particularly where state legislation resulted in BST-Free dairy product labeling.

For reasons ranging from management preferences to simple inertia, BST may join other technologies or innovations that have not achieved the high adoption rates predicted. Examples of "underutilized" technologies assembly by Conneman, together with farmer adoption rates in the U.S. in the mid-1980s, include dairy herd improvement testing (45 percent), electronic farm accounting (30 percent), scientific feeding (70 percent), milking parlors (25 percent), and embryo transfer (0.5 percent). Even artificial insemination which was introduced in 1940 and which has proven its value for upgrading the genetic potential for dairy herds had achieved only about a 70 percent U.S. adoption rate by the mid-1980s. Only farm bulk tanks and mechanical milking have achieved essentially 100 percent adoption by U.S. farmers, and much of this shift was hurried by processor pressure and/or state milk regulations. Viewed against adoption rates for other technologies, the relatively low adoption rates for BST do not appear so unusual.

Implications of Low BST Adoption Rates for Farmers

What are the economic implications for the large number of dairy farmers who do not plan to use BST? Cornell University agricultural economists, Knoblauch, Smith and

Putnam separated the 259 herds in the Cornell University Farm Business Summaries which had participated in the Cornell farm records program in 1993 and 1994 into four groups. Group I consisted of farms that did not use BST in 1994. Group II consisted of farms that used BST on less than 25 percent of the cow days in 1994. Group III used BST during more than 25 percent of the cow days in 1994. Group IV started using BST in 1994 but quit before year end. In the study, a cow day was defined as each day a cow was in the herd from February–December, 1994.

The dairy farmers in Group III who used BST more than 25 percent of the cow days in 1994 expanded by 21 cows, sold 1,752 pounds more milk per cow (8.9 percent), and witnessed an increase in the cost of producing milk by $.22 per hundredweight. Net farm income of this group increased by $20,568 (25.9 percent) from 1993 to 1994. Comparable changes in net farm income for the other groups of dairy farmers were increases of $2,791 (9.4 percent) for Group I farms that did not use BST, $540 (1.2 percent) per farm for farms in Group II that used BST on less 25 percent of cow days, and decreases of $6,987 (-13.0 percent) for farms in Group IV that stopped using BST in 1994.

The Cornell University analysts acknowledge that not all the increase in milk production and profits for Group III farmers using BST at the higher rate can be attributed to BST. Group III farmers had larger herds and greater labor efficiency and profitability than farmers in the other groups before BST was used. However, this information suggests that: (1) BST increases the advantages of efficiently managed farms, and (2) that farmers have many "technology treadmill" incentives for using BST.

Impacts of Conflicts Among Players Affected by BST

The conflicts mainly pitted certain consumers who were apprehensive about the impact of BST on product quality / safety plus certain dairy farmers who feared that BST would depress farm level milk prices and harm family farms, against Monsanto and the three other firms seeking commercial approval of BST. The consumer / farmer groups in some cases allied themselves with other groups that opposed new biotechnologies for aesthetic, religious, or philosophical reasons.

In brief, the consumer / farmer groups questioned government approval of a product for commercial sale that consumers didn't want, and that could cause some (smaller) dairy farms to go bankrupt, and would mostly benefit four large companies. This tactic delayed FDA approval of the product and reduced BST use, at least temporarily, below analytical *ex ante* expectations.

As part of their marketing / public relations rebuttal efforts, Monsanto and its allied companies pointed out possible benefits to consumers (lower food costs) and farmers (lower production costs). When biotechnology companies had made similar arguments for other technologies that had contributed to improved seeds, higher crop yields, better keeping qualities for fruits and vegetables, or eliminated disease in livestock, their arguments generally were accepted by consumers and farmers. But, when the new product merely permitted additional production of milk at lower cost, the argument proved much more difficult to sell.

Milk is already relatively inexpensive for many U.S. consumers and the promise of a small reduction in the cost of dairy products has little appeal, particularly if the lower

costs are associated with a possible reduction in product quality/safety. Additionally, U.S. consumers no longer accept at face value assurances from scientists that a food product is safe. Furthermore, many operators of smaller dairy farms are concerned about the impact of the "technology treadmill" associated with BST on their farms. Their apprehensions are heightened by fears that consumers will reduce total milk consumption if BST is used.

Commercial introduction of BST was delayed for several years by the FDA's tardiness in setting policy for its review as well as for other new biotechnological products (Caswell, Fuglie, and Klotz, and Southerland). The policy that emerged appears to affirm long-standing FDA practices. In particular, review policies do not call for the FDA to reject a new technology because it can have adverse socio-economic impacts on certain groups. Hence, the FDA avoided establishing a precedent that the Agency, others in government, and many others in the scientific community believe would prevent introduction of valuable new technologies. However, repeated appeals made to the U.S. Congress by consumer and producer groups calling for delays in commercial introduction of BST undoubtedly caused the FDA to be exceptionally thorough in its BST efficacy and safety reviews.

Consumer/producer appeals were directly linked to a 90-day moratorium on approval of BST. The FDA formally approved Monsanto's *Posilac* for commercial sale on November 5, 1993. At the request of U.S. Senator Russ Feingold of Wisconsin, who was sympathetic to calls from consumer/producer groups for further delays in the commercial introduction of BST, the sale of *Posilac* was delayed until February 1, 1994.

How much impact did the various appeals which emphasized socio-economic

impacts have? Many scientists suggested that BST would be approved for commercial sale by the FDA as early as 1990-91. While BST use in the U.S. in the mid-1990s fell short of *ex ante* expectations, it is unclear what farmer adoption rates for the technology ultimately will be. Consumer resistance to the product undoubtedly will keep rates from rising to the 61–77 percent rate suggested by 1984 producer surveys. However, the Cornell University data suggest that powerful incentives exist for operators of efficiently managed dairy farms to use BST. The incentives presumably will increase when the USDA withdraws milk price supports in 1999.

Producers attempting to decide whether to use BST may be encouraged to do so by the strong commercial demand that prevailed in the U.S. for dairy products in the U.S. in 1995. Commercial sales of dairy products in 1995 increased by 3 percent over 1994 levels despite the presence of BST in part of the U.S. milk supply. The increase in U.S. dairy product sales reflected mostly expanded sales of cheese and butter. Fluid milk sales remained essentially flat in the U.S. from 1994 to 1995. The extent to which the flat fluid milk sales in 1995 reflect concern about BST is currently unknown.

LESSONS LEARNED FROM THE BST EXPERIENCE

Useful lessons emerge from the BST experience for all participants concerned about political, consumer / producer acceptance battles for new biotechnologies :

1. Many controversies surrounding the commercial introduction of the important test-case biotechnology, BST, were predictable. However, consumer / producer coalitions

formed to oppose introduction of BST proved to be stronger than predicted.

2. Food quality / safety is important to consumers. While we may not know its exact monetary worth, we do know that U.S. consumers will not readily accept a possible reduction in food quality / safety in return for a small reduction in food costs.

3. Large markets exist in some U.S. states for fluid milk carrying the BST-Free label. In addition, niche markets have developed for cheeses and other dairy products carrying a BST-Free label. While concerns about BST milk may erode over time, the persistence of higher than normal levels of concern about BST and food quality / safety suggests that these niche markets may have a long life.

4. Experience with BST-Free labeling in some ways parallels the growth in acceptance of organic foods. Despite evidence suggesting that many organic foods are indistinguishable from conventional foods in nutritive value, the organic foods market has grown. Moreover, many consumers seem willing to accept producer certifications indicating that they get organic foods when they pay for them, particularly at so-called "farmer markets." (Some states, California particularly, have instigated regulations defining organic foodstuffs, organic farming, and production inputs that can be used in organic farming.) If farmer certified BST-Free status gains similar consumer acceptance, the market failure associated with scientifically indeterminable product quality for BST milk and non-BST milk may be unimportant because the quality of non-BST milk will be perceived *de facto* by the market as high.

5. Experience with BST and daminozide (Alar) for apples have similarities. The Alar episode, 1988-89, sharply reduced profits of Washington State producers of red

Delicious apples. Among other things, application of the now-banned chemical helped to produce a deep color in red Delicious apples and give the apples a distinctive shape. However, after environmental groups and CBS's "60 Minutes" TV show publicized possible cancer risks associated with Alar, many parents stopped feeding their children apples even though the scientific dietary benefits outweighed the vaguely established immediate health risks. People with children were simply afraid of the risk. The BST case is different because no scientific evidence currently exists indicating that dairy products produced with BST pose a health hazard. However, similarities exist between the cases because consumers of red Delicious apples were unwilling to accept a possible reduction in food quality/safety in return for an attribute that was of limited value to them—an improvement in the cosmetic appearance of the apples. The analogous trade-off made by consumers with regard to BST milk was described earlier.

6. Other new products of industrial microbiology and genetic engineering are likely to receive a warmer reception than BST. Porcine somatotropin (PST), a hormone which produces leaner pork, is such a product. If the leaner pork produced with PST is safe, consumers may respond to PST pork as a valuable innovation. The motivation would likely be influenced by their desire to reduce fat in their diets, and increased awareness that nutrition affects their health. Producers also may have strong incentives to use PST since the leaner pork produced with the product is likely to command a higher price than conventional pork if consumers accept its health consequences.

The *FLAVR SAVR* genetically-engineered tomato, produced by Calgene, is another such product: a tasty, vine-ripened tomato with an extended shelf life. Consumers have

raised little concern about the quality/safety of this product. However, groups that oppose many new biotechnologies, some of which joined forces with consumers and dairy farmers to delay introduction of BST, are still likely to continue their opposition to "bio-engineering" of "natural" food products.

7. The European Union's (EU) Council of Ministers of Agriculture has decided not to allow commercial sales of BST for use in EU dairy herds until after the 1999/2000 milk marketing year. Socio-economic considerations influenced this decision. As world dairy markets become more open, as a result of the Uruguay Round GATT agreement and subsequent trade agreements, many EU dairy farmers probably will wish to gain access to BST to be competitive. They will be aided in their requests to use BST by manufacturers of the product who regard the EU market as potentially lucrative.

8. Certain environmental, animal rights, and consumer groups in Europe have asked EU ministers to ban imported dairy products made with BST milk. There is precedent for such action: the 1988 EU decision to ban imports of U.S. beef produced with a growth hormone. The U.S. plans to challenge the EU beef import ban under the World Trade Organization and might also challenge similar barriers on dairy products. The challenge would be based partly on claims that dairy import restrictions are not justified by scientific evidence relating to product quality/safety and efficacy.

9. Monsanto's experience with BST suggests that firms with "deep financial pockets" and staying power have obvious advantages for developing and marketing complex biotechnologies. Despite early losses on BST, Monsanto may find it feasible to continue to sell (and internally subsidize) the product, reaping early mover advantages and taking

advantage of the large BST market share that it has obtained in the U.S. However, BST undoubtedly will cause Monsanto and other firms to employ different screens for selecting new biotechnologies for commercialization in the future.

IMPLICATIONS

1. Government reviews of new bio-tech products will be increasingly sensitized to both manufacturer claims based on "science," and consumer/market concerns about quality (health)/price (cost) consequences. Consumer perception of food quality status may not concern itself much with science even though scientific testing is a necessary (but not sufficient) condition for an effective marketing strategy.

2. Government review processes for approving new bio-tech products may have been standardized as a result of the prolonged BST process—but do not count on it because of changing political objectives. For example, new biotechnology product review committees will skeptically view products that promise small reductions in production and food costs while raising concerns in consumers' minds about product quality/safety.

3. Gaining confidence and acceptance by manufacturers about a new bio-technology is crucial to both an effective short-term and long-run marketing strategy. Farmers' classical technology adoption process was short-circuited for BST. Nonetheless a Cornell University study suggests that farmers' incentives to adopt BST remain potentially strong.

4. Use of "size-neutral" rationales for marketing new technology can be turned

against the seller. Farm size is highly correlated to quality of management, market contact, and experience with impacts stemming from technology adoption. These considerations put large and small farms on a different plane. BST will cause sellers' claims of size neutrality for other new technologies to be viewed skeptically.

5. All technology-use decisions have both political and economic implications: political due to the response to public pressure (market, interest group); economic due to successful possible “early mover” monopolistic, or oligopolistic, rent-seeking (profits).

6. Accurate labeling of a product and the market image it initially creates is critical. First, consumer perceptions and reactions are difficult and costly to overcome. Labeling issues remain unresolved as a result of the BST experience which revealed that many consumers want to know how a product is made, e.g., whether it is product of biotechnology and genetic engineering. Some consumers prefer conventional foods for reasons relating to food safety, aesthetics, or religion. The niche markets that emerged for BST-Free dairy products underscore this point.

7. A large issue raised is the need to prevent future foods produced with biotechnologies from being stigmatized. This could happen if those foods are labeled as bio-tech products. A viable compromise position involves acceptance of the equivalent of BST-Free labels for other products of biotechnology as long as the labels do not convey false health claims. This may satisfy disaffected consumers while short circuiting calls for broader, stigma-producing labels on new products.

SUMMARY

The path to selling and using effective, consumer-approved, producer-accepted, and government-sanctioned biotechnology is hazardous for all interest groups involved. Scientific studies showing beneficial health/cost/production ratios are necessary. However, sufficient conditions of short-run political acceptance and longer run economic benefits are also needed.

Business strategists will need to anticipate future health/economic issues related to their potential technological introductions. Without doubt, large, well-financed, multi-product firms stand a better long-run chance for successful market development than do small firms. This situation has nothing to say about the technology at risk, only that the acceptance process is long and costly.

Perhaps the inventors of new technology, those who manufacture it, those who use it, and the consumers who absorb it, are all adversely affected by the current process. On the other hand, slowing the process could produce a host of unwanted outcomes. The road between these extremes will always be rocky given the political possibilities within a democracy.

REFERENCES

Barham, B.L., F.H. Buttel, D. Jackson-Smith, J. McNichol, and S.D. Wood. "The Political Economy of rBST Adoption in America's Dairyland," *ATFFI Technical Report No. 2*, May 1995, 32 pages.

Caswell, M.F., K.O. Fuglie, and C.A. Klotz. "Agricultural Biotechnology--An Economic Perspective," *Agricultural Economic Report No. 687,* May 1994, 52 pages.

Conneman, G.J. "Historical Perspective on the Adoption of New Technologies on Dairy Farms," National DHIC Farmers' Biotechnology Conference, Philadelphia, PA, March 10, 1987.

Daughaday, W. and D. Barbano. "Food Safety and Product Quality," in Bovine Somatotropin & Emerging Issues--An Assessment, Westview Special Studies in Agriculture Science and Policy, 1992, p. 267, Boulder, CO.

Douthitt, R. Quoted from "Consumers Dislike rBGH," *Capital Times,* January 27-28, 1996, p.3A.

Elam, T. Private Communication on Marketing BST, January 31, 1996.

Eppard, P.J., J.L. Vicini, W.J. Cole, and R. J. Collier. "Effect of Bovine Somatotropin on Animal Health," *Proceedings of Maryland Nutrition Conference for Feed Manufacturers*, 1989, pp. 74-79.

Fallert, R., T. McGuckin, C. Betts, and G. Bruner. "bST and the Dairy Industry--A National, Regional, and Farm-Level Analysis," *Agricultural Economic Report No. 579,* October 1987, 114 pages.

Knoblauch, W.A., S.F. Smith, and L.D. Putnam. "Does BST Use Cost or Pay?" *Hoards Dairyman*, November 1995, p. 744.

Moore, D.A. and L.J. Hutchinson. "BST and Animal Health," in *Bovine Somatotropin & Emerging Issues--An Assessment*, Westview Special Studies in Agriculture Science and Policy, 1992, pp. 99-141, Boulder, CO.

Southerland, D. "A Swifter FDA Boosts Biotech Industry," *Washington Post,* August 10, 1993.

Thompson, P.B. "Food Labels and the Ethics of Consent," *Choices*, 1st Quarter 1996, pp. 11-13.

Von Witzke, H. and C.H. Hanf. "BST and International Agricultural Trade and Policy," in *Bovine Somatotropin & Emerging Issues--An Assessment*, Westview Special Studies in Agriculture Science and Policy, 1992, pp. 271-301, Boulder, CO.

Willis, C. "BST Proves Costly for Monsanto," *Capital Times*, February 17-18, 1996, P. B1.

Yonkers, R.D. "Potential Adoption and Diffusion of BST Among Dairy Farmers," in *Bovine Somatotropin & Emerging Issues--An Assessment*, Westview Special Studies in Agriculture Science and Policy, 1992, pp. 176-192, Boulder, CO.