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THE ECONOMIC IMPLICATIONS OF BOVINE GROWTH HORMONE ON DAIRY FARM PROFITABILITY

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Techniques such as recombinant DNA and gene transfer promise major benefits to both consumers and producers in areas like medicine, pharmaceuticals, chemicals and agriculture. This "new biotechnology" continues the long history of technological change and innovation which has resulted in more efficient production processes, improved product quality and the release of economic resources for alternative uses. As such, modern advances in biotechnology join technical change resulting from research in electronics and computers, robotics and large scale mechanization in helping to increase productivity and improve the world's living standard.

Bovine growth hormone (bGH) is a naturally occurring protein produced by dairy cattle. It is one factor regulating the volume of milk production. The gene responsible for bGH production has been isolated and transferred from animal to ordinary bacteria cells (Miller et al., 1980). The altered bacteria can then be reproduced on a large scale by standard fermentation techniques and the resulting growth hormone (which is produced by the bacteria) can be isolated, purified and made available for commercial use in large quantities. When injected into dairy cows, the hormone has resulted in significant increases in milk production. Overall, results have demonstrated a 10 to 40 percent increase in milk yield (see review by Bauman and McCutcheon, 1985).

With this type of potential, various private sector firms are investigating the commercial production of bGH. Several have announced their intention to bring bGH to the commercial market as their first biotechnology product. Commercial introduction, however requires Food and Drug Administration (FDA) approval. Eventual FDA approval, however, does not establish bGH's commercial viability nor provide any creditable evidence regarding its potential economic and social impacts. The purpose of this study is to investigate those implications for dairy farm profitability under the assumption that FDA approval will eventually be granted. Details are in Kalter et al., 1985.

Potential profitability of using bGH is investigated by analysis of three representative dairy farms. These three farms are constructed to represent the broad diversity of resources available to dairy farm managers in New York State, the Northeast, and the Lakes States. The resources on these representative farms, cost and return information from enterprise budgets, and milk production and feed requirements with and without bGH are used to obtain profit maximizing enterprise levels using linear programming (LP). Results from LP runs without bGH and with several bGH response rates are used to analyze farm firm level issues including crop rotations, and feed usage on farms with varying resource characteristics.

In an effort to simplify the analysis and to concentrate on the relative impacts of bGH, farms representing various resource levels within a region were configured. For purposes of this analysis, New York State data were used in determining the level of key characteristics for these farms. The resulting representative farms are thought to emulate much of the dairy farming activity in the Northeast and Lake States, although the proportion of total production represented by any one representation will differ on a state by state basis.

After reviewing the available data (data summarized in Smith and Putnam 1983), three farms types were chosen to represent the spectrum of dairy activity in the region. The three farm types are (1) farms growing only forage crops, (2) farms growing some but not all of their required grain, and (3) farms with excess grain to sell as a cash crop. Data from the Dairy Farm Business Summary records were grouped using these categories to obtain averages and ranges of resource and productivity characteristics. Table 1 outlines the general characteristics of the three representative farms. Since milk production per cow is highly variable and crucial to the analysis, each representative farm is evaluated at 13,000 and 16,000 pounds of milk sold per cow.

The 65 cow forage only representative farm is intended to characterize small units (200 acres of crop land) located on medium to poor quality land and capable of roughage production only. On the basis of the Farm Business Summary data, it is assumed that 60 acres (30 percent) can grow corn silage and the remaining cropland must produce mainly grass hay production. The other two representative farms characterize larger dairy operations but differ with respect to their land resource. Both are assumed capable of corn grain production but one must purchase some grain to feed the herd while the other has sufficient land to produce all feed requirements, except protein and mineral supplements, with a residual harvest available for off-farm sale.

Variable costs for crop enterprises include seed, fertilizer, chemicals, fuel, machinery repairs, and harvesting expenses. Variable expenses for dairy enterprises include veterinary, breeding, bedding, supplies, building repairs, and livestock marketing but do not include feed as those expenses are incurred by the crop enterprises or through purchased feeds. These costs and labor requirements were developed largely from the

Table 1: CHARACTERISTICS OF REPRESENTATIVE FARMS[a]

Representative Farm	Dairy Herd Size (milking cows)	Total Cropland (acres)	Maximum Corn Production (acres)	Maximum Corn Grain Production (acres)	Full Time Family Worker Equivalents Available[b]	Hay Crop	Hay Yields (tons, ac)[c, d]	Corn Silage Yield[c, e] (tons/ac)	Grain Corn Yield[c, f] (bu/ac)
Forage Only	65	200	60	0	2 (5520 hrs.)	Mixed mostly grass hay	2.6	14.0	-
Corn Grain	100	250	125	125	2.5 (6900 hrs.)	Mixed mostly legume hay	3.2	14.5	80
Crop Sales	100	400	250	250	2.5 (6900 hrs.)	Mixed mostly legume hay	3.2	14.5	93

[a]All farms have cows with 1300 pound body weights, 28 percent culling rate, 15 percent calf death loss and 13 month calving interval. The latter two characteristics mean 78 percent of cows produce a live replacement.

[b]Additional labor requirements hired at $3.55/hour.

[c]All yields are harvested quantities on an as is basis.

[d]Eighty-eight percent dry matter, stored as dry hay with a 4 percent dry matter loss.

[e]Thirty-three percent dry matter, stored in conventional upright silo with an 8 percent dry matter loss.

[f]Eighty-nine percent dry matter, stored as dry shelled corn with a 2 percent dry matter loss.

Oklahoma State University Farm Enterprise Data System's (FEDS, Krenz) budgets. The FEDS budgets provide a consistant data set across the United States which can be utilized to expand the regional scope of this analysis if desired. However, the most recent set of crop budgets available at the time of the analysis was for 1981. To insure consistency across enterprises and with the selected yield levels, adjustments were made using Knoblauch and Milligan (1982) for the crop enterprises and Knoblauch (1981) and Milligan et al., (1981b) for dairy enterprises.

The prices and costs used are from 1981. The USDA Agricultural Prices Annual Summary (Crop Reporting Board 1980, 1981, 1982) were consulted to specify the price of corn grain and soybeans. Because the relative prices of these two feedstuffs are important, a single price year was not considered sufficient. Instead, the average price of corn (per bushel) received by farmers and the average price paid by farmers per hundred weight of soybean oil meal 44 was calculated for 1980-1982. Fifty cents was added to the average price of corn received to obtain purchase prices. The resulting price of $3.50/bu. of corn and $15.60/cwt of soybean oil meal is then used in the model's respective purchasing activities.

The ration for each of the representative farms for each bGH response level is formulated for the three alternative forage compositions given available feedstuffs by using the Least Cost Balanced Dairy Ration Program developed by Milligan et al., (1981a). The three forage compositions are all hay, half hay and corn silage on a dry matter basis, and three-fourths corn silage on a dry matter basis. The least cost nutritionally balanced ration varies according to the cow's age, productivity, weight etc. The nutrient requirements used in this program are based on the National

Research Council (1978) and met by the feedstuffs which are specified as being available.

Results from trials with bGH at Cornell have indicated an increase in production during part of lactation after peak production of from 15 to 40 percent (Bauman et al., 1985). In this study, new rations for each forage composition are formulated (using the least cost balanced ration program) for each alternative feeding program assuming a 10, 20, 30, and 40 percent increase in production during the last 215 days of the lactation cycle. This increase is 6.4, 12.8, 19.2 and 25.6 percent, respectively, over the total lactation. These rations are then incorporated into the representative farm model to analyze the effect of bGH on the optimal organization of the farm when one maximizes revenue over variable cost. The linear programming tableau is schematically described in Figure 1.

In analyzing the impact of bGH, it is important to realize that a change of this magnitude in production has ripple effects throughout the farm operation. In addition to the expected changes in feed requirements and profitability, crop acres, feed purchases and/or sales and labor requirements may change. The economic issue, then, is how the total, and therefore marginal, revenues and costs of the whole dairy farm operation react to bGH response.

Tables 2 and 3 summarize the results of the analysis pertaining to feed rations assuming normal intake (projected by Milligan et al., 1981). On all representative farms, it is clear that the return over variable costs increases with increasing response to bGH at the milk price of $12.69 per cwt. This increase ranges from near 6 percent for farms at the 6.4 percent response rate to 20-25 percent at the 25.6 percent response rate.

Figure 1: SCHEMATIC OF LP MATRIX FOR THE REPRESENTATIVE FARMS

Activities / Constraints	Dairy Cow & Heifer Enterprises	Sell Replacements, Culls, Bull Calves & Milk	Crop Production Enterprises	Feed Purchase	Crop Sales	Labor Hire	Corn Restriction Accounts
Objective Function (MAX Returns over Variable Cost)	x	x	x	x	x	x	
Labor Requirements	x		x			x	
Crop Acre & Rotation Constraints			x				x
Feed Accounting	x	x	x	x	x		
Milk Accounting	x	x					
Calf and Cull Cow Accounting	x	x	x				

a "x"'s indicate that non-zero entries are contained in the cell

Table 2: REPRESENTATIVE FARM CHANGES DUE TO bGH RESPONSE WITH 16 000 POUNDS BASE PRODUCTION AND NORMAL INTAKE ASSUMPTION

	12.8% Response			25.6% Response		
	Forage Only	Corn Grain	Crop Sales	Forage Only	Corn Grain	Crop Sales
Increase in ROVC[a]						
Farm, $	9,798	14,784	16,478	18,558	28,723	32,164
Per Cow, $	151	148	165	286	287	322
Marginal Feed Cost/cwt, $	5.24	5.39	4.55	5.72	5.67	4.84
Change in Crop Acres						
Hay	+ 3	- 6	+63	+ 6	+59	+50
Corn Silage	- 3	- 4	-62	- 6	-62	-62
Corn Grain	--	+10	- 2	--	+ 2	+11
Net Feed Purchase[b] ($)						
Change ($)	+7,112	+10,646	+13,825[b]	+15,639	+27,636	+23,750[c]
Change (%)	+32.9	+41.1	--	+72.4	+106.8	--

[a]Return over variable costs
[b]Purchases minus sales
[c]Reduction in sales

Table 3: REPRESENTATIVE FARM CHANGES DUE TO bGH RESPONSE WITH 13,000 POUNDS BASE PRODUCTION AND NORMAL INTAKE ASSUMPTION

	12.8% Response			25.6% Response		
	Forage Only	Corn Grain	Crop Sales	Forage Only	Corn Grain	Crop Sales
Increase in ROVC[a]						
Farm, $	8,531	12,972	13,629	16,928	25,475	26,867
Per Cow, $	131	130	137	260	255	269
Marginal Feed Cost (cwt), $	4.81	4.89	4.50	4.87	5.04	4.62
Change in Crop Acres						
Hay	0	- 8	0	0	-13	0
Corn Silage	0	- 1	- 1	0	- 4	- 4
Corn Grain	--	+ 9	+ 1	--	+17	+ 4
Net Feed Purchase[b] ($)						
Change ($)	+5,205	+7,741	+7,508[b]	+10,533	+16,140	+15,450[c]
Change (%)	+44.3	+69.2	--	+89.7	+144.2	--

[a]Return over variable costs
[b]Feed purchases minus crop sales
[c]Reduction in excess cash crop sales over feed purchases

The economic benefits of administering the hormone vary across the three farm types and two production groups. The small forage only farm, at a given response rate, improves its return over variable costs by a somewhat higher percentage than the larger farms. Low producing herds increase their percentage return more than higher producers on small and medium size farms but high producers have a slight advantage on larger farms (Table 2). On a per cow basis increased return is greatest on the large farm with corn grain sales because the increased feed required reduces crop sales as opposed to increasing feed purchases. The per cow increase in returns over variable costs is lowest on the small farm with a low producing herd. Likewise, the increase in return per hundredweight of additional milk production is greater on the larger farm (but generally at the lower production level).

The marginal cost per hundredweight of milk production behaves as expected, with marginal costs generally increasing as production response to bGH improves. The values range from 4 to 6 cents per pound of milk production. The low end of the range is, as expected, for the crop sales representative farm.

The changes in feed acquisition are the product of the feed requirements just analyzed, the crop characteristics, and the sale and purchase prices. The responses on the representative farms with lower production portray marginal adjustments with little or no change in the profit maximizing forage composition (Table 3). Consistent with the results of the formulated rations, the ration with half hay crop and half corn silage is the predominant choice (see Kalter et al., 1984). On the forage only farm with the poorer quality MMG hay, the maximum acreage of corn silage is always utilized (with lower production). With greater response to bGH and the corresponding decrease in total forage, the proportion hay crop decreases slightly. On the larger representative farms, forage composition is unchanged while forage acres decline and/or hay sales increase.

The most profitable forage composition shifts from half and half to all hay with bGH and the higher production level, as is apparent in the results of the 100 cow representative farms (Tables 2 and 3). The result is a dramatic adjustment in crop acreages (Table 2). Net feed purchase is greater than if ration composition is unchanged; however, crop expenses show a relative decrease. The magnitude of the shift is a function of the linear programming techniques used. On the forage only farm, with its lower quality hay crop, forage composition is unchanged.

Finally, the marginal return to both land (and associated machinery) and cows (and associated facilities) is of interest. Returns to cows and associated facilities are uniformly higher with increased response rates, and generally the percentage increase is higher for low versus high producers, but the absolute increase is greater only for the small farm. Likewise, the percentage increase in marginal return to animals is higher on the small farm than on the two larger farms, but the absolute increase is greater on the larger farms. The marginal return to land is generally stable across all scenarios (except for the small farm, where it declines in the case of the low producing herd), implying that the capitalized value of land will be stable (except for marginal operations where it would decline) while the value of the animals and associated real property improvements will rise.

SUMMARY

The administration of bGH and the subsequent production response results in major changes in the dairy cow enterprises and some adjustments in crop rotations. Total feed requirements increase although less than proportionately with production response. Since crop acres remain constant, the extra feed requirements result in increased feed purchases and/or decreased crop sales. Changes in the required forage are generally met through changes in the cropping program.

When intake is assumed to response in a normal pattern, the total forage requirement decreases and forage (hay and corn silage) acreage generally declines. Purchased concentrate increases two to four times as rapidly on the forage only and corn grain representative farms. On the crop sales, farm corn grain sales decrease dramatically.

With enhanced intake more forage and concentrate are required (see Kalter et al., 1985). Increases in purchased feed are ameliorated since more nutrients are provided by an acre of forage than by an acre of corn grain. For farms similar to the forage only farm with no current surplus forage, forage purchases would be required with bGH. Many managers consider purchasing forage as an undesirable option.

With stable milk prices, return over variable costs to the representative farms increase 5 to 26 percent depending on farm characteristics and response rate. The return over variable cost per cow increases with response rate, is greater for higher base production, is greater with the enhanced intake assumption, and is greater for the crop sales representative farm. The shadow prices or marginal values are generally constant on land and associated machinery and increasing on cows and buildings.

As aggregate production responds to bGH administration, milk price will fall reducing or erasing the short-term increase in returns. The financial position of individual farms after these adjustments will depend on the ability to actually achieve response to bGH, the success of feeding management strategies to increase intake, the current financial position and use of short-term returns from bGH, and the economic and political environment of the industry.

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