Alternative Fluid Milk Procurement Systems For Florida Dairy Farmers

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Abstract

This article evaluates the effects of alternative fluid milk procurement strategies on the aggregate net revenue of Florida cooperative members. They are (1) supplemental milk obtained from import sources, (2) supplemental milk obtained from a supply plant, (3) increased supply as a result of an expanded production area, and (4) supplemental milk obtained through pooling arrangements with regional dairy cooperatives. The final ranking of a scenario appears to be dependent primarily on the total cost of exports within the model. The optimum procurement strategy for Florida cooperatives should concentrate on reducing the quantity of surplus milk.

Key Words: cooperative, exports, imports, net revenue, pooling, procurement

In the area of milk marketing, a wide variety of studies have been published. For the most part, these studies concentrate on evaluating the regional impact of a single procurement strategy or milk assembly alternative. For example, Kilmer *et al.* evaluated the effects on the Florida dairy industry from reducing milk seasonality by altering freshening date distributions. Gao *et al.* studied the feasibility of implementing a seasonal pricing strategy for Florida producers. Other studies that concentrate on seasonal pricing plans are Prindle and Livezey, Kaiser *et al.*, and Sargent. Another heavily researched area in milk marketing is milk assembly. Preston *et al.* and Buccola and Conner concentrated on minimizing assembly cost in the northeastern region of the U.S.

The types of studies mentioned above evaluate the economic impact of different assembly, pricing, and procurement strategies. Although an analysis of alternative milk marketing arrangements has been conducted (Prato), one type of study that is missing in the literature is a comparative analysis of multiple alternative fluid milk procurement strategies. With a comparative analysis, the results of alternative procurement strategies (e.g., milk imports, membership expansion, supply plant, etc.) are used to determine the procurement strategy that maximizes the net returns for dairy cooperative members.

Florida Dairy Situation

In 1992, 2,771.5 million pounds of milk (table 1) was supplied to Florida milk marketing cooperatives by 367 dairy operations of which 307 were in Florida and 60 were in Georgia and Alabama (Florida Milk Marketing Cooperative records). With the average production per cow in Florida at 14,249 pounds (Florida Agricultural Statistics Service), this means that the 367 dairy operations in Florida and Georgia have approximately 530 cows per producer. Having an industry where production is concentrated in the

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Table 1. Florida milk marketing cooperative production, processor demand, imports and exports for 1992 in hundredweight

Month	Production	Demand	Imports	Exports
		hundredweight		
January	2,592,353.6	2,515,657.49	36,220.97	142,303.29
February	2,475,987.8	2,394,951.93	4,165.12	75,180.94
March	2,703,269.0	2,538,451.17	2,801.80	157,148.36
April	2,557,728.9	2,283,341.97	2,016.21	287,369.22
May	2,586,776.5	2,255,611.89	2,482.79	316,980.80
June	2,232,585.0	2,133,695.18	8,451.96	94,083.29
July	2,059,571.6	2,206,044.45	151,188.76	10,747.26
August	1,971,501.5	2,152,298.04	199,193.61	14,485.56
September	1,866,607.7	2,204,653.15	348,764.43	1,781.00
October	2,068,180.3	2,306,688.19	249,949.37	2,607.02
November	2,143,736.1	2,280,140.60	156,092.88	5,819.46
December	2,457,223.2	2,358,046.07	40,509.35	147,898.13
TOTAL	27,715,521.2	27,629,580.1	1,201,837.25	1,256,404.33

hands of a few large producers and with virtually all Florida producers being members of the two Florida milk marketing cooperatives creates an environment in which policy changes can be administered quickly and effectively.

The Florida cooperatives are responsible for supplying milk to 20 processing facilities located throughout Florida (Florida Milk Marketing Cooperative records). In this article, these processing facilities are grouped according to location in order to form 10 marketing areas.

Florida, like many states throughout the country, must contend with the seasonality problem in milk production and consumption. Specifically, during the months of July through November when consumption is greater than production (Florida Milk Marketing Cooperative records), Florida producers must deal with climatic and biological constraints on milk production. The summer and fall seasons are accompanied by heat and humidity, both of which have an adverse effect on conception rates and milk production (Kilmer *et al.*, p. 1). As a result of the deficit, Florida dairy cooperatives must obtain supplemental milk from import sources in order to fulfill supply contracts. Conversely, the flush months, December through June, force the Florida dairy industry to contend with a surplus of milk (Florida Milk Marketing Cooperative records). This surplus of milk is a direct result of reduced heat and humidity (Kilmer *et al.*, p. 1). Production is greater than consumption (Florida Milk Marketing Cooperative records). Another factor which contributes to the surplus is the fact that producers find winter production more profitable than summer production (Gao *et al.*, p. 215). Consequently, the supply of milk available from producers exceeds milk handlers' demand.

The seasonality of milk production is an expensive problem throughout the Florida dairy industry. For example, in 1992 Florida cooperatives paid as much as $23.77 per hundredweight for supplemental milk (Florida Milk Marketing Cooperative records). The highest price paid for Florida production in 1992 was $16.40 per hundredweight (Florida Agricultural Statistics Service, p. 9). As a direct result of milk seasonality, farmers are subjected to unstable milk revenues. The producers are forced not only to deal with the high costs of imports during the deficit months, but also the low price received for exports during flush months.

In 1992, the Tampa Independent Dairy Farmers Association (TIDFA) and the Florida Dairy Farmers Association (FDFA) utilized imports[1] from 17 sources located throughout 12 states as sources of supplemental milk (Florida Milk Marketing Cooperative records). The price of these imports is positively related to the volume of milk and the distance traveled. From January 1992 to December 1992, approximately 64 percent of the imported milk originated from sources within 200-400 miles from Florida processors (Florida Milk Marketing Cooperative records). As the distance traveled increases, so does the cost of imported milk. If the cooperatives seek to offset these added costs but payment is not sufficient to cover the cost of importing milk from distant suppliers, cooperative members must bear the cost.

Producers must also contend with the costs associated with increased exports during the December through June period. In 1992, surplus milk was delivered to 24 milk handling plants as distant as 1573 miles from Florida processors (Florida Milk Marketing Cooperative records). Florida producers are penalized on two fronts. First, the majority of surplus milk is disposed of at Class III prices[2]. Second, Florida producers must bear the transportation costs, which increase with the distance traveled. In 1992, the net price received for surplus milk after deductions for transportation cost ranged from \$6.72 to \$11.19 per hundredweight (Florida Milk Marketing Cooperative records).

In order to minimize the cost associated with milk seasonality, producer organizations must implement an efficient milk procurement system. The alternative fluid milk procurement strategies that are analyzed in this study include (1) an expanded production area, (2) milk obtained from supply plants, (3) supplemental milk from other parts of the country, and (4) supplemental milk obtained through pooling arrangements with Dairymen Inc. and Southern Milk Sales. In the article, each of the four procurement scenarios is analyzed on an aggregate net revenue (*ANR*) basis under conditions representing total coordination of milk shipments between the Florida Dairy Farmers Association and the Tampa Independent Dairy Farmers Association. The results of the analysis indicate the procurement system that maximizes the aggregate net revenue for the Florida dairy producers.

Empirical Model

The decision variables and the mathematical form of the objective function are illustrated below in equations (1) and (2), respectively. Along with the decision variables and objective function, the constraints needed to model the dairy industry are presented in equations (3) through (9).

$$\text{Decision Variables} = Q_{map},\ Q_{mop},\ Q_{mah} \tag{1}$$

$$\begin{aligned}
&\text{Maximize } ANR = \\
&\sum_{a=1}^{40} [Q_{ma}((\sum_{o=1}^{17}\sum_{p=1}^{10}[UR_m P_{m1}(Q_{map}+Q_{mop})+(1-UR_m)P_{m2} \\
&(Q_{map}+Q_{mop})+OOP_{mp}(UR_m(Q_{map}+Q_{mop})+(1-UR_m) \\
&(Q_{map}+Q_{mop}))-(P_{mo}+D_{op}HR)Q_{mop}]+\sum_{h=1}^{19}(P_{m3}-D_{ah}HR) \\
&Q_{mah})/Q_{ma})-(\sum_{P=1}^{10} ZON_{ap}Q_{map}+PU_{ma}+BAS_{ma}-DIS_{ma}) \\
&-COP_m Q_{ma}]
\end{aligned} \tag{2}$$

$$\sum_{a=1}^{40} Q_{map} + \sum_{o=1}^{17} Q_{mop} = Q_{mp} \qquad p = 1, \ldots, 10 \tag{3}$$

$$\sum_{p=1}^{10} Q_{map} + \sum_{h=1}^{19} Q_{mah} = Q_{ma} \qquad a = 1, \ldots, 40 \tag{4}$$

$$\sum_{a=1}^{40} Q_{mah} \le C_{mh} \qquad h = 1, \ldots, 19 \tag{5}$$

$$\sum_{p=1}^{10} Q_{mop} \le Q_{mo} \qquad o = 1, \ldots, 17 \tag{6}$$

$$\sum_{p=1}^{10} Q_{mop} \ge LB_{mo} \qquad o = 1, \ldots, 17 \tag{7}$$

$$\begin{aligned}
&(\sum_{p=1}^{10} ZON_{ap}Q_{map} + PU_{ma} + BAS_{ma} - DIS_{ma}) \\
&\quad / Q_{ma} \le 1.284 \qquad a = 1, \ldots, 40
\end{aligned} \tag{8}$$

Q_{map}, Q_{mop}, $Q_{mah} \geq 0$ (9)

where

Q_{map} = Quantity of cooperative member milk in month m shipped from production area a to processing plant p in hundredweights;

Q_{mop} = Quantity of milk imported in month m from origin o to processing plant p in hundredweights;

Q_{mah} = Quantity of cooperative member milk exported in month m from production area a to hard manufacturing plant h in hundredweights;

Q_{ma} = Quantity of member milk production available at production area a in month m in hundredweights;

UR_m = Class one utilization rate in month m;

P_{mi} = Minimum federal order price of Class i milk in month m;

OOP_{mp} = Over order payment in month m for processing plant p;

P_{mo} = Price per hundredweight of milk imported in month m from origin o;

D_{op} = Distance from origin o to processing plant p;

HR = Hauling rate per mile, per hundredweight of milk;

D_{ah} = Distance from production area a to hard manufacturing plant h;

ZON_{ap} = Transportation charge per hundredweight of milk from production area a to processor p;

PU_{ma} = Total pickup charge at production area a in month m;

BAS_{ma} = Total base charge at production area a in month m;

DIS_{ma} = Total volume discount at production area a in month m;

COP_m = Cost of production per hundredweight during month m;

Q_{mp} = Quantity demanded in month m of processing plant p in hundredweights;

C_{mh} = Capacity of hard manufacturing plant h in month m in hundredweights;

Q_{mo} = Quantity supplied from origin o in month m in hundredweights;

LB_{mo} = Lower bound of shipments from origin o in month m in hundredweights;

1.284 = Production area to market hauling rate cap.

The objective function (equation (2)) maximizes the sum of the monthly aggregate net revenue of all production areas while operating under the structure of the alternative procurement strategies. The model maximizes over the sum of each production area's net revenue and results in the optimal interstate and intrastate flows of milk for Florida cooperative members.

The constraints in the model are designed to simulate marketing conditions for Florida cooperative members as well as the supply and demand restrictions placed on milk production and consumption. Equation (3) maintains that a processor's monthly demand for raw milk is equal to the quantity of milk supplied by Florida cooperative members plus supplemental milk obtained from import sources. Next, equation (4) insures that the supply from each production area is sold to a processing and/or manufacturing plant. Equation (5) recognizes that the manufacturing plants have limited capacities; therefore, the quantity of milk shipped from the production areas to the manufacturing plant must be less than or equal to the manufacturing plant's total manufacturing capacity during each month. Equation (6) is a supply constraint. Since the total quantity of imports from a particular source is limited, especially during the deficit months, equation (6) constrains the amount of imports to the available supply at a specific source. Under the supply plant or pooling scenarios, a lower bound is associated with the amount of milk shipped from a supply point to Florida processors. Equation (7) constrains the sum of the monthly shipments from a supply plant or pooled producers to a quantity that is greater than or equal to the lower bound. In equation (8), the upper bound for production area to market transportation cost is established. In the model, no production area can be charged an average monthly hauling rate higher than the upper bound. The final constraint, equation (9), is a nonnegativity constraint for the unknown decision variables.

Alternative Procurement Scenarios

The four alternative strategies in the article are: (1) supplemental milk obtained from import sources, (2) supplemental milk obtained from a supply plant, (3) increased supply as a result of an expanded production area, and (4) supplemental milk obtained through pooling arrangements with Dairymen Inc. (DI) and Southern Milk Sales (SMS). The primary difference in each model is the source and cost of supplemental milk. In the discussion that follows, the conceptual framework and restrictions of each individual model are presented.

Of the 17 import sources, two locations require special attention. In 1992, pooling arrangements[3] allowed direct shipments from Dairymen Inc. (DI) and Southern Milk Sales (SMS) members to Florida processors. In the alternative procurement strategies where DI and SMS members are not pooled in the Florida Milk Marketing Orders (e.g., the import and supply plant scenarios), direct shipments from these producers to Florida processing plants are not allowed in the model. As a result of this assumption, DI and SMS have a shipping point at Quitman, GA and Albany, GA, respectively.[4]

Import Scenario

The import scenario represents the base model from which the other models are developed. The model is designed so that the demand at the processing plants is satisfied by Florida cooperative members' production and supplemental milk obtained from import sources that are not associated with pooling arrangements in the Florida Milk Marketing Orders. The plant that provides the imported milk receives a Florida Milk Marketing Order weighted price adjusted for transportation costs. This scenario is designed to reflect the costs that Florida cooperatives incur from purchasing supplemental milk in the market place without prior purchasing agreements.

DI/SMS Pooling Scenario

At the current time, the Florida cooperatives obtain supplemental milk from members of Dairymen Inc. and Southern Milk Sales. As a result of a pooling agreement made with these cooperatives, FDFA and TIDFA obtain supplemental milk from DI and SMS members located in north Florida, south Georgia, and south Alabama. These farmers receive the Florida Milk Marketing Order weighted price. In the cooperative pooling arrangement, the initial source of supplemental milk is DI and SMS producers that are pooled in the Florida Milk Marketing Orders. Although these producers are members of other cooperatives, the pooling arrangement allows the Florida cooperatives to determine the destination of the pooled milk. By centrally coordinating the shipments of milk, all four cooperatives hope to save transportation cost (Industry Source). If additional milk is needed, then milk is imported from other sources.

One difference between the import model and the cooperative pooling scenario is that the pooling arrangement establishes both an upper and lower bound on the monthly quantity of milk shipped from DI and SMS production areas to Florida processors. The upper bound averages 214,366 hundredweight per month and the lower bound averages 7,138 hundredweight per month which represents a minimum quantity of DI and SMS production that must be pooled in the Florida Milk Marketing Orders (Industry Source). Under either constraint, all milk committed to Florida (i.e., an average of 214,366 hundredweight per month) will receive a Florida Milk Marketing Order weighted price. This arrangement reduced the volume of imports from other sources in the deficit months but added to the surplus to be exported in the other months.

Expansion Scenario

The expansion scenario is designed to simulate the affects of the Florida cooperatives expanding their production area to include additional members in Georgia and Alabama on a permanent basis. The additional production that is incorporated in the model is represented by the total production of the members of DI and SMS that are currently pooled in the Florida Milk Marketing Orders. As a result of the expansion model, these producers are no longer associated with DI or SMS, but become permanent members of the Florida cooperatives. The Georgia and Alabama producers who become members of a Florida milk marketing cooperative receive the same gross prices as farmers located in the state of Florida. After the adjustments for the new members, the model operates along the same guidelines as the import scenario.

Supply Plant Scenario

The final procurement strategy that is modeled in the article is the supply plant scenario. In this scenario, the Florida cooperatives' first source of supplemental milk is a supply plant located outside of the market area that is pooled on the Florida Milk Marketing Orders. The cooperatives pay a blend price for all of the milk that the pooled producers supply. At this time, shipping the supply plant's milk to markets is the full responsibility of the cooperatives. Although the revenue generated from the sale of the pooled milk contributes to the Florida pool, the per hundredweight and transportation cost associated with the additional milk decrease the value of the net pool.

After consulting with industry sources, Bowling Green, Kentucky was chosen as the location of the supply plant. The supply plant is located in this area because Bowling Green represents the center of a large production area in southern Kentucky. The amount of milk pooled at the supply plant is 200,000 hundredweights per month. This figure was obtained from an industry source and approximates the total amount of milk that is currently pooled from DI and SMS members in Florida, Georgia, and Alabama.

In regards to the operations of the supply plant, a decision was made to allow the plant to function as only a receiving station with no manufacturing capabilities (Industry Source). As a result of this assumption, the total quantity of milk at the supply plant must be shipped to Florida processors and/or existing manufacturing facilities. As a result of Federal Milk Market Order guidelines for establishing a supply plant, at least 51 percent of the supply plant's monthly milk receipts must be shipped to the Florida market. The dairy farmers providing milk to the supply plant receive a Florida Milk Marketing Order weighted price adjusted for transportation costs.

Data Requirements

The input for the model requires monthly data collected during the 1992 calendar year. The first data category involves production and the formation of production areas. In order to establish a production area for any scenario in the article, production data on a per farm basis is needed from each cooperative.[5] The only guideline that is used when establishing a production area is that each area contains at least three or more producers. For the most part, the 40 production areas correspond with a single county. In situations where several counties are combined to form a single production area, the county with the largest annual production will contain the geographical center of that production area.

In each of the procurement scenarios, one cost of production estimate is used for all production areas. The per hundredweight cost of production estimates for each month in 1992 were provided by the Dairy Science Department at the University of Florida (table 2). The expense categories used were feed, payroll, heifer replacements, and other. On an annual basis, the percentage of total cost that is represented by the four expense categories included in the model for feed is 47.5 percent, for payroll is 18.3 percent, for heifer replacements is 7.2 percent, and other is 27.0 percent.

The next data category deals with processing plants in Florida. In the model, specific locations in Florida are designated as marketing areas. These marketing areas represent one or more processors in a specific area. After consulting with an industry source, 10 marketing areas in the Florida market were established. The monthly demand at each marketing area is determined by the sum of the total quantity of milk shipped to processor(s) associated with a marketing area. The total quantity delivered to any marketing area includes the quantity of cooperative members' production and imported milk that is supplied from the cooperatives to the marketing area (Florida Milk Marketing Cooperative records). The class prices that are paid by marketing areas in the model

Table 2. Cost of production estimates in dollars per hundredweight

Month											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
13.60	12.88	13.25	13.73	11.90	12.25	17.58	15.50	16.79	15.98	15.02	15.31

Source: Dairy Science Department at the University of Florida.

correspond to the class prices of Federal Marketing Orders 6, 12, and 13. In addition to the information above, over order payments and utilization rates are calculated for each marketing area.

The total number of export alternatives in the base model is 19. These 19 locations represent viable export alternatives for the Florida cooperatives. A viable export destination is defined as a manufacturing plant that receive greater than or equal to 100,000 pounds of milk in 1992 (Industry Source).

As far as the processing capacity for manufacturing plants is concerned, the model is designed so that the cooperatives have a predetermined limit on the amount of milk they can export to a manufacturing plant during each month. The monthly limit for a plant coincides with the total amount of exports shipped to that plant by cooperatives during 1992. In the model, the price paid by the manufacturing plants is determined from pricing data obtained from the four cooperatives.

The next data category deals with information on import sources. Each of the 17 import sources in the model represent a location in which supplemental milk was obtained by Florida cooperatives in 1992. The quantity of milk available at each import source coincides with the quantity of milk imported from a particular source by the Florida cooperatives. The prices that the cooperatives must pay for the supplemental milk is determined by using the actual prices reported by the cooperatives.

The final data requirement provides information on transportation cost. There are two types of transportation cost in the model. These are the transportation cost associated with imports and exports and the production area to market transportation cost. In order to determine the transportation cost to and from import and export alternatives, a hauling rate of $2.00 per loaded mile (a load of milk is equivalent to 475 hundredweights) is utilized (Industry Source). This value remains constant across months and scenarios.

The second transportation cost in the model is the production area to market transportation cost accessed to each production area by the cooperatives. The variables that determine the final hauling charge paid by a production area are (1) base charge per hundredweight, (2) mileage or zone charge to the marketing areas, (3) pick-up charge, and (4) a volume discount. The production area to market transportation cost for a production area is calculated by adding together the total base, zone, and pick-up charges and then subtracting the total volume discount. The figure that remains must be less than or equal to $1.284 per hundredweight (Florida Milk Marketing Records).

Results

When analyzing the results of the four alternative procurement scenarios, the endogenous variables that are comparable across scenarios are evaluated on an annual basis. Additional variables that are used to evaluate procurement scenarios are (1) net revenue per hundredweight, (2) cost of imports and exports, and (3) quantity of imports and exports. In the paragraphs that follow, the results of the aggregate net revenue (*ANR*) of Florida cooperative members and the variables outlined above are discussed.

Aggregate Net Revenue

The objective of this article is to determine the optimum procurement strategy that maximizes the aggregate net revenue of Florida cooperative members. In the results, the variable that represents the sum of cooperative members' net revenue is the aggregate net revenue. Since the procurement scenarios are evaluated on an annual basis, the *ANR* value in each month is summed together to form an annual *ANR* value for each scenario. Along with the *ANR* value, a weighted average net revenue per hundredweight is used to compare the alternative scenarios. This variable represents the average net revenue per hundredweight for dairy producers in the Florida market before payments for capital investments and management are deducted.

The annual *ANR* values and the net revenue per hundredweight for the four procurement scenarios are presented in table 3. Of the four alternative procurement scenarios, the import strategy results in the highest *ANR* value, $39.61 million (m) and a net revenue per hundredweight of $1.429. The DI/SMS pooling scenario, which is the strategy that is currently employed by the Florida cooperatives, is the second place scenario. This procurement scenario results in a *ANR* value of $32.61m and a $1.177 net revenue per hundredweight. The DI/SMS pooling arrangement falls short of the optimal procurement strategy by $7m. In third place, the supply plant scenario generates a net revenue per hundredweight of $1.164 from a $32.27m *ANR* value. The fourth and final place is occupied by the expansion scenario. The *ANR* value from the expansion scenario is $31.43m, which results in a net revenue per hundredweight of $1.038.

Exports

Exports, or surplus milk, are analyzed by comparing and contrasting the annual quantity and cost of surplus milk across scenarios. In table 4, there are two export categories, (1) Florida Cooperative Members and (2) Supply Plant and DI/SMS Pooling (Non Florida Cooperative Members). In the first category, the levels of the export variables are directly associated with the surplus milk from only Florida cooperative members. The quantity and cost of any pooled milk that is diverted are not included in this export category. The export variables associated with pooled milk appear in the Supply Plant and DI/SMS (Non Florida Cooperative Members) category.

The cost of exports in each strategy plays a significant role in determining the optimum procurement scenario. In the model, the disposal fees associated with surplus milk decrease the value of the net pool, which results in a lower net blend price. As a result of this relationship, the quantity of exports in a model is inversely related to the *ANR* value. The quantity and cost of Florida cooperative members' exports in each scenario are illustrated in table 4. The relative position of the strategies is (1) import scenario: 1.12 million (m) hundredweights at a cost of $1.57 per hundredweight.; (2) DI/SMS pooling arrangement: 1.25m hundredweights costing $1.81 per hundredweight; (3) supply plant scenario: 1.84m at $1.94; and (4) the expansion scenario: 2.85m at a cost of $2.02 per hundredweight.

In addition to these exports, the supply plant and DI/SMS pooling scenarios have surplus milk associated with the pooled producers. For example, the pooled producers in the supply plant scenario diverted 820,015.67 hundredweights of milk at a cost of $1.02m, or $1.25 per hundredweight. The quantity and cost of diverted milk from DI/SMS members are 1.60m hundredweights and $1.62m, respectively. This is equivalent to $1.02 per hundredweight.

When analyzing the position of each scenario, a pattern corresponding to the source of supplemental milk is found in the results. For example, the source of supplemental milk in the import strategy does not affect the quantity of surplus milk. In general, the surplus milk in this scenario corresponds to the amount of production from Florida cooperative members that exceeds demand. On the other hand, the source of supplemental milk for the DI/SMS pooling arrangement, expansion, and supply plant scenarios adversely affect the quantity of surplus milk from Florida cooperative members during flush months. Both pooling arrangements require a lower bound on the shipments (i.e., minimum shipments to Florida) from the pooled producers to Florida processors. The lower bound in each scenario displaces production from the Florida cooperative members. As a result of the lower bound, exports from the Florida cooperatives increase by at least an amount equal to the lower bound. The expansion scenario results in an increase in exports of 1.73 million hundredweight. when compared to the import strategy. Since the expansion scenario obtains supplemental milk by increasing the membership in the cooperative, the additional surplus milk originates from the new cooperative

Table 3. Annual financial results of alternative scenarios

Variables	Import	Supply Plant	Expansion	DI/SMS Pooling
	Procurement Scenarios			
Aggregate Net Revenue ($) (per hundredweight)	39,613,139 (1.429)	32,275,591 (1.164)	31,437,144 (1.038)	32,610,800 (1.177)
Gross Pool($)	477,721,000	495,346,000	497,346,000	499,804,000
Net Pool ($)	457,041,000	449,053,000	487,425,000	491,641,000
Net Blend Price ($/hundredweight)	16.49	16.20	16.09	16.23
Milk pool (hundredweight)	27,716,252	27,719,321	30,293,661	30,292,113

Table 4. Annual export results of alternative scenarios with quantities in hundredweights

Variables	Import	Supply Plant	Expansion	DI/SMS Pooling
	Procurement Scenarios			
Exports: Florida Cooperative Members				
Quantity	1,128,851	1,844,213	2,859,579	1,254,565
Cost ($) (per hundredweight)	1,770,113 (1.57)	3,582,516 (1.94)	5,800,804 (2.02)	2,272,758 (1.81)
Exports: Supply Plant and DI/SMS Pooling (Non Florida Cooperative Members)				
Quantity	---	820,016	---	1,601,494
Cost ($) (per hundredweight)	---	1,021,631 (1.25)	---	1,629,568 (1.02)

members. This scenario results in the largest amount of exports from the Florida cooperatives.

Imports

The next endogenous variable is imports, or supplemental milk. In this category, the quantity and cost of imports are compared across scenarios. Like the export situation, the two categories of imports are supplemental milk originating from the supply plant and DI/SMS members and supplemental milk obtained from sources not associated with a pooling arrangement. The quantity and cost of both sources of supplemental milk are illustrated in table 5.

The first import category illustrates the quantity and cost of supplemental milk obtained from the supply plant and DI/SMS producers (table 5). In the supply plant scenario, Florida cooperatives utilized 1.57 million hundredweights of supplemental milk at a cost of $17.17 per hundredweight. In the DI/SMS pooling arrangement, the average cost for the 970,902.01 hundredweights of milk obtained from the pooled producers is $16.23.

The last import category illustrates the quantity and cost of supplemental milk obtained from import sources that are not pooled in the

Table 5. Annual import results of alternative scenarios with quantities in hundredweights

	Procurement Scenarios			
Variables	Import	Supply Plant	Expansion	DI/SMS Pooling
Imports: From Supply Plant and DI/SMS Pooling				
Quantity	---	1,579,984.32	---	970,902.01
Cost ($) (per hundredweight)	---	27,131,840 (17.17)	---	15,757,740 (16.23)
Imports: From Other Import Sources (Non Supply Plant and DI/SMS Pooling)				
Quantity	1,042,910	178,287	201,314	197,722
Cost ($) (per hundredweight)	18,909,300 (18.13)	3,057,600 (17.15)	4,122,940 (20.48)	3,985,912 (20.16)

Florida market (table 5). The lowest quantity of imports originates from the supply plant scenario. In this model 178,287 hundredweights are imported annually at a cost of $17.15 per hundredweight. The position of this scenario relative to other scenarios is attributed to the quantity of milk pooled at the supply plant. During deficit months, the total pool of 200,000 hundredweights is shipped into the Florida market before alternative import sources are considered.

The DI/SMS pooling arrangement and the expansion scenario result in the second and third largest quantity of imports, respectively. The simulation of the DI/SMS pooling arrangement generates 197,722 hundredweights of imported milk valued at $20.16 per hundredweight. In the expansion scenario, the total quantity of imports is 201,313 hundredweights. The per hundredweight cost of the supplemental milk is $20.48.

The most expensive scenario relative to supplemental milk is the import scenario. In this model, 1.04 million hundredweight. of milk are imported into the Florida market at a total cost of $18.90 million (i.e., $18.13 per hundredweight) to the Florida cooperative members. In relation to the supply plant scenario, the quantity and cost of imports increase by 864,622 hundredweights and $15.85 million. These results correspond exactly to what is expected from the model. In the DI/SMS pooling arrangement, supply plant, and expansion scenarios, the quantity of imports is decreased as a result of pooling arrangements or expanding the cooperatives' membership. In the import scenario, the primary source of supplemental milk is the open market. Therefore, the quantity and cost of imports are substantially higher than in the other procurement scenarios.

Analysis

The final positions of the procurement strategies (table 3, *ANR* per hundredweight) are (1) imports, (2) DI/SMS pooling arrangement, (3) supply plant, and (4) expansion. With respect to the cost of exports (table 4, cost per hundredweight), the alternative scenarios occupy the same rank as those for *ANR*. The positive relationship in relative positions is not present between the cost of imports (table 5, cost per hundredweight) and the *ANR* value. The only explanation for these findings seems to be related to the revenue generated from the sale of imports and exports. The price received by the cooperatives for supplemental milk is the Class I and II prices in the Florida market. On the other hand, export milk is disposed of at the Class III price. Along with the lower price, the total cost of production associated with the surplus milk reduces the sum of cooperative members net revenue. Overall, supplemental milk generates more revenue per hundredweight. in the gross pool and the cost of production associated with supplemental milk is not an explicit cost for the Florida cooperative members. With the current marketing conditions prevalent in the model, a scenario's *ANR* value is affected more by the quantity and cost of exports than imports.

The procurement strategy where supplemental milk is obtained from import sources generates the highest aggregate net revenue for Florida cooperative members. The import scenario is first since the total cost of exports is not influenced by the lower bounds of pooling guidelines (i.e. supply plant and DI/SMS pooling scenarios) or the additional surplus milk from new members. The significance of the export cost on a scenario's final position is demonstrated in the results of the import scenario. For example, even though this strategy has the highest total cost of supplemental milk, the first place finish in relation to the cost of exports has a tremendous influence on the model's first place *ANR* value.

The current procurement scenario that is utilized by the Florida cooperatives is the pooling arrangement with members of other cooperatives. This analysis indicates that the aggregate net revenue and the net blend price resulting from this scenario rank second. Like the supply plant scenario, the pooling arrangement has a positive affect on import variables, but export variables are adversely affected in this scenario. When compared with other scenarios, the total cost of imports and exports in the pooling arrangement rank second in both categories. The lower bound on the shipments from the pooled producers results in a extremely high cost of exports for Florida cooperatives. As a result of the pooling arrangement, the net blend price and the sum of cooperative members' net revenue decrease.

The third highest net blend price and sum of Florida cooperative members' net revenue belong to the supply plant scenario. Since the supply plant ships all of its milk to the Florida market during deficit months, this procurement strategy results in the lowest quantity and cost of imports. On the other hand, the lower bound on shipments from the supply plant to Florida processors causes this scenario to be expensive in terms of exports. In surplus months, the additional milk from the supply plant displaces production from Florida cooperative members, thereby increasing the quantity and cost of exporting milk from Florida relative to the top two scenarios.

The final procurement strategy is the scenario where supplemental milk is obtained by expanding the Florida cooperatives' membership. Although this scenario is third relative to import variables, the model does succeed in substantially decreasing the quantity and cost of imports. What forces this scenario to occupy last place is the export variables. By expanding the cooperatives' membership, the problems associated with surplus milk become increasingly difficult because of the additional production from the new members. For example, the cost of exports for the Florida cooperative members in this model exceed those in the next best scenario by $2.22 million. In the end, the expansion scenario results in the highest cost of exports and the lowest net blend price.

Finally, the previous discussion of alternative procurement scenarios focused on the implications for Florida cooperative members without mentioning the consequences on the farmers not represented by Florida cooperatives. The ranking of the scenarios is (1) import, (2) DI/SMS pooling, (3) expansion, and (4) supply plant (table 6). This is the same ranking as that based on *ANR* except three and four are reversed.

Sensitivity Analysis

In order to determine the stability of the results under changing marketing conditions, sensitivity analysis is conducted. The first step involves deciding what parameter(s) should be changed in the models. When analyzing the results of the alternative scenarios, one can see that the final ranking of the procurement scenario is primarily dependent on the total cost of exports and to a lesser degree on the total cost of imports. Given this observation, an alternative for sensitivity analysis is to change the parameters influencing the total cost of exports and imports. Some of these parameters are (1) distance to manufacturing plants

Table 6. The Impact of alternative procurement scenarios on non-Florida cooperative producers in hundredweight[a]

Model	Procurement Scenarios			
	Import	Supply Plant	Expansion	DI/SMS Pooling
Model price	$16.05	$14.03	$16.09	$16.23
Milk Marketing Order blend price	$13.48[b]	$13.49[c]	$14.30[d]	$14.30[d]

[a] The prices in this table are the gross prices to the farmer, not mail box prices.
[b] This is the simple average of the 1992 annual Federal Milk Order blend prices in 19 Milk Marketing Orders (Federal Milk Marketing Order) representing the 12 states that Florida cooperatives imported milk from to include GA, IL, IN, IO, KY, LA, MD, MI, MO, NC, TN, and WI.
[c] This is the 1992 annual Federal Milk Order blend price in the Milk Marketing Order (Federal Milk Marketing Order) representing the state that Florida cooperatives had a supply plant located in (KY).
[d] This is the simple average of the 1992 annual Federal Milk Order blend prices in two Milk Marketing Orders (Federal Milk Marketing Order) representing the two states that Florida cooperatives expanded its membership to (Al and GA) or pooled milk with producers in the Milk Marketing Orders in AL and GA.

and import sources, (2) hauling rate, and (3) manufacturing plant's capacity and quantity of milk available from an import source.

By changing the hauling rate paid by cooperatives, one is changing all three parameters outlined above. For example, if the hauling rate is reduced from $2.00 per loaded mile to $1.50, this change in hauling rate is analogous to (1) a reduction in mileage (i.e., manufacturing plants and/or import sources are now closer to Florida when measured on a dollar basis), (2) a reduction in the hauling rate due to a reduction in operating expenses, or (3) an increase in the amount of manufacturing plant capacity and/or amount of supplemental milk (i.e., given a constant radius, the number of export plants and import sources inside the radius increases based on transportation cost). Essentially, when the hauling rate is modified, the results of the model reflect the outcome of changing (1) mileage, (2) hauling rate, or (3) plant capacity/supply of supplemental milk.

Sensitivity analysis models

As discussed previously, the only parameter that is changed for sensitivity analysis is the hauling rate. Given a initial hauling rate of $2.00 per loaded mile, the models designed for sensitivity analysis incorporate hauling rates of $1.50 and $2.50 per loaded mile, a change of 25 percent.

With sensitivity analysis, there are several options when modeling the alternative procurement scenarios. For example, both imports and exports need to be assigned a hauling rate. Excluding models where import and export hauling rates move in opposite directions, one is left with six different models that can be used to conduct a sensitivity analysis. The differences in these six models are presented in table 7.

Results of sensitivity analysis

The base scenario has the import and export hauling rates set at $2.00 per loaded mile. The final ranking of the alternative procurement scenarios in the base scenario is (1) import, (2) DI/SMS pooling, (3) supply plant, and (4) membership expansion. The results of the sensitivity analysis show that the relative position of each procurement scenario does not change for four out of six sensitivity models (table 8). These models are All/HR/Up, MP/HR/Up, XP/HR/Up, and XP/HR/Dn. Although the *ANR* per hundredweight. does change across these models, the final ranking of the procurement scenarios is not affected.

The sensitivity models that result in a change in the final ranking are the MP/HR/Dn and All/HR/Dn models. The final ranking of the procurement scenarios in these models are identical: (1) import, (2) supply plant, (3) DI/SMS pooling,

Table 7. Sensitivity analysis models

	Hauling Rate (loaded mile)	
Model	Import	Export
Base	$2.00	$2.00
All/HR/Up	$2.50	$2.50
All/HR/Dn	$1.50	$1 50
MP/HR/Up	$2.50	$2.00
MP/HR/Dn	$1.50	$2.00
XP/HR/Up	$2.00	$2.50
XP/HR/Dn	$2.00	$1.50

Table 8. Annual *ANR* per Hundredweight for sensitivity models

	Procurement Scenarios			
Model	Import	Supply Plant	Expansion	DI/SMS Pooling
Base	$1.429	$1.177	$1.164	$1.038
All/HR/Up	$1.397	$1.139	$1.083	$.987
All/HR/Dn	$1.468	$1.220	$1.257	$1.096
MP/HR/Up	$1.413	$1.173	$1.121	$1.035
MP/HR/Dn	$1.452	$1.186	$1.228	$1.048
XP/HR/Up	$1.419	$1.145	$1.139	$.993
XP/HR/Dn	$1.448	$1.213	$1.206	$1.089

and (4) membership expansion (table 8). Notice that the import and membership expansion scenarios retain their initial position while the pooling and supply plant scenarios switch position. These results suggest that as the distance from the import source and the Florida milk market decreases, the supply plant scenario is a more profitable alternative than the DI/SMS pooling agreement, which is the current strategy utilized by the Florida cooperatives.

Conclusions

Given the marketing conditions described in the model, the degree of success associated with a procurement scenario appears to be dependent primarily on the total cost of exports within the model. Scenarios that concentrate on reducing surplus milk generate a higher aggregate net revenue for cooperative members than those strategies that are more concerned with reducing the cost of supplemental milk. For example, the import scenario, which is the best procurement strategy, generates the highest cost of imports and the second lowest cost of exports. On the other hand, in the expansion scenario the total cost of supplemental milk is substantially reduced from the import scenario, but these cost savings are not enough to offset the additional expenses related to the disposal of surplus milk. For this reason, the expansion scenario results in the lowest aggregate net revenue for cooperative members. The current procurement strategy ranked second. Based on these results, the optimum procurement strategy for Florida cooperatives is to concentrate on reducing the quantity of surplus milk.

The results from the study of alternative procurement strategies for Florida cooperatives provide additional information that cooperatives should consider when deciding on a procurement strategy that maximizes the aggregate net revenue of its members. For example, the results of the article shows that as cooperative members' aggregate net revenue increases, net blend price increases and total cost of exports decreases. With the current marketing conditions, the results indicate that the maximum level of cooperative members' net revenue corresponds with the scenario that results in the lowest total cost of exports. In fact, in all scenarios the relative position of the total cost of exports is identical to the final ranking of each procurement strategy. This conclusion simply states that the total cost of exports is directly associated with the level of the cooperative members' aggregate net revenue, given current marketing conditions.

Implications

The results of this article imply that the current strategy of pooling milk into the Florida market from Dairyman Inc. and Southern Milk Sales is nonoptimal. Of the four alternative procurement scenarios analyzed in the article, this scenario is the second best procurement strategy. The optimal procurement scenario is the import strategy. These implications are based strictly on the economic results of the article. Other factors (e.g., relations with other cooperatives and expansion of cooperative membership) that Florida cooperatives may consider when implementing a procurement strategy are not accounted for in the model.

Another implication of the article deals with surplus milk. Under current marketing conditions, any alternative procurement strategy that increases surplus milk from cooperative members is nonoptimal. The results suggest that the cost of supplemental milk reduces the net revenue of cooperative members less than the cost associated with surplus milk. Therefore, procurement scenarios that incorporate pooling arrangements or membership expansion programs are nonoptimal if the cooperatives' objective is to maximize the aggregate net revenue of members.

References

Buccola, Steven T. and M.C. Conner. "Least-Cost Milk Assembly and Manufacturing Plant Locations For the Northeastern Dairy Industry." J. Northeastern Agr. Econ. Council, 8(1979):6-12.

Federal Milk Marketing Order. *Federal Milk Marketing Order Statistics*: Washington, D.C., 1992 Annual Summary.

Florida Agricultural Statistics Service. *Florida Agricultural Statistics: Livestock, Dairy, Poultry*. Orlando, FL.: June 1994.

Gao, Xaoming, Thomas H. Spreen, and Michael A. DeLorenzo. "A Bio-Economic Dynamic Programming Analysis of the Seasonal Supply Response By Florida Dairy Producers." *S. J. Agr. Econ.*, 24(1992):211-220.

Kaiser, Harry M., Pascal A. Oltenacu, and Terry R. Smith. "The Effects of Alternative Seasonal Price Differentials on Milk Production in New York." *Northeastern J. Agr. Res. Econ.*, 17(1988):46-55.

Kilmer, Richard L., John Morrill, Thomas H. Spreen, and Michael DeLorenzo. "The Effects of Alternative Cow Freshening Distributions on Milk Production and Imports in Florida." *Northeastern J. Agr. Econ.*, 21(1992): 151-59.

Prato, Anthony A. "Evaluation of Alternative Milk Marketing Arrangements in Southeast Florida". *Amer. J. Agr. Econ.*, 58(1976):93-97.

Preston, Warren P., Emerson M. Babb, and James K. Binkley. "Efficient Milk Procurement in the East North Central United States. " *North Central J. Agr. Econ.*, 7(1985):18-26.

Prindle, Allen M. and Janet S. Livezey "Optimal Production Schedules for a Representative Farm Under Alternative Seasonal Milk Pricing Patterns of the Base-Excess Plan." *J. Northeastern Agr. Econ. Council.*, 10(1981):23-29.

Sargent, Russell. "The Seasonal Pricing Plan for Milk." *J. Farm Econ.*, 49(1967):643-55.

Endnotes

1. For the purposes of the current study, imports are defined as milk that is not produced by Florida cooperative members but is sold to milk handlers supplied by the Florida cooperatives.

2. Milk marketing orders use a classified pricing system. Producers are paid a Class I price for milk used by consumers as fluid milk. This price is higher than the producer milk used in soft dairy products such as cottage and ice cream. Producers are paid a Class II price for milk used in soft products. Finally, producers are paid a Class III price for milk used in hard dairy products such as cheese, butter and non-fat dry milk. The Class III price is the lowest of all class prices.

3. As a result of negotiations among Florida cooperatives, DI, and SMS, some members of DI and SMS located in South Georgia, North Florida, and Southern Alabama are allowed to ship their production to Florida cooperatives' pool plants or divert their production to nonpool plants for the account of a pool handler.

4. Dairymen Inc., actually calculates farm to market transportation cost for member milk by using the terminal in Quitman, GA as a delivery point (Industry Source). For this reason, Quitman, GA represents the import source for DI. On the other hand, Southern Milk Sales has no terminals or receiving stations in southern Georgia. Since Albany, GA represents the center of production for Southern Milk Sales' producers (Industry Source), this location is established as the import source for production from Southern Milk Sales.

5. For Southern Milk Sales and Dairymen Inc., production information was requested for only producers that were pooled in the Florida market during 1992.