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An Evaluation of the Effectiveness of the Florida Cooperative's Seasonal Pricing Plan on Seasonal Production Variability

Andrew A. Washington, Robert W. Lawson Jr., and Richard L. Kilmer

ABSTRACT

From 1993–1995, Florida dairy cooperatives implemented a seasonal pricing plan in an attempt to decrease the variability in seasonal production. Farmers that participated in the seasonal pricing plan were able to reduce seasonality in each year when compared to 1992 by as much as 20 percent. For farmers that did not participate, seasonality increased in each year by as much as 32 percent. Overall, the seasonal pricing plan was effective in reducing seasonality for those farmers that chose to participate in the plan and that its limited short-run success was the result of seasonality increases by non-participating farms.

Key Words: *amplitude, seasonal pricing plan, seasonality.*

Florida milk production varies throughout the year, with production being highest in the spring and lowest in the late summer. There are two primary reasons for this occurrence. First are biological factors that are affected by moderate temperatures in the spring and hot weather in the summer. Second is the farmer's perception of the profitability of spring production. During the cooler months, more milk per cow is produced at lower input cost levels (Kaiser, Otenacu, and Smith). Additionally, the demand for milk varies seasonally due to school lunch programs and tourism. However, milk consumption tends to be less volatile than production. These yearly patterns of production and consumption result in supply and demand imbalances that require Florida cooperatives to import and export bulk fluid milk during various times of the year.

Correcting the disequilibrium in seasonal supply and demand is the responsibility of Florida cooperatives because of "full supply" contracts with milk processors. Although these contracts benefit individual farmers as well as processors by facilitating the ease of selling and buying milk, cooperatives are faced with the responsibility of importing and exporting milk at a substantial cost (Lawson).

In an attempt to reduce the variability in seasonal production, Florida cooperatives implemented a seasonal pricing plan in January, 1993. The overall objective of the pricing plan was to provide an incentive for dairy farmers to produce less milk during the surplus months and more during the deficit months. By achieving this objective, the pricing plan would reduce costs associated with importing

Andrew A. Washington is an assistant professor in the Department of Economics, Southern University, Baton Rouge and former doctoral student, Robert W. Lawson Jr. is a former master's student; and Richard L. Kilmer is a professor in the Food and Resource Economics Department, University of Florida, Gainesville.

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and exporting milk. The seasonal pricing plan was in place from January, 1993 through December, 1995. During the early part of 1996, Florida cooperatives voted to do away with the seasonal pricing plan.

The purpose of this article is to assess the effectiveness of the Florida seasonal pricing plan in reducing the seasonality in milk production. Past studies that analyzed seasonal pricing plans and their effects on milk production seasonality include Caine and Stonehouse; Kaiser, Otenacu, and Smith; and Sun, Kaiser, and Forker. Each of these studies simulated changes in seasonality that resulted from different types of seasonal pricing scenarios, and not the effects of an actual pricing plan. However, this article analyzes the effects of an actual seasonal pricing plan on milk production seasonality. Specific objectives of this article are (1) to estimate separately the seasonality in Florida milk production for those farmers who did and did not participate in the seasonal pricing plan in 1993, 1994, and 1995, (2) to statistically compare Objective 1 results with the seasonality in 1992 for both participating and non-participating farmers and to assess changes in seasonality for the years the pricing plan was in place (1993–1995), and (3) to compare the seasonality estimates of farmers that participated in the pricing plan with those who did not.

Background

In 1992, the last year before the pricing plan implementation, raw fluid milk was imported during the deficit period, July through November. Because of transportation costs, imported milk costs cooperatives more, on average, than milk produced in Florida. For the year, Florida cooperatives imported 120,183,725 pounds of milk at a total cost of $21,695,206 for an average price of $18.05 per hundredweight (Lawson, Kilmer, and Nubern).

Costs were also incurred during December through June when cooperatives exported milk. However, in addition to transportation cost, exported milk receives the Class III price. In 1992, Florida cooperatives exported 125,640,433 pounds of milk at a return of $12,044,594 (Lawson, Kilmer, and Nubern). Over the 1992 exporting months, the weighted average return for exports, net transportation cost, ranged from $8.35 per hundredweight in December to $10.64 per hundredweight in June for an average price of $9.59 per hundredweight. The average cost of production during the same period ranged from $11.90 per hundredweight in May to $15.31 per hundredweight in December. This indicates that selling to the export market is not profitable for Florida Dairy Farmers.

In January, 1993, a seasonal pricing plan was implemented by Florida Cooperatives in an attempt to decrease the variability in seasonal production. By enticing individual farmers to change their production patterns, the pricing plan was to aid in cutting the costs associated with imports and exports. Each farm's production in the three highest producing months (March, April, and May) was summed and divided by 92 (the total number of days in these three months) to give a per-day base production amount for each farm. The premium per hundredweight was paid in August, September, and October (the lowest production and highest importing months) when the average daily production in any of these months was greater than 75 percent of the daily base production in March, April and May. Farmers meeting this criterion were paid a premium of at least $3.00 per hundredweight, which was added to the market price for all milk produced in excess of 75 percent of their daily production base. A farmer could qualify for a premium in all three months.

Figure 1 depicts the average daily production in 1992 equivalent pounds for each month from January, 1992 through October, 1995 (Lawson).[1] Average daily production calculations include all farms in the Florida Dairy Farmers Association (FDFA) and the Tampa Independent Dairy Farmers Association (TIDFA) that had monthly production data continuously from January 1992 through October 1995. These farms represented 76.40, 89.95,

[1] The seasonal pattern for the years 1993, 1994, and 1995 was used in conjunction with 1992 pounds for the purpose of comparison.

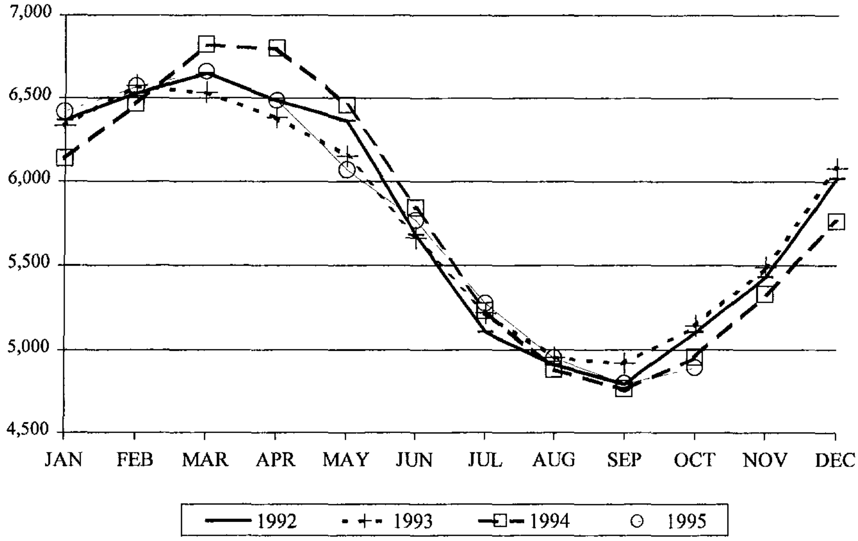

Figure 1. Milk Production 1992, 93, 94, 95: Florida Seasonal Daily Production (Thousands) January 1992–October 1995

89.47, and 81.57 percent of the production for 1992, 1993, 1994, and 10 months in 1995.

Fall milk production as a percentage of spring milk production increased in 1993 as compared to 1992. If Florida cooperatives were to face 1992 demand with 1993 seasonality, fewer imports and exports would have been required to balance demand and supply. Production seasonality in 1994 worsened compared to 1992. More total imports and exports would have occurred over the year if the 1994 seasonal pattern were imposed on 1992. In 1995 the seasonality curve shifted back near the 1992 seasonal pattern. Although the changes in 1995 were more subtle than those changes in 1993, fewer imports and exports would have occurred in 1992 than in 1995 (Lawson).

Overall the seasonal pricing plan worked in the short-run. In 1993, the seasonal pricing plan reduced the variability in seasonal production, particularly in those months in which the imbalances were the greatest. However, in 1994, seasonal variability increased. Because of the introduction of BST in early 1994, it could be argued that the benefits of BST outweighed the benefits of the pricing plan.[2] Given that the effects of BST may have only moderately affected production in 1995, seasonality adjusted to that of 1992.

Estimation Procedure

Seasonality estimates for 1992 through 1995 were obtained using a sine function estimation procedure where the degree of seasonality is measured by the amplitude of the sine function. Makridakis, Wheelwright, and McGee suggest the following procedure for estimating a sine function in which the amplitude is estimated as

$$(1) \quad y_t = A \sin\left[\left(\frac{ft}{n}\right)2\pi + \phi\right] + \epsilon_t$$

where y_t is the dependent variable, A is the amplitude of the sine waved, f is the frequency or number of times the sine wave is completed over the span of observations, t is a

[2] The use of BST increases production per cow during periods when temperatures are favorable to milk production; however, during the hotter months animals do not eat enough feed in order for BST to be effective. This results in more production during the months when production is relatively high and no change in production when production is relatively low, resulting in higher seasonal variability.

time index, n is the number of observations, and ϕ is the phase angle (in radians).[3]

Estimating equation (1) is a nonlinear regression problem that is not easily solved directly. However, making use of the trigonometric theorem

$$(2) \quad A[\sin(U + V)] = A(\sin U)(\cos V) + A(\cos U)(\sin V),$$

equation (1) is linearized and becomes the following equation:

$$(3) \quad y_t = A \cos \phi \sin\left[\left(\frac{ft}{n}\right)2\pi\right] + A \sin \phi \cos\left[\left(\frac{ft}{n}\right)2\pi\right] + \epsilon_t.$$

By letting $A \cos \phi = \beta_1$ and $A \sin \phi = \beta_2$, equation (3) becomes

$$(4) \quad y_t = \beta_1 \sin\left[\left(\frac{ft}{n}\right)2\pi\right] + \beta_2 \cos\left[\left(\frac{ft}{n}\right)2\pi\right] + \epsilon_t.$$

Equation 4 is sufficient when the intercept is zero or when the dependent variable is equal to zero at the mean. However, the dependent variable in this article is a seasonal production index that is equal to 1 at the mean and not 0. Therefore an intercept term is needed. Hence equation (4) becomes

$$(5) \quad y_t = \beta_0 + \beta_1 \sin\left[\left(\frac{ft}{n}\right)2\pi\right] + \beta_2 \cos\left[\left(\frac{ft}{n}\right)2\pi\right] + \epsilon_t$$

where A can be derived as

$$(6) \quad A = \sqrt{\beta_1^2 + \beta_2^2}.$$

Equation (5) can be estimated using ordinary least squares (OLS), where estimates of A are functions of parameter estimates $\hat{\beta}_1$ and $\hat{\beta}_2$ (equations 6).

To determine if production seasonality significantly changed for the years in which the pricing plan was in place, a test using the amplitude was used. Given that $\hat{A}$ is a nonlinear function of $\hat{\beta}_1$ and $\hat{\beta}_2$, the estimated standard error of $\hat{A}$ is calculated as described by Greene (p 360). The estimated standard error of $\hat{A}$ is equal to the square root of the variance of $\hat{A}$ which is

$$(7) \quad \text{Var}[\hat{A}] \approx \left(\frac{\partial \hat{A}}{\partial \beta}\right)' \text{Var}[\beta]\left(\frac{\partial \hat{A}}{\partial \beta}\right),$$

where the standard error is

$$(8) \quad SE[\hat{A}] = \sqrt{\text{Var}[\hat{A}]}.$$

The Var[β] is the OLS estimated variance of $\hat{\beta}$, $s^2(\mathbf{X}'\mathbf{X})^{-1}$.
The hypothesis test of interest is:

$$H_o: \quad A_i^y = A_j^y$$
$$H_a: \quad A_i^y \gtrless A_j^y$$

where A_i^y is the amplitude for year y. The above test would determine if the seasonality in year y for ith type farms was significantly different from jth type farms.[4] Other tests of interest are comparing the amplitude estimates for similar type farms but for different years. This would determine if production seasonality changed from year to year given a farm's participation or non-participation in the pricing plan. The hypothesis tests of interest involve the comparison of two random variables. Milton and Arnold (pp. 346–352) describe a test procedure for comparing the mean of two random variables when their variances are equal and unequal.

For participating and non-participating farms alike, the amplitude estimate $\hat{A}$ for 1993, 1994, and 1995 were each tested for equality with their corresponding amplitude estimates for 1992. To determine the pattern of change

[3] The amplitude A is the height and depth of the sine function where the maximum and minimum values of the sine function are A and −A respectively. The phase angle is the shift of the sine wave from left to right.

[4] The subscripts i and j indicate participation and non-participation in the seasonal pricing plan respectively.

during the years the pricing plan was in place, a similar test was used where the amplitude estimate for 1993 was tested for equality with 1994, 1994 tested for equality with 1995, and 1995 tested for equality with 1993. This was also done for participating and non-participating farms separately. Last, a statistical test was used to test the equality of amplitude estimates for participating and non-participating farms for each year.

Data

Data was taken from four sources: FDFA, TIDFA, Dairy Head Improvement Association (DHIA), and a survey sent to dairy farmers throughout the state. The resulting data set was 68 farms with production data from January 1992 through October 1995, pricing plan participation, and other variables. All farmers included in the data set were farmers that produced each year from 1992 through 1995 and were DHIA members (Lawson).[5] In 1993, 1994, and 1995, the percentage of the sample participating in the pricing plan was 37, 40, and 47 percent respectively.

To test for selection and non-response bias, t-tests were performed comparing production size and seasonality estimates for the total population of farms in the state and the 68 farms in the data set. Test results indicate that for production in 1993, there was no significant difference between the 68 farms and total population. However, for all other years, farmers in the data set produced more milk than the total population, producing on average 10, 17, and 12 percent more milk in 1992, 1994, and 1995 respectively. When comparing the seasonality estimates of the population with the 68 farms, tests indicate that there was no significant difference between the two groups for 1992 and 1994, but for 1993 and 1995 the 68 farms were statistically more seasonal. The sample farms were on average 5.6 and 9 percent more seasonal for those years, respectively.

For 1992 through 1995, equation (5) was estimated using OLS for farms that participated in the pricing plan and a separate equation for those that did not. (y) was an index of average daily production for all farms for each month for any of the years 1992–1995 (the number of observations equaled the number of months in a given year). The production index for 1992 was derived separately for those farmers that did or did not participate in the pricing plan in any of the three years in which it was in place. Examples include production in 1992 by farmers that participated in 1993, production in 1992 by farmers that did not participate in 1993, production in 1992 by farmers that participated in 1994, production in 1992 by farmers that did not participate in 1994, etc. This was done for the purpose of comparing amplitude estimates of participating or non-participating farms for the years the pricing plan was in place with amplitude estimates in 1992. This would determine if farmers increased or decreased in seasonal production by participating or not participating in the seasonal pricing plan.[6]

When comparing the overall seasonality for total production for five years prior to the pricing plan (1988–1992), statistical tests indicate that the seasonality in 1992 was not significantly different from the seasonality in 1989. For all other years the seasonality in 1988 and 1990 was 5 and 10 percent less while 1991 was 11 percent greater. Given these results, using 1988 or 1990 instead of 1992 as the base would likely weaken results particularly if 1990 is used. Using 1989 as the base year should give similar results as 1992 and using 1991 should give even stronger results since this year was more seasonal than 1992.

Because it was the last year before the pricing plan was in place, 1992 was used as the

[5] Farmers not in the DHIA were eliminated because the DHIA data set contained variables that were not in the FDFA and TIDFA data sets but were necessary for Lawson (1997) and for further research on this subject.

[6] The frequency f was equal to 1 because the sine wave was completed once during a given year. The time index t was an index from 1 to 12 for each month, and n was equal to 12, the total number of months. For 1995, $n = 10$ and t is from 1 to 10. This is because the data set ended in October 1995.

Table 1. Empirical Results for Pricing Plan Farms and Non-Pricing Plan Farms for 1992, 1993, 1994, and 1995

	Pricing-Plan Farms				
Year	R^2	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{A}$
1992(93)[a]	.98	1.0000	0.15280	0.03941	0.1578
		(.00476)[b]***	(.00674)***	(.00674)***	(.00674)*
1992(94)	.97	1.0000	0.14659	0.04568	0.1535
		(.00599)***	(.00847)***	(.00847)***	(.00847)*
1992(95)	.97	1.0000	0.15593	0.04348	0.1619
		(.00476)***	(.00674)***	(.00674)***	(.00867)*
1993	.98	1.0000	0.12089	0.03853	0.1269
		(.00390)***	(.00552)***	(.00552)***	(.00552)***
1994	.97	1.0000	0.14306	-0.00452	0.1431
		(.0056)***	(.00792)***	(.00792)	(.00792)*
1995	.99	0.99922	0.12323	0.02884	0.1266
		(.00447)***	(.00567)***	(.00687)***	(.00557)***
	Non-Pricing-Plan Farms				
Year	R^2	$\hat{\beta}_0$	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{A}$
1992(93)	.97	1.0000	0.16502	0.04257	0.1704
		(.00759)***	(.01074)***	(.01074)***	(.01074)***
1992(94)	.98	1.0000	0.16681	0.03808	0.1711
		(.00578)***	(.00818)***	(.00818)***	(.00818)***
1992(95)	.98	1.0000	0.16131	0.03917	0.1660
		(.00759)***	(.01074)***	(.01074)***	(.00798)***
1993	.99	1.0000	0.17618	0.03189	0.1790
		(.00391)***	(.00553)***	(.00553)***	(.00553)***
1994	.98	1.0000	0.19160	0.00572	0.1917
		(.00668)***	(.00944)***	(.00944)	(.00944)***
1995	.99	0.99315	0.22407	0.02332	0.2253
		(.00409)***	(.00519)***	(.00629)***	(.00470)***

[a] y is the 1992 production index for farms that participated in the pricing plan in 1993.
[b] Standard errors are in parentheses.
*** Parameters are significant at $\alpha = .01$.

base year. Additionally, the production amplitude measure for 1992 was closest to the average amplitude measure for the entire five years (1988–1992), indicating that seasonality in 1992 was the closet to the expected seasonality for that period. Therefore the use of 1992 as the base year is justified because it best represents the average seasonalility for the five-year period prior to the seasonal pricing plan.

Results and Discussion

Table 1 shows the OLS results for equation (5). All parameter estimates are significant at the .01 significance level except the 1994 estimate for β_2 for both participating and non-participating farms. The results indicate that the amplitude estimates ($\hat{A}$) for pricing plan farms for 1993, 1994, and 1995 (0.1269, 0.1431, and 0.1266) were all less than their corresponding amplitude estimates for 1992 (0.1578, 0.1535, 0.1619).[7] Results also indicate that the amplitude estimates for non-participating farms for 1993–1995 (0.1790, 0.1917, and 0.2253) were all greater than the amplitude estimates for 1992 (0.1704, 0.1711, 0.1660). This would suggest that for the years

[7] The same set of farms did not participate for three years in the seasonal pricing plan.

Table 2. Testing the Hypothesis that the Amplitude in 1993, 1994, and 1995 Did not Change Significantly from the Amplitudes in 1992

H_o:	Pricing-Plan Farms t statistic	Non-Pricing-Plan Farms t statistic
$A^{93} = A^{92(93)a}$	−12.292598***	2.4710319**
$A^{94} = A^{92(94)}$	−3.1111992***	6.2615006***
$A^{95} = A^{92(95)}$	−11.535032***	21.033482***

[a] Amplitudes for 1992(93), 1992(94), 1992(95), 1993, 1994, and 1995.
*** Indicates rejection of H_o at the α =.01 significance level.
** Indicates rejection of H_o at the α =.05 significance level.

Table 3. Testing the Hypothesis that the Amplitude Did not Change During the Years the Pricing Plan Was in Place

H_o:	Pricing-Plan Farms t statistic	Non-Pricing-Plan Farms T statistic
$A^{94} = A^{93}$	5.82854***	4.00154***
$A^{95} = A^{94}$	−5.55641***	10.58876***
$A^{95} = A^{93}$	−0.13490	20.16357***

*** Indicates rejection of H_o at the α = .01 significance level.

the pricing plan was in place those farms that participated in the pricing plan were able to reduce seasonality while their non-participating counterparts actually increased when compared to 1992. Results also indicate an increase in seasonality from 1993 to 1994 for both pricing-plan and non-pricing-plan firms. One possible explanation for this occurrence is the introduction of BST in 1994, which could have increased the variability in seasonal production, thereby affecting both pricing plan and non-pricing firms.

Table 2 shows the results of the hypothesis test restricting the amplitudes for 1993, 1994, and 1995 equal to the amplitudes for 1992(93), 1992(94), and 1992(95) respectively. Results indicate that at any reasonable significance level, the amplitude for 1993 was significantly smaller than the amplitude for 1992(93) for pricing plan farms. This suggests that farmers that participated in the pricing plan in 1993 significantly decreased in seasonality when compared to 1992. Test results when comparing the amplitude estimates for 1994 to 1992(94) and 1995 to 1992(95) also indicate that the estimates in 1994 and 1995 were both significantly smaller than the estimates for 1992(94) and 1992(95). Farmers that participated in the pricing plan in any of the years that it was implemented significantly reduced the variability in seasonal production when compared to 1992.

For the farms that did not participate in the seasonal pricing plan, the amplitude estimates were significantly different from 1992 as well. However, during each year the pricing plan was in place those farmers that did not participate in the pricing plan had significantly larger amplitude estimates when compared to 1992. Test results for 1993, 1994, and 1995 indicate that farmers not participating in the seasonal pricing plan actually increased in seasonality when compared to 1992.

Overall, amplitude estimates for pricing plan farms was decreased by as much as 20 percent when compared to 1992. However, for those farms that did not participate, seasonality actually increased in each year, with amplitude increases by as much as 32 percent. This suggests that the pricing plan may have been effective throughout its implementation period, and that its apparent lack of success may be the result of overproduction by nonparticipants and not the farmers' inability to change.

Table 3 shows the statistical results when comparing the amplitudes for the years in which the pricing plan was in place. The purpose of these tests was to indicate if seasonality changed from year to year during the plan's implementation period. For farms participating in the pricing plan, results indicate that the amplitude estimate for 1994 was significantly larger than the estimate for 1993. This would suggest that seasonality in 1994 was significantly larger than seasonality in 1993. As previously discussed, this is likely due to the expanded use of BST during the early part of 1994. When comparing the amplitude estimates for 1994 and 1995, results

Table 4. Testing the Hypothesis that the Amplitudes Are Equal for Pricing-Plan Farms and Non-Pricing-Plan Farms for the Years 1992, 1993, 1994, and 1995

H_o:	t statistic
$A_p^{92(93)} = A_{np}^{92(93)}$	3.44940***
$A_p^{92(94)} = A_{np}^{92(94)}$	5.16516***
$A_p^{92(95)} = A_{np}^{92(95)}$	1.20985
$A_p^{93} = A_{np}^{93}$	−23.11884***
$A_p^{94} = A_{np}^{94}$	−13.64276***
$A_p^{95} = A_{np}^{95}$	−41.21855***

*** Indicates rejection of H_o at the $\alpha = .01$ significance level.

indicate that the estimate for 1995 was significantly smaller than the estimate for 1994 for pricing plan farms. This suggests that seasonality decreased in 1995 when compared to 1994 for pricing plan farms. When comparing 1995 to 1993, the results indicate that there was no significant difference between the amplitude estimates in 1993 and 1995. Overall, farms participating in the pricing plan reduced production seasonality in 1993, increased in 1994, and decreased again in 1995 compared to 1993. This supports what was suggested previously: the effects of BST in 1994 may have increased seasonality but these effects may have dissipated.

For non-participating farms, statistical results suggest an increase in production seasonality from year to year for the years the pricing plan was in place. When amplitude estimates for 1993, 1994 and 1995 are compared, statistical results indicate that the estimate for 1994 was statistically larger than the estimate for 1993, 1995 statistically larger than 1994, and 1995 statistically larger than 1993. This indicates that non-participating farms not only increased in seasonality when compared to 1992 but they also increased in seasonality over the period 1993–1995. This also suggests that the pricing plan's apparent lack of success may have been due to non-participating farmers increasing in seasonal production and not the ineffectiveness of the pricing plan.

Table 4 illustrates the result of the statistical test equating the amplitudes of pricing plan farms and non-pricing plan farms for 1992–1995. The results suggest that farmers that participated in the pricing plan in 1993 and 1994 were less seasonal in 1992 than those farms that did not. However, there was no significant difference in 1992 seasonality between farms that did or did not participate in the pricing plan in 1995. Overall these results suggest that participating and non-participating farms were about the same with regard to seasonal production in 1992. For the years the pricing plan was in place (1993–1995), the amplitude estimates for pricing plan farms were all significantly lower than the estimates for non-pricing plan farms. Thus, production seasonality for pricing plan farms was significantly lower for years 1993–1995 when compared to non-pricing plan farms. These results support the hypothesis that the reduction in seasonality by pricing plan farms in 1993–1995 was due to participation in the seasonal pricing plan.

Summary and Conclusion

Florida's Dairy Industry is characterized by seasonal imbalances in supply and demand throughout the year. To make up for these imbalances, Florida Dairy Cooperatives import and export bulk fluid milk at a substantial cost. In 1992, the transportation cost of importing milk into Florida totaled $21,695,206, and the average returns from exporting ($9.59 per hundredweight) were consistently lower than the cost of production for the exporting period.

In January, 1993, Florida dairy cooperatives implemented a seasonal pricing plan in an attempt to decrease the variability in seasonal production. The purpose of the pricing plan was to encourage dairy farmers to change their production patterns so that less milk would be produced during months of highest production (December through June) and more produced during months of lowest production (July through November). In changing seasonal production the cost associated with importing and exporting milk would be reduced. The seasonal pricing plan was in place from January 1993 through December 1995.

Overall, the seasonal pricing plan appears to have worked in the short-run (Figure 1). In

1993, the seasonality was reduced, particularly in those months in which the imbalances were the greatest. However, in 1994 seasonal variability increased. Because of the introduction of BST, it could be argued that the benefits of BST outweighed the benefits of the pricing plan. Given that the effects of BST may have only moderately affected production in 1995, seasonality adjusted to that of 1992. Because 1995 was the last year the seasonal pricing plan was in place, it is only speculative what would have happened in 1996.

Although the seasonal pricing plan may have appeared unsuccessful in reducing seasonality in 1994 and 1995, assessing the affects of the pricing plan on farms that participated in the plan separately from those that did not show a different outcome. In an attempt to assess the effects of the seasonal pricing plan in reducing seasonality for participating and non-participating farms, a sine function estimation procedure was used. For each year a sine function was estimated for farms that did and did not take advantage of the seasonal pricing. Results indicate that of the 68 farms used in this study those farmers that participated in the seasonal pricing plan were able to reduce seasonality in each year (1993–1995) by as much as 20 percent. For those farms that did not participate, seasonality actually increased in each year by as much as 32 percent. Thus, the pricing plan was effective for those farms that participated and the apparent lack of success was the result of non-participating farmers increasing seasonality.

Statistical tests were used to determine if seasonality was significantly different for the years the seasonal pricing plan was in place as compared to 1992. Tests were also used to determine seasonality differences between 1993, 1994, and 1995, and to determine if seasonality differed for pricing plan and non-pricing plan participants. Results indicate that for pricing plan farms, seasonality in 1993, 1994, and 1995 had significantly decreased when compared to 1992. Of the years the pricing plan was in place, seasonality was significantly higher in 1994 than in both 1993 and 1995. For non-pricing-plan farms statistical results indicate that seasonality in 1993, 1994, and 1995 was significantly higher when compared to 1992. Results also indicate that seasonality increased with each year. For 1992 through 1995 there were no years in which seasonality was the same for both participating and non-participating firms.

Both the estimating procedure and statistical results suggest that the seasonal pricing plan was effective in reducing seasonal variability in 1993 through 1995 for farms that participated in the plan. Given that seasonality increased for those firms that did not participate, this dampened or overshadowed the pricing plan's effectiveness. Thus, an effective seasonal pricing plan requires a cost of non-participation or a penalty for excess seasonal variability. This policy would do away with the incentive for non-participants to overproduce to make up for the decrease in production by those who participate.

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