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SP 93-27

## **Staff Paper Series**

### **ALTERNATIVE FLUID MILK PROCUREMENT SYSTEMS FOR THE FLORIDA DAIRY FARMERS**

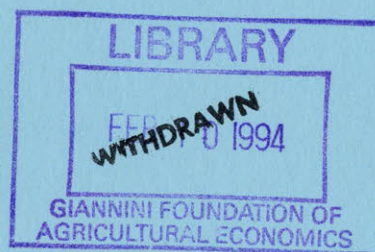
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## ABSTRACT

The objective of this study is to analyze the effects of alternative fluid milk procurement strategies on the aggregate net revenue of Florida cooperative members. The five alternative strategies in the study are (1) supplemental milk obtained from import sources, (2) Florida production modified by a self-sufficiency plan, (3) supplemental milk obtained from a supply plant, (4) increased supply as a result of an expanded production area, and (5) supplemental milk obtained through pooling arrangements with Dairymen, Inc. and Southern Milk Sales. The software that is used to operationalize the models is the General Algebraic Modeling System (GAMS). In the current study, GAMS is used to solve a linear programming model using monthly data for 1992.

Given the current conditions in which the procurement scenarios are modeled, the final ranking of a scenario appears to be dependent on the total cost of exports within the model. Scenarios that concentrate on reducing surplus milk generate a higher aggregate net revenue (ANR) 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 second 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 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 surplus milk disposal. For this reason, the expansion scenario results in the lowest aggregate net revenue for cooperative members. Based on these results, the optimum procurement strategy for Florida cooperatives should concentrate on reducing the quantity of surplus milk. These conclusions are supported by the levels of aggregate net revenue and cost of imports and exports for each procurement scenario.

Of all the procurement alternatives that the Florida cooperatives have available, the optimum procurement scenario is the self-sufficiency strategy. A self-sufficiency plan concentrates on reducing both the cost of imports and exports. By reducing the cost of supplemental and surplus milk, the blend price paid to producers under the self-sufficiency strategy is the highest of any of the alternative procurement strategies.

A self-sufficiency plan operating at maximum efficiency results in no imports or exports. With no imports or exports, the self-sufficiency plan could incorporate premiums of \$1.57 per hundredweight (cwt.) during flush months and \$1.64 per cwt. in months that are deficit. These figures represent maximum premiums based on the

results of the study.

**Key Words:** procurement strategies, aggregate net revenue, imports, exports, supplemental milk, self-sufficiency, pooling, and supply plant

## INTRODUCTION

### Florida Dairy Situation

Florida dairy farmers have a fluid milk market that is constantly growing. Milk consumption in Florida has grown an average of about 3% from 1980 to 1989 (Kilmer et al. 1990, p. 1). The structure of the individual farms throughout Florida allows the dairy cooperatives flexibility in balancing supply with demand. For example, in 1987, 99.3% of the total milk inventory in the Florida dairy industry was supplied by 350 dairy operations. (Jacobson 1990, p. 2). In this study, these individual farms are aggregated into 40 production areas, which represents a county or a group of counties. Furthermore, based on 1990 statistics for the southeast region of the United States, Florida ranked first in average number of dairy animals per farm with 150 (Schiek 1991, p. 16). Having an industry where production is concentrated in the hands of a few large producers creates an environment in which policy changes can be administered quickly and effectively. The Florida dairy producers have the authority and the organizational structure to implement an efficient milk procurement system via their milk marketing cooperatives.

The Florida cooperatives are responsible for supplying milk to 20 processing facilities located throughout Florida (Florida Cooperative Data). In the study, these processing facilities are grouped according to location in order to form 10 marketing areas within the Florida market. As the demand for fluid milk continues to increase at these processing facilities, Florida dairy cooperatives must implement a procurement system that balances supply with demand while maintaining attractive revenue levels for the individual producers. In the years past, the search for an efficient procurement system has been hampered by the fact that milk production is seasonal.

Florida, like many states throughout the country, must contend with the seasonality problem in milk production and consumption. Specifically, during the months of June through November when consumption patterns are steadily increasing (Kilmer et al. 1990, p. 17), Florida producers must deal with the environmental and biological constraints placed upon milk production (Kilmer and Blake 1989, p. 2). 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. 1992, p. 1). Animals freshening during this time period are not as productive as those freshening in the winter and spring. As a result of the decrease in production during the time period from June

through November, dairy cooperatives must obtain supplemental milk from import sources in order to fulfill supply contracts.

In Florida the seasonality problem is apparent throughout the year. As noted earlier, the deficit months are June through November (Kilmer and Blake 1989, p. 2). Conversely, the flush months, December through May, force the Florida dairy industry to contend with a surplus of milk during the winter and spring seasons (Kilmer et al. 1990, p. 16). This surplus of milk is a direct result of reduced heat and humidity (Kilmer et al. 1992, p. 1) and a seasonal decrease in consumption patterns (Kilmer et al. 1990, p. 17). Another factor which contributes to the surplus is the fact that many producers perceive spring production as more profitable than fall production (Kaiser et al. 1988, p. 47). This perception results in producers planning their calving patterns so that many of their animals freshen during the winter and spring seasons. 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 1988 Florida cooperatives paid as much as \$22.87 per hundredweight for supplemental milk (Kilmer et al. 1990, p. 11). The highest price paid for Florida production in 1988 was only \$16.10 per hundredweight (Florida 1992, p. 9). As a direct result of milk seasonality, cooperatives are subjected to unstable milk revenues (Industry Source) and milk handlers are forced to deal with higher operating costs due to the uneven monthly supply of fluid milk (Kilmer et al. 1992, p. 1). The final group affected by the seasonality problem is the producers. 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.

Currently, the Tampa Independent Dairy Farmers Association (TIDFA) and the Florida Dairy Farmers Association (FDFA) utilize imports<sup>1</sup> from 17 sources located throughout 13 states as the primary sources of supplemental milk (Florida Cooperative Data). The price of these imports is positively related to the volume of milk and the distance traveled (Kilmer and Blake 1989, p. 1). From April 1988 to March 1989, approximately 60% of the imported milk originated from sources within 300-400 miles and 1300-1400 miles from Florida (Kilmer et al.

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<sup>1</sup> 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.

1990, p. 3). As the distance traveled increases, so does the cost of imported milk. If the over order payment is not sufficient to cover the cost of importing milk from distant suppliers, there is a possibility that producers will make up the difference by receiving a lower price for their output (Kilmer et al. 1990, p. 2).

As mentioned earlier, producers must also contend with the decrease in revenue associated with increased exports during the spring. Spring production results in a surplus of fluid milk that must be exported to milk handlers located in the northern states since no manufacturing facilities are located within the state of Florida. In 1992, surplus milk was delivered to 19 milk handling plants as distant as 1200 miles from Florida (Florida Cooperative Data). Florida producers are penalized on two fronts with surplus milk. First, the majority of surplus milk is disposed of at class III prices. In 1988, the price received for surplus milk after deductions for transportation cost ranged from \$2.01 to \$11.19 per hundredweight (Kilmer et al. 1990, p. 14). Second, the distance traveled by exports and the price realized by producers are negatively related (Kilmer et al. 1990, p. 3). To this end, milk seasonality has the potential to reduce producers' income.

In order to reduce the cost associated with milk seasonality, producer organizations must implement the most efficient milk procurement system. Some alternative fluid milk procurement sources that are analyzed include (1) Florida milk production as modified by self-sufficiency incentives, (2) an expanded production area, (3) milk obtained from supply plants, (4) supplemental milk from other parts of the country, and (5) supplemental milk obtained through pooling arrangements with Dairymen Inc., and Southern Milk Sales. In the current study, each of the five procurement scenarios is analyzed on a net revenue 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. If a more cost efficient procurement system is implemented by the cooperatives, consumers may experience a possible decrease in consumer prices.

### Problem Statement

The problem is: What is the optimal fluid milk procurement system for the Florida dairy cooperatives that balances supply with demand while maximizing the aggregate net revenue of the Florida dairy producers?



### Objectives

The general objective of this study is to determine if it is economically feasible to implement a more efficient milk procurement system for Florida dairy cooperatives. Specific objectives include (1) develop alternative procurement strategies for Florida dairy cooperatives that adhere to supply and demand constraints while maximizing the aggregate net revenue of producers, (2) develop a model to analyze the costs and revenues that dairy producers will receive under different procurement strategies and (3) identify the costs associated with obtaining supplemental milk from other parts of the country.

## MODEL DEVELOPMENT

### Empirical Model

The necessary components of the empirical model include an objective function and constraints that are designed to operate on a monthly basis. 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 insure an accurate representation of the dairy industry are presented in equations (3) through (9).

$$(1) \quad \text{Decision Variables} = Q_{map}, Q_{mop}, Q_{mah}$$

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

$$(3) \quad \sum_{a=1}^{40} Q_{map} + \sum_{o=1}^{17} Q_{mop} = D_{mp} \quad p = 1, \dots, 10$$

$$(4) \quad \sum_{p=1}^{10} Q_{map} + \sum_{h=1}^{19} Q_{mah} = Q_{ma} \quad a = 1, \dots, 40$$

$$(5) \quad \sum_{a=1}^{40} Q_{mah} \leq C_{mh} \quad h = 1, \dots, 19$$

$$(6) \quad \sum_{p=1}^{10} Q_{mop} \leq S_{mo} \quad o = 1, \dots, 17$$

$$(7) \quad \sum_{p=1}^{10} Q_{mop} \geq LB_{mo} \quad o = 1, \dots, 17$$

$$(8) \quad (\sum_{p=1}^{10} ZON_{sp} Q_{map} + PU_{ma} + BAS_{ma} - DIS_{ma}) / Q_{ma} \leq 1.284 \quad a = 1, \dots, 40$$

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

where ANR = monthly aggregate net revenue;

$Q_{map}$  = 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;

$D_{mp}$  = Demand in month m of processing plant p in hundredweights;

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

$S_{mo}$  = Available supply from origin o in month m in hundredweights;

$LB_m$  = 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. By instructing the model to maximize over the sum of each production area's net revenue, the model 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 to observe the supply and demand restrictions placed on milk production and consumption. Each constraint serves a specific purpose within the model. For example, 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 area 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 are 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 goal of this study is to analyze the effects of alternative procurement strategies on the sum of Florida cooperative members' net revenue. The five alternative strategies in the study are: (1) supplemental milk obtained

from import sources, (2) Florida production modified by a self-sufficiency plan, (3) supplemental milk obtained from a supply plant, (4) increased supply as a result of an expanded production area, and (5) supplemental milk obtained through pooling arrangements with Dairymen Inc., (DI) and Southern Milk Sales (SMS). The primary difference in each model is the source of supplemental milk. In the discussion that follows, the conceptual framework and restrictions of each individual model are presented.

### Import Scenario

Of the five alternative procurement scenarios, 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 cooperative members' production and/or supplemental milk obtained from import sources. Of the 17 import sources, two locations require special attention. In 1992, pooling arrangements<sup>2</sup> 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 Marketing Orders (e.g., the import, supply plant, and self-sufficiency 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.<sup>3</sup>

The import scenario allows the Florida cooperatives to obtain supplemental milk from import sources that are not associated with pooling arrangements. This scenario is designed to reflect the costs that Florida cooperatives incur from purchasing supplemental milk in the market place without prior purchasing agreements.

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<sup>2</sup> As a result of negotiations between 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.

<sup>3</sup> Dairymen Inc., actually calculates farm to market transportation cost for member milk by using the terminal in Quitman, GA as a marketing area (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.

### 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. The production provided by DI and SMS members is pooled in the Florida Milk Marketing Orders.

As stated previously, the primary difference in all of the scenarios is the source of supplemental milk for Florida dairy cooperatives. In the cooperative pooling arrangement, the initial source of supplemental milk is DI and SMS producers that are pooled in the Florida 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).

Another difference between the import model and the cooperative pooling scenario is that the pooling arrangement establishes a lower bound on the quantity of shipments from DI and SMS production areas to Florida processors. The lower bound represents a percentage of the total quantity of DI and SMS production that is pooled in the Florida Milk Marketing Orders. In the current model, the lower bound is set at 3.33% of the pooled milk (Industry Source).

### Self-sufficiency Scenario

The goal of the self-sufficiency scenario is to alter cooperative member's production so that the Florida milk market is totally self sufficient. In this scenario, the Florida market represents a closed market where only Florida cooperative members supply milk to processors in the model. In order to achieve this goal, the supply of milk at each of the 40 production areas is adjusted uniformly so that total supply equals the demand of the 10 processors. The adjustments that are necessary to ensure equality of supply and demand differ from January through December. For example, in the following flush months, total supply is uniformly decreased in each production area until total supply equals total demand: January (3%), February (3.3%), March (6.1%), April (10.7%), May (12.8%), June (4.4%), and December (4%). On the other hand, production is uniformly increased at each production area during the deficit months. The necessary increases are (1) 7.1% in July, (2) 9.2% for August, (3)

18.1% in September, (4) 11.5 % for October, and (5) 6.4% in November. On the average, production decreased 6.33% during flush and increased 10.46% during the deficit months. Since the model utilizes monthly cost of production estimates, the adjustments in a production area's monthly supply are reflected in the total cost of production.

In order to operationalize the self-sufficiency model, an additional constraint is necessary in the program. The objective of the constraint is to guarantee that a processor's demand is satisfied with only Florida cooperative members' production. As a result of this constraint, no imports are allowed in the model. With a constraint binding imports to zero, the available supply at each production area is always utilized in the Florida market. Since imports are not allowed and total supply equals processors' demand, exports are also reduced to zero.

#### 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, Florida, and Alabama. The additional production that is incorporated in the model is represented by the members of DI and SMS that are currently pooled in the Florida 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.

In most of the flush months, the surplus milk generated in this model exceeds the base model's total manufacturing capacity. In this situation, the capacity at all export plants are increased uniformly until the total manufacturing capacity equals the amount of surplus milk. The months that require adjustments and the corresponding increase in plant capacity are January (31.7%), February (22.4%), March (61.5%), May (14.4%), June (42.5%), and December (4.3%).

#### Supply Plant Scenario

The final procurement strategy that is modeled in the study is the supply plant scenario. In this scenario, the Florida cooperatives' first source of supplemental milk is a supply plant that is pooled on the Florida Milk Marketing Orders. In essence, the supply plant can be visualized as a large producer for the Florida cooperatives.

For example, 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 in this model. 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.

In the supply plant scenario, the problems associated with surplus milk are compounded. In order to dispose of this excess milk at manufacturing plants, the capacities at the 19 manufacturing plants in the model needed to be increased uniformly. The adjustments that are necessary include capacity increases in the months of January (73%), February (78.4%), March (41.9%), April (24.2%), May (30.4%), June (88.7%), and December (63.8%).

The final difference in the supply plant scenario and the base model involves the Federal Market Order guidelines for establishing a supply plant. At least 51% of the supply plant's monthly milk receipts must be shipped to the market where the milk is pooled. In essence, the pooling provision establishes a lower bound on shipments from the supply plant to processors in Florida.

#### Data Requirements

Most of the data needed to conduct the study was collected from the Florida Dairy Farmers Association, Tampa Independent Dairy Farmers, Southern Milk Sales, and Dairymen Incorporated. The combined sales from these organizations account for virtually all of the milk that is sold to processors within the Florida milk market



(Industry Source). The input for the model requires monthly data collected over a one year time span. In order to model a typical year within the dairy industry, a time period was selected that contained no major market disturbances. After analyzing information for the previous seven years, the 1992 calendar year was chosen as the most appropriate time period for the study. The specific data requirements are associated with production, processors, manufacturing plants, import sources, and transportation cost.

### Production Areas and Supply

The first data category to be discussed involves production and the formation of production areas. In order to establish a production area for any scenario in the study, production data on a per farm basis is needed from each cooperative<sup>4</sup>. Once a farm's address and production data are obtained, Lotus 123 is used to organize the data by month and county. 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, a production area corresponds 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 order to complete the discussion concerning production data, the monthly cost of production needs to be addressed. 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 are listed in Table 1.

When calculating these estimates, the following expense categories were used: (1) feed, (2) payroll, (3) heifer replacements, and (4) other. On an annual basis, the percentage of total cost that is represented by the four expense categories included in the model is the following: (1) feed: 47.5%, (2) payroll: 18.3%, (3) heifer replacements: 7.2%, and (4) other: 27.0%.

Table 1: 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 of the University of Florida

<sup>4</sup> For Southern Milk Sales and Dairymen Inc., production information was requested for only producers that were pooled in the Florida market during 1992.

### Marketing Areas and Demand

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.

In the model, 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 (Cooperative Records). The class prices that are paid by marketing areas in the model 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.

### Export Alternatives

The total number of export alternatives in the base model is 19. These 19 locations represent viable export alternatives for the Florida cooperatives (Industry Source). In order to qualify as a viable export alternative, the manufacturing plant needed to 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 by using pricing data obtained from the four cooperatives.

### Import Sources

The next data category deals with information on import sources. The base model includes 17 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. At times, a weighted average price is used in certain months for an import source.

### Transportation Cost

The final data requirement provides information on transportation cost. There are two types of transportation cost in the model. For example, the model calculates production area to market transportation cost and transportation cost associated with imports and exports. The integral parts of both types of transportation cost are highlighted below.

In order to determine the transportation cost to and from import and export alternatives, respectively, distances are needed. AUTOMAP, a software package, is used to determine the distance variables for all production areas, marketing areas, export alternatives, and import sources. Along with the mileage, the additional information needed to calculate the transportation cost on imports and exports is a hauling rate. In the model, the hauling rate on imports and exports is \$2.00 per loaded mile with a load of milk equal to 475 hundredweights (Cooperative Records). 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.

## RESULTS AND ANALYSIS

When analyzing the results of the five alternative procurement scenarios, the endogenous variables that are comparable across scenarios are evaluated on an annual basis. Although the primary goal of the analysis is to determine which procurement scenario results in the highest value for the sum of cooperative members' net revenue, other variables in the output offer valuable information as well. For example, the 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.

### Comparative Results

The variables that are described above are the common variables among the five alternative procurement scenarios. In order to fully understand the affects of each scenario on the sum of cooperative members' net revenue, the variables are compared across scenarios in the discussion below.

### Aggregate Net Revenue

As stated in the objectives, the goal of the study 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.

The net revenue per hundredweight is a variable that is directly associated with the ANR value. The net revenue per hundredweight is determined when the ANR value is divided by the total production of Florida cooperative members. 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 net revenue per hundredweight that is used to compare among scenarios is the 1992 weighted average based on the total production of Florida cooperative members that is calculated from the monthly results of each procurement scenario.

A comparative analysis of the annual ANR values and net revenue per hundredweight reveal the optimum procurement scenario. The annual ANR values and the net revenue per hundredweight for the five procurement scenarios are presented in Table 2.

Of the five alternative procurement scenarios, the self-sufficiency strategy results in the highest ANR value, \$43.95 million (m). The net revenue per hundredweight associated with this scenario is \$1.591. The import

scenario is a close second with a ANR value of \$39.61m 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 third 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 \$11.34m. In fourth place, the supply plant scenario generates a net revenue per hundredweight of \$1.164 from a \$32.27m ANR value. The fifth 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 2, 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 of exports, 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 2. By design, the self-sufficiency scenario results in no surplus milk; therefore, the quantity and cost of exports are zero. With this scenario aside, the relative position of the other strategies is (2) import scenario: 1.12 million (m) hundredweights at a cost of \$1.57 per cwt.; (3) DI/SMS pooling arrangement: 1.25m hundredweights costing \$1.81 per cwt; (4) supply plant scenario: 1.84m at \$1.94; and (5) the expansion scenario: 2.85m at a cost of \$2.02 per cwt.

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 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 cwts. from 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 members. This scenario, by far, 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, there are two categories of imports, (1) supplemental milk originating from the supply plant and DI/SMS members and (2) 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 2.

The first import category illustrates the quantity and cost of supplemental milk obtained from the supply plant and DI/SMS producers (Table 2). In the supply plant scenario, Florida cooperatives utilized 1.57 million

Table 2: Annual Results of Alternative Scenarios With Quantities in Hundredweights

Variables	Procurement Scenarios				
	Import	Supply Plant	Expansion	Seasonal Pricing	DI/SMS Pooling
Aggregate Net Revenue (\$)	39,613,139.1	32,275,590.7	31,437,144.4	43,957,218.4	32,610,800
(per cwt.)	(1.429)	(1.164)	(1.038)	(1.591)	(1.177)
Gross Pool(\$)	477,721,000	495,346,000	497,346,000	464,826,000	499,804,000
Net Pool (\$)	457,041,000	449,053,000	487,425,000	464,826,000	491,641,000
Net Blend Price (\$/cwt.)	16.49	16.20	16.09	16.82	16.23
Exports: Florida Cooperative Members					
Quantity	1,128,850.87	1,844,212.60	2,859,578.98	0	1,254,565.20
Cost (\$)	1,770,112.74	3,582,515.5	5,800,803.06	0	2,272,757.53
(per cwt.)	(1.57)	(1.94)	(2.02)	(0.00)	(1.81)
Exports: Supply Plant and DI/SMS Pooling (Non Florida Cooperative Members)					
Quantity	---	820,015.67	---	---	1,601,494.15
Cost (\$)	---	1,021,630.93	---	---	1,629,567.99
(per cwt.)	---	(1.25)	---	---	(1.02)
Imports: From Supply Plant and DI/SMS Pooling					
Quantity	---	1,579,984.32	---	---	970,902.01
Cost (\$)	---	27,131,840	---	---	15,757,740
(per cwt.)	---	(17.17)	---	---	(16.23)
Imports: From Other Import Sources (Non Supply Plant and DI/SMS Pooling)					
Quantity	1,042,909.85	178,287.25	201,313.59	0	197,722.17
Cost (\$)	18,909,300	3,057,600	4,122,940	0	3,985,911.66
(per cwt.)	(18.13)	(17.15)	(20.48)	(0.00)	(20.16)
Gross Haul(\$)	22,290,900	21,639,500	24,132,500	23,524,600	22,120,200
Net Haul (\$)	20,239,100	19,587,700	21,890,500	21,476,412.3	20,068,600
(per cwt.)	(0.73)	(0.71)	(0.72)	(0.78)	(0.72)

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. With the milk imported from these sources, the cost variable warrants a further explanation. For example, the cost of supplemental milk obtained from the supply plant reflects the transportation cost to the Florida market and the weighted average per hundredweight cost of the milk. The annual per cwt. cost of \$14.02 is a weighted average based on the quantity of milk pooled at the supply plant. As far as imports from DI/SMS producers are concerned, the Florida cooperatives pay no transportation charges on the supplemental milk. As a result of the pooling arrangements, the pooled producers receive the Florida blend price and transportation cost to the Florida market is handled by DI and SMS (Industry Source). The cost per hundredweight of \$16.23 is the weighted average blend price in the Florida market.

The last import category illustrates the quantity and cost of supplemental milk obtained from import sources that are not pooled in the Florida market (Table 2). The self-sufficiency scenario is at the top of the list with no imports in 1992. As with the export variables, one must understand that the self-sufficiency scenario is designed so that no milk is imported in the model. In this scenario, the total demand of processors is satisfied by Florida cooperative members.

The second 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, 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 third and fourth 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 cwts. of milk are imported into the Florida market at a total cost of \$18.90 million, or \$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

### Optimum Scenario

As indicated by the comparative analysis, the optimum procurement strategy is the self-sufficiency scenario. The results of the self-sufficiency model need to be considered along with the model's specifications in the program. For example, the model represents a static situation where total demand by processors equals total supply from current Florida cooperative members.

As a result of simulating a static market, the total quantity of imports and exports in this scenario is zero. These results illustrate a self-sufficiency program operating at maximum efficiency. In the face of actual market conditions, replicating the results of the self-sufficiency scenario is next to impossible. In reality, some amounts of imports and exports are expected under the use of any self-sufficiency program. Another issue that the model does not address is competition from other producers and/or cooperatives. In the self-sufficiency scenario, the model assumes that Florida processors buy milk only from Florida cooperative members. In reality, the blend price paid to producers under a self-sufficiency plan will attract competition from other suppliers. This increase in competition could result in a net blend price that is lower than the blend price reported from the self-sufficiency scenario.

Using the conditions that are specified in the model, the self-sufficiency program maintains some degree of flexibility when dealing with imports and exports. For instance, the ANR value of the second best scenario is \$4.34 million (m) less than the ANR value in the self-sufficiency scenario. If the constraints on imports and exports are relaxed, the self-sufficiency scenario remains optimal as long as the ANR value does not decrease by \$4.34m. If the sum of the cooperative members' net revenue decreases by an amount greater than \$4.34m, the import model

becomes the new optimal procurement scenario.

The advantage of implementing the self-sufficiency scenario is that the Florida cooperatives pay their own members for the supplemental milk. By not importing or exporting milk, the Florida cooperatives can pay members up to \$4.34 million in seasonal price incentives in order to induce a supply response from cooperative members. In this situation, the total cost to the Florida cooperative under the self-sufficiency and import scenarios is the same. The only difference is that cooperatives are rewarding their own members for altering production levels so that the demand in the Florida market is satisfied by production from Florida cooperative members.

As demonstrated in the self-sufficiency scenario, the most efficient self-sufficiency plan results in no imports or exports. In this situation, the cooperatives realize substantial savings from not having to incur the cost of supplemental and surplus milk. These savings result from producers altering freshening date distributions in response to a self-sufficiency plan. In order to properly implement a self-sufficiency plan, a supply response study of the Florida cooperative members needs to be conducted. Although this procedure and the discussion of alternative self-sufficiency plans are beyond the scope of the current study, the results of the import scenario provide useful information on the levels of the premiums that cooperatives can pay in a self-sufficiency plan.

During the deficit months of July through November, the import scenario results in 1,042,909 hundredweights of supplemental milk being imported at a total cost of \$18,909,300 (Table 2). These figures show an average cost of imports of \$18.13. The difference between the average cost of imports and the average net blend price is \$1.64. By not importing supplemental milk, the cooperatives could stimulate production from members during deficit months by offering a premium of \$1.64 per cwt. for additional production that is above current production levels in the model. Using the results of the import and self-sufficiency scenarios, the \$1.64 is the maximum premium that cooperatives could pay members for additional milk production.

The final situation that needs to be addressed is the surplus milk. As stated previously, the most efficient self-sufficiency plan results in no surplus milk. In the import scenario, which is the second best procurement strategy, 1,128,850 cwt. of milk is exported at a cost of \$1,770,112 (Table 2). With these figures, the average transportation cost of surplus milk in the import scenario is \$1.57 per cwt. In order for the cooperatives to decrease the quantity of exports to zero with a self-sufficiency plan, a maximum premium of \$1.57 per cwt. could be paid

on the difference between a producer's new, lower production level and the producer's current level of production. Unlike the premium for supplemental milk, which is paid on additional production relative to current levels, the \$1.57 is paid on the reduction in production. An important point to remember is that the \$1.57 per cwt. is a maximum premium based on the results of the self-sufficiency and import scenarios.

As stated previously, discussing possible self-sufficiency plans for the Florida cooperatives is beyond the scope of the current study. In the discussion above, the objective is to identify levels of premiums that could be paid to cooperative members under the guidelines of a self-sufficiency plan. These premiums are based solely on the optimal results of the self-sufficiency and import scenarios, which represent the two extremes of the same scenario. For example, the self-sufficiency strategy represents the extreme position of the scenario where no imports and exports are allowed. At the other end of the spectrum, the import strategy results in the maximum quantity of imports and exports for the Florida cooperatives in 1992. Given this relationship between the two scenarios, under any other conditions (i.e. a self-sufficiency plan allowing imports and exports), the premiums that are calculated above need to be adjusted.

#### All Scenarios

After comparing the variables in Table 2 across scenarios, the results appear to show a strong mathematical relationship between the final ranking of a scenario and its cost of exports. For example, the final positions of the procurement strategies are (1) self-sufficiency, (2) imports, (3) DI/SMS pooling arrangement, (4) supply plant, and (5) expansion. In relation to the cost of exports, the alternative scenarios occupy the same position as those above. The positive relationship in relative positions is not present between the cost of imports 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 cwt. 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, not imports.

Given the relationships described above, the model with no imports and exports, the self-sufficiency scenario, is the optimum procurement strategy. The import scenario is second 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 (\$14.78m above fourth place), the second place finish in relation to the cost of exports has a tremendous influence on the model's second place ANR value.

The position of the final three scenarios is influenced heavily by the source of supplemental milk in each model. For example, the two scenarios that utilize pooling agreements are the third and fourth place scenarios. Although these arrangements decrease the quantity and cost of imports, the lower bound on the shipments from the pooled producers to the Florida market displaces production from members of the Florida cooperatives. As a result of this situation, the quantity and cost of surplus milk in the models increase. Finally, the fifth place procurement strategy is the expansion scenario. In this model, the Florida cooperatives obtain supplemental milk by increasing the membership in the cooperatives. Although this strategy decreases the quantity and cost of imports, the problems with surplus milk during flush months are compounded immensely. The cost of exports from the Florida cooperative members in this model exceed those in the next best scenario by \$2.22 million. The additional cost of exports results in a last place finish for the expansion scenario.

## SUMMARY, CONCLUSIONS, AND IMPLICATIONS

### Summary

The objective of this study is to analyze the effects of alternative fluid milk procurement strategies on the aggregate net revenue of Florida cooperative members. The five alternative strategies in the study are (1) supplemental milk obtained from import sources, (2) Florida production modified by a self-sufficiency plan, (3)

supplemental milk obtained from a supply plant, (4) increased supply as a result of an expanded production area, and (5) supplemental milk obtained through pooling arrangements with Dairymen, Inc. and Southern Milk Sales.

The software that is used to operationalize the models is the General Algebraic Modeling System (GAMS). In the current study, GAMS is used to solve a linear programming model using monthly data for 1992. The objective function of the linear programming model is to maximize the aggregate net revenue of Florida cooperative members.

Of the five procurement strategies, the study indicates that the self-sufficiency scenario maximizes the sum of Florida cooperative members' net revenue and results in the highest net blend price of all scenarios. As shown by the results in this scenario, a self-sufficiency plan operating at maximum efficiency results in a market where the supply of milk from Florida cooperative members equals the demand of processors in the Florida market. In this situation, the import and export variables are reduced to zero.

In order to reduce the quantity of imports and exports below current levels, the Florida cooperatives need to implement some type of self-sufficiency plan. Based on the result of the import scenario, the maximum premium that cooperatives could offer producers to induce a marginal change in production during the surplus and deficit months is \$1.57 and \$1.64 per cwt., respectively. On a monthly basis, the highest premium for a surplus month is \$1.73 (May) and the highest premium in a deficit month is \$2.30 (September). These premiums equal the savings from not importing or exporting milk. Although eliminating all imports and exports to and from the Florida market is unrealistic, the results of this scenario suggest that a self-sufficiency plan that reduces the cost of imports and exports will likely increase the Florida cooperative members' net revenue.

The procurement strategy where supplemental milk is obtained from import sources generates the second highest aggregate net revenue for Florida cooperative members. In this scenario, the Florida cooperatives purchase supplemental milk from many import sources. In fact, of the five procurement strategies, this scenario results in the highest quantity and cost of supplemental milk. The reason for the high cost of supplemental milk is related to transportation cost. As far as other variables are concerned, the import scenario has the second lowest quantity and cost of exports and the second highest net blend price.

The current procurement scenario that is utilized by the Florida cooperatives is the pooling arrangement

with members of other cooperatives. This study indicates that the aggregate net revenue and the net blend price resulting from this scenario are third. 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 third 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 fourth 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 second 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 three scenarios.

The final procurement strategy is the scenario where supplemental milk is obtained by expanding the Florida cooperatives' membership. Although this scenario is fourth 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. In the end, the expansion scenario results in the highest cost of exports and the lowest net blend price.

### Conclusions

Given the current marketing conditions prevalent in the model, the degree of success associated with a procurement scenario appears to be dependent 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 second 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 surplus milk. For this reason, the expansion scenario results in the lowest aggregate net revenue for cooperative members. Based on these results, the optimum procurement strategy for Florida cooperatives should concentrate on reducing the quantity of surplus milk. These conclusions are supported by the level of each procurement scenarios ANR value and cost of imports and exports.

Of all the procurement alternatives that the Florida cooperatives have available, the optimum procurement scenario is a self-sufficiency strategy. The self-sufficiency scenario concentrates on reducing both the cost of imports and exports. The net blend price that is paid to producers under the self-sufficiency scenario is higher than that of any other procurement strategy.

A self-sufficiency plan operating at maximum efficiency results in no imports or exports. Under these conditions, the self-sufficiency plan could incorporate premiums of \$1.57 per cwt. during flush and \$1.64 per cwt. in months that are deficit. These figures represent maximum premiums based on the results of the study. Although complete self sufficiency is unattainable, the results of the study suggest that Florida cooperatives should move in the direction of self-sufficiency by implementing a self-sufficiency plan.

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 study show 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 the study on alternative procurement strategies for the Florida cooperatives imply that the current strategy of pooling milk into the Florida market from Dairyman Inc. and Southern Milk Sales is nonoptimal. Of the five alternative procurement scenarios analyzed in the study, this scenario is the third best procurement strategy. The optimal procurement scenario is the self-sufficiency strategy. If the objective of the Florida cooperatives is to maximize the sum of members' net revenue, a self-sufficiency plan instead of pooling arrangements needs to be implemented by the cooperatives. These implications are based strictly on the economic results of the study. Other economic factors (e.g., relations with other cooperatives) that Florida cooperatives may consider when implementing a procurement strategy are not accounted for in the study.

Another implication of the study 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.

The results of the study show the most efficient fluid milk procurement system for the Florida cooperatives. Because the system is more cost efficient, there is a possibility that consumer prices may decrease.

### Limitations And Suggestions For Further Research

The study is designed to analyze the effects of alternative fluid milk procurement systems on the aggregate net revenue of Florida cooperative members. A limitation of the study is that the linear programming model in the study is a static model utilizing monthly data from 1992. A suggestion for further research is to analyze the effects of the procurement strategies using a dynamic model. Other limitations in the study are (1) cost of production is the same for all production areas, (2) prices are exogenous in the model, (3) the supply of individual producers is aggregated to form production areas, and (4) processors are combined to form marketing areas. Each of these limitations suggest the need for further research.



Additional research is also needed in the area concerning producers' supply response to seasonal price incentives. The study shows that the Florida cooperatives should move in the direction of self-sufficiency. A limitation of the study is that the results of the self-sufficiency scenario are induced. The producers' supply response to seasonal price incentives is not incorporated into the self-sufficiency scenario. The model is designed to simulate the results of a self-sufficiency plan operating at maximum efficiency, not to determine the incentives needed to elicit a supply response from producers. Finally, additional research is needed to analyze the effects of a more efficient milk procurement system on consumer prices.

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