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BIOTECHNOLOGY IN MASSACHUSETTS: IMPACT OF BOVINE GROWTH HORMONE ON THE DAIRY INDUSTRY WITH COMMENTS ON THE WHOLE-HERD BUYOUT PROGRAM

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Extension Paper Series #86-2

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Introduction

This paper sketches the potential impact of Bovine Growth Hormone, commonly referred to as bGH, on the Massachusetts dairy industry. Assumptions and data for the discussion were gleaned from the current literature regarding bGH and were applied to Massachusetts dairy industry statistics. No new research on bGH has been conducted for the state. Our intent is to create awareness of the potential impact of bGH availability on the Massachusetts dairy industry. We neither support nor oppose the commercial availability of bGH and the private companies involved with its development.

The Federal Whole-herd Buyout Program has affected the number of dairy farms across the nation. This paper includes a section that describes statistically the Massachusetts farms participating in the program and the composition of the remaining Massachusetts dairy farms.

Explanation of bGH

Bovine Growth Hormone is a protein produced in the pituitary gland of dairy cattle; it is one of many factors that control the quantity of milk that a cow produces. Researchers have known for many years that the hormone increases milk production but since it appears in only minute quantities in the pituitary gland, it is expensive to gather from slaughtered animals. Recently, the gene responsible for bGH production has been isolated and transferred from animals to ordinary bacteria cells. The altered bacteria can then be reproduced on a large scale with standard fermentation techniques and the generated growth hormone can be isolated, purified and made available for commercial use in large quantities.

The economics of bGH have been studied by researchers at Cornell University (Kalter et al) in conjunction with that school's Center for Biotechnology which is partially supported by private industry. Their findings show a rise in average production of 10 to 40% per cow with a 25% increase being most likely, and an increase in farmer returns over variable costs of 5 to 26%. Total feed requirements increase less than proportionately with the increased production response. Additional dairy feed requirements are predicted at $ .40 per cow, and the cost of producing bGH ranges between $ .06 and $ .15 per dose. The actual selling price for bGH once it is marketed is unknown. These production results depend upon farm management, cow response, and estimated prices for feed, bGH doses, and milk. For individual farms, strong economic incentives exist to adopt bGH; however, unanswered questions remain, such as long run effects of several lactation cycles, influences on culling, and calving rates. Also, researchers at other universities are testing bGH on dairy cows, and at least Wisconsin's preliminary results suggest that Cornell's results on production response are too high when the increased production is measured over the entire lactation cycle. Early in the cycle the increase is much less as the cow already has substantial amounts of bGH in its system.

Current Overview of the Massachusetts Dairy Industry

In Massachusetts, the dairy industry dominates livestock production and constitutes 25% of all farm marketing cash receipts. Over the past decade, historical trends in the industry have exhibited a decline in the number of dairy farms and number of cows, steady increases in the average yearly production per cow, and decreases in overall milk production during the first five years offset by increases during the decade's second half.

Farm numbers are declining nationwide, and Massachusetts is no exception. Since 1975, 290 dairy farms ceased operation, a decline from 977 farms to 687 by 1985. This is a total decrease of 29.7% and an average yearly decrease of 3.67%. The decline slowed to 1.13% from 1978 to 1982, but has accelerated since 1982 at an average annual rate of 5.4%. The number of cows decreased by an average annual change of 1.7% which is less than the decline in farm numbers. Hence, in terms of number of cows, the size of dairy farms increased.

Herd size data from the July 1985 milk inspection records of the Massachusetts Department of Food and Agriculture were analyzed. Data were entered for 682 farms and 51,898 cows; herd size ranged from 4 to 1909 head with the second largest farm reporting 800 cows. The largest farm was often deleted from analysis to avoid bias toward the large farms. The mean herd size was 73 cows without the largest farm with a standard deviation of 62 cows; the median was 57 (50% of the farms had fewer than 57 cows and 50% had more than 57 cows) showing the skewness toward the larger herd size.

Data were placed in subsets according to herd size at 50 cow intervals. Of the 682 farms, 553 had 100 or fewer cows and 296 had 50 or fewer cows. Figure 1 illustrates the composition of farms with 50 or fewer cows. Figure 2 shows the farms in the 0 to 100 cow category; the mean of this group was 52 cows with a standard deviation of 52 cows and a median of 50 cows. Analyzing the 129 farms with herd sizes greater than 100 exhibits a mean of 167 cows with a standard deviation of 87 cows and a median value of 140 cows. Sixty-four percent of these farms had less than 150 head. This group is illustrated in Figure 3, and even though the two largest farms, 800 and 1909 head, are excluded from the histogram, the skewness toward the larger sized farms can be seen.

Figure 1

Farms with 50 and Fewer Cows

Middle of Interval (Cows)	Number of Farms	
5	6	***
10	6	***
15	10	*****
20	26	*************
25	23	************
30	40	********************
35	37	*******************
40	50	*************************
45	59	******************************
50	39	********************

Each * represents 2 farms.

Note: For farms with 50 or fewer cows the median was 38 cows, the mean was 35 cows with a standard deviation of 11 cows.

Figure 2

Farms with 100 or Fewer Cows

Middle of Interval (Cows)	Number of Farms	
5	6	***
10	6	***
15	10	*****
20	26	*************
25	23	************
30	40	********************
35	37	*******************
40	50	*************************
45	59	******************************
50	47	************************
55	39	********************
60	48	************************
65	30	***************
70	33	*****************
75	22	***********
80	18	*********
85	17	*********
90	16	********
95	7	****
100	19	**********

Each * represents 2 farms.

Note: For farms with 100 or fewer cows the median was 50 cows, the mean was 52 cows with a standard deviation of 22 cows.

Figure 3

Farms with Greater Than 100 Cows
The two largest farms, 1909 and 800 head, are excluded

Middle of Interval (Cows)	Number of Farms	
100	0	
110	27	***************************
120	23	***********************
130	10	**********
140	8	********
150	14	**************
160	4	****
170	6	******
180	3	***
190	2	**
200	8	********
210	1	*
220	1	*
230	3	***
240	2	**
250	5	*****
260	0	
270	0	
280	2	**
290	0	
300	2	**
310	2	**
320	0	
330	1	*
340	0	
350	1	*
360	0	
370	0	
380	1	*
390	0	
400	1	*
410	0	
420	1	*

Note: For farms with greater than 100 cows (but excluding the two largest farms) the median was 140 cows, the mean was 162 cows with a standard deviation of 66 cows.

In Massachusetts, the majority of farms had between 40 and 60 cows with the greatest concentration at 45 and 60 head. Another concentration of farm size fell in the 100 to 120 head category. Larger farms cluster at intervals of 50, for example, 150 and 200 head. This clustering is due mostly to management and expansion limits of equipment and buildings, such as barn size, milk truck capacities, and calving and culling rates.

Average annual production per cow in Massachusetts exceeded national and regional averages and exhibited steady increases until 1984, the last year for which data are available. The U.S. average decreased in 1984 and the Massachusetts average fell approximately 260 pounds below the national average. Prior to 1984, the state average increased 1.31% yearly. The downturn in 1984 was a reaction to the milk diversion program. Nationally, one method some farm managers used to decrease total milk output was to decrease the pounds produced per cow instead of reducing cow numbers. This was accomplished by decreasing the use of concentrate feeds and by feeding less. Additionally in Massachusetts, forage quality decreased due to weather conditions in 1984.

Total milk production in the state increased during the early 1980's at an average rate of 1.07%; this partially offset a 1.48% average annual decline initiated in 1975. As mentioned, 1984 had a 5.89% decrease in total production with production falling from 611 to 575 million pounds. Since 1973, total production has ranged from 566 to 611 million pounds with an average of 588 million pounds for the 12-year period.

Production Estimates 1990, 1995

Across the nation, average annual production per cow is expected to increase due to improved genetics, feeding, and management. Mix (1985) estimates an increase in the U.S. average of 250 pounds annually which raises production approximately 1.7 to 1.9% per year until 1995. This estimate exceeds the Massachusetts historical annual mean of 1.31%. Yearly average unit production without bGH for Massachusetts through 1995 was estimated from the historical production data over the last two decades and is shown in Table 1. By 1990, average production estimates increase to 14,063 pounds per cow and rise to just over 15,000 pounds by 1995.

Following the historical trend, the assumption that the Massachusetts present herd size of 47,000 head will decrease by 2000 cows by 1990 and another 2000 by 1995 was incorporated into the analysis. Based on a 1990 herd size of 45,000 head, total production would reach 633 million pounds during that year without bGH. This is a 10% rise above the 1984 level of 575 million pounds. By 1995, based on a herd size of 43,000 cows, total production yields 645 million pounds which is a 12% increase above 1984's output.

Although cow numbers have decreased over the past decade, total production has hovered consistently around 600 million pounds since 1973. This is due to increases in milk production per cow. To maintain yearly total milk production at 600 million pounds for 1990, the state's herd size must be reduced to 42,700 head; a decrease of 4,300 head. This is without the availability of bGH and based on an average annual production of 14,063 pounds per cow. It must be remembered that unit production varies considerably among farms; Wyman Farms, Inc., in Bridgewater, averaged 17,000 pounds per cow[1/]. To not exceed 600 million pounds in 1995, cow numbers must decrease by 7,000 head to 40,000 cows; this is based on a projected unit production level of 15,007 pounds per cow (see Table 1).

1/ Agri-Mark Journal, Oct. 1985, p. 7

Table 1

Massachusetts Annual Average Unit Production
(pounds per cow)

t[1]	Year	No. bGH	bGH Response Rates +10%	bGH Response Rates +25%
20	1983 (actual)	13,000		
21	1984 (actual)	12,234		
22	1985 (estimated)[1]	13,178	14,496	16,473
23	1986	13,350	14,685	16,688
24	1987	13,525	14,878	16,906
25	1988	13,702	15,072	17,128
26	1989	13,881	15,269	17,351
27	1990	14,063	15,469	17,579
28	1991	14,247	15,672	17,809
29	1992	14,433	15,876	18,041
30	1993	14,622	16,084	18,278
31	1994	14,813	16,294	18,516
32	1995	15,007	16,507	18,759

[1] The equation used in forecasting 1985, 1986, and future production levels was the natural exponential equation of the form $Y(t) = 9900e^{.013(t)}$; with $t = 22, 23, \ldots 32$ for years 1985, 1986, through 1995, where Y is the annual average unit production in year t and e is the number 2.71828... . To forecast production, substitute the value of t associated with the year of interest and carry out the calculations. For example, production in 1993 ($t = 30$) is estimated by $(9900(e)^{(.013)(30)} = 14,622$.

Now we shall incorporate the availability of bGH into our model. The use of bGH will escalate these figures. The degree of impact depends upon the adoption rate, defined as the percentage of the state's total herd size using the product, and the response rate, defined as the percentage of increase in average milk production per cow.

Kalter et al's experimental results gave response rates of 10 to 40% with 25% occurring most frequently. Response rates of 10% and 25% were used in making calculations in this paper. These values represent average unit production levels that are 10% and 25% above the estimated average unit production shown in Table 1. At a 10% response rate unit production reaches 15,469 pounds in 1990 and 16,507 pounds in 1995. With a 25% response rate, the production average is estimated to be 17,579 pounds per cow in 1990 and 18,759 pounds in 1995.

Adoption rates represent the percentage of the total population that will utilize a technological development. Throughout the past decade, the average number of cows on all farms has been decreasing. As stated, we expect the 1985 level of 47,000 head to decrease by approximately 2,000 head to 45,000 by 1990 and another 2,000 head by 1995. These state herd sizes are used to estimate adoption numbers or the number of cows administered bGH. In 1990, a 30% adoption rate indicates that 13,500 head are being administered bGH and 70%, 31,500 cows, are not. Those receiving bGH will have average production levels at either 10% or 25% above those cows not receiving bGH. After a trial period, bGH will either be adopted or not adopted on any given farm; partial adoption will tend to be a rare case. It is beyond this paper's scope to speculate which sized farms would or would not adopt and estimate the number of head receiving bGH in that manner.

Table 2 displays total production estimates for varying adoption rates and response rates of 10% and 25% for 1990 and 1995. The adoption rates used are 80%, 50% and 30%; 0% represents no adoption. These values were calculated by multiplying the estimated number of cows in the state (45,000 for 1990 and 43,000 for 1995) by the rate of adoption, then by the predicted production per cow for the given year. The total production level is determined by summing the production contributed by those cows adopting bGH based on either the 10% or 25% response rate and the production from non-adopting cows, based on forecasted average production estimates without bGH. For example, in 1990 with a 30% adoption rate and a 10% response rate, approximately 13,500 cows will be receiving bGH and produce an average of 15,469 pounds per cow; their contribution to total production equals 209 million pounds. The 31,500 non-adopting cows contribute an average of 14,063 pounds each for a total of 443 million pounds. In total, production equals 652 million pounds. At the same adoption rate with a 25% response to bGH, the cows receiving bGH contribute 237 million pounds and raise the total produced to 680 million pounds. If adoption increases to 50%, total production equals 664 million pounds at a 10% response rate in 1990 and 712 at the 25% response rate.

For 1995, average unit production increases while the number of total head decreases to 43,000. Non-adopting cows contribute 15,007 pounds each and those receiving bGH each produce 16,507 pounds or 18,759 pounds at the 10% or 25% response rates, respectively. A 50% adoption rate with a 10% response rate yields a total production level of 678 million pounds. Without accounting for a reduced herd size, total production would reach 762 million pounds. Predicted production levels for 1995 are presented in the bottom half of Table 2.

Table 2

Estimated Total Milk Production for Massachusetts - 1990, 1995
With Varying Adoption and Response Rates for bGH

Year	bGH Repsonse Rates	bGH Adoption Rates 80%	50%	30%	0% (No bGH)
		(million pounds)			
1990	(45,000 head on farms)				
	10% (15,469 lbs/cow)	557	348	209	0
	+ Non-adopting (14,063 lbs/cow)	127	316	443	633
	Total Production	684 1/	664	652	633
	25% (17,579 lbs/cow)	633	396	237	0
	+ Non-adopting (14,063 lbs/cow)	127	316	443	633
	Total Production	760	712	680	633
1995	(43,000 head on farms)				
	10% (16,507 lbs/cow)	568	355	213	0
	+ Non-adopting (15,007 lbs/cow)	129	323	452	645
	Total Production	697	678	667	645
	25% (18,759 lbs/cow)	645	403	242	0
	+ Non-adopting (15,007 lbs/cow)	129	323	452	645
	Total Production	774	726	694	645

1/ Calculation: (45,000 cows x .80 x 15,469 lbs/cow x 10^{-6})
+ (45,000 cows x .20 x 14,063 lbs/cow x 10^{-6})

State Consumption Levels

State data for the consumption of fluid milk and milk products are unavailable. This paper assumes national data from the U.S. Department of Agriculture, presented in Table 3, to be representative of per capita consumption in Massachusetts. These data exhibit an increasing trend in U.S. per capita consumption of milk equivalent. In 1983, per capita U.S. consumption was 578 pounds of milk equivalent; an increase of 7% from 1975. Estimates predict per capita consumption levels of 581 pounds for 1985 and 590 pounds for 1990 (Mix).

Applying the U.S. per capita consumption level for 1985 to the estimated 1985 Massachusetts population of 5.82 million yields a projected total milk consumption equivalent of 3.38 million pounds for the state.

The U.S. Bureau of Census projects just over a 1% increase in the Massachusetts population for 1990. Considering the U.S. per capita consumption of milk equivalent is estimated to increase by 1.5% in the next five years, the pounds of milk required to meet the state's demand for milk in 1990 will remain fairly constant.

By comparing these consumption demand quantities with the state's milk production (see Table 4) it becomes evident that Massachusetts is a deficit state and must import milk from other states. In 1984, the Bureau of Dairying issued 7,592 out-of-state Certificates of Registration. This imbalance is not unique to the Massachusetts industry. Milk handling and processing is regionalized nationally. Federal Milk Marketing Order #1 serves New England and eastern New York and is not in a deficit situation. Transporting fluid milk across state lines is common. Also, the formation of milk cooperatives promotes regionalization; Agri-Mark, Inc. serves members in New England and

Table 3

National Per Capita Consumption of Milk Equivalent

Year	Lbs/Capita
1975	540 1/
1980	542 1/
1983	578 1/
1985	581 2/
1990	590 2/

1/ USDA - ERS; "Food Consumption, Prices, and Expenditures", Supt. of Documents #A1.34:713 (Nov. 1984)

2/ Mix, L.S., p.9

Table 4

Milk Demanded by Massachusetts Population vs.
Milk Supplied by Massachusetts Dairy Farms

Year	Quantity Required (Million lbs.)	Quantity Supplied (Million lbs.)
1975	3126	601
1980	3109	570
1985	3381 (est.)	619 (est.)
1990	3491 (est.)	633 (est.)

eastern New York with approximately 80% of Massachusetts dairy farms participating.

Although milk from several states enters the same milkshed and is subject to the same Federal pricing policies for a specific Milk Marketing Order, production costs vary among states. Compared to other dairy regions, Massachusetts dairy farmers rent a significant portion of their cropland, field size is smaller, many purchase a large percentage of their grain requirements, and few raise surpluses for the cash-crop market. The technology boom experienced by Massachusetts has led to increased urbanization and placed agricultural industries in keen competition for land and water. The high value of much of the state's agricultural real estate creates high opportunity costs for farmers. Massachusetts dairies find themselves in an adverse situation because they are under competition with out-of-state farms that face lower production costs yet receive the same milk price.

One method of improving profitability is to increase milk production per cow. Under experimental conditions, bGH exhibits this potential. Individual farm use may prove to increase efficiency and profits initially. However, after bGH obtains approval from the Food and Drug Administration, it will be marketed nationwide, and any economic advantage gained by adopting the technology early will be lost as increasing numbers of farms adopt. Eventually, Massachusetts dairies will face the same scenerio as existed prior to bGH, namely, higher production costs than other states.

With bGH usage, milk production levels will increase nationally. Massachusetts' contribution to this region's milkshed will rise along with respective portions from other states. If dairy support prices remain stable (an unlikely assumption given the political pressure to solve the surplus problem), government stocks of dairy products would jump dramatically at a huge cost to the taxpayer. In the long run, real milk prices must decline. The direction of the adjustment process facing the dairy industry is clear, and it is only the speed of that adjustment, and which states will experience the brunt of the adjustment, that remains uncertain.

Retaining Current Production Level

Following Federal farm policy objectives of not perpetuating the national milk surplus and retaining the current, annual state production level in 1990 and 1995 will require a decrease in the Massachusetts herd size with or without the advent of bGH. Table 5 displays the reduction required in pounds of milk produced and number of cows to retain annual production at 600 million pounds. With bGH availability, the necessary reduction depends upon the rates of adoption and the increased production response from bGH. Reduction in herd size is calculated by dividing the necessary total production decrease in millions of pounds by the average annual production per cow. This latter figure depends upon the response rate and year.

Historically, the total number of cows has been declining; as mentioned, a reasonable expectation is a decrease of 2,000 cows to 45,000 by 1990 and another 2,000 head decrease by 1995 bringing the total down to 43,000. With a zero adoption rate, which is a plausible scenario if bGH is not approved by the Federal Food and Drug Administration or the product is banned from use in this state, the herd must decease by an additional 2,347 head in 1990 to retain production at 600 million pounds. This is a total reduction of 4,347. In 1995, assuming unit production increases to the predicted 15,007 pounds, herd size must decrease by 7,200 head from the 1985 level of 47,000 cows. This is a reduction of 3,200 more than predicted by the historical trend. Even without bGH, the number of milking cows in Massachusetts must decrease 9% by 1990 and 15% by 1995 to prevent the state's total production from increasing.

Table 5

Retaining Production at 600 Million Pounds
Reductions Beyond the Historical Trend

bGH Adoption Rates	1990 (45,000 Head) bGH Response Rates 10% Mil.lbs.	# Cows	25% Mil.lbs.	# Cows	1995 (43,000 Head) bGH Response Rates 10% Mil.lbs.	# Cows	25% Mil.lbs.	# Cows
50%	64	4344	112	7168	78	4962	126	7556
30%	52	3596	80	5347	67	4343	94	5888
0% (No bGH)	33	2347	33	2347	45	3200	45	3200

Availability of bGH increases the necessary reduction in cow numbers. In 1990, at a 30% bGH adoption rate and 25% response rate, herd size must be reduced by 5,347 beyond the natural trend. This is based on an annual predicted unit production level of 17,579 pounds for adopting cows and 14,063 pounds for the non-adopting cows. The same scenario in 1995, with unit production rising to 18,759 pounds, and 15,007 pounds for adopting and non-adopting respectively requires a decrease of 5,888 cows. At a 10% response rate with 50% adoption, herd size would need to decrease by 4,344 additional head to retain total production at 600 million pounds in 1990. For 1995, the herd would need to be reduced by 4,962 head beyond the historical trend. Hence, to prevent state production increases in the two five-year periods, reduction in cow numbers must exceed the approximate 4% historical trend decrease by at least 10%.

The question that arises is: How will such a reduction be spread across the farm sector? Will individual herds decrease in size by an equal percentage across all farms? Will dairy farms of a certain size fold while others maintain their herd size or perhaps grow? Without contacting dairy managers, it is impossible to predict their readiness to reduce herd size or to exit from the industry. To shed some light on these pertinent questions, we refer to our previous description of the Massachusetts dairy farm sector and herd size distribution.

Nineteen percent of all farms have a herd size of more than 100 cows and of these, approximately 25 farms milk more than 200 head. The state could achieve the estimated reduction of 4,347 head by 1990 if the largest seven farms exited the industry. By 1995, eliminating the 16 largest herds would reduce the herd by 7,200 head. These figures do not include production increases due to bGH response.

At the other end of the farm-size spectrum, if the 1990 and 1995 reductions come solely from farms with the fewest cows, the smallest 161 farms would need to exit the industry by 1990; all these farms having fewer than 40 cows. To reach the 7,200 head reduction by 1995, the 229 smallest farms must exit; these have herd sizes of 45 or fewer cows.

These scenarios can be applied to necessary reductions with bGH. A 30% adoption rate and 10% response rate yields a decrease of 3,596 cows by 1990. This would require the smallest 142 farms or the five largest farms to exit. The same bGH scenario in 1995, which requires a reduction of 4,343 head, would lead to seven of the largest farms or the 161 smallest farms leaving the industry.

A more realistic scenario would have a mix of reductions among different farm sizes. In this study, farms were categorized according to the number of head and arranged in groups with the following herd sizes: 0 to 50 cows, 51 to 100, 101 to 150, 151 to 200, 201 to 250, and over 250 cows. First we describe reductions for 1990 and 1995 with no bGH usage. Then we include bGH responses and adoption rates.

Eliminating 4,347 head by 1990 would reduce the 1985 herd by 9%. This percentage was applied to each farm size category. Such a reduction would require a decrease of 1,011 cows in herds of 50 or fewer cows. This would equate to 58 of the smallest farms or one in five farms in this category. Farms with 51 to 100 cows must decline by 1,559 head; based on a mean of 71 cows per farm in this category, this would require one in approximately ten farms to exit the industry in this group. Based on average farm size of 51 cows for all farms, approximately 85 farms would need to exit the industry to retain the 1990 total production at 600 million pounds.

The 1995 required decrease of 7,200 cows would account for approximately

141 farms based on the average farm size of 51 cows. This is one in every five Massachusetts dairy farms.

With bGH availability, the necessary decrease in cow numbers intensifies as previously shown in Table 5. A 50% bGH adoption rate with 25% response would require a 16% reduction in all herd size categories above the historical trend reduction by 1990. Across all herds, this is a loss of approximately one in six farms. By 1995, the same adoption and response rates yield an 18% reduction above the historical trend.

Decreasing cow numbers on all farms is a possible way of accomplishing the necessary herd size reductions. Removing 16% from each herd would require farms with 50 or fewer cows to reduce herds by approximately 6 cows, based on a mean herd size of 35 head. Each farm in the next category with 51 to 100 head would need to withdraw about 11 cows from production based on the mean herd size of 71 head. Larger farms with 201 to 300 cows would need to decrease herds by 39 cows based on a mean of 242 head per farm. These figures are calculated by using the annual unit production averages presented in Table 1.

However, decreasing cow numbers by an even percentage across all farms will not decrease production necessarily to the state's historical total production of 600 million pounds. As under previous Federal dairy programs, the cows that are withdrawn from production are the low producers, those with annual unit production levels below the average. Removing these animals from the herd is good management for most any farm. To allow for this management practice and to meet the historical state total production of 600 million pounds, the reduction numbers just mentioned would need to be escalated. Since individual farm data with individual animal production records are unavailable, an estimate cannot be given. We can state only that the number of head needed to be withdrawn per farm would increase.

The Impact of the Dairy Termination Program

The Dairy Termination Program (DTP) or 'Buyout' is a provision of the 1985 Farm Security Act aimed at reducing the nation's dairy surplus by paying farmers to withdraw from the dairy industry for at least five years. Nearly 14,000 dairy farmers nationwide will participate in the program, sending nearly a million dairy cows to slaughter. In Massachusetts 66 farmers had bids accepted by the Federal Government and hence will cease dairying for the minimum of five years and will slaughter their herds.

The state's herd-size will be reduced by nearly 9,000 cows and this 'instant' reduction has obvious implications to our present inquiry. We identified the 66 farms included in the 'Buyout' and removed their herds from the 1985 state's dairy inspection records, the data underlying this work. Information on the farms participating in DTP is given in Table 6. As can be seen the largest farms really went for the DTP. Participation increased with herd-size, both in terms of the percentage of farms participating and the number and percent of cows included. The seven largest farms had over 4,000 cows, about half of the total number of cows included in the buyout.

Possible explanations as to why the large firms jumped at the DTP revolve around the differences between large and small dairy farmers. Smaller operations are more likely to be family-owned and operated and the decision to abandon dairying is a decision to abandon a way of life. Large operations are more likely to view the decision strictly as a business decision. The opportunity to be paid to withdraw resources from a competitive industry which faces considerable uncertainty was attractive to such operators. They can now wait and see what the dairy situation will look like five years from now, at which time they are free to re-enter.

Table 6

Massachusetts Farms Participating in the
Whole-Herd Buyout, by Herd Size

Herd Size	Farms: In DTP*	Farms: Not in DTP	Percent of Category Farms in DTP	Cows** in DTP: Number	Cows** in DTP: Percent of Category
0-50	24	272	8.1	844	8.1
51-100	23	234	8.9	1,592	8.7
101-250	12	105	10.3	2,034	11.9
Over 250	7	5	58.3	4,399	72.7
Total	66	616	9.7	8,869	17.1

* DTP is the Dairy Termination Program of the 1985 Farm Security Act.

** Data are based on 1985 state farm inspection record and hence may not match the exact number of cows actually involved in the Buyout.

The removal of the small farms does not account for many cows. The 24 smallest farms participating in DTP account for only 844 cows; or 36.4 percent of the farms in DTP account for only 9.5 percent of the cows to be removed from dairying. However, these farmers are the least likely to re-enter after a five-year departure.

Although it is obvious that removing cows from production should ease the surplus problem, forecasting the effect of the 'Buyout' program is difficult for several reasons. First, nonparticipating farmers will likely increase their production as they seek to increase their revenue to help pay the program's 40-cent-per-hundredweight assessment on continuing dairy farmers and because they will likely face lower feed costs encouraged by the feed grains provision of the 1985 bill. Second, some of the cows removed under the 'Buyout' will be replaced under various legal arrangements that allow employees, not owners, to continue in the dairy business. Some employees of the largest farms participating in the 'Buyout' are seeking ways to lease land and equipment, to buy cows, to build new barns and to begin milk production. Since the owners are not investors the proposal is legal. For example, Bob Shaw of Northfield, MA has begun seeking investors to start a new dairy farm with 500 cows after his employer, Big Pine Meadows Farm Corporation, became a participant in DTP (Greenfield Recorder May 10, 1986, p. 1).

The typical farm that the Government probably had in mind for the DTP had an owner-operator, 55 years of age, and milking a 50-cow herd. Such an operator is unlikely to return to dairying, but large operations have hired farm managers and other skilled employees who wish to continue doing what they do best - working in the dairy industry. These employees are likely to seek new investors to start up a new dairy farm and in five years they may or may not become re-employed by their former employer. In Massachusetts seven of our ten largest herds are in the 'Buyout' and hence this potential entry by employees is substantial. These seven farms account for half of the cows to be removed by DTP from the 66 farmers participating in Massachusetts.

Lastly, after five years farmers who participated in DTP may re-enter dairying. Older owner-operators are unlikely to do so unless the dairy business outlook improves or they finance their children's entrance into dairying. Large operators are more difficult to assess. If government price supports allow a profit to be made they are likely to re-enter.

Given these three factors it is unlikely that the 'Buyout' will have its intended effect nationwide. Ed Jesse of the University of Wisconsin has forecasted that 1986 national milk production could exceed the 1985 level by 2-3 billion pounds even with the 'Buyout'. The outcome for Massachusetts is not clear. Massachusetts is and has been a deficient milk production state, yet we had one of the largest participation rates in DTP in the country. The reason for this is that other states have a comparative advantage in milk production (recall that a comparative advantage need not be an absolute advantage) and milk flows into Massachusetts from other states. Our analysis here assumes that the state will continue producing 600 million pounds of milk - an assumption based on historical levels. That level is a benchmark used to examine in a rough way the likely impact of bGH on our state's dairy industry. Should the comparative advantage shift our way - but nothing suggests it will - then expanded production is warranted. States with fewer alternative uses for their land and other resources will continue heavily committed to dairying (e.g., Wisconsin).

When the 66 Massachusetts farms remove their nearly 9,000 cows from our state-wide herd, the number of cows falls to 43,000; almost the exact number of cows we forecasted for the year 1995 using historical trends - but we arrive there a decade earlier. If we assume that these cows will not be replaced and that the 'Buyout' substitutes for the projected decrease in the number of cows by 1995, we are then left with 3,000 cows too many to maintain constant production of 600 million pounds, using our estimated 1995 production figure of 15,007 pounds per cow without bGH. When bGH is included, the 'Buyout' is offset by the increased production attributable to bGH. The 'Buyout' reduced the Massachusetts herd size by 17 percent. If we use the optimistic response rates for bGH and very high adoption rates (exceeding 50 percent) we could see this entire reduction replaced by increased production from bGH. Given that the <u>net</u> effect of the 'Buyout' will not reduce our production by 17 percent, further reductions in cow numbers will be required to hold our state production to its historical 600 million pounds. Massachusetts will see a continued reduction in the number of dairy farms and an increase in the milk production per cow even without bGH. The possibility of bGH becoming commercially available within three years only intensifies the downward pressure on the number of dairy farmers in the Bay State.

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