# Appendix B

# Detailed National and Regional Impacts of bovine Somatotropin and Other Emerging Technologies Under Alternative Dairy Policies

The national policy evaluation.s in chapter 5 were conducted with an econometric-simulation model of the U.S. agricultural sector (AGSIM). AGSIM is a disaggregate agricultural-sector model that utilizes econometric supply and demand relationships for major crop and livestock commodities. Figure B-1 illustrates the conceptual framework of the simulation model. The model contains regional supply representations of major crop commodities and an annual livestock supply sector. For this study a regional dairy supply component was incorporated into the model to analyze regional impacts of technology adoption under alternative dairy policies. National demand relationships for all crop and livestock commodities are utilized in the model.[1]

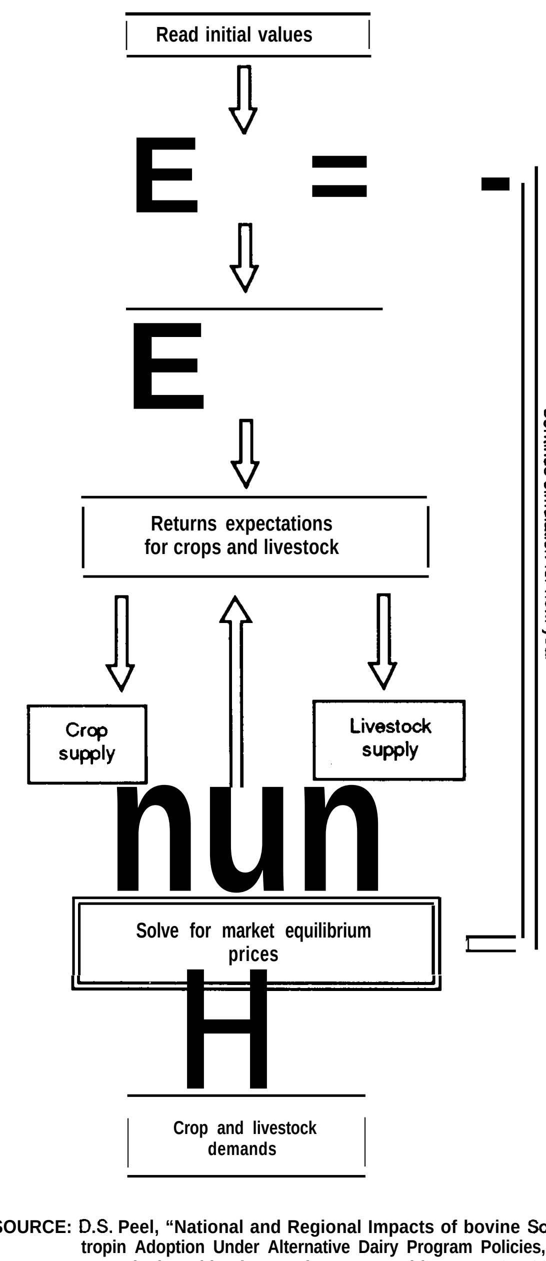
Supply relationships in the model are specified as functions of expected returns to production, Thus, aggregate supply relationships directly reflect the microlevel impacts of policies or technological change that change revenue components (e.g., yield) or cost components (e.g., product cost) or both. Further details of the crop portion of the model and regarding use of the model for policy analysis are contained in Taylor (2,3).

The livestock model (LIVESIM) utilized in the agricultural-sector model described above was developed by Peel (l). LIVESIM contains separate market representations for fed beef, nonfed beef, pork broilers, turkey, milk, lamb, eggs, and veal. The original aggregate supply relationships for milk production were replaced by regional supply equations.

Of particular importance for this study is the disaggregation of beef and dairy sources as contributors to fed and nonfed meat supplies in the model. The indirect impacts of dairy policy alternatives on other livestock subsectors are captured endogenously (within the model) through changes in fed and nonfed beef supply. Changes in dairy returns influence not only milk production but also impact calf crop, cow slaughter, and calf slaughter. The importance of these impacts was highlighted by the controversy over the dairy termination program of 1986. That program caused a significant decline in cattle prices.

Crop and livestock sectors are directly linked in the market in LIVESIM. Livestock returns (which drive livestock supply equations) are partly determined by feed

**Figure B-I-Simulation Model**




SOURCE: D.S. Peel, “National and Regional Impacts of bovine Somatotropin Adoption Under Alternative Dairy Program Policies, ”OTA commissioned background paper, Washington, DC, 1990.

[1]This appendix is based on the OTA commissioned background paper ‘‘National and Regional Impacts of bovine Somatotropin Adoption Under Alternative Dairy Program Policies” prepared by Derrell S. Peel, Oklahoma State University. It is available through the National Technical Information Service.

costs calculated internally from feed rations and crop prices. Changes in crop prices directly impact livestock returns and thus livestock supply. In turn, total livestock production in part determines demands for the individual crops and influences crop prices accordingly.

## *The Regional Dairy Model*

For this analysis, total milk supply is determined from regional equations for milk production per cow and dairy cow inventory. Data for the econometric estimates were aggregated from State data. Ten regions, consistent with the standard USDA production regions (discussed in ch. 2), were used in the model. Dairy returns for each of the regions is based on a USDA data series known as the regional cost of production budgets for dairy.

Market-clearing prices are calculated by balancing raw milk production, on a per-capita basis, against per-capita milk demand. The resulting national milk price is regionalized in the model via regressions of regional milk price on national milk price. These regional price relationships implicitly capture the net effect of the classified pricing system on regional milk prices.

### Modeling Dairy Policy

The econometric-simulation model captures the primary impacts of milk price support programs by calculating milk and dairy returns based on the maximum equilibrium market price or on an exogenously specified milk support price. Thus milk production per cow, dairy herd inventory, dairy replacement inventory, and the dairy impact on cow slaughter and calf crop all reflect the influence of the milk support price.

Government support of milk production is treated on a raw milk equivalent (ME) basis. Since the government only purchases manufactured milk products, all government purchases are made at a manufacturing milk price, which is assumed to be $1 per hundredweight (cwt) less than the all-milk price.

This analysis assumes that a minimum level of government milk purchases of 3 billion pounds of milk annually will be required for program needs. Government may purchase more than this minimum level to balance milk supply and demand at the prevailing support price.

### Modeling Technology Adoption

The impacts of bovine Somatotropin (bST) adoption and other emerging technologies were incorporated into the econometric-simulation model under the following assumptions:

1. output per cow increases 1.5 percent per year in base scenario without bST,
2. output per cow, due to bST, increases 1,320 pounds annually,
3. the daily cost of bST is $0.30 per cow,
4. cows are treated for 150 days annually,
5. overall feed efficiency is improved by 5 percent for treated cows.

The model increases feed use marginally for additional milk production resulting from bST use. However, feed required per cwt of milk production is 5 percent lower with bST because cow maintenance requirements are spread over more units of production. The model also assumes that per cwt variable costs for other production expenses increase incrementally with bST use.

Three alternative rates of industry adoption of bST (low, medium, and high) were considered for the 10 production regions of the United States. Complete presentation of the development and assumptions of the alternative adoption rates are presented in appendix A.

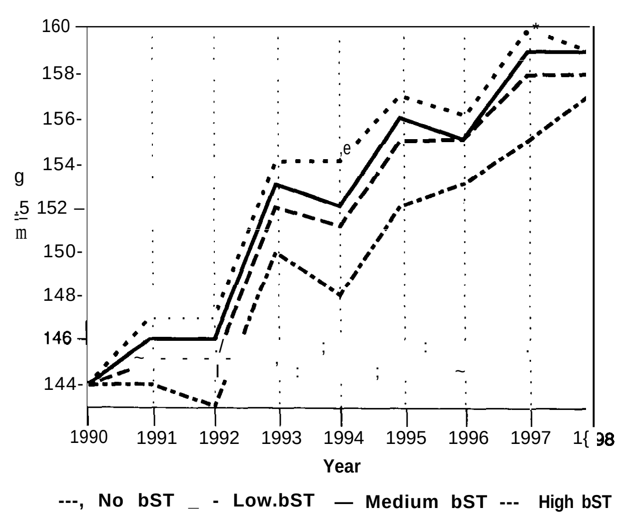
## *Results*

Various combinations of the policy alternatives described above and the alternative adoption rates for bST were analyzed. In addition, the possibility that bST adoption could have some exogenous impact on milk demand was considered in several scenarios.

### Impact of bST Adoption

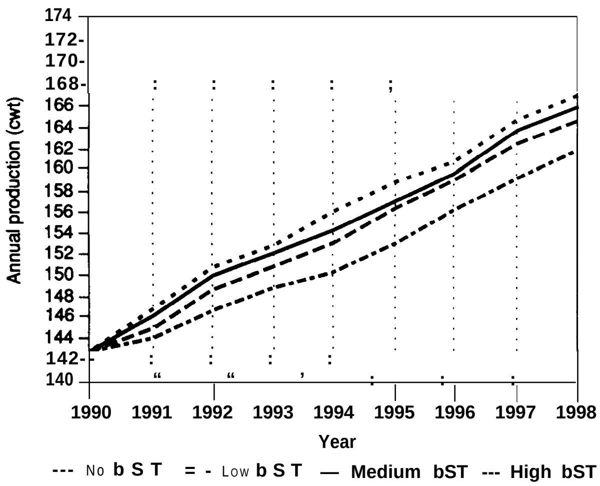
Of primary concern in formulating dairy policy is the impact that bST adoption will have on total milk production and consequently on government purchases related to the dairy program. Figure B-2 shows total milk production under different levels of bST adoption. This figure assumes an annual trigger adjustment for milk support price. The maximum impact in terms of addi-

**Figure B-2—Projected Total Milk Production With Trigger Policy Under Alternative bST Scenarios**



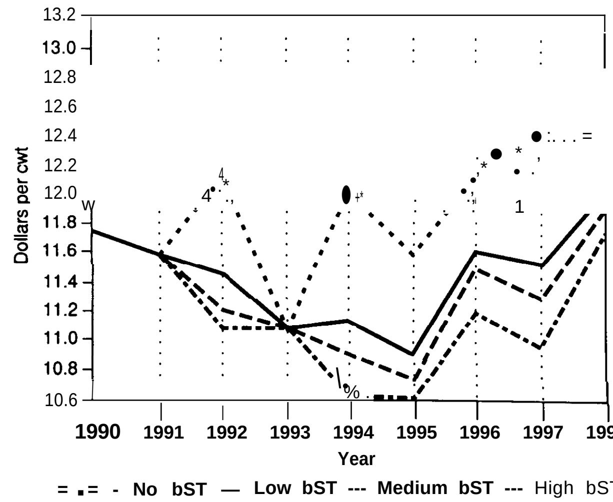

SOURCE: Office of Technology Assessment, 1991.

**Figure B-3-Projected Milk Production per Cow**




SOURCE: Office of Technology Assessment, 1991.

**Figure B-4—Projected All Milk Price With Trigger Policy Under Alternative bST Scenarios**




SOURCE: Office of Technology Assessment, 1991.

tional milk production occurs in 1994, with total production of 154 billion pounds under high bST adoption compared with 151 billion pounds under low bST adoption. Figure B-3 shows the impact of bST on milk cow productivity.

Differences in milk production due to alternative levels of bST adoption would be more pronounced if the milk support price was not triggered down (see figure B-4). With no bST, the baseline simulation of the model results in a single $0.50 per cwt adjustment in milk-support price from $10.60 to $10.10 in 1992. Under each of the three alternative levels of bST adoption, an additional $0.50 per cwt decrease to $9.60 in 1994 is required to keep government purchases of milk under the 5 billion pound level. Figure B-5 shows the high levels of government purchases of milk in 1991 and 1993 that precipitate the reductions in milk support price.

## Comparison of Alternative Policies

The implications of bST adoption depend on the policy scenario under which adoption takes place. This section considers the impacts of alternative policy options on milk production and price under the assumption of a medium level of adoption.

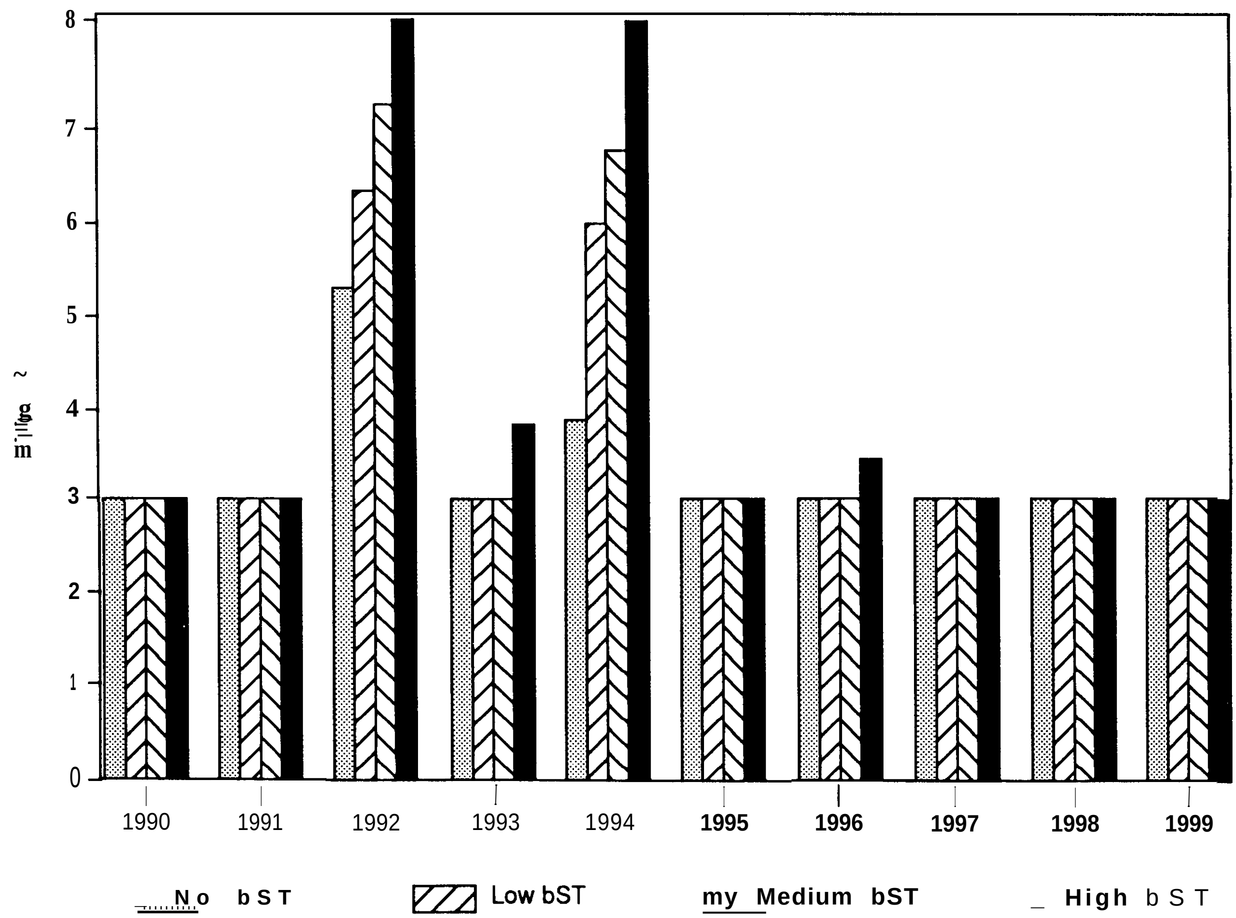
Figure B-6 shows total milk production under the fixed support price, annual trigger, and quota policies. The impact of the dairy termination (buyout) program is not included in this section because government milk purchases never exceed 15 billion pounds-the amount assumed to initiate a buyout program. Milk production generally increases to similar levels under each of the policies. However, milk production is lowest for the quota and highest for the freed support scenario for most years. The trigger policy results in milk production levels between those associated with the other two policies and production that is somewhat more variable from year to year.

The fixed support price and quota scenarios maintain a milk support price of $10.60 (see figure B-7). The all-milk price is $1.00 greater than the manufacturing price of milk. Beginning in 1995, milk price under the quota policy begins to rise over the support level. In contrast, the trigger policy allows milk price to fall substantially before it rises again as the industry cuts production.

The impacts of the alternative policies on government purchases of milk are summarized in figure B-8. As expected, the fixed support price policy is the most expensive, resulting in government purchases well above the minimum milk purchase level in order to maintain the support price. The quota and trigger policies are able to keep government purchases much lower although the trigger is slower to compensate for the impact of bST adoption. Annual government purchases between 1991 and 1998 average about one-third less under the trigger policy compared to the fixed support price.

The trigger and quota policies accomplish their goals by different means. All of the policies result in increased government purchases for milk in 1991, the first year of bST adoption. However, it is assumed that within a year the quota policy is able to reduce the size of the dairy herd to a level that limits government purchases for excess milk and maintains the milk price at the higher support price ($10.60). The trigger policy reduces the support price in 1992 and again in 1994 before controlling government purchases of excess milk.

**Figure B-5—Projected Government Milk Purchases With Trigger Policy Under Alternative bST Scenarios**




SOURCE: Office of Technology Assessment, 1991.

## Regional Impacts

In addition to concerns over the national impacts of bST adoption under different policy scenarios are concerns about how the technology will affect the industry's regional structure and dynamics. One way to summarize what the regional impacts of bST adoption might be is to analyze changing milk production patterns across the Nation.

Figure B-9 shows total production shares for the 10 production regions of the country in 1990 and 1998. This chart assumes a trigger policy for adjusting milk support price and a medium level of bST adoption. Trends already observed in the dairy industry continue in this simulation. Declining market shares are noted for the Corn Belt and the Northern Plains with smaller reductions in the Delta, Appalachian, and Southeast. Largest increases in market share are noted in the Pacific region. The Lake States and Northeast maintain roughly their current market shares over this period.

Figure B-10 shows the impact of alternative policies on regional market shares, with medium level of bST adoption. There is little difference between the impact of the fixed support price and that of trigger policies in regional market shares. The quota does not allow market shares to change as much as the other policies. Rather, the quota is assumed to fix market shares at 1990 levels. Some change occurs because of trends in milk cow productivity even though the dairy herd is fixed in size.

## Alternative Demand Scenarios

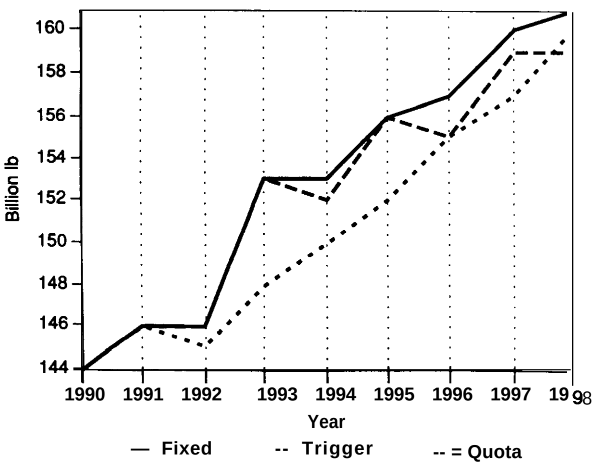
Continued consumer concern over bST prompted consideration of scenarios with exogenous changes in milk demand reflecting adverse consumer reaction to bST in milk. Three alternative demand scenarios were compared in the model:

Baseline: used in all previous scenarios

Temporary: large temporary demand reduction with small permanent demand reduction

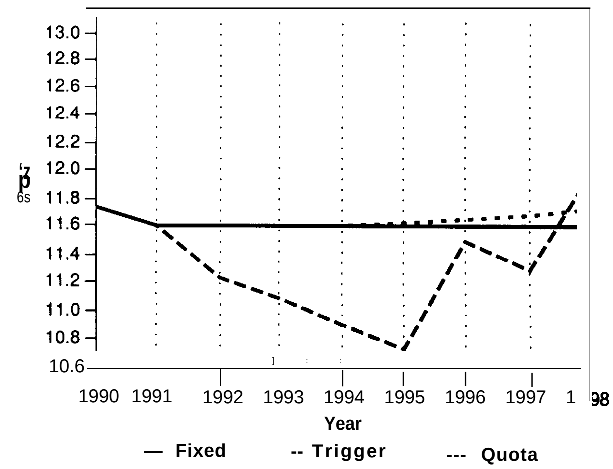
Permanent: large permanent demand reduction

**Figure B-6-Projected Total Milk Production With Medium bST Adoption Under Alternative Dairy Policies**



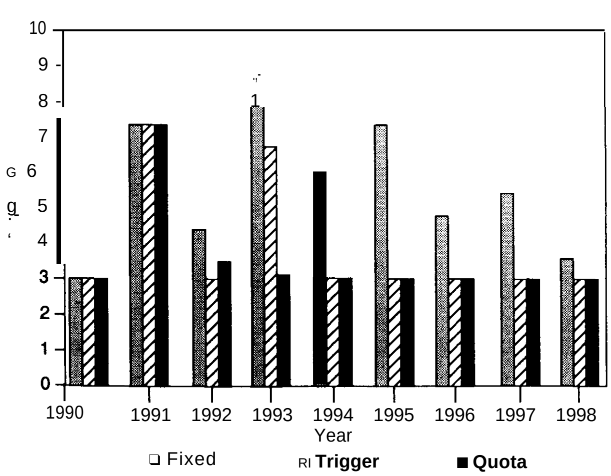

SOURCE: Office of Technology Assessment, 1991.

**Figure B-7—Projected All Milk Price With Medium bST Adoption Under Alternative Dairy Policies**



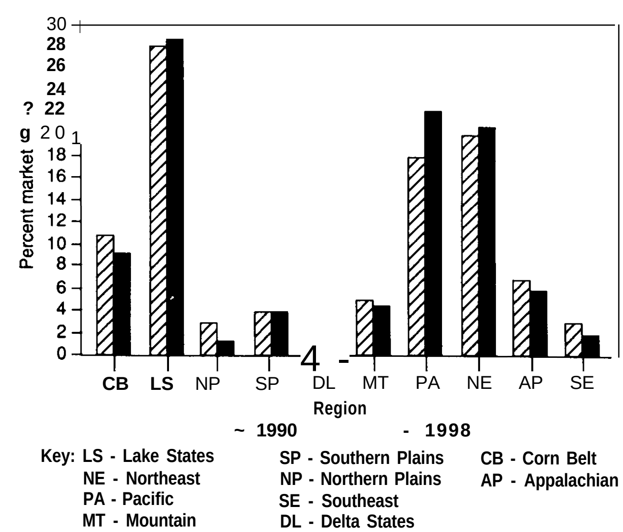

SOURCE: Office of Technology Assessment, 1991.

**Figure B-8—Projected Government Milk Purchases With Medium bST Adoption Under Alternative Dairy Policies**




SOURCE: Office of Technology Assessment, 1991.

**Figure B-9—Actual and Projected Regional Milk Market Shares With Trigger Price Policy, 1990 and 1998.**



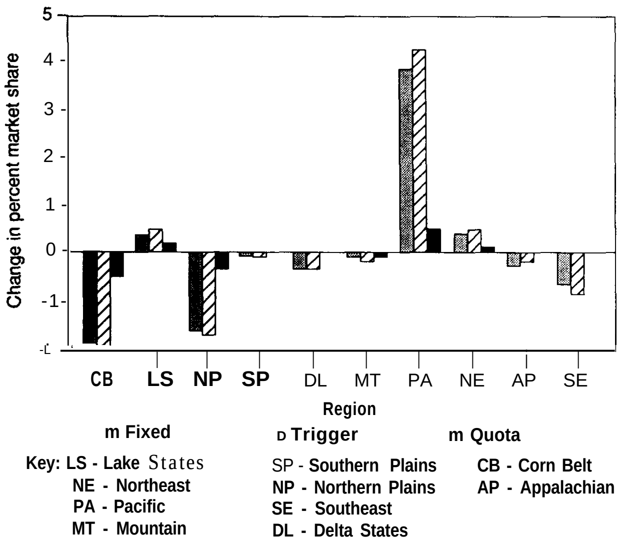

SOURCE: Office of Technology Assessment, 1991.

Details of these alternative demand scenarios are presented in chapter 5.

*Alternative Milk Demand Under Current Policy*—Figure B-n illustrates the impacts of alternative milk demands assuming a continuation of the current trigger policy for adjusting milk support price and the medium level of bST adoption. Changes in milk demand have large implications for milk price. While the base level of demand results in milk price near $12 per cwt for all years, a permanent large demand reduction would allow milk price to fall as low as $8.60 in 1997 before beginning to rise.

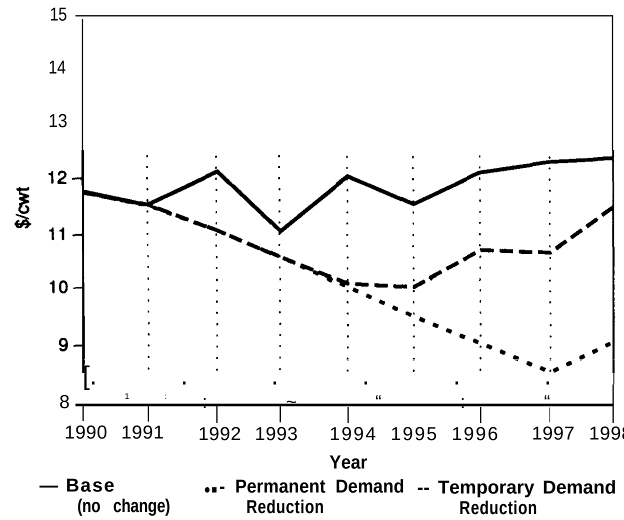
Figure B-12 shows the level of government milk purchases under the different levels of demand. Reduced

**Figure B-l O-Projected Change in Milk Market Shares for Alternative Dairy Policies Between 1990 and 1998**




SOURCE: Office of Technology Assessment, 1991.

**Figure B-1 l—Projected All Milk Price With bST Adoption Under Alternative Milk Demands**




SOURCE: Office of Technology Assessment, 1991.

milk demand, under both demand reduction scenarios, results in government milk purchases of 21 billion pounds in 1991 at a cost of about $2.5 billion. With the temporary demand reduction, government purchases decline fairly rapidly as the support price declines. With the permanent large demand reduction, however, government purchases decline slowly as the trigger lowers support price.

*Policy Comparison With Permanently Reduced Milk Demand—In* the face of large surpluses in milk production, the implications of the alternative policies are more sharply delineated. Assuming a permanent large reduction in milk demand, and future excess production, the choice of policies clearly will have much larger impacts than it would under the baseline demand scenario.

The reduced demand scenario is useful, not because it is a likely result of bST adoption, but because similar conditions (in terms of relative supply and demand) could prevail for a number of other reasons. For example, if bST results in greater average productivity increases than is here assumed, or if adoption rates are substantially higher, then supply excesses similar to those under the reduced demand scenario could result. This scenario thus can be viewed as a proxy for a number of supply or demand situations that could produce large surpluses of milk.

Figure B-13 shows the impact of reduced demand on milk production (given medium bST adoption) with alternative policies-fixed support price, trigger-adjusted support price, production quota, and a dairy termination program. Differences in the time path of milk production under the quota and the other policies are readily apparent. The quota results in a quick downward adjustment in dairy herd size necessary to avoid large government expenditures while maintaining milk price at the $10.60 support level. The dairy termination program (buyout occurs in 1992) adjusts herd size in a manner similar to the quota in 1992, but herd size and total milk production climb rapidly before declining again in 1998. The trigger policy results in an eventual but much delayed decline in milk production. The fixed support price policy, as expected, maintains the highest level of milk production of the alternative policies.

The implications of the alternative policies on milk price are likewise quite dramatic (see figure B-14). The fixed support and quota policies maintain a milk support price of $10.60. Figure B-14 shows that the all-milk price correspondingly is at the minimum level of $11.60 with these policies after bST is adopted (and the demand shift occurs). The trigger and dairy termination programs allow milk support price to adjust downward in the face of excess milk production. The trigger results in milk price declines to a minimum of $8.60 in 1997. The dairy termination program also allows milk price to fall to this level but with a delay of 1 year compared to the trigger policy. This is because the dairy termination program buyout occurs in 1992, avoiding the need for a reduction in milk support price prior to 1993.

Figure B-15 reiterates these impacts in terms of government milk purchases. It is significant to note that while the dairy termination program reduces milk purchases and expenditures quite successfully in 1992 (the year that liquidation occurs), milk production quickly bounces back and milk program purchases are not much lower than those associated with the trigger policy alone. From 1995 to 1998, purchases under the trigger policy are actually less than they are under the dairy termination program.

## Impacts on Other Agricultural Sectors

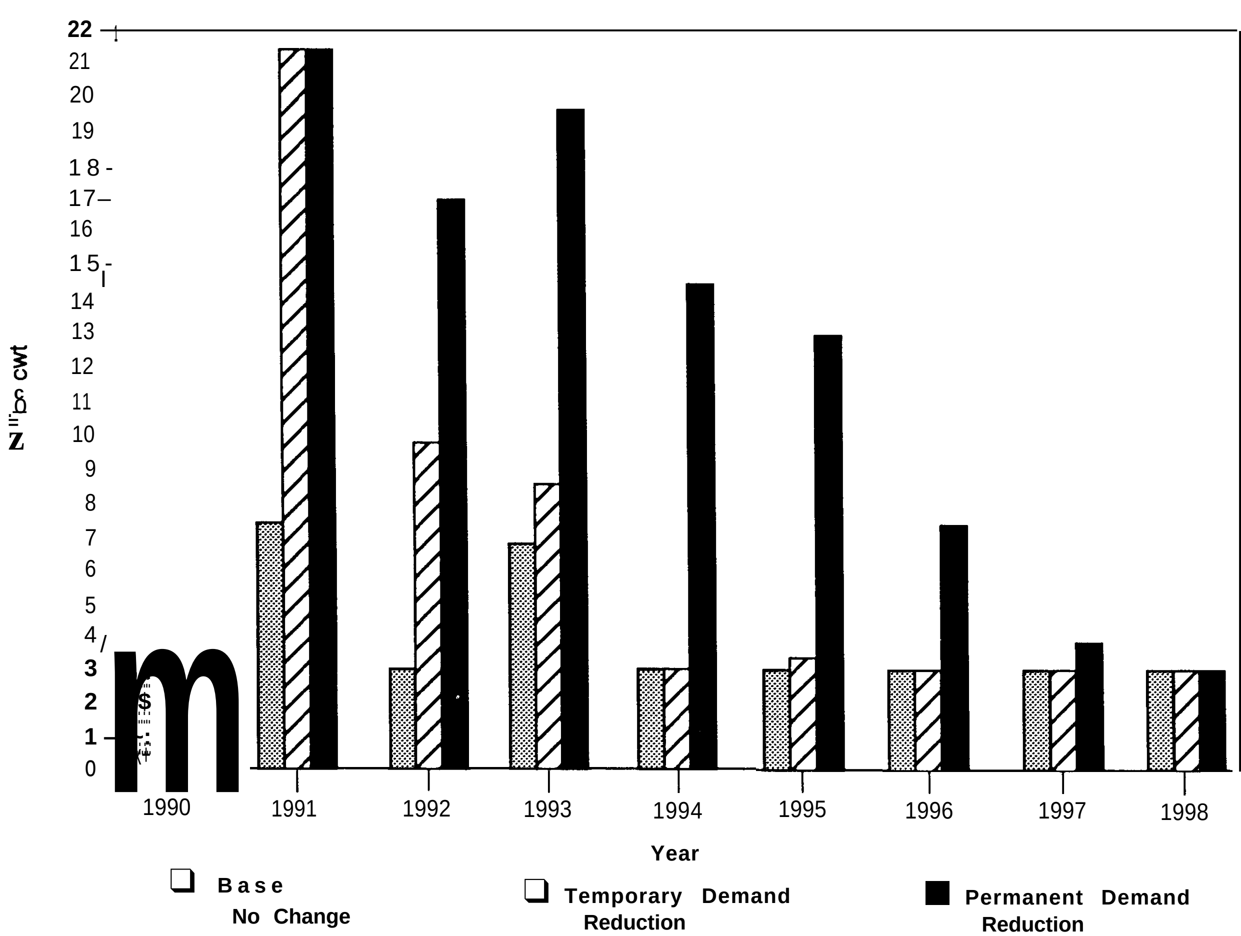
The adoption of bST appears to have relatively minor impacts on agricultural sectors outside of dairy. Table B-1 summarizes agricultural commodity prices over the period 1995-1998 for the freed support price, trigger-adjusted support price, and quota policies with and without bST adoption (medium level).

The adoption of bST does create a marginal increase in demand for feed in the dairy industry. However, the net effect, when all markets adjust, is extremely small. Among all crops, impacts on the all hay price are largest with bST adoption; average hay prices increase by $1.25 to $2.50/ton depending on the policy scenario.

Impacts in the livestock sectors are limited mostly to cattle, and average price effects are minute. Interestingly, how bST adoption impacts yearling, calf, and cow prices depends on the policy scenario. This indicates that dairy policy can affect the timing and magnitude of changes in the dairy herd.

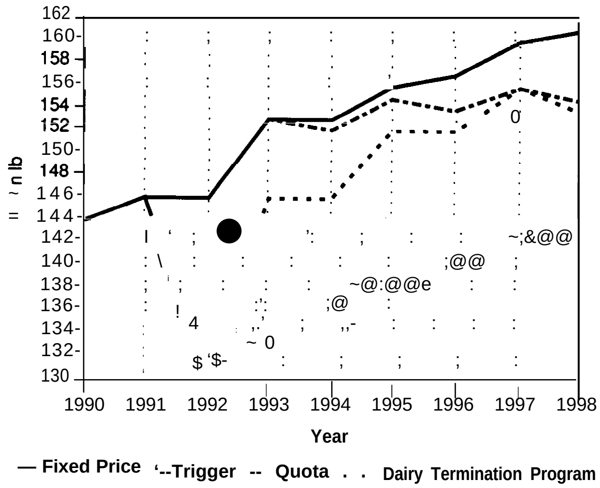
The impact of a dairy termination program on livestock prices is of particular interest. Figure B-16 shows the dynamic paths of yearling cattle price for alternative dairy policies. (Figure B-16 also assumes a permanent milk demand decrease in conjunction with bST adoption.)

**Figure B-12—Projected Government Milk Purchases With bST Adoption Under Alternative Milk Demands**



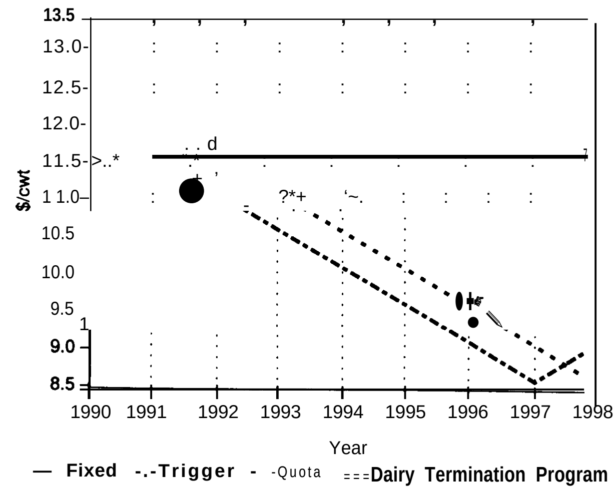

SOURCE: Office of Technology Assessment, 1991.

**Figure B-13—Projected Milk Production With Permanently Reduced Milk Demand Under Alternative Dairy Policies**



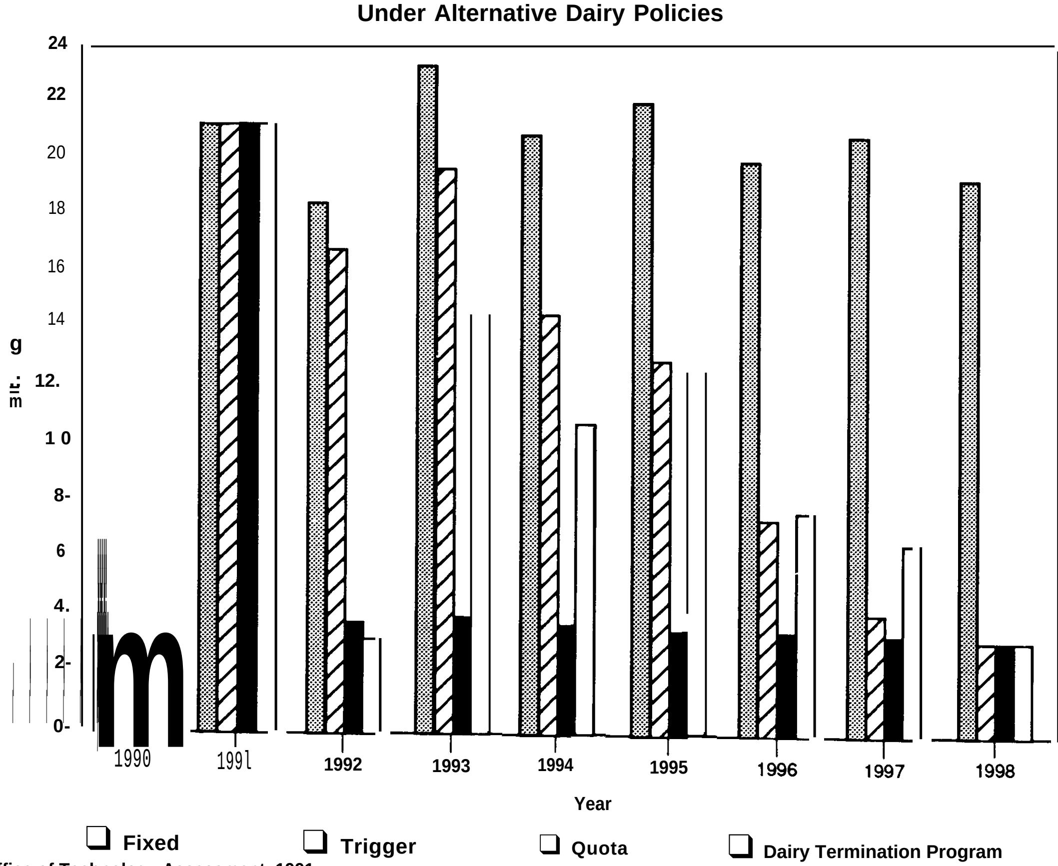

SOURCE: Office of Technology Assessment, 1991.

**Figure B-14-Projected All Milk Price With Permanently Reduced Milk Demand Under Alternative Dairy Policies**




SOURCE: Office of Technology Assessment, 1991.

**Figure B-15—Projected Government Milk Purchases With Permanently Reduced Milk Demand Under Alternative Dairy Policies**




SOURCE: Office of Technology Assessment, 1991.

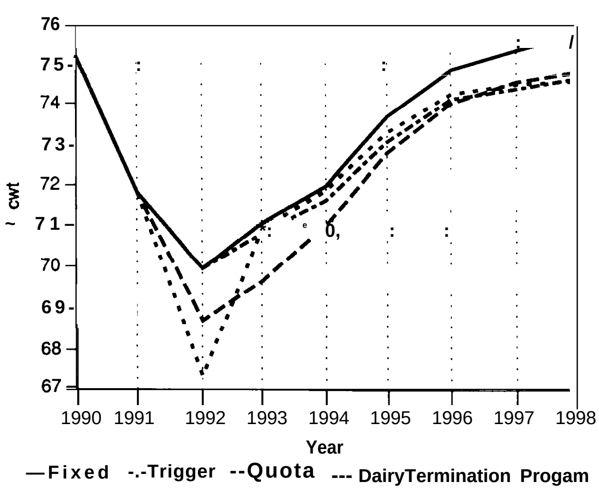
**Table B-l—Impacts of bST Adoption on Other Agricultural Sectors, 1995-98**

| | Policy scenarios | | | | | |
|---|---|---|---|---|---|---|
| | Fixed price support | | Trigger price | | Quota | |
| Commodity (units) | No bST | bST | No bST | bST | No bST | bST |
| Corn ($/bu) | 2.85 | 2.86 | 2.85 | 2.86 | 2.85 | 2.86 |
| Grain sorghum ($/bu) | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 | 2.54 |
| Barley ($/bu) | 2.60 | 2.61 | 2.60 | 2.61 | 2.60 | 2.61 |
| Oats ($/bu) | 1.39 | 1.40 | 1.39 | 1.40 | 1.39 | 1.39 |
| Wheat ($/bu) | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 | 3.09 |
| Soybeans ($/bu) | 6.46 | 6.47 | 6.46 | 6.46 | 6.46 | 6.46 |
| Cotton ($/lb) | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 | 0.86 |
| All hay ($/ton) | 103.06 | 105.55 | 102.95 | 104.64 | 102.77 | 104.03 |
| Yearling cattle ($/cwt) | 74.87 | 74.94 | 74.92 | 74.79 | 75.08 | 74.97 |
| Calf ($/cwt) | 81.84 | 82.01 | 81.93 | 81.84 | 82.16 | 82.06 |
| cows ($/cwt) | 56.97 | 57.11 | 57.05 | 56.84 | 57.33 | 57.14 |
| Hogs ($/cwt) | 51.08 | 51.09 | 51.06 | 51.11 | 51.01 | 51.04 |
| Broilers (@/lb) | 61.38 | 61.45 | 61.43 | 61.43 | 61.46 | 61.47 |
| Turkeys (¢/lb) | 69.32 | 69.38 | 69.41 | 69.29 | 69.55 | 69.49 |
| Eggs (¢/dozen) | 81.15 | 81.20 | 81.14 | 81.18 | 81.14 | 81.16 |
| Lamb ($/cwt) | 91.46 | 91.63 | 91.45 | 91.62 | 91.41 | 91.51 |

KEY: bu==bushel; cwt=hundredweight (100 pounds); lb= pound.

SOURCE: Office of Technology Assessment 1991.

**Figure B-16--Projected Yearling Cattle Price With Permanently Reduced Milk Demand Under Alternative Dairy Policies**




SOURCE: Office of Technology Assessment 1991.

**Annual yearling cattle prices are about $4.35 per cwt lower in 1992 as a result of the dairy termination program (compared to the trigger policy). Cow prices in 1992 are over $6.00 per cwt lower with the dairy termination program compared to the trigger policy. The quota policy affects cattle price in much the same way as the dairy termination program; its impacts are slightly less in magnitude in 1992, the year that the quota is imposed, but prices are slightly lower under the quota relative to the dairy termination program for several more years.**

## *Appendix B References*


1. Peel, D. S., "A Dynamic Econometric-Simulation Model of the U.S. Livestock Industry," Ph.D. dissertation, Department of Agricultural Economics, University of Illinois, 1989.
2. Taylor, C.R., "A Description of AGSIM, an Econometric-Simulation Model of Regional Crop and National Livestock Production in the United States," staff paper ES89-1, Department of Agricultural Economics and Rural Sociology, Auburn University, Auburn, Alabama, January 1989.
3. Taylor, C.R., "AGSIM User's Manual, Version 89.5," staff paper ES89-11, Department of Agricultural Economics and Rural Sociology, Auburn University, Auburn, AL, October 1989.