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## THE IMPACT OF ALTERNATIVE PAYMENT ARRANGEMENTS ON THE PERFORMANCE OF FLORIDA SUGARCANE COOPERATIVES

Rigoberto A. Lopez and Thomas H. Spreen

### Abstract

Payment arrangements among members of a cooperative play a critical role in the performance of the cooperative. The impact of three payment systems is assessed for Florida sugarcane cooperatives through a bi-level programming model which incorporates both individual and collective behavior.

**Key words:** cooperatives, mathematical programming, sugarcane.

A group of individuals with common interests usually attempts to further those interests. Olson points out that unless there is coercion or some type of device to make individuals act in their common interests, rational self-centered individuals will not act to achieve their common group interests.

A cooperative enterprise is an organization owned and operated by its members which operates solely for their benefits. A processing cooperative, which processes members' raw product by altering its form, faces the problem of best coordinating the deliveries of the members who may have conflicting interests in the operation of the cooperative plant. This is different than the case of vertically integrated investor-owned firms where the raw product is an input in the production process and not a vehicle of returns in itself. One way to discern the characteristics of cooperative associations from investor-owned firms is by considering the principles that govern the relationships between a cooperative and its members. Abrahamson states the following principles: (1) service at cost by the cooperative, (2) member control and ownership, and (3) limited return on capital.

Arrangements, as used in this paper, are formal commitments (e.g., contracts) that specify how members' raw product is to be marketed, that is, establishing rules by which net savings (costs) of the cooperative and fixed processing capacity are allocated to the members. Conflicts and interdependence in the operation of a co-

operative plant provide the motivation for cooperative members to establish arrangements that determine the manner in which members' deliveries are coordinated. In this regard, Trifon (p. 217) states that "*conflict will prevail over phases of rapidly rising unit-costs (resulting from exhaustion of inflexible capacity, especially under severe resource restriction).*"

The settlement of arrangements is conditioned by the manner in which control and decisionmaking are shared by the members. The internal power structure of the cooperative can be characterized by three groups: the members, the board of directors, and the management team. The dominance of one group over another and of coalitions within the dominant group affect the types of arrangements generated according to the interests and objectives of the dominant elements. Shaffer addresses some of the complications involving alternative linkages between ownership and control of farmer cooperatives. He argues that one can reasonably expect the management of the cooperative to be more responsive to members' preferences than in investor-owned firms. In this study, it is assumed that payment arrangements are set by the dominant group, but such a group is not explicitly identified. In doing so, the dominant group would set up the environment in which its objective is best accomplished. The difficulties involved in cooperative decisionmaking, in particular identification of a cooperative objective, are identified by Aresvik and Zusman.

In the foregoing discussion, questions relating to the nature of the cooperative objective are raised. Ladd (1982) argues that maximization of total net returns is the most plausible single objective for a cooperative enterprise. Helmberger and Hoos argue that the cooperative maximizes cooperative surplus, leading to an equilibrium given by the point where net average revenue product from the members' raw product equals the supply function of the members. LeVay and Zusman challenge the existence of a single, unambiguous cooperative objective on the grounds that conflict of interests among

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Rigoberto A. Lopez is an Assistant Professor, Department of Agricultural Economics and Marketing, Cook College, Rutgers-The State University of New Jersey. Thomas H. Spreen is an Associate Professor, Food and Resource Economics Department, University of Florida.

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the members does not allow an objective definition.

Nonetheless, one can reasonably postulate that the members' objective is the maximization of their own net returns and that payment arrangements significantly affect the behavior of members, and hence, the performance of the cooperative. The manner in which a cooperative enterprise compensates (charges) its members for their contribution to (use of) the cooperative plays a crucial role in providing incentives for their collective welfare and in determining the distribution of returns among the members. In a processing cooperative, a payment system allocates cooperative net savings among the members and influences decisions on product quality, size of deliveries, and when to deliver the raw product for processing. Payment arrangements can be viewed as instruments to potentially enhance the performance of cooperatives. Knutson notes that most buy-sell cooperatives lack sophistication in marketing. He also states that committed commodity marketing cooperatives hold the potential for improving price discovery largely through improved grading systems, timing of marketing, and establishment of more realistic location price differentials.

The objective of this paper is to provide a methodological framework for the empirical assessment of alternative payment arrangements among members of processing cooperatives. An empirical model is developed for Florida sugarcane processing cooperatives and three payment systems are analyzed. These payments are based on sugarcane weight, sugar weight, and use value of the delivered sugarcane.

### PREVIOUS WORK

Studies with similar objectives as undertaken in this paper include analyses by Bar, Hardie, Buccola and Subaei, Ladd (1974), and Zusman. These studies are not primarily concerned with payment arrangements *per se* and, with the exception of Buccola and Subaei, do not provide empirical results.

Hardie and Bar developed linear programming models for cooperatives and both prescribe efficient pricing solutions from the shadow values. Hardie's model allows for various grades of raw material and suggests pricing each product in accordance with its shadow price. Helmsberger et al. discuss the shortcomings of this approach. Bar presents a model based on the decomposition principle of linear programming. The model is composed of a master program in which management strives to maximize

total net returns of the cooperative and a set of subprograms that represents the members' problem. Management influences members' behavior in the model through the pricing of fixed costs. Variable costs are exactly allocated to each service or delivery. From the analysis, Bar suggests that fixed costs must be allocated in accordance to the shadow price of resources but concludes that maximum cooperative profits are unattainable.

Buccola and Subaei consider *ex post* payment arrangements. They analyze the risk and distributional implications of alternative product pooling schemes once net savings of the cooperative have been determined. They do not, however, characterize surplus as depending upon the payment scheme. Ladd (1974), on the other hand, addresses alternative cooperative objectives. Results indicate that an efficient quantity maximizing cooperative differs from an efficient price maximizing cooperative and both differ from a profit maximizing cooperative. Zusman concludes that the Pareto optimal solution in a marketing cooperative is achieved through allocating cost in accordance with marginal cost and allocating the remaining surplus through side payments.

The conclusions of Bar, Hardie, and Zusman are congruous with each other and to the findings of the present study. The model presented in this paper concerns alternative *ex ante* rules of apportioning cooperative savings. The problem is conceptualized as a bi-level programming problem in which payment rules are set at level 1 (by the dominant group within the cooperative) and members react at level 2 by trying to maximize their own net returns given the payment scheme set at level 1. Thus, the model is analogous to the one presented by Hardie in the sense that members' behavior is differentiated from the behavior of a collective decisionmaker. Hardie's model does not incorporate alternative rules of allocating cooperative surplus (or costs). In the model proposed in this paper, the cooperative always strives to maximize total profits but the cooperative objective embodies the payment arrangement and the members' behavior. In addition, the model includes spatio-temporal and plant capacity factors that affect the operation of processing cooperatives.

### FLORIDA SUGARCANE PROCESSING COOPERATIVES

In Florida, sugarcane processing cooperatives account for approximately 35% of all cane processed (Zepp).<sup>1</sup> Figure 1 depicts the operation

<sup>1</sup>The Florida sugar industry is located in the southern end of Lake Okeechobee and comprises more than 340,000 acres which produced 1,121,490 short tons of raw sugar in the 1980-81 season (Alvarez et al.).

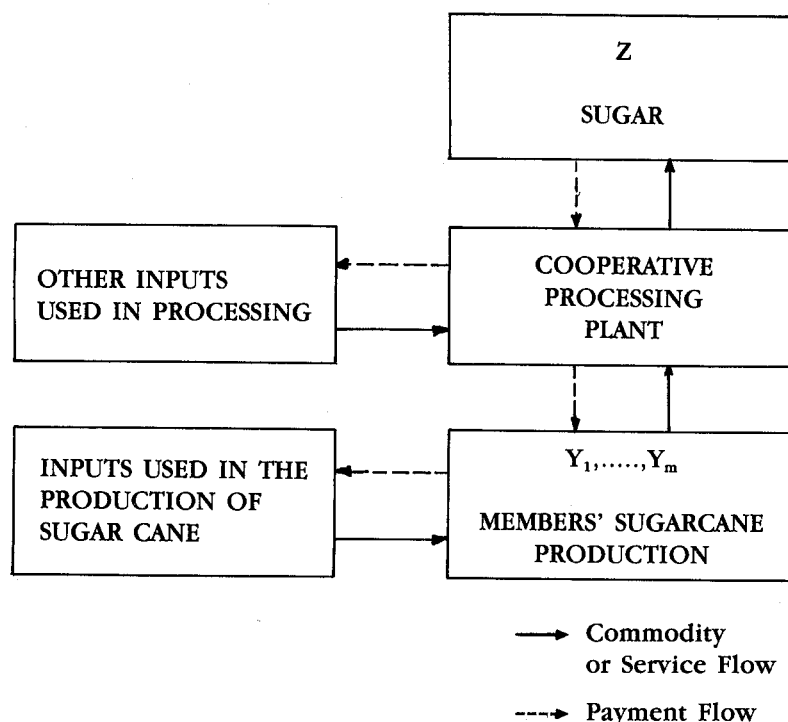


Figure 1. Flows of Inputs, Outputs, and Payments in Florida Sugarcane Processing Cooperatives.

of Florida sugarcane cooperatives in relation to its members and other involved segments. These cooperatives harvest, haul, and process members' sugarcane and produce and sell the sugar. These cooperatives pay members from net savings generated from the sales of sugar less fixed and variable costs (harvesting, hauling, and processing). This paper deals with rules of apportioning this surplus; i.e., the broken line that flows from the cooperative plant to the members in Figure 1. As is customary in cooperatives, Florida sugarcane cooperatives pay an initial price at the time of delivery and distribute a deferred patronage at the end of the accounting period.

Florida sugarcane cooperatives currently pay their members according to the amount of "net standard tons"<sup>2</sup> of cane delivered in an attempt to compensate for the amount of sugar extracted from the delivered raw product (Crane et al.). Payment is adjusted by the average harvest and transportation costs per ton of cane delivered. Since members are currently paid according to sugar delivered and sugar content in the cane increases as the season progresses (Alvarez et al.), members prefer to deliver their cane as late as possible to increase their revenues.

Sugarcane processing cooperatives face the problem of determining the best use of limited

processing capacity. The harvest season extends from October to April when sugar accumulates in the cane (Alvarez et al.). Conflicts arise among the members because of the perishability of sugarcane (storage cannot be utilized), and members' preferences for delivery time. These conflicts are settled, in part, through the imposition of individual delivery quotas to ensure adequate deliveries in both "good" and "bad" delivery times within a processing season.

Sugarcane cooperative members influence the quality and quantity of deliveries through the selection of varieties of cane, area of cane cultivated, and times of deliveries. There are at least five reasons for variation in the value added generated across varieties. Varieties of cane differ by (1) tons of cane produced per acre, (2) sugar content, (3) fiber content, which affects ease of processing or time to process, (4) growing costs, and (5) temporal quality and tonnage patterns (Meade and Chen, Miller and James, Alvarez et al.).

The payment problem for a Florida sugarcane cooperative is to allocate the net savings of the cooperative to the members. The payment system directly affects members' behavior, and hence, affects the level and distribution of net returns among the members. The balance of this paper consists of three parts. First, the payment

<sup>2</sup>Field trash and cane tops are subtracted from the delivered cane to obtain "net tons" of cane. "Standard tons" of cane are net tons of cane adjusted with a quality factor which is determined upon analysis of the sucrose content in the cane juice (Meade and Chen).

systems to be instituted are defined. Then, a bi-level programming model is developed for the problem. Finally, the model parameters are estimated and empirical results are presented and discussed.

### PAYMENT SYSTEMS

Consider a sugarcane processing cooperative composed of  $m$  members with closed membership. The cooperative only processes members' raw product and the members are committed to deliver all their production to the cooperative.

Let  $Y_{ifv}$  denote the amount of raw product produced from variety  $v$  ( $v=1, \dots, V$ ), delivered in processing period  $t$  ( $t=1, \dots, T$ ) from field  $f$  ( $f=1, \dots, F$ ), belonging to member  $i$  ( $i=1, \dots, m$ ). Let  $H_{ifv}$  be a binary choice variable which equals one if field  $f$  belonging to member  $i$  is harvested in period  $t$ , planted with variety  $v$ , and equals zero otherwise. Define  $J$  and  $H$  as the vectors containing  $Y_{ifv}$  and  $H_{ifv}$ , respectively. Let  $Y$  denote total raw product delivered by the members. The inner product of  $J$  and  $H$  equals  $Y$ , i.e.,  $H \cdot J = Y$ . Further, define  $Y$  as the vector of raw product deliveries for the planted fields containing all nonzero cross products of  $H_{ifv}$  and  $Y_{ifv}$ .

Assume the cooperative variable cost function,  $C(Y)$ , is separable so that the cost of harvesting, transporting, and processing each member's delivery can be allocated to that grower. This assumption is reasonable since Florida sugarcane cooperatives compute variable expenses per ton delivered (harvesting, hauling, processing) and they record the amount of raw material and variety contained in each delivery. Let  $Z$ ,  $P_z$ , and  $FCC$  denote the total amount of sugar produced by the cooperative, the price at which the cooperative sells  $Z$ , and the fixed cooperative cost, respectively.<sup>3</sup> Then, cooperative surplus ( $CS$ ), the net cooperative saving available for members' payment, is:

$$(1) \quad CS = P_z Z - C(Y) - FCC.$$

The payment problem for the cooperative concerns the allocation of cooperative surplus as defined in equation (1), among the members. Because of the nonprofit nature of cooperative associations,  $CS$  is entirely returned to the members. Thus, the following payment constraint must hold:

$$(2) \quad CS = \sum_i PAY_i^k$$

where  $PAY_i^k$  denotes the payment to grower  $i$

under payment system  $k$  for the delivery of the raw product. For simplicity, it is assumed that the cooperative does not retain any earnings, or conversely, that members have no liquidity preference with respect to deferred payments. Even though an infinite number of payment systems can be devised to allocate equation (1), three are considered which seem plausible and are commonly used by the sugarcane industry (Meade and Chen).

First, consider a payment system that allocates cooperative surplus based on tonnage of raw material delivered. The price per unit of  $Y$  is  $\tilde{P}_y = CS/Y$ , and the payment for the delivery of  $Y_{ifv}$  is:

$$(3) \quad PAY_{ifv}^1 = \tilde{P}_y Y_{ifv},$$

Under this payment system, a grower's payment is directly proportional to the tons of cane delivered regardless of the sugar or fiber content of the cane.

Second, consider a system in which members are paid for the amount of sugar that is extracted from their deliveries. Payment is based on  $Z$  rather than on  $Y$  and a "price" can be expressed as  $\tilde{P}_z = CS/Z$ . The payment for the delivery of  $Y_{ifv}$  is:

$$(4) \quad PAY_{ifv}^2 = \tilde{P}_z Z_{ifv},$$

where  $Z_{ifv}$  represents the finished product equivalent of  $Y_{ifv}$ , i.e., the sugar extracted from  $Y_{ifv}$ .

Third, consider the case where members are paid on a use value basis, and thus they are paid for the quantity of sugar extracted from their deliveries adjusted for the cost of processing and other cooperative services. Thus, payment for the delivery of  $Y_{ifv}$  is:

$$(5) \quad PAY_{ifv}^3 = P_z Z_{ifv} - C(Y_{ifv}) - FCC_{ifv},$$

where  $FCC_{ifv}$  is the fixed cooperative cost allocated to delivery of  $Y_{ifv}$ . Fixed cooperative costs can be allocated in several ways. Sharing  $FCC$  based on the amount of raw material is one criterion. In Bar's model, the cooperative influences members through the allocation of fixed costs. Following Zusman, it is assumed that every member's share of  $FCC$  is predetermined, although Zusman's analysis would suggest that no equilibrium vote exists to allocate  $FCC$ . Note that under this payment system, the value of marginal product that the cooperative realizes is precisely the payment that the grower receives for that delivery.

<sup>3</sup>In this paper, sugar is considered as the sole output of sugar production, although molasses and bagasse are by-products of sugar production. This paper also abstracts from rotational issues by assuming that all cane is in the second (average) year of crop cycle. Crane et al. address the issues involved in rotation and stubble replacement.

## A MATHEMATICAL PROGRAMMING MODEL

Given a payment system to allocate cooperative surplus among the members, a member decides what variety to plant in a given field of sugarcane since different varieties will result in different net returns under alternative payment systems. In addition, the schedule of deliveries depends on the payment system because tonnage, sugar, and other factors embodied in alternative payment systems are linked to the time of delivery.

### Variety Selection Problem

The problem of variety selection can be viewed as one of choosing among alternative techniques of production. Assume that the time span for decisionmaking allows for the selection of varieties of sugarcane for the fields to be planted. The characteristics that determine yields, costs, and processing-capacity use are unique to each field of sugarcane (usually 40 acres).

In deciding which variety to plant in a given field ( $f$ ) for deliveries in a particular processing period ( $t$ ), a member ( $i$ ) will strive to maximize

$$(6) NR_{ift}^k = PAY_{ift}^k - GC_{ift},$$

where  $NR_{ift}^k$  and  $PAY_{ift}^k$  are net returns and payment to the grower under payment system  $k$  for deliveries of  $Y_{ift}$ .  $GC_{ift}$  is the grower's cost incurred in producing  $Y_{ift}$ . Furthermore, equation (6) gives the valuation of deliveries from the member's standpoint; i.e., how much that delivery is worth to the grower. For instance, if the payment is based on raw product, the grower will be concerned only with the amount of raw product at delivery time.

When payment is based on use value, the payment for  $Y_{ift}$  is the value added from the delivery. When balanced with the grower's cost as in equation (6), this payment system leads to a production decision analogous to Olson's condition for the optimal amount of a collective good (costs and benefits shared in the same proportion), Zusman's marginal cost pricing in a marketing cooperative, or to the member's internalization of the marginal revenue product for a "coordinated" cooperative as suggested by Lopez and Spreen.

### Cooperative Maximization Problem

In the present analysis, it is assumed that the task of the cooperative is to maximize total net returns of the members provided that the mem-

bers are trying to maximize their own net returns. Individual members choose which field (area) to plant and select the varieties planted. The cooperative is responsible for harvesting the fields planted in the "best" possible sequence. The decision to plant a particular field, and hence make it available for harvest, is contingent upon members' valuation of deliveries which depends on the prevalent payment system and grower's cost in equation (6). Thus, the objective contribution of each delivery is given by equation (6), as viewed by the member. Further, Lopez and Spreen have shown that when members behave as price takers, a solution analogous to that of Helmberger and Hoos is found when one maximizes members' total net returns. Given the added dimensions of quality, space, and time, cooperative equilibrium depends upon the prevalent payment system. Regardless of the payment system, "fairness" in use of the cooperative processing plant over the processing season is achieved through individual delivery quotas based on the amount of raw product.

Three sets of constraints that regulate operation of a sugarcane cooperative in a given processing season are processing plant capacity, members' delivery quotas, and the payment constraint (no deferred payments or taxes).<sup>4</sup> There are two limits that define processing plant capacity: a lower limit ( $M_t^l$ ) which specifies the minimum amount of cane that justifies economic operation of the mill and an upper limit ( $M_t^u$ ) which specifies the maximum amount that can be processed in a given period. Members' delivery quotas are imposed to induce "fairness" in using the processing plant in "good" and "bad" delivery periods. A member's delivery in each processing period must be contained between the upper quota,  $Q_{it}^u$ , and lower quota,  $Q_{it}^l$ , for period  $t$ . The quotas are used in the model without questioning the implication of alternative supply control policies.

Assuming that the cooperative objective is to maximize total net returns under a given payment system, the task of the cooperative is to maximize:

$$(7) \sum_i \sum_f \sum_t W_{ift} NR_{ift}^k \quad \text{Total Members' Profits}$$

subject to:

$$(8) M_t^l < \sum_i \sum_f W_{ift} < M_t^u \quad \text{Mill Capacity}$$

$$(9) Q_{it}^l < \sum_f W_{ift} < Q_{it}^u \quad \text{Members' Quotas}$$

$$(10) \sum_i PAY_i^k - CS = 0 \quad \text{Payment Constraint}$$

<sup>4</sup>Individual member quotas can be defined such that their sum equals mill capacity in a particular harvest period. The model formulation, however, includes both mill capacity and members' quotas for completeness.

$$(11) NR_{it}^k = \text{Max}_v NR_{itv}^k \quad \text{Variety Selection}$$

where  $W_{it}$  is a binary choice variable such that  $W_{it}$  equals one if field  $f$  of member  $i$  is harvested in time  $t$ , and is equal to zero, otherwise.<sup>5</sup> If  $\sum W_{it}$  is zero, that field is left idle. For payment  $t$

based on raw or finished product, equation (10) can be written as  $\bar{P}_y = CS/Y$  and  $\bar{P}_z = CS/Z$ , respectively. For a use value payment system, equation (7) must be adjusted for fixed cooperative costs to obtain the total members' net returns. FCC is assumed to be shared in a pre-determined manner, and hence, it does not influence production decisions. The nested optimization in equation (11) determines the valuation of deliveries from the members' standpoint and corresponds to the problem given in equation (6).

### ESTIMATION OF PARAMETERS

The parameters of the stated mathematical programming problem are estimated for a sugarcane cooperative operating in South Florida. Primary data were collected to estimate  $Z_{itv}$  and  $Y_{itv}$  with statistical models similar to those specified by Alvarez et al. Predicted  $Z_{itv}$  and  $Y_{itv}$  are used directly in the estimation of cooperative surplus and the specification of the constraints of the model. The processing season is divided into five harvest periods ( $T=5$ ), each encompassing 4 weeks, within which the individual members' quotas and mill capacity were defined. The cooperative under study processed sugarcane from 800 fields with a daily processing capacity of 7,140 tons of cane operating 140 days (200,000 tons per processing period). The cooperative is assumed to consist of five members ( $m=5$ ), each owning 160 fields ( $F_i=160$ ). The five most frequent varieties (planted in 98 percent of fields in the 1979-80 processing season) are selected as the varieties available to a grower ( $v=A, B, C, D$ , and  $E$ ).

All prices and costs are adjusted to December 1981 dollars. Cooperative costs incurred in harvesting, transporting, and processing the cane are assumed to be linear in raw product. The per unit costs were obtained from budget figures. A survey was conducted to obtain indices for the processing and growing costs for the sugarcane varieties. The processing cost func-

tion is adjusted for varietal processing quality (fiber content) with indices obtained from the survey. FCC is estimated as the daily mill capacity in tons times the fixed cost per ton as estimated by the United States Department of Agriculture. Grower's cost per acre is estimated from secondary data (USDA) and is adjusted with growing cost indices for varieties of cane. Lopez presents a more detailed discussion on the estimation of the parameters of the sugarcane cooperative for which the model was operationalized.

### METHODOLOGY

The multilevel programming approach discussed by Candler et al. is analytically appropriate for the solution of the mathematical programming problem given by equations (7) through (11). The problem can be conceptualized as a bi-level programming problem: at level 1, arrangements for payments (policies) are set where the cooperative's objective is the maximization of total net returns and, at level 2, a member makes production decisions to maximize net returns taking policies set at level 1 and other members' actions as given.

Figure 2 shows the five-step algorithm used to solve the bi-level programming problem. Step 1 is to specify a payment system. Step 2 is to specify an initial "price" for members' deliveries. At step 3, a nested optimization is performed in which the variety that yields the highest net return under a given payment system is determined for each field harvested during each processing period. Step 3, then, simulates a second level decision (members' behavior) where the valuation of deliveries (objective contribution) is determined. Once assignment of varieties is determined, step 4 consists of determining the planting and harvesting patterns that maximize total net returns given the quotas and limited processing capacity.

After step 4 is completed, members' price is computed and compared to the price specified at step 2. If the two prices are equal, the cooperative is in equilibrium and total payments are equal to cooperative surplus. If not, the algorithm returns to step 2 and calibrates "price" toward convergence of both prices. By construction, the use value payment system does not require iterations to achieve price convergence. In the case of nonlinear processing cost function or endogenous fixed cooperative cost shares, an

<sup>5</sup>Since the decision variables ( $W_{it}$ ) represent fields, member quotas and mill capacity restrictions must be expressed in terms of field rather than tons of sugarcane. To ensure feasibility of the solution, the model is solved using an initial estimate of member quotas and mill capacity restrictions based upon fields. Next, the tonnage processed for each member in each processing period is computed. If these values are outside either member quotas or mill capacity expressed in tons of sugarcane, the bounds based on fields are calibrated and the model is resolved. The procedure is repeated until the solution is feasible on an actual tonnage basis.

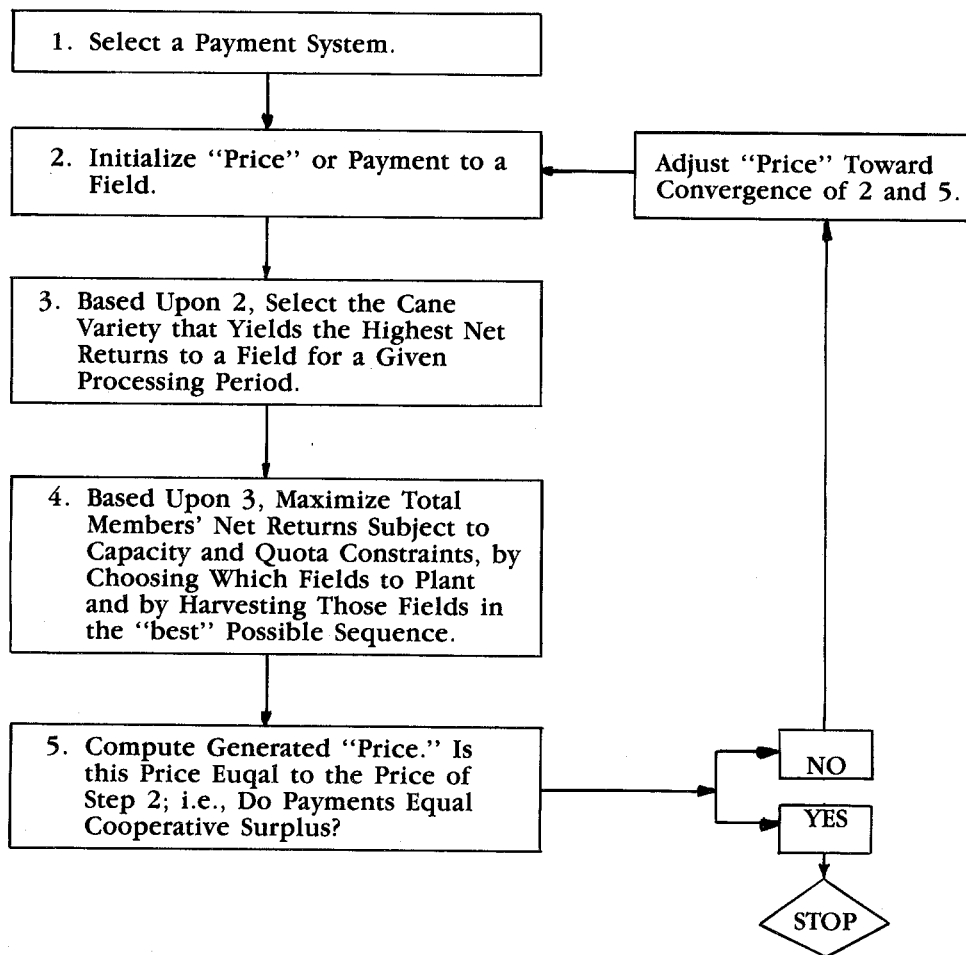


Figure 2. Solution Procedure for the Mathematical Programming Model.

iterative scheme would be needed to obtain an equilibrium.

The algorithm is completed for each of the payment systems. Members' profits are compared and the payment system that yields highest total members' profits is designated as potentially Pareto superior relative to another payment system.

The procedure embodies optimization subproblems at steps 3 and 4. Optimization at step 3 is computationally trivial since it only involves choosing among five alternative (varieties) for each field in a given period. The problem at step 4 is an integer programming problem ( $W_{it}$  integer) and use of the simplex method will not ensure integer solution. The problem can be viewed as an assignment problem (assigning fields to processing periods) which can be formulated as an equivalent transportation problem. Bradley et al. show that any capacitated transshipment problem, of which the transportation problem is a special case, can be expressed as a network flow problem. They show that computation time can be reduced up to 200 times by using specialized

network flow algorithms rather than alternative solution techniques. The specific adaptation of the above problem to a network flow framework is explained by Lopez.

## EMPIRICAL RESULTS

The bi-level programming problem was solved with the three payment systems defined above. Performance measures for each of the payment systems are presented in Table 1. Differences in performance results are due to differences in the pattern of deliveries, varieties grown and area of cane planted by the members.

Under a use value payment system, the cooperative makes total net returns of \$4,271,419 for a single processing season, the highest of all the scenarios considered, Table 1. Payment based on sugar delivered ranked second with total net returns of \$2,304,719 which represents a loss of \$1,966,700 from the use value payment system solution. Payment based on the amount of raw product results in \$2,251,238 total net returns, which represents a loss of

TABLE 1. RESULTS OF PERFORMANCE MEASURES FOR ALTERNATIVE PAYMENT SYSTEMS FOR FLORIDA SUGARCANE COOPERATIVES

Performance measure	Payment based on		
	Raw product	Finished product	Use value
Net returns (\$)			
Total .....	2,251,238	2,304,719	4,271,419
Member 1 .....	447,420	395,707	671,244
Member 2 .....	277,892	341,602	795,679
Member 3 .....	440,081	545,957	1,077,546
Member 4 .....	159,580	105,611	355,661
Member 5 .....	926,265	915,842	1,371,419
$P_r$ (\$/ton) .....	17.00 <sup>a</sup>	17.08	20.23
$P_s$ (\$/ton) .....	174.95 <sup>a</sup>	175.34	208.76
Tons of sugarcane .....	908,153	906,863	974,172
Tons of sugar .....	88,273	88,326	94,390
Varieties of cane ...	C	C	C,B
Acres of cane .....	24,960	24,896	25,024

<sup>a</sup>These are equilibrium prices in their respective payment arrangements.

\$2,020,181 from the use value payment solution. Focusing on individual members, some members benefited positively with cane-based payment rather than with sugar-based payment and vice versa. For example, member 3 is better off with sugar-based payment than with cane-based payment by \$105,876, while member 4 is better off with cane-based payment by \$53,969. The redistributive impact among alternative payment arrangements is not surprising since individual members have comparative advantages in producing cane or sugar. However, each member is better off under a use value payment system than in any other system.

The difference in total net returns between cane-based and sugar-based payments is \$53,481 which is not as large as one could expect. Two reasons are envisioned to provide, in part, an explanation for the phenomenon. First, the variety-choice set used in the estimated model may not allow a large variation in quantity-quality choice. Second, the amount of sugar may not be independent of the amount of cane. Since cooperative revenues depend on sugar, while cooperative variable costs depend on cane tonnage, under a cane-based or sugar-based payment system, highly productive growers (high sugar content, low cane tonnage) are penalized for their deliveries which in turn leads to underproduction as in the case of externalities. A use value payment system leads to the highest raw product price ( $P_r = 20.23$ ), the greatest amount of raw product (974,172 tons of cane) and the greatest amount of sugar (94,390 tons).

The differences between total net returns with a use value payment system and the other systems show the importance of the internalization of the cooperative processing costs and revenues by individual cooperative members. The difference among payment systems lies in the valuation of deliveries made by the members.

While a use value payment system induces the members to individually bear the costs and revenues that the cooperative realizes, it also leads to a selection of differing cane varieties (variety B is planted only with the use value payment) and to more efficient harvesting and planting schedules. Payment systems result in different patterns of deliveries throughout the processing season (mill loads and sugar production per period).

In general, the results are consistent with *a priori* expectations. A question arises as to why a use value payment system has not been adopted. The answer seems to lie in the conflict of interests involved and the potentially high costs of monitoring such a system. In this analysis, it is assumed the cooperative consisted of five members of similar size. The five-member assumption is employed to simplify the dimensions of the empirical model, although it makes the results somewhat limited. Zusman has shown that as members become more divergent in size, conflicts are more likely. Implementation of a use value payment system would imply some arbitrariness in allocating costs. For instance, would a member located at some distance from the plant be willing to pay higher transportation costs?

The use of quotas throughout the payment scenarios insured more even distribution of net returns (Lopez). In spite of these limitations, the results support the case for a strong management or board of directors to implement rules that coerce members into producing efficiently. This is also supportive of Hobbes' theory that states that one way to insure the preferred outcome is to establish a government (management or board of directors) with sufficient power to ensure that it is in every man's interest to choose the preferred outcome.

## CONCLUDING REMARKS

The purpose of this paper is to assess the impact of alternative payment arrangements on the performance of Florida sugarcane processing cooperatives. A bi-level mathematical programming model is developed for the problem. The empirical results indicate that by using a payment based on use value of the deliveries, a cooperative can significantly increase members' total net returns when compared to payment based on raw or finished product.

As for the manner in which Florida sugarcane cooperatives are currently operating, the results suggest that these cooperatives should devise a payment system that charges each member for the cost of processing deliveries. Such a charge must be based on tonnage of sugarcane adjusted for processing quality of the deliveries. This

measure is likely to enhance the performance of these cooperatives.

An important limitation of the analysis is that it ignores the monitoring and enforcement costs of the various payment arrangements. The magnitude of these costs could result in a second-best solution with a payment arrangement with

low implementation costs regardless of the incentives transmitted to the members. Another limitation of the model is its nonstochastic nature. Risk considerations such as freeze tolerance of the varieties of cane are factors that growers incorporate in their variety selection decisions.

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