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## Introduction

Seven years have passed since the U.S. government approved the commercial use of recombinant bovine somatotropin (rBST), a synthetic relative of a naturally-occurring growth hormone that stimulates milk production in cows. Prior to approval, national controversy over rBST, more popularly known as BGH (bovine growth hormone), raged for almost a decade (Barham, 1996). Opponents and proponents alike envisioned rBST as a juggernaut technology, one that would change the dairy industry in dramatic ways, first and foremost by substantially raising herd productivity and overall milk production and then perhaps by driving away consumers from dairy products. With these concerns in mind, opponents also believed that rBST's effects would drive tens of thousands of (smaller-scale) dairy farmers out of business by both depressing milk prices and rendering small-scale producers less competitive. Meanwhile, proponents hailed the technology as a valuable management tool for improving herd performance and the efficiency of dairy farms of any scale. At the peak of the controversy, the U.S. Congress debated whether to overturn the Food and Drug Administration's approval, and the Senate demanded a special, full-length report by the Office of Management and Budget (1994) assessing the potential impacts of rBST on the U.S. dairy industry and society.

Given the intensity of the debate in the early 1990s, it is noteworthy that rBST's seventh anniversary as a commercial product passed with hardly a mention from any of the erstwhile protagonists, even in Wisconsin which had been at the center of the national tempest. These "after-the-storm" conditions reflect the fact that markets and regulations shaping rBST use have been relatively stable for several years now, with most demand-side uncertainties surrounding U.S. consumer reaction largely dissipated, at least for the time being. Instead of chaos and disruption, what emerged quickly in Wisconsin, and in some other major dairy producing states (including California and Minnesota), were segmented markets for fluid milk as well as for some processed products (cheeses, soft products, etc.). These market niches have held steady or perhaps receded in certain instances. Generally, retailers and processors, respectively, use signs above the dairy case and product labels to signal to consumers the availability of dairy products from cows not treated with rBST. For dairy farmers, this marketplace stability means that rBST adoption decisions are now probably based on their own adoption preferences, production strategies, other farm-level factors, and the local presence (or lack of) segmented markets for dairy products rather than uncertainties about consumer reaction.

This stability makes it a propitious time to explore traditional questions about rBST adoption, such as: How common is rBST use? How has adoption evolved since 1994? What does the future hold for rBST use? What types of farms and farmers are and are not using rBST? Is rBST making a notable difference in the structure and performance of the Wisconsin dairy industry, and, by extrapolation, the U.S. dairy industry? At the same time, this paper also addresses some less traditional questions, such as: Is rBST better understood, not as a juggernaut technology, but as one that fits best particularly well on operations already using a certain set of management practices and technologies? Relatedly, are there identifiable production strategies where rBST use is not likely to be a key part of the management package? These additional questions allow both a deeper examination of the factors shaping rBST adoption and a reframing of farm technology adoption issues that explicitly considers how different forms of specialization or production strategies might influence adoption outcomes (Rogers, 1983).

The data used in most of this report come from a statewide, random sample mail survey that the Program on Agricultural Technology Studies (PATS) undertook in the first half of 1999. We sent the "1999 Wisconsin Dairy Farm Poll" to over 1,600 Wisconsin dairy farmers, and about 50 percent of them responded. Included in the 1999 survey was a question on rBST use that asked: "Do you currently use Posilac™ (rBST or BGH) on any milking cows?" In addition, we incorporate results from a similar survey undertaken in the spring of 1997 with two sets of farmers: a random sample with 1,019 respondents and a longitudinal panel of 294 farmers who had also responded to our Dairy Farm Poll in 1995.

In the 1999 survey, no questions were asked about the performance of Posilac™, or future use intentions (see Barham et al., 1995). However, many questions were asked about the characteristics of the farm operation, such as herd size, land ownership and rental arrangements, technologies and management practices of the operation, use of hired labor, off-farm work efforts of the operator and family members, and demographic characteristics of the operator and their family. This information is used in the paper to explore the factors shaping rBST adoption decisions.

The paper is organized as follows. Section 2 reports on rBST adoption rates on Wisconsin dairy farms in 1999. We estimate the proportion of cows statewide that are currently treated with rBST as well as the effects of rBST use on Wisconsin milk production levels. We examine the degree to which the increase in rBST adoption rates since 1995 is accounted for by changes in adoption by continuing farmers or by distinctive adoption patterns among exiters and entrants. Section 3 explores farm-level factors shaping adoption with a focus on the role of other technologies and production strategies as well as farm size. These data demonstrate an astonishing degree of scale bias in the adoption of rBST and a strong association between rBST use and the use of certain other technologies. They also show that rBST is used most commonly on farms following what we call a "high-end full confinement" strategy, one that involves the use of a package of production-enhancing technologies, and that is also giving rise to a cohort of larger and relatively rapidly expanding farms in Wisconsin. Section 4 returns to the traditional questions about the impact of rBST adoption on the structure and organization of the Wisconsin dairy industry and the future of rBST adoption in Wisconsin. The final section summarizes the study's main findings and discusses their implications for further research.

## Adoption Patterns of rBST by Wisconsin Dairy Farmers

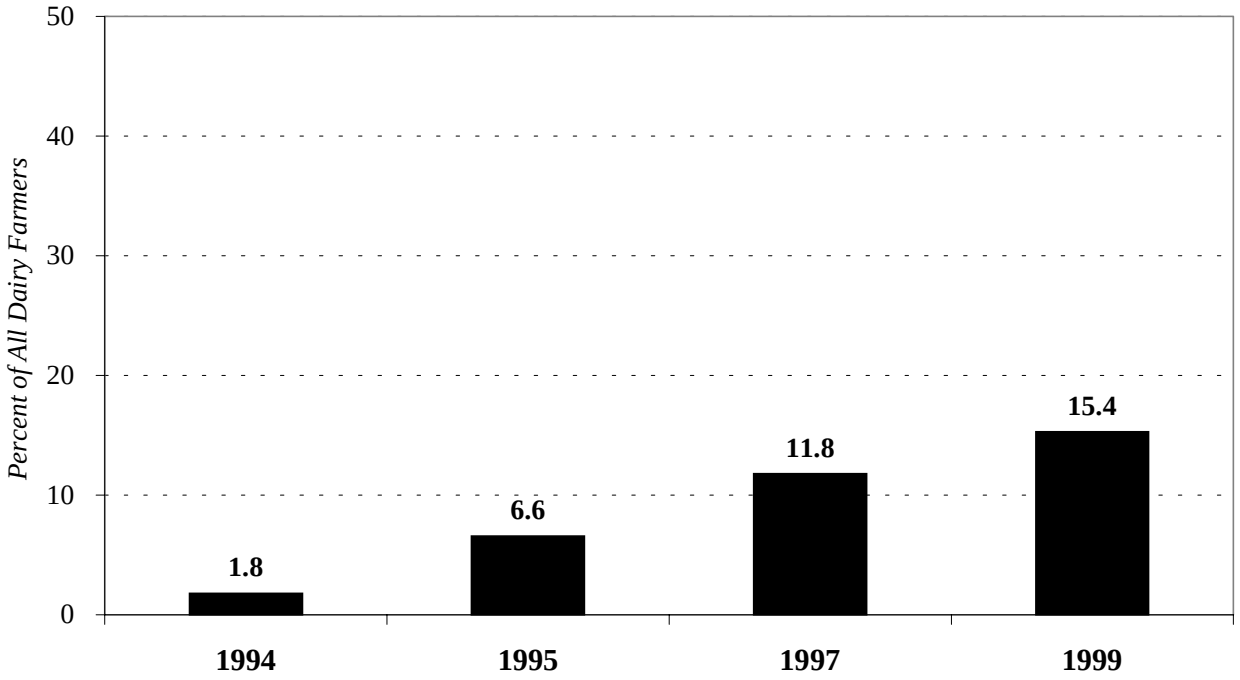
The results of our spring 1999 survey suggest that rBST is used by 15.4 percent of Wisconsin dairy farmers (see Figure 1). This adoption rate represents more than a doubling from 1995 when 6.6 percent of Wisconsin dairy farmers reported using rBST on some of their herd. However, the rate of growth in rBST use may be slowing – the growth rate between 1995 and 1997 was almost 80 percent, compared to a 30 percent growth rate between 1997 and 1999.

How do Wisconsin's adoption trends compare with adoption elsewhere? Fetrow (1999) cites Monsanto sales data to estimate that just over 15 percent of U.S. dairy producers and 30 percent of dairy cows had used Posilac™ (the only rBST product on the market) since its introduction in February of 1994. Given that this national estimate could include farmers who had tried rBST on their herds but were no longer using it (roughly 5 percent of Wisconsin dairy farms fit this description), the national adoption rates of rBST in 1997 and 1999 were probably fairly close to the 12 and 15 percent figures reported by Wisconsin producers.

It is worth noting that these adoption rates are much lower than were anticipated by those who thought of rBST as a juggernaut technology (Office of Management and Budget, 1994). There were many *ex-ante* predictions of national farm-level adoption rates of at least double or triple this level, although, to be fair, those forecasts did not envision scenarios in which rBST's introduction would give rise to a segmented market and a substantial niche for rBST-free dairy products. These lower adoption rates nonetheless have implications for the impacts of rBST adoption on milk production, essentially ensuring a more minor supply and price impact than envisioned by most analysts *ex ante*.

Based on Monsanto's recommendations for use of Posilac™ (generally after the 9$^{th}$ week of lactation), and assuming a 10-month lactation period, one can calculate that a farm would be near full

**Figure 1: Percent of Wisconsin Dairy Farms Using rBST, 1994-1999.**




adoption of rBST if approximately 66 percent of the milk herd were under treatment at any given time. In our 1997 survey, farms that used rBST reported treating roughly half of their milk cows at any point in time, or about 75 percent of what might be called maximum adoption.[1] Using herd size data from adopters and non-adopters in 1999, and assuming treatment rates of 50 percent on adopting farms, we estimate that slightly more than 15 percent of Wisconsin milk cows were being treated with rBST in 1999. Presuming a 10 percent increase in milk supply from those cows (a well-established estimate for average productivity increases from rBST use), it appears likely that rBST is accounting for no more than a 2 percent increase overall in Wisconsin milk supplies. Even if we were to assume higher rBST use elsewhere around the country, especially in the Western United States, where adoption rates and herd size both tend to be higher, then rBST use is probably directly responsible for no more than a 3-4 percent increase in the national milk supply.

Given the highly inelastic demand for dairy products, and the associated volatility of dairy prices, an instantaneous 3-4 percent supply boost would probably make a 10-12 percent difference in average milk price levels. However, that estimate would overstate the dynamic effects of rBST, because even without rBST dairy herd productivity in Wisconsin and the U.S. has tended to grow at relatively high rates (more than 2 percent per year). Thus, this one-time production boost created by the use of rBST seems relatively minor when compared with the secular trend of ongoing productivity growth in the industry. In terms of milk prices, then, rBST has also fallen short of the major impact that many analysts foresaw during the heat of the controversy.

*Exiting Farms also Affect Apparent rBST Use Rates*

A less obvious point is that the increase in Wisconsin's rBST adoption rate over the past four years is by no means accounted for solely by an increase in the number of farm operators using rBST. In Table 1, the total number of rBST-using farms in the state is estimated for 1994, 1995, 1997, and 1999. From 1995 to 1999 there has been a 21 percent decline in the number of dairy farms, a 133 percent increase in the aggregate rate of rBST adoption, but only an 84 percent increase in the number of rBST users. In other words, roughly two-thirds of the increase in rBST adoption rates in Wisconsin between 1995 and 1999 can be accounted for by the growth in the number of rBST adopters. The rest of the apparent increase in adoption results from the disproportionate exit of farms that were not using rBST. Without delving here into the potential causal link in any detail, we would attribute the higher exit rate among non-adopters primarily to factors other that rBST adoption choices, especially the retirement

**Table 1: Rate of Increase of rBST Use among Wisconsin Dairy Farms**

| | Total Farms | Use Rate (%) | Total Users |
|---|---|---|---|
| Annual Estimated Total | | | |
| 1994 | 28,641 | 1.8 | 516 |
| 1995 | 27,346 | 6.6 | 1,805 |
| 1997 | 24,566 | 11.8 | 2,899 |
| 1999 | 21,624 | 15.4 | 3,330 |
| Percent change | | | |
| 1995 to 1997 | -10.2 | 78.8 | 60.6 |
| 1997 to 1999 | -12.0 | 30.5 | 14.9 |
| 1995 to 1999 | -20.9 | 133.3 | 84.5 |

of older and smaller-scale farms (Jackson-Smith and Barham, 2000). At the same time, new dairy entrants do not appear to be contributing to the overall increase in rBST use rates. Data from a 1996 survey of beginning dairy farmers (see Buttel et al., 1999) found only a 5.4 percent adoption rate of rBST among recent entrants, which was less than the statewide average 6.6 percent figure for 1995 and much less than the 11.8 percent statewide average in 1997.

*Data from a Longitudinal Panel of Farms*

Combined, these low adoption rate estimates for exiters and entrants suggest that most of the increase in rBST use originates with continuing farmers who have adopted rBST recently. Our longitudinal data on rBST use from 289 dairy farms surveyed in both 1995 and 1997 confirm this conclusion. Their responses to the rBST use question in both years are cross-tabulated in Figure 2. Notice first that the adoption rates among this sample of continuing farms were almost twice those of the dairy farm population at large in 1995 and then slightly higher in 1997 (for the comparison numbers, see Figure 1). These figures show both the higher adoption rate and the increase in use among continuing (non-exiting) farmers. Figure 2 also offers another interesting point, which is that while adoption among the panel farms increased by a net 2.9 percent over that time period, almost 5 percent of the longitudinal respondents were new adopters while roughly 2 percent of the continuing farmers stopped using rBST (in other words, roughly 1 in 5 of those using rBST in 1995 had disadopted by 1997). Overall, it appears that rBST adoption is not a simple cumulative process in which the decision is permanent and irreversible, as there were fairly substantial changes in rBST adoption behavior in both directions among these continuing farmers.

## Factors Shaping rBST Adoption

Previous analyses of rBST use on U.S. dairy farms (Barham et al. 1995, Barham, 1996, Zepeda, 1995) report that in comparison with non-adopters, rBST adopters are likely:

(1) to have significantly larger herds;
(2) to use complementary production maximizing technologies, especially total mixed ration equipment (TMR);
(3) to be younger;
(4) to have higher levels of formal education; and,
(5) to have herds with higher milk productivity even before rBST adoption.

One concern with these initial analyses of early adopters was whether later adopters would have similar characteristics as use of the technology diffused, or , alternatively, whether rBST use would spread to farmers with other characteristics. The data reported below suggest that the major differences found earlier between adopters and non-adopters have persisted, and have even become more exaggerated among the 1999 respondents. We start our discussion with some observations on these differences between rBST adopters and non-adopters

**Figure 2: rBST Use Status in 1995 and 1997 among Longitudinal Panel Farms**

| Number of Farms (Percent of total) | | rBST Status in 1997 | | |
|---|---|---|---|---|
| | | NO | YES | 1995 total |
| rBST Status in 1995 | NO | 238 (85.3%) | 13 (4.7%) | (90.0%) |
| | YES | 5 (1.8%) | 23 (8.2%) | (10.0%) |
| | 1997 total | (87.1%) | (12.9%) | |

before trying to explain the reasons why these patterns have held and even deepened over time.

*Some Key Attributes of rBST Adopters*

In 1999, the mean herd size of Wisconsin dairy farms using rBST was more than two and a half times the size of dairy farms not using rBST, 157 compared to 61 (see Table 2). Farms employing rBST also reported levels of per cow milk production that were 20-25 percent higher on average. Figure 3 displays the strong degree of size bias in rBST adoption and its persistence over the past four years. For example, only 5 percent of farms under 50 cows in 1999 were using rBST, compared to 75 percent of the farms with over 200 cows. This significant

**Figure 3: Size Bias of rBST Adoption in Wisconsin**

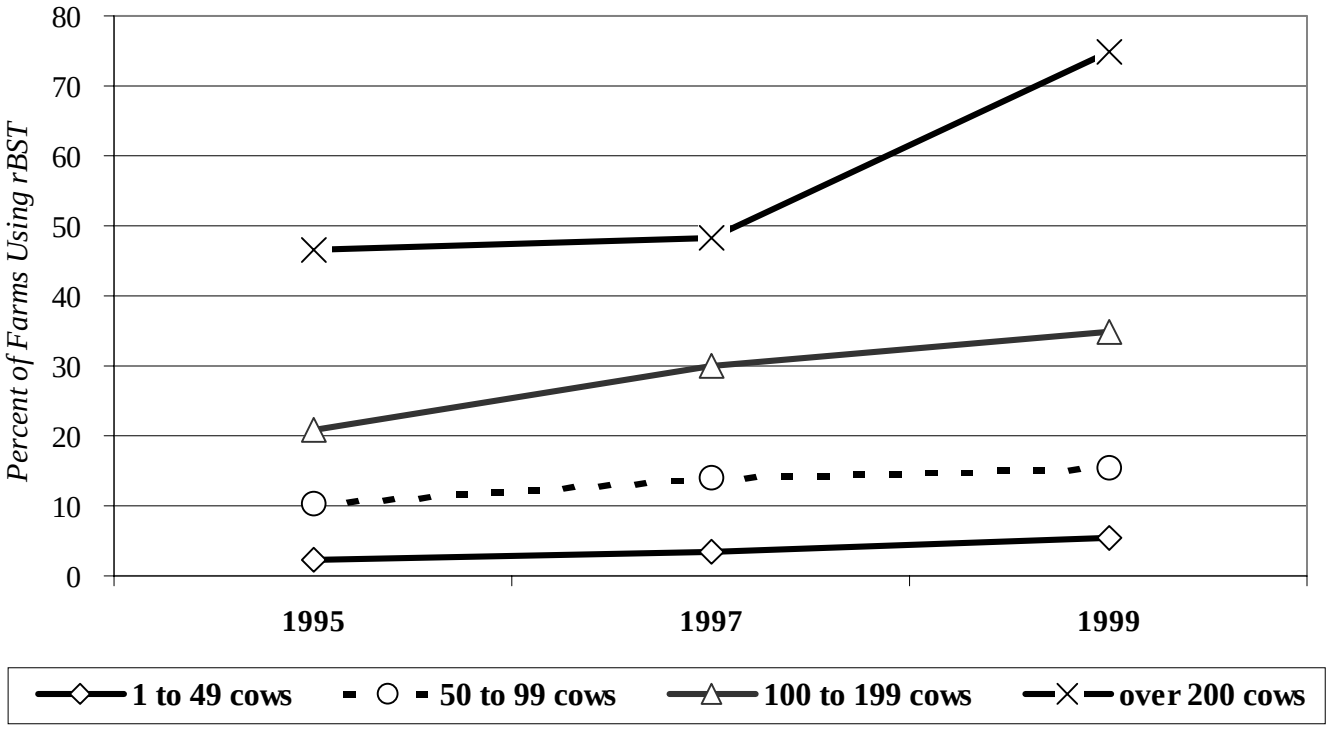


**Table 2: Comparison of Farms by rBST Adoption Status**

| | Current rBST User | Non-rBST user | Difference |
|---|---|---|---|
| Percent (Number) of Sample | 15.4 (118) | 84.6 (648) | |
| Mean herd size | 156.8 | 60.7 | 258% |
| Median herd size | 85 | 50 | 170% |
| Mean pounds milk shipped per cow per day | 71.7 | 57.4 | 125% |
| Rolling Herd Average (if reported) | 22,947 | 19,129 | 120% |
| Percent Using other Technologies: | | | |
| Balances feed rations 4 times a year | 93.2 | 60.5 | +32.7 |
| Keeps herd production records on individual cows | 92.3 | 48.9 | +43.4 |
| Schedules regular vet service | 89.8 | 62.2 | +27.6 |
| Total Mixed Ration Machinery (TMR) | 75.2 | 19.7 | +55.5 |
| Computer for farm records | 58.7 | 27.3 | +31.4 |
| Free stall for milking herd | 41.5 | 14.4 | +27.1 |
| Parlor milking system | 30.5 | 9.5 | +21.0 |
| Milk 3-times per day | 17.9 | 0.8 | +17.1 |
| Management Intensive Rotational Grazing (MIRG) | 14.4 | 24.7 | -10.3 |

absolute gap in rBST adoption between smaller and larger herds was also evident in 1995, but it has widened with the more rapid growth in adoption of rBST among the larger herd size categories. This strong degree of size bias in rBST adoption in Wisconsin and the small proportion of large dairy herds in Wisconsin is the primary reason the state's overall adoption rate remains at 15 percent.[2]

Another way of looking at the attributes of rBST adopters is to look at the other technologies and management practices they tend to use on their farms. These are shown in Table 2. There are several striking differences in practices between adopters and non-adopters. For example, rBST adopters are more likely than non-adopters to use regular services of a veterinarian, keep herd production records on individual cows, use TMR machinery, and regularly balance their herd's feed rations. In addition, rBST adopters are far more likely to have a free stall housing facility or a parlor, and to milk three times daily, than are non-adopters. However, adopters are less likely to use management-intensive rotational grazing (MIRG) as a part of their feeding strategy for their cows, which is sensible given the increased incentive to optimize feed consumption of cows being treated with rBST. Yet, it is interesting that 14 percent of the rBST adopters are also using MIRG as part of their production strategy. While this adoption rate is lower than the statewide MIRG adoption rate of 22 percent, it does imply that a substantial number of rBST users may be pursuing a hybrid approach in combining what are often viewed as disparate management approaches.

In Table 3, we take a closer look at the adoption of four herd "productivity-oriented" practices (vet services, herd production records, balanced feed rations, and TMR machinery) by distinct herd size categories. These data support two fundamental observations about rBST adoption patterns:

(1) rBST adopters of all herd size categories are far more likely to use these four productivity-oriented technologies than non-adopters. Indeed, in herd sizes over 50 cows, there is almost universal adoption of three of them by rBST users, with only TMR having less than a 90 percent adoption rate for the herd size category of 50-99 cows. Put differently, the uniformity in use of the other four technologies by rBST

**Table 3: Technology Adoption Rates by Herd Size and rBST Use Status, 1999.**

| Size of Herd | rBST Use Status in 1999 | Percent Using Other Practices: Total Mixed Ration Machinery (TMR) | Schedules regular vet service | Keeps herd production records on individual cows | Balances feed rations 4 times a year |
|---|---|---|---|---|---|
| 1 - 49 cows | User | 35.3 | 70.6 | 88.2 | 58.8 |
| | Non-user | 6.6 | 50.2 | 36.6 | 41.3 |
| 50 - 99 cows | User | 70.0 | 90.2 | 92.0 | 98.0 |
| | Non-user | 27.1 | 71.6 | 60.5 | 74.8 |
| 100 - 199 cows | User | 93.1 | 93.1 | 93.1 | 100.0 |
| | Non-user | 50.0 | 79.6 | 58.5 | 90.7 |
| 200+ cows | User | 95.2 | 100.0 | 95.2 | 100.0 |
| | Non-user | 57.1 | 71.4 | 42.9 | 85.7 |

adopters suggests that **management and production system orientations that give rise to use of these associated technologies are critical in shaping rBST adoption decisions**.

(2) Adoption rates of the four associated technologies also show strong size biases among non-adopters, with the most dramatic being the increase in TMR use rates from only 6 percent of herds under 49 cows to 57 percent on herds over 200 cows. **Therefore, it appears as if use of rBST, which is the latest of these technologies to come on line, is strongly associated with a bundle of technologies and management practices that are most likely to be adopted by farmers of larger scale**.

In other words, the size-bias of rBST adoption rates discussed above is probably a byproduct of a deeper logic driving patterns of technology use and herd size choice on dairy farms rather than because rBST is an inherently size-biased technology, or that rBST itself drives growth in herd size. **This first inference about the size-bias of rBST adoption being related to other factors associated with rBST use would be consistent with the frequent and commonsense assertion that rBST treatments (i.e., the injections of rBST into cows) are in some sense scale-neutral**. At the same time, it would help to explain how the potential size bias of adopting other management practices and technologies that need to be in place to make rBST use effective could be giving rise to the dramatic size-bias in rates of rBST adoption shown above. A second inference follows from the first: **rBST use is more common on larger farms because the overall management approaches taken by these farms influences both their expansion behavior and their use of rBST**.

As suggested above, the milk per cow yields of rBST adopters are significantly greater than are those of non-adopters, about 20-25 percent higher in fact.[3] If we subtract the average 10 percent increase in milk production associated with rBST and the mean application rate of rBST to 50 percent of the herd, then in the absence of rBST, per cow productivity would still be about 15 percent higher in the adopting herds than in the non-adopting herds. This gap may be the result of differences in herd genetics and/or the use of other technological and management practices that boost milk yields. Either way, it is important to point out that a 10 percent increase in production on a more productive herd will, on average, be more profitable than a similar 10 percent increase on a less productive herd. This profitability

advantage arises from the greater number of pounds of milk obtained on more productive cows for given fixed investments in the rBST injection, maintenance of the metabolic energy base of the cow, and management of the cow's health and nutrition needs. In other words, it is not at all surprising that operators managing herds with a higher initial level of productivity per cow would be more likely to adopt rBST.

Finally, the demographic characteristics of rBST adopters and non-adopters are compared in Table 4. As suggested above, rBST adopters tend to be younger and have higher levels of formal education than non-adopters. For example, 22 percent of rBST adopters have a 4-year college degree or graduate school experience, compared to only 8 percent of non-adopters. In addition, another 38 percent of rBST adopters have had some post-high school educational training compared to 28 percent of non-adopters. These differences in educational background may reflect or give rise to differences in management strategies, familiarity with and preference for certain technological options, and hence choices in technology use.

*Specialization Strategies on Wisconsin Dairy Farms and rBST Use*

This section argues that Wisconsin dairy farmers who pursue distinctive "specialization strategies" have different rBST adoption patterns and herd size dynamics. By specialization strategy, we mean the choice of a division of labor and set of management responsibilities that are associated with distinctive technological packages and overall production strategies. Most common is the classic Wisconsin family farm, identified here as a traditional semi-confinement operation. It is one where the owner-operator (perhaps along with the spouse or other family member) basically manages all of the work tasks and executes most of them, including feeding, caring for, and milking the herd as well as planting, cultivating, and harvesting the crops and forage for the animal's feed. This integrated management and work approach provides the potential to exploit economies of scope by avoiding the coordination costs involved with exchanging information and arriving at decisions with other managers and workers. It also reduces or eliminates the need to monitor hired labor for its quality and quantity of effort.[4]

At the same time, given the inherent limits of time and energy of one or two operators, there may be significant constraints to growth and the use of certain technologies because of the wide variety of tasks that the lead operator must already do. The strength and severity of this constraint may vary notably depending on the type of milking facility used by the farmer (e.g., stanchion barn versus parlor), but it is still likely to have an impact at a smaller scale of operation than the other two types of specialization strategies we consider next.

Until a decade ago, semi-confinement operations were almost the exclusive type of operation in Wisconsin (Jackson-Smith and Barham, 2000). In the past ten to fifteen years, two other types of specialization strategies have emerged as significant alternatives in Wisconsin. One of them,

**Table 4: Demographic Characteristics by rBST Adoption Status, 1999**

| | rBST User | rBST Non-user |
|---|---|---|
| Mean Age of Operator | 43.9 | 47.1 |
| Operator Education Level (percent) | | |
| Less than High School Diploma | 2.5 | 14.7 |
| High School Grad | 39.0 | 49.8 |
| Some College or Trade School | 28.0 | 22.1 |
| 2-year College Degree | 8.5 | 5.8 |
| 4-year College Degree | 16.9 | 5.9 |
| Some Grad School or Post Grad | 5.1 | 1.7 |

which was mentioned above, is the "high-end, full confinement" strategy. It is distinguished by its pursuit of economies of specialization in management and work tasks, such that the lead operator(s) is (are) no longer primarily responsible for executing all of the major management and labor tasks. Along with a more explicit division of management and labor responsibilities comes the potential for making significant investments in hired labor, herd expansions, new facilities, and technologies. These generally require more management intensity yet have an associated potential for increasing productivity (both on a per cow and per hour of labor basis).

The third specialization strategy that we identify is distinctive from the other two because of its emphasis on lower inputs of both labor and capital. The "low-input" category has the potential for gains from both management specialization and economies of scope, along with lower investment requirements through reduction in the activities done by the farm operation and operator. The most common practice within the "low-input" group in Wisconsin is management-intensive rotational grazing, which reduces the labor and capital costs involved in cultivating and harvesting crops by putting the cows on pasture and managing their use carefully. Dairy farms where all of the feed is purchased provide another but much less common example of a low-input strategy, because the operator's focus can be on exclusively caring for and milking cows and not on the many tasks associated with cultivating and harvesting crops.

There is ample reason to believe that producers in the high-end confinement group will be far more likely than will producers in the other two groups to adopt production-maximizing technologies, including but not limited to rBST. On the one hand, their strategy emphasizes investments, technologies, and division of responsibility aimed at increasing herd productivity and farm performance, which would increase the likely profitability of rBST use for reasons already discussed. On the other hand, the other two specialization strategies (traditional semi-confinement and low-input operations) are undertaken to increase overall farm efficiency through streamlined management and coordination and/or lower levels of inputs and fixed investments. These latter approaches are likely to inhibit the adoption of management- and capital-intensive practices and technologies, such as rBST.

The criteria behind our division of the 1999 sample data into these three categories will be more fully explained in a subsequent report on technology trends in the Wisconsin dairy industry. In brief, they are as follows:

(1) A farm is in the "high-end, full confinement" group if:

   a. The operator is <u>not</u> using management-intensive rotational grazing; **and,**
   b. He (she) has a parlor and free stall housing; **or else**,
   c. Three of the following four productivity-oriented management practices are being followed: regularly scheduled vet services, herd production record-keeping for individual cows, balanced feed rations, and the use of total mixed ration equipment, **and,**
   d. The main operator does not work off-farm (more than 5 hours per week), and the main operator does less than 50 percent of the farm labor.[5]

(2) A farm is in the "low input" category if the operator adopts management-intensive rotational grazing, or if he (she) does not own any land, or if he (she) owns land but does not produce grain. More than 85 percent of the low input category in our sample are MIRG adopters.

(3) Finally, any dairy farm that does not meet either the criteria for the high-end, full confinement or the low input specialization strategy is considered to be in the traditional semi-confinement category. In other words, they are not using MIRG, they do not have a parlor or freestall housing facility, and they do not meet any of the other criteria that would put them in the other two categories.

Applied to the 1999 PATS sample, about one quarter of Wisconsin dairy farms in our sample are in each of the high-end confinement and low-input groups and about one half are in the traditional semi-confinement category. Table 5 reports these proportions as well as rBST adoption rates, mean and median herd size, per cow productivity, and operator education levels for the three specialization strategies. The findings strongly correspond to the logic of the three specialization strategies suggested above.

**Table 5: Comparison of Dairy Farms using Different Specialization Strategies, 1999.**

| | Specialization Strategies | | |
|---|---|---|---|
| | High-end, Full Confinement | Traditional Semi-Confinement | Low-input Strategies |
| Percentage (Number) of Sample | 23.1 (185) | 51.5 (412) | 25.4 (203) |
| rBST Adoption Rate (%) | 36.4 | 7.9 | 10.1 |
| Mean Herd Size | 148.6 | 54.4 | 49.8 |
| Median Herd Size | 95 | 50 | 44 |
| Pounds of milk shipped (per cow per day) | 65.6 | 58.7 | 55.3 |
| Rolling Herd Average (if reported) | 21,294 | 19,785 | 18,515 |
| Mean Age of Farmer | 45.7 | 47.7 | 46.0 |
| Formal Education Rate (%) | | | |
| Up to High School Diploma | 50.3 | 67.8 | 58.4 |
| Some College or Trade School | 37.3 | 24.6 | 29.7 |
| BA Degree or Higher | 12.4 | 7.6 | 11.9 |

The observed rBST adoption rates are 36 percent among the high-end, full-confinement operations, compared to 8 percent among the traditional semi-confinement operations, and 10 percent on the low input operations (note that the subset of low input operations using MIRG had an rBST adoption rate of slightly less than 10 percent). Thus, the high-end, full-confinement operations are about four times more likely than are either of the other two groups to be using rBST.

Observed rBST adoption rates is certainly not the only distinctive feature separating these three specialization groups. Levels of formal education are highest among the "high-end" producers, with the "low-input" group close behind. The traditional semi-confinement producers are considerably less likely than the other two categories to have some college training or more, which may help to explain their tendency to continue using the more conventional approach to dairy farming. The average herd size comparisons are rather striking as well. The high-end, full-confinement operations have a herd size mean of nearly 150 cows compared to 54 and 50, respectively, for the other two categories. However, the median of 95 cows for high-end producers suggests that a substantial part of the size gap among these three types of operations stem from a relatively small number of very large high-end confinement operations. Nonetheless, it is clear that these specialization paths are strongly associated with choices in herd size.

The final comparison across the three groups is shown in Table 6. This table reports the operator's attitudes on a range of questions related to changes in dairy farm structure in Wisconsin. The table gives the percentages of farmers in each of the specialization categories that agree or strongly agree with various statements. There are some notable similarities. All three specialization groups strongly support the importance of maintaining a system of family-operated family farms in Wisconsin. And, somewhat surprisingly, none of the three groups strongly views the growth of large dairy farms as essential to increase the competitiveness of Wisconsin agricul-

ture, although the "high-end" group is more likely to hold this view than the other two groups. The main differences across the groups relate to their attitudes towards encouraging their children to farm and their views of different dairy farm structure and technology trends. In particular, the "high-end" and "low-input" groups are more likely to encourage their children to farm than the traditional semi-confinement operations. Large-scale dairy farming in Wisconsin is, not surprisingly, more favorably viewed by the "high-end" group than it is by the other two. Finally, there is a related difference in viewpoints about the viability of intensive rotational grazing as an alternative to conventional dairy practices, except that in this case it is the low-input respondents who are more positive about this option than are the other two groups. In a larger sense, Table 6 also shows that the attitudes of the three groups are quite consistent with the hypothesized differences in the structure and technological orientation of their operations.

**The Future of rBST Adoption and Related Issues in Wisconsin**

This section examines three related topics: (1) future estimates of rBST use in a context of

**Table 6: Comparison of Attitudes By Specialization Strategy, 1999.**

| Statement | High-end, Confinement | Traditional Semi-Confinement | Low-input or grazier |
|---|---|---|---|
| | *(percent who agree or strongly agree)* | | |
| Maintaining a system of family-operated farms is essential to the future of rural Wisconsin | 87.0 | 90.2 | 91.3 |
| I would like to encourage my children to become farmers. | 47.0 | 31.8 | 42.5 |
| More large dairy operation and other large farms are needed to increase the competitiveness of Wisconsin agriculture. | 19.6 | 6.2 | 7.1 |
| The replacement of smaller family farms by large-scale farms using hired labor would have undesirable economic and social consequences for Wisconsin. | 50.0 | 63.4 | 63.6 |
| Large-scale dairy farming, such as that in California where herds of several thousand cows are common, is inevitable in Wisconsin. | 40.7 | 23.7 | 23.0 |
| Intensive rotational grazing is a viable alternative to conventional dairy practices. | 42.9 | 40.8 | 73.3 |

structural change; (2) the potential implications of these estimates for milk supply and pricing; and, (3) possible directions for the evolution of rBST use in Wisconsin. The future estimates of rBST use are constructed from the findings of the previous two sections of the paper, in which we examined the underlying logic of rBST adoption, the emergence of different specialization strategies, and recent patterns of structural change in Wisconsin dairy farming. Although formal forecasts of future rBST use are not provided, we do construct some rough but reasonable predictions, which are then used to examine milk supply, dairy prices, and other outcomes.

*Projecting Current Trends: Structural Change, Specialization, and rBST Use*

First, we examine future rBST use patterns in Wisconsin under the assumption that there are no significant changes in market conditions for milk production with rBST. The estimates are constructed based on findings from the previous two sections about use of rBST on farms of different sizes and with distinctive patterns of technology use. These estimates also therefore rely on projecting what the structure of Wisconsin dairy farming might look like in five years. That projection is done using some very simple assumptions mostly generated from the 1999 survey results.

We offer two forecasts of rBST use in 2003 – one based on a simple projection of recent changes in rBST users and herds and the other based on projections of specialization trends and rBST use changes among these groups of producers. As it turns out, these two projections give very similar results, with nearly 25 percent of farms and cows being treated with rBST in 2003.

The first forecast is derived from information about: (a) the number of Wisconsin dairy farms in each of three years (1995, 1997, and 1999); (b) our survey-based estimates of the average number of rBST users in Wisconsin those years; (c) and the estimated rBST adoption rate among farmers in the state. Total farm numbers were obtained from Wisconsin Agricultural Statistics Service publications and the estimated rBST adoption rates and number of users was previously reported in Table 1 above. Between 1995 and 1999, there was a decline of 21 percent in the number of dairy herds in Wisconsin, which was a somewhat greater than the historical rate of farm loss. In Table 7, we extend this trend four years to 2003 to come up with an estimate of the number of dairy farms in 2003 (roughly 17,100). Then, to estimate the total number of rBST users in 2003, we project forward the 14 percent increase in users between 1997 and 1999. This produces a total of roughly 4,400 rBST users in 2003. Combining the estimated total number of herds and the estimated number of rBST users leads to an estimated 25.7 percent rBST adoption rate forecast for 2003. This may seem high compared to the 15 percent figure at the five-year mark, though it is still far less than the 50 percent plus figures that were projected within 3 to 5 years of commercial release (Office of Management and Budget, 1994).

It is worth noting that more than half of this projected future increase in aggregate rBST adoption rates in Wisconsin reflects the exit of non-adopters rather than the expansion of rBST use by continuing farmers.

Using this historical projection method, we can also adjust for the projected size of herds in 2003 and a use rate of rBST of about 50 percent of the herds over 100 cows. The results suggest that in 2003 about 26 percent of the dairy cows in Wisconsin will be treated with rBST.

Our second forecast method is derived using trends in specialization paths and separate rBST adoption estimates among each of those distinct groups. First, we estimate how many farms are likely to be in each of the three specialization groups in 2003. This is done by combining historical rates of change, using our own expert judgment about recent trends (including a slowing in the rate of MIRG adoption) and adjusting the subtotals so that the total number of herds is still 17,100 in 2003. Second, we estimate the rBST use rate for each subgroup. Because the 1999 adoption rates of rBST for the traditional semi-confinement and low input groups are very similar, 8 percent and 10 percent, respectively, and because we do not envision these levels changing much in the future, we hold the rBST rates constant for these two groups. For the “high-end” group, however, we allow rBST use to rise to 50 percent of all farms in this subgroup by 2003 (a rough projection of historical rates of rBST use increase among these farms).

**Table 7: Estimated rBST Adoption Rate in 2003 (By Specialization Strategy).**

| | METHOD 1 | METHOD 2 | | | |
|---|---|---|---|---|---|
| | Simple Historical Projections | High-end, Confinement | Traditional Semi-Confinement | Low-input or grazier | TOTAL |
| 1997 Estimates | | | | | |
| number of farms | 24,559 | 4,567 | 16,167 | 3,825 | 24,559 |
| percent of farms* | 100.0 | 18.6 | 65.8 | 15.6 | 100.0 |
| percent using rBST* | 11.8 | 28.9 | 8.4 | 5.7 | 11.8 |
| number of farms using rBST | 2,898 | 1,320 | 1,358 | 218 | 2,898 |
| 1999 Estimates | | | | | |
| number of farms | 21,627 | 5,038 | 11,099 | 5,490 | 21,627 |
| percent of farms* | 100.0 | 23.3 | 51.3 | 25.4 | 100.0 |
| percent using rBST* | 15.4 | 36.4 | 8.1 | 10.2 | 15.4 |
| number of farms using rBST | 3,330 | 1,834 | 899 | 560 | 3,330 |
| Rates of Change | | | | | |
| Percent change in farm numbers from 1997 to 1999 | -11.9 | 10.3 | -31.3 | 43.6 | -11.9 |
| Percent change in number of rBST users, 1997 to 1999 | 14.9 | 38.9 | -33.8 | 156.9 | 14.9 |
| Estimated Farm Numbers in 2003 | | | | | |
| number of farms** | 17,100 | 6,100 | 4,500 | 6,500 | 17,100 |
| percent of farms | 100.0 | 35.7 | 26.3 | 38.0 | 100.0 |
| Estimated rBST Use Rates | | | | | |
| est. rbst adoption rate *** | 25.7 | 50.0 | 8.0 | 10.2 | 23.8 |
| number of rBST users | 4,400 | 3,050 | 360 | 663 | 4,073 |

Notes: * = based on results of 1997 and 1999 Wisconsin Dairy Farm Polls.
** = estimated based on historical rates of change and expert knowledge.
*** = extrapolated based on change in adoption rates between 1997-1999

When we do this for each of the three groups, we arrive at a total estimate of about 23.8 percent rBST adoption among all Wisconsin dairy farms in 2003. This result is driven mainly by the growth in the number of farms in the high-end confinement category and their increased propensity to adopt rBST. It also reflects the fact that the number of traditional, semi-confinement farms (historically a group with very low rBST adoption rates) are expected to decline precipitously. Using the projected herd size figures for rBST adopters and non-adopters in these categories in 2003 and a 50 percent use rate on farms adopting rBST, we estimate that 25 percent of the cows in Wisconsin will be treated with rBST in 2003 (compared to a 15 percent figure in 1999).

This second estimate has three obvious sources of error. One possible source may be that rBST adoption among the other two groups may actually grow in the future; rBST use did grow from 5 percent to 10 percent within the low-input group between 1997 and 1999. However, we believe that this may be less of a trend than a one-time event given their much lower propensity to adopt the other

associated technologies. Second, the growth in rBST adoption among the "high-end" producers may tail off from its acceleration between 1997 and 1999. We did attempt to account for this possibility by reducing their rBST adoption rate to 50 percent from the 56 percent figure a straight-line projection of the 1997-1999 growth rate would have created by 2003. A third source of error might be overestimating the pace of herd growth and new technology adoption between 1999 and 2003. Given the extremely depressed milk prices in 2000 and early 2001, as well as unpublished reports that many farmers are reducing unnecessary cash expenses and delaying plans for herd expansion, it is likely that the "high-end confinement" group may actually be increasing more slowly than historical trends might suggest.

*Impacts of rBST Use*

If by 2003, rBST adoption is up to 25 percent of farms and cows, then we can anticipate that the Wisconsin milk supply will have increased by about 3 percent over what it would be without rBST over the four-year period. As in section two above, estimating the *ceteris paribus* effects of this supply increase on milk prices requires an estimate of the price elasticity of demand for milk products. A reasonable estimate is between -0.3 and -0.4. Thus, for each 1 percent increase in supply we should expect to see a 2.5 to 3.3 percent decline in milk prices. In other words, a 3 percent increase in milk supply resulting from increased rBST adoption could effectively reduce milk prices by 7-10 percent, holding all other effects constant. As discussed above, the magnitude of this effect would be considerably less than those induced by the secular growth in milk productivity in the industry.

*Institutional and Market Context in Wisconsin, the United States, and Beyond*

When rBST was approved for commercial use, many fluid milk processors in Wisconsin, under pressure from consumers and retail outlets, chose to label their milk or in some other way signal consumers that their product was not from cows treated with rBST. This "voluntary labeling" scheme was aimed at assuaging the concerns of some consumers about the potential effects of rBST on milk quality, the health of cattle, and the viability of family farms. Labeling also meant that some processors asked farmers to certify in writing that they were not using rBST, so that they could legally make their "Farmer Certified BGH-Free" labeling claim.

Since those early years of rBST commercialization, consumer attention to the rBST issue has declined considerably. It seems reasonable to assume that some of the recent increase in rBST use has occurred because the issue has receded from public controversy. This change has allowed processors to use milk from cows that are treated with rBST and hence they are less likely to ask farmers to curtail or limit their use. Will consumer concern about rBST continue to recede? Will the future of rBST use depend increasingly on decisions made by farmers as to which technologies best fit their management styles and their farm conditions rather than consumer demand pressures?[6]

The answers to these questions are fundamental to the future of rBST use in Wisconsin and worldwide. Indeed, what seems most clear is that there is no latent support for rBST among consumers, so that any news about rBST is bad news and likely to have negative effects on demand for milk produced from cows treated with rBST. Nonetheless, if consumer awareness depended only on current trends in U.S. federal and state regulations and actions of milk marketing boards, processors, and retailers, the controversy would probably continue to fade. Basically, only a few relatively small operations, some selling organic milk products, make it part of their ongoing campaigns to inform the consumer of the origin of the milk relative to rBST. Yet, the answer may not depend only on U.S. regulatory and domestic market conditions, because internationally the prospect of consumer resistance - both directly with rBST and indirectly via a growing consumer reaction against other agricultural biotech products - has reemerged in the late 1990s and the early part of the twenty-first century.

With respect to rBST, in the summer of 1999, the U.N. food safety agency, the Codex Alimentarius Commission, which sets food quality and safety standards for the World Trade Organization (WTO), ruled unanimously in favor of the 1993 European moratorium on rBST use on animal health grounds.[7] The Codex ruling essentially forced the U.S. to abandon its challenge of the European moratorium in the WTO. This ruling, as well as European consumer resistance to foods produced using biotechnology ingredients, could potentially have feedback

effects on the use of these technologies in the United States for two reasons. One is that it may raise both farmer and processor concerns about acceptance of their products internationally, and another is that consumers in the U.S. may respond to the news of food processors moving away from use of these technologies elsewhere with similar demands. Thus, while recent adoption trends suggest that the future of rBST in Wisconsin could be one of gradual growth in adoption, these other factors represent a dark cloud on the horizon for the future of this technology.

International trade pressures and increased U.S. consumer resistance to rBST could potentially even reduce rBST adoption if the following types of scenarios were to unfold. One scenario for discouraging future rBST use would be if some processors seeking to export U.S. dairy products required their farmers to legally certify no use of rBST in order to satisfy retailers and consumers in other countries. Given the relatively low rates of adoption currently, and the strong likelihood that exports will continue to account for a very small share of U.S. dairy production, it seems unlikely that this kind of feedback effect would provide much of a constraint on rBST use in the U.S. Nonetheless, rBST-free labeling for export could have a wider effect than suggested by the 5 percent level of U.S. exports relative to total dairy production. The reason is that a large proportion of the exports are and will continue to be bulk commodities purchased for export out of a broader stream of U.S. dairy products rather than products especially made for export markets. As such, the need for identity preservation could have a much larger impact on rBST adoption than that suggested by the proportion of production that goes for export.

An even more negative scenario for rBST use would be if the strong consumer reaction in Europe against rBST and other food products with genetically modified organisms (GMOs) spreads broadly to the U.S. consumer market. In that case, the rBST controversy could flare again, and provide a stronger dampening constraint on its adoption than the export-based one just described. Such a scenario may seem unlikely but it is by no means improbable, especially given the recent Starlink crisis and the doubts it casts on the stability of foods produced using agricultural biotechnology.

In the first place, it is likely that European consumer and environmental groups and other advocacy organizations here in the U.S. will attempt to generate a broader market response in the U.S. to products involving agricultural biotechnology. While the likelihood of this outcome being achieved might seem minimal to supporters of agricultural biotechnology in the U.S., appraisals by stock market analysts of the value of agricultural biotechnology subsidiaries suggest that savvy investors have serious doubts about the future market situation for these technologies (New York Times, 2000). They, too, may be placing too much emphasis on a low probability event, but there is no doubt that the market terrain of agricultural biotechnology products in general has become much more uncertain since 1998.

This potential spillover effect to dairy products is made more likely by the fact that rBST labeling of dairy products is still very much in transition. While, in Wisconsin, attention to r-BST-free labeling has receded, in California rBST-free labeling on dairy products continues to be quite prominent. Also, organic milk markets continue to expand, and their niche is reinforced by increased consumer awareness regarding the distinctive production characteristics of their products. Indeed, these rBST-free labels and organic products are a solid part of the ongoing marketing strategy of many processors.

The examples from California exemplify the fact that in the largest and often leading-edge market of the U.S. rBST-free labeling remains solidly in place. This situation in California and Wisconsin, as well as federal regulations that allow voluntary labeling decisions at the state level, make it relatively easy to envision how a surge in consumer demand for labeling across the country and among other dairy products could possibly be reinvigorated by the GMO debate. This prospect renders the construction of forecasts for future rBST use more uncertain than they would otherwise seem from a simple extension of recent marketing and distribution trends in the U.S.

**Conclusions**

At the seven-year mark since its introduction, adoption of rBST on Wisconsin dairy farms remains well below the levels predicted by leading analysts

prior to its release. Yet, adoption has grown substantially, from 6.6 percent in 1995 to 15.3 percent in 1999. Recent growth has been propelled in part by the exit of non-users as well as by increases in the number of dairy farms using the technology. To the extent that farm exits due to retirement and other factors continue to be both high and more prevalent among non-adopters, rBST adoption rates in Wisconsin (expressed as a percentage of farms) will continue to grow even if there are few new users. However, it is also possible that the recent storm clouds hovering over GMO crops and agricultural biotechnology in general could spill over onto rBST, and that growth in rBST adoption could thereby be curtailed or even reversed. While that scenario is by no means likely, it seems worth keeping in mind, especially compared to a year or two ago when there seemed to be no signs of controversy in the U.S. over GMO crops or any other agricultural biotechnology products.

One aim of this paper was to delve deeply into the underlying patterns of rBST adoption among Wisconsin dairy farmers, especially how their decisions may be closely linked to three prevalent types of specialization strategies. Two empirical observations motivated this analysis. First, rBST adoption in Wisconsin in 1999 has a dramatic size-bias, with the average adopting farm having well more than twice the mean herd-size of the non-adopters. Second, a series of associated technologies (herd records, regular vet visits and feed ration balancing, and use of Total Mixed Ration equipment [TMR]) that are integral to farm management strategies aimed at higher per cow milk production are also very strong predictors of rBST adoption. These same practices also seem more likely to be adopted on farm enterprises that are large enough to allow management and labor to specialize more on the challenges associated with the use of these technologies.

Interest in the potential explanatory value of "specialization strategies" led us to divide Wisconsin dairy farms into three distinct types: "high-end confinement operations," "traditional semi-confinement operations," and "low-input operations." Both "high-end confinement" and the "low-input" operations have both become more prevalent throughout the 1990s but especially in recent years. In terms of rBST use, the "high-end" confinement group was shown to be about four times more likely to adopt than were the other two groups. It is also worth noting that the operators of these "high-end" farms have the highest average levels of educational attainment, although the low-input operations are not far behind them in average years of formal schooling.

One major implication from this discussion of specialization paths deserves further consideration, and it could have important effects on both farm structure in Wisconsin dairying and rBST adoption. The issue is whether a closer look at the changes occurring on farms pursuing the three specialization paths would show us to be in a period where new forms of specialization on Wisconsin dairy farms are transforming the industry. A closer look at the profitability, viability, and dynamism of dairy farms following these specialization paths could be quite instructive, as could the factors that shape farmers' decisions about what paths to pursue.

The potential role of specialization strategies in explaining rBST adoption decisions is also worthy of further exploration. Such an effort would break new ground in the empirical modeling of technology adoption by trying to explain the adoption of particular technologies in terms of how they fit into a larger decision about what types of production strategies to pursue across distinctive options. Better answers to this adoption question and the ones raised above regarding the profitability and viability of the various specialization paths would help researchers and extension professionals to provide higher quality information to farmers about what these paths have to offer them and their families.

## Endnotes

1. As an aside it seems worth noting that the proportion of cows treated varied widely among rBST adopters. Fully a third of the producers reported treating less than 35 percent of the herd, while a fifth were treating more than 66 percent of their herd. It is not clear why as many as 20 percent of the rBST adopters would be using rBST on more than 66 percent of their herd, although extended lactations is one possible explanation.
2. Only 3 percent of the farms in our sample had more than 200 cows in 1999.
3. The 20 percent figure is the difference between the rolling herd averages, while the 25 percent figures is the difference between the milk shipped per lactating cow per day. The latter estimate was

reported by more respondents than the former, which depends on having some sort of production records.
4. From a risk perspective, the traditional semi-confinement operation could also be viewed as protected from fluctuations in feed and labor markets because of their self sufficiency in these inputs. Thus, for the many decades, when dairy prices were supported, they faced relatively little market-side risks.
5. The survey respondents reported the average hours per week of farmwork they and other persons do on their dairy operation. From this information we were able to investigate the relative importance of the labor of the lead operator to the overall labor on the farm.
6. It is also worth noting that in the early years after the commercial introduction of rBST, some farmers were explicit in their expression of political opposition to rBST as a reason for not adopting it on their farms. That rationale may still be in place in some instances, although it also seems likely that with the receding controversy, other factors may have become more critical in shaping farmer adoption decisions.
7. This decision also reinforced the ban on rBST by the Canadian government earlier in 1999.

## References


Barham, B.L. (1996). Adoption of a politicized technology: bST and Wisconsin dairy farmers, American Journal of Agricultural Economics, 78 (4): 1056-1063.

Barham, B., Buttel, F. H., Jackson-Smith, D., McNichol, J. and Wood, S. D. (1995). The political economy of rBST adoption in America's dairyland. (ATFFI Tech. Rep. No. 2). Madison, WI: University of Wisconsin.

Buttel, F. H., D. B. Jackson-Smith, B. Barham, D. Mallarkey, and L. Chen. 1999. Entry Into Wisconsin Dairying: Patterns, Processes, and Policy Implications, PATS Research Report No. 4. Madison: Program on Agricultural Technology Studies, University of Wisconsin, May.

Fetrow, J. (1999). The economics of recombinant bovine somatotropin on U.S. dairy farms. AgBioForum, 2, 2, Spring.

Jackson-Smith, Douglas B., and Bradford Barham. 2000. "Dynamics of dairy industry restructuring in Wisconsin," pp 103-127 in Schwartzweller and Davidson (eds.), Research in Rural Sociology and Development, Vol. 8. London: Elsevier Press.

Office of Management and Budget (1994). The Use of Bovine Somatotropin (rBST) in the United States: Its Potential Effects. A Study Conducted by the Executive Branch of the Federal Government, Washington, D.C., U.S. Publishing Office.

Rogers, Everett M. (1983). Diffusion of Innovations, 3rd Edition. New York, NY: The Free Press.

Zepeda, L. (1990). Predicting bovine somatotropin use by California dairy farmers. Western Journal of Agricultural Economics, 15 (July): 55-62.

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