OPTIMAL DISTRIBUTION OF REVENUE GENERATING ASSETS IN AN AGRICULTURAL COOPERATIVE RETAIL SYSTEM

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(ABSTRACT)

Changes in farm structure and increased competition have placed pressure on cooperatives' retail distribution system to meet their farmers changing needs in a profitable fashion. This research attempted to identify changes in regional profitability resulting from different consolidation alternatives for farm supply outlets. Cost and revenue coefficients were developed from available data in the Maryland region, including sales by zip code. Linear and integer programming were used to maximize profit across nine stores given those stores' 1983 gross margin percentages, operating costs, and asset capacities. The optimal solutions of several scenarios indicated that several stores could be closed with little effect on the region's total sales. Specialization through consolidation provided the most profitable venture, especially in product lines requiring processing such as bulk fertilizer and feed.

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CHAPTER I

INTRODUCTION

Many agriculture retail cooperatives are less profitable partially because many of their primary customers, medium sized farms have gone out of business [USDA]. This change in the distribution of farm sizes combined with increases in variety of competition has contributed to decreases in profitablity. Given the changing size of farms, cooperatives must consider changes in their distribution structure if they are to maintain market share and remain profitable.

1.1 Cooperative Background

In order to understand the cooperative distribution problem, a generalized exposition on agriculture cooperatives' purpose is necessary. Some agriculture cooperatives came into existence to assure farmers of quality products at competitive prices. The first form of a supply cooperative came about when farmers organized to purchase supplies for their farms at lower prices by pooling orders. Over time, cooperatives grew and their functions changed. Cooperatives found it beneficial to keep some inventory on hand. This evolutionary process led to local cooperatives with a warehouse, a manager, and a truck for deliveries. Some of these local cooperatives found additional economies in purchasing products and servicing farmers by banding together in federations. Some of these federations merged into large incorporated cooperatives and centralized regionals. All of these structures: local cooperatives; federations; and corporations are included in the cooperative supply sector.

Cooperatives attempt to operate for the mutual benefit of the farmers who own and are the users of the cooperative. Each patron gets one vote regardless of the quantity of purchases. Thus cooperatives, at least in principle, try to serve all their farmer-members equitably regardless of size.

The present distribution system includes a wholesale network, broken down by product line, and a retail network, broken down by location. The wholesale divisions distribute products to the retail outlets, and take a specific margin for the activities they perform. Many of the retail outlets have been in place for several decades and have depreciated to a point where little book value remains. Some of these stores' major capital equipment is near replacement age. These stores and their equipment, in general, are technologically antiquated and smaller than newer stores and equipment. Many of the older stores are also close together. The average distance of 219 stores from one Southern States Cooperative retail location to another was eighteen miles.

1.2 Patron Background

Just as the cooperative distribution structure has altered little, the total volume demanded of farm supplies which they and competitors distribute has not and probably will not drastically alter from current volume in the near term. Total demand for inputs into the production process is a derived demand originating from the demand for agricultural commodities. Little growth in the demand for agricultural commodities is expected, because of four basic economic events. There is little domestic population growth now or expected in the near future. This stable population is coupled with a stable demand for food per capita and leaves the agricultural industry with little potential to increase sales in the domestic market. The high federal government deficit has produced responses like the Gramm-Rudman bill and political trends toward less government purchases of agriculture commodities to enhance this domestic market. Also, although possibly a short term situation, the strong dollar has limited the amount of exports thus limiting expansion in the foreign market [Coffey, 1984b].

While total agricultural demand is expected to be relatively stable, the size distribution of the farms who produce in this market has been steadily changing. There has been a bimodal trend towards both larger and smaller farms, with a decrease in number of medium-size farms [USDA]. The medium-size farms still dominate in number, but there is a definite trend away from the middle. A Southern States Cooperative study found farms over 1000 acres increased 9 percent, and farms under 50 acres increased 14 percent in the years 1978-82 in their trade area [Swann]. Farms 50-1000 acres in size decreased slightly in number. This trend is confirmed when comparing the 1982 Census of Agriculture to earlier census. Most farmers controlling less than 50 acres have incomes which are supplemented off the farm.

Much of the gain in small farm numbers arises from a creep of suburbia into previously rural areas leading to the notion of part time and hobby farms which are frequently referred to as "farmettes". The main purposes of these farms include operation for hobby or tax reasons rather than for production purposes. The sites where farms are becoming larger are in areas away from this urbanization. This movement of suburbanization results in heavy or pocketed areas of commercialization.

1.3 Needs of the Patrons

As farm structure changes, supply needs in the aggregate for agriculture change. As a general rule, the large commercial farmers are usually more educated in the production process and more price sensitive than smaller and part-time farmers [Dunn, and Hamm]. These farmers can search and find low prices for the large volumes they purchase, and realize substantial cost savings. Commercial farmers offer a considerable volume to whomever supplies their inputs. Often, price is very important to these businessmen, because of the quantity involved. Research indicates large and small farmers have approximately the the same cooperative loyalty [Dunn].

Some examples of how the needs of the large commercial farmers differ from other patrons' needs will help illustrate how the needs in aggregate will continue to change. Some commercial farmers have the equipment to spread fertilizer and to spray pesticides. These are usually the most price sensitive of all commercial operators. Since these commercial patrons usually have different size and states of technology, their needs in the information area will differ from suburban users. They might obtain basic and specialized information from many sources including extension, educational experience, or magazines. More current or technical information may be needed in addition to the need for low prices [Farm Credit Associations]. However, the results of a survey of young farmers which had 524 farm responses, indicated that technical information is the least important reason for purchasing from a particular supplier [Coffey, 1982b].

There exists a need for more specialized equipment for commercial farmers without their own equipment. These commercial operators need top-of-the-line spray equipment and specialized services such as herbicide impregnated fertilizer. Operating this equipment for small and medium size operations is very costly. If pricing reflected the costs, many of the smaller operations could not afford the service. Cooperatives have provided such services for their patrons since other suppliers would not do so.

1.4 Gap in Needs and Service

Cooperatives' present distribution system is structured to meet the needs of the small and medium sized operations. The distribution system evolved when farms were smaller on the average and had less range in sizes. Cooperatives are still able to meet the needs of most small and medium sized farms, but their ability to match the needs of the larger operations is questionable.

The importance of large commercial farmers to suppliers can be demonstrated in feed, where 50 percent of the commercial feed dollars were spent by 5 percent of the largest farmers in Kentucky and 3 1/2 percent of the largest farmers in Maryland. This situation is equally valid in fertilizer where 20 percent of the largest farmers purchased 80 percent of the commercial fertilizer in both Kentucky and Maryland [USDA].

Cooperative suppliers are failing to fill the needs of this important group. Large operations' emphasis on low prices and in some instances specialized services are difficult to provide in the current distribution framework. The present system handles some products such as seed, bagged fertilizer, and chemicals, more times between the producer and the consumer (long supply line) than do some competitors. However, with other products sold by cooperatives or their competitors such as farm supplies, this longer supply line is necessary. The cooperative wholesale network assesses handling costs and a margin to the product before the retail points receive the good. When large operations shop for low prices, inflexibility in this first margin by the wholesale part of the cooperative puts the retail part of the cooperative at a disadvantage. Since the retail store is more of a price taker than its competition, it must bear the entire decrease in margins to price competitively thus making it difficult to show a profit and maintain volume.

Matching services with needs is as important as matching prices with costs and competition [Swann]. This is especially true with cooperatives' informational services such as technical advisors and salespeople. The current distribution structure must provide many levels of information services because of different requirements of farm customers. This information service is expensive and if not billed separately, must be included in prices. If the information is unwanted or ignored, the price paid appears to be to high. A Southern States survey showed 34 per cent of Southern States patrons thought Southern States prices were too high [Coffey, 1984a].

Service involving equipment use is also expensive and should match the needs of the patrons. Most small cooperative retail outlets cannot generate enough business to pay for the expensive specialized equipment that some large scale farm operations require.

In summary, the large commercial farmer apparently demands more specialized services including equipment, pricing services such as volume discounts, and some information services. If some, or all, of these needs are unfilled, the patrons will look to other farm supply outlets for a better bundle of goods and services than the cooperatives can supply. There is a gap between the needs of the larger commercial farmer and the ability to meet those needs within the present organizational structure of most cooperatives.

1.5 Competitors Strategy

Retail cooperative stores have two main competitors, non-cooperatives and other cooperatives. Proprietary firms have some advantages over the cooperative system. Because single owners can purchase from any number of suppliers without any restrictions, they can often acquire goods more cheaply than cooperatives when they are not allowed that alternative. However, cooperatives do enjoy a substantial amount of buying power on some products although much of the benefit remains at the wholesale level. In addition, the proprietary firm's owner is able to make quicker equipment purchase decisions due to his smaller organizational structure. Also the individual proprietorship can expand its market area and volume and still not compete with sister stores.

Other non-cooperative competition includes large corporate distributors which specialize in one product line and pick one portion of a cooperative's business in which to specialize. These specialized dealers, including product manufacturers, can attract the volume necessary to support specialized equipment, since they usually are selective in location, pinpoint high volume areas, and are not tied to serving the needs of all the farmers. Chemical distributors, including Helena and Monsanto, which distribute products to cooperatives also sell directly to the largest commercial customers. Cooperatives are beaten on price alone in this market. In the seed line, venders make farmers' dealers and they offer them wholesale prices. These supply lines are very short compared with cooperatives. Again, direct pricing hurts the sales volume of cooperatives by attracting the large patrons.

Product prices and specialized services (including equipment and information) are two goods which specialized dealers provide more attractively than cooperatives. Some direct distribution does occur within cooperatives at the regional level, but this is a very small percent of the market. Non-cooperative competition specializing in agronomic services in concentrated commercial agriculture areas is eroding the cooperatives market share and farmer base [Swann,pg12].

In some areas, local cooperatives are very densely packed and compete with each other for business. Sometimes neither of the competing stores from the same cooperative can maintain the volume needed to sustain large investments in specialized equipment. The competition between cooperatives also hurts the farmer, since he is an owner of the cooperative. In the Southern States organization, individual cooperatives also compete with one another. In a recent farm and home survey, 40 percent of the Southern States patrons shopped at two or more stores [Coffey, 1984c]. Many of the managers of Southern States stores felt their greatest competition is "the Southern States store down the road".

1.6 Cooperative Performance

A no growth input market combined with increased competition, both outside and from other cooperative stores, has decreased cooperatives' profits. Low sales cause operation at undercapacity and decrease profitability of the whole enterprise. If the needs of the large commercial user continue to be unfilled, then there will be a greater decrease in sales volume. This volume loss will in turn affect profitability.

Cooperatives' conservativeness and asset rigidity is not an isolated case in the marketplace. Other industries, notably steel and automotive, have been reluctant to change their asset distribution. Foreign competition in those markets was able to segment the market and gain market share. Cooperatives are in a similar position with respect to non-cooperative competition.

1.7 Problem Statement

The problem is two-fold. First, the low sales volume produced from small and medium sized operations is not sufficient to contribute to the high costs resulting from the cooperatives' distribution structure. Second, services that the large commercial user needs, can not be generated by the existing structure of the cooperative.

Although the end goal of cooperatives is the service of farmers' needs, strengthening the cooperative through increased efficiency indirectly also serves farmers' needs. Cooperatives often lack efficiency due to:

1) small store size; 2) too many stores serving the same

geographic area; 3) too many handlers of the product (long supply- line); 4) undercapacity of some assets and lack of some specialized assets; and 5) employees without the expertise to interact with the larger commercial operator.

The small size of cooperative farm supply outlets detracts from cooperative patrons receiving the best combination of price and service. Inefficient distribution networks add too much cost to products. Additionally, by operating large numbers of smaller outlets, cooperatives are spreading their management talent thinly. Often small farm supply operations lose qualified management personnel because volume is insufficient to support necessary salaries. These problems are part of the reason cooperatives have difficulty servicing farmers' needs.

Generally in the above areas the one major problem source is within the structure of the distribution system. When there is a store in every small town, the stores are too small to offer specialized services for commercial areas. Their fixed costs can't be spread out over a large volume of business and this affects profitablity. Cooperatives are now searching for alternatives in outlet organization in order to recapture and better serve commercial agriculture.

1.8 Proposed Solution

Increasing service or reducing price to the larger farm operator is the only way to increase or maintain sales and market share. Given that the input market is not growing, increasing market share would be the means to increase sales. To increase volume, the cooperative must meet the needs of the concentrated commercial agriculture sector. One possible way to increase volume in the commercial agriculture sector would be to consolidate parts of the distribution system in order to eliminate some overhead costs. This may allow reinvestment into needed services and increased service to the large commercial farmers. The resulting distribution system may not serve all size farms equally.

If sales volume cannot be increased, a reduction in costs would be needed to increase profits. Achieving both increased sales and reductions in operating costs, would best help the profitability of the retail system. The change in distribution system could be one part of a greater merchandizing strategy to service both commercial and part-time farms. In this study, the feasibility of consolidation will be assessed.

Cooperative retail outlets in close proximity (within 20 miles), may be able to consolidate operations and thus provide goods and services at lower prices or with higher patronage refunds. Combining operations will create outlets large enough to provide the specialized services large farm operators demand. Combined operations could improve the quality of cooperative management by increasing the available pool of management talent. Consolidation may also reduce costs by reducing overlapping capital, labor, and management, to make the new or reorganized units more efficient and productive. The type of consolidation which is most appropriate will depend on geographical barriers and patron concentration [Clay and Martin].

Some of the possible consolidated structures include:

1) Super Store - true consolidation of two or more stores with one survivor and one closed or sold to the private sector as a franchised private dealer.

2) Branch System - a farm center located in an existing facility with other stores in the vicinity operating on a reduced basis.

3) Specialized Stores - consolidation to a one manager operation with each of the remaining stores having a specialized service besides the basic farm supplies.

4) Service Center - rolling stock, information, pricing of volume sales, and salesmen for agronomic services consolidated to one location leaving present management unchanged.

Another possible solution would be to restructure the entire cooperative. Perhaps Petroleum, Feed, and Fertilizer could be made into separate units or divisions with their own management and distribution system. Such a solution makes the distribution path or supply line to the larger commercial patron more direct. Separating fertilizer from other divisions would be the extreme in making distribution a more direct route. A variation of this restructuring could include making a division responsible for large commercial accounts over $100,000 in sales, which could employ a different merchandizing strategy than the other traditional division. Evaluating these types of solutions is beyond the scope of this study. This research will try to examine how the retail system could increase efficiency of the current system. Once this efficiency is achieved, market share can be regained by reducing prices and increasing service, without cutting so deeply into profitability.

1.9 Objectives

The objectives of this research are:

1) To develop cost coefficients for the retail farm supply businesses of different size and product mixes.

2) To develop revenue coefficients for retail farm supply businesses of different size and product mixes.

3) To develop a model which captures revenue, cost, and service level relationships to facilitate changes in product mix, number of stores, and store volume.

4) To identify changes in regional profitablity resulting from different consolidation alternatives for farm supply outlets.

5) To develop procedures and guidelines which management can use to make consolidation decisions.

The fulfillment of these objectives would suggest the direction that cooperatives should move towards in their retail distribution system. The result would also include both model development and the use of case study data and results to generalize optimal distribution alternatives.

1.10 Procedures

To accomplish these objectives, information concerning costs of serving different sized operations in different product lines must first be assembled. Southern States provided data in the form of operating statements, balance sheets, and market research information. The data includes institutional financial information from all stores in the chosen geographic regions. The region under study will be Region 2 in Maryland including stores in Taneytown, Union Bridge, Hampstead, Westminster, Mt. Airy, Woodbine Frederick, Sykesville, and Woodsboro (Figure 1). The

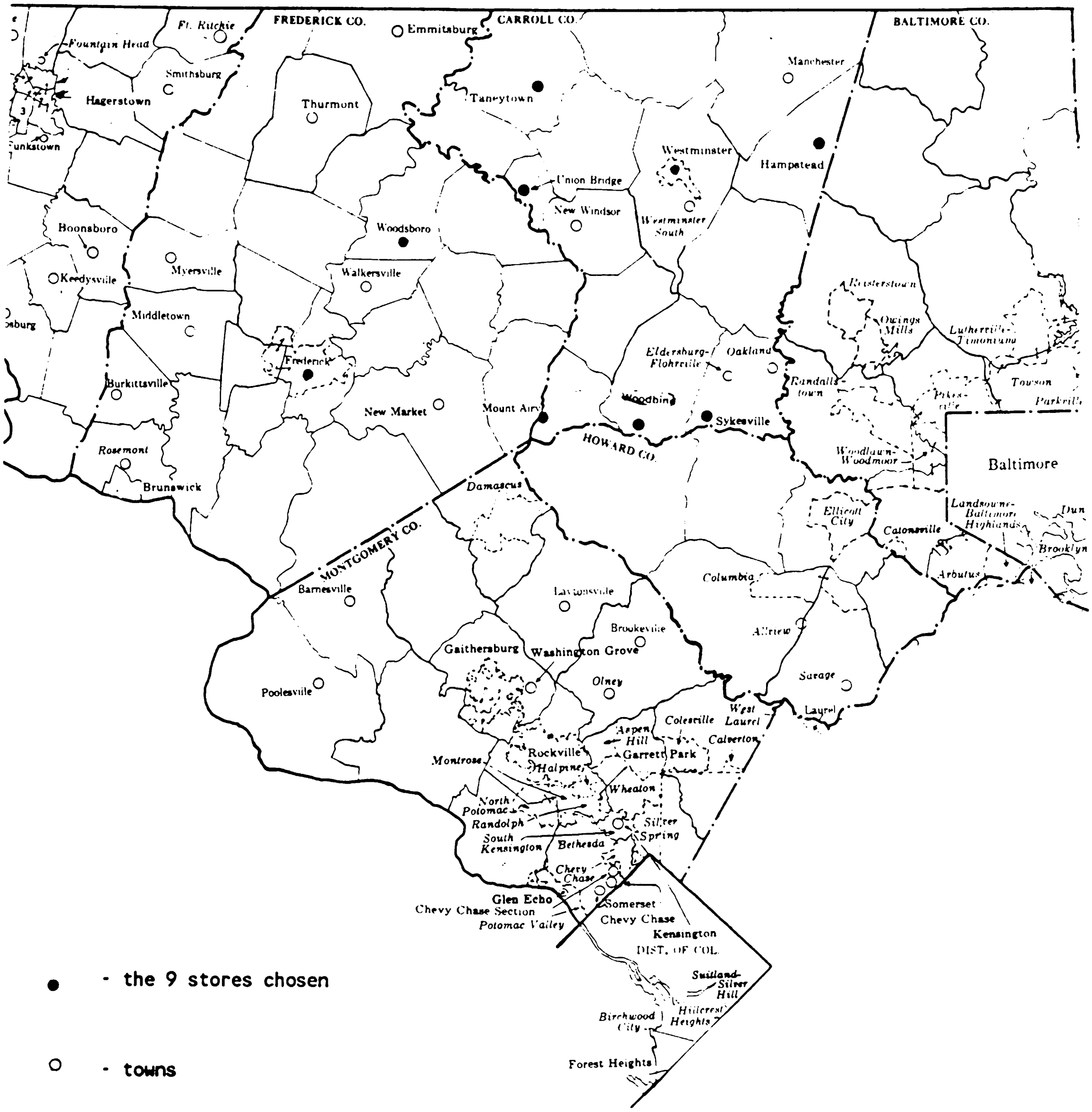


FIGURE 1 : Map of Region in Maryland including nine stores

region has nine stores which should be large enough to allow inferences to be drawn for other locations, yet small enough to be manageable. The large number of stores allow many organizational choices. This region was chosen because of its high degree of commercialization, the high density of stores, and because it was relatively representative of other trade areas. This will allow some generalization of the results to other areas.

Store technical coefficients were gathered from the chosen area to both examine available data, and for use in studying the effects of consolidation in the case study region. A programming model was used to maximize profits for the region. An economic model was constructed to obtain technical coefficients on present store distribution structure in relation to product and service mix and return on assets. The coefficients were develped to allow for various mixes of service. The product and service mix differed by store. The coefficients also included market share, potential, product mix and volume and other demand characteristics determined from existing Southern States sales. Changes in revenue, expenses, and asset distribution were all addressed through movement towards an optimal structure.

Once the programming model was developed, many scenarios were tested to check the effects on total profitability in an area. In this research various distribution systems was compared at one point in time using a linear programming algorythm. The model determined the most efficient number of resources needed to make each alternative most profitable. With linear programming, sensitivity analysis determined the key information needed to analyze restructuring and the change in that information needed for an alternative structure to become the optimal solution. All scenarios were compared to the current and optimal structures' individual product mix as well as the region's total profitability.

1.11 Thesis Organization

Chapter II includes a review of relevant literature in the areas of optimal size, number, and location studies. Chapter III develops the theory for the modelling, describes the procedures used in the model building process and explains the assumptions made because of limitations in the data. Chapter IV presents the results of the model using the Maryland stores as an example. Sensitivity analysis is examined and results are explained. Chapter V summerizes the research activity and discusses its implications for cooperatives.

CHAPTER II

THEORETICAL CONSIDERATIONS

Analysis of the problems outlined in the introduction requires more than one body of knowledge. The most probable solution to the problems would involve restructuring the retail distribution system. This solution could affect: profitability by changing the cost structure; and sales by changing the service level. The theory of efficient organization within market areas is the main area of literature this research relies upon. Retail distribution, rather than the conventional approach of commodity processing, will be employed in this research. Price theory and service literature help address how sales will change with reorganization. These theories embody many key economic concepts within their framework.

2.1 Efficient Organization within a Market

Literature, between 1950 and 1975, addressing optimal fixed assets for many enterprises was reviewed by French. Most the literature concentrated on the processing sector of industry versus the retail system. French's review classified research of organization efficiency within market areas as either continuous or discrete. The continuous space approach assumes the market is continuous and uniform in product density. The discrete space approach treats the market as discontinuous and varied in product density. The assumptions of each approach make their methods and weaknesses different.

The continuous space approach optimizes size, number, and location of plants by estimating an average long-run cost function including processing, assembly, and distribution costs. Figure 2 shows the volume where the long run average total cost (ATC) function is minimized which will be the optimal size of the plant. ATC is the sum of average assembly costs (AAC) and average processing costs (APC). Given a region's total potential for supply or demand, several of these optimally sized plants may be required. The total volume in the market boundaries divided by the volume per plant, yields the optimal number of plants in the market area. For example, if the total potential was 2450 units and optimal size was 800 units/plant, as in Figure 2, then the optimal number would be three plants. The optimal locations are determined by arbitrarily selecting one plant site which in turn forces the other plant locations equidistant from the first site.

The first major work in the continuous space arena was done by Olsen, Cobia and Babb, and later Williamson examining milk assembly. Later work was applied to the optimal size, number, and location of grain elevators, livestock markets, milk plants, and cotton warehouses.

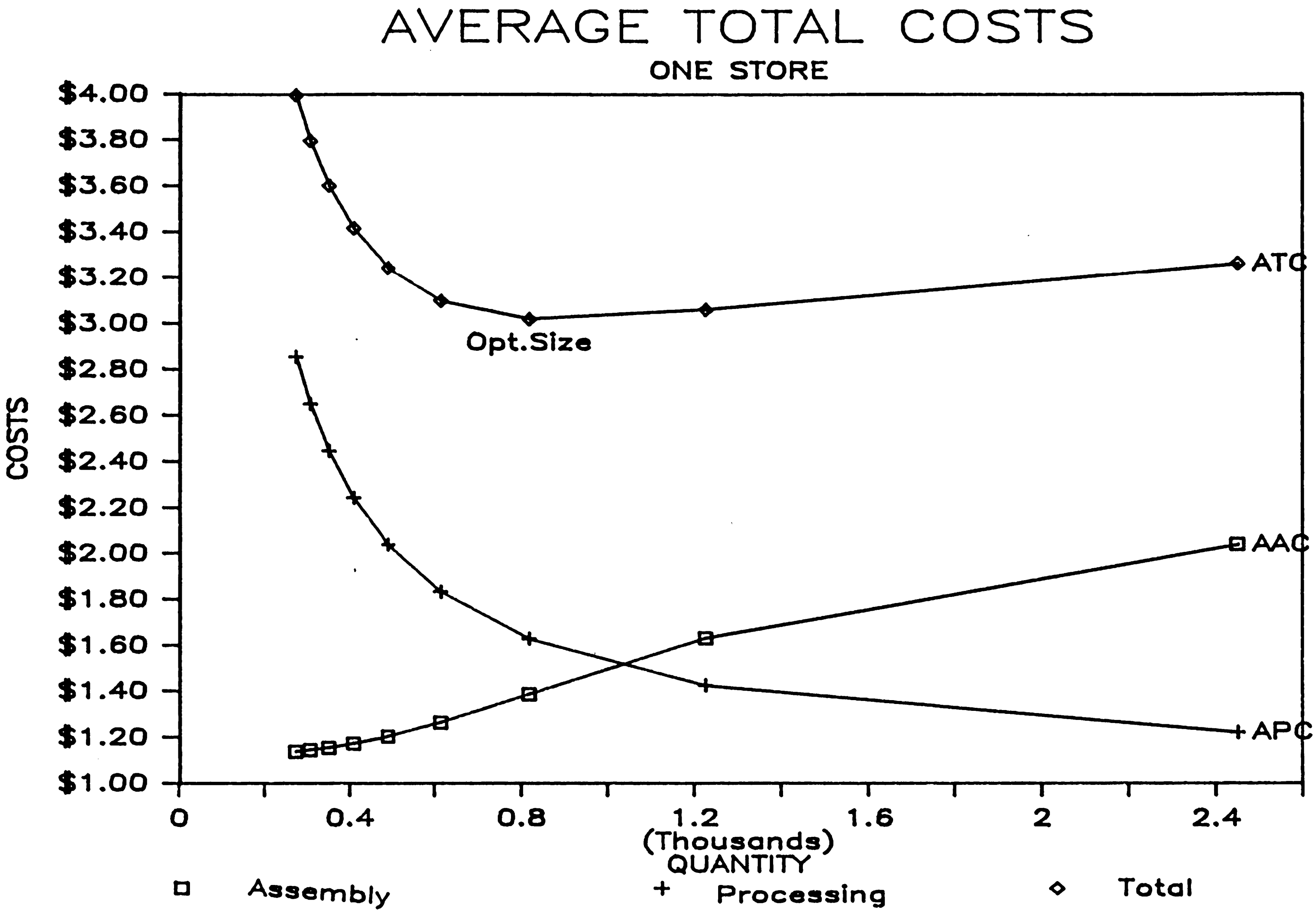


FIGURE 2: CONTINIOUS APPROACH DETERMINING OPTIMAL SIZE

French pointed out several of the limitations which apply to research following the continuous space approach. First the supply density is not usually uniform and continuous in the market. Secondly, there are definite locational constraints because of existing facilities, available resources and highway networking. These factors would still allow the choice of an initial arbitrary location, but subsequent sites would require location at points other than those selected in the perfect grid fashion necessitated by the continuous space approach.

Lastly, plant cost functions are different in each location because of different equipment originally purchased, different stages of existing location's depreciation, and different management effectiveness including employees' productivity. If a distribution system were starting with a clean slate this limitation would not be serious.

These difficulties encourage serious examination of French's second classification of efficient organizational theory, the discrete approach. The original discrete model was developed by Stollsteimer solving for optimal size, number, and location of plants incorporating a restricted set of market territories and a limited number of plant location sites. This and later models still require a priori knowledge of the long run processing cost functions and assembly or transportation cost functions. The latter comprise a matrix of site to site costs versus an equation with distance as the independent variable in the continuous approach.

Stollsteimer stated that "solving this problem is important to the firm, both from the standpoint of maximizing profit and as a guide for investment in plant and equipment. His model emphasizes the processing of a single raw material and its assembly. Multi-product processing and final product distribution was left for future work. Algebraically, the problem can be written as:

$$\underset{(J|L_k)}{\text{Minimize}}\ TC = \sum_{j=1}^{J} P_j X_j \ |L_k + \sum_{i=1}^{I} \sum_{j=1}^{J} X_{ij} C_{ij} \ |L_k$$

with respect to:

$J \leq L$ - plant numbers

$L_k = 1 \ldots \binom{L}{J}$ - locational pattern

subject to:

$\sum_{1}^{J} X_{ij} = X_i$ - Quantity of raw material at origin i;

$\sum_{1}^{I} X_{ij} = X_i$ - Quantity of material processed at plant j;

$\sum_{1}^{I} \sum_{1}^{J} X_{ij} = X$ - Quantity total of raw material;

$X_{ij}, X_j \geq 0$ and $C_{ij} > 0$.

where:

TC = total processing and assembly cost;

P_j = unit processing costs in plant j at L_j;

X_{ij}= Quantity of raw material shipped from origin i to plant j;

C_{ij}= unit shipping cost from origin i to plant j;

L_k = a locational pattern for J plants and L combinations;

L_j = a specific location for an individual plant;

$|L_k$= given the locational pattern.

Stollsteimer listed four variations of the model based upon which assumptions were used relating to $P_j X_j \, | L_k$. The assumptions rest on whether $P_j X_j \, | L_k$ changes between locations. These assumptions change the ease of solving the model. The four cases are:

1. Economies of Scale in plant operations with plant costs independent of location;
2. Economies of Scale in plant operations with plant costs varying with location;
3. No Economies of Scale in plant operations with plant costs independent of location; and
4. No Economies of Scale in plant operations with plant costs varying with location.

Case 2 is the most general and Case 3 is the most restrictive of the assumptions. Stollsteimer's method can be viewed as a six step process as follows.

Step 1: All transportation and assembly costs are collected for all possible store numbers and combinations. (This includes any difference in processing costs between locations.)

Step 2: Select the least cost location pattern within each store number. For example in Figure 3 for a one store pattern, the one location, F, of the seven with the least total transportation cost would be selected. Likewise, for a three store pattern, the 1 combination of the 35 with the least total transportation cost would be selected.

Step 3: A total of 7 least cost selections ranging from one store to all seven stores would be then expressed as a function of store numbers as in Figure 4.

Step 4: Processing costs are assumed to be linear functions with a positive intercept and slope. All stores have the same slope and intercept.

Step 5: Figure 5 expresses these processing costs as functions of store numbers. The intercept is the total variable cost of the first store plus the first stores fixed costs. As more stores are added supplying the fixed market quantity, the fixed cost is increased and the variable cost remains the same.

Step 6: Figure 6 adds the processing costs (TPC) to assembly costs (TAC) obtaining total costs (TC) as a function of store numbers. The least total cost provides the number of stores which are optimal. The location of

Example: With a maximum of 7 stores, there are a total of 127 possible combinations. But there are seven least cost patterns total, one for each number of stores used in the permutation. The following formula is for the number of total patterns possible:

$$\text{Number of Patterns} = \binom{L}{J} = {}_{L}C_{J} = \frac{L!}{J!(L - J)!}$$

These combinations can be written as combinations of letters A through F, each representing a location.

Number of Stores	1	2	...	6	7
	A	AB BD CG		ABCDEF	ABCDEFG
	B	AC BE DE		BCDEFG	
Number	C	AD BF DF		ACDEFG	
of	D	AE BG DG	etc.	ABDEFG	
Combinations	E	AF CD EF		ABCEFG	
	F	AG CE EG		ABCDFG	
	G	BC CF FG		ABCDEG	
Optimal Combination	F	CE	...	ABDEFG	ABCDEFG

The above example results in 127 combinations as calculated by the formula. It is summarized as follows:

Number of Stores	1	2	3	4	5	6	7 = Total
Number of Patterns	7	21	35	35	21	7	1 = 127

FIGURE 3 : Selection of Least Cost Pattern

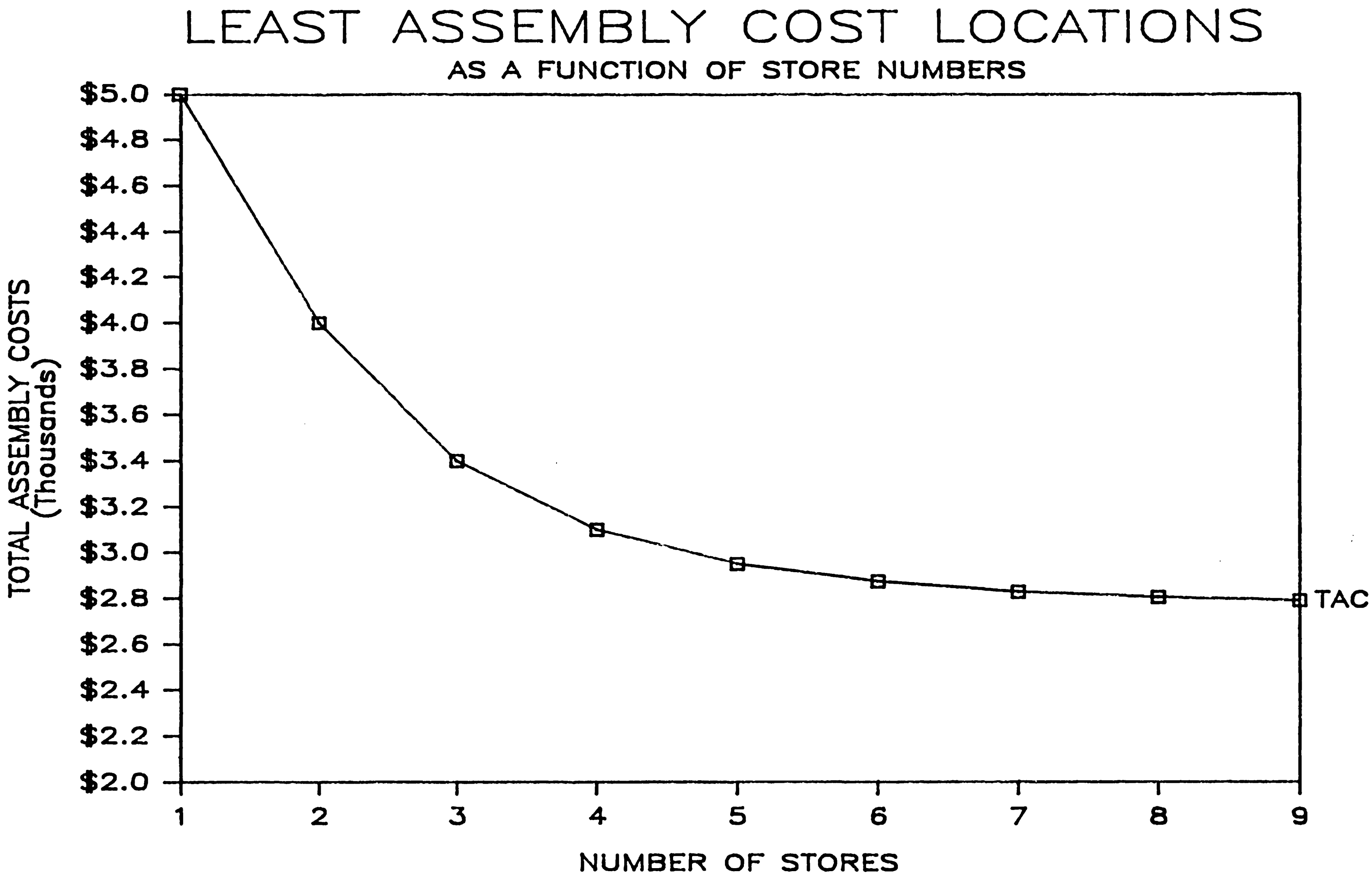


FIGURE 4: Discrete Approach expressing Assembly Costs as a Funtion of Store Numbers

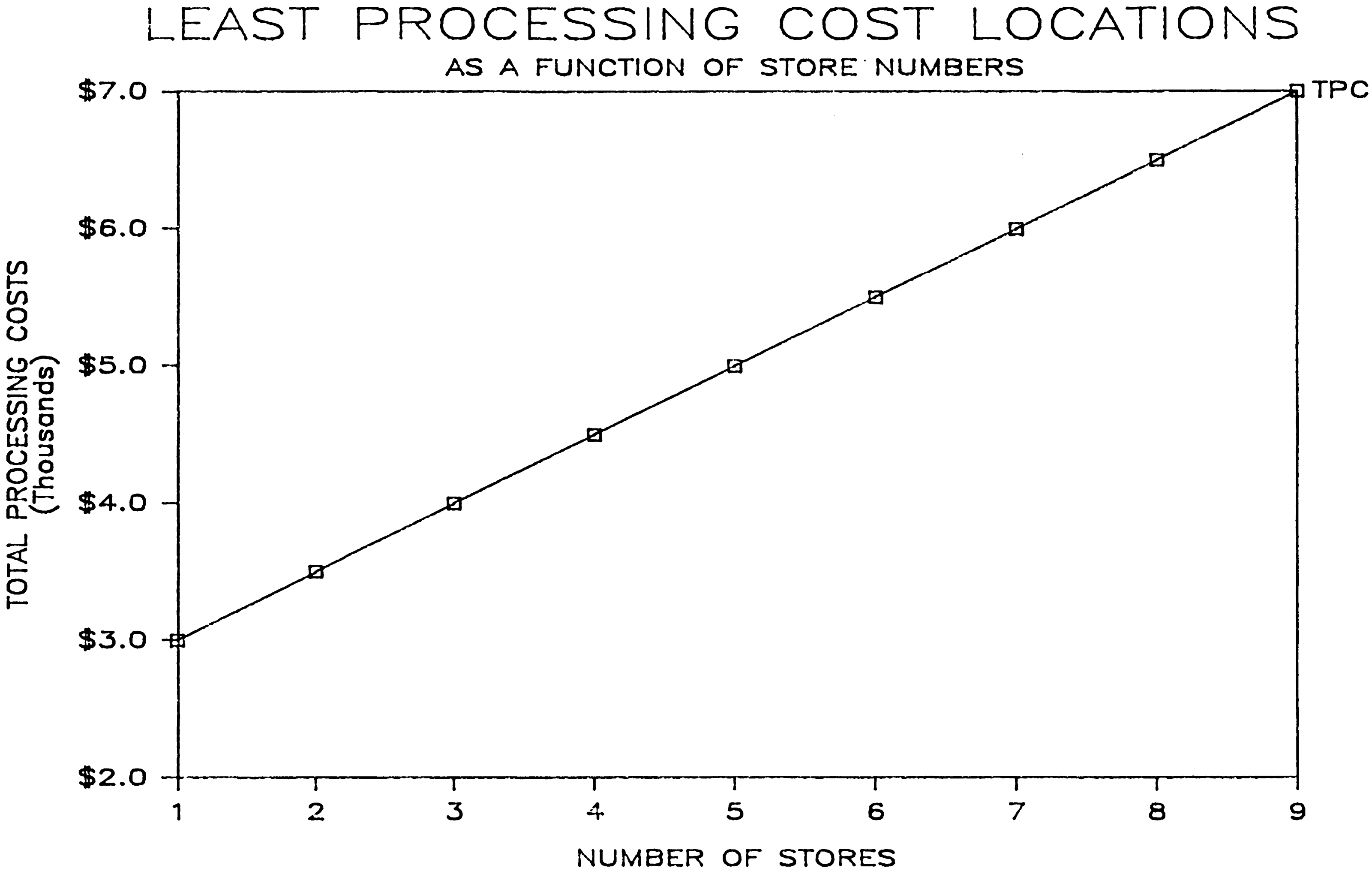


FIGURE 5: Discrete Approach expressing Processing Costs as a Funtion of Store Numbers

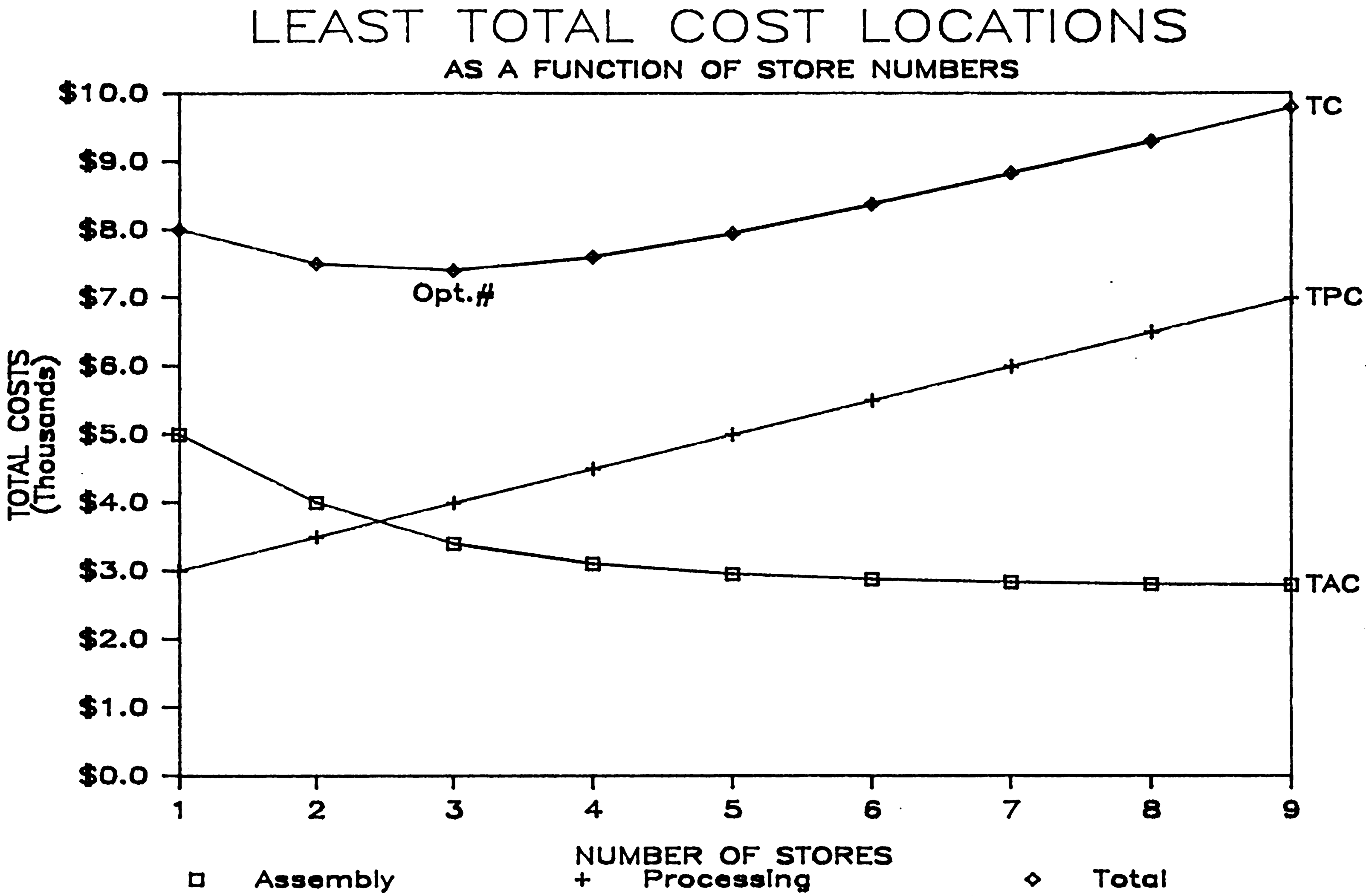


FIGURE 6: Discrete Approach summing Assembly and Processing
Costs to Total Costs as a Funtion of Store Numbers

each is already known from Step 2 as shown in Figure 3. In this example The optimal number of stores is 3, and the optimal location is the one of 35 patterns chosen to represent the 3 store pattern. The optimal size is 1/3 the total volume since the processing costs are equal.

The basic Stollsteimer model has been expanded by several economists. One expanded model developed by Polopolus, encompassed multiple-product plants. As the product dimension increases, assembly costs are affected by varying locational patterns. The expanded model has an additional subscript (m) signifing different products and additional summations for both processing costs and assembly costs.

$$\underset{(J|L_k)}{\text{Minimize}}\ TC = \sum_{m=1}^{M} \sum_{j=1}^{J} P_{mj} X_{mj} \ |L_k + \sum_{m=1}^{M} \sum_{i=1}^{I} \sum_{j=1}^{J} X_{mij}\ C_{mij} \ |L_k$$

Although this model is an expansion of Stollsteimer's model, many of the same deficiencies and assumptions remain unchanged. All the stores retain the same functions for processing costs. In addition to homogeneous processing costs, the cost functions exclude economies of scale.

All the costs, transportation, assembly and processing, are represented by a specific functional form. A form of economies is included in this expanded model by considering joint processing costs. By estimating joint cost savings from multiproduct processing, Polopolus showed an increase in the likelihood of multiproduct plants versus single product plants. His model included three products: tomatoes, okra, and sweet potatoes. Tomatoes and okra are harvested and processed at the same time, removing any joint processing savings. A multitude of products help spread out fixed costs and lower average total costs. A simple example would look like:

$$TPC = A_t + A_o + A_s - JPC_{os} - JPC_{ts}$$

where:

t - tomato
o - okra
s - sweet potato
A - average total costs
JPC - joint processing costs

Later work by Irving Hoch of the University of California at Berkely pointed out a possible flaw in the Stollsteimer and Polopolus models. Using total transfer costs as a function of plant numbers, Hoch showed the resultant function can be concave over some regions of the function. This finding is important for if the transfer function is concave and then added to a linear processing cost, a concave total cost function results. Neither Stollsteimer or Polopolus considered the possibility of the total cost functions they were minimizing being concave, since finding a global minimum optimum can not be guaranteed with a concave function.

When minimizing transfer costs and moving from a smaller number of stores to a larger number of stores, the new locational configuration often includes different stores from those found at a smaller number of stores. Hoch demonstrated with a hypothetical set of raw material sites, plant locations, and road networking, the decrease in transfer costs from two stores to three stores is larger than the decrease in transfer costs from one store to two stores. When added to processing costs as in Figure 6, the resulting total cost function used in minimization would be concave over some store numbers.

Other deficiencies associated with the discrete model, which are similar to the continuous models, include assumptions of uniform density within county subdivisions because of data limitations. Also, plant cost functions both exclude economies of scale and are identical from location to location. Different equipment in age, size and model and different employees and management make the defense of identical cost functions difficult. In this analysis many of these assumptions were avoided, although others were made.

An extension of the Stollsteimer model which is not directly applicable to this study, but deserves mention is the transhipment model first introduced by King and Logan. This model modified the basic linear programming model to simultaneously analyze both assembly and distribution systems. It emphasized relationships equating supply to demand. Other variations to the Stollsteimer model used include models with objective functions requiring non-linear and separable programming techniques.

2.2 Price Theory

Literature on optimal size, number, and location of plants emphasizes minimizing total costs of processing and distribution. Although one consideration in restructuring a retail system includes how costs will change, the affects on sales must also be considered. McCloskey, in a chapter of his book relating to monopolistic competition and the economies of location, pointed out the effects of location on revenue in retail plants. In a retail setting minimizing costs of distribution and warehousing can be inappropriate since this could result in less revenue and profit for the firm.

With non-perfect competition, local monopolies arise due to spatial considerations. Location influences travel costs by increasing the final price a consumer bears. This theory helps explain why distance is important in determining market share. Given two stores with similar cost structures and pricing schemes, patrons will purchase goods at the location minimizing transport costs, ceterus paribus.

A point of indifference exists halfway between the two locations if their prices are equal. In other words clients will choose the closer store because it is the most inexpensive when travel is considered. If the point of purchase price differs, then the indifference point shifts toward the higher price.

Demand curves can be estimated using various price levels at a location. Figure 7 assumes a uniform density of demand in both directions which allows distance to be used as a proxy for quantity. The price at store A,B, and C are the price paid at that location. The delivered price lines represent the added cost of travel to the location to purchase the good. This combination of price paid plus the cost of travel is the realized price. At the geographic point where realized prices from two different stores are equal, the consumers living there are indifferent to either store. This place is the indiffernce point, 15 miles from store A in the example in Figure 7. Past this point store A will not have any sales due to absolute price disadvantage due to distance. This results in zero market share as showed by the bottom figure. If price at store A increases without other stores changing price, the indifference point at 15 miles from Store A, shifts toward the origin thus quantity is decreased conforming with demand theory.

This pricing theory is a useful way of considering the effects of location on revenues. It also has several

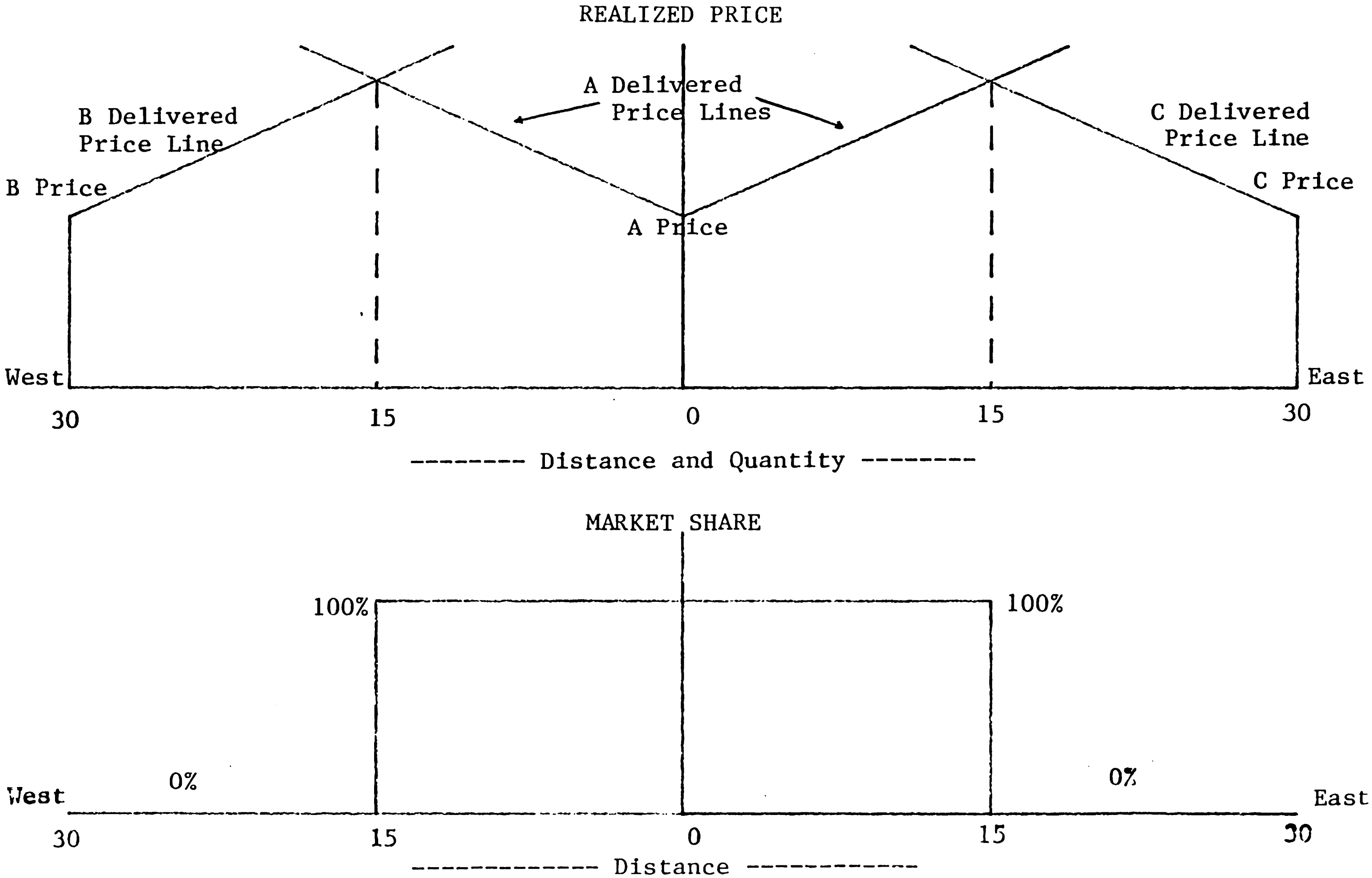


FIGURE 7 : Price Theory's Local Monopoly

assumptions which restrict its application. The assumption of uniform density is necessary if distance can represent quantity sold at a given price. Similar to the discussions between continuous and discrete efficiency models, this assumption fails because of pockets of commercialization.

One other limiting factor of this theory is concerned with local monopolies. The theory explains the marketplace, rather than one franchised network in a marketplace with competitors.

Location and distance are variables which should be considered when retail structure changes. Service level can also be affected, perhaps adversely for some and positively for others. One study addressed increased service through consolidation.

2.3 Service

Love and Long studied the feasibility of utilizing floatation fertilizer equipment in the Southern States region by merging fertilizer operations. They noted this new technology gave the competition who were using it a 20 day advantage per season because they could spread in wetter field conditions. They collected county statistics for the three counties in the study area and store data concerning stores in the region. The condition of Southern States facilities and type of fertilizer competition was noted. Embracing Southern States view of a need for this equipment, Love and Long found the volume needed for the system to breakeven. Costs, both fixed and variable were arrived at by constructing budgets.

2.4 Conclusions

This research will rely on some of each of the above theories when addressing the problems facing cooperatives today. Literature from efficient organization theory considered finding a distribution structure without any locations already being established or starting from a clean slate. This is somewhat different from the goal of this research: discerning how cooperatives should increase their efficiency in order to increase service to patrons.

Although prices will be similar between stores, demand and cost structures will differ and lead to different levels of profitability. This research will combine discrete markets along with continuous density areas when capturing various product potentials in the marketplace.

Literature relating to price theory will be useful in limiting market potentials caused by long distances upon any reorganization. With Southern States there is some justification for assuming prices are equal. At least cost of goods sold are virtually the same since the vender is Southern States and little volume discounting is done at the store level. Also Southern States has established gross margin guidelines which help assure similar pricing.

Stores set prices with competition including other Southern States stores which also contributes to similar pricing.

When considering how the cooperative should be structured, information concerning other suppliers which can influence that decision in the market is unavailable. With this disaggregate demand a store will have only part of the total market share if a competitive store is located closer to a particular segment of the market.

Little literature examining how retail distribution should be restructured was found. Most of the Stollsteimer work and all the transhipment models considered the amount demanded constant. Changes in location would have little effect on the quantity demanded, although it could affect the quantity demaned from a particular supplier. The consumer is the end distribution point in the marketing system. This is more difficult to model, because they have the independant control of choice. The literature reviewed however does have many aspects which should provide a good base when building a model addressing cooperatives problems.

CHAPTER III

PROCEDURES, DATA, AND MODEL

In Chapter I the problem of cooperatives falling market share was discussed along with possible changes in this trend through retail restructuring. In Chapter II, various related work was reviewed. Given the specific problem and existing knowledge, several different techniques could be used when finding a "solution" to the problem. Which procedure is used determines what data will be needed. The available data then dictates how that procedure is specifically formulated.

The developement of the model included two basic goals. First it had to be of a form cooperatives (other than Southern States) could readily determine coefficients for it. Second, the model should not merely solve a problem in one area for one cooperative, but should be developed so all cooperatives could expand on and use it for their own problems.

3.1 Current Practices

In the Introduction the relationship of the retail stores to the wholesale division through the two margin system on some products was discussed. Retail stores are either service, management contract, or franchised stores. They carry about the same product lines and sell feeds, fertilizers, seed, lime, chemicals and farm supplies.

Their feed products include bagged, bulk, and mixed types. Although this appears to be an adequate deliniation, records of feed product sales are inadequate to determine their composition in these categories. The bagged group contains all of the actual feed products sold through the store, both over-the-counter and delivered. The bulk group includes all bulk products mixed in the regional mill but billed through the store. The last feed group includes mixing services: grinding and mixing. The tons mixed include products owned by the patron and products sold as the first group, bag feed, but used in the mixing as feed supplements.

Crop needs are broken into more discernable groups. Bag and bulk fertilizer make up the primary group. Bulk fertilizer can be either of the dry or liquid form. Lime is separated from fertilizer sales, but none of the stores keep an inventory of lime. Some do spread it, others let their supplier make the deliveries and keep a small margin for ordering and scheduling. Seed is sold over-the-counter. Chemicals are both sold over-the-counter and through liquid fertilizer trucks.

The major over-the-counter group of sales is farm supplies which include health products, cleansers, utensils, hardware, tools, paint, automotive, and lawn/garden supplies. This wide variety of products requires a range of distribution services. A model examining possible changes in the distribution of these products must include the most fundamental services to capture the wide variety of needs the system currently serves.

3.2 Logic for the Model

The goal of the analysis is to find out whether a change in distribution structure can enhance the efficiency of cooperative operation. A simulation technique could be used, but an intensive series of analyses would be needed in order to evaluate different structures. The solution would be to choose the best outcome from the many different scenarios tried. This selected scenario is not guaranteed to be the best of all possible scenarios, just the best of the ones modeled.

An optimization technique would inherently be structured for the task of searching for a solution without manually having to examine each possibility. Cost minimization has frequently been the choice where stores seek to minimize distribution, assembly, and processing costs [French]. Profit maximization would include the minimization of these costs and also consider revenue implications. Changing retail structure based on minimization of costs might cause disaggregate demand to shift downward and reduce profits. Thus profit maximization is the preferred approach.

3.3 Programming Models

Programming models involve the planning and linking of activities to reach a specified goal. Linear, integer, separable, quadratic, and dynamic are examples of programming models which basically revolve around the same technique. Linear programming (LP) is the basis of programming models. The process includes two main concepts, the objective function and various constraints [Hillier and Lieberman]. The objective function is an equation for which the model attempts to maximize or minimize the value. The equation is usually the summation of multiplicative terms. Within the multiplicative items, the one that is known with certainty, a priori, is a coefficient (c_j), and the one that is solved for is the decision variable or activities (X_j). Constraints, are a series of equations which limit the activities' values. In equation form a maximizing linear programming model can be specified as:

$$\text{Maximize:} \quad \sum_j c_j X_j, \quad (X_j)$$

$$\text{Subject to:} \quad \sum_i \sum_j a_{ij} X_j \begin{matrix} < \\ = \\ > \end{matrix} b_i,$$

$$X_j \geq 0.$$

The subscripts i indicate the number of constraints. The subscripts j represent the number of activities (decision variables) in the model. A feasible solution is one which meets all the requirements of the constraints. An optimal solution is the feasible solution with the best, in this case a maximum, value for the objective function.

Integer programming is an extension of the basic linear programming model. The integer model is identical to the linear model except that several activities are restricted to take on integer values. In this analysis those activities consist of lumpy assets, such as having one or two trucks rather than 1.34 trucks. Revenue and expenses are left in the linear continuous format.

3.4 Basic Concept of this Distribution Model

Having decided on the technique of optimization, specifically maximization, the broad concept of a regional model was developed. Data sources were examined for availability and content. The data used should be accessible to most cooperative systems. This availability of data is very important for the model to be applied to other situations and not exclusively to the case of Southern States in Maryland. The main data used originate from financial records at the store level. These included operating statements, depreciation schedules, and balance sheets. Other data were drawn from interviews with store managers and memorandums from operations managers, which also should be available to other cooperatives. The use of such common data not only makes the gathering of such input for the model easier, but also aids in formulating the output in a form easy for regional managers or planners to understand and present.

In the model data on revenue is linked to expenses through the use of service providing assets. Revenue, expenses, and assets are building blocks which are integrated to insure representation of relationships. Each of the three concepts are interrelated in such a way that elimination or a change in one is sure to have an effect on at least one of the others. For example, an increase in revenue often increases expenses or requires an increase in assets. This is important when considering restructuring the distribution systems because when closing a store, assets are gone and so are revenue and most expenses. Any store picking up the slack will increase revenue, but probably will have an increase in expenses and in some assets.

The general framework for the model rests in the linkages of these three concepts. Figure 8 gives an example of how the concepts are linked. Block A consists of revenue earnings. It brings revenue into the model under several restrictions including distance to demand. Block B connects block A to block C, the assets, through the needs of specific products for certain assets in order for the sale

	REVENUE								ASSETS					EXPENSES								RHS	
PROFIT	+%	+%	+1	+%	+%	+%	+%	+%					+1	-1	-1	-1	-1	-1	-1	-1	-1	MAX	
Bag Feed	GD																					<	POT
Bulk Feed		KD			A																	<	POT
Mix Feed			MD																			<	POT
Bag Fert				GT																		<	POT
Bulk Fert					KT																	<	POT
Lime						LM																<	POT
Seed							SD															<	POT
F.Suppl.								FS														<	POT
Warehouse	X						X	X	WH													>	0
Showroom					B			X		SH		C										>	0
Grind&Mix		X									GM											>	0
Fert.Bld.				X								BL										>	0
Trucks	X	X	X	X	X	X	X	X					TR									>	0
Wage	X	X	X	X	X	X	X	X						WG								=	
Deprec.									X	X	X	X	X		DP							=	
Opp. Cost	X			X	X		X	X	X	X	X	X	X			OP						=	
Tax&Lic.	X			X	X		X	X					X				TL					=	
Insurance	X			X	X		X	X			E		X					IN				=	
Utilities									X		X	X							UT			=	
Repairs					D				X		X	X	X			F				RP		=	
Gas,L,Oil													X								GS	=	

FIGURE 8 : The General Programming Framework

to be made. For example, bagged feed sales have certain warehouse and truck requirements. The bottom section, blocks D and E, links block A and C to F, the expense block. Block D represents volume related expenses. Block E links expenses with operations of specific assets. Together the blocks are a proxy for activities taking place at the retail location.

This framework and the three categories model cooperatives' structure. Some of the nuances and relationships will differ from cooperative to cooperative depending on accounting practices and product lines, but the model itself is sound. The explaination of more specific information regarding the structure of and coefficients in the model is provided in the rest of the chapter.

3.5 Objective Function

In any business, a major objective is profit maximization. One of the most crucial ingredients is sales since profit is equal to total revenue less expenses. Sales are the first step and first item on the operating statement. Sales are obtained by capturing a percentage of the market potential for a product or service. Demand for these goods are necessary for there to be the need for retail stores to start with.

The objective function in programming models is the equation which is optimized. For the regional cooperative, Southern States, the goal was maximization of profit for the region rather than maximization of profit for each of the nine stores. Maximizing profit for each store would allow competition between stores and perhaps a suboptimal solution for the regional cooperative. To maximize profit in a region all stores' profits must be summed. Profit in the retail outlet sense could be defined as revenue minus total costs or algebraically:

$$(1) \quad \text{Profit} = \sum_{k=1}^{9} \sum_{j=1}^{8} \sum_{i=1}^{68} C_{jk} X_{ijk} - \sum_{k=1}^{9} \sum_{l=1}^{12} XP_{kl},$$

where: X = Dollar Sales by Store, by Product, by Zip code;
C = Gross Margin percent;
XP= Dollar Expenses;
k = the store;
j = the product;
i = the Zip code; and
l = the expense line item.

A linear programming model obtains a solution by selecting activities. In the objective function, two types of activities were present. First, dollar sales were solved for in the model. The solution specifies each store's sales of a product to a zip code. The other activity brought into the solution was the corresponding expense of that store for its sales broken down into 11 expense line items. The 8 products included in the model were bagged feed, bulk feed, mixed feed, bagged fertilizer, bulk fertilizer, lime, seed, and farm supplies. The 11 expense items tracked include wages, depreciation, utilities, repairs, taxes & license, insurance, opportunity cost, gas/lube/oil, advertising, other general, and bad debt.

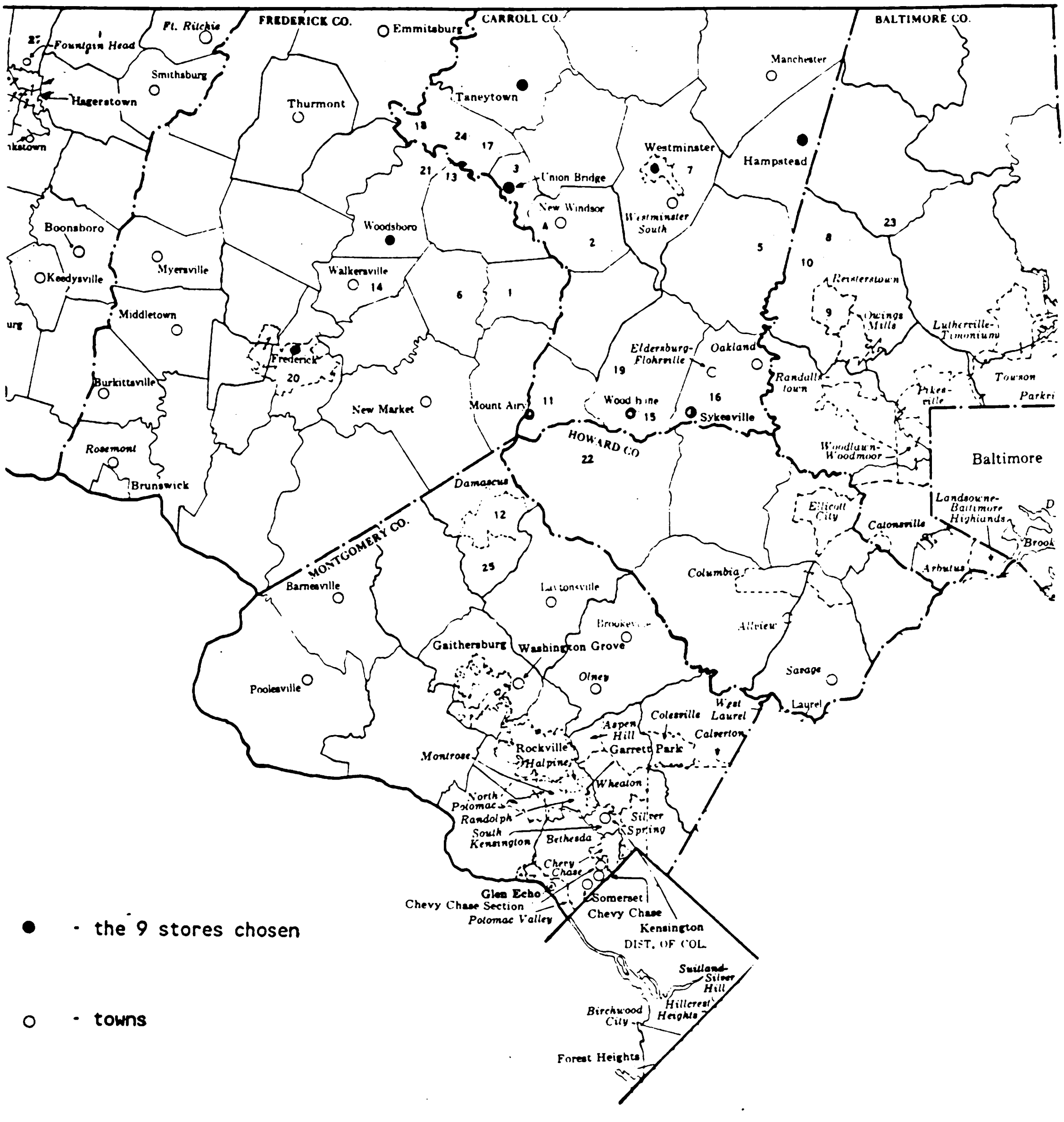
Southern States Cooperative picked the Frederick and Carroll counties of Maryland as an area of concern. Nine stores were chosen for study using an index of store distance overlappment. For each zip code, a simple index was developed scoring the number of stores within serving distance. The index, Z, was calculated as follows:

```
Z =       3 * ( number of stores within 10 miles )
      +   2 * ( number of stores within 15 miles )
      +   1 * ( number of stores within 20 miles );
```

which is equivalent to:

```
Z =       6 * ( number of stores within 10 miles )
      +   3 * ( number of stores between 10 and 15 miles )
      +   1 * ( number of stores between 15 and 20 miles ).
```

The largest index constructed was for Unionville in Frederick county (zip code 21792) with a score of 38 with 4 stores within 10 miles, 8 stores within 15 miles, and 10 stores within 20 miles. On Figure 9 the top 25 indices which all have scores over 25 were pinpointed on a map. These clusters of zip code regions indicated areas of greatest concentration. Nine stores surrounding these "hot spots" and all the zip codes they served were picked for analysis. The nine stores were Hampstead, Westminster,



- the 9 stores chosen

○ - towns

FIGURE 9 : Map of 25 most overlapping Zip Codes

Sykesville, Woodbine, Mount Airy, Frederick, Union Bridge, Woodsboro, and Taneytown. Appendix K lists the zip codes in the six county area. Of the 161 zip codes listed, 97 had sales as indicated by the total sales figures. These sales came from any of the 21 stores serving the area. Of the 97 zip codes with sales over $25,000, 52 had sales of $25,000 or greater from two or more stores. The nine stores chosen had sales in 68 of the 97 zip codes with sales.

The selling activities for each of the nine stores have coefficients indicating how much they contribute to profit. The coefficient for revenues was gross margin percentage. The gross margin percentage coefficient established the contribution to profit made by the corresponding sales activity. That contribution is known as gross profit or gross margin dollars.

Gross margin percent differs by product line, so sales were differentiated by product to incorporate this information. This means total gross margin dollars for a region will be the summation of gross margin dollars over products and stores. Product sales was an activity to be solved for in the model, gross margin percentage, however was exogenous to the model. It reflects management's ability, services included, regional competition, accounting system, price level, and other factors unique to that store. These objective function gross margin coefficients were obtained from taking the average of 1981, 1982, and 1983 percentages for each of the stores. Appendix F summarizes the percentages used as Q-16.

This alternative was preferable to two others: Using one year's percentage rather than an average of years; or the use of an average of all stores' gross margin percentage in the region. The former method increases the likelihood of modeling unusual years and biassing the outcome. The latter method was unacceptable, since differences between locations do exist. An average of past gross margin percentages was the best estimator of future percentage given the available information.

Where gross margin percentage was the coefficient for the contribution of revenue, the coefficient in the objective function for the operating expenses was simply a negative one. Minus for deducting the costs from income, and one for inclusion of the total expense. The expenses were also activities solved for in the model consisting of 11 adapted accounting expenses and opportunity costs. The actual amount of each expense was determined in the models structure depending on levels of assets and volume of product sold. How each of the 11 are derived and linked are explained in their own section below.

3.6 Revenue Constraints

While the objective function was the equation maximized, the constraints were the equations which limited the activities and also the objective function value. The first constraint needed in the model was to limit revenue. Each zip code has a limited amount of demand for a product. The more distant a store was from that zip code, the less sales a store could obtain. In mathematical terms this revenue limitation could be expressed as:

(2) $a_{ijk} \ X_{ijk} < b_{ij}$

(3) $\sum_{k=1}^{9} X_{ijk} < b_{ij}$

where a_{ijk} = 1 / maximum percentage of potential store k can achieve in zip code i, for product j

b_{ij} = the total potential for product j in zip code i

X_{ijk} = Dollar Sales in zip code i for product j for store k

Equation (2) limits a store's sale of product to a zip code to a specific percentage of that zip code's product potential based on distance. Equation (3) insures the total of all the stores' product sales to that zip code remains within the zip codes's product potential.

This constraint was very important because it bounded the objective function from increasing continuously by imposing limits on sales at each zip code. With these constraints revenue could be earned for service to a zip code but that zip code has a limit to its patronage. In the programming model the most effective limit on revenue would be a zip codes total potential to all suppliers for a good.

A record of past product purchases from all suppliers was unavailable at the zip code level from the Census Bureau or elsewhere.

A proxy was needed in place of this zip code data. If good market share and agriculture zip code information were available, 1982 Census data could be used at the county level for commercial feed, fertilizer, seed, and chemicals. These figures could be trended with 1978 data to arrive at predicted 1986 data for these counties. The categories reported in the Census are much broader than actual Southern States accounting lines.

The county data would need reduction into potential per zip code. The Agriculture Census does collect information at this level without publishing it. Two problems with publishing such data are the size of the publication that would result and the potential of revealing individual responses. A consortium of companies has bought zip code data from the 1980 dicennial census collection but the cost of obtaining it was beyond the means of this project.

Using 1982 Census data, possible transformations to arrive at a zip code potential per product line include two alternatives. Hypothetically, once potentials were arrived at using Census product lines, a fixed percentage could be used in disaggregating the product line, such as commercial feed, into Southern States bagged, bulk, and mixed components.

To arrive at the potential for a zip code, one hypothetical method would be to categorize the zip code as a percentage of its county by land volume, or agriculture land volume. Steps would include determination of crop land volume per zip code for fertilizer and chemicals, along with some animal index for feed and population, or household income for home, lawn, and garden supplies. Unfortunately, the only data at the zip code level was acres of land. Land volume per zip code was available for a state at a cost of $1000.00. Agriculture land volume per county subdivision was available through the state planning board, but conversion from zip code to county subdivision or visa versa was unavailable.

A second approach at breaking down county data from Census information could utilize available Southern States data for zip codes in relation to available data for counties. Given the necessary information used in a transformation of this kind, the resultant potential can finally be reduced to current Southern States sales per zip code. The transformation of county data to total zip code potential is acceptable using Southern States zip code information, but then a second part of the transformation to limit a stores potential due to a competitor's market share is needed. The best estimation of this part would be current market share or some percentage of such. The end result of such a transformation, demonstrated by the following proof, is current cooperative sales to a zip code. Since Southern States current cooperative sales to a zip code is an equivalent estimator to anything using Census data concerning potential sales in a zip code, Census county data is not used. The proof of this is as follows:

the ideal is: $SP/Z = SMS * TZP$,

which is equal to: $SP/Z = \frac{CZS}{TZP} * TZP$,

simplifying produces: $SP/Z = CZS$.

where SP/Z = Store Potential per Zip code
SMS = Store Market Share
TZP = Total Zip Code Potential
CZS = Cooperative Zip Code Sales

Since the proper data by product line and zip code was unavailable and possible transformations of known data would have yielded poor approximations, an alternate method of zip code potential by product line was utilized. Total sales to a zip code by any Southern States store was known for 1982. The best approximation for potential as affected by distance would then be current (1982) sales.

The 1982 sales per zip code was tabulated by Southern States by store for total sales of all products. Since the original data was total sales per zip code, two possible transformations were available arriving at sales per product line per zip code. The weaker of the two would aggregate all store total sales for a given zip code and multiply those sales by the average percent of a product's sales relative to total Southern States sales.

Even within the study area there was substantial variance of product demand making sales of a product on a zip code basis less accurate. A second possible transformation was used to make the conversion in this study. The total sales per zip code of each store was multiplied by that store's percentage of product sold per total products sold. Then each product was summed across stores for a given zip code. The resultant sales of a product in each zip code is more accurate due to less variation in a stores' market area than in the region's.

A better but unavailable technique would be the collection of product line sales per zip code rather than total sales per zip code. This information is collected by Southern States neighbor cooperative Agway. Both collect their sales data by cross indexing sales from patronage refunds with the zip code on the mailing label. Agway is now tracking this additional data, because they itemize yearly patronage by product line for their customers.

The data have two faults in addition to the ones intrinsic to the transformation. One originates from the assumption that a patron's home zip code is also the zip code of the farm. This was a relatively small problem since 79 percent of patrons surveyed by Southern States [Coffey, 1984a] live at the farm. It was unknown how many live off the farm but within the same zip code.

The second deficiency in this sales potential calculation involves Southern States total sales recorded per zip code. Only sales over $20,000 per zip code were published by Southern States in their release of "Agricultural Projections, Market Potentials and Store Market Areas" [Coffey, 1984d]. Under $20,000 zip codes were listed as far away as California. The analysis could have been improved by including zip codes within the state under $20,000, but the cost for re-collecting this data was too high. The use of data from the $20,000 or greater reporting was fairly acceptable since 70-95% of store sales was captured by zip codes greater than $20,000, depending on the store.

Several zip codes within the study area showed zero Southern States sales. Zero sales could be attributed to zip codes comprised of a town's post office boxes or possibly rural zip codes with little agriculture potential. Excluding these should have little affect on the analysis. The only possible way exclusion of zip codes containing zero could bias the analysis, would be if the zip codes had significant potential. This could arise in regions where the concentration of stores were high thus forcing all individual stores to sales less than $20,000. With all stores considered such a zip code could have considerable potential.

Once the potentials for a given zip code were put in the model, individual stores could obtain all, part of, or none of this potential. The proportion a store will capture depends on intangible things such as service, price, loyalty, and many others. Distance could preclude stores from capturing sales from a given zip code. Distance incorporates several factors that affect farmers' patronising a store many miles away. One is the number of stores which lie between the customer and the store as distance increases. A second reason for nonpatronage, drawn from price theory, is the increased cost of travel to the store as distance increases.

The distance concept was the variable used when considering the maximum of a zip code's potential that a store could capture in this model since potential store locations and zip code locations were fixed. Price could be changed with programs, service with investment, and maybe some loyalty with advertisement. Thus distance was the major obstacle against achieving potential relevant to the model. A Farm and Home Survey done by Southern States [Coffey, 1984a] showed that 90 percent of the patrons preferred visiting the store. A desire to visit a purchasing location gives merit to the assumption that distance has an important influence on store patronage due to cost of travel.

Deriving the coefficient which represented the influence of distance on sales in the model could have been accomplished in a variety of ways. All methods considered precluded an actual analysis of patrons reaction if a competing store was eliminated. First they could have been derived using price theory, which suggests each store owns a local monopoly around its location. Figure 7 of Chapter 2 showed a store could attain 100 percent of potential up to an indifference point between two stores. Past the distance indifference point, another store would have 100% of the potential. This is an acceptable procedure only if the prices are exogenous and cost functions for distance traveled are known. Since this was not the case another method was used.

A second possibility incorporates a large data set used in examining this relationship. All Southern States sales to each zip code in the six county area were summed for that zip code. Each store's sales could then be represented as a percentage of the total. Distances were measured from all stores serving this six county region. The resulting array of points representing these two factors were very disperse. A regression line could have been estimated to predict sales as a function of distance in a linear or non-linear form. Using such a line for coefficient creation would do an injustice to those stores attaining a market share above the line. Approximately half of the observations would fall in this class.

An appropriate coefficient would allow any store the maximum potential given distance, if its service, price, and competition were optimal. The observations at the maximum percentage of potential for each distance were therefore used when representing the potential for any store under optimal conditions. Figure 10 contains all the observations including outlyers which were excluded in the formulation of an envelope of values.

Using this plot, sales could be obtained up to 23 miles. Table 1 shows the results of selecting these maxima along the envelope of maxima and the transformation process used in converting them to coefficients. This calculation merely shows the algebra necessary to limit sales X_i by some percentage of the potential. The percentage is divided through the expression and the resultant reciprocal is the coefficient used in the programming model. The transformation arises from the algebraic formation of:

$$X_i < \max \% * b_i$$

$$\frac{1}{\max \%} * X_i < b_i$$

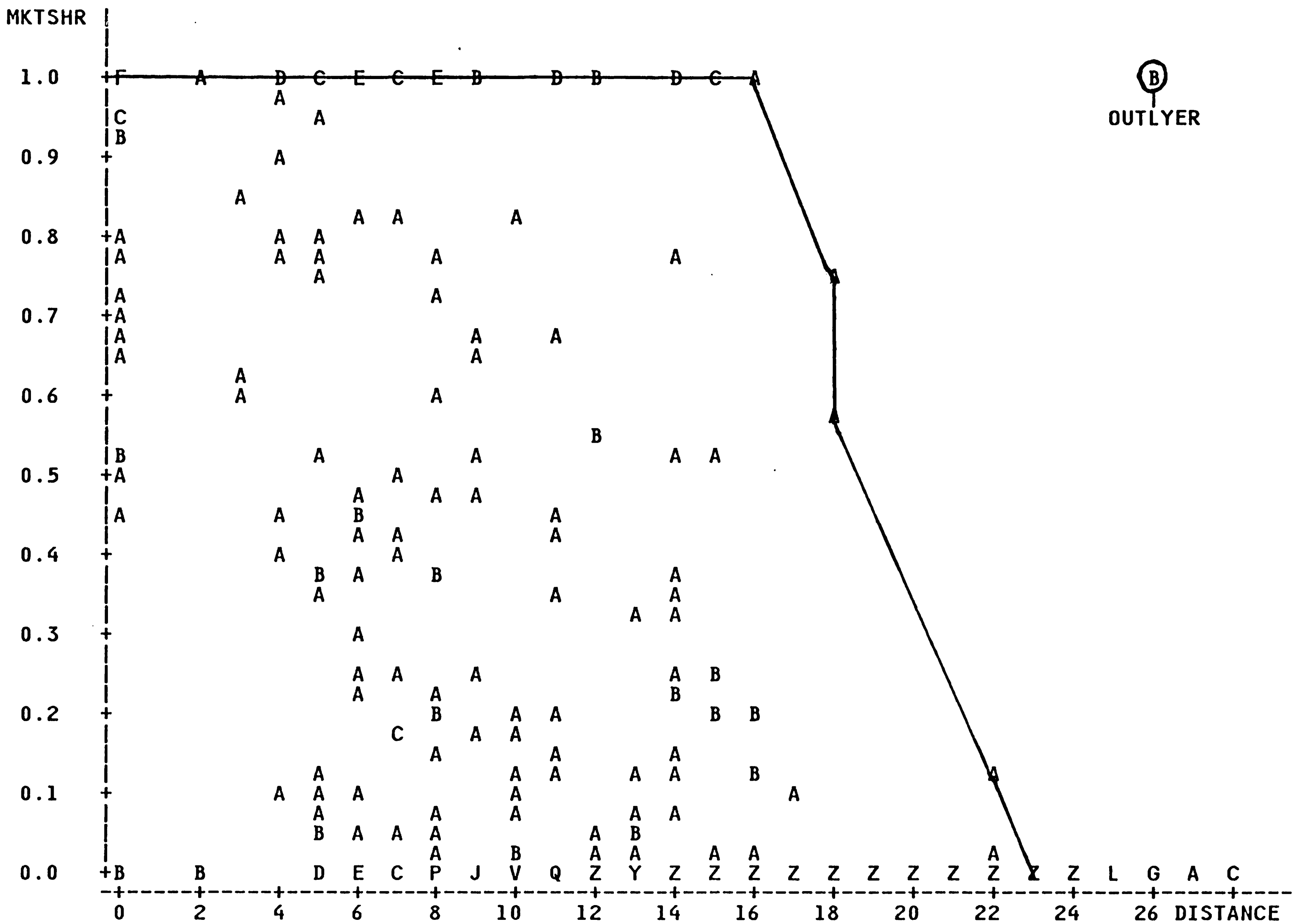


FIGURE 10 : PLOT OF MARKETSHARE VS DISTANCE LEGEND: A = 1 OBS, B = 2 OBS., ETC

TABLE 1 : List of Transformations

distance (miles)	max %	a_{ij}
0	100	1
1	100	1
2	100	1
3	100	1
4	100	1
5	100	1
6	100	1
7	100	1
8	100	1
9	100	1
10	100	1
11	100	1
12	100	1
13	100	1
14	100	1
15	100	1
16	100	1
17	88.5	1.13
18	75	1.33
19	60	1.67
20	45	2.22
21	30	3.33
22	15	6.67
> 23	0	

where: a_{ij} = 100 / maximum percentage of a potential

$$a_i \; * \; X_i \; < \; b_i$$

where: X_i = sales of a product in zip code i;

max % = the maximum percentage of potential a store can attain due to distance;

b_i = the total 1982 sales of a product j in zip code i; and

a_i = 1 / max %.

The results of the maximum structure conforms with two surveys. The first under Joe Coffey in 1984 indicated that approximately 80 percent of the farmers travel 15 miles or less for their farm supplies [Coffey, 1984c].

Another survey by the United States Department of Agriculture in 1979 showed the average distance traveled by farmers was 13 miles for feed, 11 miles for fertilizer, and 11 miles for fencing [USDA]. Neither survey attempted differentiation by patron's volume. Coffey's survey also was indifferent to type of product.

Since there was no published information on differences among product lines, all the product line's coefficients were kept the same with respect to the influence of distance on sales. The data again, as the case with potentials, was unavailable for zip codes by product lines. This revenue restriction places an upper bound on profit without connecting revenue to assets or expenses. Later constraints further tie these together.

3.7 Asset Requirements

For a cooperative to have revenue, products and services must be sold. These products and services require capital assets when handling the product and providing the services in the retail system. Various asset combinations were already in place but the model allowed them to be upgraded, transferred, or divested depending on the product and level of service demanded.

Capital assets are used for three basic purposes: storage, processing, and transportation. The assets are in the form of warehouses, feed and fertilizer mills, and trucks. One of the basic functions of retail marketing is storage. Very rarely is any product sent directly from wholesale to the patron's farm. Products are stored for different periods of time, depending on form, quantity, and services required. Bagged feed is stored for one to several weeks. Some farm supplies are stored for months.

Since storage needs vary by product, transformations must be made for each product line. First, revenue in a product line was transformed to average inventory. Although inventory was really seasonal, average inventory made the model manageable. Bagged feed and fertilizer, seed, and farm supplies were transformed in the model to dollars of inventory by linking the revenue sold with the average turnover of that product for each store. See Appendices H and I for more details of these transformations.

These inventories then must be stored. A linkage was made based upon George Timberlake's figures in Appendix E for assets needed to support sales. These figures were used to form inventory per square foot coefficients [Timberlake, 1983]. The warehouse and showroom storage areas are measured in square feet. Farm supplies are primarily stored in the showroom. Excess and larger farm supplies are kept in the warehouse along with bagged feed, fertilizer, and seed. Bagged fertilizer is sometimes also stored outdoors. The amount of storage area is important because sales need inventory, and inventory needs storage. The model insures that space is available for storage of inventory if there are sales.

Current capacities for both the showroom and warehouse were obtained from store managers (Appendix B, Q1-2). The model allows an option for building additional showroom and warehouse floor space if profit would increase for the region. The floor space can be added at 1000 sq.ft. increments. The costs associated with such an addition are explained in detail in the discussion of expenses.

Storage of products is only one service performed by retail systems. Processing is another which is performed in many retail systems. In agricultural supply cooperatives, especially in this region in Maryland, custom grinding and mixing of feed and blending of fertilizer is commonplace.

Processing changes raw materials or ingredients into a more specialized or complete feed ration or fertilizer blend.

Revenue in these processed product lines must be transformed into volume of output or tons of product. This was accomplished in the model by dividing the composite product price into revenue. Total sales of the product when adjusted by a composite price per ton originating from an average manager response to question 13 in Appendix D results in tons of a product sold. Once this quantity was determined, a quantity that must be processed can be derived, similar to a quantity to be stored.

The existing facilities were given a capacity in tons per year by the respective store managers (Appendix B, Q3-4). This capacity did not all have to be utilized, but storage above current capacity could only occur with additional investment. The model allows for added capacity for processing. Managers could not provide estimates of amount of added capacity that would result from any specific investment. Since each store is unique, it would not be appropriate to make an average estimate. The model was structured to allow for added investment in processing facilities for future research, but the added processing capacity allowed in this analysis is zero since managers could not provide estimates. Warehouse space was not required for these two product lines because space to store bulk ingredients was included in these processing facility capacities. Another process, storing and drying of grain, was included with grinding and mixing capacity.

While storage and processing are two important functions performed by retail cooperative stores, delivery of products is also a very important and expensive service. Various types of trucks are used for this purpose depending on the product transported.

Several linkages were needed when converting the revenue of a product sold to number of each type of truck needed. The model converts the revenue of these products delivered to units of tons through a composite price and percentage of product delivered index (Appendix B, Q-8,13). Once the delivered amount of product was determined, the type of delivery and distance of delivery become important.

Distance of delivery was important for several reasons. The farther the distance, the more costly making the delivery becomes. The individual load is the same but fewer deliveries are made each day. The combination of fewer but longer and thus more expensive loads results in the total cost of a days deliveries to be equivalent to several more short runs. To model this phenomenom, truck capacity was decreased if deliveries were to more distant points. Total costs of a days deliveries remain constant, regardless. Thus costs per delivery for longer runs were higher.

As distance delivered increases, cost per delivery increases or capacity decreases. Both approaches could arrive at the same costs of long distance deliveries. A decrease in capacity while holding expenses at those of maximum usage, increases average costs or cost per delivery. Store managers gave their impressions of how truck capacity per year decreased with distance (Appendix B, Q-7). An average of responses was used for all trucking for any product. The average was 115 percent of capacity if deliveries were made within 6 miles. A percent of capacity of 99.89 was used for 6 to 12 mile deliveries. This indicates the average delivery they are presently making. Ninety six percent of capacity and 70.11 percent were used for 12 to 17 mile and 18 to 23 mile deliveries, respectively.

Stake body trucks or general purpose trucks are one type of vehicle used for deliveries. The stores in this study area have 30 of these delivery trucks that are used for delivering farm supplies, seed, and bagged fertilizer as well as bagged feed (Appendix B, Q5G-H). Since data was unavailable on farm supplies and seed deliveries, the model concentrates on tons of bagged feed and bagged fertilizer. A small percentage of bagged feed sold is currently delivered according to responses of managers' questionnaires. But bagged feed makes up a large part of the deliveries made by these trucks. Numbers for general purpose truck capacity were unavailable. The following calculation was performed based on reasonable assumptions for finding this capacity:

```
   2 Tons   / Load
X  3 Loads / Day
------------------
=  6 Tons   / Day
X  5 Days   / Week
------------------
= 30 Tons   / Week
X 50 Weeks / Year
 ----------------
1500 Tons   / Year
```

The amount of 1500 tons was used in the model because compared to dual purpose trucks, which haul four times this amount a year but also 4-6 times per load, this tonnage appears reasonable. If 3000 tons of bagged material must be delivered, then 2 trucks will be needed at the location. This is also true of bagged fertilizer which is usually also hauled by stake bodies or sometimes by semitrailers with a smaller percentage picked up at the store. Quantities delivered are subject to a delivery charge which appears as trucking revenue. This charge and the volume of product delivered varies between stores (Appendix B, Q8).

Mixed feed was the critical item in the transportation of feed. Feed mixed at the store must be delivered to patrons by the stores. The questionnaire(Q8B1) in Appendix B obtained the percentage of custom feed hauled. This feed must be hauled by a store's truck or by stores' jointly owned trucks. This product line was critical because bagged feed could be picked up at the store and regionally made feed could be hauled by its own fleet. The total number of trucks available for this use cannot exceed the total number of trucks already in the system without further purchase of a vehicle. There are 14 bulk feed trucks currently used by the nine stores (Appendix B, Q5A). They have a capacity of 6600 tons per year (Appendix B, Q-6A).

One product, bulk feed, must be delivered from a regional mill in Baltimore. It can be delivered by haulers originating at the store or the mill. Delivery by the store will be indifferent to distance from the store to patron, since this distance is insignificant when compared to the distance from the regional mill to the store. The trucks originate at the store, proceed to the mill, return to the patron and back either to the mill or the store. Although the distance per delivery varies, the total number of trips possible per year per truck will be constant for each store since the store and mill locations are constant. Capacity of trucks are less than that of feed delivered from the store.

Either regional haulers at a fixed rate or any of two truck types could be chosen for delivery of bulk feed. The model considers trucks owned and operated by the regional mill as exogenous, because the regional mill has control over these trucks. Dual purpose trucks and semitrailers can haul this feed. All trucks currently in service by the store were of the dual purpose type. Since the stores already owned dual purpose trucks for the hauling of mixed feed, they were also used for feed originating from the regional mill. If mixing of ingredients at the store was discontinued, dual purpose trucks could be sold and the larger capacity semitrailers could be purchased if volume warranted. The capacity of the semitrailers were provided by Southern States feed division from its regional mills fleet (Appendix G). The least cost combination will be chosen for delivery of bulk feed. Trucking revenue is included in the price of bulk feed. If the store uses its trucks to make regional deliveries, truck capacity is utilized but trucking revenue is not increased. On the other hand, when this feed is hauled by regional carriers, an 11 dollar charge per ton is assessed against the store (Appendix B, Q-8).

The tons of bulk feed delivered from the mill by a store's trucks has a lower capacity per year than deliveries of store mixed feed. The regional mill, in Baltimore, is between 27 and 47 miles from the stores. The use of managers projections of decreases in a truck's capacity was done earlier up to 23 miles. This information was extrapolated using the regional mill's distance and by decreasing the capacity by 2.27% per mile. This was done for distances from 27 to 32 miles from the regional mill. From 32 miles on, the total reduction remains at 45 percent of close proximity capacity (Appendix J).

For deliveries from the store of mixed feed the truck capacity calculations discussed above were used. Deliveries in the agronomic services as well as for mixed feed were subject to truck capacity limitations. Bulk fertilizer tonnage is seldom picked up at the store and must be dumped or spread. It can be spread by fertilizer buggies, fertilizer trucks, combination bed trucks, new Big A's , or even sprayed (Nitan) by spray trucks, combination bed trucks, or Big A's with nurse trucks. The number of existing rolling stock are limited to the total number of vehicles of that type among the nine stores (Appendix B, Q5). Additional vehicles for agronomic purposes may be purchased if it is profitable to do so. Capacities of each vehicle was derived from the average of the managers' responses to the questionaire and budgets (Appendix B, Q-6; Appendix F).

Lime can be spread by lime trucks or Big A's. It also can be serviced by the wholesaler of lime in some areas. No lime inventory was kept. Capacities of all fertilizer and lime vehicles were obtained from the average response of managers concerning their existing vehicles (Appendix B, Q-6). Charges for spreading of lime, fertilizer and chemicals differ by location (Appendix B, Q-9-11).

3.8 Operating Expenses

The third part of the model deals with the expenses incurred when selling a product or service. Sales, inventory, and the capital assets required for storing, processing, and transporting a product all incur certain expenses for their continuation. The model uses Southern States accounting classifications, since data was available through accounting records and the expenses were adequately delineated. The expenses tracked by the model were depreciation, licenses & taxes, insurance, wages, utilities, repairs, petroleum, bad debts, advertising, other and opportunity costs.

Depreciation in the model was considered for both existing assets and new investments. Depreciation for existing assets was totaled by asset type: grinding and mixing; fertilizer blending; warehouse; showroom and office; and also by types of trucks from Southern States 1985 Uni-group report (Appendix C, Q18).

Assets used in processing and storing were assigned to each store location. Expenses tied to that asset help decide what product mix at each location was most profitable for the region. If the product line was unprofitable and the model excluded assets which were linked to those sales, the store's expenses were decreased by the depreciation amount. This means the model sells those assets for the book value of the asset and no income was earned. Rolling assets' depreciation was combined by truck type and averaged over all trucks. In the model trucks were assigned to stores as needed rather than keeping them based at their original location. Additional trucks were expensed using Timberlake's budgets (Appendix D,F).

The addition of assets at a location for the increase of storage or processing capabilities was expensed as depreciation. These coefficients were derived by dividing total investment by life of the investment. On these assets, 33 years was used for length of life, based on current depreciation practices.

Existing trucks or rolling stock in the model are depreciated in a similar fashion. The exception being the depreciation amount was averaged over all stores by truck type, since the asset could be transfered between stores. This links the expense to the transferable asset, trucks, rather than any one location. Any additional rolling stock was assigned to a particular store which purchased it.

Opportunity costs were assigned to new investments in a similar fashion as depreciation. The entire opportunity cost was assigned to the current year, because the investment could be used for other purposes including investment in Treasury bonds. An interest rate of 11 percent was used for this money.

The opportunity rate or expected internal rate of return could be higher or lower depending on the alternative investment chosen. This 11 percent rate was used for three reasons. The first being that the rate was two percent below a rate used by Timberlake in 1983 [Timberlake, 1983]. Secondly, many long term (30 year) rates have recently been fluctuating near 10 percent. Thirdly, The Baltimore Bank for Cooperative's seasonal interest rate plus .25 percent was the one used by Southern States retail accounting to assess interest to stores for borrowings.

This opportunity cost was also applied to inventory since the money invested there could also be invested in other ventures. Opportunity costs were assessed for existing assets based on the book value of the asset and charged to the respective stores excluding land and trucks (Appendix C, Q-19).

A large expense for wages or salaries was considered in the model. Some products and activities are more labor intensive than others. Bulk feed and lime, when delivered by the regional mill or supplier, require only ordering and billing, which are much less labor dependent than equipment use. The following were the wage expense allocated as percent of sales: Feed at 5.6 percent; Fertilizer at 6.8 percent; Seed at 6.0 percent; and Farm Supplies at 10.0

percent. These were obtained from Timberlake's budgets included as Appendix E [Timberlake, 1983].

The utility expense coefficient was derived from a stores utility expense for a year divided by the stores sales for that year (Appendix C, Q-15). This figure was then expressed as a percentage of sales and will fluctuate with volume. Different product lines draw upon utilities unequally. Mixed feed, bulk fertilizer, and other warehouse products were the areas the questionaire concentrated on because of their heavy reliance on electricity for processing (Appendix B, Q-14). The managers provided views on what percentage of utilities each used and those numbers were used to multiply by the utility expense coefficient.

Gas, lube, and oil expenses were solely linked with transportation. First, existing and additional trucks needs for petroleum were calculated at full capacity using Timberlake's budgets (Appendix D). Semitrailers coefficients originated from the feed division [Messenger], (Appendix G). Several short runs or a few long runs would use approximately the same amount of gas. This assumption was further substantiated considering that during feed unloading and fertilizer spreading the truck remains running.

Taxes and licenses, and insurance were linked to inventory, which includes bagged feed and fertilizer, mixed feed and fertilizer, seed, and farm supplies. The percentage of expenses charged to inventory was obtained from previous budgets located in Appendix E [Timberlake, 1983]. The percentages of 0.25 percent for taxes and licenses and 0.75 percent for insurance were used for inventory expenses. Trucks were debited of these two expenses using Timberlake's second budget (Appendix D) for all but semitrailers where numbers from the feed division were used [Timberlake,1984 ; Messenger].

Repairs are primarily expensed to rolling stock, although processing assets can also retain a large repair expense. Repair coefficients for rolling stock were taken from Timberlake's budgets (Appendix D). Both existing trucks and new additional trucks were given the same values. Processing repairs were handled much in the same way utility expense was handled. Total repair expenses for each store was divided by total sales in that year (Appendix C, Q15). This percentage was divided between the mixed feed facility, bulk fertilizer facility, warehouse and showroom using answers obtained from the managers questionaire (Appendix B, Q-14). The last three expenses, bad debt, advertising, and other are handled in exactly the same way as a percentage of total store volume. As total volume increases these expenses increase at a fixed rate. The expense rate differs among stores attempting to capture some of the differences in cost structures. The actual percentages used were obtained from Appendix C in question 15. The other expense is a general category for administrative expense, computer accounts, stamps, collection expense, meeting, miscellanous, and telephone expense.

3.9 Conclusions

The three main ingredients in the model all have potential for further refinement. For added detail to the discussions in sections 3.5 through 3.8 is provided in Appendix L. Tableaus are provided to illustrate the structure and the logic of the model. Increased data collection is needed for the coefficients to be further refined. The structure of the model was correct and all essential characteristics were included. Both revenue and costs were included with costs depending both on volume and amount of assets required.

The model discussed in this chapter can be used for both linear and integer programming. This model will be run as is first for a continuous solution, then for an integer solution. Some of the variables will be tested for sensitivity. Added constraints may be used to try different scenarios, but the basic structure will remain unaltered.

CHAPTER IV

RESULTS

The preceding chapters discussed the problems facing cooperatives, organizational theory, and the construction of a programming model. The development of the model addressed revenue and cost relationships for nine stores in Maryland. The basic question analyzed was how the stores should be arranged and equipped to maximize profit for Southern States. The model highlighted Southern States desire to look at the macro picture for the region.

When looking at the larger picture of several stores, some stores have a comparative advantage over other stores in the region. Cost structures and better management are all arguments for larger but fewer stores. However fewer stores mean customers must travel longer distances to reach them and hence increase the likelihood that they will not buy from the cooperative. Each area wants its own store. These factors make for pressure against consolidation.

The linear programming model was used to derive a basic solution, considering these tradeoffs. Various scenarios were then conducted to find what change in profit and sales further reorganization might have. Assets could be divested, used at undercapacity, at full capacity, or even upgraded to increase volume or capacity. Integer programming added several benefits to the linear model, including forcing assets to incur the entire lump of expenses if that asset was in operation. Once the integer model was run, several options needed to be explored, including closing several stores. These options were run to see how the income statement would be affected.

4.1 Baseline Analysis

When examining how the distribution of assets and sales vary with different scenarios, some benchmark had to be selected for comparisons to be made. Several options were available. First, profit was an obvious criterion for comparing scenarios. Unfortunately, although the model used virtually the same revenue and expense divisions as current operating reports, the profit as computed by the model is different from profit found in the operating reports. The unrestricted model varied from Southern States actual behavior for several reasons. First of all, the model required opportunity cost to be overcome for assets to be used and inventory to be bought. Secondly, the model maximized profit and thus changed sales and assets from the current situation to a more optimal structure. Thirdly, a linear programming model, no matter how large, is a simplification of an actual situation. As such it would be unreasonable to expect it to exactly replicate a firm's behavior. Therefore, in order to obtain a linear programming solution, approximating 1983 sales which could serve as a comparison to other scenarios, a baseline run was executed utilizing restrictions forcing sales of products to be approximately that of 1983 sales. The actual sales for 1983 are tabulated in Table 2. The sales and assets resulting from the attempt to to simulate Table 2 in the baseline run are tabulated in Table 3. Also Tables 2 and 3 list actual profit for 1983 and the profit calculated by the model, respectively. The profit in Table 3 was used for comparisons between the current structure and the proposed structures resulting from the scenarios.

In order to conduct the baseline analysis, product sales were first restricted to be greater than the approximate level of 1983 sales. Then a two step process was employed. It should be noted that a similar process was employed in the following analyses except for the integer programming analysis. In this first stage, existing storage assets were restricted to be at their current levels, that is no divestment was allowed and unlimited additional warehouse and showroom capacity was allowed. The purpose of the first run was force stores to 1983 levels and to find stores which within the model required additional assets to maintain 1983 sales levels. Both existing and additional assets could not be left as inequality constraints since, as discussed below, per

TABLE 2 : Actual 1983 Product Sales in Thousands of Dollars for 9 Stores in Study Region (1983)

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Suppl	TSAL
1-Hamp	263	539	28	100	684	42	146	689	2.5M
2-West	387	713	28	120	733	42	92	630	2.7M
3-Syks	345	732	22	70	333	24	88	417	2.1M*
4-Wbin	456	66	15	32	10	8	46	295	0.9M
5-Tany	359	1297	28	82	314	34	93	364	2.6M
6-UnBr	101	614	19	22	232	8	41	171	1.2M
7-MtAr	598	483	19	95	315	48	118	40	2.1M
8-Wbor	428	1117	24	514	382	9	108	48	2.6M
9-Fred	650	1910	53	109	556	44	201	984	4.5M
TOTAL	3.6M	7.5M	0.2M	1.1M	3.6M	0.3M	0.9M	4.0M	21.2M

Key:

Profit = $776,322

* = Sykesville reported only total sales, used average product mix from other 8 stores for breakdown.

M = Millions of dollars, all other numbers are in Thousands

TABLE 3 : Baseline Simulation of Thousands of Dollars of Product Sales for 9 Stores in Study Region and Stores' Assets as a percentage of capacity (BASELINE)

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Supp	TSAL
1-Hamp	250	715	25	80	650	55	140	700	2.7M
2-West	350	700	25	100	700	40	111	600	2.7M
3-Syks	350	700	20	50	300	20	80	400	2.0M
4-Wbin	510	50	10	28	0	5	40	300	1.0M
5-Tany	350	1300	25	40	300	30	90	360	2.6M
6-UnBr	100	600	15	10	200	5	40	170	1.2M
7-MtAr	600	400	15	70	512	40	110	40	1.9M
8-Wbor	400	1100	20	290	350	5	100	50	2.4M
9-Fred	650	1900	75	80	500	40	200	1801	5.5M
TOTAL	3.6M	7.5M	0.2M	0.7M	3.5M	0.2M	0.9M	4.4M	21.9M

ASSETS
(% capacity)

Store	EGM	AGM	EFT	AFT	EWH	AWH	ESH	ASH
1-Hamp	.23	0	.30	0	1	2.4	1	1.6
2-West	.10	0	.29	0	1	3.8	.52	0
3-Syks	.20	0	.09	0	.74	0	.80	0
4-Wbin	.08	0	0	0	1	1.8	1	0
5-Tany	.19	0	.15	0	.61	0	1	.54
6-UnBr	.08	0	.07	0	1	1.8	1	.08
7-MtAr	.09	0	.17	0	.21	0	.18	0
8-Wbor	.10	0	.13	0	.66	0	.08	0
9-Fred	.18	0	.13	0	1	19.2	1	4.2

Key:

Profit = $1,750,493
M = millions of dollars

E-Existing, A-Additianal, GM-Grinding&Mixing, FT-Fertilizer Blending, WH-Warehouse, SH-Showroom square foot of storage space additional assets were cheaper than current existing assets. Thus the model preferred using additional assets first. The first run forced these more expensive existing units to be in the solution at their full levels (equal to one). The model indicated that store's 1, 2, 4, 6, and 9's warehouse needed additional space and store's 1, 5, 6, and 9's showroom also needed additional room. These stores needed more than existing capacity in the model.

Before continuing to the second step in the establishment of the baseline of Table 3 two factors must be discussed. The first addresses why existing assets could be more expensive than additional assets. The reason for this can be traced back to Chapter 3 section 8. Expenses such as repairs were assigned to existing assets since those expenses could not be attributed to volume. Also depreciation and opportunity costs on existing assets were sometimes more because fixtures such as forklifts and paint machines were included in these assets. Thus, existing assets include expenses from services related to product lines, which additional assets do not have to bare. The inclusion of these types of expenses in the additional assets would result in a double counting of these expenses in the model.

It is also paradoxical that additional assets are needed in some locations to obtain current sales levels. A combination of possibilities could explain this. First, all warehouse space may not have been reported in the questionaire. Bagged fertilizer requires no warehouse space in the model because it is often kept out of doors. All farm supplies in the model require warehouse space, although fencing, mulch, lumber, peatmoss, and other items are often kept outdoors like bagged fertilizer, and ground space was not included in capacity calculations of the store. Second, the coefficients of storage space requirements calculated from Timberlake's budget (Appendix E) reflect Southern States best judgement, but it is reasonable to expect that they would vary by product mix within each product line or by display and storage method. The coefficients were the best available information on storage needs and as such, were the ones used. However, they apparently did not capture the actual situation. Once the first step toward the baseline run was made, a store's need for additional space was identified. The second run allowed all stores not needing additional floor space, to under-utilize their existing assets. No additional assets were available to them. This was not possible in step one, because all existing assets were forced to one to determine stores requiring additional assets. The results of this second run are those recorded in Table 3 and they were used for comparisons.

A second means of comparison other than profit, between current practices and optimal modeled conditions, were sales by product. Current sales for products are listed in Table 2 along with totals by store and product line for the region. Sales in Table 3 representing the baseline are roughly similar to those of 1983. This is not surprising since they were restricted to be. These sales make excellent reference points to compare how stores under optimal structures selected by the model differ from the current product mix. Sales are the most often used measurement within this analysis.

The usage of existing and additional assets are an important third way to examine the various scenarios. It should be noted that current levels of asset usage are more complicated than that depicted in the scenarios. The usage of existing assets according to relationships in place in the model are provided in Table 3. Notice in some instances the existing facilities (E**) are less than one. In these stores, that asset is at a percentage undercapacity by the difference between that number, and one. For example in Table 3, Hampstead's existing grinding and mixing facilities are at 23 percent capacity or 77 percent under capacity. Also in this store existing assets such as the warehouse and showroom were at full capacity (1) and additional assets are needed to insure sales. The need for additional assets in the baseline analysis was explained above. This is not the case for processing assets, where no facility used more than 30 percent of its capacity. Within the use of existing truck assets, the actual number of trucks per store were tabulated in Appendix B (Q5). The number required in the baseline run is found in Table 4. The only trucking limit which was binding was that of the dual purpose bulk feed trucks. All 14 currently owned dual purpose trucks were needed in the baseline. Since the existing asset was binding, the activity for purchasing additional dual purpose trucks was then used other types of trucks were used below their existing numbers.

All three methods: profit, sales and asset utilization were used to compare the structures found optimal by the model to the baseline structure. These methods were also used for comparisons between various scenarios and the optimally derived structures.

4.2 Continuous Solution

The model was then run without being restricted to 1983 sales levels as in the baseline run. One effect of removing these restrictions was specialization of stores. Table 5 gives the level of sales in the model, after the two step process previously explained was performed. The consolidation effect, forcing stores to specialize,

TABLE 4 - Trucks used in Baseline run

ROLLING STOCK
(number used)

	1Hamp	2West	3Syks	4Wbin	5Tany	6UnBr	7MtAr	8Wbor	9Fred	Total
ABIGA	-	-	-	-	-	-	-	-	-	-
ECBTK	.6	.4	.1	-	.1	.1	.3	.1	.5	2.2
ACBTK	-	-	-	-	-	-	-	-	-	-
EDPTK	1.3	1.5	1.1	.1	2.6	1.2	.8	2.1	3.4	14
ADPTK	-	-	-	-	-	-	-	-	.6	.6
EGPTK	.3	.2	.3	.6	.6	*	.4	.8	.2	3.4
AGPTK	-	-	-	-	-	-	-	-	-	-
EFTBUG	.5	.7	.5	-	1.5	.4	.7	1.6	.8	6.7
AFTBUG	-	-	-	-	-	-	-	-	-	-
ASEMI	-	-	-	-	-	-	-	-	-	-
ESPTK	-	*	.1	-	.1	*	.2	.3	-	.7
ELMTK	-	-	-	-	-	-	-	-	-	-
EFTTK	-	-	-	-	-	-	-	-	-	-
ELQEQ	.1	.1	.2	-	*	.1	.7	.1	*	1.3

Key:

* = negligible
\- = zero

E-Existing, A-Additional, TK-TrucK, CB-Combination Bed, DP-Dual Purpose, GP-General Purpose, FT-FerTilizer, SP-Spray, LM-Lime, LQEQ-LiQuid EQuipment

TABLE 5 : Continuous Optimal Solution in Thousands of Dollars in Product Sales and Stores' Assets as a Percentage of Capacity

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Supp	TSAL
1-Hamp	9	2707	1	2	651	114	3	0	3.6M
2-West	517	1649	74	53	0	52	576	672	3.7M
3-Syks	4	40	*	2	30	4	12	13	0.1M
4-Wbin	2060	3	1	486	0	*	*	2817	5.4M
5-Tany	27	2	0	0	0	0	0	0	* M
6-UnBr	0	17	0	1	0	38	0	142	0.2M
7-MtAr	529	2198	5	119	2204	1	27	10	5.4M
8-Wbor	5	0	2	*	585	*	1	0	0.7M
9-Fred	827	849	147	85	41	29	290	750	3.3M
TOTAL	4.0M	7.5M	0.2M	0.7M	3.5M	0.2M	0.9M	4.4M	22.5M

ASSETS
(% capacity)

Store	EGM	AGM	EFT	AFT	EWH	AWH	ESH	ASH
1-Hamp	.01	0	.30	0	.01	0	0	0
2-West	.30	0	0	0	1	9.35	.58	0
3-Syks	*	0	.01	0	.02	0	.03	0
4-Wbin	.01	0	0	0	1	34.5	1	10.1
5-Tany	0	0	0	0	.01	0	0	0
6-UnBr	0	0	0	0	.83	0	.95	0
7-MtAr	.03	0	.75	0	.12	0	.05	0
8-Wbor	.01	0	.21	0	.01	0	0	0
9-Fred	.35	0	.01	0	1	9.1	1	0

Key:

Profit = $2,340,013
* = negligible
M = millions of dollars

E-Existing, A-Additional, GM-Grinding&Mixing, FT-Fertilizer Blending, WH-Warehous, SH-Showroom

emphasizes the principle of comparative advantage. Different stores have different levels of costs and pricing. Stores increasing tasks that they do well can have a profitable effect for the region. The major constraint stopping individual stores from completely monopolizing a product line was the distance involved in transportation and demand.

The profit of the consolidated store structure in the continuous model was $2.34 million. This is noticeably higher than that of the baseline model with a profit of $1.86 million.

The sales for individual products and stores are also listed in Table 5. Although the profit is higher in the consolidated run, the amount of sales with this specialization is approximately equal to the baseline. The increased profitablity was caused by letting stores with comparative advantage do what they do best.

Examining the difference between sales in the baseline and in the continuous solution illustrates major differences in structure. First, comparing stores' total volume in the baseline, Frederick and Westminster in Table 3 had the greatest level of sales, while Woodbine and Union Bridge had the least amount. In the continuous solution (Table 5), Mount Airy and Woodbine had the largest sales while Taneytown, Sykesville, Union Bridge, and Woodsboro all had low sales of one million dollars or less.

The reasons for this change in sales distribution is a change in distribution of individual product sales. The product line of bagged feed had the most exaggerated of the consolidation effects. Woodbine had sales of $2.1 million in the continuous solution. In the baseline the largest bag feed store was Frederick with $0.6 million sales. Woodbine was seventh in sales of bagged feed in the baseline with $0.35 million. Frederick, which was first in the baseline, dropped to second in the continuous solution but increased sales by $170,000. A further comparison between the baseline and the continuous solution indicates that Woodbine's increase in bagged feed volume necessitated 34 additional units of warehouse space. Although such an increase in volume seems intuitively impossible from a demand aspect, the distance coefficients developed in Table 1 allow for this possibility. This increase does not conform to expectations. However information to adjust the disctance coefficients to make this result more reasonable was not available.

Farm Supplies followed a very similar pattern in the consolidation. Woodbine again earned $2.8 million in farm supply sales while Frederick was second. In the baseline, Frederick was number one in farm supply sales with $1.8 million and Woodbine was sixth with $0.3 million. Hampstead which was second in farm supply sales in the baseline lost all $689,000 in the continuous solution. It closed and divested its showroom and emphasized bulk feed and fertilizer. This volume of farm supplies forced Woodbine to add ten, 1000 square foot increments to the existing floorspace. The increase in farm supplies also contributed along with bagged feed at Woodbine to increase warehouse space needed. Taneytown and Woodsboro also divested of their showroom (Table 5). Divestment in the model eliminates depreciation and opportunity costs on the book value.

In the baseline, bulk feed originating from the Baltimore mill was sold by Frederick, Taneytown, and Woodsboro. In the continuous model, Hampstead, Mount Airy, and Westminster sold most of the bulk feed. All bulk feed was delivered by the stores' trucks.

Mixed feed was processed by all the stores in the baseline with Frederick leading in sales volume. Within the continuous model, Frederick and Westminster performed all the grinding and mixing. This consolidation was not unexpected, since most of the mixed feed facilities were operating well below capacity in the baseline.

In the baseline, bagged fertilizer was dominated by Woodsboro with one half million dollars in sales. Woodbine, in the continuous model, captured the same amount. No assets except trucks are required for bulk feed and bagged fertilizer.

Bulk fertilizer was spread by all stores except Woodbine with Westminster, Hampstead, and Frederick handling most of the product in the baseline. Mount Airy, Hampstead, and Woodsboro handled virtually all the bulk fertilizer in the continuous solution. Neither processing function, mixed feed or mixed fertilizer were at full capacity in the baseline. Even with the consolidated functions, in the continuous solution, the stores were not at capacity.

Lime and seed were two product lines which all stores had sales of in the baseline, although the volume of these sales was less than other product lines. Hampstead was responsible for more lime sales and Westminster increased seed sales in the continuous model.

The continuous model characterized by the results in Table 5 let stores using all existing warehouse or showroom space buy additional space. Westminster, Woodbine, Mount Airy, and Frederick all needed expansion in the warehouse to facilitate increases in sales. Sykesville, Union Bridge, and Mount Airy needed additional room for the sales floor. Additional facilities for processing: grinding/mixing of feed and blending of fertilizer were not needed since the facilities at Westminster and Frederick were sufficient for feed and facilities at Hampstead and Mount Airy were sufficient for fertilizer.

Changes in rolling stock between the optimal continuous solution and that of the baseline solution were what could be expected given the changes of product sales. Total numbers of rolling stock did not change between the models represented by Table 4 and 6. This result is correct, because total sales of products requiring transportation also did not change. Dual purpose trucks were consolidated towards stores specializing in bulk and mixed feed: Mount Airy; Westminster; and Hampstead. Tenders or rental spray rigs were used more heavily in the continuous solution, 3.7 to 1.3 trucks, due to Mount Airy's larger emphasis on liquid fertilizer sales.

The continuous optimization model was tested for sensitivity of objective function coefficients (c_j) and Right Hand Side constraints (b_i). This sensitivity was performed using the RANGE option of the MPS programming algorithm. The purpose of this analysis was to test the stability of the optimal structure.

Many of the coefficients could not be tested with this option. All internal relationships constituting transfer rows fell in this group, because only b_i and c_j are varied over the range specification. The relationship between inventory and warehouse space was an important relationship which would have proved interesting. However, two important coefficients did provide logical and relevant analysis: Gross margin percentages and asset capacities.

TABLE 6 - Trucks used in Continuous Solution

ROLLING STOCK
(number used)

	1Hamp	2West	3Syks	4Wbin	5Tany	6UnBr	7MtAr	8Wbor	9Fred	Total
ABIGA	-	-	-	-	-	-	-	-	-	-
ECBTK	.6	-	*	-	-	-	1.6	.1	.1	2.4
ACBTK	-	-	-	-	-	-	-	-	-	-
EDPTK	3.3	3.8	.1	*	*	*	4.1	*	2.7	14
ADPTK	.8	-	-	-	-	-	-	-	-	.8
EGPTK	*	.2	*	2.6	*	*	.4	*	.3	3.5
AGPTK	-	-	-	-	-	-	-	-	-	-
EFTBUG	.5	-	.1	-	-	-	3.3	3.0	.1	7
AFTBUG	-	-	-	-	-	-	-	-	-	-
ASEMI	-	-	-	-	-	-	-	-	-	-
ESPTK	-	-	*	-	-	-	.8	.5	-	1.3
ELMTK	-	-	-	-	-	-	-	-	-	-
EFTTK	-	-	-	-	-	-	-	-	-	-
ELQEQ	.2	-	-	-	-	-	3.4	.1	*	3.7

Key:

* = negligible
- = zero

E-Existing, A-Additional, TK-TrucK, CB-Combination Bed, DP-Dual Purpose, GP-General Purpose, FT-Fertilizer, SP-SPray, LM-LiMe, LQEQ-LiQuid EQuipment

Gross margin percent coefficients are as critical to the model as they are important to the business. The gross margin percentage range over which the sales of a product are stable varies depending on the level of the coefficient. Sales at zero or restricted by an asset's capacity are very insensitive to changes in the gross margin objective function coefficient. Higher gross margin percent stores, which are not restricted, can be very sensitive to the gross margin coefficient chosen. Westminster and Woodbine's farm supply sales could change by $100,000 each, with only a 0.1 percent (.001) change in the gross margin coefficients. Interestingly, the shift in dollars would be to the other sensitive store in this case. Many of these cases are so tied in restrictions that good estimates of these kinds of sensitivities cannot be itemized. But since these coefficients do appear to be critical, a scenario was run with equal gross margin coefficients in an attempt to assess their effect on distribution structure. The analysis of this run is provided later in this chapter.

A second input of equal interest, but of less significant interpretation was asset capacities. Processing capacities were not binding. Usefulness of range analysis pertaining to them was limited. Storage assets on the other hand, were often binding. Hampstead, Taneytown, and Woodsboro all divested of their showrooms and forfeited farm supply sales. Forcing these stores to use the showroom and sell farm supplies could cost the region $4,300 to $12,600. Woodbine and Frederick used all their existing showroom and if capacities provided by the store managers underestimated their existing showroom, costs for the region would increase by thousands of dollars. This was because the additional showroom activity is less expensive than the existing one and increasing existing space would decrease the need for cheaper additional space. The additional space was cheaper than even the decrease in per unit costs the existing showroom that resulted from the spreading of costs over increased capacity. Of the rolling stock analyzed, only bulk feed trucks were interesting. Losing one of the 14 trucks would cost the region $9,700, since an additional truck would need to be purchased.

In conclusion, the major change from the baseline was specialization. This result lead to several possible scenarios that may be more feasible within the policies of Southern States. Even without running these scenarios, the trend towards specialization is obvious.

4.3 Integer Solution

Once the results were analyzed for the continuous optimal model, an integer model was run. This model was expected to round partial use of assets up or down depending on how profitability was affected. Specified asset activities not within an .001 tolerance level would be made into integer values. The first integer solution was used rather than the most optimal integer solution, because the cost of obtaining the latter was prohibative. The necessary computer time to find the optimal solution given 60 or more integer variables and combinations thereof was well in excess of 30 minutes CPU time. As such, these results cannot truely be considered as the best feasible plan.

In processing, the integer solution produced an interesting result. Taneytown, as shown in Table 7, increased its mixing of feed to $59,000 in revenue and $446,000 in related bagged feed from no grinding and mixing in the continuous solution (Table 5), thus incurring the entire cost of the grinding and mixing facility. Mount Airy was using its feed facilities at three percent of capacity, when the integer algorithm forced it to an integer value of one. This forced the entire cost of the facility into the model without adding any tons of throughput to pay for it. Westminster and Frederick, which were the largest local feed manufacturers in the continuous solution, remained so by keeping existing grinding and mixing facilities in operation.

The other processing activity summarized in Table 7, fertilizer blending, produced no unexpected results. The

TABLE 7 : Thousands of Dollars in Product Sales and Stores' Assets as a Percenatage of Capacity for Integer run (INT)

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Supp	TSAL
1-Hamp	0	2629	0	2	651	114	0	0	3.5M
2-West	332	1539	16	53	0	52	576	0	2.6M
3-Syks	4	40	0	2	0	4	12	500	0.6M
4-Wbin	2055	0	0	486	0	*	*	167	2.7M
5-Tany	445	83	59	0	0	0	0	0	0.6M
6-UnBr	0	2	0	1	0	38	0	150	0.2M
7-MtAr	387	2170	5	119	1869	1	252	219	5.3M
8-Wbor	0	0	0	*	921	*	*	0	1.0M
9-Fred	647	1000	147	85	0	29	66	294	2.6M
TOTAL	3.9M	7.5M	0.2M	0.7M	3.4M	0.2M	0.9M	1.3M	19.2M

ASSETS
(% capacity)

Store	EGM	AGM	EFT	AFT	EWH	AWH	ESH	ASH
1-Hamp	0	0	1	0	0	0	0	0
2-West	1	0	0	0	1	0	0	0
3-Syks	0	0	0	0	1	0	1	0
4-Wbin	0	0	0	0	1	2	1	0
5-Tany	1	0	0	0	1	0	0	0
6-UnBr	0	0	0	0	1	0	1	0
7-MtAr	1	0	1	0	1	0	1	0
8-Wbor	0	0	1	0	0	0	0	0
9-Fred	1	0	0	0	1	2	1	0

Key:

Profit = $1,995,563
* = negligible
M = millions of dollars

E-Existing, A-Additional, GM-Grinding&Mixing, FT-Fertilizer Blending, WH-Warehous, SH-Showroom

largest three bulk fertilizer providers stayed in the solution, while those at zero or slightly above left the solution. Sales of bulk fertilizer shifted some. As in the continuous solution, additional fertilizer facilities were not needed.

Products not linked to facilities being forced to integer values did not change. That is, sales of bulk feed, bagged fertilizer, and lime remained virtually the same between the continuous and integer solutions.

Storage assets, when forced to integer values, reacted rather peculiarly as shown by comparing Tables 5 and 7. For existing warehouse space, all stores with heavy utilization in the continuous solution retained the warehouse facilities. Also Taneytown and Sykesville kept their warehouse due to increases in bagged feed and farm supplies respectively. Woodbine although it kept its existing warehouse and showroom, failed to add any showroom and added only two units of additional warehouse. The level of investment found in Table 7 was much more reasonable than the previous levels indicated by the continuous solution. This shift in storage area caused farm supplies to be decreased by two million dollars in sales.

The magnitude of warehouse increments were explained in Chapter 4 section 2. Effects on rolling stock deployment were unaffected by the integer solution. This can be seen in the similarity between Tables 6 and 8.

The profit in the integer solution dropped $345,000, from the continuous solution. This was due to two factors. First the charge for the entire asset even when at undercapacity. This reflects a more representative situation, and increases costs and decreases profit. Second, sales on the margin with little contribution to profit left the solution because they cannot support the entire cost of operation. This too, is a more reasonable result. Based on these two factors profit can be expected to decrease, although not by a large amount. This was the case.

The integer solution was in many ways preferable to the continuous solution because: 1) all costs associated with an asset in use were accounted for; 2) Taneytown, a significant feed center within the current structure (Table 3), came into this integer solution; and 3) increments of additional showroom and warehouse space were of a more reasonable scale.

4.4 Scenarios

The continuous and integer models were overall rather similar in their results. Several scenarios were, however, suggested by their outcomes.

4.4.1 Equal Gross Margin Coefficients

During the sensitivity analysis, gross margin percent appeared to have an important role in the selection of an

TABLE 8 - Trucks used in Integer Solution

ROLLING STOCK
(number used)

	1Hamp	2West	3Syks	4Wbin	5Tany	6UnBr	7MtAr	8Wbor	9Fred	Total
ABIGA	-	-	-	-	-	-	-	-	-	-
ECBTK	1	-	-	-	-	-	2	1	-	3
ACBTK	-	-	-	-	-	-	-	-	-	-
EDPTK	3	3	-	-	1	-	3	0	3	13
ADPTK	1	-	-	-	-	-	1	-	-	2
EGPTK	*	.1	*	2.6	.7	*	.3	*	.2	3.9
AGPTK	-	-	-	-	-	-	-	-	-	-
EFTBUG	.5	-	-	-	-	-	2.8	4.5	-	7.8
AFTBUG	-	-	-	-	-	-	-	-	-	-
ASEMI	-	-	-	-	-	-	-	-	-	-
ESPTK	-	-	-	-	-	-	-	-	-	-
ELMTK	-	-	-	-	-	-	-	-	-	-
EFTTK	-	-	-	-	-	-	-	-	-	-
ELQEQ	.2	-	-	-	-	-	2.9	.3	*	3.4

Key:

* = negligible
- = zero

E-Existing, A-Additional, TK-Truck, CB-Combination Bed, DP-Dual Purpose, GP-General Purpose, FT-FerTilizer, SP-SPray, LM-Lime, LQEQ-LiQuid EQuipment

optimal structure. For this scenario, gross margin percent coefficients which did not vary by location were used. They were obtained from the average of the eight stores excluding Sykesville, for six product lines: bagged feed, bulk feed, bagged fertilizer, bulk fertilizer, seed, and farm supplies. Sykesville, as discussed in chapter 3 section 5, is a private dealer, and as such, not included in operating statements available at the regional cooperative.

The equal gross margin percent model more closely reflects a minimization of operating costs, since the variance in revenue dispersion was eliminated. The largest affect of normalizing gross margin percentages was the shift in $3.5 million in bulk feed sales from Westminster and Mount Airy in the continuous solution (Table 5) to Frederick as demonstrated in Table 9. This would indicate Frederick has some comparative advantage in the transportation of bulk feed. Nine bulk feed trucks were operated by Frederick in this scenario to achieve this level of sales as listed in Table 10. Dual purpose trucks previously used by Westminster and Mount Airy were transferred to Hampstead.

The next most dramatic shift caused by normalizing gross margin percentages was that of $1.8 million in bagged feed, $0.2 million in bagged fertilizer, and $0.5 million

TABLE 9 : Equal Gross Margin Scenario in Thousands of Dollars in Product Sales and Stores' Assets as a Percentage of Capacity(EQGM)

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Supp	TSAL
1-Hamp	16	2707	1	320	789	114	372	520	5.0M
2-West	72	52	14	0	8	52	5	1160	1.4M
3-Syks	64	190	*	11	30	4	40	754	1.1M
4-Wbin	238	3	1	6	0	*	*	217	0.5M
5-Tany	164	0	21	1	0	0	5	0	0.2M
6-UnBr	0	17	0	36	0	38	*	172	0.2M
7-MtAr	2310	23	5	330	2355	1	4	568	5.9M
8-Wbor	461	2	40	37	289	*	0	0	0.9M
9-Fred	666	4471	147	7	41	29	490	750	7.1M
TOTAL	4.0M	7.5M	0.2M	0.7M	3.5M	0.2M	0.9M	4.1M	22.3M

ASSETS
(% capacity)

Store	EGM	AGM	EFT	AFT	EWH	AWH	ESH	ASH
1-Hamp	.01	0	.36	0	1	0	1	.88
2-West	.06	0	*	0	1	6.87	1	0
3-Syks	*	0	.01	0	1	0	1	1.02
4-Wbin	.01	0	0	0	1	0	.72	0
5-Tany	.16	0	0	0	.08	0	0	0
6-UnBr	0	0	0	0	1	0	1	.09
7-MtAr	.03	0	.80	0	1	0	1	1.40
8-Wbor	.20	0	.11	0	.49	0	0	0
9-Fred	.35	0	.01	0	1	8.74	1	0

Key:

Profit = $1,957,144
* = negligible
M = millions of dollars

E-Existing, A-Additional, GM-Grinding&Mixing, FT-Fertilizer Blending, WH-Warehous, SH-Showroom

in farm supply sales from Woodbine to Mount Airy. Considering that the two stores are only 7 miles apart indicates Woodbine has a gross margin advantage, while Mount Airy has an operating cost advantage for warehouse items such as those transferred. This knowledge combined with the stability of the bulk fertilizer processing activity, point to a locational advantage in the Mount Airy/Woodbine region. Also without Woodbine's clear advantage in the continuous solution's farm supply gross margins, farm supply sales increased in: Hampstead by $0.5 million; Westminster by $0.5 million; Sykesville by $0.7 million; and as previously mentioned, Mount Airy by $0.5 million. Considering the moderate size of Woodbine's farm supply business in the baseline, a point could be made for discounting Woodbine's large standing in the continuous farm supply solution. Woodbine with the reduction in sales in this equal gross margin scenario, compared to the continuous solution, decreased its number of general purpose trucks as well as additional warehouse space used in delivery and storage of those products. Since Hampstead and Mount Airy increased their farm supply business relative to the continuous solution, their showrooms were used to capacity and additional units were built.

Taneytown started grinding and mixing feed once bagged feed margins were equal. Taneytown was closed in the continuous solution, but in the integer solution used its

TABLE 10 - Trucks used in Equal Gross Margin Solution

ROLLING STOCK
(number used)

	1Hamp	2West	3Syks	4Wbin	5Tany	6UnBr	7MtAr	8Wbor	9Fred	Total
ABIGA	-	-	-	-	-	-	-	-	-	-
ECBTK	.74	.01	.01	-	-	-	1.75	.05	.05	2.61
ACBTK	-	-	-	-	-	-	-	-	-	-
EDPTK	3.52	.26	.28	.01	.32	.03	.05	.15	9.4	14
ADPTK	.61	-	-	-	-	-	-	-	-	.61
EGPTK	.43	.02	.06	.25	.26	.01	1.74	.26	.21	3.44
AGPTK	-	-	-	-	-	-	-	-	-	-
EFTBUG	.65	.01	.06	-	-	-	3.57	1.50	.08	5.87
AFTBUG	-	-	-	-	-	-	-	-	-	-
ASEMI	-	-	-	-	-	-	-	-	-	-
ESPTK	-	*	.02	-	-	-	.82	.26	-	1.10
ELMTK	-	-	-	-	-	-	-	-	-	-
EFTTK	-	-	-	-	-	-	-	-	-	-
ELQEQ	.19	*	.02	-	-	-	3.70	.06	*	3.97

Key:

* = negligible
- = zero

E-Existing, A-Additional, TK-TrucK, CB-Combination Bed, DP-Dual Purpose, GP-General Purpose, FT-FerTilizer, SP-SPray, LM-LiMe, LQEQ-LiQuid EQuipment

present facilities. Elimination of feed services at Taneytown would be premature.

The equal gross margin scenario shed light on the influence of gross margin in the model's results. These insights are: 1) Frederick has a transportation advantage for bulk feed; 2) Mount Airy has a locational advantage for bagged warehouse items; and 3) Woodbine's performance in the continuous model might have been overestimated due to its high gross margin percentages on a currently small volume of business.

4.4.2 Closure of Stores based on Continuous Solution

In the continuous solution several stores had sales below $1.0 M. Several combinations of store closings could be performed with the continuous optimization model. In this scenario all four of the stores under $1.0 million were closed to check the effect on profit and total sales. Sykesville, Taneytown, Union Bridge, and Woodsboro all had $0.1, negligible, $0.2, and $0.7 million in total sales, respectively in the continuous solution. Table 11 reports the effect of closing these stores on sales and assets for each of the the remaining stores. The remaining stores picked up some of the slack left by the four absent stores. The assets varied to allow the sales increase as shown by comparing Tables 5 and 6 with Tables 11 and 12. Only bulk feed sales were decreased, and by only $0.1 million.

Rolling stock stayed constant with a slight decrease in the number of fertilizer buggies needed. The effect of closing these four stores was almost nonexistant (less than $35,000 in profit) due to the small volume of the total they made up.

One major point can be gathered from this scenario. If the distance coefficients are reliable, several stores can be closed without having an adverse affect on total sales and profits.

4.4.3 Closing Woodbine and Union Bridge

The previous analysis of store closings originated from total sales of stores in the continuous solution being below the $1.0 million level. In the baseline two stores, Woodbine and Union Bridge were below that level. Woodbine in the continuous solution, however, had sales of $5.4 million. This scenario tested both the effect of closing stores that are currently small and the effect of closing a store with significant sales in the continuous solution.

The effect of such a closing can be seen by comparing Tables 5 and 13 and Tables 6 and 14. Like the previous scenario of four stores closing, little total sales were lost. Bag feed sales, instead of bulk feed in the preceding scenario, totaling $0.1 million were not picked up by other stores. The summation of other product sales was the same. Maintenance of profit was a different issue. Over $120,000

TABLE 11 : Scenario 1, Close Syskesville, Taneytown, Union Bridge, and Woodsboro (SCN1)

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Supp	TSAL
1-Hamp	11	2707	1	4	747	114	6	0	3.8M
2-West	523	1649	75	53	46	52	576	1160	4.3M
3-Syks	-	-	-	-	-	-	-	-	- M
4-Wbin	2060	41	1	486	0	*	10	2258	4.9M
5-Tany	-	-	-	-	-	-	-	-	- M
6-UnBr	-	-	-	-	-	-	-	-	- M
7-MtAr	529	2198	5	119	2396	5	27	219	5.9M
8-Wbor	-	-	-	-	-	-	-	-	- M
9-Fred	861	849	147	85	296	67	290	750	3.7M
TOTAL	4.0M	7.4M	0.2M	0.7M	3.5M	0.2M	0.9M	4.4M	22.4M

ASSETS
(% capacity)

Store	EGM	AGM	EFT	AFT	EWH	AWH	ESH	ASH
1-Hamp	.01	0	.34	0	1	0	1	0
2-West	.31	0	.02	0	1	14.96	1	0
3-Syks	-	-	-	-	-	-	-	-
4-Wbin	.01	0	0	0	1	27.72	1	7.83
5-Tany	-	-	-	-	-	-	-	-
6-UnBr	-	-	-	-	-	-	-	-
7-MtAr	.03	0	.82	0	1	0	1	0
8-Wbor	-	-	-	-	-	-	-	-
9-Fred	.35	0	.07	0	1	9.37	1	0

Key:

Profit = $2,304,135
* = negligible
M = millions of dollars

E-Existing, A-Additional, GM-Grinding&Mixing, FT-Fertilizer Blending, WH-Warehous, SH-Showroom

TABLE 12 : Trucks used in Scenario 1, (Table 11)

ROLLING STOCK
(number used)

	1Hamp	2West	3Syks	4Wbin	5Tany	6UnBr	7MtAr	8Wbor	9Fred	Total
ABIGA	-	-	-	-	-	-	-	-	-	-
ECBTK	.71	.04	-	-	-	-	1.79	-	.34	2.88
ACBTK	-	-	-	-	-	-	-	-	-	-
EDPTK	3.34	3.82	-	.07	-	-	4.05	-	2.72	14
ADPTK	.79	-	-	-	-	-	-	-	-	.79
EGPTK	.01	.19	-	2.62	-	-	.43	-	.28	3.53
AGPTK	-	-	-	-	-	-	-	-	-	-
EFTBUG	.62	.05	-	-	-	-	3.65	-	.52	4.84
AFTBUG	-	-	-	-	-	-	-	-	-	-
ASEMI	-	-	-	-	-	-	-	-	-	-
ESPTK	-	*	-	-	-	-	.84	-	-	.84
ELMTK	-	-	-	-	-	-	-	-	-	-
EFTTK	-	-	-	-	-	-	-	-	-	-
ELQEQ	.18	.01	-	-	-	-	3.79	-	.03	4.01

Key:

* = negligible
- = zero

E-Existing, A-Additional, TK-TrucK, CB-Combination Bed, DP-Dual Purpose, GP-General Purpose, FT-FerTilizer, SP-SPray, LM-LiMe, LQEQ-LiQuid EQuipment

in profit was lost due to the change from optimal structure of the continuous solution. The change in structure was identical to that seen in the equal gross margin coefficient scenario. Mount Airy and others picked up the sales. From that scenario, the cause of profit decrease was probably due to losing Woodbine's high gross margin percentages. Frederick while picking up a lot of Woodbine's farm supply sales, was forced to increase its warehouse and showroom space considerably. All other storage and processing assets remained the same as in the continuous solution. The only change in rolling stock was a transfer of two trucks from use at Woodbine to Mount Airy. This scenario reaffirms: 1) the locational advantage of Mount Airy; 2) the gross margin effect of Woodbine; and 3) the ability to close several stores without an adverse affect on profit and sales.

4.5 Analysis Across Scenarios by Product

Most of the major results of the model have been discussed. In order to summarize the results of all runs with the least amount of repetition, Table 15 and Figure 11 have been prepared.

In general, the results showed that several (2 to 4) stores could be closed down without a loss in sales. The results as tabulated in Table 15 indicated that four stores (not always the same four) out of nine were all that was

TABLE 13 : Scenario 2, Close Stores Woodbine and Union Bridge, Thousands Dollars in Product Sales and Stores' Assets as a Percenatge of Capacity(SCN2)

SALES
(,000$)

Store	Bag Feed	Bulk Feed	Mixed Feed	Bag Fert	Bulk Fert	Lime	Seed	Farm Supp	TSAL
1-Hamp	9	2707	1	2	651	114	3	0	3.6M
2-West	632	1649	5	106	0	52	576	1160	4.4M
3-Syks	42	40	1	11	30	4	12	500	0.6M
4-Wbin	-	-	-	-	-	-	-	-	- M
5-Tany	27	17	0	0	0	0	0	0	* M
6-UnBr	-	-	-	-	-	-	-	-	- M
7-MtAr	2307	2198	5	530	2204	1	27	219	7.9M
8-Wbor	5	0	2	1	585	*	1	7	0.7M
9-Fred	850	849	147	97	41	67	290	2519	5.2M
TOTAL	3.9M	7.5M	0.2M	0.7M	3.5M	0.2M	0.9M	4.4M	22.4M

ASSETS
(% capacity)

Store	EGM	AGM	EFT	AFT	EWH	AWH	ESH	ASH
1-Hamp	.01	0	.30	0	1	0	1	0
2-West	.30	0	0	0	1	15.96	1	0
3-Syks	.01	0	.01	0	1	0	1	0
4-Wbin	-	-	-	-	-	-	-	-
5-Tany	0	0	0	0	1	0	1	0
6-UnBr	-	-	-	-	-	-	-	-
7-MtAr	.03	0	.75	0	1	0	1	0
8-Wbor	.01	0	.21	0	1	0	1	0
9-Fred	.35	0	.01	0	1	28.88	1	7.08

Key:

Profit = $2,218,982
* = negligible
M = millions of dollars

E-Existing, A-Additional, GM-Grinding&Mixing, FT-FerTilizer Blending, WH-WareHouse, SHowroom

TABLE 14 - Trucks used in Scenario 2, (Table 13)

ROLLING STOCK
(number used)

	1Hamp	2West	3Syks	4Wbin	5Tany	6UnBr	7MtAr	8Wbor	9Fred	Total
ABIGA	-	-	-	-	-	-	-	-	-	-
ECBTK	.57	-	.01	-	-	-	1.60	.11	.05	2.34
ACBTK	-	-	-	-	-	-	-	-	-	-
EDPTK	3.33	3.80	.06	-	.03	-	4.05	.01	2.72	14
ADPTK	.80	-	-	-	-	-	-	-	-	.80
EGPTK	.01	.24	.05	-	.04	-	1.91	.01	.28	2.54
AGPTK	-	-	-	-	-	-	-	-	-	-
EFTBUG	.50	-	.06	-	-	-	3.27	2.97	.08	6.88
AFTBUG	-	-	-	-	-	-	-	-	-	-
ASEMI	-	-	-	-	-	-	-	-	-	-
ESPTK	-	-	.02	-	-	-	.75	.52	-	1.29
ELMTK	-	-	-	-	-	-	-	-	-	-
EFTTK	-	-	-	-	-	-	-	-	-	-
ELQEQ	.15	-	.02	-	-	-	3.39	.12	-	3.68

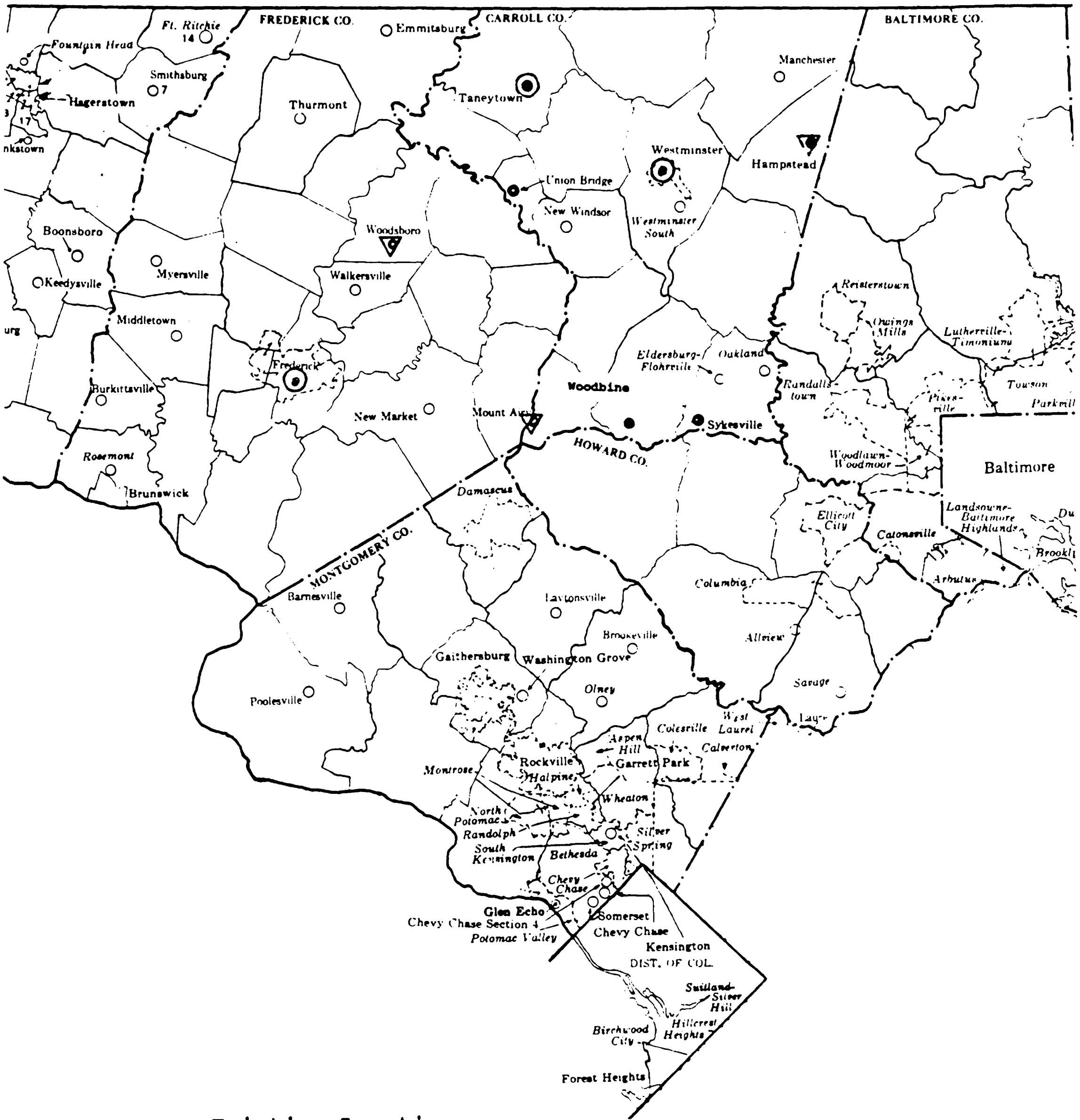
Key:

- = zero

E-Existing, A-Additional, TK-TrucK, CB-Combination Bed, DP-Dual Purpose, GP-General Purpose, FT-FerTilizer, SP-SPray, LM-LiMe, LQEQ-LiQuid EQuipment

TABLE 15 : Summary Table of Store Rankings by Product Sales

Scenario	1st	2nd	3rd	4th
Bag Feed				
Continuous-	Woodbine	Frederick	Mt. Airy	Westminster
Integer -	Woodbine	Frederick	Taneytown	Mt. Airy
E.Gross M.-	Mt. Airy	Frederick	Woodsboro	Woodbine
Scenario 1-	Woodbine	Frederick	Mt. Airy	Westminster
Scenario 2-	Mt. Airy	Frederick	Westminster	
Bulk Feed				
Continuous-	Hampstead	Mt. Airy	Westminster	Frederick
Integer -	Hampstead	Mt. Airy	Westminster	Frederick
E.Gross M.-	Frederick	Hampstead		
Scenario 1-	Hampstead	Mt. Airy	Westminster	Frederick
Scenario 2-	Hampstead	Mt. Airy	Westminster	Frederick
Mixed Feed				
Continuous-	Frederick	Westminster		
Integer -	Frederick	Taneytown	Westminster	
E.Gross M.-	Frederick	Woodsboro	Taneytown	Westminster
Scenario 1-	Frederick	Westminster		
Scenario 2-	Frederick			
Bag Fertilizer				
Continuous-	Woodbine	Mt. Airy	Frederick	Westminster
Integer -	Woodbine	Mt. Airy	Frederick	Westminster
E.Gross M.-	Mt. Airy	Hampstead	Woodsboro	UnionBridge
Scenario 1-	Woodbine	Mt. Airy	Frederick	Westminster
Scenario 2-	Mt. Airy	Westminster	Frederick	Sykesville
Bulk Fertilizer				
Continuous-	Mt. Airy	Hampstead	Woodsboro	
Integer -	Mt. Airy	Woodsboro	Hampstead	
E.Gross M.-	Mt. Airy	Hampstead	Woodsboro	
Scenario 1-	Mt. Airy	Hampstead	Woodsboro	
Scrnario 2-	Mt. Airy	Hampstead	Woodsboro	
Farm Supplies				
Continuous-	Woodbine	Frederick	Mt. Airy	UnionBridge
Integer -	Sykesville	Frederick	Mt. Airy	Woodbine
E.Gross M.-	Westminster	Sykesville	Frederick	Mt. Airy
Scenario 1-	Woodbine	Westminster	Frederick	Mt. Airy
Scenario 2-	Frederick	Westminster	Sykesville	Mt. Airy



● - Existing Locations

○ - Grinding & Mixing Locations

▽ - Fertilizer Blending Locations

FIGURE 11 : Summary Map of Processing Store Locations

necessary to sustain the baseline level of sales for each product.

Specifically, Figure 11 lists the overall locations which dominated across scenarios in the processing product lines. Mount Airy, Hampstead, and Woodsboro, as listed by Table 15, could support baseline levels of bulk fertilizer sales at a greater profit, through optimal location, gross margins, and cost structures. Likewise, Frederick, Westminster, and Taneytown could supply feed mixing services for the region.

In non-proccessing product lines, similar results were seen. Bulk products not mixed at the store, bulk feed and lime, resulted in equally as much consolidation. The main cause was enhanced gross margin percentages. Bagged products which have a higher commercial farm demand, such as bagged fertilizer and seeds, also consolidated but to a much lesser degree. The change of stores in the equal gross margin scenario as compared to the other scenarios leaves doubt as to the action needed with these two products.

In summary, the amount of consolidation and specialization is a function of product line and the amount of handling needed. This result occurred even with equal distance coefficients used across products. If these distance coefficients had differred by product spcecialization may have varied by product even more.

4.6 Conclusions

The use of all the scenarios, not one alone, lets a more informed decision be made as to the direction in which distribution structure should change. Of course the cooperative could not and should not put all recommendations of the model in place at once, but the results of the model help indicate direction.

Although some changes between models and scenarios are drastic, many of the results have a common thread. It is from this that implications can be derived and recommendations can be drawn. From the drastic changes between models, needs for future research can be drawn.

Although profit was noticeably higher in the optimal structure when compared to the baseline, was it a significant improvement? Probably not enough to immediately convert to that structure. The numbers may not be exact, and everything might be a little bit extreme, but when grinding and mixing facilities and fertilizer blending facilities deteriorate and need major renovation, these models give a suggestion to direct processing traffic. They give an indication what stores should increase showroom and farm supply promotions.

The solutions indicate which processing facilities should remain. If cooperatives are committed to providing these services, a specialized structure would be more profitable and probably provide better service.

Bulk fertilizer service was very stable throughout the scenarios. Mount Airy has a definite comparative advantage in this product line. Any Big A service center may want to be located there. The Mount Airy location also was preferred for bagged warehouse products. Any super store location would do good to locate there.

Specialization in bulk feed is warranted even with the lack of overhead and asset requirements. Stores the model indicates should sell no bulk feed, need not be forced out of business, but rather that store should guide the patron to calling the neighboring store specializing in bulk feed because they can give them more competitive pricing. Perhaps these major feed ordering stores could set prices and send them to the branch stores. There are many ways to ease into a store's specialization in that product line.

Union Bridge should be a store front. No more than two men and maybe one should be at that location. No processing, and no trucks of any kind. Although the model indicates no bagged feed should be sold at Union Bridge, that is mainly due to the restriction that it needs some trucking. Both bagged feed and fertilizer could be sold there but none should be trucked.

The consolidation of farm supplies and showroom activities should not be considered too strongly until coefficients associated with these sales can be developed further. High gross margins at Woodbine and perhaps too much of a shipping distance allowed for this product line could skew the results.

CHAPTER V

CONCLUSIONS

This research developed a technique to answer a general problem of cooperatives. Future work is needed to refine the actual coefficients pertaining to loyalty, potential, and economies of scale. Any decision of the kind addressed in this study should use this additional information regardless of the technique used. Rather than attack the many data requirements and develope a shallow model, this model was expanded to show what information is needed to make the model a real instrument for decision makers in cooperatives. The tool has been developed and weaknesses in it for analyzing an interrelated system such as a distribution structure have been identified. Suggestions have been made on how refinement of the model and further data collection might progress to improve upon it.

The model did not utilize the methods of Stollsteimer, rather, it more closely matched the workings of the marketplace and important relationships within the present distribution system. Both linear and integer programming were used to find the optimal structure under restrictions of discrete demand, fixed capacities, and linear cost relationships. The integer models improved the performance of the model, but were very costly for the added benefit.

The scenarios performed with this model, helped to better understand the workings of the distribution system and keys to increased profitability. Some of the findings included a need for specialization by product line. Specialization would put pricing control in one place and allow existing asset capacities to be more fully utilized. This would lead to increased gross margin dollars with the lowest cost expenditures. Specialization at locations where comparative advantages exist allows restructuing to increase profitability. Some of the changes suggested through the use of this model, should help retail cooperatives become more efficient, which in turn may help them maintain market share, and better serve their patrons.

5.0 Performance Summary of Objectives

This thesis was initiated to accomplish the objectives set down in the first chapter. Those five objectives can be summarized into three main areas; 1) Collection of pertinent store information, 2) Development of procedures incorporating key relationships, and 3) Deriving a result with implications to a cooperative decision-maker. None of these three areas were accomplished to perfection. Of these three items, the development of procedures was the one concentrated upon.

There were several reasons for this concentration. Very little previous work had been done in the area of cooperative retail restructuring. The main purpose of the procedures, however, was to attain the third objective of aiding in the restructuring decision. This could only be done properly by performing the first two objectives in a rigorous fashion. Properly performing the first two objectives would be an impossible task in a single study. A model complicated and powerful enough to characterize a distribution structure is often the full time activity of an operations research department.

The data needed to obtain realistic results must come from many phases of the retail operation. Inventory, credit, service, pricing, marketing, and a thousand other factors are performed by a retail operation. Records are kept in different forms, produced in many reports, handled by different departments, and even kept in different ways. The data currently collected was not collected with this kind of analysis in mind.

A model could have been developed using theoretical data and still have made a contribution. First hand data would require collection over time and much energy in coordinating the collection. This type of collection is a company task. The data used in this analysis was not theoretical or first hand, it originated from reports and memorandums commonly available within a cooperative.

5.1 Procedure Summary

Emphasis on the model and procedure development, helps a cooperative learn what records are needed to properly analyze restructuring of stores. The results provided from the model are valid in every way, but may not be exact. More importantly, the type of information available from the model's analysis allows the cooperative to decide if the potential result is worth the effort of increasing accuracy through collection of data. Proper development of the model allows it to be used in other regions and cooperatives by following its framework. This was more productive than concentrating on the Maryland case area.

There are many good and bad points within this work. Since procedures were emphasized, the three major strengths and weaknesses of the model are itemized below. Specifically, the general framework was solid.

The strengths are:

1) The use of a region profit maximization technique is the actual goal of cooperatives;

2) The use of zip codes to make revenue a discrete rather than continuous variable, more closely approximates real demand faced by locations;

3) The inclusion of both cost and revenue changes are a real consideration when closing a store.

The weaknesses are:

1) The cost relationships used do not reflect economies of size since it is a linear model.

2) Many of the fixed relationships with respect to different stores and volume levels are also not static as in a linear model.

3) The model is large and expensive, as well as cumbersome and unfriendly for a novice to use.

5.2 Data Summary

The deficiencies in data collection are solvable given the proper resources. One strength of the data used in this study is that it is readily available. More weaknesses are present in the data used than the procedures due to the area of concentration. One such fault lies in the division of zip code sales by product line, which had to be taken as a percent of the serving stores product mix. Another deficiency arises from costs not being kept for cost centers with their own operating statements. Costs are charged to a general account and not credited against any one or group of products or assets. Also the distance coefficients used do not really reflect what action consumers might take upon restructuring.

5.3 Implications Summary

The implications of this research were best summarized in Chapter 4. Cooperatives must look at the big picture when analyzing store restructuring. Little attention was given to the mico concept of how patron's attitudes would change. Even when using demand theory, analyzing how untried changes in structure would affect patron's loyalty to the cooperatives would be extremely difficult. Retail stores would argue the loyalty effect is large.

An old adage is applicable to cooperatives' current position in the market. It states "You can't be all things to all people", and cooperatives have tried. Competitors are taking over market share because of cooperative's inefficiency in the distribution system. Specialization through consolidation can better serve large farmers' needs. Large farmers must be coveted if enough volume is to be attained for cooperatives to remain as much of a force in the agriculture supply market as they have been in the past. A policy decision must be made as to whether the cooperative will sit the fence and slowly lose market share; or move towards serving smaller and larger farms in a separate manner; or concentrate on either larger or smaller farmers. It is possible that increasing effeceincy through consolidation will also help cooperatives better serve smaller farms in at least some product lines.

5.4 Needs for Future Research

Future research should attempt to decrease the weaknesses in both procedures and data. In the conclusions relating to procedures, three weaknesses were discussed. Correcting for linear cost relationships would require better data and a different algorithm to analyze non-linear relationships. Many of the relationships and the entire framework of the model would be unchanged. If this model was modified, the second weakness of static internal relationships could also be addressed. These relationships could be set up to change with volume as costs with volume changes.

The last stated weakness of the model, and perhaps its greatest, is ease of use. For better usability, this model could be condensed to one tenth of its present size with the assumption that only one store could service any one zip code. At that size, an enhanced micro-computer might be able to do the computations. A program from Scientific Press (VINO) designed to link with the spreadsheet from Lotus Development Corporation, would make an excellent way to solve this smaller matrix. Through Lotus spreadsheet data could be loaded and reports could be generated. Once the template was developed, the input format could be very user friendly and that input linked directly into the model. Correction of the first two procedural weaknesses by using non-linear programming would make this third correction difficult. Non-linear models require more time and space to solve for a solution and may expand the problem out of any micro-computers range.

Correction for the weakness in data are not incompatible like the corrections in procedure imperfections with mico-computer usage. Collection of product sales by zip code is already done in other cooperatives. Little time but some computer space would be needed to enhance the accuracy of the revenue potentials.

Collection and assignment of cost data is also within the cooperatives' grasp. Reports assigning costs to individual trucks were initiated in 1984. Unfortunately, these reports were inaccurate and not of a full year's length. Costs should also be assigned to processing and storage centers for this and other types of analysis. Southern States has just started putting mini-computers in the stores. This may help facilitate such record keeping.

The remaining data deficiency is distance coefficients for demand. Although some work has been done in this area, survey's fail to either differentiate by product or allow a distribution of responses to be made. A survey also may not be the way to check actual action in this case.

There is much good to be said for the accomplishments of this research. A framework has been developed from which further research can be done.

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APPENDIX A: QUESTIONAIRE

The following questionarie was sent to the nine store managers in charge of the stores in the study area by mail. One week later, the mailing was followed by a personal visit for 30 to 60 minutes in duration. The results of this questionaire are summarized in Appendix B.

RETAIL STORE INFORMATION

FACILITIES

Q-1 Capacity of Warehouse?

A. EXISTING.............................._______ SQ.FT.

B. Size of an ADDITIONAL unit ...._______ SQ.FT.

C. Total Cost of Additional unit........_______ $.

Q-2 Capacity of Showroom?

A. EXISTING.............................._______ SQ.FT.

B. Size of an ADDITIONAL unit ...._______ SQ.FT.

C. Total Cost of Additional unit........_______ $.

Q-3 Capacity for Grinding & Mixing?

A. EXISTING.............................._______ TONS / YR.

B. ADDING CAPACITY THOUGH INVESTMENT...._______ TONS / YR.

C. TOTAL COST OF ADDITION..............._______ $.

Q-4 Capacity of Fertilizer Blending?

A. EXISTING.............................._______ TONS / YR.

B. ADDING CAPACITY THOUGH INVESTMENT...._______ TONS / YR.

C. TOTAL COST OF ADDITION..............._______ $.

Q-5 Number of Vehicles?

A. Feed Trucks........................._______ ?

B. Fertilizer Trucks..................._______ ?

C. Lime Trucks........................._______ ?

D. Fertilizer Buggies.................._______ ?

E. Combination Bed Fertilizer Trucks..._______ ?

F. Spray Rigs.........................._______ ?

Q-6 <u>Average Ton Capacity per Year?</u>

A. One Existing Feed Truck................ ________ Tons?

B. One New Feed Truck..................... ________ Tons?

C. One New Feed Semitrailer............... ________ Tons?

D. One Existing Fertilizer Truck.......... ________ Tons?

E. One New Fertilizer Truck............... ________ Tons?

F. One New Big A.......................... ________ Tons?

G. One Existing Lime Truck................ ________ Tons?

H. One New Lime Truck..................... ________ Tons?

I. One New Lime Big A..................... ________ Tons?

J. One Fertilizer Buggy................... ________ Tons?

K. One Combination Bed Fertilizer Truck... ________ Tons?

L. One Spray Rig.......................... ________ Acres?

Q-7 The above capacities are relative to the average distance hauled to the patrons. How would these capacities change if all the sales were within X miles? (circle either decrease or increase).

A. 6 miles.............decrease/increase..... ______ % ?

B. 6 & 12 miles.........decrease/increase..... ______ % ?

C. 12 & 17 miles.......decrease/increase..... ______ % ?

D. 17 & 23 miles.......decrease/increase..... ______ % ?

Q-8 The Makeup of Feed Trucking (Include delivery charges if billed as Feed Trucking Revenue).

A. Percent of Bag Feed delivered by your trucks?

_________% at __________$ per ton.

B. Percent of Custom Feed delivered by your trucks?

_________% at __________$ per ton.

C. Percent of Bulk Feed delivered by your trucks?

_________% at __________$ per ton.

D. Percent of Bulk Feed Hauled by the Regional Mill?

_________% at __________$ per ton.

Q-9 Makeup of Fertilizer Spreading?(include charges if billed as separate Revenue section).

A. Percent of Bulk Fertilizer spread by your trucks?

_________% at __________$ per ton.

B. Percent of Bulk Fertilizer spread by rental equipment?

_________% at __________$ per ton.

C. Percent of Bulk Fertilizer trucked?

_________% at __________$ per ton.

D. Percent of Bagged Fertilizer spread by rental equipment?

_________% at __________$ per ton.

E. Percent of Bagged Fertilizer trucked?

_________% at __________$ per ton.

Q-10 <u>MAKEUP OF LIME SPREADING?</u>

A. Percent of Lime sold and spread by your trucks?

_______% at __________$/ton and ________% Gross Margin.

B. Percent of Lime contracted and spread from outside?

_______% at __________$/ton and ________% Gross Margin.

Q-11 <u>MAKEUP OF CHEMICAL APPLICATION?</u>

A. Percent of Chemicals sold and applied by your trucks?

_______% at __________$/acre and ________% Gross Margin.

Q-12 <u>RATIOS</u>

A. There are ________ Custom Ton(s) to every __________ Regional Ton(s).

B. There are ________ Custom Ton(s) to every __________ Ton(s) Stored and and Dryed.

C. There are ________ Fertilizer ton(s) spread per Acre?

D. There are ________ Chemical dollars applied per Acre?

Q-13 <u>COMPOSITE PRICES OF PRODUCTS AND SERVICES</u> <u>82</u> <u>83</u> <u>84</u>

A. Bag Feed............. _____,_____,_____ $ / Ton.

B. Bulk Feed............ _____,_____,_____ $ / Ton.

C. Bag Fertilizer....... _____,_____,_____ $ / Ton.

D. Bulk Fertilizer...... _____,_____,_____ $ / Ton.

E. Spread Lime.......... _____,_____,_____ $ / Ton.

F. Grinding and Mixing.. _____,_____,_____ $ / CWT.

G. Storing & Drying..... _____,_____,_____ $ / Ton.

H. Chemicals (applied).. _____,_____,_____ $ / Acre.

Q-14 DELINIATING OPERATIONAL COSTS.

A. Utilities Expense can be assigned to the following as a percentage of:

Custom Feed Tons?.................... _________%.

Bulk Fertilizer Tons?................ _________%.

All others?.......................... _________%.

TOTAL.................... 100 %.

B. Repair Expense can be assigned to the following as a percentage of:

Fixed Assets (Non-rolling stock)?... _________%.

Rolling Stock (Trucks)?............. _________%.

TOTAL.................... 100 %.

C. Taxes and Licenses can be assigned to the following as a percentage of:

Fixed Assets (Non-rolling stock)?... _________%.

Rolling Stock (Trucks)?............. _________%.

TOTAL.................... 100 %.

D. Wage Expense can be assigned to the following as a percentage of:

Feed Warehousing.................... ________%.
Fertilizer Warehousing.............. ________%.
Seed Warehousing.................... ________%.
Farm Supply Warehousing............. ________%.
Showroom Activity................... ________%.
Feed Grinding and Mixing............ ________%.
Fertilizer Blending................. ________%.
Fertilizer Trucking................. ________%.
Feed Trucking....................... ________%.

TOTAL.................... 100 %.

APPENDIX B: SURVEY TABULATION

This Appendix provides a summary for the questionaire in Appendix A. The information was used in all phases of the model. Product tableaus in Appendix L use this data summary to indicate where and how the data was used. In the modeling missing responses took on the average value of that question from the responding stores.

SURVEY TABLULATION

		FRED9	W'BORO8	TANEY5	MT.AIRY7	W'BINE4	UB6	WESTM2	HAMP1	SYKES3	TOT/AVG
Q-1:5	FACILITIES										
1A	EXISTING Square Feet of Warehouse?	6000	7000	15000	11000	3000	2200	7000	7000	10000	
1B	ADDITIONAL warehouse expansion?	5600	0	3000	0	3000	0	0	21000	0	
1C	Appoximate expansion COST?	20000	0	.	0	.	0	0	700000	0	
2A	EXISTING Square Feet of Showroom?	3000	2500	900	875	1200	600	4640	1200	2000	
2B	ADDITIONAL SQ.FT. of Showroom?	0	0	2400	875	800	0	0	10000	0	
2C	Appoximately how much would this addition cost?	0	0	150000	50000	6000	0	0	400000	0	
3A	EXISTING Ton Capacity/Year of Grnd & Mix fac.?	26280	10000	13000	10000	6500	13000	17500	8500	5000	
3B	ADDITIONAL Grnd & Mix Capacity w/ Investment?	0	0	13000	0	0	0	0	12000	15000	
3C	What Approximate COST for that expansion?	0	0	10000	0	0	0	0	300000	5000	
4A	EXISTING Ton Capacity/Year of Blnd Fert. fac.?	21900	10000	10000	10000	0	10000	10000	10000	10000	
4B	ADDITIONAL Blnd Fert. Capacity w/ Investment?	0	0	0	0	0	0	0	20000	0	
4C	What Approximate COST for that expansion?	0	0	0	0	0	0	0	100000	0	
5A	Number of Bulk Feed Trucks?	3	1	2	1	1	1	2	1	2	14
5B	Number of Fertilizer Trucks?	2	1	0	2	0	0	2	0	2	9
5C	Number of Lime Trucks?	0	0	0	2	0	0	1	0	0	3
5D	Number of Buggies?	8	8	11	3	0	3	7	5	6	51
5E	Number of Combination Trucks?	2	0	0	2	0	1	1	2	0	8
5F	Number of Spray Rigs?	2	2	0	0	0	0	1	0	1	6
5G	Number of Delivery Trucks?	4	1	7	1	1	0	3	1	4	22
5H	Number of All-purp Trucks?	1	1	1	1	1	1	0	1	1	8
5I	Number of Tenders?	1	0	0	0	0	0	1	0	0	2
5J	Number of Nitro Applicators?	2	1	3	1	0	2	2	4	1	16
5K	Number of Nurse Tanks?	16	2	1	1	0	1	7	4	3	35
Q-6	AVERAGE CAPACITY										
6A	Existing Feed Truck	4000	7000	8000	4750	5200	13000	4500	10000	3000	6600
6B	New Feed Truck	6000	10000	8000	4750	.	.	.	10000	.	6600
6C	Semi Trailer	5688	.	.	.	.	.	.	.	6000	6000
6D	Existing Fert. Truck	1000T	2000T	CB	CB	.	CB	2500T	CB	2400T	2000
6E	New Fert. Truck	4500T	.	.	.	.	.	.	.	2400T	3000
6F	Big A	.	.	.	.	.	.	.	.	.	
6G	Existing Lime Truck	.	.	.	.	.	.		.	5000T	
6H	New Lime Truck	.	.	.	.	.	.	4500T	.	.	
6I	New Lime Big A	.	.	.	.	.	.	.	.	.	
6J	Fertilizer Buggy	200T	800T	1200T	1000T	.	700T	300T	1200T	1000T	800
6K	Combination Bed	1500T	.	15000A	3000T	.	6000T	2500T	20000A	.	14000A
6L	Spray Rig	.	.	12000A	2200A	.	.	1000A	10000A	3000A	
6M	Tender	.	.	.	.	.	.	.	.	.	
6N	Nitro Applicator	.	900A	6000A	.	.	.	.	5000A	2400A	

		FRED9	W'BORO8	TANEY5	MT.AIRY7	W'BINE4	UB6	WESTM2	HAMP1	SYKES3	1/AVG
Q-7	Change in Capacity										
7A	If all sales were w/in 6 miles	1.1	1.0	1.2	1.50	1	1	1.1	1.2	1.25	0.8696
7B	If all sales were between 6 & 12 miles	1.05	0.89	1.0	1.25	0.83	0.89	1.03	1.05	1.0	1.0011
7C	If all sales were between 12 & 17 miles	1.0	0.78	0.81	1.0	0.67	0.78	0.97	0.90	0.75	1.0393
7D	If all sales were between 17 & 23 miles	0.95	0.67	0.62	0.75	0.5	0.67	0.90	0.75	0.50	1.4263
Q-8											
8A1	Percent Bag Feed Delivered	10%	12.5%	50%	20%	33%	5%	10%	25%	25%	
8A2	If revenue, then charge/ton	$8	$6	$5	$8	.	$8	.	$7	.	$7
8B1	Percent Custom Feed Delivered	80%	45%	75%	15%	10%	40%	100%	75%	25%	
8B2	If revenue, then charge/ton	$8	$5	$5	$8	.	$5	.	.	.	$6.2
8C1	Percent Bulk Feed Delivered	98%	15%	100%	100%	100%	5%	100%	95%	100%	
8C2	If revenue, then charge/ton	$8	.	$7	.	.	$5	.	$7	.	
8D1	Percent Bulk Feed Regional Delivered	0%	85%	0%	0%	0%	95%	0%	5%	0%	
8D1	If revenue, then charge/ton	.	.	.	.	.	$11.	.	$11	.	
Q-9											
9A1	Percent Dry Bulk Fertilizer Spread	70%	10%	10%	60%	.	35%	60%	60%	25%	41%
9A2	If revenue, then charge/ton	$18/T	$5/A	$5/A	$4.5/A	.	$5/A	.	$4.5/A	.	$4.75/A
9B1	Percent Dry Bulk Fetilizer Equip.	30%	80%	70%	35%	.	60%	30%	15%	35%	44%
9B2	If revenue, then charge/ton	$6/T	$6/T	$5/T	$4.5/T	.	$5/T	.	$4.5/T	.	$5.15/T
9C1	Percent Dry Bulk Fertilizer Trucked	.	.	.	.	.	.	5%	.	5%	
9C2	If revenue, then charge/ton										
9D1	Percent Bagged Fertilizer Trucked	3%	50%	33%	20%	.	5%	10%	30%	30%	23%
9D2	If revenue, then charge/ton	$6/T	$6/T	$5/T	$8/T	.	$6/T	.	$7/T	.	$6
9E1	Percent Liquid Fertilizer thru Equip Rent	.	5%	5%	10%	.	15%	5%	10%	10%	10%
9E2	If revenue, then charge/ton	.	.	$1.65/A	$1.5/A	.	.	$1.5/A	$1.5/A-NC	.	$1.5
9F1	Percent Liquid Fertilizer Spread	100%	95%	90%	85%	.	35%	80%	70%	60%	75%
9F2	If revenue, then charge/ton	.	$5/A	$5/A	$4.5/A	.	.	$5/A	$5/A	.	$5
Q-10											
10A1	Percent Lime Spread	0%	100%	0%	100%	100%	90%	90%	0%	20%	
10A2	If revenue, then charge/ton	.	.	.	.	.	.	.	.	.	
10B1	Percent Lime contracted out	100%	0%	100%	0%	0%	5%	10%	100%	80%	
10B2	If revenue, then charge/ton	.	.	.	.	.	.	.	.	.	
Q-11											
11A1	Percent Chemicals Applied	95%	90%	75%	72%	.	60%	70%	70%	30%	
11A2	If revenue, then charge/ton	$5/A	$5/A	$5.5/A	$4.5/A	.	$5/A	.	$5/A	.	
11B1	Percent Chemicals thru Equip Rent	.	0%	10%	10%	.	35%	5%	5%	5%	
11B2	If revenue, then charge/ton	.	.	$1.65/A	$1.5/A	.	.	$1.5/A	$1,5/A	.	

		FRED9	W'BORO8	TANEY5	MT.AIRY7	W'BINE4	UB6	WESTM2	HAMP1	SYKES3	AVG.
Q-12											
12A	Custom to Regional Feed Ratio	75%C	20%C	90%C	20%C	43%C	50%C	50%C	71%C	17%C	
12B	STD Tons to GM Tons Ratio	3.33	1.67	0.33	0.5	0.1	0.5	0.6	0.2	0.5	
12C	Bulk Fert. Tons to Acres Ratio	500#/A	300#/A	300#/A	425#/A	.	500#/A	500#/A	400#/A	300#/A	400#/A
12D	Chemical $ to Acres Ratio	30$/A	30$/A	20$/A	27.5$/A	.	40$/A	20$/A	40$/A	25$/A	$30./A
12E	Liquid Fert. $ to Dry Fert.	10%L	40%L	20%L	44%L	.	40%L	.	25%L	50%	33%
Q-13											
13A	Composite Bag Feed Price/ Ton 82,3,4	260	205	210	210	230	190	225	180	200	$212
13B	Composite Bulk Feed Price/ Ton 82,3,4	200	175	180	175	210	155	160	210	180	$183
13C	Composite Bag Fertilizer Price/ Ton	160	177	163	165	150	155	140	140	150	$155
13D	Composite Bulk Fertilizer Price/Ton	122	125	190	160	.	175	160	200	180	$164
13E	Composite Lime Price/ Ton HAULED?	.	20.5	.	22	21	13.4	18.5	.	22.5	$20.5
13F	Composite Lime Price/ Ton OUTSIDE?	21.8	.	19.4	.	.	19.5	18.5	19	22.5	
13G	Composite Price/ CWT of Grinding and Mixing/CWT	0.80	1.0	0.50	0.80	0.95	0.70	0.70	0.65	1.00	
13H	Composite Price/ Ton of Storing and Drying/T	.	9.0/T	14/T	4.25/T	3.4/T	3.5/T	7.6/T	4.8/T	.	6.6/T
Q-14											
14A1	Utilities XP related to Custom Feed	70%	30%	60%	60%	40%	50%	60%	48%	.	
14A2	Utilities XP related to Blended Fert.	10%	20%	20%	30%	.	30%	30%	40%	.	
14A3	Utilities XP related to Other Whse Activities	20%	50%	20%	10%	60%	20%	10%	12%	.	
14B1	Repair XP related to Whse	2%	10%	2%	15%	?5%	?20%	5%	5%	.	
14B2	Repair XP related to Shrm	4%	10%	2%	10%	?5%	?20%	5%	5%	.	
14B3	Repair XP related to Custom Feed	20%	30%	6%	15%	?5%	?20%	20%	20%	.	
14B4	Repair XP related to Blended Fert.	14%	40%	40%	20%	?5%	?20%	10%	30%	.	
14B5	Repair XP related to Total Trucking	40%	TXP	50%	40%	80%	20%	60%	50%	.	

APPENDIX C : OTHER DATA

Question 15 and 16 were gathered from a data tape, which included all stores financial records from 1981 to 1983. Question 17 was measured on a map. Question 18 and 19 came from Uni-Group reports covering 1984 provided by Southern States.

DATA FROM DATA SET		FRED.9	W'BORO.8	TANEY.5	MT.AIRY7	W'BINE4	UB.6	WESTM. 2	HAMP.1	SYKES3	AVG.
Q-15	EXPENSES										
15A	Advertising XP as % of TSales	.0026	.0032	.0047	.0053	.0069	.0022	.0023	.0024	.0040	
15B	Bad Debt XP as % of TSales	.0067	.0035	.0032	.0024	.003	.001	.0001	.0004	.0025	
15C	Other XP as % of TSales	.016	.020	.021	.021	.029	.019	.019	.018	.020	
15D	Utility XP in 1983	50K	12K	11K	6K	7K	5K	31K	10K	16.5K	16.5K
15E	Repair XP in 1983	30K	15K	26K	15K	6K	10K	18K	10K	16K	16K
15F	Total Sales in 1983	4.64M	2.78M	2.65M	2.17M	0.94M	1.25M	2.84M	2.58M		
Q-16	GROSS MARGIN PERCENT										
16A	Bag Feed	12.2	10.2	12.4	12.8	15.2	11.2	16.2	14.1	13.0	
16B	Bulk Feed	15.9	8.6	13.8	16.4	13.7	15.4	17.4	17.0	14.7	
16D	Bag Fertilizer	22.3	17.1	16.1	21.3	24.5	16.7	20.6	17.5	19.5	
16E	Bulk Fertilizer	20.1	21.5	21.4	20.0	8.9	17.9	19.5	19.5	18.6	
16F	Lime (Spread Self)	7.5	8.0								
16G	Seed	23.6	19.2	16.7	22.4	24.6	18.6	27.2	19.4	21.3	
16H	Farm Supply	24.6	20.4	18.1	22.3	26.6	22.2	24.0	14.8	21.4	
Q-17	DISTANCE TO BALTIMORE	47	42	42	33	28	45	31	27	26	
Q-18	DEPRECIATION										
18A	Depr. XP related to Custom Feed	17,997	18,953	6,332	36	1591	104	6,750	590	6,544	6,544
18B	Depr. XP related to Blended Fert.	11,849	6,465	4,672	324	187	6288	9,622	6,510	5,740	5,740
18C	Depr. XP related to Showroom	4,253	4,797	3,588	2860	519	512	7,430	2,062	3,510	3,510
18D	Depr. XP related to Warehouse	3,741	1,901	2,480	1764	187	312	4,094	2,262	2,093	2,093
18E	Depr. XP related to Spray Truck	209									
18F	Depr. XP related to General Purpose Truck	548									
18G	Depr. XP related to Dual Purpose Feed Trucks	1152									
18H	Depr. XP related to Combination Bed Fert. Trucks	815									
18I	Depr. XP related to Liquid Equipment	111									
18J	Depr. XP related to Straight Fertilizer Trucks	1369									
18K	Depr. XP related to Fertilizer Buggies	108									
Q-19	OPPORTUNITY COST										
19A	11% of Book Value of Custom Feed	12,166	13,594	4,714	18	609	134	2,841	279	4,294	4,294
19B	11% of Book Value of Blended Fert.	9,495	4,754	1,182	178	244	1670	3,986	2,252	2,970	2,970
19C	11% of Book Value of Showroom	6,612	6,305	2,846	2,966	471	352	14,782	1,761	4,496	4,496
19D	11% of Book Value of Warehouse	6,482	1,816	2,172	576	244	226	6,991	3,338	2,746	2,746
19E	11% of Book Value of Spray Truck	57									
19F	11% of Book Value of General Purpose Truck	103									
19G	11% of Book Value of Dual Purpose Feed Trucks	558									
19H	11% of Book Value of Combination Bed Fert. Trucks	48									
19I	11% of Book Value of Liquid Equipment	13									
19J	11% of Book Value of Straight Fertilizer Trucks	282									
19K	11% of Book Value of Fertilizer Buggies	35									

APPENDIX D : TIMBERLAKE BUDGET 1984

These budgets represent the additional truck expenses used in the model. Also non-depreciation and opportunity cost values were used for existing trucks.

COST ANALYSIS

Type Equipment: Fertilizer Spreader Truck (Diesel) w/Newton Crouch Body

Cost: $32,625 Average

Expenses:

Depreciation	7 Yrs.	$ 4,661	
Interest	12%	3,915	
Taxes & Licenses		852	(1)
Insurance	5%	1,631	(2)
Repairs	4%	1,305	
Gasoline, Oil, Grease		9,850	(3)
Labor & Fringe Benefits (one man)		9,633	(4)
Total Expenses		$31,847	
Plus 15% R.O.I. (15% of Cost less Interest)		979	
Profitability Income Needed		$32,826	

Income and Usage:

6369.4 acres annually @ $5.00 per acre = $31,847 covers expenses
6565.2 acres annually @ $5.00 per acre = $32,826 covers expenses & R.O.I.

Variable use effect on unit cost:

2000 acres annually @ $15.92 per acre = $31,847 covers expenses
4000 acres annually @ $ 7.96 per acre = $31,847 covers expenses
7000 acres annually @ $ 4.55 per acre = $31,847 covers expenses
7000 acres annually @ $ 4.69 per acre = $32,826 covers expenses & R.O.I.

Remarks:

(1) Taxes and Licenses - Based on $2.00 per $100 property tax and $200 for licenses. Varies from state to state and counties or cities within state.

(2) Insurance - Based on average for operating territory. Kentucky has highest rates; Virginia, lowest. Other factors affecting rates - weight, use, age, and location.

(3) Fuel - Based on 150 days use - 50 gal. per day at $1.20 per gallon and $300 for oil and grease annually, tires $550 = $9,850.

(4) Labor - Based on 1 man $4.75 per hour for 9 months plus 30% fringe benefits.

FIXED COST ANALYSIS

Type Equipment: Fertilizer Tender Body (Webster, etc.)
Cost: $4,550 Average

Expenses:

Depreciation	7 Yrs.	$ 650
Interest	12%	546
Taxes and Licenses	2%	91
Insurance	1%	46
Repairs	4%	182
Total Expenses		$1,515
Plus 15% R.O.I. (15% of Cost less Interest)		$ 136
Profitability Income Needed		$1,651

Income or Usage:

216.4 tons annually @ $7.00 per ton = $1,515 covers expenses
235.9 tons annually @ $7.00 per ton = $1,651 covers expenses & R.O.I.

43.3 days rental @ $35 per day = $1,515 covers expenses
47.2 days rental @ $35 per day = $1,651 covers expenses & R.O.I.

Variable use effect on unit cost:

100 tons @ $15.15 per ton = $1,515 covers expenses
200 tons @ $ 7.58 per ton = $1,515 covers expenses
300 tons @ $ 5.05 per ton = $1,515 covers expenses

COST ANALYSIS

Type Equipment: Liquid Nitrogen 1000 Gal. Nurse Tank
Cost: $2.385 Average

Expenses:

Depreciation	10 Yrs.	$ 239
Interest	12%	286
Taxes & Licenses	2%	48
Insurance	1%	24
Repairs	2%	48
Total Expenses		$ 645
Plus 15% R.O.I. (15% of Cost less Interest)		$ 71.55
Profitability Income Needed		$ 763

Income or Usage:

161.2 tons annually @ $4.00 per ton = $645 covers expenses
190.7 tons annually @ $4.00 per ton = $763 covers expenses & R.O.I.

Variable use effect on ton cost:

50 tons annually @ $12.90 per ton = $645 covers expenses
100 tons annually @ $ 6.45 per ton = $645 covers expenses
150 tons annually @ $ 4.30 per ton = $645 covers expenses
200 tons annually @ $ 3.22 per ton = $645 covers expenses

COST ANALYSIS

Type Equipment: Liquid Nitrogen Applicator
John Blue Applicator w/400 tank
Cost: $5,900 Average

Expenses:

Depreciation	10 Yrs.	$ 590
Interest	12%	708
Taxes & Licenses	2%	118
Insurance	1%	59
Repairs	4%	236
Total Expenses		$1,711
Plus 15% R.O.I. (15% of Cost less Interest)		$ 177
Profitability Income Needed		$1,888

Income and Usage:

103.7 acres @ $1.65 per acre = $1,711 covers expenses
114.4 acres @ $1.65 per acre = $1,888 covers expenses & R.O.I.

COST ANALYSIS

Type Equipment: Bulk Feed Truck (Diesel - Auger Type)
Cost: $36,135 Average

Expenses:

Depreciation	7 Yrs.	$ 5,162	
Interest	12%	4,336	
Taxes and Licenses		922	(1)
Insurance	5%	1,807	(2)
Repairs	4%	1,445	
Gasoline, Oil, Grease		6,065	(5)
Labor & Fringe Benefits		12,168	(4)
Total Expenses		$31,905	
Plus 15% R.O.I.			
(15% of Cost less Interest)		$ 1,084	
Profitability Income Needed		$32,989	

Income or Usage:

3191 tons annually @ $10.00 per ton = $31,905 covers expenses
3299 tons annually @ $10.00 per ton = $32,989 covers expenses & R.O.I.

Variable use effect on unit cost:

1200 tons annually @ $26.59 per ton = $31,905 covers expenses
2400 tons annually @ $13.29 per ton = $31,905 covers expenses
3000 tons annually @ $10.64 per ton = $31,905 covers expenses
3000 tons annually @ $11.00 per ton = $32,989 covers expenses & R.O.I.

Remarks:

(1) Taxes & Licenses - Based on $2.00 per $100 property tax and $200 for licenses. Varies from state to state and counties or cities within state.

(2) Insurance - Based on average for operating territory. Kentucky has highest rates; Virginia, lowest. Other factors affecting rates: weight, use, age, and location.

(3) Cost - Average cost for bulk truck with pneumatic unloading system - $39,525

(4) Labor - Based on one man 40 hours per week @ $4.50 plus 30% fringe benefits.

(5) Diesel Fuel - Based on 120 miles per day @ 7 miles per gallon @ $1.20 fuel cost plus oil and grease and tires.

(a) 17.1 gallons diesel fuel @ $1.20 per gal. = $20.52 per day x 260 working days annually = $5,335.

(b) 6 servicings @ $30.00 each, tires $550 = $730.

FIXED COST ANALYSIS

Type Equipment: 5 Ton Spreader Buggy for Fertilizer and Lime
Cost: $6,760 Average

<u>Expenses</u>:

Depreciation	5 Yrs.	$ 1,352
Interest	12%	811
Taxes and Licenses	2%	135
Insurance	1%	68
Repairs	3%	203
Total Expenses		$ 2,569
Plus 15% R.O.I. (15% x $6,760 = $1,014 - Int. $811)		203
Profitability Income Needed		$ 2,772

<u>Income</u>:

380.6 tons @ $6.75 per ton = $2,569 covers expenses
410.6 tons @ $6.75 per ton = $2,772 covers expenses & gives 15% R.O.I.

102.8 1/2 days rental @ $25 per 1/2 day = $2,569 covers expenses
110.9 1/2 days rental @ $25 per 1/2 day = $2,772 covers expenses & gives 15% R.O.I.

Variable use effect on unit cost:

100 tons @ $25.69 per ton = $2,569
200 tons @ $12.84 per ton = $2,569
300 tons @ $ 8.56 per ton = $2,569
400 tons @ $ 6.42 per ton = $2,569

500 acres @ $5.14 per acre = $2,569
1000 acres @ $2.57 per acre = $2,569
1350 acres @ $1.90 per acre = $2,569
1557 acres @ $1.65 per acre = $2,569

APPENDIX E : TIMBERLAKE BUDGET 1983

The following budgets were used for expenses relating to inventory, specifically taxes and insurance. Also required floorspace for inventory was calculated by dividing warehouse and showroom space into average inventory.

Feed Operational Cost - Per Inventory Value

Inventory Carrying Cost	Cost	
$1,000,000 feed sales	Interest	13%
10% margins	Insurance	.25%
$ 100,000 margins	Taxes	.75%
900,000 cost of goods sold	Miscellaneous	6%
17 inventory turns	Deterioration	
53,000 average inventory	Obsolescence	
	Theft, Shoplifting	
	Handling	
		20%

.20 x 53,000 = 10,600

$\frac{10,600}{53,000}$ = 20¢ per $ inventory value

Facility Cost		Facility Carrying Cost	
Bulk feed station	$ 15,000	Interest	13%
Warehouse 40' x 50' - 2000 sq. ft. @ $15 =	30,000	Insurance	1%
		Taxes	1%
Salesroom and Office 400 sq. ft. @ $40 =	16,000	Repairs	5%
		Depr.	5%
Est. Facility Cost	$ 61,000		25%

.25 x 61,000 = $15,250

$\frac{15,250}{53,000}$ = 29¢ per $ inventory value

Labor	Cost
5.6% of sales = $56,000 (adm. & sales - $20,000) (handling - 3 men $36,000)	$\frac{\$56,000}{53,000}$ = $1.05 per $ inventory value

Administrative and Others	Cost	
	1% adm. x $1,000,000	$10,000
	13% Int. A/C x 111,000 (90% chgs. = $900,000 on book for 45 days	14,430
	.002 Bad Debt	2,000
	.001 Adv.	1,000
		27,430

$\frac{27,430}{53,000}$ = $.52 per $ inventory value

$2.06 per $ inventory value

FERTILIZER OPERATIONAL COST - PER INVENTORY VALUE

Inventory Carrying Cost		Cost	
$1,000,000 sales		Interest	13%
18% margin		Insurance	.25%
$ 180,000 margin		Taxes	.75%
820,000 cost of goods sold		Miscellaneous	
4.5 inventory turns		Shrinkage, damage, etc.	3%
182,222 average inventory value			17%
		.17 x 182,222 = $30,977	
		$\frac{30,977}{182,222} = \$.17$	
		$.17 per $ invevtory value	

Facilities		Cost	
1600 tons		Interest	13%
1000 tons bulk building @ $50	$50,000	Depreciation	10%
		Insurance	1%
400 ton K_2O slab	6,000	Taxes	1%
100 ton liquid	8,000	Repairs	5%
100 ton bagged warehouse			30%
20' x 50' = 1000 sq. ft.			
@ $15	15,000	.29 x $79,000 = $23,700	
	$79,000		
		$\frac{23,700}{182,222} = \$.13$	
		$.13 per $ inventory vaule	

Labor	Cost
6.8% of sales = $68,000	$\frac{68,000}{182,222} = .372$ or .37
(Adm. & sales $20,000)	
(Handling - 4 employees - $48,000)	
	$.37 per $ inventory value

Administrative and Other Expenses	Cost	
	1% adm. x $1,000,000	$10,000
	Acct/Rec 13% interest x $110,958 (90% of sales charged and carried for 45 days)	14,424
	.002 Bad Debt	2,000
	.001 Adv.	1,000
		$27,424
	$\frac{27,424}{182,222} = \$.15$	
	$.15 per $ inventory value	

$.82 per $ inventory value

SEED OPERATIONAL COST - PER INVENTORY VALUE

Inventory Carrying Cost	Cost	
$300,000 sales	Interest	13%
19% margin	Insurance	.25%
$ 57,000 margin	Taxes	.75%
243,000 cost of goods sold	Miscellaneous	6%
6 turns	Shrinkage	
40,500 average inventory	Handling	
	Obsolescence, etc.	
		20%
	$.20 per $ inventory value	

Facility		Cost	
Warehouse 40' x 30' =		Depreciation	5%
1200 sq. ft. @ $15 =	$18,000	Interest	13%
Salesroom and Office		Insurance	1%
400 sq. ft. @ $40 =	$16,000	Taxes	1%
	$34,000	Repairs	5%
			25%

.25 x $34,000 = $8500

$\frac{8500}{40500}$ = $.21 per $ inventory value

Labor	Cost
6% of sales = $18,000 (6% x 300,000 = $18,000)	$\frac{18,000}{40,500}$ = $.44 per $ inventory value

Administrative and Other Expenses	Cost	
	Adm. 1% x $300,000	$3,000
	Acct/Rec 13% interest x $33,288 (90% of sales charged and carried for 45 days)	4,327
	.002 Bad Debt x $300,000	600
	.001 Advertising x $300,000	300
		$8,227

$\frac{8,227}{40,500}$ = $.20 per $ inventory value

$1.05 per $ inventory value

FARM SUPPLIES OPERATIONAL COST - PER INVENTORY VALUE

Inventory Carrying Cost		Cost	
$400,000 sales		Interest	13%
· 18% margin		Insurance	.25%
72,000 margin		Taxes	.75%
328,000 cost of good sold		Miscellaneous	6%
2 inventory turns		Shrinkage	
164,000 average inventory		Obsolescence	
		Handling, etc.	
			20%
		$.20 per $ inventory value	

Facility Cost		Cost	
Salesroom - 4000 sq. ft.		Depreciation	3%
@ $40	$160,000	Interest	13%
Warehouse - 2000 sq. ft.		Insurance	1%
@ $15	30,000	Taxes	1%
	$190,000	Repair	1%
			19%

.19 x $190,000 = $36,100

$$\frac{36,100}{164,000} = \$.22$$

$.22 per $ inventory value

Labor

10% of sales (400,000) = $40,000

Cost

$$\frac{40,000}{164,000} = \$.24$$

$.24 per $ inventory value

Administrative and Other Expenses	Cost	
	Adm. 1% x $400,000	$ 4,000
	Acct/Rec. 13% x 44,383 (90% of sales charged and carried for 45 days)	5,670
	.2% Bad Debt ($400,000)	800
	.1% Adv. ($400,000)	400
		$10,870

$$\frac{10,872}{164,000} = \$.066 \text{ or } .07$$

$.07 per $ inventory value

$.73 per $ inventory value

APPENDIX F : BIG A BUDGET

Provided by Region 2 operations staff. Capacities and expenses for Big A's or Terragators were taken from this budget.

EQUIPMENT		
1664 Terra-Gator (Air $1940 + 10 ply Tires $1000)	$57,000	
Liquid and dry combination body	32,000	
	$89,000	
SUPPORT EQUIPMENT		
2 - Ten Wheel Trucks	$30,000	
4 - 4 1/2 Ton Side Dumps) 2 - Tanks (1500 gal. poly or stainless steel))	32,000	
2 - Bulk Chemical Tanks and Meters	2,500	
	64,500	
TOTAL COST	$153,500	
YEAR #1 INCOME		
105 Days - Fertilizer 11,550 acres x $5.00 =	$ 57,750	
Lime 6,000 tons x $5.00 =	30,000	
TOTAL INCOME	$ 87,750	
ANNUAL EXPENSES		
Depreciation: 1664 Terra-Gator 57,000 @7 yr.		$ 8,143
Body 32,000 @10 yr.		3,200
2 Used Trucks - 30,000 @5 yr.		6,000
Dumpsters - 22,000 @5 yr.		4,400
Tanks & Meter - 12,500 @10 yr.		1,250
		$22,993
Interest - 153,500 x 10.98%		$16,854
Insurance - 153,500 x 2%		3,070
License - Two Trucks x 300		600
Taxes - Two Trucks - 30,000 x 5%		1,500
Repairs - Including tires, oil and grease —		6,800
Fuel - 105 working days - 3 trips daily = 60 miles 10 gal. diesel per day per truck = 2100 gal. Annually @$1.20 per gallon		2,520
Terra-Gator - 105 working days = 60 gal of diesel daily (105 x 60 =) 6300 gal. @$1.20 per gal.		7,560
Labor - One full time man/20,000) Two part time men (Carrol Pet.)/14,000)		34,000
Management - One person		14,000
TOTAL EXPENSES		$ 109,897
FIRST YEAR - INCOME	$ 87,750	
EXPENSES	109,897	
NET LOSS	($ 22,147)	

<u>YEAR #2 INCOME</u>			
105 Days - Fertilizer	14,000 acres x $5.00 =	$ 70,000	
Lime	7,000 tons x $5.00 =	35,000	
TOTAL INCOME		$105,000	
<u>EXPENSES</u>			
Depreciation			$ 22,993
Interest - 153,500 - 22,993 = 130,507 x 10.98 =			14,330
Insurance - 130,507 x 2% =			2,610
License - 2 Trucks @$300 each			600
Repairs - Including tires, oil and grease			7,000
Fuel - 2,200 gals x $1.25 (2/Trucks)			2,750
Terra-Gator - 6,500 x $1.25 =			8,125
Labor - One full time man - 21,000)			
Two part time men (Carroll Pet.) - 14,700)			50,400
Management - one person - 14,700)			
TOTAL EXPENSES			$ 108,808
SECOND YEAR - INCOME		$105,000	
EXPENSES		108,808	
NET LOSS		($ 3,808)	
<u>YEAR #3 INCOME</u>			
105 days - Fertilizer	16,000 acres x 5.00 =	$ 80,000	
Lime	8,000 tons x 5.00 =	40,000	
TOTAL INCOME		$120,000	
<u>EXPENSES</u>			
Depreciation			$ 22,993
Interest - 130,507 - 22,993 = 107,514 x 10.98% =			11,805
Insurance - 107,514 x 2% =			2,150
License - Two trucks @$300 each			600
Repairs - Including tires, oil and grease			7,200
Fuel - 2,500 gal x 1.30 (2/Trucks)			3,250
Terra-Gator 7,000 gal. x $1.30 =			9,100
Labor - One full time man - $22,050)			
Two part time men (Carroll Pet.) - 15,435)			52,920
Management - one person - $15,435)			
TOTAL EXPENSES			$ 110,018
THIRD YEAR - INCOME		$120,000	
EXPENSES		110,018	
NET PROFIT		$ 9,982	

APPENDIX G

Semitrailer Figures

SEMITRAILER FIGURES

Wage	$.54 / mile	28,964 / year
Repair	$.21 / mile	11,263 / year
Gas,Lube,Oil	$.23 / mile	12,336 / year
Depreciation	$.13 / mile	6,973 / year
Licenses	$.05 / mile	2,682 / year
Insurance	$.03 / mile	1,609 / year
Interest	$.05 / mile	2,683 / year

Miles = 1,003,000
Trucks = 18.7

Capacity regardless of distance - 5,688 tons / year
Capacity within 10 miles - 10,000 tons / year

Source : Dick Messenger, Southern States

APPENDIX H

1983 Product Turnover Reports

1983 Fertilizer, Seed, and Farm Supply Turnover was used as internal coefficients in the model as Q17A-D.

1983 Feed Average Monthly Inventory was used in Appendix I for each stores feed inventory in the calculation of a new Feed turnover figure.

Source: Timberlake, 1983.

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02C | HAMPSTEAD COOP., INC. | STORE NUMBER = 13923

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$801,293	$111,574	$689,719	$37,947	18.18	21.12	13.9 ^	2.94 ^	2.15	2.40 - 2.80
	12-31-82	$692,411	$108,189	$584,222	$32,336	18.07	21.41	15.6 ^	3.34 ^		
FERTILIZER	12-31-83	$825,443	$142,840	$682,603	$98,460	6.93	8.38	17.3 ^	1.45 ^	0.80	1.00 - 1.40
	12-31-82	$1,031,398	$192,676	$838,722	$131,035	6.40	7.87	18.7 ^	1.47 ^		
SEEDS	12-31-83	$146,122	$26,969	$119,153	$18,308	6.51	7.98	18.5 ^	1.48 ^	1.00	1.15 - 1.45
	12-31-82	$142,362	$24,671	$117,691	$21,304	5.52	6.68	17.3 ^	1.16 ^		
FARM SUPPLIES	12-31-83	$681,254	$95,933	$585,321	$200,209	2.92	3.40	14.1 ^	0.48**^	0.60	0.75 - 1.00
	12-31-82	$685,906	$93,645	$592,261	$279,961	2.12	2.45	13.7 ^	0.34**^		
PETROLEUM	12-31-83	$8,753	$-1,376	$10,129	$1,676	6.04	5.22	-15.7 ^	-0.82**^	3.60	3.80 - 5.00
	12-31-82	$10,280	$211	$10,069	$2,018	4.99	5.09	2.1 ^	0.11**^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = O2C | WESTMINSTER COOP., INC. | STORE NUMBER = 19443

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$1,100,406	$209,086	$891,320	$85,589	10.41	12.86	19.0 ^	2.44 ^	2.15	2.40 - 2.80
	12-31-82	$1,119,810	$204,530	$915,280	$119,456	7.66	9.37	18.3 ^	1.71**^		
FERTILIZER	12-31-83	$896,135	$181,838	$714,297	$211,815	3.37	4.23	20.3 ^	0.86 ^	0.80	1.00 - 1.40
	12-31-82	$989,125	$215,196	$773,929	$210,316	3.68	4.70	21.8 ^	1.02 ^		
SEEDS	12-31-83	$92,101	$24,495	$67,606	$21,579	3.13	4.27	26.6 ^	1.14 ^	1.00	1.15 - 1.45
	12-31-82	$95,322	$25,249	$70,073	$22,069	3.18	4.32	26.5 ^	1.14 ^		
FARM SUPPLIES	12-31-83	$620,990	$140,673	$480,317	$196,728	2.44	3.16	22.7 ^	0.72 ^	0.60	0.75 - 1.00
	12-31-82	$621,974	$130,183	$491,791	$205,800	2.39	3.02	20.9 ^	0.63 ^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02B | WOODBINE COOP., INC. | STORE NUMBER = 19633

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$521,480	$91,519	$429,961	$16,466	26.11	31.67	17.5 ^	5.54 ^	2.15	2.40 - 2.80
	12-31-82	$439,821	$71,595	$368,226	$16,083	22.90	27.35	16.3 ^	4.46 ^		
FERTILIZER	12-31-83	$50,432	$8,553	$41,879	$2,896	14.46	17.41	17.0 ^	2.96 ^	0.80	1.00 - 1.40
	12-31-82	$118,395	$14,376	$104,019	$3,927	26.49	30.15	12.1 ^	3.65 ^		
SEEDS	12-31-83	$46,102	$11,360	$34,742	$13,726	2.53	3.36	24.6 ^	0.83**^	1.00	1.15 - 1.45
	12-31-82	$39,367	$9,774	$29,593	$5,659	5.23	6.96	24.8 ^	1.73 ^		
FARM SUPPLIES	12-31-83	$292,728	$78,364	$214,364	$97,975	2.19	2.99	26.8 ^	0.80 ^	0.60	0.75 - 1.00
	12-31-82	$281,196	$72,823	$208,373	$93,004	2.24	3.02	25.9 ^	0.78 ^		
PETROLEUM	12-31-83	$1,540	$-244	$1,784	$491	3.63	3.14	-15.8 ^	-0.50**^	3.60	3.80 - 5.00
	12-31-82	$2,650	$-359	$3,009	$566	5.32	4.68	-13.5 ^	-0.63**^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02C   TANEYTOWN COOP., INC.   STORE NUMBER = 18963

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$1,656,790	$234,333	$1,422,457	$61,165	23.26	27.09	14.1 ^	3.82 ^	2.15	2.40 - 2.80
	12-31-82	$1,459,653	$200,038	$1,259,615	$59,069	21.32	24.71	13.7 ^	3.39 ^		
FERTILIZER	12-31-83	$430,452	$82,881	$347,571	$77,700	4.47	5.54	19.3 ^	1.07 ^	0.80	1.00 - 1.40
	12-31-82	$553,065	$111,628	$441,437	$78,324	5.64	7.06	20.2 ^	1.43 ^		
SEEDS	12-31-83	$92,784	$14,922	$77,862	$21,943	3.55	4.23	16.1 ^	0.68**^	1.00	1.15 - 1.45
	12-31-82	$91,278	$14,107	$77,171	$14,107	5.47	6.47	15.5 ^	1.00**^		
FARM SUPPLIES	12-31-83	$362,289	$69,231	$293,058	$169,083	1.73	2.14	19.1 ^	0.41**^	0.60	0.75 - 1.00
	12-31-82	$382,470	$62,430	$320,040	$174,544	1.83	2.19	16.3 ^	0.36**^		
PETROLEUM	12-31-83	$3,631	$14	$3,617	$1,149	3.15	3.16	0.4 ^	0.01**^	3.60	3.80 - 5.00
	12-31-82	$6,088	$-34	$6,122	$1,499	4.08	4.06	-0.6 ^	-0.02**^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02C | WESTMINSTER COOP-UNION BRIDG | STORE NUMBER = 19463

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$714,960	$76,646	$638,314	$37,345	17.09	19.14	10.7 ^	2.05**^	2.15	2.40 - 2.80
	12-31-82	$661,701	$76,265	$585,436	$54,893	10.67	12.05	11.5 ^	1.39**^		
FERTILIZER	12-31-83	$261,957	$43,637	$218,320	$49,390	4.42	5.30	16.7 ^	0.89 ^	0.80	1.00 - 1.40
	12-31-82	$266,197	$50,072	$216,125	$50,251	4.30	5.30	18.8 ^	1.00 ^		
SEEDS	12-31-83	$41,099	$7,140	$33,959	$10,240	3.32	4.01	17.4 ^	0.70**^	1.00	1.15 - 1.45
	12-31-82	$43,272	$8,594	$34,678	$5,315	6.52	8.14	19.9 ^	1.62 ^		
FARM SUPPLIES	12-31-83	$170,475	$37,648	$132,827	$59,554	2.23	2.86	22.1 ^	0.63 ^	0.60	0.75 - 1.00
	12-31-82	$161,088	$39,624	$121,464	$55,020	2.21	2.93	24.6 ^	0.72 ^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02C MT. AIRY COOP., INC. STORE NUMBER = 16243

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$1,081,190	$161,640	$919,550	$29,135	31.56	37.11	15.0 ^	5.57 ^	2.15	2.40 - 2.80
	12-31-82	$1,002,970	$157,591	$845,379	$26,039	32.47	38.52	15.7 ^	6.05 ^		
FERTILIZER	12-31-83	$458,729	$79,175	$379,554	$64,732	5.86	7.09	17.3 ^	1.23 ^	0.80	1.00 - 1.40
	12-31-82	$609,173	$117,961	$491,212	$59,017	8.32	10.32	19.4 ^	2.00 ^		
SEEDS	12-31-83	$118,214	$26,573	$91,641	$25,283	3.62	4.68	22.5 ^	1.05 ^	1.00	1.15 - 1.45
	12-31-82	$128,589	$25,715	$102,874	$18,819	5.47	6.83	20.0 ^	1.37 ^		
FARM SUPPLIES	12-31-83	$408,159	$90,906	$317,253	$130,602	2.43	3.13	22.3 ^	0.70 ^	0.60	0.75 - 1.00
	12-31-82	$426,723	$88,842	$337,881	$115,406	2.93	3.70	20.8 ^	0.77 ^		
PETROLEUM	12-31-83	$2,726	$-38	$2,764	$511	5.41	5.33	-1.4 ^	-0.07**^	3.60	3.80 - 5.00
	12-31-82	$3,152	$-49	$3,201	$493	6.49	6.39	-1.6 ^	-0.10**^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02C — WOODSBORO COOP. — STORE NUMBER = 19653

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$1,545,093	$146,990	$1,398,103	$78,851	17.73	19.60	9.5 ^	1.86**^	2.15	2.40 - 2.80
	12-31-82	$1,735,493	$178,026	$1,557,467	$91,765	16.97	18.91	10.3 ^	1.95**^		
FERTILIZER	12-31-83	$484,253	$99,847	$384,406	$106,013	3.63	4.57	20.6 ^	0.94 ^	0.80	1.00 - 1.40
	12-31-82	$636,850	$124,357	$512,493	$110,629	4.63	5.76	19.5 ^	1.12 ^		
SEEDS	12-31-83	$108,397	$20,260	$88,137	$27,476	3.21	3.95	18.7 ^	0.74**^	1.00	1.15 - 1.45
	12-31-82	$112,786	$23,505	$89,281	$19,481	4.58	5.79	20.8 ^	1.20 ^		
FARM SUPPLIES	12-31-83	$479,169	$112,719	$366,450	$226,612	1.62	2.11	23.5 ^	0.50**^	0.60	0.75 - 1.00
	12-31-82	$501,953	$97,428	$404,525	$205,091	1.97	2.45	19.4 ^	0.48**^		
PETROLEUM	12-31-83	$7,496	$-1,046	$8,542	$1,043	8.19	7.19	-14.0 ^	-1.01**^	3.60	3.80 - 5.00
	12-31-82	$9,371	$-664	$10,035	$1,441	6.96	6.50	-7.1 ^	-0.46**^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

SOUTHERN STATES RETAIL GROSS MARGIN RETURN ON INVENTORY - (GMROI) - REPORT

REGION = 02C — FREDERICK COOP., INC. — STORE NUMBER = 13203

COMMODITY	YEAR ENDING	RETAIL SALES	GROSS MARGIN	COST OF GOODS SOLD	AVERAGE MONTHLY INVENTORY	INV. TURNS	SALES-TO-INV. RATIO	PERCENT GROSS MARGIN	GMROI INDEX	S.S.C. CRITICAL LEVEL	S.S.C. NORMAL RANGE
FEED	12-31-83	$2,560,194	$413,178	$2,147,016	$116,965	18.36	21.89	16.1 ^	3.52 ^	2.15	2.40 - 2.80
	12-31-82	$2,506,556	$383,969	$2,122,587	$106,899	19.86	23.45	15.3 ^	3.59 ^		
FERTILIZER	12-31-83	$708,582	$130,572	$578,010	$238,631	2.42	2.97	18.4 ^	0.55**^	0.80	1.00 - 1.40
	12-31-82	$894,388	$159,962	$734,426	$255,093	2.88	3.51	17.9 ^	0.63**^		
SEEDS	12-31-83	$200,737	$49,569	$151,168	$24,620	6.14	8.15	24.7 ^	2.01 ^	1.00	1.15 - 1.45
	12-31-82	$182,884	$41,804	$141,080	$26,055	5.41	7.02	22.9 ^	1.61 ^		
FARM SUPPLIES	12-31-83	$973,430	$221,911	$751,519	$301,603	2.49	3.23	22.8 ^	0.74 ^	0.60	0.75 - 1.00
	12-31-82	$904,356	$219,154	$685,202	$300,299	2.28	3.01	24.2 ^	0.73 ^		
PETROLEUM	12-31-83	$5,066	$-434	$5,500	$1,063	5.17	4.77	-8.6 ^	-0.41**^	3.60	3.80 - 5.00
	12-31-82	$6,992	$-542	$7,534	$1,202	6.27	5.82	-7.8 ^	-0.45**^		

** INDICATES THE GMROI INDEX IS BELOW THE CRITICAL LEVEL

HOW TO CALCULATE THE VALUES LISTED ABOVE

SALES-TO-INVENTORY RATIO = (RETAIL SALES LESS SERVICES) DIVIDED BY THE AVERGE MONTHLY INVENTORY

PERCENT GROSS MARGIN = (GROSS MARGIN LESS SERVICE GROSS MARGIN) DIVIDED BY (RETAIL SALES LESS SERVICES)

GMROI INDEX = (SALES-TO-INVENTORY RATIO) TIMES (PERCENT GROSS MARGIN)

GMROI REPRESENTS THE DOLLAR MARGIN GENERATED FOR EACH DOLLAR IN INVENTORY FOR ONE YEAR

APPENDIX I

The first two pages represent the calculation needed to derive a turnover coefficient for bagged feed. Inventory figures originated from Appendix H. Feed turnover figures from that report were inappropriate, since bulk feed was included. The second part which is the third page attempts to show the computation necessary to find the Coefficient indicated.

Attention Patron:

Page _170_ omitted from numbering

Attention Patron:

Page _171_ omitted from numbering

Calculation of Percentage of Bagged Feed used through Mixing Services

NGDZIP1-4D	NBGFDPTT	Coef.	
		Grinding and Mixing Dollars	28201
		----------------------------	-----
		Price of Grinding and Mixing	.65
=		CWT of Grinding and Mixing	43386
		----------------------------	-----
		CWT per Ton	20
=		Tons of Grinding and Mixing	2169
	X		X
		% Tons mixed sold as Bagged	.333
=		Tons Sold	723
	X		X
		Price of Bag Feed	212
=		Dollars of Bagged G&M Feed	153,297
		----------------------------	-------
		Total Dollars of Bag Feed	262,522
=		% of Bagged Feed Mixed	58.4%
Coef. =		1 - % Bagged Feed Mixed	.416

Hampstead 0.416
Westminster 0.637
Union Bridge 0.071
Taneytown 0.457
Woodsboro 0.801
Frederick 0.643
Mt. Airy 0.859
Woodbine 0.880
Avg. = Sykesville 0.711

APPENDIX J

Calculation of Capacity Loss due to travel to Baltimore Feed Mill.

$$\frac{1.15 - 0.7011}{1.15} = \frac{.4489}{1.15} = 2.2445$$

		Q17
Frederick	1 / (1.15 - (2.2445 * 47)) =	10.526
Taneytown	1 / (1.15 - (2.2445 * 42)) =	4.831
Woodsboro	1 / (1.15 - (2.2445 * 42)) =	4.831
Mt. Airy	1 / (1.15 - (2.2445 * 33)) =	2.445
Woodbine	1 / (1.15 - (2.2445 * 28)) =	1.916
Union Br.	1 / (1.15 - (2.2445 * 45)) =	7.143
Westminster	1 / (1.15 - (2.2445 * 31)) =	2.203
Hampstead	1 / (1.15 - (2.2445 * 27)) =	1.838
Sykesville	1 / (1.15 - (2.2445 * 26)) =	1.765

The minimum capacity assuming one load was calculated as follows:

```
1 Load =     18 Tons / Day
       *      5 Days / Week
         ------------------
             90 Tons / Week
       *     50 Weeks
         ------------------
           4500 Tons
       /  10,000 Tons
       =     .45
```

Minimun Coefficient 1 / .45 = 2.222

APPENDIX K : LIST OF ZIP CODES AND COMBINED SALES

Zip	Name	County	Sales($)	Marker	Rank
BALTIMORE					
21013	Baldwin	B	158340		
21019	BentleySprin	B	0		
21020	Boring	B	0		8
21021	Bradshaw	B	0		
21022	Brooklandvil	B	0		
21023	Butler	B	25153		23
21027	Chase	B	0		
21030	Cockeysville	B	154707		
21031	Cockeysville	B	0		
21051	Fork	B	0		
21052	FortHoward	B	0		
21053	Freeland	B	40070		
21055	Garrison	B	0		
21057	GlenArm	B	27856		
21071	Glyndon	B	114931	*	10
21082	Hydes	B	58119		
21087	Kingsville	B	32828		
21092	LongGreen	B	0		
21093	Lutherville-	B	133259		
21105	MDLine	B	0		
21111	Monktom	B	415306		
21117	OwingsMills	B	169158	*	
21120	Parkton	B	243744	*	
21128	PerryHall	B	0		
21131	Phoenix	B	164618	*	
21133	Randlestown	B	0		
21136	Reistertown	B	274777	*	9
21139	Riderwood	B	0		
21152	Sparks-Glenc	B	224414	*	
21153	Stevenson	B	0		
21155	Upperco	B	526298	*	
21156	UpperFalls	B	0		
21161	WhiteHall	B	1299079	*	
21162	WhiteMarsh	B	0		
Total Baltimore			4062657		
CARROL					
21048	Finksburg	C	121381	*	5
21074	Hampstead	C	1279215	*	
21080	Henryton	C	0		
21088	Lineboro	C	0		
21102	Manchester	C	315010	*	
21107	Millers	C	81035	*	
21157	Westminster	C	2271423	*	7
21725	Detour	C	60936	*	18
21735	Gaither	C	0		15
21757	Keymar	C	644802	*	24

Zip	Name	County	Sales($)	Marker	Rank
21764	Linwood	C	166235	*	4
21768	Middleburg	C	92324	*	17
21771	Mount Airy	C	1767435	*	11
21776	New Windsor	C	401260	*	2
21784	Sykesville	C	419460	*	16
21787	Taneytown	C	1440108	*	
21791	UnionBridge	C	1425073	*	3
21797	Woodbine	C	950742	*	19
Total Carrol			11436439		
HOWARD					
20701	AnnapolusJcn	H	0		
20708	Montpelier	H	0		
20759	Fulton	H	30050	*	
20763	Savage	H	0		
20777	Highland	H	0		
20810	Laurel-Scagg	H	116897	*	
21029	Clarksville	H	103904	*	
21036	Dayton	H	25711	*	
21043	ElliotCity	H	379614	*	
21044	Columbia	H	0		
21045	Columbia	H	35993	*	
21046	Columbia	H	0		
21083	Iichester	H	0		
21104	Marriottsvil	H	50390	*	
21150	Simpsonville	H	0		
21163	Woodstock	H	0		
21723	Cooksville	H	0		
21737	Glenelg	H	221175	*	
21738	Glenwood	H	66873	*	
21765	Lisbon	H	0		22
21794	WestFriendsh	H	64566	*	
Total Howard			1095173		
MONTGOMERY					
20702	Ashton	M	21055		
20704	Beallseville	M	45356	*	
20720	Boyds	M	157487	*	
20729	Brookville	M	32731	*	
20734	Clarksburg	M	38677	*	25
20750	Damascus	M	163488	*	12
20753	Dickerson	M	250968	*	
20760	Gaithersburg	M	569381	*	
20767	Germantown	M	86956	*	
20812	GlenEcho	M	0		
20817	W.Beathesda	M	0		
20818	CabinJohn	M	0		

Zip	Name	County	Sales($)	Marker	Rank
20832	Olney	M	25907	*	
20833	Brookeville	M	74071		
20837	Poolesville	M	369385		
20838	Barnesville	M	0		
20839	Beallsville	M	0		
20841	Boyds	M	222219	*	
20842	Dickerson	M	221448	*	
20850	Rockville	M	457028	*	
20852	Rockville	M	242938		
20853	Rockville	M	47381		
20854	Rockville	M	386016	*	
20855	Rockville	M	79794		
20860	SandySpring	M	0		
20861	Ashton	M	0		
20862	Brinklow	M	0		
20866	Burtonsville	M	0		
20868	Spencerville	M	0		
20871	Clarksburg	M	95582	*	
20872	Damascus	M	151082	*	
20874	Germantown	M	232771		
20877	Gaithersburg	M	192343		
20878	Gaithersburg	M	116198		
20879	Gaithersburg	M	242564		
20880	WashingtonGr	M	0		
20879	Gaithersburg	M	46237	*	
20895	Kensington	M	0		
20896	GarrettPark	M	0		
20901	SilverSpring	M	56918		
20904	SilverSpring	M	89236		
Total Montgomery			4715217		
FREDERICK					
21701	Frederick	F	2448053	*	20
21710	Adamstown	F	353379	*	
21714	BraddockHts	F	0		
21716	Brunswick	F	27990		
21717	Buckeystown	F	53914	*	
21718	Burkittsvill	F	24585		
21727	Emmitsburg	F	236640	*	
21754	Ijamsville	F	405048	*	
21755	Jefferson	F	1033419	*	
21758	Knoxville	F	331868		
21759	Ladiesburg	F	0		13
21762	Libertytown	F	0		6
21769	Middletown	F	963803	*	
21770	Monrovia	F	112629	*	
21773	Myersville	F	386240	*	

Zip	Name	County	Sales($)	Marker	Rank
21774	New Market	F	0		
21775	New Midway	F	0		21
21777	PointofRocks	F	0		
21778	RockyRidge	F	252901	*	
21780	Sabillasvill	F	0		
21788	Thurmont	F	635901	*	
21790	Tuscarora	F	31975	*	
21792	Unionville	F	0		1
21793	Waldersville	F	767511	*	14
21798	Woodsboro	F	413400	*	
Total Frederick			8479256		
WASHINGTON					
21711	BigPool	W	0		
21712	Big Spring	W	22183		
21713	Boonsboro	W	191519		
21715	Brownsville	W	0		
21719	Cascade	W	0		
21720	Cavetown	W	0		
21721	Chewsville	W	0		
21722	ClearSpring	W	83017		
21733	FairPlan	W	0		
21734	Funkstown	W	0		
21736	Gapland	W	142809		
21740	Hagerstown	W	361895	*	
21741	Hagerstown	W	0		
21742	Hagerstown	W	0		
21750	Hancock	W	308051		
21756	Keedysville	W	83535		
21767	Maugansville	W	0		
21779	Rohrersville	W	0		
21781	St.James	W	0		
21782	Sharpsburg	W	109659		
21783	Smithsburg	W	46301		
21795	Williamsport	W	457161		
Total Washington			1806130		
TOTAL for 21 Stores			1594872		

Key: B-Baltimore, C-Carrol, H-Howard, M-Montgomery, F-Frederick, and W-Washinton

Source: Region 2 Agricultural Projections, Market Potentials, and Store Market Areas.

APPENDIX L : DETAILED ABBREVIATED MODEL

Sections 3.5 through 3.8 of the text add detail to the general framework discussed in 3.4 and shown in Figure 8. The actual model has over 6800 rows and over 6200 columns. Since there is over 360 pages of input and 250 pages of output, neither will be discussed in their entirety. Instead a detailed abbreviated tableau is provided in order to further illustrate structure and logic of the model. Figure L.1 is the first overall tableau and consists of all the individual smaller tableuas that follow.

In Figure L.1, PROFIT is the same as in the individual product tableaus found later in this Appendix and is the total profit for the region. TTSALES is a summing mechanism to collect all product revenues for all stores. Each of the nine boxes numbered N=1 to N=9, represent one of the nine stores. The figure numbers listed in each box represent the figure numbers of the individual product tableaus and as such number eight tableaus. Each of these tableaus are in the following pages. The bottom two rows of boxes, labeled N=T and N=TT, represent the additive process used to guarentee zip code sales for all stores do not exceed that zip code's potential. This was explained in section 3.3 and was represented by Equation (3).

Table L.1 lists abbreviations used in the product tableaus consisting of Figures L.2 through L.9. The abbreviations with the exception of ZIP1-4, are identical to those used in the actual modelling process. The table is separated into columns and row abbreviations.

NTSAL in each of the nine boxes is similar to TTSAL for summing revenue, except NTSAL performs that activity solely for store N. The construction of the model has been explained in each of the individual sections. These product tableaus allow the actual data to be found.

The elements of all eight tableaus consist of four types: Elements with a (Q) indicate data provided in

Appendix B or C depending on the number along with the (Q). Elements listed in a (T*) form indicate the table from which they are drawn. An abbreviation (APP*) corresponds with the Appendix where this was developed. Lastly, a number represents a relationship which is equivalent across all stores. These numbers originate from an Appendix, more specific information on their origin is provided in the text associated with that relationship. These nine tableaus should provide an adequate explaination to model structure and data used. Figures L.2 through L.9 have a lot of redundancies so that they mighted be viewed independantly and understood. The column NEXPENSE does not actually exist in the model. It represents all the individual expenses which are separately tracked. Product lines which require processing such as Figure L.4 and L.6 are the most complex with many activities being interrelated.

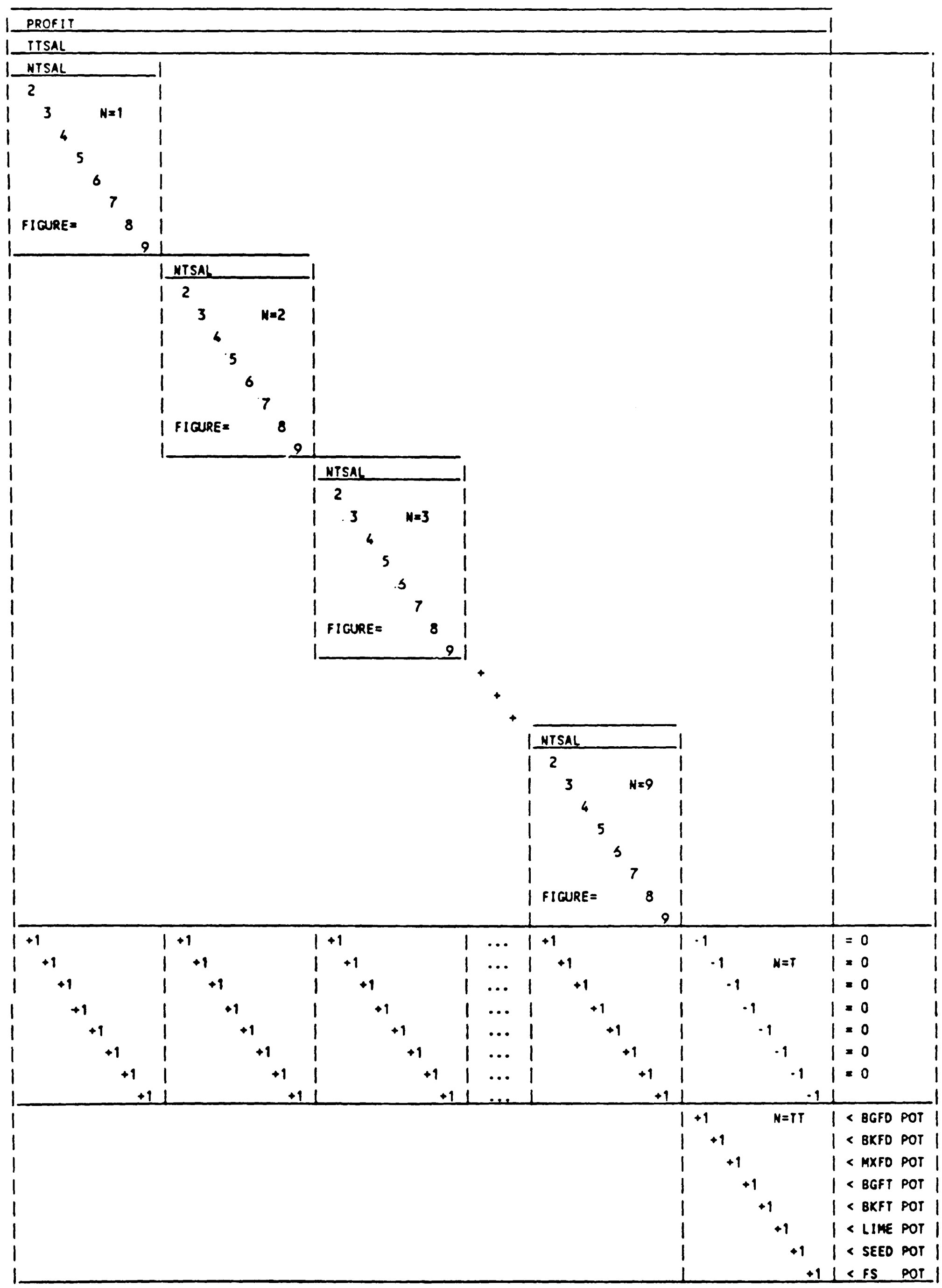

FIGURE L.1 : MASTER MODEL

TABLE L.1 : List of Abbreviations used in the Model and Tableaus

COLUMNS

NxxZIPyD

- N - Store number
  - 1 = Hampstead
  - 2 = Westminster
  - 3 = Sykesville
  - 4 = Woodbine
  - 5 = Taneytown
  - 6 = Union Bridge
  - 7 = Mount Airy
  - 8 = Woodsboro
  - 9 = Frederick
- xx - Product line
  - GD = Bag Feed
  - KD = Bulk Feed
  - MD = Mixed Feed
  - GT = Bag Fertilizer
  - KT = Bulk Fertilizer
  - LM = Lime
  - SD = Seed
  - FS = Farm Supplies
- ZIPy - Zip Codes (last 4 digets)
  - ZIP1 = the ones within 6 miles of a store
  - ZIP2 = the ones between 6 and 12 miles of a store
  - ZIP3 = the ones between 12 and 18 miles of a store
  - ZIP4 = the ones between 18 and 23 miles of a store
- D - Revenue activity in dollars

NxxxxD - Total Revenue for Store N for Product xxxx

- xxxx = BGFD - Total Bag Feed Revenue for Store N
  - BKFD - Total Bulk Feed Revenue for Store N
  - MXFD - Total Mixed Feed Revenue for Store N
  - BGFT - Total Bag Fertilizer Revenue for Store N
  - BKFT - Total Bulk Fertilizer Revenue for Store N
  - LIME - Total Lime Revenue for Store N
  - SEED - Total Seed Revenue for Store N
  - FS - Total Farm Supply Revenue for Store N

NxxxxTT - Total Tons for Store N for Product xxxx

- xxxx = BGFD - Total Bag Feed Revenue for Store N
  - BKFD - Total Bulk Feed Revenue for Store N
  - MXFD - Total Mixed Feed Revenue for Store N
  - BGFT - Total Bag Fertilizer Revenue for Store N
  - BKFT - Total Bulk Fertilizer Revenue for Store N

TABLE L.1 : List of Abbreviations used in the Model and Tableaus (Cont')

NxxINV - Inventory of xx for store N
xx = FD - Feed
xx = FT - Fertilizer
xx = SD - Seed
xx = FS - Farm Supplies

NxxTKD - Dollars Revenue from Trucking xx
xx = FD - Feed
xx = FT - Fertilizer
NFTSPD - Dollars Revenue from Spreading Fertilizer at N
NFTEQD - Dollars Revenue from Fertilizer Equipment Rental
REGHAUL - Bulk Feed Tons hauled by the Regional Feed Mill
NFDTKTR - Bulk Feed Tons hauled by Store N
NFDTKT1 - Mixed Feed Tons hauled by Store N within 6 mi.
NFDTKT2 - Mixed Feed Tons hauled by Store N to 6-12 mi.
NFDTKT3 - Mixed Feed Tons hauled by Store N to 12-18 mi.
NFDTKT4 - Mixed Feed Tons hauled by Store N to 18-23 mi.
NFDTKTT - Tons of Feed Trucked at Store N

NFTACSP1- Fertilizer Acres Spread by Store N within 6 mi.
NFTACSP2- Fertilizer Acres Spread by Store N 6-12 mi.
NFTACSP3- Fertilizer Acres Spread by Store N 12-18 mi.
NFTACSP4- Fertilizer Acres Spread by Store N 18-23 mi.
NFTACSPT- Total Fertilizer Acres Spread by Store N

NLMHLT1 - Lime Hauled and spread by Store N's Trucks w/in 6
NLMHLT2 - Lime Hauled and spread by Store N's Trucks 6-12mi
NLMHLT3 - Lime Hauled and spread by Store N's Trucks 12-18m
NLMHLT4 - Lime Hauled and spread by Store N's Trucks 18-23m
NLMRGT1 - Lime Spread by the Supplier
NLMRGT2 - Lime Spread by the Supplier
NLMRGT3 - Lime Spread by the Supplier
NLMRGT4 - Lime Spread by the Supplier
NLMHLD - Total Lime Dollars Spread by the Store N
NLMRGD - Total Lime Dollars Spread by the Supplier

NxxWHSE - Space in Store N's warehouse used by product xx
xx = FD - Feed
xx = FT - Fertilizer
xx = SD - Seed
xx = FS - Farm Supplies

NEWHSE - Existing Warehouse Capacity used at Store N
NAWHSE - Additional Warehouse Capacity bought at Store N
NESHRM - Existing Showroom Capacity used at Store N
NASHRM - Additional Showroom Capacity used at Store N
NEGM - Existing Grinding/ Mixing Capacity used at Store N
NAGM - Additional Grinding and Mixing Capacity used at "

TABLE L.1 : List of Abbreviations used in the Model and Tableaus (Cont')

NEFTFAC- Existing Fertilizer Blending Capacity Used at N
NAFTFAC- Additional Fertilizer Blending Capacity Used at N

NEDPTK - Existing Dual Purpose Trucks Used by Store N
NADPTK - Additional Dual Purpose Trucks Used by Store N
NASEMI - Additional SemiTrailers Used by Store N
NEGPTK - Existing General Purpose Trucks Used by Store N
NAGPTK - Additional General Purpose Trucks Used by Store N
NECBTK - Existing Combination Bed Fertilizer Trucks Used
NACBTK - Additional Combination Bed Fertilizer Trucks Used
NABIGA - Additional BIG A or Terrigator's Used at Store N
NEFTTK - Existing Fertilizer Trucks Used by Store N
NESPTK - Existing Spray Rigs Used by Store N
NELQEQ - Existing Liquid Equipment Used by Store N
NEFTBUG- Existing Fertilizer Buggies Used by Store N
NAFTBUG- Additional Fertilizer Buggies Used by Store N

NEXPENSE - Total of that expense item
NDEPR - Total Depreciation at Store N
NOPP - Total Opportunity Cost at Store N
NINS - Total Insurance at Store N
NLIC - Total License and Taxes at Store N
NGLO - Total Gas, Lube, and Oil at Store N
NREP - Total Repair at Store N
NWAGE - Total Wage or Salary at Store N
NUTL - Total Utilities at Store N

TABLE L.1 : List of Abbreviations used in the Model and Tableaus (Cont')

ROWS

NTSAL - Totals All Revenues for the N th Store

NxxxZIPy - Revenue Potential Constraint
N - Store number
1 = Hampstead
2 = Westminster
3 = Sykesville
4 = Woodbine
5 = Taneytown
6 = Union Bridge
7 = Mount Airy
8 = Woodsboro
9 = Frederick
xxx - Product line
GFD = Bag Feed
KFD = Bulk Feed
MFD = Mixed Feed
GFT = Bag Fertilizer
KFT = Bulk Fertilizer
LIM = Lime
SED = Seed
FS = Farm Supplies
ZIPy - Zip Codes (last 4 digets)
ZIP1 = the ones within 6 miles of a store
ZIP2 = the ones between 6 and 12 miles of a store
ZIP3 = the ones between 12 and 18 miles of a store
ZIP4 = the ones between 18 and 23 miles of a store

NxxxxPT - Totals Revenue of all zip codes for Store N for Product xxxx
xxxx = BGFD - Bagged Feed
BKFD - Bulk Feed
MXFD - Mixed Feed
BGFT - Bagged Fertilizer
BKFT - Bulk Fertilizer
LIME - Lime
SEED - Seed
FS - Farm Supplies

NxxTURN - Cost of Goods Sold is turned to Inventory of xx
xx = FD - Feed
xx = FT - Fertilizer
xx = SD - Seed
xx = FS - Farm Supplies

TABLE L.1 : List of Abbreviations used in the Model and Tableaus (Cont')

NxxxxPR - Transfers Sales Dollars To Tons for Product xxxx
    xxxx = BGFD - Bagged Feed
           BKFD - Bulk Feed
           MXFD - Mixed Feed
           BGFT - Bagged Fertilizer
           BKFT - Bulk Fertilizer

NLMHLPR - Totals Lime Tons Spread to Dollars by the Store N
NLMRGPR - Totals Lime Tons Spread to Dollars for Supplier
NSTDPR - Transfers tons of mixed feed to dollars of grain stored and dryed
NFTSPPR - Transfers Acres Spread to Dollars Spreading Rev.
NFTEQPR - Transfers Acres Spread to Dollars Equipment Rev.
NxxTKPR - Transfers tons of product xx sold to tons trucked
    xx = FD - Feed
    xx = FT - Fertilizer

NFTSPTR - Transfers Acres needing Spreading of Fertilizer to number of trucks
NLMSPTR - Transfers Lime Hauled by Store N to Number of Trucks
NLQEQTR - Transfers Acres Needing Equipment Rental to Number of Rental Spray Rigs Needed
NFDTRAN - Transfers Feed tons needing trucked to number of trucks
NFDTKRTR- Allows Bulk Feed Tons to be hauled by Region or by Store N
NFDTKRTT- Sums bulk feed and mixed feed needing trucked
NFDTKRT1- Transfers Mixed Feed Revenue to Tons delivered within 6 mi.
NFDTKRT2- Transfers Mixed Feed Revenue to Tons (6-12 mi.)
NFDTKRT3- Transfers Mixed Feed Revenue to Tons (12-18 mi.)
NFDTKRT4- Transfers Mixed Feed Revenue to Tons (18-23 mi.)

NBGFTTR - Transfers Bagged Fertilizer tons sold to be delivered
NFTSPRT1- Dry Fertilizer Revenue transfered to Acres Spread
NFTSPRT2- Dry Fertilizer Revenue transfered to Acres Spread
NFTSPRT3- Dry Fertilizer Revenue transfered to Acres Spread
NFTSPRT4- Dry Fertilizer Revenue transfered to Acres Spread
NFTACSPT- Totals Dry Fertilizer Acres Spread by Store N

NLMSPRT1- Allows either Supplier or Store to Haul / Spread
NLMSPRT2- Allows either Supplier or Store to Haul / Spread
NLMSPRT3- Allows either Supplier or Store to Haul / Spread
NLMSPRT4- Allows either Supplier or Store to Haul / Spread

TABLE L.1 : List of Abbreviations used in the Model and Tableaus (Cont')

NxxWHRAT- Transfers product xx Inventory to Warehouse Space
xx = FD - Feed
xx = SD - Seed
xx = FS - Farm Supplies

NTWHSE - Totals Product Warehouse Needs into Existing and Additional Warehouse Space
NEWHCAP - Existing Warehouse Capacity available at Store N
NAWHCAP - Additional Warehouse Capacity possible at Store N
NTSHRM - Transfers Sales to Showroom Space Needed
NESHCAP - Existing Showroom Capacity at Store N
NASHCAP - Additional Showroom Capacity at Store N
NTGMCAP - Totals Grinding & Mixing Tons to Capacity needed
NEGMCAP - Existing Grinding and Mixing Capacity at Store N
NAGMCAP - Additional Grinding and Mixing Capacity at N
NTFACCAP- Transfers Tons of Fertilizer needed blending to Blending Facility
NEFACCAP- Existing Fertilizer Blending Capacity at Store N
NAFTFAC - Additional Fertilizer Blending Capacity at Store N

NETKCAP - Existing number of available Dual Purpose Trucks
NATKCAP - Additional number of Dual Purpose Trucks needed
NASEMCAP- Additional number SemiTrailers purchasable
NGPTRAN - Transfers general purpose hauling needs to truck #
NEGPCAP - Existing General Purpose Truck Capacity at Store N
NAGPCAP - Additional General Purpose Trucks at Store N
NECBCAP - Existing Combination Bed Fertilizer Truck Capacity
NACBCAP - Additional Combination Bed Fertilizer Trucks
NBIGACAP- Additional BIG A or Terrigator's Used at Store N
NFTTKCAP- Existing Fertilizer Trucks Available for Store N
NSPTKCAP- Existing Spray Rigs Available for Store N
NLQEQCAP- Existing Liquid Equipment Available for Store N
NTBUGCAP- Transfers Tons Needing Dry Equipment to Number of Buggies
NEBUGCAP- Existing Fertilizer Buggies Available to Store N
NABUGCAP- Additional Fertilizer Buggies Available to Store N

NDEPRXP - Totals Depreciation Expense at Store N
NOPPXP - Totals Opportunity Cost at Store N
NINSXP - Totals Insurance Expense at Store N
NLICXP - Totals License and Taxes Expense at Store N
NGLOXP - Totals Gas, Lube, and Oil Expense at Store N
NREPXP - Totals Repair Expense at Store N
NWAGEXP - Totals Wage or Salary Expense at Store N
NUTLXP - Totals Utilities Expense at Store N

	NGDZIP1D	NGDZIP2D	NGDZIP3D	NGDZIP4D	NBGFDD	NBGFDTT	NFDTKD	NFDINV	NFDWHSE	NEWHSE	NAWHSE	NEGPTK	NAGPTK	NEXPENSE	RHS
PROFIT					+Q16A		+1.0							-1	N MAX
NTSAL					1		1								=
NGFDZIP1	1														< POT1
NGFDZIP2		1													< POT2
NGFDZIP3			1												< POT3
NGFDZIP4				T2											< POT4
NBGFDPTT	-APPI	-APPI	-APPI	-APPI	1										=
NBGFDPR					1	-212									=
NFDTKPR						-Q8A2*Q8A1	1								=
NFDTURN					1-Q16A			-Q17A							=
NFDWHRAT								-1	26.5						=
NTWHSE									-1	Q1A	1000				> 0
NEWHCAP										1					< 1
NAWHCAP											1				< x=100
NGPTRAN						-Q8A1						1500	1500		> 0
NEGPCAP												1			< TOT Q5G,H
NAGPCAP													1		< x=100
NLICXP								0.0025				500	500	-1	=
NINSXP								0.0075				1807	1807	-1	=
NREPXP										Q14B1*Q15E		1445	1445	-1	=
NGLOXP												5000	5000	-1	=
NUTLXP										Q14A3*Q15D				-1	=
NWAGEXP					0.056		0.056							-1	=
NDEPRXP										Q18D	450	Q18F	5000	-1	=
NOPPXP								0.11		Q19D	1650	Q19F	2200	-1	=

FIGURE L.2 : BAG FEED TABLEAU

	NKDZIP1D	NKDZIP2D	NKDZIP3D	NKDZIP4D	NBKFDD	NBKFDTT	REGHAUL	NFDTKTT	NFDTKTR	NEDPTK	NADPTK	NASEMI	NEXPENSE		RHS
PROFIT					+Q16B		-11						-1	N	MAX
NTSAL					1									=	
NKFDZIP1	1													<	POT1
NKFDZIP2		1												<	POT2
NKFDZIP3			1											<	POT3
NKFDZIP4				T2										<	POT4
NBKFDPTT	-1	-1	-1	-1	1									=	
NBKFDPR					1	-183								=	
NFDTKRTR						1	-1		-1					=	
NFDTRAN									-APPJ	6600	6600	10000		>	0
NFDTKRTT								-1	1					=	
NETKCAP										1				<	Tot Q5A
NATKCAP											1			<	4
NASEMCAP												1		<	2
NLICXP										922	922	2682	-1	=	
NINSXP										1807	1807	1609	-1	=	
NREPXP										1445	1445	11263	-1	=	
NGLOXP										6065	6065	12336	-1	=	
NWAGEXP									(.056*183)				-1	=	
NDEPRXP										Q18G	5162	6973	-1	=	
NOPPXP										Q19G	6246	2682	-1	=	

FIGURE L.3 : BULK FEED TABLEAU

	NMDZIP1D	NMDZIP2D	NMDZIP3D	NMDZIP4D	NMXFDD	NMXFDTT	NFDTKT1	NFDTKT2	NFDTKT3	NFDTKT4	NFDTKTT	NFDTKD	NSTDD	NEGM	NAGM	NEDPTK	NADPTK	NASEMI	NEXPENSE		RHS
PROFIT					1							1	1						-1	N	MAX
NTSAL					1							1	1							=	
NMFDZIP1	1																			<	POT1
NMFDZIP2		1																		<	POT2
NMFDZIP3			1																	<	POT3
NMFDZIP4				T1																<	POT4
NMXFDPTT	-1	-1	-1	-1	1															=	
NBGFDPTT						-212*.3333														=	
NFDTKRT1	-1						(Q13G/.05*1/Q8B1)													=	
NFDTKRT2		-1						(Q13G/.05*1/Q8B1)												=	
NFDTKRT3			-1						(Q13G/.05*1/Q8B1)											=	
NFDTKRT4				-1						(Q13G/.05*1/Q8B1)										=	
NFDTKPR											-Q8A2	1								=	
NMXFDPR					0.05	-Q13G														=	
NSTDPR							-Q12B*Q13H						1							=	
NFDTKRTT							1	1	1	1	-1									=	
NFDTRAN							-.8696	-.1.0011	-1.0393	-1.4263						6600	6600	(5688*COEF)		>	0
NETKCAP																1				<	Tot Q5A
NATKCAP																	1			<	4
NASEMCAP																		1		<	2
NTGMCAP						-1								Q3A	0					>	0
NEGMCAP														1						<	1
NAGMCAP															1					<	1
NLICXP																922	922	2682	-1	=	
NINSXP																1807	1807	1609	-1	=	
NREPXP														Q14B3*Q15E		1445	1445	11263	-1	=	
NGLOXP																6065	6065	12336	-1	=	
NUTLXP														Q14A1*Q15D					-1	=	
NWAGEXP					0.056							.056	.056						-1	=	
NDEPRXP														Q18A	2000		5162	6973	-1	=	
NOPPXP														Q19A	1100		6246	2682	-1	=	

FIGURE L.4 : MIXED FEED TABLEAU

	NGTZIP1D	NGTZIP2D	NGTZIP3D	NGTZIP4D	NBGFTD	NBGFTTT	NFTTKT	NFTTKD	NFTINV	NEGPTK	NAGPTK	NEXPENSE		RHS
PROFIT					+Q16D			+1.0				-1	N	MAX
NTSAL					1			1					=	
NGFTZIP1	1												<	POT1
NGFTZIP2		1											<	POT2
NGFTZIP3			1										<	POT3
NGFTZIP4				T2									<	POT4
NBGFTPTT	-1	-1	-1	-1	1								=	
NBGFTPR					-1	155							=	
NFTTKPR							Q9D2	-1					=	
NBGFTTR						Q9D1	-1						=	
NFTTURN					1-Q16D				-Q17B				=	
NGPTRAN							-1			1500	1500		>	0
NEGPCAP										1			<	TOT Q5G,H
NAGPCAP											1		<	x=100
NLICXP									0.0025	500	500	-1	=	
NINSXP									0.0075	1807	1807	-1	=	
NREPXP										1445	1445	-1	=	
NGLOXP										5000	5000	-1	=	
NWAGEXP					0.056			0.056				-1	=	
NDEPRXP										Q18F	5000	-1	=	
NOPPXP									0.11	Q19F	2200	-1	=	

FIGURE L.5 : BAG FERTILIZER TABLEAU

	NKTZIP1D	NKTZIP2D	NKTZIP3D	NKTZIP4D	NBKFTD	NBKFTT	NFTINV	NFTACSP1	NFTACSP2	NFTACSP3	NFTACSP4	NFTACSPT	NLQACSP1	NLQACSP2	NLQACSP3	NLQACSP4	NLQACSPT	NEFTFAC	NAFTFAC
PROFIT					Q16E														
NTSAL					1														
NKFTZIP1	1																		
NKFTZIP2		1																	
NKFTZIP3			1																
NKFTZIP4				T2															
NBKFTPTT	-1	-1	-1	-1	1														
NBKFTPR					-(1-Q12E)	164													
NFTSPRT1	-1							(164/2000/Q12C)/1-Q12E											
NFTSPRT2		-1							(164/2000/Q12C)/1-Q12E										
NFTSPRT3			-1							(164/2000/Q12C)/1-Q12E									
NFTSPRT4				-1							(164/2000/Q12C)/1-Q12E								
NFTSPRTT								-1	-1	-1	-1	1							
NFTSPTR								-.8696	-1.0011	-1.0393	-1.4263								
NFTSPPR												Q9A1*Q9A2					Q9F1*Q9F2		
NFTEQPR												Q9B2*Q12C/2000*Q9B1					Q9E1*Q9E2		
NLQSPRT1	-1												(1/Q12E*26.4)						
NLQSPRT2		-1												(1/Q12E*26.4)					
NLQSPRT3			-1												(1/Q12E*26.4)				
NLQSPRT4				-1												(1/Q12E*26.4)			
NLQSPRTT													-1	-1	-1	-1	1		
NLQSPTR													-.8696	-1.0011	-1.0393	-1.4263			
NFTTURN					(1-Q16E)		Q17B												
NECBCAP																			
NACBCAP																			
NBIGACAP																			
NFTTKCAP																			
NSPTKCAP																			
NTFACCAP						-1												Q4A	0
NEFACCAP																		1	
NAFACCAP																			1
NTBUGCAP								-.8696	-1.0011	-1.0393	-1.4263								
NEBUGCAP																			
NABUGCAP																			
NLQEQTR													-.8696	-1.0011	-1.0393	-1.4263			
NLQEQCAP																			
NLICXP							0.0025												
NINSXP							0.0075												
NREPXP																		Q14B4*Q15E	
NGLOXP																			
NUTLXP																		Q14A2*Q15D	
NWAGEXP					0.068														
NDEPRXP																		Q18B	2000
NOPPXP							0.11											Q19B	1100

FIGURE L.6.1 : BULK FERTILIZER TABLEAU

	NFTSPD	NFTEQD	NECBTK	NACBTK	NABIGA	NEFTTK	NESPTK	NELQEQ	NEFTBUG	NAFTBUG	NEXPENSE	RHS
PROFIT	1	1									-1	N MAX
NTSAL	1	1										=
NKFTZIP1												< POT1
NKFTZIP2												< POT2
NKFTZIP3												< POT3
NKFTZIP4												< POT4
NBKFTPTT												=
NBKFTPR												=
NFTSPRT1												=
NFTSPRT2												=
NFTSPRT3												=
NFTSPRT4												=
NFTSPRTT												=
NFTSPTR			(14000	14000	16000	10000 /Q9A1)						> 0
NFTSPPR	-1											=
NFTEQPR		-1										=
NLQSPRT1												=
NLQSPRT2												=
NLQSPRT3												=
NLQSPRT4												=
NLQSPRTT												=
NLQSPTR			(14000	14000	16000		10000 /Q9F1)					> 0
NFTTURN												=
NECBCAP			1									< TOT Q5E
NACBCAP				1								< x=10
NBIGACAP					1							< x=10
NFTTKCAP						1						< TOT 15B
NSPTKCAP							1					< TOT Q5F
NTFACCAP												> 0
NEFACCAP												< 1
NAFACCAP												< 1
NTBUGCAP									9091	9091		> 0
NEBUGCAP									1			< TOT Q5D
NABUGCAP										1		< x=10
NLQEQTR								(3750/Q9E1)				> 0
NLQEQCAP								1				< TOT Q5J
NLICXP				852	852	852	852	135	135	135	-1	=
NINSXP				1631	1631	1631	1631	68	68	68	-1	=
NREPXP			1305	1305	6800	1305	1305	203	203	203	-1	=
NGLOXP			9850	9850	10000	9850	9850				-1	=
NUTLXP											-1	=
NWAGEXP	.068	.068									-1	=
NDEPRXP			Q18H	4611	22993	Q18J	Q18E	Q18I	Q18K	1352	-1	=
NOPPXP			Q19H	4894	18854	Q19J	Q19E	Q19I	Q19K	1014	-1	=

FIGURE L.6.2 : BULK FERTILIZER TABLEAU

	NLMZIP1D	NLMZIP2D	NLMZIP3D	NLMZIP4D	NLIMED	NLMHLT1	NLMHLT2	NLMHLT3	NLMHLT4	NLMHLD	NLMRGT1	NLMRGT2	NLMRGT3	NLMRGT4	NLMRGD	NABIGA	NEXPENSE	RHS
PROFIT										.138					.09			N MAX
NTSAL					1													=
NLIMZIP1	1																	< POT1
NLIMZIP2		1																< POT2
NLIMZIP3			1															< POT3
NLIMZIP4				T2														< POT4
NLMSPRT1	-1					20.5					20.5							=
NLMSPRT2		-1					20.5					20.5						=
NLMSPRT3			-1					20.5					20.5					=
NLMSPRT4				-1					20.5					20.5				=
NLIMEPTT					1					-1					-1			=
NLMHLPR						20.5	20.5	20.5	20.5	-1								=
NLMRGPR											20.5	20.5	20.5	20.5	-1			=
NLMSPTR						-.86960	-1.0011	-1.0393	-1.4263							7000		> 0
NBIGACAP																1		< 2
NWAGEXP										.068							-1	=

FIGURE L.7 : LIME TABLEAU

	NSDZIP1D	NSDZIP2D	NSDZIP3D	NSDZIP4D	NSEEDD	NSDINV	NSDWHSE	NEWHSE	NAWHSE	NEXPENSE		RHS
PROFIT					+Q16H					-1	N	MAX
NTSAL					1						=	
NSEDZIP1	1										<	POT1
NSEDZIP2		1									<	POT2
NSEDZIP3			1								<	POT3
NSEDZIP4				T2							<	POT4
NSEEDPTT	-1	-1	-1	-1	1						=	
NSDTURN					1-Q16H	-Q17C					=	
NSDWHRAT						-1	33.75				=	
NTWHSE							-1	Q1A	1000		>	0
NEWHCAP								1			<	1
NAWHCAP									1		<	x=100
NLICXP						0.0025				-1	=	
NINSXP						0.0075				-1	=	
NREPXP								Q14B1*Q15E		-1	=	
NUTLXP								Q14A3*Q15D		-1	=	
NWAGEXP					0.06					-1	=	
NDEPRXP								Q18F	450	-1	=	
NOPPXP						0.11		Q19F	1650	-1	=	

FIGURE L.8 : SEED TABLEAU

	NFSZIP1D	NFSZIP2D	NFSZIP3D	NFSZIP4D	NFSD	NFSINV	NFSWHSE	NESHRM	NASHRM	NEWHSE	NAWHSE	NEXPENSE		RHS
PROFIT					+Q16I							-1	N	MAX
NTSAL					1								=	
NFSZIP1	1												<	POT1
NFSZIP2		1											<	POT2
NFSZIP3			1										<	POT3
NFSZIP4				T2									<	POT4
NFSPTT	-1	-1	-1	-1	1								=	
NFSTURN					1-Q16I	-Q17D							=	
NFSWHRAT						-1	27.35						=	
NTWHSE							-1			Q1A	1000		>	0
NEWHCAP										1			<	1
NAWHCAP											1		<	x=100
NTSHRM					-1/255			Q2A	1000				>	0
NESHCAP								1					<	1
NASHCAP									1				<	x=100
NLICXP						0.0025						-1	=	
NINSXP						0.0075						-1	=	
NREPXP								Q14B2*Q15E		Q14B1*Q15E		-1	=	
NUTLXP										Q14A3*Q15D		-1	=	
NWAGEXP					0.06							-1	=	
NDEPRXP								Q18C	1250	Q18D	450	-1	=	
NOPPXP								Q19C	4400	Q19D	1650	-1	=	

FIGURE L.9 : FARM SUPPLY TABLEAU

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