The financial and management implications of bovine somatotropin on the Arizona dairy industry

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Schoeffling, James Robert, M.S.

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U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

THE FINANCIAL AND MANAGEMENT IMPLICATIONS OF BOVINE SOMATOTROPIN ON THE ARIZONA DAIRY INDUSTRY

by

James Robert Schoeffling

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STATEMENT BY AUTHOR

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SIGNED: James Schaeffer Lung

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Robert C Angus June 1, 1988

Dr. Robert Angus
Professor of Agricultural Economics

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ABSTRACT

This study examines how Bovine Somatotropin (BST) may impact Arizona dairy producers. The results of dairy scientists experimenting with BST are summarized in terms of reported milk yields and possible changes in feeding and herd management. Dairy enterprize budgets representative of Arizona are constructed to examine how income statements may change if BST is approved. The effects of increased milk supply on Arizona milk prices is estimated using the institutional structure of the Central Arizona Order and the United Dairyman of Arizona. Results of experiments with BST in Arizona are used to generate net returns at several rates of adoption under changing milk prices for three dairy farms in Arizona.

CHAPTER 1

INTRODUCTION

Bovine Somatotropin

Bovine Somatotropin (BST), is a naturally occuring hormone produced in the pituitary gland by dairy cows. BST diverts nutrients to the mammary glands and proliferates alvicolar cells used by lactating cows in milk production. Dairy scientists have found that BST can be synthetically produced and subsequently injected into cows to increase milk yields.

The gene responsible for BST production can be isolated and transferred to ordinary bacteria cells (Miller et al., 1980). The altered bacteria can then be reproduced on a large scale by standard fermentation techniques. Subsequently, the hormone, which is produced by the bacteria, can be isolated, purified, and made available for commercial use.

Dairy scientists suggest that synthetic BST can increase milk yields on commercial dairy farms. However, there is no concensus by how much BST will increase milk yields or change herd management practices. Estimates of milk yield increases have ranged from 10 to 40 percent in experiments across the country. This range of results can be attributed to differences in experimental procedure as well as regional differences and herd management practices.

Heat stress in warm and humid regions could limit BST's full impact on production respose. Unbalanced rations, could offset BST's influence on milk yield. Moreover, if higher levels of milk production can be obtained with BST, superior management techniques may be required to prevent deleterious effects on animal health and reproductive performance. Consequently, the adoption of BST by Arizona dairy producers, may be influenced by intensive drylot management styles, warm temperatures and high grade forages grown in Arizona.

BST may be available for commercial use within two or three years. However, the effect of synthetic BST on animal health and milk containing BST on humans is not clear. The drug is still at the testing stage of the FDA's approval process.

The Purpose

The purpose of this research is to investigate the potential implications of BST on dairy farm incomes in Arizona. BST research by agricultural economists indicate that some of the same structural, environmental and institutional factors which characterize regional patterns in milk production may influence the impact of BST adoption. Consequently, the adoption of BST by Arizona dairy producers may be influenced by the intensive drylot management styles in Arizona. BST could be used to increase milk production without increasing herd size. Therefore, if BST becomes commercially available, it could give the highly intensive dairy producer of Arizona a chance to expand production without the commitment to extra land and facilities.

The Plan of this Study

The objective of this study is to investigate how BST may affect the incomes of Arizona dairy producers at various rates of adoption. The results of dairy scientists experimenting with BST are summarized in terms of reported milk yields and possible changes in production factors required. Research by agricultural economists on BST and the adoption of new technology is examined to determine if adoption rates for BST in Arizona can be modeled. The effects of increased milk supply on Arizona milk prices is estimated using the institutional structure of the Central Arizona Order and the United Dairymen of Arizona. Three dairy enterprise budgets representative of Arizona were constructed to examine what could be the financial impacts of BST. Results of experiments with BST in Arizona are used to generate net returns at several rates of adoption under changing milk prices for three dairy farms in Arizona.

CHAPTER 2

REVIEW OF DAIRY SCIENCE LITERATURE

Herd Management Implications with BST

Dairy Science research indicates that productivity gains are obtained when cows are not burdened with unecessary stress from improperly balanced feed rations, heat and cold, improper milking, or poor health (Bauman and McCutheon, 1984). Herds without appropriate management may even produce less with BST injections. Milk response in the first stage of lactation is less than the response in the later stages, similar to three times a day milking. Herds with superior management respond positively to three times a day milking while herds with inferior management respond poorly. Similarly, dairy scientists injecting cows with BST have experimented with high producing herds fed high quality forages and grains in controlled environments.

Milk Yield

Across the country, small increases in milk yield from BST are reported in the early lactation (the first 91 days), but increases are greater when cows are injected after 60-80 days. Generally, increases in milk yield are accompanied by increased feed intake. Below, figure 2.1, represents the average response of 40 cows injected with 500 milligrams of BST every two weeks. Huber et al., (1988), found that the

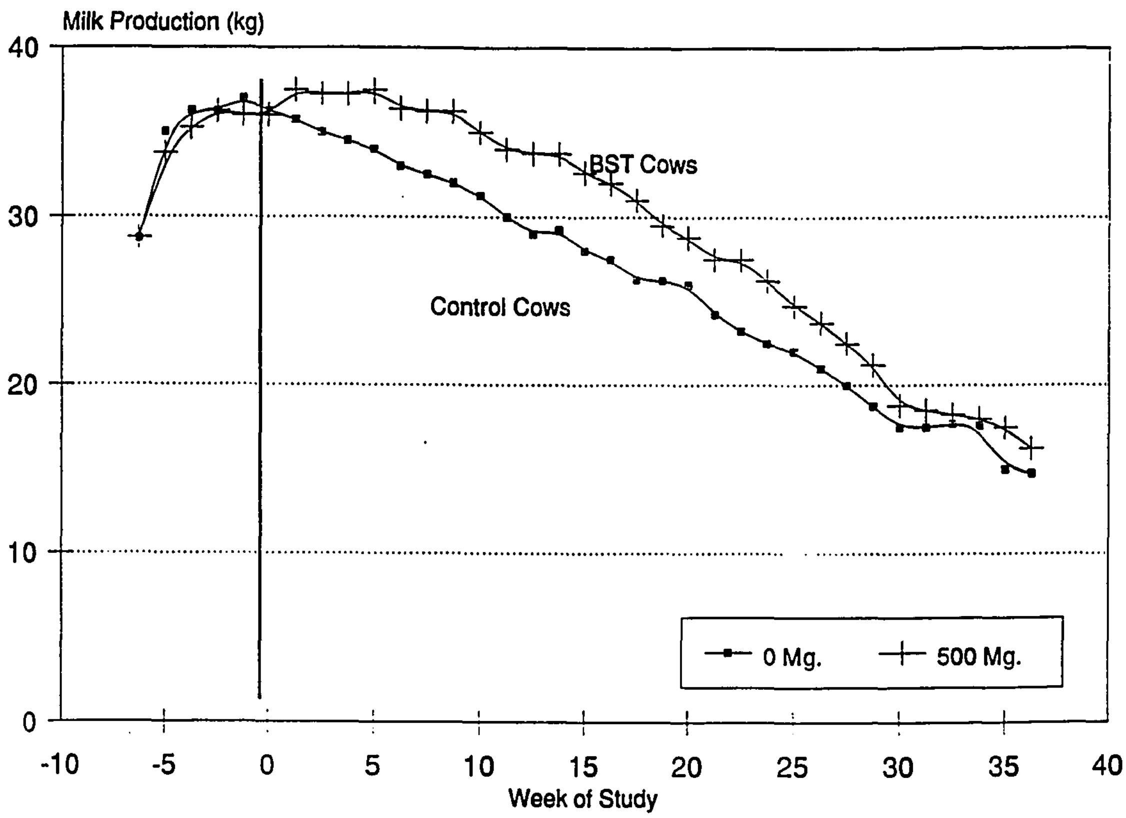

Figure 2.1: The Effect of Bovine Somatotropin on Actual Milk Production at Arizona

mean respose to BST was 12% more milk and 7% more feed in all production groups. Generally, dairy scientists recommend injections begin 60 days after calving as the cow is coming out of a negative energy balance to reduce possible effects on reproduction.

Huber (1988) suggests that increased milk yields from BST can be acheived with cows in low producing months. Low producing cows receiving BST increase milk yield by a larger percentage than high producing cows. Heifers receiving BST were found to increase milk yield by 3-4% while second and third lactation cows were found to increase milk yield by 12-24%. Again, the mean respose reported by Huber et al.,1988, 12%, is less than the findings by other reseachers, however,increases were variable by cow and by herd in all experiments in all regions of the country suggesting cows react differently to BST.

Milk yield increased with all cows injected with BST in the North America(Table 2.1). Dramatic increases were reported by Bauman (1985) at Cornell. 36% more milk, the mean response, was acheived with daily injections of 27 milligrams per day of BST in eight cows. Less dramatic were the findings of Annextad (1986) at the Univesity of Minnesota. 22% more milk was acheived in 8 cows receiving 25 milligrams of BST daily. The mean response of all test herds in America and Europe injected bi-weekly was about 15% and 21% for cows injected biweekly (Hart 1988). On all test

Table 2.1: Response of Lactating Cows to Long-Term Administration of BST on Experimental Farms Across North America

Reference Location	Cow Nos.	Study: Weeks	BST Dose Mg./Day	Days After Calving	Change due to BST (FCM) Kg/Day	Change due to BST Dry Matter Kg./Day
Bauman, 1985	C- 6	27	0	84	27.9	
Cornell	T- 6	27	27	84	38	5.1
Soderholm, 1986	C- 9	37	0	35	28.5	21.8
Minnesota	T- 9	37	25	37	37.2	24
Baird, 1986	C- 8	38	0	28-35	25.7	21.3
Georgia	T- 8	38	25	28-35	30.4	22.4
Chalupa, 1986	C- 8	37	0	28-35	24.2	17
Pennsylvania	T- 8	37	25	28-35	29.5	17.5
Chalupa, 1987	C-34	37	0	28-35	27.7	20.2
Pennsylvania	T-34	37	25	28-35	32.1	21.2
Burton, 1987	C-10	38	0	28-35	26.7	19.5
Ontario	T-10	38	25	28-35	31.5	20.5
Annexstad, 1986	C- 8		0		29.8	23.7
Minnesota	T- 7		25		36.8	27.4
Huber, 1986	C-31	36	35	91	26.3	24.3
Arizona	T-30	36	35	91	29.5	24.8

T = Treatment C = Control

farms, fat corrected milk increased slightly more. Although relative differences in BST response may not easily be explained, all cows injected with BST were reported to produce more milk.

Feeding

Dairy scientists found ration formulation and feeding strategy require modifiction to provide adequate feed intake. Huber suggests that feeding of a lactating cow can change in two ways. First, the cows voluntary intake increases proportional to nutrient requirements at higher levels of milk production 6-8 weeks after receiving an injection. Proportional increases were common in low producing cows. Second, an alternative feeding ration is required in higher producing cows. Milk yields increase less significantly in the higher producing group but respond more when fed a higher percentage of energy. In both feeding groups and production groups, Huber, reports that cows demonstrate an eagerness to eat more when injected with BST. Theoretically, the ration balance between energy requirements and crude protein should be adjusted for milk production increases with or without BST.

The two feeding strategies assume that the nutrient requirements for body maintenance are not affected by BST use, when feeding plans are changed to meet changes in milk production. This assumption was validated as early as 1985, (Peel et al.,1985) and (Tyrrell, 1985). Subsequently, the economic benefits of BST use are derived from improvements in feed efficiency. Generally, the ratio of milk to feed inputs increases while nutrients used for body maintenance are a smaller percentage of the total feed intake.

Rations fed top cows in BST experiments were variable like milk yields. Peel (1985) reported cows ate entirely pasture with no concentrates and incresed their intake 8%. Bauman (1985) reported cows were fed a mixed ration composed of corn silage, hay silage, corn grain and soybean meal and incresed their intake 12%. However, milk production increases were nearly identical in these two studies. Huber reported cows ate alfalfa hay, alfalfa cubes, a grain mix, whole cotton seed and cotton seed hulls and increased their intake an average of 7% in the herd.

Bauman reported BST treated cows increase their voluntary feed intake in as much time as high producing cows at the onset of lactation. Bauman found that BST treated cows produced more heat and the extra heat was exactly what was predicted based on the extra milk produced and the extra feed consumed. Therefore, if enery requirements for body maintenance remain unchanged, feeding requirements with BST will increase to a level required of higher milk production. Schneider (1986), warns however, any nutritional constraint which limits production could be devastating if not corrected when BST is used.

Heat Stress

Huber's findings at the Arizona experimental farm have important implications for herds in warm regions. Temperatures of BST treated and non treated lactating cows were identical in the cooler months but increased only slightly in the warmer months for treated cows. Other research at Missouri (Johnson 1988), indicate that BST increased heat production and heat loss with no adverse heat balance problems. Generally, research which focused on heat stress and BST suggests that BST may not cause adverse heat balance problems. Heat produced with BST is equal to the amount of heat given off. Again, milk yield increased slightly in the summer months suggesting that BST may even improve cows metabolic efficiency. Similarly, the findings of BST research at Cornell indicate that none of the heat stress related factors were observed. Bauman (1985) reported that a BST treated cow giving 20,000 pounds of milk is the same as an untreated cow giving 20,000 pounds of milk.

Coppock (1987) suggests, cows which receive BST could be under greater heat stress than cows without BST in regions or seasons of high humidity or temperature. Cows assign a high priority to body maintenance. One of the first responses to heat stress is a reduction in feed intake, a defense against further heat production. Huber, like Coppock, suggests, strategems that relieve heat stress should be employed because cows assign a higher priority to body maintenance and a uniform temperature

Nutritional changes are suggested to increase metabolic efficiency (Coppock 1985) (Huber(1988). Supplemental fat increases energy density in high producing cows. Chalupa (1982), shows that fat consumption increased metabolic efficiency from 65% to 74%. Supplemental fat is the principal dietary change presently known to to increase metabolic efficiency in lactating cows.

Animal Health and BST

Acheivement of high production levels requires low levels of production limiting diseases such as mastitas. Conversely, the sudden emergence of an increase in disease in a high producing herd could influence future increases in milk production. Consequently, disease surveillance and control become important tools to identify emerging constraints to milk production and BST therapy. Herds with poor management and low levels of disease control could expect poor results from BST treatment. Huber reported differences in herd health were not observed including ketosis and mastitas. Weaver (1986) recommmends that the focus of disease control should shift from reducing disease to early detection of diseases with BST.

Reproduction with BST

Whether or not BST will exacerbate reproductive disorders has not been clearly determined. If the partitioning of nutrients is such that there is inadequate energy available for fetal development, the cow could terminate the reproductive process at an early stage (Britt 1985). This could be represented by infertility. Conception rates in cattle are reduced when body temperatures are elevated because of high ambiant temperature or fever. Again, recent findings by dairy scientists suggest that BST may not cause adverse heat problems, though it is difficult to measure. Huber observed in the the higher temperature of Arizona, cows inability to conceive increased from 2.4 percent to 2.9 percent when BST was used. If BST raised the metabolic rates in BST cows in Arizona, it made it more difficult for cows to maintain a normal temperature and the ability to conceive was reduced.

Dairy Herd Management (May, 1988), indicated that twin offspring from BST treated cows increased 6% on a commercial drylot dairy in Southern California. Similarly, multiple births were reported by Huber (1988). Generally, multiple births can be detrimental to cows because they may have trouble getting good body condition in late lactation or in the dry period. If cows calve or begin lactation in poor body condition, they may retain the placenta or have a prolapsed uterous. Huber (1988) suggests that perhaps BST treatment could begin 80 days after she has conceived . This could reduce problems in reproduction. Dairy Scientists reported no affects of BST on offspring.

CHAPTER 3

REVIEW OF THE LITERATURE BY AGRICULTURAL ECONOMISTS

Analyses to Measure the Economic Implications of BST

Numerous working papers and reports deal with the potential economic impacts of BST on the dairy industry. Generally, agricultural economists recognize the variability of the findings reported by dairy scientists and their findings may not generate reliable predictions in an economic analysis. Therefore, economic reports on the impact of BST are more speculative than determinate. Agricultural economists have researched profit maximization and optimization with BST on the farm, the effect of extra milk generated by BST on federal dairy policy and methods to forecast the adoption and diffusion rates of BST by dairy producers. The most widely cited research on the economic impacts of BST rely on the first technique (Kalter, *et al*., 1984).

The Cost of Producing BST

Several factors are important to understanding the market potential of BST. Scale economies exist with respect to production which implies monopoly power could develop and the price of BST could exceed the cost of producing and marketing BST (Kalter, 1985). Therefore, an economic analysis of BST is complicated by the indeterminate price of BST as a factor in milk production. The price of BST will depend on how much the conferred market power will permit the firm to extract if indeed the market power is monopolistic.

Another factor impacting the market price of BST relates to the technical issue of fermentation yield in the production process. Attempting to raise BST yields above .09 grams per liter results in 50 percent of the product lost due to the up-scale of the fermentation plant. If improved yields could be obtained by resolving the problems of mixing and increased heat generation in the up-scale, the costs will be reduced. Kalter estimates the price of BST will range between $1.97 and $4.23 per gram based on plant capacities of 0.5 million to 7.0 million doses per cow, per day, respectively.

The effects of BST on dairy cows have not been examined under the environmental and and management schemes of commercial dairy farms. The daily dose required to raise production on commercial farms may be different than on experimental farms. The Kalter research assumes a 44 mg. per day dose. However, Bauman (1985), observed that 27 mg. per day is as effective as 44 mg. per day and and milk increases are the same. Finally, the extent and speed of market penetration will depend on individual dairy producers.

Linear Programming to Measure BST Impacts.

Kalter (1985), uses three representative farms in New York state to measure farm level impacts with BST. A feeding ration for each farm is formulated for alternative forage compositions and generated annual feed requirements per cow for each feeding program. The ratios were incorporated into a farm linear programming model as alternative means of meeting feed requirements. The program maximizes return over variable cost. Optimal feed rations and other farm inputs were tested at 10, 20, 30 and 40 percent response rates to BST.

Kalter's program illustrates the need for a higher ration of corn. The return to farms at stable market prices can range from 6 to 25 percent before deducting the cost of the hormone at stable milk prices. The market price of cows increases while land prices stabilize except those not capable of corn production. Feed utilization increases and cropping patterns respond to the optimal ration which raises feed prices.

The economic benefit of using BST varies slightly across the representative farm types. Small farms improve returns over variable costs by a smaller percentage than large farms. Low producing herds increase returns more than high producing herds on small and medium sized farms. Increased return is greatest on the farm with corn sales. The per cow increase in return over variable costs is lowest on the small farm with a low producing herd. The marginal factor cost of milk production decreased 4 to 6 cents per pound of milk as production response to BST improves. In summary, Kalter's program demonstrates that BST is a "viable" commercial product and will be profitable to dairy producers at current milk prices.

Boehlje (1986), develops a linear program to estimate the impact of BST on 31 market areas. It includes crop, livestock and agricultural transportation markets. He estimates cow numbers will decrease 15 percent and milk production will decrease in most regions caused by the simultaneous drop in milk prices. The base price of milk with no government support will decrease to $10.16 per hundred pounds. However, milk production per cow will increase 25 percent. Milk production will decrease in the Midwest, the Southern Plains, the Southwest and the Northeast. Increases will occur in Ohio, the Southeast and the Northern Great Plains. Boehlje's program indicates that shifts in milk production are certain to happen as producing regions become self sufficient in milk and will not require imports from other states.

Estimating Milk Supply and Demand with BST

Magrath (1986), and Kalter (1987), developed a partial equilibrium model to study BST under different policy scenarios. Their studies were identical. They estimate a log-linear output function as an approximation of a supply curve. They ranked their farm data from least cost to most cost-efficient and subsequently corrected them by the Cochrane-Orcutt procedure. Another Cobb-Douglas function established the functional relationship for changes in the size of dairy herds. Cow numbers are a function of farm size. Marginal farms with small output generally have small herds, so small farms and large farms were estimated independently. Empirical demand functions for milk from BST treated cows are not available. The demand equation by Magrath (1986)and Kalter (1987) reflects an inelastic relationship between milk price and quantity of milk. A relationship which is commonly thought to be true based on numerous other milk studies (Ippolito and Masson, 1969) .

The shifting supply curve caused by BST can not be estimated. Therefore, Magrath and Kalter estimate a free market clearing price and quantity and then incorporate the effect of BST. The model indicates milk production will fall 11 percent and farm numbers will fall 17 percent. Again, they assumption that increasing milk supply will reduce farm numbers. The range of possible effects due to

BST is modeled by increasing the constant term of the Cobb-Douglas output function; the effect is to increase output by a constant percent for all farms. Magrath says, "his technique and his results are consistent with the findings of Kalter; this technique does not affect input use or the prices of variable inputs, it only generates more output."

Hallberg (1986), employed a modification of a one product partial equilibrium model to estimate the magnitude of the impacts by BST on dairy farm enterprize budgets in the Northeast. His model assumes a regional blend price and no support price. Adoption of BST assumes the supply curve will shift or increase 15 percent in the Hallberg study.

Hallberg's findings indicate milk blend prices will fall 14.4 percent; producer receipts will decline 11.6 percent; consumers will spend 14.4 percent less for the same dairy products; they will consume 2.3 percent more fluid milk and 6.6 percent more manufactured products. Hallberg claims, at near full adoption of BST, a typical Northeast dairy farmer will have little choice but to adopt the technology. Failure to adopt, reduces net revenues above feed costs 22 percent. He also warns that producers with high non-feed costs will be vulnerable to a sharp fall in the price of milk.

BST and the Use of Dairy Enterprize Budgets

Buxton et al., (1986), prepares annual budgets and financial statements for representative farms in all regions of the nation. Four BST adoption scenarios were studied with lags to four years. The study assume a $1.00 fall in the milk support price. A dairy simulation model is used to simulate the major relationships of the representative farms The variables include: milk production, crop rotation, feed purchases and sales, machinery replacement and depreciation, income taxes, cash and cash withdrawls. Subsequently, the farm's annual income statement, cash flow statement and balance sheets are evaluated to determine solvency.

The findings suggest farms in the Southeast exhibit certainty of survival, which may be a reflection of the higher market order price in this region. The probability of large farms surviving is higher than it is for small farms in all regions. This may be due to the higher fixed asset farms of the Midwest and economies of size. Moderate sized farms of the Southwest and the Midwest improve their chance of survival when BST is adopted within two years of approval. However, a $1.00 drop in the milk support price could have an adverse effect on dairies in the Midwest and the Southwest. In these regions, large farms would discontinue production. Finally, milk production occurs in regions having larger average farm sizes with lower costs of production. The rate of shifts will be speeded with BST.

Researchers use linear programming models, comparative static analysis and budgeting techniques to estimate the economic impacts of BST. The greatest challenge appears not in these areas but estimating the potential adoption rates of the new technology.

Research on the Adoption of BST

Yonkers presented Buxton's results at the BST Conference in St. Louis, in 1988, and elaborated on BST adoption. Again, he suggests larger farms are more likely to adopt BST. Noting a study by Carley and Fletcher (1981), size of herd is positively correlated with management practices such as DHI testing, forage testing, ration balancing and artificial insemination. Carley et al., claims, "the typical dairy farmer who adopts BST will tend to have a large head of cows producing above average, be younger than average, be in a partnership operation and have a college education."

Some researchers have duplicated Grilliches appplication of the logistics curve to study technological change. Grilliches (1961) used the logistics function to explain ex post facto the adoption and diffusion of hybrid corn in the 1950's. Using the slope and the upper limit of the asymptote, Grilliches, sought to explain differnces in the adoption of hybrid corn between regions. Although Grilliches sucessfully made this application to ex post data, can this application be used for ex ante evaluation of BST?

Kalter and Lessor (1986), estimated an approximation of a differential equation which had the form of a logistic function for survey data on New York dairy producers. The survey asked dairy producers if they would adopt BST and if they did over what period of time. The procedure used by Kalter and Lessor was to expose producers to facts about BST with an advertisement in The Hoard's Dairyman (June 1985). The dairy producers resposes suggests a moderate to rapid adoption rate with a projected ceiling of 63 to 85 percent. These adoption rates are acheived within three years of commercialization. This adoption rate is more rapid than adoption rates for previous dairy technologies such as bulk tanks and artificial insemination. Kalter concludes, "...while further tests are needed before this procedure may be broadly accepted, there is no reason why it will not be broadly applicable to the score of biotechnology advances which will be approaching market readiness over the next year and beyond."

The approach by Kalter and Lessor may be simple to apply and the results may be reasonable. The problem is the data were collected after producers were exposed to a hypothetical fact sheet which detailed the results of experiments using BST. Thus, the results may simply reflect the scenario already set up as information to the dairy producer. It can be concluded by Kalter and Lessors' research that the estimated adoption rates are also hypothetical.

A better question may be what is known about the adoption and diffusion process ? Grilliches ascertained two main issues with regard to adoption of hybrid corn among regions. First, differences in adoption of hybrid corn can be explained by the expected profitability of the new technology to be used by producers. This issue is a consequence of the amount of adaptive research carried out by state experiment stations (Ruttan). Second, differences in adoption among regions can be explained by differences in the size and densities of the market for the new technology, which will determine the number of buyers.

Other reseachers have found similar results. Mansfield (1961) examined twelve innovations in four industries. He concluded, "adoption is positively related to the expected profit of the innovation to the users and the size of the investment made by the developers. Kislev (1973), found the rate of technological adoption is influenced by the level of skill of adopters and the availability of information about the technology. In summary, it appears much is known about the adoption and diffusion process, but there are no error proof ways of using this knowledge for ex ante analysis.

CHAPTER 4

MILK MARKETING AND MILK PRICING IN ARIZONA

Dairy scientists have found BST will significantly raise milk production per cow on experimental farms. There is consensus among some dairy scientists that commercial dairy producers who want to have the full advantage of synthetic BST will change their herd management practices. Agricultural Economists concur, BST may spur intensive milk production on commercial farms and may speed regional shifts in milk production already under way on the national level. This chapter examines the characteristics of milk production on dairy farms in Arizona and adapts the effect of increased milk yields caused by BST to the institututional framework of milk marketing and milk pricing in Arizona.

Characteristics of Dairy Farms and Milk Production in Arizona

Dairy farms in Arizona are characterized by corrals, drylots, a milking parlor, 500 or more cows and purchased feed. These characteristics permit the milking of 1000 cows or more on as little as 25 to 30 acres of land. The dry and warm climate in Arizona eliminates the capital requirement associated with farms of the Midwest and the Northeast such as, expensive housing for cattle and feed storage systems. Generally, feed is stored without containers and cattle are kept in open corrals.

Purchasing feed inputs in Arizona means milk production in Arizona can be sensitive to feed costs. High milk yields are acheived with high energy and protein feeds grown year around with constant sunlight, applied nutrients and irrigation (Schuh, 1988). Arizona milk producers purchase most of their forage requirements from feed growers near Phoenix and along the Colorado river basin; however, an increasing amount of grain sorghum is being purchased from west Texas when prices are higher in Arizona relative to different growing seasons. Moreover, the mobility of milk cows in corrals coupled with low humidity in Arizona puts less stress on milking cows which tends to boost milk production from the fall to the middle spring. Temperatures in excess of 100 degress in June, July, August and September lower milk production per cow--the end of the milk flush months.

There are an estimated 126 dairy farms and 90,000 cows in the State of Arizona (Arizona Aricultural Statistics, 1987). Average milk production is 18,500 pounds of milk per year. Arizona dairy producers have the highest participation rate in the country for participation in the Dairy Herd Improvement Association (Table 4.1). Eleven percent of the cows in Arizona are registered. Since 1967, milk production has been 17 to 19 percent above the national average (Arizona Agricultural Statistics:1987).

ROLLING HERD AVERAGE OF OFFICIAL HERDS ABOVE 645 FAT

July 1987

HERD NAME	COWS IN HERD	BREED	MILK	% FAT	FAT	DAYS IN MILK AT 1ST BREED
*Stotz Dairy	769	GH	22,117	3.74	828	200
*Feenstra Dairy	27	GH	20,937	3.78	791	190
*A & H Dairy	677	GH	19,893	3.92	780	204
*DeJong Dairy (Mesa)	392	GH	21,790	3.55	774	188
Del Rio Dairy, Inc.	332	GH	20,470	3.76	769	188
*Milky Way Dairy	1396	GH	20,413	3.76	767	183
Happy Acres Holstein Dairy	221	GH	19,926	3.73	742	197
Butler Dairy	314	RH	18,388	4.02	739	220
Happy Acres Brown Swiss	45	RBS	18,015	4.08	736	196
Roeloffs Dairy	1224	GH	19,313	3.79	731	175
*Desert Crest Dairy	479	GH	19,920	3.65	727	177
C & B Dairy	809	GH	19,802	3.67	727	186
*Triple G Dairy	1533	GH	19,540	3.68	718	173
Martha Linda Dairy	1495	GH	19,076	3.76	717	176
*Rijlaarsdam Dairy	938	GH	18,969	3.76	713	209
Pete J. Treguboff Dairy	354	RH	19,173	3.71	712	217
Lobollanta Dairy, Inc.	449	GH	18,392	3.86	709	166
*Arizona Dairy Co. #4	1193	GH	19,822	3.57	707	196
*Smith-Lunt Dairy	915	GH	19,323	3.66	707	193
P & W Dairy	709	GH	18,095	3.89	704	187
*W. L. Baker Dairy, Inc.	479	GH	18,242	3.82	697	199
*Arcor Enterprises	207	RH	20,169	3.45	696	197
*Arizona Dairy Co. #1	937	GH	20,476	3.39	695	195
*Schuburg Holsteins	559	RH	18,640	3.70	691	213
Arnold Anglin Dairy	480	GH	18,621	3.68	686	182
Calimar Dairy	503	GH	18,905	3.62	685	182
*Cliffs Dairy	193	GH	18,489	3.66	677	161
*Arizona Dairy Co. #2	1060	GH	19,664	3.43	674	196
*RGB Brown Swiss	41	RBS	17,358	3.87	673	225
*Arizona Dairy Co. #3	1206	GH	19,134	3.50	671	198
Rezzonico Ranches	670	GH	17,951	3.69	662	178
C & B Dairy	177	RBS	15,872	4.16	661	186
Gladtime West	248	GH	17,896	3.69	660	194
Shamrock Hill Farm	3363	GH	18,808	3.51	660	177
Parker Farms (Chandler)	1880	GH	17,841	3.70	660	188
Marana Dairy	464	RH	17,996	3.65	657	201
*Feenstra Dairy	545	GJ	13,597	4.83	657	170
*Johan Bolle Dairy	277	GH	20,037	3.28	657	165
Herseth Feedlots, Inc.	774	GH	17,253	3.75	648	180
*Arizona Dairy Co. 1R	56	RH	17,986	3.60	647	216
University of Arizona Dairy	210	RH	18,643	3.47	646	179

* 3 X's a day milking

Ninety percent of Arizona's drylot dairy operations are located within 60 miles of Phoenix. Continuing urbanization in this area encourage these dairy operators to relocate every 15-20 years (Dairy Relocation Study, 1985). The possibility of relocation allows important adjustments to be financed primarily by land appreciation. Replacement of worn and obsolete facilities, equipment and expansion adjustments are easily made when "starting from scratch", an improvement which relocation makes possible.

Milk Marketing and Milk Pricing in Arizona

Milk pricing in Arizona is regulated by three important institutional mechanisms. First, a free movement of prices to equilibrate supply and demand is hampered by the federal dairy support program. Milk production in excess of consumer demands is purchased by the Commodity Credit Corporation as butter, cheese and dry-milk. Second, the Central Arizona Milk Marketing Order requires handlers and cooperatives pay producers alternative prices for alternative milk uses. Milk used for fluid consumption receives a higher price than milk used for butter and cheese. The respective utilizations and prices are used to calculate the Federal Order's blend price-a weighted average price. Third, the blend price is used to calculate the quota price paid by the United Dairymen of Arizona (UDA) for a percentage of their milk. A smaller percentage of producer milk receives the lower over-quota price which is generally the class III price, the result of producers purchasing base from UDA. UDA is a milk producer cooperative that operates a supply management program and encourages milk producers to produce at levels near consumer demands. Other programs such as import restrictions, anti-trust exemptions for cooperatives and school lunch programs affect the structure of the dairy industry and contribute to the complexity of price movements.

The Dairy Support Price

The federal order system and UDA's supply management program are important institutions in Arizona's dairy industry, however the most important factor affecting price and income may be the support price. The effect of supporting milk prices above free market levels is demonstrated in Figure 4.1 below:

The price support maintains the price of milk above the equilibrium price level Pe. Producers supply Q1 while at the support price. Consumers demand Qd, leaving excess production Q1 - Qd. The excess production is purchased by the Commodity Credit Corporation (CCC) and eventually disposed of in a variety of ways. The effect of a new technology such as BST forces the supply curve to the right, from S1 to S2, which can increase the amount purchased by the CCC, Q2 - Q1, if the price support is maintained.

Some price adjustment occurs at the farm level in the form of premiums for fat, protein, somatic cell content,

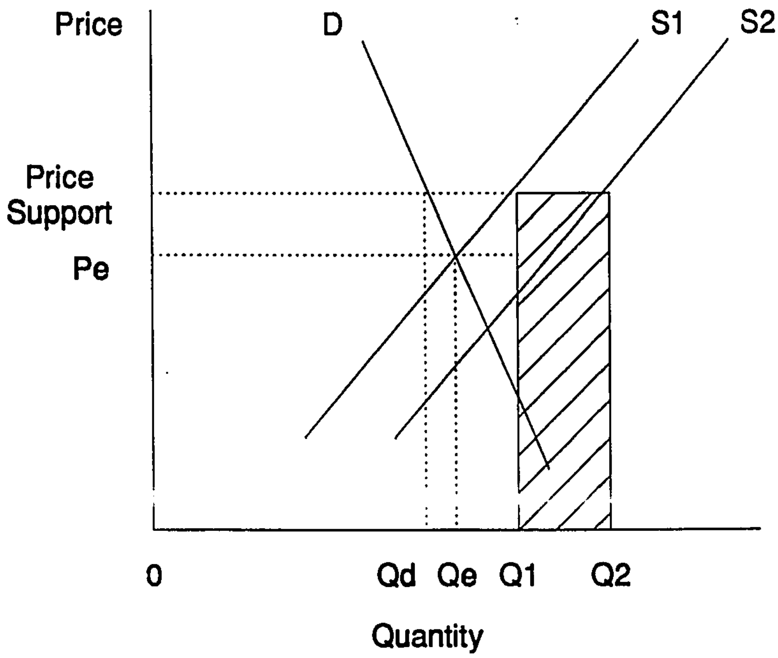

Figure 4.1: The Effect of Increased Milk Production from BST on CCC Purchases and the Support Price

quantity and distance to handler. However, there is little incentive for processors and manufactures to decrease prices paid to producers if the price support also is not adjusted down. Therefore, producers do not get a price signal unless Congress mandates a new lower price support level. The 1986 Farm Bill has written in to it, when CCC purchases climb to 5 billion pounds per year, the support price will be reduced .50 cents on January, 1 of the fiscal year. Conversely, the law establishes, if decreases in net removals fall to 2.5 billion pounds or below, the support will be increased .50 cents per hundred weight (1986 Farm Bill).

The Central Arizona Milk Marketing Order

A federal milk marketing order is a legal mechanism issued by the Secretary of Agriculture to regulate the trade of Grade A milk in a specific geographic area. The Agricultural Marketing Act of 1937 established that such orders may exist. The objective of the act is to provide farmers with adequate income through minimum milk prices and assure an orderly and adequate supply of milk. The Order regulates the terms of trade in milk markets to achieve equal bargaining rights between processors and handlers.

A marketing area is defined by the order and is intended to include distributors which compete with each other for milk sales. The functions of a federal order are among the following: classifying milk by use, establishing minimum producer prices, defining market areas, pooling and providing a thorough and impartial audit of handlers to insure payments to dairy farmers based on the utilization of milk.

The class prices established by an order apply to the milk delivered to regulated handlers by producers in the marketing area. The Federal Milk Market Administrator establishes allocation procedures for milk arriving from other milk marketing orders. An order designates prices by classes according to the use of milk. The Central Arizona Order has a three use classification system. Class I use includes products packaged for fluid consumption such as whole milk. Class II use includes milk for cream, yogurt, cottage cheese and ice cream. Class III use includes milk butter, cheese and nonfat dry milk (See Table 4.2, Volumes and Prices 1987-88). Producer's cash receipts were up 9.681 million dollars in 1987 to a level of 184.6 million dollars from 1986. This increase was caused by a 65 million pound increase in milk marketed and an average annual increase in milk prices (Arizona Agriculture Statistics, 1987).

The price paid by regulated processors for milk is based on the Minnesota and Wisconsin (M-W) price in all orders. The (M-W) price is calculated from prices paid producers by 110 randomly selected cheese, butter and nonfat dry milk manufacturing plants in Minnesota and Wisconsin.

Table 4.2: Volumes and Prices of Milk by Class Use, Quota and Over-Quota Price.

Mo Yr	UTILIZATION Class I	Class II	Class III	PRICE Class I	Class II	Class III	Total Monthly Volume	& Revenue	SUPPORT PRICE	BLEND PRICE	QUOTA PRICE	OVER QUOTA PRICE
Apr 87	68,973	12,782	47,705	13.79	11.38	11.00	129460	$1621352	11.35	12.52	11.00	12.79
May 87	67,918	12,276	50,018	13.55	11.37	11.00	130212	1610065	11.35	12.36	11.00	12.62
Jun 87	63,545	12,803	39,716	13.52	11.26	11.07	116064	1442946	11.35	12.43	11.07	12.69
Jul 87	66,006	13,004	34,885	13.52	11.17	11.17	113895	1427321	11.35	12.53	11.17	12.80
Aug 87	66,139	11,861	29,118	13.59	11.27	11.27	107118	1360662	11.35	12.70	11.27	12.97
Sep 87	69,479	12,529	32,138	13.69	11.48	11.42	114146	1462016	11.35	12.81	11.42	13.08
Oct 87	74,999	12,134	32,350	13.79	11.67	11.35	119483	1543012	11.10	12.91	11.35	13.19
Nov 87	66,731	12,321	38,658	13.94	11.34	11.34	117710	1508332	11.10	12.81	11.34	13.08
Dec 87	73,039	11,477	40,371	13.87	11.22	11.12	124887	1590748	11.10	12.74	11.12	13.01
Jan 88	71,762	11,132	46,361	13.86	11.19	10.91	129255	1624987	10.60	12.57	10.91	12.84
Feb 88	69,667	13,003	45,137	13.64	10.81	10.60	127807	1569273	10.60	12.28	10.60	12.54
Mar 88	73,343	14,408	54,836	13.43	10.43	10.43	142587	1707211	10.60	11.97	10.43	12.22
Average	69,300	12,478	40,941	13.68	11.22	11.06	122719	$1538994	11.10	12.52	11.06	12.82
Total	831,601	149,730	491,293				1472624	$18467927			=====	=====

Prices paid by these plants are determined by relatively competitive supply and demand conditions. The minimum Class I price set by the Central Arizona Order is the (M-W) price plus a fixed differential of $2.52--a mandate from congress. The add on differential is based on the distance from the generally high producing area near EauClaire, Wisconsin, to reflect a blend price high enough to encourage adequate supplies of fluid milk. The Class I price is a minimum price. Producers can increase the Class I differential by negotiating over-order payments. The blend price is a weighted average price which depends on the amount of milk in Class I, II and III as determined by the Milk Market Administrator.

Pooling describes the way total returns from sales of milk are distributed among producers. In Arizona, market wide pooling combines the money value of all milk delivered by all producers in one pool which is divided by the amount of milk priced under the order. Producers are paid a blend price or a weighted average price. However, other orders may have individual handler pooling. Producers delivering milk to a handler under individual handler pooling receive a blend price which reflects Class I utilization of the particular handler only. Therefore, producers in the same order may receive different prices because different handlers have different uses for milk.

The UDA and Supply Management

Almost all Arizona dairy producers have membership in UDA (UDA Publication 1980-1988). UDA members produce 90 percent of all milk pooled by the Central Arizona Order. A significant portion of the remaining milk pooled in Arizona is produced by Shamrock Farms, a producer-handler and also a member of the UDA. The UDA cooperative operates a supply-management program which encourages members to adjust milk production to market needs. UDA supplies the needs of dairy processing plants for Class I and Class II uses; however, it diverts most of the remaining procurement to its own manufacturing facilities to absorb day to day fluctuations in demand. The market is cleared of excess milk by converting it into cheese or butter and milk powder. Fundamentally, UDA is a milk producer's cooperative, but it also assumes the role of processor and bargaining agent.

The Arizona Market, defined by the federal order, is several hundred miles from alternative sources of milk supply. Milk imported from other marketing regions may cost $2.00 per hundred weight more than the Class I price in the Central Arizona Order (State of Arizona vs. UDA, 1980). UDA's effort to supply the Arizona market as efficiently as possible, encourages the production of reserve supplies for the hot season when milk is short. This is preferred to long distance shipments of milk in times of shortage.

Conversely, milk producers are paid less during the flush season if their production exceeds Arizona's milk demands.

The concept of supply management in Arizona began in the 1930's when abuses of shipping rights occured by handlers (Lough, 1974). Handlers were concerned with having a sufficient supply of milk at all times. Indeed, it is to a handler's advantage to have a surplus of milk or effectively a buyers market. Producer groups united and formed the Central Arizona Order. This order included a base-surplus provision. The provision established a base setting period in the hot, seasonally low producing, summer months when supply was decreasing. This season was referred to as the "base-setting" months.

Dairy producers were paid the Class I price or more for all the milk they could produce in the hot season. During the spring flush, the high producing period, dairy producers were paid the same Class I price for a quantity of milk equal to what they had supplied during the base setting period. Quantities of milk exceeding base in the flush season were paid less. The value of base, which is controlled by the market, has attained market values ranging from $3.00 per pound in the beginning to $34.00 at times (Angus, 1988). The market value of base refers to one pound of milk marketed daily. Base may be traded between private parties, thus the actual sale value is rarely recorded. The coop must handle the base transfer but has nothing to do with the pricing of base.

An Arizona dairy producer must own or lease base to receive the higher quota price for milk (See Table 4.2, Volumes and Prices, p.41). Occasionally, base will be sold or leased between members. Producers who are not members of UDA must compete for outlets for their milk. UDA grants milk base to members according to their production in base earning periods. The amount of base owned by members differs among them. New producers have the option of becoming UDA members and building up their own bases in base earning periods or purchasing base from UDA members. UDA has supply arrangements with most processors in Arizona. UDA requires these processors to deal exclusively with UDA. If a non UDA member wants to market his milk in Arizona and he does not own base nor can he find an alternative buyer, he can sell his milk at the over-quota price to UDA.

<u>The Economics of Milk Pricing in Arizona with BST</u>

The Federal Dairy support price and the Central Arizona Order increase the milk prices received by producers and the total quantity of milk produced in Arizona. The supply management program operated by UDA decreases the supply of manufacturing milk pooled under the Central Arizona Order limiting the total milk pooled under the Order, which subsequently increases the weighted average price of milk received by a base owner. The actual effect of the base-quota plan on a producer or a cross section of producers is uncertain because producers have different cost structures and individual producers account for various levels of all milk produced in Arizona. Moreover, the possibility that a non-UDA member may ship milk to UDA for the over-quota price makes it possible for dairy farms with various milk marketings and various cost structures to coexist in Arizona.

Prior to the introduction of a base plan in Arizona, a typical dairy farm was producing (q) units of milk at the Central Arizona Order price (PB) represented by The Farm in (Figure 4.2). Similarly, the dairy industry in Arizona, represented by, The Industry, in figure 4.2 was producing (Q1) units at the Order's blend price.

A milk base plan, created to limit the seasonal variation of milk production, established that producers could have access to a higher priced market for their milk, if they purchased or earned base. On the farm, the quota price is noted by (Quota) and the quantity of quota milk acheived with base is indicated along the X axis and noted by (Quota) . The immediate effect of introducing a base quota plan is the upward shift of a producers average total cost curves from (ATC1) to (ATC2) and an increase in milk production from (q) to (q') on the farm. The upward shift along the marginal cost curve illustrates the opportunity

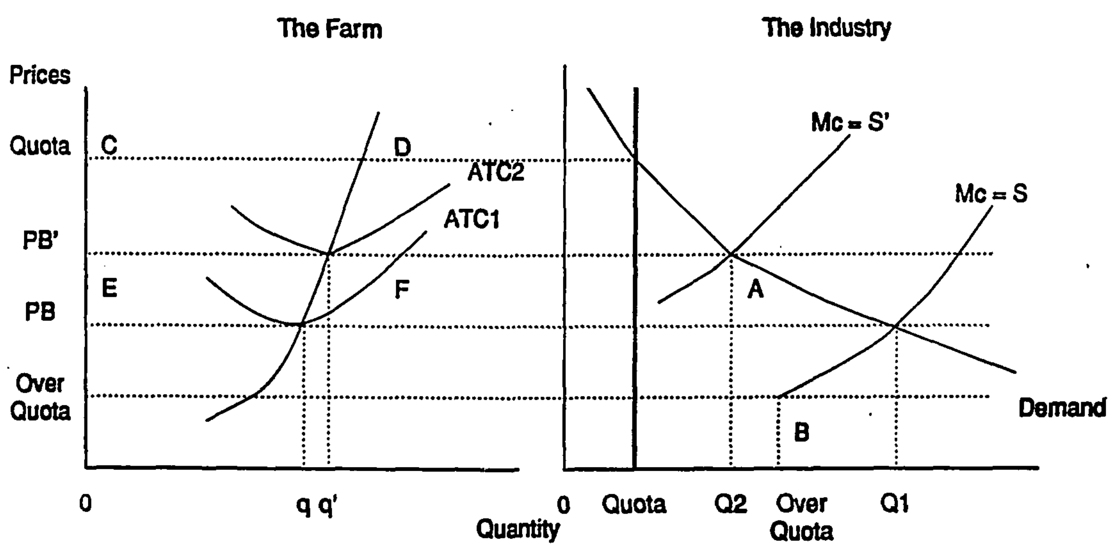

Figure 4.2: The Effect of Supply Management on
The Arizona Dairy Industry and a Farm

cost of investing in base. Again, the effect of purchasing base allows the producer access to a higher priced market, thereby increasing marginal revenue above previous levels and encourages extra production to a limit. However, the decision to purchase base increases the costs associated with additional pounds of milk and subsequently constrains farm output and all milk pooled in Arizona from (Q1) to (Q2). In the higher production months, producers return less average revenue per pound of milk if they exceed their base-quota. The marginal response to the introduction of the milk base plan is the over-quota price. Conversely, producers return more revenue per pound of milk produced in the summer months if they can maintain production at the quota level when warm conditions generally reduce milk yields per cow.

Indeed, farms investing in milk base will limit their milk production thereby increasing the price they receive for their milk. A weighted aveage of the quota price and the overquota price is represented by (PB'). Base enabled the farm to have access to the higher price (PB') and to have the gains from the new weighted average price. The value of base is equal to the area represented by (C,D,E,F). The increase in the cost structure of farms due to the fixed cost of base ownership leads to a decrease in the industry's total milk production from (S) to (S') represented by quantities (Q1) and (Q2) respectively and an increase in the weighted average milk price UDA members receive.

Arizona Producers on a Treadmill with BST (Cochrane 1979)

Dairy producers in Arizona who adopt BST early may find that the unit cost of milk production is reduced. This is illustrated by the adopter in Figure 4.3 by the decline in (ATC1) to (ATC2). Early adopters may increase their output from Q1 to Q2 and earn a profit equal to the area (PB1,R,S,T) as long as the quota and over-quota prices remain constant at (PB1) reflecting no change in the weighted average price received by producers. (PB1) may hold for the adopter if all producers do not adopt at once. However, as more and more producers adopt the technology, the price paid producers for their extra milk will be the over-quota price which will decrease the Order blend price and subsequently decrease the quota price.

Profitability with BST on Arizona dairy farms may encourage other producers to adopt the technology. Widespread adoption of BST will increase milk production further, again decreasing the Order blend price and UDA's quota price from Quota 1 to Quota 2. The end result for the adopters of BST is illustrated in chart A. UDA's quota price falls thereby decreasing producers weighted average price from (PB1) to (PB2) and the economic gains of this technology will have disappeared. Dairy farms will be required to adjust to an alternative equilibrium if the

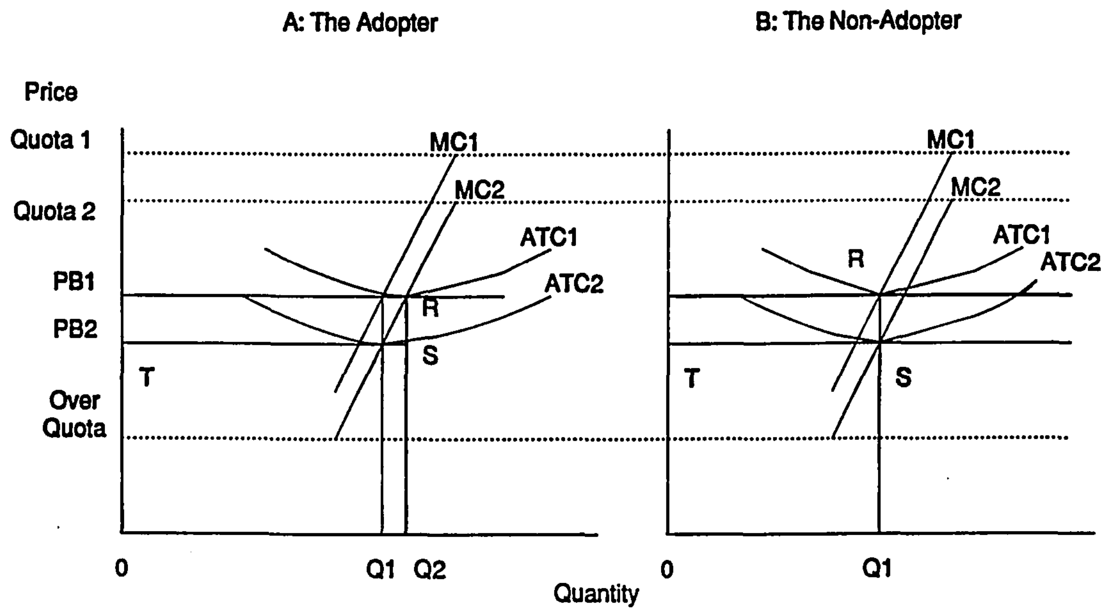

Figure 4.3: The Effect of Decreased Average Total Costs from BST Compared with Non-Adopters

mechanics of the supply management program, the support price and the federal order adjust for larger quantities of milk.

In the long run, losers from BST may be the producers who do not adopt, unless the Federal policy will be to continue supporting the price of milk. The consumers will receive the same amount of product at a lower price. If the cost structure of the non-adopter is (ATC1) in Chart B and the weighted average price of quota and over-quota milk falls from to (BP1) to (BP2), the non-adopter will be sustaining losses equal to (PB1,R S PB2). The cost structure of the non-adopter will be above (PB2) and he will be sustaining losses. The widespread adoption of BST and the fall of (PB1) to (PB2) has the effect of further widening his losses. The non-adopter may not be able to maintain losses of this magnitude in the long-run and he may fail.

The Treadmill and the Milk Support Price

The operation of the treadmill with the milk support price is described below in Figure 4.4. The innovater adopts BST technology and the cost structure declines from ATC1 to ATC2. The price of the product holds at PB1. Again, other farmers follow the lead of the early adopter. The cost structure of these farmers declines and earns a profit equal to (PB1,R,S,T). The price support mechanism and Order pricing holds the weighted average market price of

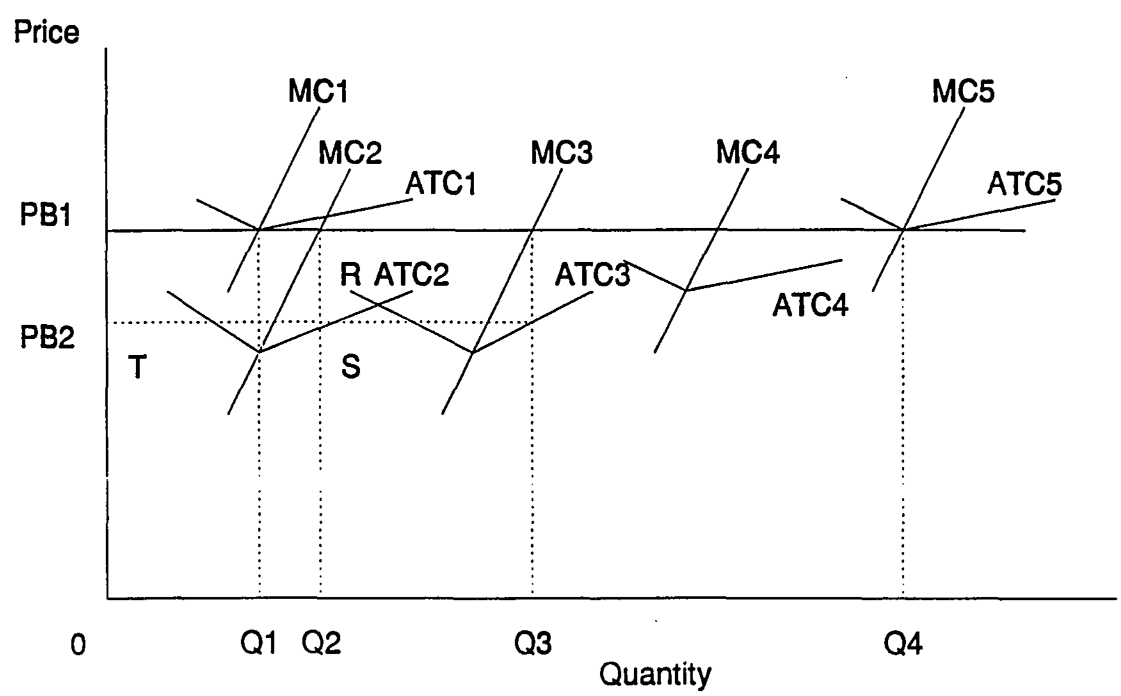

Figure 4.4: The Long-Run Implications of BST Adoption with the Milk Support Price

quota and overquota milk near (PB1). However, the supply management program operated by UDA decreases the quota price but by no more than what producers are guaranteed under the Order program. Adopters will continue to earn a profit as long as the price is supported above free market conditions. If the economic gain from BST use is significant, some producers may expand the size of their operations while others could even reduce the number of cows they milk and still realise a profit. According to the theory, the more aggressive producers who have accumulated economic gain from BST use, may capitalize on facilities or land owned by other producers not generating positive income. The new cost structure for expanding farms could be illustrated by ATC3. As the aggressive farm has grown larger and expanded, the unit cost of production has risen, a result of rising land values and farm values. If the remaining producers strive to increase profits even further through added capitalization, they drive up the price of the limiting factors such as land or capital to a level where the marginal cost of milk production is less profitable, which is represented by (ATC4). In the final solution, the scale operations for more aggressive farmers have increased to the level where average cost and marginal cost equal the institutional price of milk. The number of farms have decreased. If more and more producers adopt BST, the aggregate supply of milk is increased, government purchases of dairy products is increased while the price of milk is maintained above competitive conditions.

If the government support program becomes costly based on added pounds of milk from BST, the 1986 Farm Bill requires a .50 reduction in the support price. Similarly, the supply management program operated by UDA requires producers to receive the lower over-quota price for additional milk produced with BST. The effect of decreasing milk prices is represented by PB1 to PB2. The mechanics of the treadmill are still in operation, however, the magnitude of the expansionist tendencies of aggressive dairy farmers is limited and less efficient producers could discontinue producing milk.

Calculating Milk Prices in Arizona with BST

The theoretical analysis leads to the assumption that increased milk production from BST would enter Class III utilization and be paid the over-quota price. No extra milk would enter Class I and Class II utilization because Arizona dairy producers have agreed to purchase base to receive the higher quota price for an agreed upon percentage of their milk. Therefore, when the UDA receives extra Class III milk due to producers using BST, the blend price will decline and subsequently drive down the price of quota milk.

Today, UDA members receive a quota price for the percentage of base owned by them. The price is determined by the board of directors at UDA. The quota price, found to be positively correlated with the Order blend price, can be regressed on the order blend price to simulate the behavior of the UDA board. Producers also receive an over-quota price which is typically the Class III price. The formulas below represent the functional relationships between prices received by Arizona dairy producers paid by the UDA and the order prices; the relationships are based on historical data consisting of 182 observations appended to Table 4.2 on page 41. Alternative milk prices with BST use were then estimated for the April 1987 to March 1988 marketing year:

1.1 Quota Price = (B0) + (B1)Blend Price R sq.= .99
$12.81 = -.05711 + 1.025605 ($12.55)

1.2 Over-Quota Price = Class III Price
$11.06 = $11.06

This study estimated alternative milk prices for three BST adoption scenarios which account for more and more milk in Arizona. Huber's 12% increase in milk yield was multiplied times 90,000 cows in Arizona if 20%, 50% and 100% of the cows account for the extra milk from BST. The calculation used to generate the extra milk was based on 75% of a cows's lactation affected by BST assuming injections begin 60 to 80 days after calving. A typical lactation was assumed to last 305 days and the state's herd average of 16,300 pounds was used (Arizona Ag Statistics, 1987). Milk prices affected by Arizona producers using BST are illustrated in Table 4.3 . Reductions to the (M-W)

Table 4.3: Estimated Milk Prices Based on Alternative Rates of BST Adoption and Changing Milk Support Price

Adoption Rate	Support Price	Class III cwt	Blend Price	Quota Price	Over-Quota Price	Weighted Average Price
0	0	491,293	12.52	12.82	11.06	12.40
	-.50	491,293	12.02	12.31	10.56	11.89
	-1.00	491,293	11.52	11.79	10.06	11.38
	-1.50	491,293	11.02	11.28	9.56	10.87
	-2.00	491,293	10.52	10.77	9.06	10.36
	-2.50	491,293	10.02	10.25	8.56	9.85
	-3.00	491,293	9.52	9.74	8.06	9.74
	-3.50	491,293	9.02	9.23	7.56	8.83
20%	0	517,800	12.50	12.79	11.06	12.27
	-.50	517,800	12.00	12.28	10.56	11.76
	-1.00	517,800	11.50	11.77	10.06	11.25
	-1.50	517,800	11.00	11.25	9.56	10.74
	-2.00	517,800	10.50	10.74	9.06	10.23
	-2.50	517,800	10.00	10.23	8.56	9.72
	-3.00	517,800	9.50	9.71	8.06	9.21
	-3.50	517,800	9.00	9.20	7.56	8.70
50%	0	557,561	12.46	12.75	11.06	12.24
	-.50	557,561	11.96	12.24	10.56	11.73
	-1.00	557,561	11.46	11.73	10.06	11.22
	-1.50	557,561	10.96	11.21	9.56	10.71
	-2.00	557,561	10.46	10.71	9.06	10.21
	-2.50	557,561	9.96	10.19	8.56	9.69
	-3.00	557,561	9.46	9.68	8.06	9.19
	-3.50	557,561	8.96	9.16	7.56	8.68
100%	0	623,829	12.40	12.69	11.06	12.20
	-.50	623,829	11.90	12.18	10.56	11.69
	-1.00	623,829	11.40	11.69	10.06	11.18
	-1.50	623,829	10.90	11.15	9.56	10.67
	-2.00	623,829	10.40	10.64	9.06	10.16
	-2.50	623,829	9.90	10.13	8.56	9.65
	-3.00	623,829	9.40	9.62	8.06	9.14
	-3.50	623,829	8.90	9.10	7.56	8.63

Note:Estimates are based on 76% Base and average annual prices from April 1987 to March 1988 price were also used to calculate further reductions in farm level milk prices. Increases in milk yield from BST are shown to decrease the quota price. Changes to the (M-W) price decrease further the quota and over-quota prices. Dairy producers who adopt BST early may increase their output and earn additional profit if the cost of BST adoption is less relative to the increase in revenues. Alternatively, non-adopters could receive lower prices for the same amount of milk. These estimated prices are combined with the additional costs of using BST in the next chapter which are used to generate changes to the income statements of adopters and non-adopters in Arizona.

Chapter 5

BST's Impact on the Dairy Enterprize

Dairy Scientist have been experimenting with synthetic BST on cows for three years. The effects of BST on reproduction, animal health, the method and cost of BST injections and the extra labor required to administer BST have not been determined. Some researchers suggest that implanted release injections will minimize labor, but disease surveillance and reproductive performance will require more attention from management (Huber,1988). What is known, BST injections can increase milk yield and feed intake. What is not known, how much will dairy producer's income statements be impacted with BST use if indeed changes to labor and management are minimal and changes in milk output and feed input are significant. Huber's findings at the Arizona experimental farm in Tucson were used to generate the factors of milk production which could change in the budgets of three dairy farms in Arizona. Dairy farm income statements were evaluated in terms of costs and revenues to establish the magnitude of gains made by adopters and losses made by non-adopters relative to the period before BST is made available in the market.

Representative Dairy Budgets

Computer based drylot dairy budgets of 359, 838 and 1436 milking and dry cows were developed to test BST's impact on producer's income statements. Costs and revenues are based on the Arizona Drylot Dairy Budgets developed by Selly and Armstrong in 1983. Input and output factors and prices were updated to reflect costs and revenues to the March 1987 to April-1988 marketing year. An opportunity cost to management was included to reflect possible alternative income to dairying. The budgets are representative of owners who raise their own replacements. However, opportunity costs of land and interest were not included because of varying levels of realestate values and debt in Arizona. Fixed assets were depreciated on the straight line method. Net revenues less operating costs were then summarized for three represtative farms which adopt BST and three which do not adopt BST under the milk pricing framwork in Arizona.

The assumptions regarding BST use were average milk increases would be 12% and feed increases would be 7% using Huber's results. It was assumed dairy producers would begin injections 60 to 80 days after calving. Therefore, only 75% (75% x 12%)of an adopter's milk would be affected and 80% (80% x 7%)of her feed intake would be affected. Producer income statements were evaluated if 20%, 50% and 100% of Arizona dairy producers account for the extra milk produced from BST. Institutional price changes resulting from the extra class III milk pooled in Arizona were adopted to the budgets of the adopters and the non-adopters from Table 4.3. Reductions in the milk support price of -.50 and -1.00 were also adopted to the budgets following 50% of the industry adopting BST.

The Results

Dairy producer in Arizona who adopt BST may find that the unit cost of milk production is decreased. Early adopters may increase their output and earn additional profit as long as milk prices do not suddenly adjust to increased supplies. Figure 5.1 describes the initial impact on net revenues if 20% of Arizona's producers adopt BST. Net revenues increase on all farms adopting BST. Three farms with 359, 838 and 1436 cows which adopt BST, increase their net revenues $40,000, $110,000 and $190,000 respectively, relative to their income status before BST adoption. Factors of milk production which changed significantly in the budgets were those factors related to ouput per cow. Milk sales, milk hauling and cooperative fees increased while the price of quota milk declined to $12.79 per cwt from $12.82 based on more milk shipped as over-quota milk and utilized as Class III. The only input factor changed was feed. Feed costs based on hay, silage, and concentrate increased 7% for the adopters. Average annual prices from April 1987 to March 1988 were used in the calculation with $87, $25 and $124 per ton respectively (See Abreviated Income Statements in Appendix A, The Dairy Simulation Model). Total variable costs increased $20,000, $45,000 and $75,000 respectively which indicates slight

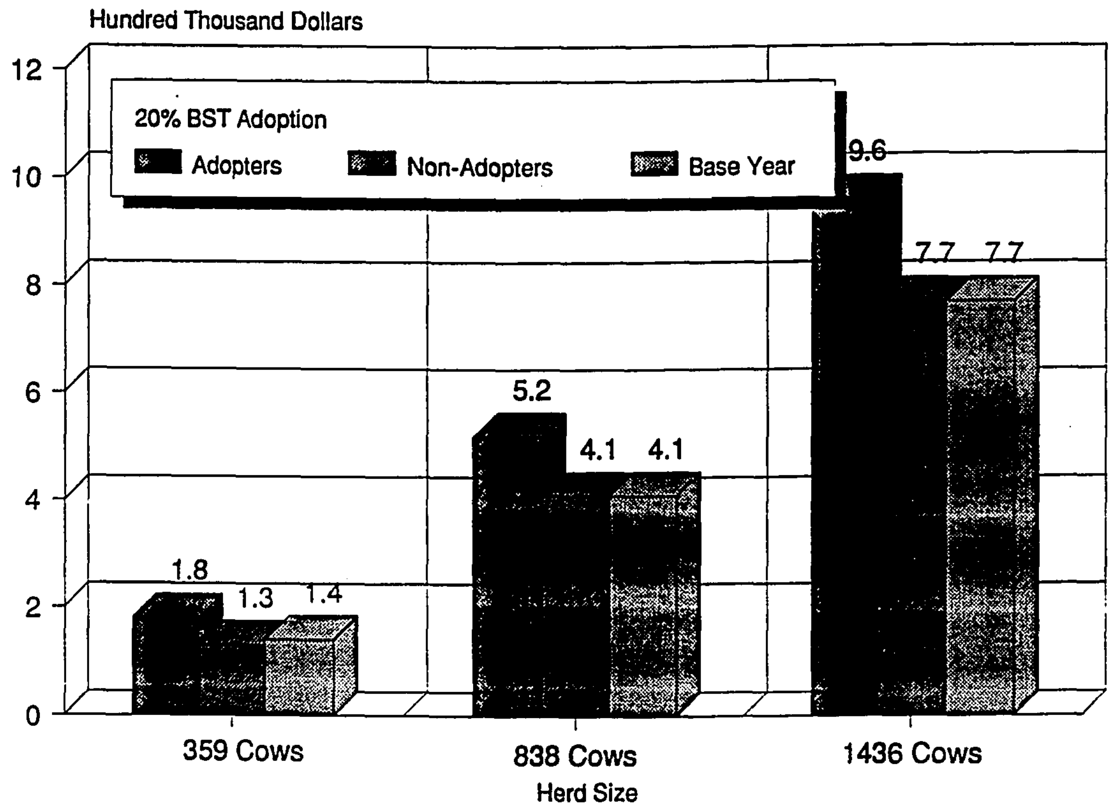

Figure 5.1: Net Revenues on Three Arizona Dairy Farms Before and After BST Adoption

economies of size in milk production. If success with BST is in part acheived with increased feed intake, then supply and price adjustments could occur in the feed industry and reflect higher costs which are not adjusted for in this analysis.

So far, this analysis has addressed the adopters. Dairy producers who do not adopt BST realize a decline in their revenues. The adopters have driven down the quota price for the industry. The non-adopter is estimated to be making $2,000 less on the smaller farm, $3,000 less on the medium sized farm and $6,000 less on a larger farm compared with what they were earning in the base period when BST had not been approved and adopted by some producers.

Each level of increasing milk yield from BST could change the the relative revenues between adopter and non-adopters compared with where they were if BST had not been approved. This differential becomes more apparent with more and more producers accounting for extra milk from BST. In general, producers who do not adopt BST may return less revenue per cow based on declining milk prices in Arizona (See Figures 5.2 and 5.3, Revenues with 50% and 100% Adoption).

Net revenues increase significantly on farms that adopt BST accounting for 50% of the milk pooled in Arizona. As the rate of adoption increases among producers who account for larger quantites of milk to %50 and then, %100,

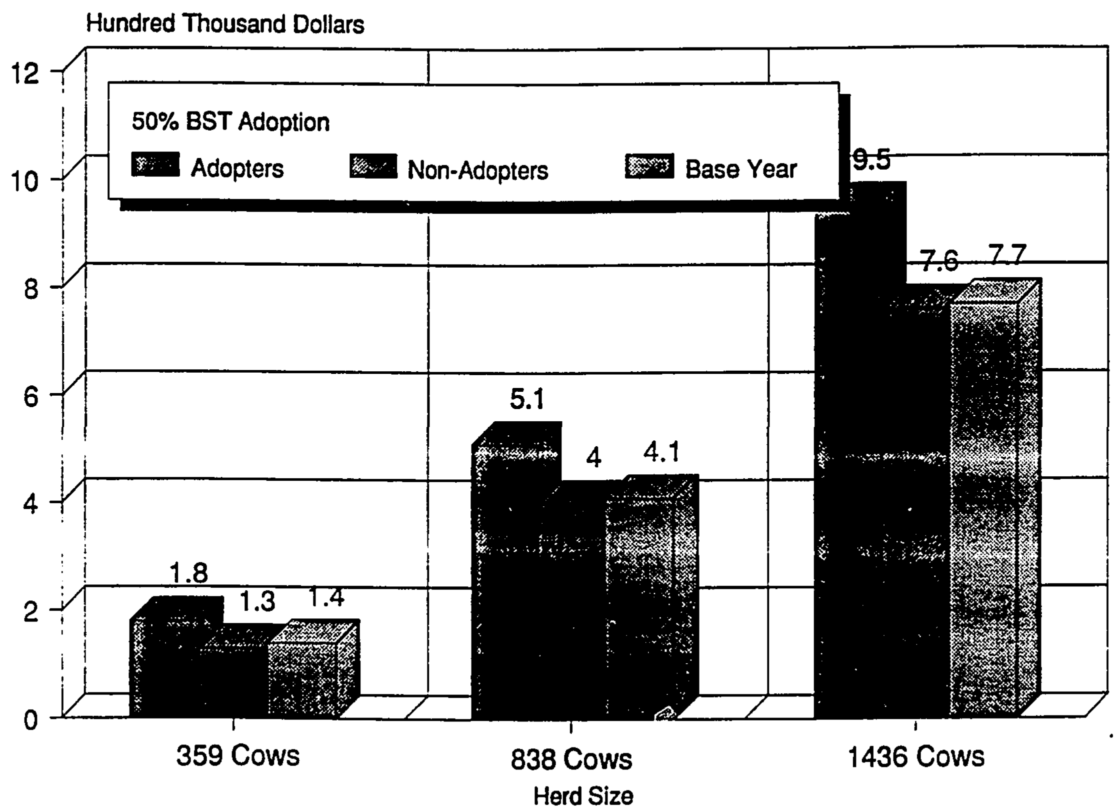

Figure 5.2: Net Revenues on Three Arizona Dairy Farms Before and After BST Adoption

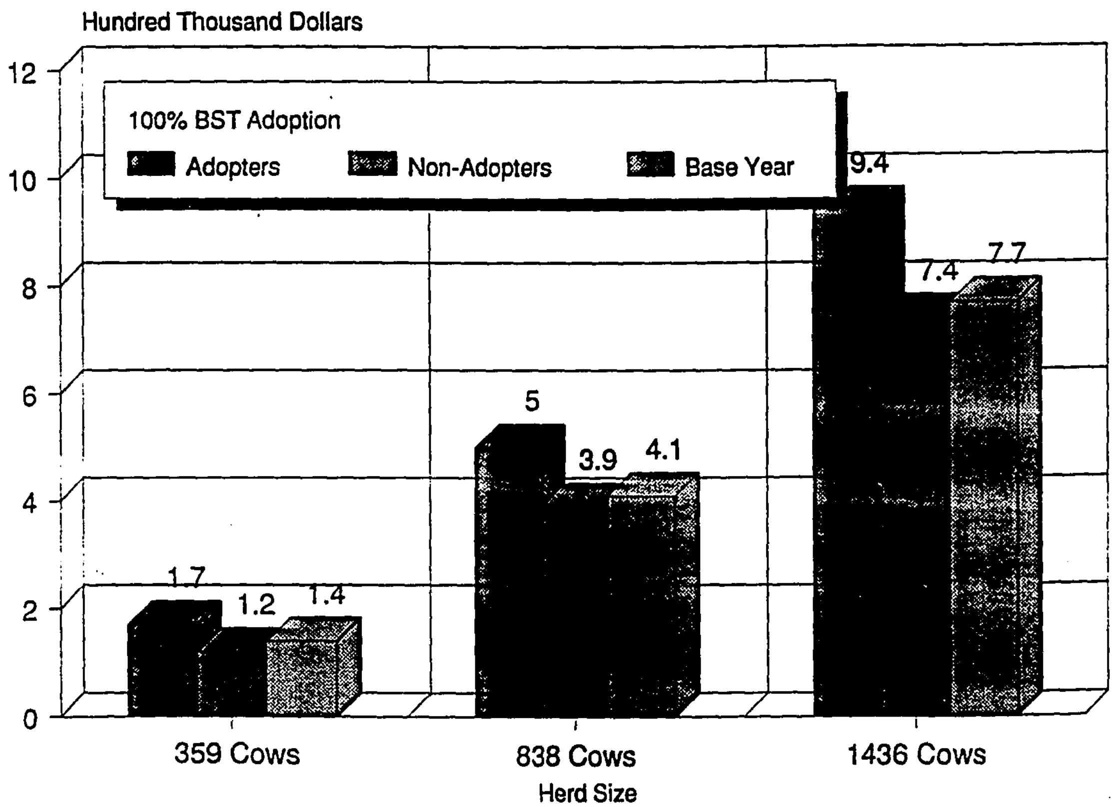

Figure 5.3: Net on Three Arizona Dairy Farms Before and After BST Adoption

the institutional price of quota milk is estimated to decline further to $12.75 and $12.69 respectively, thereby reducing the marginal revenue per pound of milk. Subsequently, the decline of net revenues to non-adopters illustrates the return to long-run equilibrium described by Cochrane(1974). As more and producers increase output from the new technology, the price falls to a level nearer to the marginal costs and average costs of producing milk in the Arizona dairy industry. Widespread adoption of BST suggests therefore that non-adopters, if there are any, would return nearly $10,000, $20,000 and $30,000 less than they were before BST is approved.

In summary, producers who adopt BST early will have immediate profits from its use before they drive down milk prices. The losers may be those producers who do not adopt BST or adopt too late as they receive the same industry prices as the adopters. Input and output costs increase less significanly than the increase in revenues to be gained from BST. However, a sharp increase in government purchases of milkcould trigger the price support falling and decrease. Arizona dairy farm profitability for all. The dairy subsidy could become costly with BST, which could initiate taxpayers and politicians to reduce government expenditures for dairy products. The effect of declining milk support prices were evaluated in the farm budgets. The results of dropping the support price $.50 and $1.00 is evaluated if %50 of

Arizona's milk pooled is affected by BST use. The results are demonstrated in figures 5.4 and 5.5.

If the support price declines .50 cents, the adopter is still making profits above the costs of producing milk in the 1987-1988 base period. The non-adopter is making significantly less. The adopter on the large farm with 1436 cows is making profits above $30,000 while the small adopter is making the same amount in the base year before BST. In the case of the non adopters, net revenues are still above the breakeven levels but may be asking whether or not they may have better alternative uses for their land, labor and management.

When the support price declines $1.00, the adopters are making significantly less than in the 1987-1988 base period. Adopter's net revenues decline to $40,000 on small farms, $70,000 on medium sized farms and $125,000 on large farms from the base period. The non-adopter is still above beakeven. However, when the support price declines $2.00, it is estimated the small nonadopter is making a loss and may be forced to leave the business. When the support price declines $2.50 even the small adopter is below the breakeven level. It was estimated, if the support price declines to $2.50, the medium sized non-adopter would lose but the medium sized adopter would not lose until the support falls $3.00. The large nonadopter and adopter would begin to fail at $3.00 and $3.50 respectively. There may be clear winners

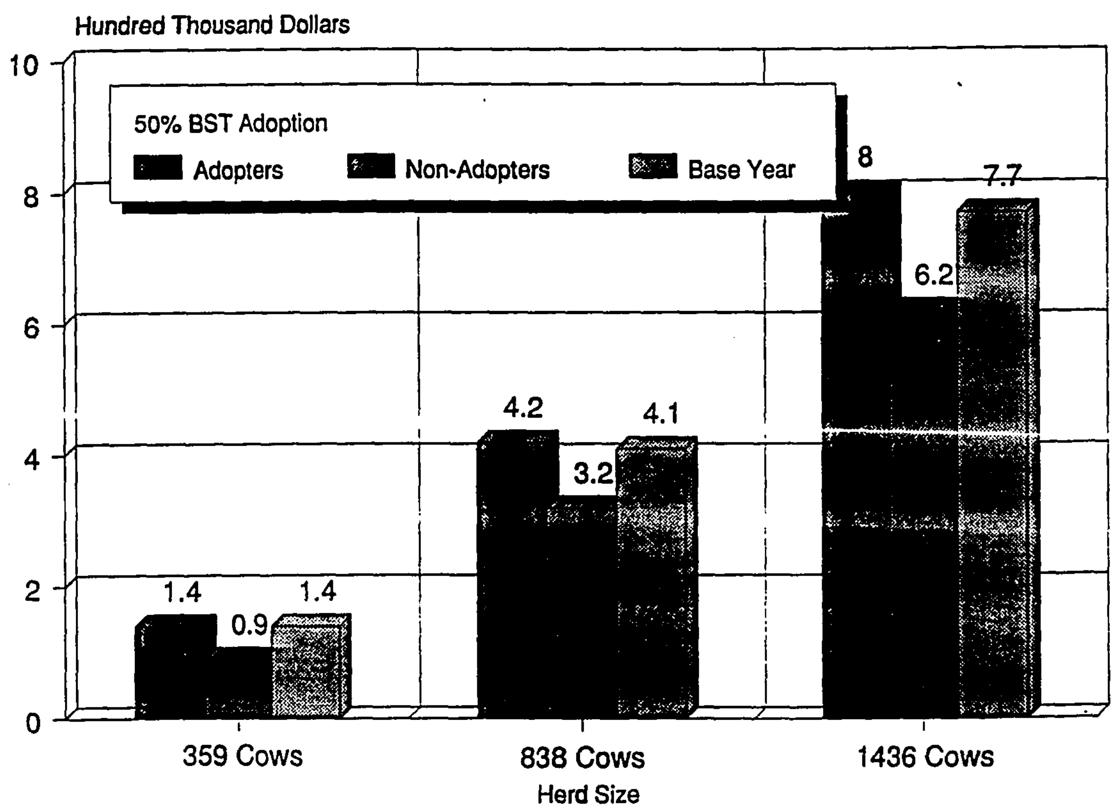

Figure 5.4: Net Revenues on Three Arizona Dairy Farms Before and After BST Adoption: M-W Price -.50.

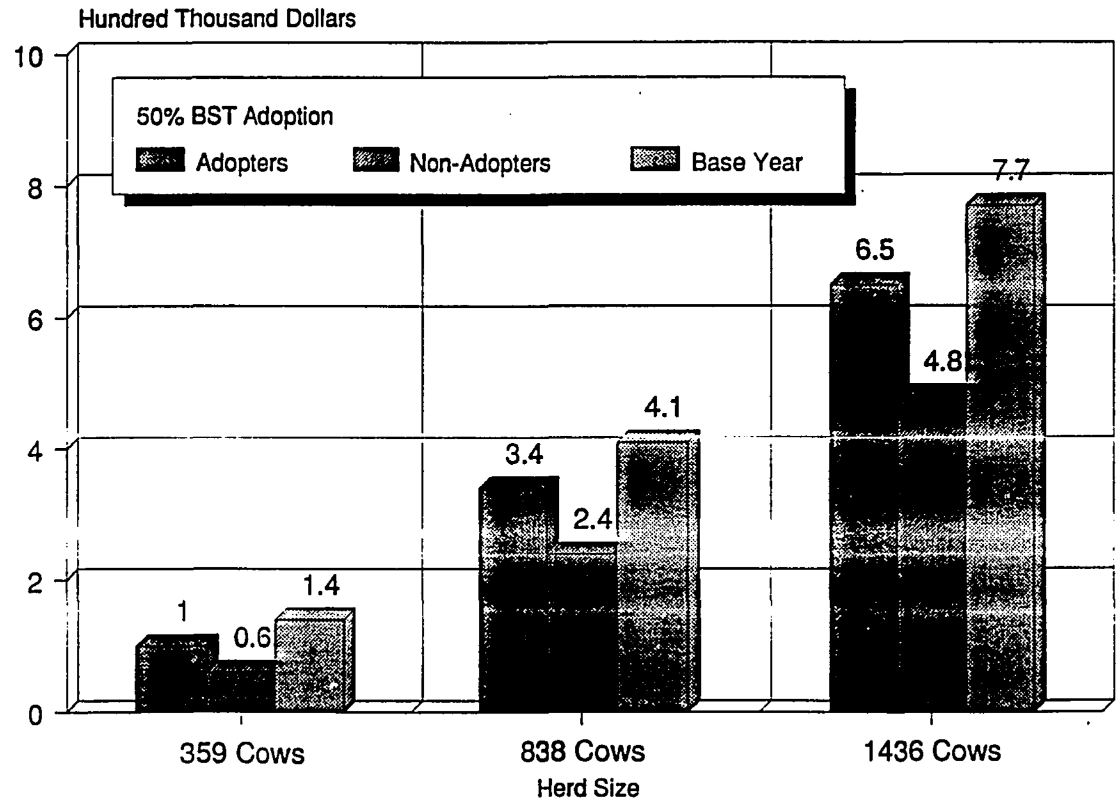

Figure 5.5: Net Revenues on Three Arizona Dairy Farms Before and After BST Adoption: M-W Price -1.00.

and losers with BST, however, this analysis has not accounted for the cost of debt financing nor the opportunity cost of land which may have an important effect on producer decision making with BST. Again, this analysis has not examined all the costs of BST use such as extra labor and management, the actual cost of BST doses and possible reduced fertility in dairy cows.

Conclusion

This study examined Dairy Science research to determine what impacts BST may have on the income statements of Arizona Dairy producers. The findings by Huber were used to generate realistic estimates on representaive drylot dairy budgets. The nature of milk production and the institutional aspects of the Order and the UDA were modeled, The results showed that prices will decline with increased milk yield from BST for several rates of adoption. Three dairy enterprise budgets calculated the effects of increasing costs and declining prices which were shown to increase net revenues for adopters and reduce net revenues for non-adopters. If CCC purchase climb to costly levels with BST, prices may decline even further at the federal level, thereby decreasing revenues for non-adopters and adopters. If BST is approved by the FDA, and some Arizona producers adopt BST while others do not, there could be clear winners and clear losers with BST.

The full impact of BST could have alternative economic implications for dairy producers and further research. A producer could use BST to reduce herd size and maintain milk production at some base level. BST could be used in the summer to generate more output when supply is short and prices are high. Additional research will be required to estimate the extra cost of labor and management and the cost of BST injections. Yet, there are many questions regarding how BST may affect animal health, human health and the properties of milk regardless of the costs and benefits of adopting BST to the farm operation.

APPENDIX A:

Dairy Industry Simulation Model

Enter Change to M-W Price ===)	$0.00
Enter Percent Change of Milk Yield ===)	0.00 %
Enter Adoption Rate of New Technology or Percent of Milk Affected by Policy===)	0.00 %
Enter Change in Quantity of Feed (60/40 Ration)===)	0.00 %
Enter Average Annual Alfalfa Price===)	$87.00 per Ton
Enter Average Annual Concentrate Price===)	$124.00 per Ton

0 = No Change
( )= Denotes Negative Number, Enter with (-) sign.

Table I: SIMULATION OF U.S.D.A. AND U.D.A. MILK PRICING POLICIES

Mo Yr	UTILIZATION Class I	Class II	Class III	PRICE Class I	Class II	Class III	Total Monthly Volume	& Revenue	SUPPORT PRICE	BLEND PRICE	OVER QUOTA PRICE	QUOTA PRICE
Apr 87	68,973	12,782	47,705	13.79	11.38	11.00	129460	$ 1621352	11.35	12.52	11.00	12.79
May 87	67,918	12,276	50,018	13.55	11.37	11.00	130212	1610065	11.35	12.36	11.00	12.62
Jun 87	63,545	12,803	39,716	13.52	11.26	11.07	116064	1442946	11.35	12.43	11.07	12.69
Jul 87	66,006	13,004	34,885	13.52	11.17	11.17	113895	1427321	11.35	12.53	11.17	12.80
Aug 87	66,139	11,861	29,118	13.59	11.27	11.27	107118	1360662	11.35	12.70	11.27	12.97
Sep 87	69,479	12,529	32,138	13.69	11.48	11.42	114146	1462016	11.35	12.81	11.42	13.08
Oct 87	74,999	12,134	32,350	13.79	11.67	11.35	119483	1543012	11.10	12.91	11.35	13.19
Nov 87	66,731	12,321	38,658	13.94	11.34	11.34	117710	1508332	11.10	12.81	11.34	13.08
Dec 87	73,039	11,477	40,371	13.87	11.22	11.12	124887	1590748	11.10	12.74	11.12	13.01
Jan 88	71,762	11,132	46,361	13.86	11.19	10.91	129255	1624987	10.60	12.57	10.91	12.84
Feb 88	69,667	13,003	45,137	13.64	10.81	10.60	127807	1569273	10.60	12.28	10.60	12.54
Mar 88	73,343	14,408	54,836	13.43	10.43	10.43	142587	1707211	10.60	11.97	10.43	12.22
Avg. . Yield	69,300	12,478	40,941	13.68	11.22	11.06	122719	$ 1538994	11.10	12.52	11.06	12.82
Annual Yield	831,601	149,730	491,293				1472624	$18467927			=====	=====

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona Under Various Rates of BST Adoption

Cow's per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Total Costs
359	$1,062,902 $845,521	$876,468 $472,098	$51,117	$135,317	$377	$1.38	$186,434	14.59%
838	$2,481,092 $1,973,669	$1,965,821 $1,102,000	$105,470	$409,802	$489	$2.57	$515,272	19.78%
1436	$4,251,610 $3,382,086	$3,289,608 $1,388,331	$188,993	$773,009	$538	$2.88	$962,001	22.22%

Weighted Average Price of Milk Received by Producers(Base=76%)====) $ 12.40
State Rolling Herd Average(90,000 cows)====) 16,362 Pounds

```
##############################################################################################
#                                                                                            #
# Enter Change to M-W Price ===============================================>   $0.00         #
# Enter Percent Change of Milk Yield ======================================>   0.12 %        #
# Enter Adoption Rate of New Technology or Percent of Milk Affected by Policy=========>   0.20 %  #
# Enter Change in Quantity of Feed (60/40 Ration)==========================>   0.07 %        #
# Enter Average Annual Alfalfa Price=======================================>   $87.00 per Ton  #
# Enter Average Annual Concentrate Price===================================>   $124.00 per Ton #
#                        0 = No Change                                                       #
#                  (   )= Denotes Negative Number, Enter with (-) sign.                      #
##############################################################################################
```

Table I: SIMULATION OF U.S.D.A. AND U.D.A. MILK PRICING POLICIES

Mo Yr	UTILIZATION Class I	UTILIZATION Class II	UTILIZATION Class III	PRICE Class I	PRICE Class II	PRICE Class III	Total Monthly Volume	Total Monthly Revenue	SUPPORT PRICE	BLEND PRICE	OVER QUOTA PRICE	QUOTA PRICE
Apr 87	68,973	12,782	50,035	13.79	11.38	11.00	131790	$ 1646985	11.35	12.50	11.00	12.76
May 87	67,918	12,276	52,362	13.55	11.37	11.00	132556	1635847	11.35	12.34	11.00	12.60
Jun 87	63,545	12,803	41,805	13.52	11.26	11.07	118153	1466073	11.35	12.41	11.07	12.67
Jul 87	66,006	13,004	36,935	13.52	11.17	11.17	115945	1450221	11.35	12.51	11.17	12.77
Aug 87	66,139	11,961	31,046	13.59	11.27	11.27	109046	1382392	11.35	12.68	11.27	12.94
Sep 87	69,479	12,529	34,193	13.69	11.48	11.42	116201	1485480	11.35	12.78	11.42	13.05
Oct 87	74,333	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Nov 87	66,731	12,321	40,777	13.94	11.34	11.34	119829	1532359	11.10	12.79	11.34	13.06
Dec 87	73,039	11,477	42,619	13.87	11.22	11.12	127135	1615746	11.10	12.71	11.12	12.98
Jan 88	71,762	11,132	48,688	13.86	11.19	10.91	131582	1650370	10.60	12.54	10.91	12.81
Feb 88	69,667	13,003	47,438	13.64	10.81	10.60	130108	1593658	10.60	12.25	10.60	12.51
Mar 88	73,343	14,408	57,403	13.43	10.43	10.43	145154	1733981	10.60	11.95	10.43	12.19
Avg. Yield	69,300	12,478	43,150	13.63	11.22	11.06	124928	$ 1563378	11.10	12.50	11.06	12.79
Annual Yield	831,601	149,730	517,800				1499131	$18760535			=====	=====

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona Under Various Rates of BST Adoption

Cow's per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Total Costs
359	$1,129,370 $911,989	$895,261 $486,838	$51,117	$182,992	$510	$2.46	$234,110	19.34%
838	$2,636,246 $2,128,822	$2,009,687 $1,136,408	$105,470	$521,093	$622	$3.00	$626,559	24.64%
1436	$4,517,481 $3,647,957	$3,364,777 $1,947,353	$188,993	$963,711	$671	$3.24	$1,152,704	27.12%

Weighted Average Price of Milk Received by Producers(Base=76%)====================> $ 12.27
State Rolling Herd Average(90,000 cows)==> 16,657 Pounds

		OBPrice	QPrice
Note: Adoption scenarios are adapted to data on previous page at top		11.06	12.79

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona for Non BST Adopters Using Recalculated Milk Pri

Cows per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Tot. Costs
359	$1,061,466	$876,468	$51,117	$133,880	$373	$1.96	$184,998	14.43%
	$844,085	$472,098						
838	$2,477,740	$1,965,821	$105,470	$406,449	$485	$2.55	$511,919	19.62%
	$1,970,316	$1,102,000						
1436	$4,245,864	$3,289,608	$188,393	$767,263	$534	$2.81	$956,256	22.06%
	$3,376,340	$1,888,391						

Weighted Average Price of Milk Received by Producers(Base=76%)====================> $ 12.37
State Rolling Herd Average(90,000 cows)==> 16,362 Pounds

Enter Change to M-W Price	$0.00
Enter Percent Change of Milk Yield	0.12 %
Enter Adoption Rate of New Technology or Percent of Milk Affected by Policy	0.50 %
Enter Change in Quantity of Feed (60/40 Ration)	0.07 %
Enter Average Annual Alfalfa Price	$87.00 per Ton
Enter Average Annual Concentrate Price	$124.00 per Ton

0 = No Change
( )= Denotes Negative Number, Enter with (-) sign.

Table I: SIMULATION OF U.S.D.A. AND U.D.A. MILK PRICING POLICIES

Mo Yr	UTILIZATION Class I	Class II	Class III	PRICE Class I	Class II	Class III	Total Monthly Volume	& Revenue	SUPPORT PRICE	BLEND PRICE	OVER QUOTA PRICE	QUOTA PRICE
Apr 87	68,973	12,732	53,531	13.79	11.38	11.00	135286	$ 1605435	11.35	12.46	11.00	12.72
May 87	57,318	12,276	55,678	13.55	11.07	11.00	125972	1574520	11.35	12.31	11.00	12.56
Jun 87	63,545	12,303	44,339	13.52	11.26	11.07	121287	1500764	11.35	12.37	11.07	12.63
Jul 87	66,006	13,004	40,010	13.52	11.17	11.17	119020	1484571	11.35	12.47	11.17	12.74
Aug 87	66,139	11,861	33,938	13.59	11.27	11.27	111938	1414987	11.35	12.64	11.27	12.91
Sep 87	69,479	12,529	37,275	13.69	11.48	11.42	119283	1520676	11.35	12.75	11.42	13.02
Oct 87	74,999	12,134	37,727	13.79	11.67	11.35	124860	1604038	11.10	12.85	11.35	13.12
Nov 87	66,731	12,321	43,955	13.94	11.34	11.34	123007	1598399	11.10	12.75	11.34	13.02
Dec 87	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.57	[illegible]	[illegible]
Jan 88	71,762	11,132	52,177	13.86	11.19	10.91	135071	1688445	10.60	12.50	10.91	12.76
Feb 88	69,667	13,003	50,888	13.64	10.81	10.60	133558	1630236	10.60	12.21	10.60	12.46
Mar 88	73,343	14,408	51,252	13.43	10.43	10.43	149003	1774135	10.60	11.91	10.43	12.15
Avg Yield	69,300	12,478	46,463	13.68	11.22	11.06	123241	$ 1599954	11.1[illegible]	12.46	11.06	12.75
Annual Yield	831,601	149,730	557,561				1503892	$13199447			=====	=====

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona Under Various Rates of BST Adoption

Cow's per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Total Costs
359	$1,127,349 $909,968	$895,261 $486,838	$51,117	$180,971	$504	$2.43	$232,089	19.12%
838	$2,631,528 $2,124,104	$2,009,687 $1,136,408	$105,470	$516,371	$616	$2.98	$621,841	24.41%
1436	$4,509,396 $3,633,873	$3,364,777 $1,947,352	$188,993	$955,627	$665	$3.21	$1,144,619	26.30%

Weighted Average Price of Milk Received by Producers(Base=76%)	$ 12.24
State Rolling Herd Average(90,000 cows)	17,033 Pounds

	QQPrice	QPrice
	11.05	12.75

Note: Adoption scenarios are adapted to data on previous page at top

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona for Non BST Adopters Using Recalculated Milk Pri-

Cows per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Tot Costs
359	$1,059,392	$876,468	$51,117	$131,807	$367	$1.93	$182,924	14.21%
	$842,012	$472,098						
838	$2,472,899	$1,965,821	$105,470	$401,608	$479	$2.52	$507,079	19.39%
	$1,965,475	$1,102,000						
1436	$4,237,570	$3,289,608	$188,393	$758,969	$529	$2.78	$947,961	21.82%
	$3,368,046	$1,888,391						

Weighted Average Price of Milk Received by Producers(Base=76%)====================) $ 12.34

State Rolling Herd Average(90,000 cows)==) 16,362 Pounds

```
* Enter Change to M-W Price ===========================================)  $0.00
* Enter Percent Change of Milk Yield ==================================)  0.12 %
* Enter Adoption Rate of New Technology or Percent of Milk Affected by Policy==========)  1.00 %
* Enter Change in Quantity of Feed (60/40 Ration)======================)  0.07 %
* Enter Average Annual Alfalfa Price===================================)  $87.00 per Ton
* Enter Average Annual Concentrate Price===============================)  $124.00 per Ton
*                      0 = No Change
*              (   )= Denotes Negative Number, Enter with (-) sign.
```

Table I: SIMULATION OF U.S.D.A. AND U.D.A. MILK PRICING POLICIES

Mo Yr	UTILIZATION Class I	Class II	Class III	PRICE Class I	Class II	Class III	Total Monthly Volume	& Revenue	SUPPORT PRICE	BLEND PRICE	OVER QUOTA PRICE	QUOTA PRICE
Apr 87	68,973	12,782	59,356	13.79	11.00	11.00	141111	$ 1749517	11.35	12.40	11.00	12.66
May 87	57,918	12,276	61,737	13.55	11.37	11.00	141931	1738975	11.35	12.25	11.00	12.51
Jun 87	63,545	12,803	50,162	13.52	11.25	11.07	126510	1558581	11.35	12.32	11.07	12.58
Jul 87	66,006	13,004	45,136	13.52	11.17	11.17	124146	1541820	11.35	12.42	11.17	12.66
Aug 87	66,139	11,861	38,759	13.59	11.27	11.27	116759	1469312	11.35	12.58	11.27	12.85
Sep 87	69,479	12,529	42,411	13.69	11.48	11.42	124419	1579336	11.35	12.69	11.42	12.96
Oct 87	74,999	12,134	40,103	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12.78	11.05	[illegible]
Nov 87	66,731	12,321	49,252	13.94	11.34	11.34	128304	1628467	11.10	12.69	11.34	12.96
Dec 87	73,039	11,477	51,611	13.07	11.22	11.12	136127	1715735	11.10	12.60	11.12	12.87
Jan 88	71,762	11,132	57,994	13.86	11.10	10.91	140888	1751902	10.60	12.43	10.91	12.70
Feb 88	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10.60	[illegible]	[illegible]	[illegible]
Mar 88	73,343	14,400	67,663	13.43	10.43	10.43	155420	1841050	10.60	11.85	10.43	12.09
Avg Yield	69,300	12,478	51,935	13.60	11.22	11.05	130763	$ 1660914	11.10	12.40	11.06	12.60
Annual Yield	831,601	149,730	623,229				1505160	$19930966			=====	=====

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona Under Various Rates of BST Adoption

Cow's per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Total Costs
359	$1,124,203 $906,822	$895,261 $486,838	$51,117	$177,825	$495	$2.39	$228,943	18.79%
838	$2,624,184 $2,116,761	$2,009,687 $1,136,408	$105,470	$509,028	$607	$2.93	$614,498	24.07%
1436	$4,496,813 $3,627,289	$3,364,777 $1,947,353	$180,993	$943,043	$657	$3.17	$1,132,036	26.54%

Weighted Average Price of Milk Received by Producers(Base=76%)====================) $ 12.20

State Rolling Herd Average(90,000 cows)===) 17,835 Pounds

	DQPrice	QPrice
Note: Adoption scenarios are adapted to data on previous page at top	11.06	12.69

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona for Non BST Adopters Using Recalculated Milk Pri.

Cows per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Tot. Costs
359	$1,056,282 $838,901	$876,468 $472,098	$51,117	$128,696	$358	$1.89	$179,814	13.87%
838	$2,465,639 $1,958,215	$1,965,821 $1,102,000	$105,470	$394,348	$471	$2.48	$499,818	19.04%
1436	$4,225,128 $3,355,605	$3,289,608 $1,888,391	$188,993	$746,527	$520	$2.74	$935,520	21.46%

Weighted Average Price of Milk Received by Producers(Base=76%)====================) $ 12.30
State Rolling Herd Average(90,000 cows)==) 16,362 Pounds

```
#################################################################################################
#                                                                                               #
# Enter Change to M-W Price ==============================================>   ($0.50)          #
# Enter Percent Change of Milk Yield ======================================>   0.12 %           #
# Enter Adoption Rate of New Technology or Percent of Milk Affected by Policy==========>  0.50 % #
# Enter Change in Quantity of Feed (60/40 Ration)==========================>   0.07 %           #
# Enter Average Annual Alfalfa Price=======================================>   $87.00 per Ton   #
# Enter Average Annual Concentrate Price===================================>   $124.00 per Ton  #
#                          0 = No Change                                                        #
#                     (   )= Denotes Negative Number, Enter with (-) sign.                      #
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Table I: SIMULATION OF U.S.D.A. AND U.D.A. MILK PRICING POLICIES

Mo Yr	UTILIZATION Class I	Class II	Class III	PRICE Class I	Class II	Class III	Total Monthly Volume	& Revenue	SUPPORT PRICE	BLEND PRICE	OVER QUOTA PRICE	QUOTA PRICE
Apr 88	68,973	12,782	53,531	13.29	10.83	10.50	135286	$ 1617792	10.85	11.96	10.50	12.21
May 88	67,918	12,276	55,878	13.05	10.87	10.50	136072	1606484	10.85	11.81	10.50	12.05
Jun 88	63,545	12,803	44,939	13.02	10.76	10.57	121287	1440120	10.85	11.87	10.57	12.12
Jul 88	55,006	13,004	40,010	13.02	10.67	10.67	119020	1425060	10.85	11.97	10.67	12.22
Aug 88	66,139	11,361	33,938	13.09	10.77	10.77	111938	1359018	10.85	12.14	10.77	12.39
Sep 88	69,479	12,523	37,275	13.19	10.98	10.92	[illegible]	[illegible]	[illegible]	12.25	10.92	12.51
Oct 88	74,999	12,134	37,727	13.29	11.17	10.85	124860	1541609	10.60	12.35	10.85	12.61
Nov 88	66,731	12,321	43,955	13.44	10.84	10.84	123007	1506896	10.60	12.25	10.84	12.51
Dec 88	73,039	11,477	45,991	13.37	10.72	10.62	130507	1587988	10.60	12.17	10.62	12.42
Jan 89	71,762	11,132	52,177	13.36	10.69	10.41	135071	1620909	10.10	12.00	10.41	12.25
Feb 89	69,667	13,003	50,888	13.14	10.31	10.10	133558	1563457	10.10	11.71	10.10	11.95
Mar 89	73,343	14,408	61,252	12.93	9.93	9.93	149003	1699633	10.10	11.41	9.93	11.64
Avg Yield	69,300	12,478	46,463	13.18	10.72	10.56	128241	$ 1535833	10.60	11.96	10.56	12.24
Annual Yield	831,601	149,730	557,561				1538892	$18430001			=====	=====

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona Under Various Rates of BST Adoption

Cow's per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Total Costs
359	$1,089,511 $872,130	$895,261 $486,838	$51,117	$143,133	$399	$1.93	$194,250	15.12%
838	$2,543,204 $2,035,780	$2,009,687 $1,136,408	$105,470	$428,047	$511	$2.47	$533,517	20.24%
1436	$4,358,044 $3,488,520	$3,364,777 $1,947,353	$180,993	$804,274	$560	$2.70	$993,267	22.63%

Weighted Average Price of Milk Received by Producers(Base=76%)====================> $ 11.73
State Rolling Herd Average(90,000 cows)==> 17,099 Pounds

							OOPrice	QPrice
Note: Adoption scenarios are adapted to data on previous page at top							10.56	12.24

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona for Non BST Adopters Using Recalculated Milk Pri·

Cows per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Tot. Costs
359	$1,024,769	$876,468	$51,117	$97,183	$271	$1.42	$148,301	10.48%
	$807,388	$472,098						
838	$2,392,079	$1,965,821	$105,470	$320,788	$383	$2.01	$426,259	15.49%
	$1,884,655	$1,102,000						
1436	$4,099,076	$3,289,608	$188,993	$620,475	$432	$2.27	$809,468	17.84%
	$3,229,553	$1,888,391						

Weighted Average Price of Milk Received by Producers(Base=76%)=====================) $ 11.84

State Rolling Herd Average(30,000 cows)==) 16,362 Pounds

Enter Change to M-W Price ==>	($1.00)
Enter Percent Change of Milk Yield ==>	0.12 %
Enter Adoption Rate of New Technology or Percent of Milk Affected by Policy=============>	0.50 %
Enter Change in Quantity of Feed (60/40 Ration)==>	0.07 %
Enter Average Annual Alfalfa Price==>	$87.00 per Ton
Enter Average Annual Concentrate Price==>	$124.00 per Ton
0 = No Change	
( )= Denotes Negative Number, Enter with (-) sign.	

Table I: SIMULATION OF U.S.D.A. AND U.D.A. MILK PRICING POLICIES

Mo Yr	UTILIZATION Class I	Class II	Class III	PRICE Class I	Class II	Class III	Total Monthly Volume	& Revenue	SUPPORT PRICE	BLEND PRICE	OVER QUOTA PRICE	QUOTA PRICE
Apr 88	68,973	12,782	53,531	12.79	10.38	10.00	135286	$ 1550149	10.35	11.46	10.00	11.69
May 88	67,918	12,276	55,878	12.55	10.37	10.00	136072	1538448	10.35	11.31	10.00	11.54
Jun 88	63,545	12,803	44,939	12.52	10.26	10.07	121287	1379477	10.35	11.37	10.07	11.61
Jul 88	66,006	13,004	40,010	12.52	10.17	10.17	119020	1365550	10.35	11.47	10.17	11.71
Aug 88	66,139	11,861	33,938	12.59	10.27	10.27	111938	1303049	10.35	11.64	10.27	11.88
Sep 88	69,479	12,529	37,275	12.69	10.48	10.42	119283	1401393	10.35	11.75	10.42	11.99
Oct 88	74,333	12,134	37,727	12.79	10.57	10.35	124350	1479179	10.10	11.85	10.35	12.09
Nov 88	66,731	12,321	43,955	12.94	10.34	10.34	123007	1445392	10.10	11.75	10.34	11.99
Dec 88	73,039	11,477	45,991	12.87	10.22	10.12	130507	1522735	10.10	11.67	10.12	11.91
Jan 89	71,762	11,132	52,177	12.86	10.19	9.91	135071	1553373	9.60	11.50	9.91	11.74
Feb 89	63,567	10,003	50,333	12.04	9.31	9.60	133558	1406678	9.60	11.21	9.60	11.44
Mar 89	73,343	14,408	61,252	12.43	9.43	9.43	149003	1625131	9.60	10.91	9.43	11.13
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Avg Yield	69,300	12,473	46,463	12.68	10.22	10.06	128241	$ 1471713	10.10	11.46	10.06	11.70
Annual Yield	831,601	149,730	557,561				1538892	$17660555			=====	=====

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona Under Various Rates of BST Adoption

Cow's per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Total Costs
359	$1,051,673 $834,292	$895,261 $486,838	$51,117	$105,295	$293	$1.42	$156,412	11.13%
838	$2,454,880 $1,947,456	$2,009,687 $1,136,408	$105,470	$339,723	$405	$1.96	$445,193	16.06%
1436	$4,206,691 $3,337,168	$3,364,777 $1,947,353	$188,993	$652,922	$455	$2.20	$841,914	18.37%

Weighted Average Price of Milk Received by Producers(Base=76%)====================> $ 11.22
State Rolling Herd Average(90,000 cows)==> 17,099 Pounds

									OQPrice	QPrice
Note: Adoption scenarios are adapted to data on previous page at top									10.06	11.73

Table II: Abbreviated Income Statements for Three Representative Dairy Farms in Arizona for Non BST Adopters Using Recalculated Milk Pri.

Cows per Farm	Total Receipts & Milk Sales	Variable Costs & Feed Costs	Fixed Costs	Net Return	Return per Cow	Return per CWT	Total Return Less Variable Cost	Return on Tot. Costs
359	$990,146 $772,765	$876,468 $472,098	$51,117	$62,560	$174	$0.92	$113,677	6.74%
838	$2,311,259 $1,803,835	$1,965,821 $1,102,000	$105,470	$239,968	$286	$1.51	$345,438	11.59%
1436	$3,960,583 $3,091,059	$3,289,608 $1,888,391	$188,993	$481,982	$336	$1.77	$670,974	13.86%

Weighted Average Price of Milk Received by Producers(Base=76%)=====================> $ 11.33
State Rolling Herd Average(30,000 cows)==> 16,362 Pounds

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