ECONOMIC FEASIBILITY OF BOVINE GROWTH HORMONE

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Bovine growth hormone (bGH)[1] is an emerging biotechnology that could have significant implications for the dairy industry. Research is needed to assist in understanding the innovation, development and adoption process with the ultimate objective of anticipating the impact of this new technology. The dairy industry is experiencing rapid technology change and considerable debate over appropriate government policy. Isolation of the impacts of bGH is particularly important. This article attempts to place the new biological innovations, and more specifically bGH, in the historic evolution of agricultural technologies; synthesize the evidence on the economic feasibility of bGH; and anticipate the impact of this technology on the dairy industry.

The history of innovation in U.S. agriculture has been periods of rapid growth followed by periods of rather slow growth. Historically, high growth periods in U.S. agriculture have been dominated by innovations in farm machinery, fertilizer, seed, and chemicals. A rapid decrease in farm employment ran concurrent with the rapid growth in productivity. Structural changes were dramatic as farm labor was replaced by newly developed technical inputs. From 1970 to the present there has been a slower rate of productivity growth and further concentration of production in large farms. Labor dislocation has not been at the dramatic rate of the 1920-1970 period, principally because agricultural employment was so severely reduced in that earlier era. Now, many observers believe U.S. agriculture is moving into a period dominated by biological innovation and that new biological technologies will be the major source of productivity growth in the future.

Major adjustments in agricultural programs appear inevitable, if preliminary estimates of production effects are realized (Tiegen, et al.) Economists have an important role in assessing these new technologies and in recommending appropriate policy to address their impact on the U.S. agricultural economy, consumers, and the international competitiveness of agricultural input suppliers. Will biotechnology lead American agriculture into another period of rapid productivity growth? More specifically, will dairy farmers rapidly adopt bGH and duplicate the dramatic results obtained experimentally (Kalter et al.)?

Economic Feasibility and Expected Impact on the Dairy Industry

Economic feasibility is based on the cost and returns to both the producers and users of the new technology. Engineering cost studies provide estimates of the production cost to the agricultural chemical firm. Field testing of biological response and changes in input requirements are used to judge feasibility of farmer use. Micro and macroeconomic modeling attempt to project the effect of the new product on the industry.

Kalter et al. developed an engineering cost study to determine probable plant size to manufacture bGH, profitability, and product price. Price is clearly related to plant size indicating that substantial economies of scale exist between the smallest scale facility analyzed and plants with a daily capacity to provide bGH for 6.5 million cows.

Evaluation of the commercial viability of bGH indicated that additional feed costs and the extent of improvement in milk production are clearly important variables in determining the incentive to use bGH. However, even if farm milk prices deteriorated sharply, a substantial incentive would likely exist to adopt bGH with prices ranging from 2 to 4 times raw production cost. Market potential of bGH will be determined by factors such as economies of scale in bGH production, fermentation yields from the industrial process, and the daily response and resulting increase in milk production.

Biological Response

Biological response in experimental tests ranged from 25% to 40% increase in milk production per cow (Kalter et al.); however, field results often have been less dramatic than those obtained experimentally. Achieving a high response will depend on good management, superior feed quality and the potential climatic effect. Two recent research results tend to mitigate the expectations for high biological response. Specifically, it has been suggested that expected response will be lowered in areas of the country where dairy cattle are stressed by heat and humidity (Jorgenson). There is the possibility that "burn out" from increasing the intensity of production per cow with the use of bGH will cause animal replacement at more rapid rates (Fox). A shorter productive life for dairy cows will increase costs.

Without milk price supports, the Economic Research Service (ERS) estimates a 5% milk supply increase would result in a price of $8.84 per hundred weight, a 10% increase would push price down to $7.17, and a 15% response yields a $5.50 price. However, such price declines would clearly result in an exit of resources, thus dampening the supply increase.

Rates of Adoption

Estimates of adoption and diffusion of bGH among New York dairy farmers indicated a relatively rapid rate of adoption, with at least half of the state herd on treatment within the first year of availability. The ceiling level of adoption of 63 to 85%, depending on the techniques for administering bGH may be achieved by about the third year. Hatch et al. obtained similar results in a survey in the Southeast with a range of expected supply response from 4.2 to 23.5%. However, this rapid adoption rate will be slowed if bGH implant technology is not available upon introduction and if consumers initially react adversely (Mix). Another potential restraint on adoption is the price of bGH. Daniel estimates that $0.40 per dose will not be profitable to dairy farmers.

The Kalter et al. approach did not account for the downward price effects on milk resulting from widespread use of bGH. Should bGH become widely used and should prices adjust, non-adopters could survive only if biological response is relatively low and demand for milk is highly elastic. Thus, use of bGH should approach 100% in a dynamic environment. The results of Kalter et al. indicate that early adapters are characterized by higher herd production averages and use (primarily) free stall barns.

Industry Impacts

In the aggregrate, as production increases due to the hormone, milk prices will fall reducing the short term gains in farm return (Mix). The number of dairymen and the size of the national dairy herd will, by necessity, decline as the market seeks a new equilibrium. Also, the size of the average dairy herd will increase and acres used for feed production will decrease (Mix). The size of the adjustment and its timing will depend not only on the production response to bGH and the rate of adoption, but on the level and scope of government price support programs for milk.

Farms with low debt loads, good soil resources, and superior management will be in the best position to survive the transition. The financial position of individual dairy farms after these adjustments will depend on response to bGH, feeding management strategies to increase intake and the economic and political environment of the diary industry. A policy simulation model developed at Texas A&M indicates that very large farms will be favored (Yonkers, et al.)

Other studies indicate that if markets are allowed to clear, the introduction of bGH will lead to further declines in milk prices, as well as farm and animal numbers (Magrath and Tauer). Output will fall, but its decline will be lessened by bGH. Kalter et al. estimated that supply response will be approximately one-half of biological response. They indicate that bGH may lead to the exit of 5,400 dairy farms within five years in New York state and a 20 percent reduction in dairy cows. A free market dairy policy will leave total output essentially unchanged. The primary beneficiaries of bGH will be consumers who stand to gain substantially from lower milk and other dairy product prices.

A remaining issue is the extent to which benefits of bGH are biased in favor of large high output farms. Over time these benefits will be capitalized into prices of land and other assets to the benefit of their owners. If equitable distribution of benefits from bGH among farmers is a concern, then future public sector research should examine delivery systems, extension and feeding programs that will decrease any size bias in the bGH technology.

The long term implications of bGH for the U.S. dairy industry has been the objective of research efforts by Boehlje and Cole. Total milk production will increase dramatically resulting either in larger surplus stocks and government program expenditures to isolate these excess supplies, or in significantly lower milk prices. Substantial reductions in dairy cow numbers will result in the production of fewer dairy calves and less dairy beef; thus to maintain total beef supplies, beef calf production will increase.

Regional shifts in milk production are also likely to occur with decreases in the Northern Great Plains and North Central States and increases in the Southeast and Eastern Corn Belt States. As bGH results in increased production with unchanged inputs, geographic regions are expected to become more self-sufficient in milk production and inter-region milk shipments may decrease significantly.

Two generalizations concerning the possibility of regional shifts in milk production are:

(1) If supply in dairy surplus areas is more price responsive than demand in dairy deficit areas, then imports into the deficit areas will increase, or

(2) if supply in dairy surplus areas is more price responsive than supply in dairy deficit areas, then imports into the deficit areas will increase.

Empirical evidence suggesting demand for milk is highly inelastic would support the plausibility of (1) and expectations of faster adoption in exporting areas would support (2). Thus, it appears that market forces would tend toward increasing imports into deficit areas unless policy makers find that outcome unacceptable.

Yonkers et al. and Mix concur in their estimates that the greatest changes in regional production will occur in the Lake States and the Pacific Southwest. The latter is expected to expand dramatically its share of national dairy production whereas the former region will experience the greatest decrease. The Southeast is relatively secure in its regional share due to its rather high regional price (Yonkers et al.)

Government costs were estimated at $3.2 billion if supply increases 15% and the price support level is maintained (Tiegen et al.) The ERS study suggests several generalizations that are supported by past technological advances in agriculture:

"Adoption of new technology is favorable for individual farmers -- assuming prices do not change; the marginal cost of producing the original output is less under the new technology than under the old; nonadopting farmers are placed at a disadvantage relative to adapters; adoption of the technology expands output, reduces prices, and can ultimately reduce producer total revenues (in the absence of price supports). With Government price supports, some of the depressing effects on producer revenue can be controlled, but only at the cost of higher prices to consumers or higher program costs to taxpayers. If incomes per farm fall enough, farms will leave production and the effects of the new technology on the remaining farms will be moderated." (Tiegen et al., p. 61).

Summary and Conclusions

Research evaluating the effects of new technologies can be very beneficial in guiding an industry through an adjustment process. Because bGH will be introduced into an industry already experiencing rapid technical change and considerable policy debate over treatment of chronic over supply, anticipatory research on the effects of bGH on the dairy industry has a high potential pay off.

The consensus is that bGH has high profit potential both to dairy farmers and agricultural chemical producers. Also, farmers are expected to adopt rather rapidly, with early adapters being the good managers with relatively large farms. Management skills and feed quality will be crucial to profitable adoption of bGH. Several research results negate the early analyses of bGH's potential biological response. Under field conditions, possibilities exist that: 1) herds exposed to stress from heat and humidity will achieve inferior results, 2) the economic life of a dairy animal may be shortened, and 3) implant technology will be slow to develop.

Projecting regional impacts has caused the greatest difficulties. Under the prevailing scenario, the following results are suggested: 1) average herd size will increase, 2) national herd size will fall, 3) many dairy farms will not survive and 4) fewer acres will be allocated to feed production. Pressure to change dairy policy will be substantial resulting from enormous government costs to restrain production. Expected regional shifts in production are largely dependent upon the set of assumptions implicit in each research effort. The traditional dairy producing areas of the Midwest and Northeast appear to be under substantial pressure to maintain their predominance, and the emergence of very large operators particularly in the Southwest seems likely.

In almost all the studies cited in this paper, the authors have had difficulties isolating the effects of one product (bGH) on an industry experiencing great pressure for change, even without this new product. However, the goal of such anticipatory research should be to arm policy makers with the best available information upon which to develop future policy.

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NOTES

(1) Bovine growth hormone is also referred to as bovine somatotropin (bST).

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