AN EVALUATION OF CHANGES IN SUPPLY STRUCTURE ON THE ECONOMIC VIABILITY OF FARM SUPPLY COOPERATIVES

by

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(ABSTRACT)

The volatile economic world of agriculture in the past two decades has had a significant impact on agribusinesses. Among these agribusinesses are farm supply cooperatives. Consolidation of farm supply cooperative stores could help to correct many inefficiencies which they face. This research attempted to create a model which would help cooperative managers consider consolidation of cooperative stores or product lines as a method to correct inefficiencies and lower the costs of doing business. A microcomputer based linear programming model which simulates the product/trade flows of a farm supply cooperative trade area was developed. This model simulates consumer behavior by minimizing the net cost (purchase price plus cost of transport) of purchasing agricultural supplies to the patron. Using the simulated product flows, the financial situation of the trade area was presented. The model was tested by analyzing several consolidation scenarios based on the costs, prices, and asset capacities of a sample trade area. Consolidation of the feed and fertilizer product lines into one location was found to be a very successful cost saving scenario for the sample trade area.

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CHAPTER 1

INTRODUCTION

1.1 Economic Environment of Agriculture and Agribusiness

Agriculture has been riding an economic roller coaster for the past two decades. The 1970's were prosperous for American agriculture. An upward trend in commodity prices and increased foreign demand for U.S. farm products led to near full utilization of farm land by the end of the 1970's [PCA]. Low interest rates and rising land values put farmers in a position where they could borrow more money. Hence, farm debt rose from $53 billion in 1970 to $175 billion by 1981 in nominal dollars without a large increase in the debt to equity ratios of farmers [USDA, 1988]. Seemingly healthy markets for farm products and a ready supply of capital helped justify farmers basic urge to enlarge their operations. This resulted in a greater demand for farm inputs such as fertilizer, feed, petroleum, and agricultural chemicals.

As farmers prospered, so did farm supply businesses. Farmers' production expenses grew from $44 billion in 1970 to $123 billion by 1979 in nominal dollars [USDA, 1981]. Farm input prices also rose during this period. The great demand and high prices for farm inputs allowed agribusinesses to be less concerned about efficiency of operation and the costs of doing business. Poor management decisions were often masked by high demand and large profits.

By the early 1980's, the farm economy hit a peak and began a rapid descent. Farmers began to feel the pinch of decreased export demand, lower commodity prices, and higher input costs. The debt to equity ratios of most farmers increased as farm land values, their main source of equity, began to fall [USDA, 1988]. Interest rates increased and, by 1981, interest expense for farmers became their single greatest production cost [PCA]. Production expenses rose from 67 percent of gross U.S. farm income in 1974 to 81 percent by 1986 [Kohl]. Profitability (defined as gross farm income as a percent of expenses) fell for all farms between 1970 and 1984 [Allen et al.]. Prices, export demand, farmland values, and interest rates were beyond the farmer's control. This left reduction of production costs as the primary method farmers had to maintain their income.

Due to farmers' financial problems, the demand for farm inputs decreased. Hence, farm supply businesses felt the repercussions. Coupled with decreasing product margins and farmers who couldn't pay their bills, farm input suppliers had trouble remaining profitable [USDA, 1988].

The demographics of farming has also changed in the past two decades. The number of mid-sized family farms has decreased while the number of small farms and large farms has been rising. This bimodal trend is likely to continue. According to recent studies, the number of mid-sized farms (annual gross sales of $25,000 to $250,000) will continue to drop from over 800,000 in 1987 to just over 200,000 by the year 2000 [Kohl]. Meanwhile, mega-farms (annual gross sales of over $250,000) will increase from over 27,000 in 1987 to over 50,000 by the year 2000 [Kohl].

The profitability of middle sized farms also lags behind that of larger farms. Between 1970 and 1984, the profitability of middle sized farms fell 14 percent while profitability only fell one percent for large farms [Allen et al.]. Larger farms have a cost advantage over their smaller counterparts. They typically have higher yields, spend less per acre on inputs, and use fewer, more efficient machines. Large farm operators usually have better access to information, finances, and other resources [Allen et al.].

1.2 The Agricultural Supply Cooperative's Historical Role

Agricultural supply cooperatives have not been immune to the changes in agriculture. As with investor oriented farm suppliers, the cooperatives were hit hard by the declining agricultural economy. However, the organization of cooperatives and their goals and purposes make the problems which they face and the proposed solutions somewhat different and more complex.

Agricultural cooperatives were first organized so farmers could work together to strengthen their power in marketing farm products, purchasing farm inputs, or providing specialized services. The farm supply cooperative is the focus of this thesis. The goal of a farm supply cooperative is to provide farmers with a steady, dependable supply of farm inputs at the lowest possible prices. Supply cooperatives buy inputs in large quantities and distribute them at a lower cost than individual members could obtain by themselves. Investor oriented firms (IOFs) attempt to maximize profits so they can maximize the welfare of their investors. Cooperatives are more concerned with economic viability. Economic viability is defined as serving the patrons at the lowest possible price while maintaining a level of sales and income sufficient to cover all costs. All of a cooperative's profits are passed on to its patrons. Hence, cooperatives may be able to supply inputs to farmers at lower prices than IOFs.

Many of the advancements in American agriculture over the years have been accomplished through the cooperative efforts of farmers. Although the first formal agricultural purchasing cooperative was formed in New York in 1863, agricultural supply cooperative efforts date back to the 1780's [USDA, 1987]. By 1985, about 4,150 farmer cooperatives handled production supplies and about 2,000 of them depended on farm supplies for 50 percent of their volume [Cropp and Ingalsbe]. Nationwide, 26 percent of all farm supplies in 1986, at a volume of $15 billion, were purchased by farmers from cooperatives [Cropp and Ingalsbe]. Thus, agricultural supply cooperatives play a critical role in the livelihood of farming.

The growth of agricultural cooperatives in the three decades prior to 1981 was astounding. The annual net sales volume of all cooperatives increased about 800 percent from 1951 to 1981 even as the number of agricultural cooperatives and their farmer memberships declined [USDA, 1987]. Cooperatives increased their share of the farm supply market from 17 percent in 1950 to 28 percent by 1985 [USDA, 1987]. However, the recession of agriculture in the 1980's brought growth in cooperatives' total business volume, net income, and shares of the farmers' marketing and purchasing business to a halt [Cropp and Ingalsbe]. All marketing and purchasing cooperatives were hurt, especially those in the food and feed grains areas, and related farm supply areas.

1.3 The Changing Needs of Patrons

Several problems have plagued supply cooperatives in the past 10 years. Many of the problems were due to the changing economy and were not controllable by the cooperatives. Others were caused by poor management and inefficiencies in the cooperative's production and distribution systems. All are a threat to the economic viability of farm supply cooperatives and, hence, their patrons. A discussion of these problems follows.

Excess capacity in cooperatives has been a problem in the 1980's. In the 1970's, cooperative leaders believed that their major problem was being unable to expand quickly enough to meet the needs of their patrons [Chambonnet and Schrader]. Supply cooperatives responded by expanding their operations in the 1970's by building more stores. Now, due to the decrease in farm input demand, much of this capacity goes unused, especially in the feed mills and fertilizer plants. Hulslander found that a cooperative trade area in Maryland was only using 14 percent of its available feed grinding and mixing capacity and 16 percent of its fertilizer blending capacity. Excess production capacity causes higher per unit costs for supply cooperatives and, in turn, higher prices for farmers. These cost inefficiencies mean that these cooperatives may no longer be supplying inputs to farmers at the lowest possible cost. Thus, these cooperatives may not be achieving their primary purpose.

The changing structure of farming presents another tough challenge for cooperatives. The size of farms in the U.S. has moved away from medium sized farms to both larger and smaller farms [Kohl]. This leaves many supply cooperatives in a difficult situation in terms of serving their members. Cooperatives were started as a mechanism where farmers with small and medium sized operations could pool orders to gain purchasing power. Yet, as farms become larger, these farm operators become more price sensitive [Dunn et al.; Hamm]. They can buy larger volumes at discounted prices directly from wholesalers and, thus, completely bypass the local cooperative. To lose the large farmers' patronage would seriously reduce the business volume of agricultural supply cooperatives. Without the business of the large farmer, cooperatives would find it difficult to cover the costs of operation. This would drive prices up for the middle sized and smaller farmers. As this trend to larger farms continues, cooperatives need to maintain their market share by meeting the high volume purchase needs of large farmers in order to remain competitive. Yet, they must continue to meet the needs of those small and mid-sized farmers for which they were originally formed.

Furthermore, cooperatives need to be able to adjust to future changes in the farm supply industry if they are to remain economically viable. Farmer preferences continually change as they demand new and better products and services. As society becomes more environmentally conscious, new laws and regulations at the federal, state, and local levels could add costs to the existing operations. The dynamic nature of the farm supply marketplace requires that cooperatives continually evaluate their operations.

Inefficiencies within cooperative stores are very detrimental to their economic viability. These inefficiencies cause higher costs to the cooperative and higher prices to farmers. Hulslander outlined the following points as sources of cooperative inefficiency. Some of these inefficiencies are not unique only to cooperatives.

Store size can create inefficiencies for cooperatives. The 1970's expansion trends led to more stores within each trade area. The smaller stores now cannot generate enough business volume over which to spread fixed costs. Customers may not receive the best combination of price and service at the small supply stores. Larger supply stores could capitalize on economies of size and more easily provide the required services.

Too many stores serving the same trade area may result in inefficiencies for regional cooperatives. This situation encourages inter-cooperative competition for the business of the same patrons. Coffey [1984] found that 40 percent of the Southern States customers patronized two or more Southern States stores. Coffey [1982] also found that for the 219 Southern States cooperative stores, the average distance between stores was 18 miles. Since 90 percent of Southern States patrons travelled 15 miles or less for farm supplies [Coffey, 1984], there is an overlap of sales areas. In these cases, both cooperative stores could have trouble maintaining enough business volume to remain economically viable. Furthermore, both the investor oriented supply firm and the local independent cooperative have an edge in competition over a regional supply cooperative. They can expand their market area and volume without competing with a sister store [Hulslander]. The number of firms serving a trade area has a significant impact on long run economic viability. With competition from private business, competing cooperatives, and sister cooperatives, a lack of sufficient sales volume for any one store may result.

Another problem stems from too many handlers of the product. Needless handling of the products leads to inefficient distribution and adds to the their cost. A more direct link from the wholesalers to the patrons would lower costs and, ultimately, the price to the patrons. A more streamlined distribution system would especially help the feed and fertilizer enterprises.

Misallocation of assets may cause inefficiency within the cooperative. Underutilized assets add unnecessary costs to the operation and increase the patron's purchase price. Few stores may get enough business to efficiently use available assets or to justify the purchase of specialized assets. Yet, supply sites lacking certain assets reduce the quality of services provided by the cooperative. This problem is typically found in the feed grinding and fertilizer blending operations of a supply cooperative.

Inefficiencies are also caused by inexperienced managers interacting with the larger commercial operator. Larger operators are much more concerned with prices than smaller farmers. They control enough sales volume to warrant special attention. However, some cooperatives lack managers with the skills to interact with these farmers. Management talent may be spread too thinly due to the large number of retail outlets. Also, since sales volume is low, good management talent might be lost because cooperatives cannot pay sufficient salaries. The lack of qualified managers makes it hard to meet the special needs of large farms.

The problems of supply cooperatives will not magically disappear. A study of farmers' loyalty to supply sources [Schrader et al., 1983] found that, although cooperative patrons are marginally more loyal than customers of IOFs, this loyalty would not allow the cooperatives room for complacency or to ignore the competition. An approach to the problem needs to be developed so supply cooperatives can remain economically viable and compete with IOFs in the changing agricultural supply marketplace.

1.4 The Cooperative's Response

Supply cooperatives can improve economic viability in two ways. One method is to increase the margins of the products sold. The second method is to increase the cooperatives' sales. A discussion of the advantages and disadvantages of each method follows.

One way to increase product margins is to increase product prices. The larger margins increase net income for the cooperatives and allow for more investment and, possibly, higher patronage refunds. However, market share might suffer from this strategy. Schrader et al., [1983] found that farmers have several alternative sources for agricultural supplies and often receive price quotes from more than one source. They also found that ten to twenty percent of farmers were willing to change suppliers for a price advantage of as little as two or three percent. Hence, a price increase by cooperatives could worsen the present situation. However, if increasing costs warrant a price increase, the cooperative must do so since no business enterprise should operate at a loss.

A second way to increase margins is to reduce the cost to the cooperative of supplying products. Since the wholesale costs are fixed, production and distribution of products are the only candidates for reduction. This is by no means as simple to implement as the increase in price. However, it may be a more feasible solution since many of the problems supply cooperatives face are due to inefficiencies in production, distribution, and organization.

The cooperative's sales could be increased in two ways. The first method is to offer better services to member farmers. This would entice farmers to purchase goods from the cooperative for reasons other than product price. It would especially benefit the smaller farmers who do not have the equipment or the capital to complete some specialized tasks on their own such as fertilizer and chemical application or feed grinding. However, increased services could result in higher prices.

Reducing prices to customers is a second way to increase sales. Price reductions would help win the large farm market back from the wholesalers. However, a price reduction to increase sales conflicts directly with attempts to increase margins. Hence, this method would have to coincide with a cost reduction to maintain the economic viability of the cooperative and to allow a comfortable operating margin for future capital investment.

Consolidation of cooperative stores could be an effective technique to help correct some of the problems cooperatives face. Cooperatives could consolidate entire supply stores or the most capital intensive enterprises such as fertilizer or feed sales into fewer locations. Consolidation could reduce costs by eliminating some of the excess production and distribution capacity of the stores. One store in a trade area at near full capacity can operate more efficiently than two or more stores producing at less than full capacity. Fewer stores producing at near full capacity may have lower per unit labor, repair, and overhead costs and, thus, can more easily capitalize upon economies of size by spreading fixed costs over more product volume. The lower costs would increase margins to the cooperative and effectively reduce the price of the products to member farmers. Fewer cooperative stores in a trade area would decrease inter-cooperative competition and increase the market share of individual stores.

Consolidation may also correct some of the inefficiencies identified by Hulslander. Consolidating into one location addresses the problems of inter-cooperative competition, underutilization of assets, and lack of management expertise. Fewer stores may also relieve long supply lines as the product may be delivered directly from the wholesaler.

Consolidation can help cooperatives to better serve the needs of large farm operations. Large, more efficient cooperative stores can lower the costs of production and allow the price discounts for the large purchases of these farmers. Larger stores can also invest in the equipment necessary to provide the services that both large and small producers require. Fewer stores also allow the most experienced managers to manage the consolidated operation.

Consolidation does have disadvantages. It actually represents a reallocation of the farmer's net purchase cost (product price plus transport costs). Consolidation lowers operating and fixed costs to the cooperative and, hence, the price to the patron. In turn, some patrons will be located farther from the consolidated cooperative and will have higher transport costs. A decrease in product sales could result as some farmers become unwilling to pay the higher transport costs. Second, delivery costs to the cooperative will be increased since fewer stores will be serving the same trade area. The decrease in operating and fixed costs must be greater than the increase in delivery costs and decrease in sales in order for consolidation to be feasible.

Consolidation cannot be implemented blindly. Three factors must be considered when making consolidation decisions. First, do any existing sites have the production and storage capacity to handle the increased volumes after consolidation? Second, will the patrons react favorably to consolidation and the reallocation of their net purchase costs? Third, does consolidation affect the financial health of the cooperatives?

1.5 Objectives and Procedures

The overall objective of this research is to analyze the effects of changes in supply, demand, and supply structure on the economic viability of farm supply cooperatives. More specifically, the objectives are:

1. To develop a microcomputer-based model which will simulate product flows based on consumer behavior.

2. To determine the degree of accuracy with which the model replicates consumer demand and cooperative operations using a case study area.
3. To evaluate the effects of consolidation and associated demand changes on the economic viability of the cooperative in the case study area.
4. To analyze the effects demand changes due to changing demographics, both independent of consolidation and with consolidation, on the economic viability of the cooperative in the case study area.
5. To identify cooperative policy implications and strategies for cooperative management to employ in consolidation decisions.

Development of a model which will simulate consumer behavior and purchasing habits is essential to this research. Previous cooperative consolidation research used linear programming models which optimized the distribution of farm inputs at the maximum profit to the cooperative [French]. Unfortunately, this is not consistent with the cost minimizing behavior of the patrons and would not accurately model their purchasing habits. This research will use a linear programming model to minimize the patron's cost of buying the product. This approach is consistent with purchasing behavior and more closely achieves the cooperative goal of supplying inputs to the farmers at the least cost.

Data from a trade area will be gathered to build the model. The test region consists of five stores which sell a full range of farm supplies. A baseline scenario will be run and the results compared to the actual distribution and financial records of the test region to assess the accuracy of the model.

Alternative scenarios will be analyzed to determine the economic viability of the trade area. Scenarios may include consolidating entire stores or simply shutting down the distribution of certain product lines from some stores. The model will determine the distribution of product, the profitability of each store, and the utilization of assets for the scenario. Demand changes will be simulated to test the sensitivity of the baseline scenario and the final consolidation scenario to them. This is a critical part of the research since changes in the supply structure of a trade area can alter the consumers' purchasing behavior.

1.6 Organization of the Thesis

Chapter 2 contains the theoretical considerations of this research and a review of literature. Included in this section are a reviews of the history of cooperatives, cooperative theory and the economic justification of cooperatives, efficient organization within a market, linear programming theory, consumer behavior theory, and previous research using retail distribution models. Chapter 3 discusses the model used in this study and defines the relevant model variables. Chapter 4 describes the test region and the data used in the model. Chapter 5 reports the results of the baseline scenario and the consolidation scenarios including an analysis of product distribution, economic viability, and asset utilization. Sensitivity analysis of demand is also discussed in Chapter 5. Chapter 6 summarizes and concludes the research and reports the limitations of the study and areas of future research. It also discusses the applicability of the model to cooperative management.

CHAPTER 2

THEORY AND REVIEW OF LITERATURE

2.1 Introduction

Andrew and Hildebrand state that theory envelopes and supports the entire research process. "The greater the command of theory possessed by the researcher, the broader will be his capabilities..." [pg. 4]. The theoretical basis for this research can be divided into four categories: theory of the cooperative, efficient organization within a market, consumer behavior theory, and the linear programming transportation model. The final section of this chapter reviews previous literature relating to agricultural retail distribution models.

2.2 Theory of the Cooperative

This section is a combination of theory, history, and a review of cooperative literature. It begins with a review of cooperative history. The next two parts explain the structure and principles, and the economic justification of cooperatives. Finally, a review the theory of the firm and its application to farm supply cooperatives is presented.

2.2.1 History of Cooperatives

The following section draws heavily from Groves and Ingalsbe, and Abrahamsen [1980; 1987]. The American Heritage Dictionary defines cooperate as "to work together toward a common end or purpose." Cooperation as a business concept with a distinct set of operating principles is about a century and a half old [Groves and Ingalsbe]. The best known early cooperative was formed in 1844 in England by the Rochdale Society of Equitable Pioneers. They formed a consumer cooperative and formulated a basic set of rules for its operation. The Rochdale principles are listed in Table 2.1. These principles covered membership requirements, voting procedures, patronage refunds, pricing, and other important aspects in the operation of a cooperative. The Rochdale principles are commonly used today for governing cooperatives. The success of this endeavor had a great impact upon the unique operating characteristics of today's agricultural cooperatives.

Agricultural cooperation also began early in U.S. history. In the 1780's, farmers formed organized societies to perform specific tasks for the benefit of the users. The first resemblance of a farm supply cooperative was an organized effort in the 1780's where farmers worked together to import purebred cattle. Farmer's clubs in Illinois and Wisconsin unsuccessfully attempted to purchase production supplies in the 1850's. The first organized farmers' purchasing association was created to buy fertilizer at Riverhead, New York in 1863.

After the Civil War, cooperatives were recognized as feasible, self-help business alternatives for agriculture producers. Three factors influenced the development of agricultural cooperatives since the middle of the nineteenth century [Groves and Ingalsbe]. The first category is economic conditions whether produced by war, depression, technology, national economic policy, or the marketplace. Farmers used cooperatives to assure reliable markets for their agricultural products and a steady

Table 2.1 - The Rochdale Principles

1. Open membership to all regardless of sex, race, politics, or religious creed.
2. One vote per member.
3. Any capital required should be provided by members and should earn a limited rate of return.
4. Any net margins should be returned to members in proportion to patronage.
5. Cooperative should allocate some funds for education in the principles and techniques of cooperation.
6. Market prices should always be charged; i.e., no price cutting to pass on cooperative savings directly.
7. Cash trading; no credit asked or given.
8. Products should be accurately formulated and labeled.
9. Full weight and measure should be given.
10. Management should be under the control of elected officers and committees.
11. Accounting reports of financial health should be presented frequently to members.

Source: Cotterill, 1987

supply of inputs during economic turmoil. The second is farmer organizations utilizing their leadership, motivational capability, enthusiasm for promoting cooperatives, effectiveness for influencing public policy, and longevity. These organizations were a collective effort to improve the welfare of farmers. The formation of cooperatives, another type of self-help organization, was a logical next step. The third category is public policy as determined by legislative intent at both the state and national level, and by judicial interpretation. Some government officials saw agricultural cooperatives as a good example of how collective efforts could produce beneficial results. Others thought cooperatives were simply another form of monopoly.

The promotion of agricultural cooperatives after the Civil War was largely due to the efforts of a farmers' organization called the Order of the Patrons of Husbandry, known now as the Grange. Knapp credits the Grange with several key contributions including (1) popularizing cooperatives as a business concept throughout the nation, (2) proving the power of cooperative action, (3) demonstrating the value of the Rochdale principles, showing that they could be applied to marketing as well as purchasing, and (4) identifying the necessity of sound business management and operations for cooperatives. Though the Grange cooperatives and many other farmer association affiliated cooperatives were short lived, they paved the way for the successful cooperatives of the future. Many of the largest and strongest cooperatives of today were started by farm organizations.

Many important acts of legislation have shaped the nature of the agricultural cooperative. Though it did not mention cooperatives, the Sherman Antitrust Act (1890) did much to discourage their development. Sections 1 and 2 of the act were of special concern to cooperatives. Section 1 declared all contracts or conspiracies, in restraint of trade or commerce among the several states or with foreign nations, illegal. In other words, collusion among sellers to fix prices or restrict trade was declared illegal. Section 2 made the formation of monopolies punishable by imprisonment. These sections made the main goals of cooperatives illegal. Farmers could not collectively, through cooperatives or any other means, influence the price of their products or attempt to gain monopoly power. An amendment to exclude agricultural cooperatives from this act was defeated because of the enthusiasm for controlling monopolies.

Since 1908, the government has passed laws to favor the cooperative environment and has become involved in the creation and funding of cooperatives in agricultural credit. Commissions created by Theodore Roosevelt and Woodrow Wilson in 1908 and 1913 studied successful European cooperatives and set in motion the events leading to the creation of the cooperative Farm Credit System.

The Clayton Act of 1914 was aimed at correcting the deficiencies of the Sherman Antitrust Act. Though it also did not specifically mention cooperatives, it was the first legal recognition of the benefits of agricultural cooperation at the federal level. Section 6 of the Clayton Act stated that human labor was not a commodity and that antitrust laws did not apply to labor, agricultural, or horticultural organizations created for the purposes of self-help. However, this exemption applied only to nonstock associations which, at the time, were a relatively unimportant part of the agricultural cooperative sector. Still, the Clayton Act opened the door to the idea that cooperatives as mutual and non-profit associations were a special and distinct type of business enterprise.

Agricultural cooperatives were finally recognized as legal business entities by the federal government with the passage of the Capper-Volstead Act of 1922. This act, entitled "An Act to Authorize Associations of Producers of Agricultural Products," clarified antitrust law treatment of agricultural cooperatives, thus facilitating their growth. The act allowed farmers to "act together in associations" to collectively process and market farm products, and to form marketing agencies-in-common. It stated that cooperatives must operate for the mutual benefit of their members and laid down several other organizational requirements. Yet, lawmakers were concerned about the ability of cooperatives to gain monopoly power. In section 2 of the act, they forbade farmers' organizations from using a monopoly position to "unduly enhance price." No other type of business was or is subject to such a consumer protection law. Still, the Capper-Volstead Act was a landmark act which enhanced the development of agricultural cooperatives.

Several subsequent acts were based on the Capper-Volstead Act. The Cooperative Marketing Act of 1926 directed the USDA to create a cooperative marketing division to collect and analyze cooperative data, conduct research pertaining to cooperatives, help in cooperative organization, and promote the knowledge of cooperative principles and practices. This act still guides the Agricultural Cooperative Service division of the USDA.

Provisions in the Agricultural Marketing Act of 1929 were aimed at promoting the success of cooperatives. These provisions established advisory commodity committees from cooperative associations, created the Federal Farm Board which helped expand and strengthen the cooperative movement, and provided a $500 million revolving fund to make loans available to cooperatives.

The New Deal administration of Franklin Roosevelt created many government agencies to help farmers and farm cooperatives battle the economic crisis of the Great Depression. These agencies included the Agricultural Adjustment Administration (1933), the Farm Credit Administration (1933), the Tennessee Valley Authority (1933), the Rural Electrification Administration (1935), and the Resettlement Administration (1935) which later became the Farm Security Administration (1937). The New Deal administration promoted cooperatives wholeheartedly because they felt the cooperative efforts of farmers set an excellent example for the entire nation.

Statistics show two very different trends in the world of agricultural cooperatives since World War II. The number of cooperatives and the patron membership have steadily decreased during this period. Figures 2.1 and 2.2 illustrate the changes in the number of cooperatives and membership for farm supply cooperatives and all agricultural cooperatives from 1951 to 1985. The passage of the Capper-Volstead Act led to a peak in the number of cooperatives at 12,000 in 1930

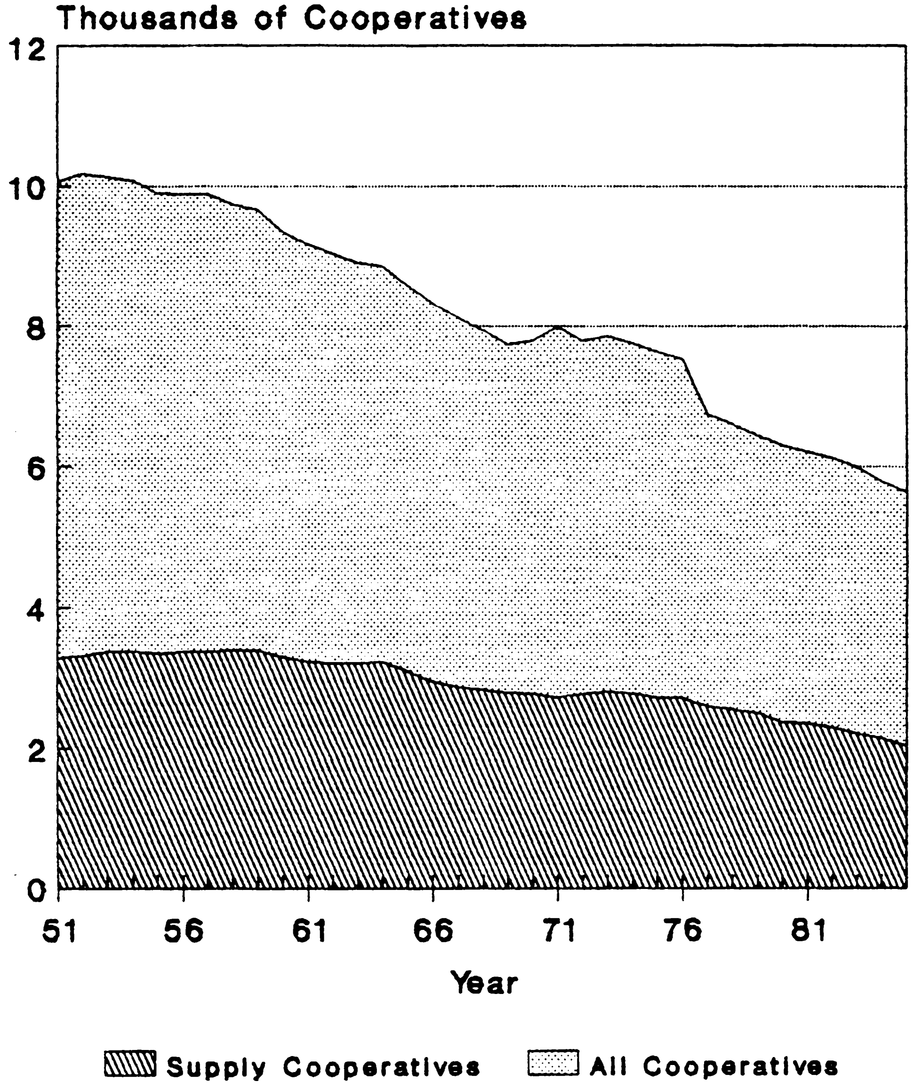


Figure 2.1 - Farm Cooperatives in the United States

Source: USDA, 1987

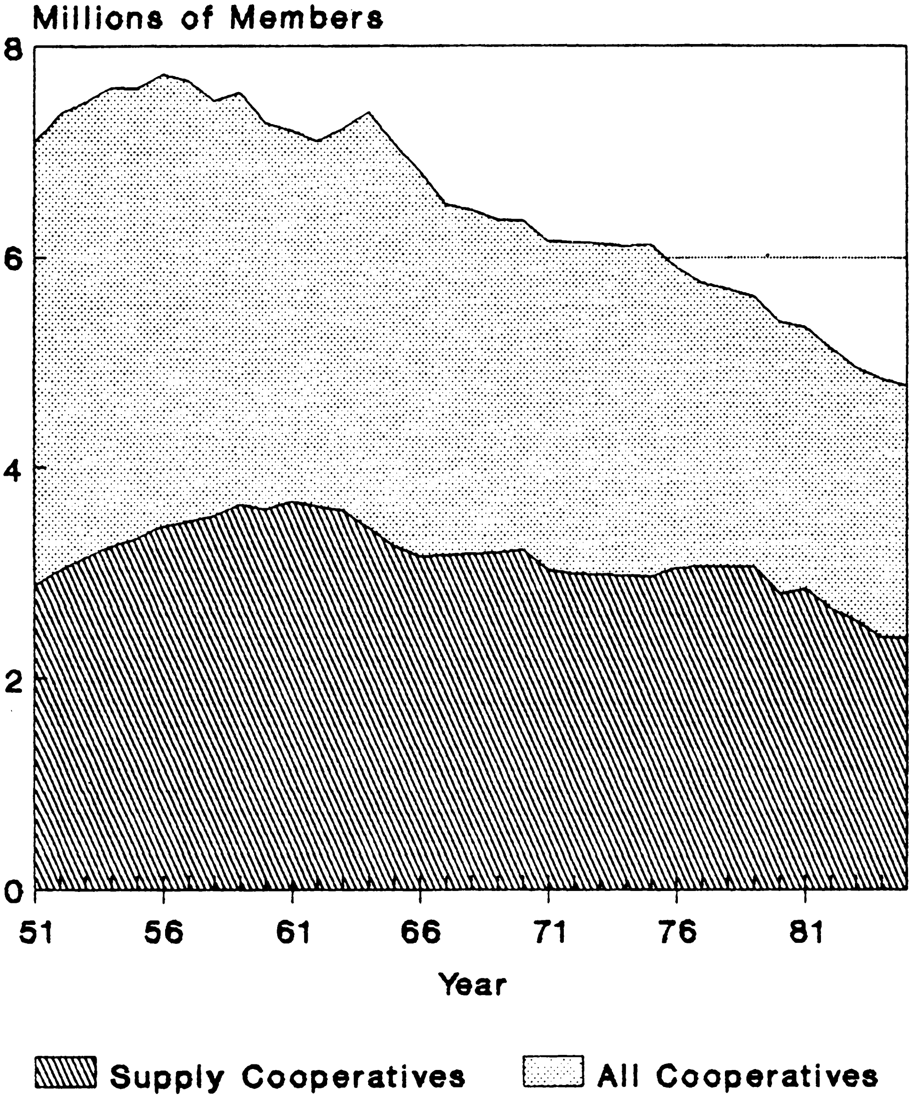


Figure 2.2 - Farm Cooperative Membership in the United States

Source: USDA, 1987

[USDA, 1987]. Since then, mergers and internal growth of cooperatives helped lead to the decline in cooperative numbers. Patron membership has fallen from its peak of just under 7,750,000 in 1956 to just over 4,750,000 by 1985 [USDA, 1987]. This trend could be due to the declining number of farms and farm operators in the U.S. Agricultural supply cooperatives have also declined in number and membership since 1959 [USDA, 1987]. Throughout this period, agricultural supply cooperatives have accounted for about 35 percent of all cooperatives and have remained a major force in the cooperative sector [USDA, 1987].

The net business volume of cooperatives has moved in the opposite direction since World War II. Figure 2.3 shows the net business volumes of farm supply cooperatives and all cooperatives since 1951. The net business volume of all cooperatives increased 780 percent from 1951 to 1981 [USDA, 1987]. Since 1981, net business volume has been volatile due to an unsteady agricultural economy [USDA, 1987]. Farm supply cooperatives account for 24 percent of all cooperative volume [USDA, 1987]. The percent of all farm supplies purchased through cooperatives grew from 19 percent in 1951 to 26 percent by 1985 [Cropp and Ingalsbe]. The net business volume growth of these cooperatives has followed the same pattern. After a period of 910 percent growth from 1951 to 1981, volatility has also come to the farm supply cooperative market [USDA, 1987].

2.2.2 Structure and Principles of Agricultural Cooperatives

The agricultural cooperative is very different from the typical investor-oriented firm. The structure and principles of cooperatives must be understood to appreciate these unique business enterprises. This section is based on the works of Barton; Cobia; Cobia and Brewer; and Cobia, Royer, and Ingalsbe.

Cooperatives where first formed so farmers could pool their resources and carry out business activities which they could not independently perform as efficiently

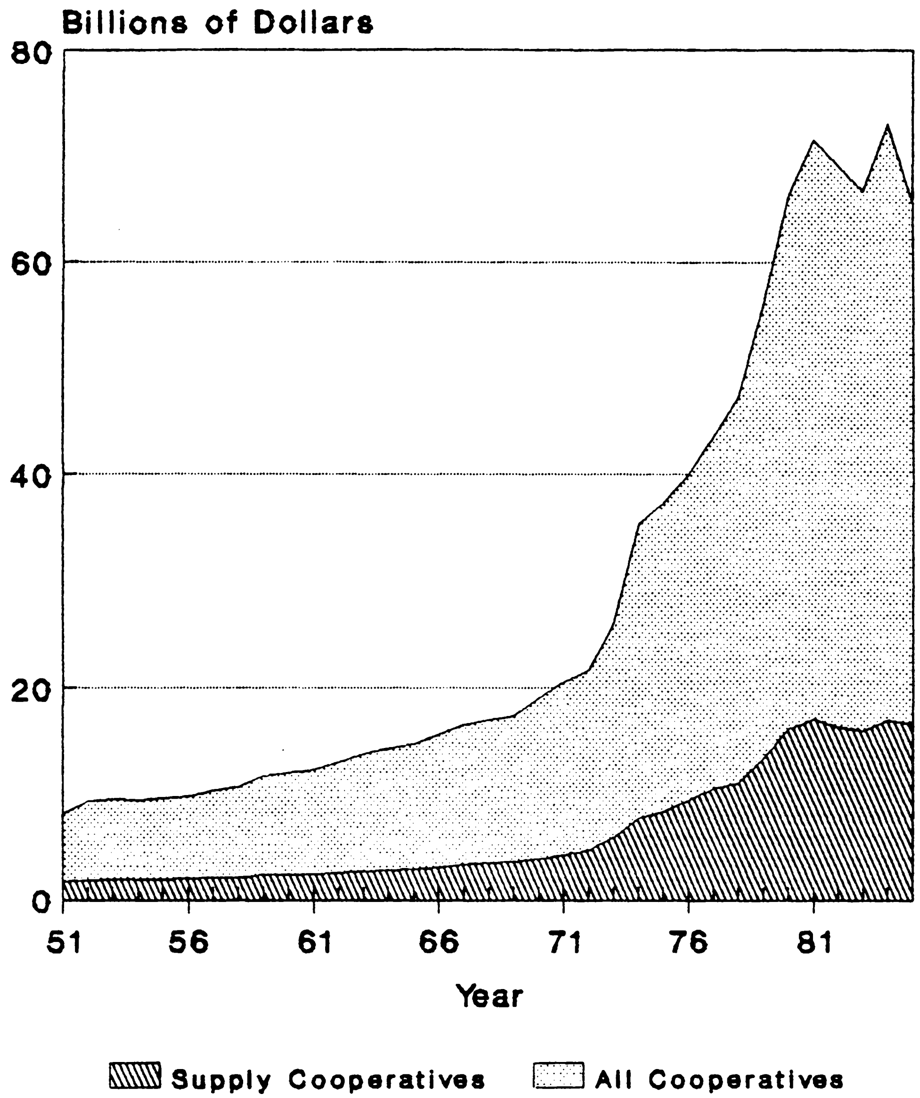


Figure 2.3 - Farm Cooperative Net Business Volumes in the United States

Source: USDA, 1987

[Barton]. In a farm supply cooperative, inputs are purchased in large quantities and distributed more cheaply than individual farmers could purchase them separately. This type of organization occurs when supply services are not available from the market or when the existing firms charged inflated prices.

Cooperatives are non-profit, user-oriented firms and are distinguished from investor-oriented firms (IOF) by three principle concepts [Barton]. The user-owner principle states that persons who own and finance the cooperative are those who use the cooperative. The users of cooperatives, referred to as members or patrons, finance it through their use of its services and through the purchase of equity certificates or stock in the cooperatives. Cooperatives can acquire three types of allocated equity (equity that belongs to an individual person or business) to finance their operations. The first method is through direct investment from the patrons through stock purchases. This typically occurs one time when a farmer first joins the cooperative. The second method is to finance the cooperative by retaining net income and dividing ownership of net income among patrons. These are known as retained patronage refunds and are commonly used by supply cooperatives. The third method is to require investments of one unit of equity capital for each unit of business transacted with the patron. These are called per-unit capital retains and are commonly used by marketing cooperatives. Retained patronage refunds and per-unit capital retains represent equity gathered through the use of the cooperative.

The cooperative can also build equity which is not assigned to any individual member. This unallocated equity can come from many sources such as non-operating income (interest or rent), from net income (from nonmembers or even members) which was not allocated or refunded, or from capital gains. Cooperatives can use unallocated equity to satisfy the legal obligations of some states which require that they maintain a certain level of unallocated equity. They also use it to help their credit situations. Creditors view unallocated equity as more permanent capital than allocated equity because it stabilizes the cooperative's financial structure. The use of unallocated equity also gives cooperatives some tax advantages.

The user-control principle says that control of the cooperative belongs to those who use the cooperative. In most cases, ownership is a byproduct of the use of the cooperative. Members primarily control the cooperative by electing a board of directors made up of their peers. Most management and policy decisions are then delegated to the board and are carried out by the managers which it selects. The members also control the cooperative by voting for or against major policies. The cooperative uses a democratic voting system. Typically, each member has one vote regardless of the volume of business the member transacted or the amount the member has invested.

The user-benefit principle states that the benefits of the cooperative are distributed to its users on the basis of their use. Besides the benefits of use (discussed in the economic justification section), patrons receive benefits in the form of patronage refunds. Since cooperatives are non-profit organizations, net income must be distributed to the members on the basis of use. Net income does not have to be paid directly to the patrons in the year it was earned. The cooperative has several distribution alternatives. These alternatives are chosen depending on the amount of investment capital the cooperative needs and by the tax methods it chooses. Patronage refunds can be given to the patrons in the year it was earned or retained to build the patrons' equity investment in the cooperative. Large cash refunds are desirable to the patrons but hurt the cooperative's financial strength.

Qualified and nonqualified patronage refunds are distinguished by the party who claims the refund in their taxable income. Qualified refunds are claimed by the patron. In order to be qualified patronage refunds as defined by the Internal Revenue Service, 1) 20 percent of the refund must be paid in cash, 2) all of the net income must come from patron business, 3) the cooperative must have been previously obligated to pay the refund, and 4) notification and payment of the cash portion must occur within specified time limits. The qualified method is more widely used than the nonqualified method.

Nonqualified patronage refunds are allocated to the patrons but retained by the cooperative and claimed as taxable income by the cooperative. The patrons do not report nonqualified refunds until they are received in cash. Cooperatives use nonqualified refunds to allocate income from nonpatron business, to reduce cash refunds, or to avoid the requirement that patrons claim patronage refunds.

The cooperative decides the exact mix of cash and noncash or qualified and nonqualified patronage refunds. Usually, refunds are qualified and consist of a certain portion returned as cash (commonly 20-50 percent). The rest are kept as retained refunds. The retained patronage refunds are returned to the patrons in later years using several methods. The most popular method is the special situation plan. It is used exclusively by 39 percent of all cooperatives and combined with other plans by 20 percent [Cobia, Royer, and Ingalsbe]. The cooperative retains the refunds until a special situation such as death, bankruptcy, or retirement occurs. Then the refunds are repaid in full. The revolving plan is the second most popular method. It is used by 29 percent of all cooperatives [Cobia, Royer, and Ingalsbe]. In this plan, the cooperative pays out retained refunds in the same order in which they were retained. Thus, the oldest equities are paid first. The average revolving period used now is 10 years [Cobia, Royer, and Ingalsbe].

The base capital plan marks members as overinvested or underinvested based on the cooperative's needs for capital and the member's use of the cooperative. Underinvested members continue to invest while overinvested members have retained refunds returned. The percentage-of-all-equities plan returns a constant percentage of retained refunds to all patrons regardless of the date issued. The final two plans are only used by three percent of all agricultural cooperatives [Cobia, Royer, and Ingalsbe].

2.2.3 Economic Justification of Cooperatives

Schrader discusses eight reasons why farmers choose to form and patronize cooperatives. The following section briefly discusses each of these reasons.

1) Market failure - Inefficient markets typically result in an unfavorable price for farm products and farm inputs. An efficient market is one which has a large number of buyers and sellers. Neither side of the market holds a pricing advantage over the other since there are many alternative buyers and sellers. In most agricultural markets, this in not the case. The farmer (whether buying farm inputs or selling farm products) is typically at a disadvantage since there are many farmers and few agribusinesses. The spacial dimensions of a market can cause this market inefficiency. As the distance between the user and the market (whether input or output market) increases, the price of the product can differ drastically for each participant. Availability of information can also differ greatly for market participants and create a source of inefficiency. Cooperatives are often formed to correct for these sources of market inefficiency.
2) Economies of size - Average in-plant costs decrease as the size of the operation increases for many supply and marketing firms. Fixed costs are spread over a greater volume, less labor per unit is needed, and storage costs are less per unit. Farmers who cooperate to form one large organization to perform the functions which they previously performed separately can realize these lower per unit costs.
3) Capture profits from another level - Firms at another level of the market system of a commodity may be earning larger returns to capital invested than producers. This implies that non-farm firms can earn monopolistic profits by preventing entry of competitors or that the capital market is inefficient. A cooperative enterprise

could take some of these monopoly profits from the present non-farm firm and make a more efficient market.

4) Provide missing services - This is a very common reason for the creation of cooperatives, especially the electric and telephone cooperatives of the 1930's and 1940's. A cooperative can provide services which the farmer could not previously receive at a reasonable price.

5) Assure supplies or markets - Market conditions sometimes dictate that a firm shut down operations or that firms do not supply less profitable product lines or provide less profitable markets. A cooperative can assure the presence of supplies, markets, or services at a desired quality and quantity.

6) Gain from coordination - Usually, coordination in a marketing system refers to vertical integration, but it can also occur in the form of contractual agreements. Coordination is beneficial in several ways. On the marketing side, information on the desired quality of marketed products can more easily make its way from the consumer to the producer who, in turn, can produce a more desirable product. On the supply side, coordination can lower the cost of intermediate inputs and decrease the cost of bargaining for these inputs.

7) Benefit from risk reduction - A group of individuals can more effectively reduce uncertainty than one individual by instituting a risk sharing program. Risk sharing can take many forms including insurance cooperatives, market pools, or cooperatives averaging costs over lines of business. The major benefit to risk sharing is to reduce the variation in returns to each individual member.

8) Market power - A cooperative can be formed to gain market power which its members could not gain alone. The nature of agricultural markets as the world's most perfectly competitive markets makes it difficult for individuals to have an influence on the price for their product. Marketing and bargaining cooperatives create a voice in the market by controlling a larger share of the commodity.

All of these reasons except the acquisition of market power have been considered by many as the competitive yardstick role [Schrader]. This simply means that maintaining competitive and efficient systems for farm supply and marketing services is the major reason for the creation and success of agricultural cooperatives.

2.2.4 Theory of the Firm

A farm supply cooperative is defined as a cooperative whose patrons purchase agricultural goods and services [Schmiesing]. These cooperatives have some similarities to investor-oriented firms. Hence, the theory of how an IOF operates is critical in understanding the operation of a farm supply cooperative. The next two sections draw heavily from Schmiesing.

An IOF is usually assumed to maximize the value of its firm to its investors by maximizing profit (net income) [Ferguson and Gould]. Profit is defined as total revenue (TR) minus total costs (TC). The firm allocates its profit to investors based on their investment through the purchase of stocks. Figure 2.4 graphically represents the IOF in a perfectly competitive market. Marginal cost (MC) is the additional cost of producing one additional unit. Marginal revenue (MR) is the additional revenue from selling one additional unit. For the IOF to achieve maximum profit, marginal cost must be equal to marginal revenue. When MR is greater than MC, the revenue added is greater than the added costs. Output should be increased as profit increases. When MR is less than MC, the added revenue is less than the added costs. Output should be decreased since the firm is losing money.

In the perfectly competitive industry, there are many buyers and sellers of a homogeneous product. Individual firms cannot differentiate their product from the product of other firms and no one firm can influence the price of the product. Output restriction or price increases (by the firm, not by outside influences) will not increase

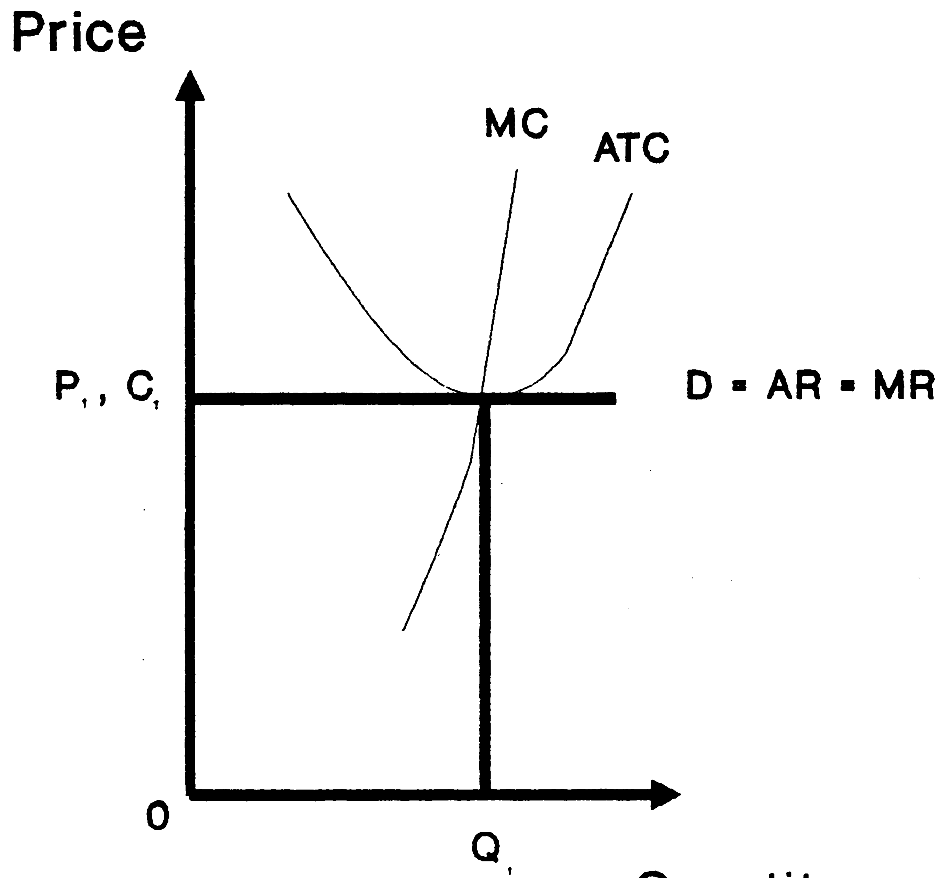


Figure 2.4 - Investor-Oriented Firm in a Perfectly Competitive Market

Source: Schmiesing

profits because customers will purchase from other firms where the product is readily available. Firms in this situation are known as "price takers." This causes the firm's demand curve to be horizontal and average revenue to equal marginal revenue at the market price. In the perfectly competitive situation, the market price is also the equilibrium price. When the decision rule for maximum profit is met (MC=MR), the market price is P_1, and the quantity produced is Q_1. The average total cost is equal to C_1 so profit is equal to P_1-C_1 multiplied by the quantity. However, in the perfectly competitive case at equilibrium, $P_1=C_1$ so there are no excess profits.

In a market which is not perfectly competitive, product differentiation and price changes can help an IOF earn excess profits. Figure 2.5 represents an IOF in a monopolistic competitive market where an individual firm can alter price. When products in the same market are differentiated, the firm's demand curve is no longer horizontal but is downward sloping. The slope of the demand curve which the monopolistic competitive firm faces is determined by the amount of competition from other firms or from substitute products. Increased competition or many close substitutes flattens the IOF's demand curve. AR and MR are no longer equal as AR represents the demand curve and MR is below the demand curve. This situation occurs because a firm which lowers price to sell more units must do so on all units sold, not simply on the additional units. The IOF will maximize revenues when MR is equal to zero. However, profit is still maximized by pricing the product where MR=MC. The firm's quantity sold is set at Q_1 (where MR=MC). Price (P_1) is set at the intersection of the quantity line and the demand curve (AR). Cost (C_1) is set at the point where quantity intersects the ATC curve. Profit equals quantity multiplied by P_1-C_1. As profit to the firm increases, the value of the firm to its investors is increased. The welfare of the consumer is hurt as the firm reaps excess profits.

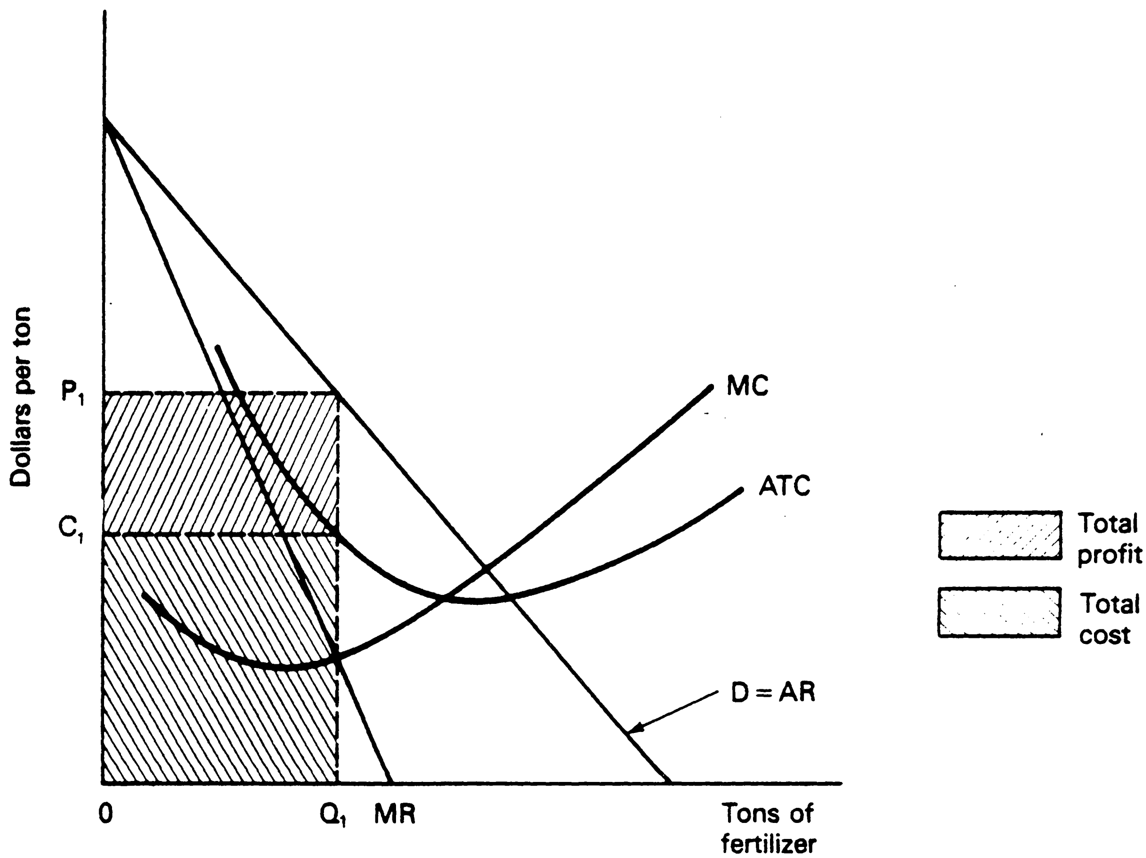


Figure 2.5 - Investor-Oriented Firm in a Monopolistic Competitive Market

Source: Schmiesing

2.2.5 Economic Theory and the Supply Cooperative

The economic theory of supply cooperatives is different from that of an IOF because cooperatives have different objectives. This occurs because IOFs are concerned with the welfare of investors while cooperatives are concerned with the welfare of patrons. Since patrons think of themselves as customers first and investors second, the objective of IOFs may not apply to cooperatives. To show the differences, assume that the organization of the IOF in the monopolistic competitive market has been altered to that of a supply cooperative. Assume that the cost structures of both firms are identical; each firm has the same technical efficiency and the same average total cost and marginal cost curves.

Vitaliano proposed three possible objectives for a supply cooperative.

1) The cooperative can operate at breakeven levels (setting prices equal to costs).
2) The cooperative can minimize the net price paid by patrons for the product.
3) The cooperative can maximize the total returns to the patrons as a group.

Objective 3 is much the same as the goal of an IOF. The total net income of the cooperative is returned to the patrons as patronage refunds. Thus, maximizing total returns to the patrons is the same as maximizing total net income to the cooperative.

Figure 2.6 is a graphical representation of the three supply cooperative objectives while Table 2.2 is a summary of the results as each objective is reached independently. When a supply cooperative chooses to focus on objective 1, it is attempting to provide the patron with the lowest possible price at the time of purchase (referred to as price paid). This objective allows the cooperative to be very price competitive with other firms in the industry. Graphically, this represents setting the

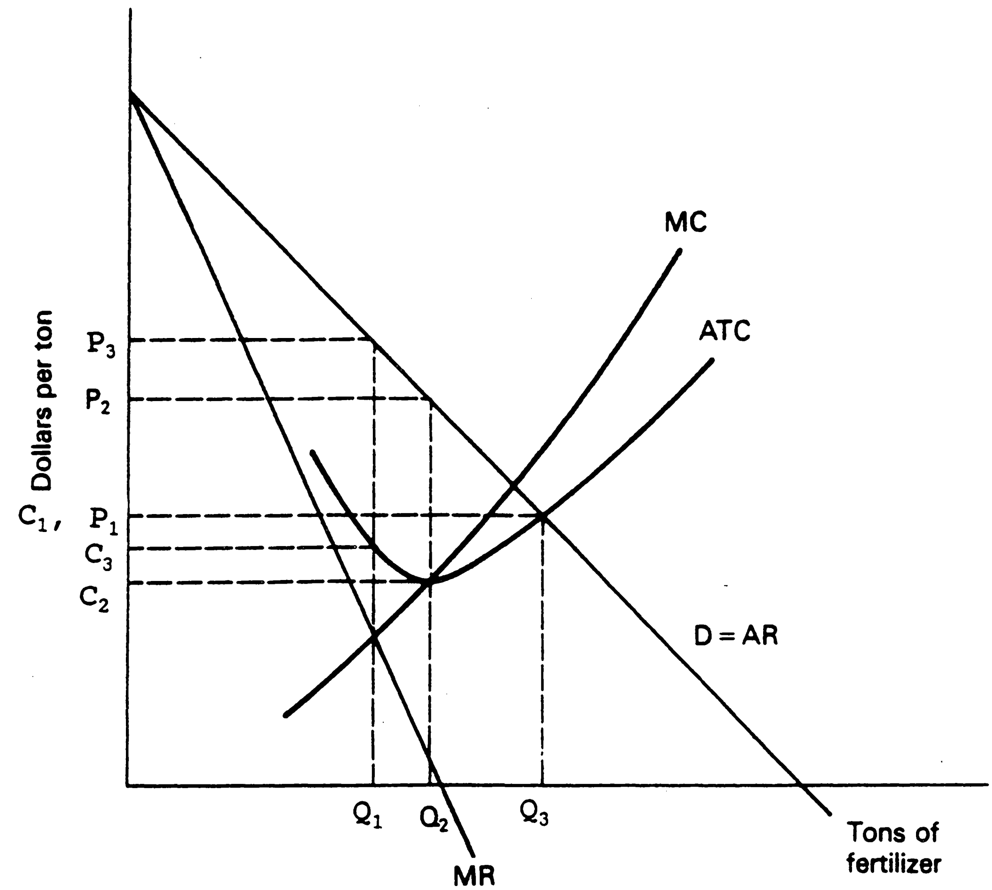


Figure 2.6 - Farm Supply Cooperative in a Monopolistic Competitive Market

Source: Schmiesing

Table 2.2 - Results of Achieving Cooperative Objectives

Objective	Rule	Output	Price paid	Refund	Net price
1) Breakeven	MC=MR	Q_1	P_1	P_1-C_1	C_1
2) Minimize Net Price	MC=ATC	Q_2	P_2	P_2-C_2	C_2
3) Maximize Net Income	ATC=D=AR	Q_3	P_3	P_3-C_3	C_3

Source: Schmiesing

price paid at the point where average total cost is equal to average revenue. In this case, the patronage refund is equal to zero since the price paid (P_1) is equal to the costs associated with one unit of production (C_1). In other words, net income is zero and none can be distributed as patronage refunds. This scenario also produces the highest net price (the price paid at the time of purchase less the patronage refund) and the highest quantity sold (Q_1). This objective is difficult to achieve because the breakeven cost is very difficult to pinpoint.

The second objective allows the cooperative to provide the product to the patrons at the lowest net price (C_2), achieved by setting the price paid (P_2) on the demand curve at the quantity where marginal cost equals average total cost. This is also the point where ATC is at its minimum. Focusing on this objective attempts to make the patrons' net cost of buying the product as low as possible. However, the low net price cannot be realized by the patrons until after the patronage refunds (both cash and retained) are distributed.

When concentrating on objective 3, the cooperative is acting much the same as an IOF. It attempts to maximize the net income to the cooperative and, hence, maximize net returns to the patrons. This scenario produces the highest price paid (P_3), the lowest quantity sold (Q_3), and a net price (C_3) between the other two net prices. The patrons as investors benefit the most in this scenario by receiving the greatest total patronage refunds (P_3-C_3). Objectives besides the traditional IOF objective present an interesting problem. An example will illustrate the point. A cooperative might wish to achieve the minimum average total cost (ATC) for providing the product to the patron and, hence, pass the savings on to the patron. There are two ways to achieve minimum ATC. The first is to create a closed membership cooperative. A smaller membership allows the demand curve to be shifted to the left to match the minimum ATC (Figure 2.7). The second alternative is to expand the physical facilities and increase output. This will shift the cost structure down and to the right so ATC

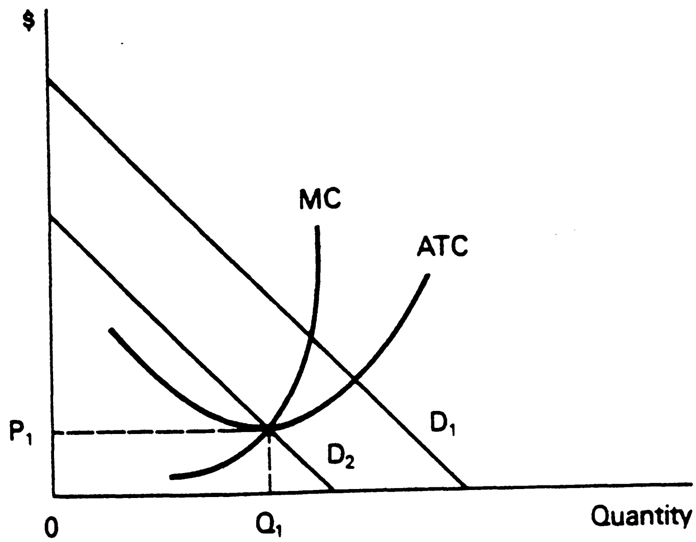


Figure 2.7 - Achieving the Minimum Average Total Cost by a Decrease in Demand Through Closed Membership

Source: Schmiesing

can match the existing demand curve (Figure 2.8). This implies that the cooperative's existing facilities are too small to achieve the output needed to achieve minimum ATC.

Sexton and others argue that cooperatives frequently confront the opposite problem. They say that cooperatives have insufficient demand (i.e., excess capacity) for achieving the minimum point on the ATC curve [Sexton; Cotterill, 1982]. Firms with excess capacity cannot achieve the point of minimum average total cost at any demand because marginal cost is below average cost at all levels of sales. Figure 2.9 illustrates the excess capacity situation. An IOF maximizing net income by producing the amount necessary for marginal cost to equal marginal revenue would charge P_1 and sell Q_1. Output would be restricted and consumers would pay a higher price than cooperatives would charge. However, it might not be in the best interest of the patrons for the cooperative to sell at this point. A cooperative that requires ATC to equal AR would charge P_2 and sell Q_2. The cooperative's price is lower and the quantity supplied is greater than those of an IOF. Thus, cooperatives in this excess capacity situation must find other solutions such as consolidation.

2.3 Efficient Organization Within a Market

Bressler and King outline three aspects in the organization of a market area; 1) product assembly from the producers to the plant location, 2) plant operation, and 3) plant to market distribution of the processed product. The costs of these operations will vary as the total volume handled by the production plant varies. The most efficient organization will result from selection of the plant volume, plant numbers, and plant location which has the lowest minimum combined costs of the three sections.

Research of organization efficiency was classified by French as either discrete or continuous. The continuous approach assumes that the market is continuous and that product density is uniform. This approach involves estimating a long-run average

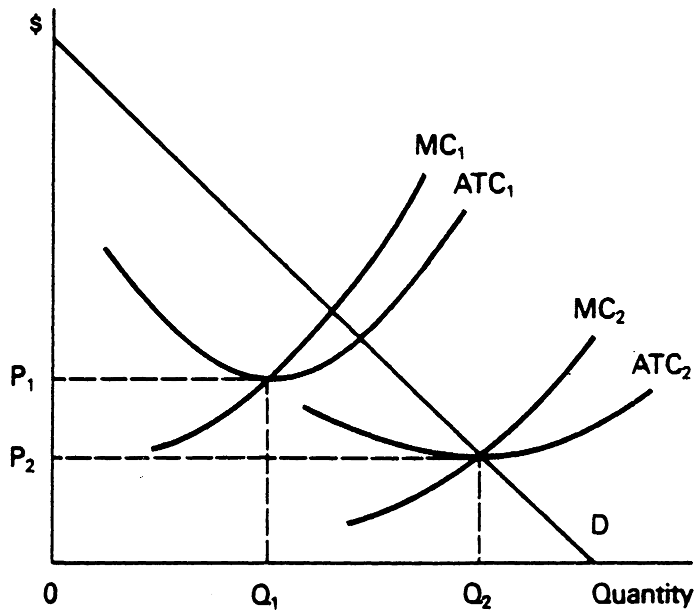


Figure 2.8 - Achieving the Minimum Average Total Cost Through the Expansion of Facilities

Source: Schmiesing

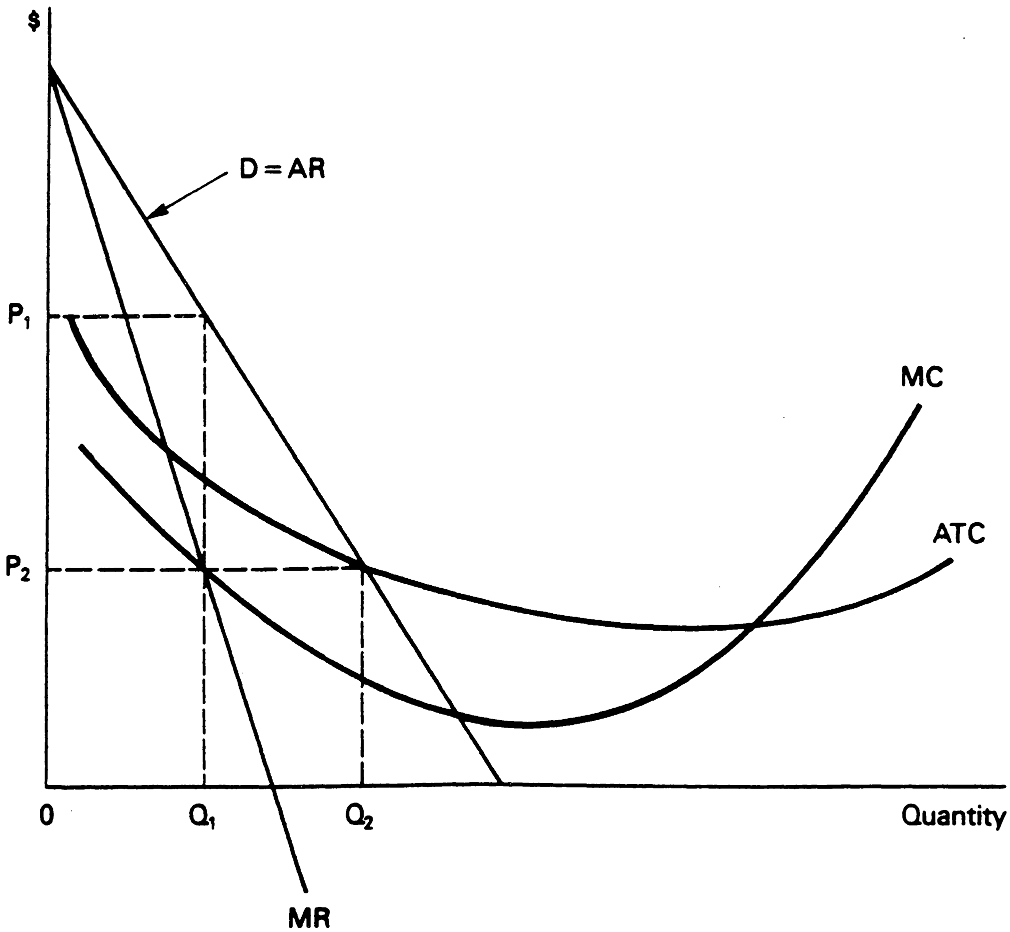


Figure 2.9 - Costs in the Excess Capacity Situation

Source: Schmiesing

total cost curve, which includes assembly costs, production costs, and distribution costs, to determine the optimal plant size for one plant. Figure 2.10 shows the cost curves of the continuous space approach. For one plant, the average assembly costs per unit increase as the size of the plant increases because assembly must spread out farther from the plant to acquire adequate raw materials for processing. On the other hand, average processing costs per unit decrease as the amount processed increases as the plant capitalizes on economies of size and scale. The optimal number of plants in the market area is then determined by dividing the total volume of the market by the cost minimizing volume per plant. The plants are then placed in the market area arbitrarily but must be equidistant from each other.

Three limitations of the continuous space approach become evident [French]. First, supply density is usually not uniform and continuous in a market. Second, there are location restrictions to the positioning of plants. Though the first plant can be strategically located, the equidistance constraint on subsequent plants makes it difficult to take advantage of existing facilities, available resources, and transportation networks. Third, plant costs are assumed constant for each plant yet differences in capital equipment and differences in management and employee efficiency make this unrealistic.

The discrete approach, first developed by Stollsteimer, solves for optimal size, number, and location of plants given a restricted set of market territories and a limited number of plant location sites. Discrete space models also require that the long run processing cost functions and transportation cost functions are known. This approach minimizes the total costs to the firm of all the stores in the market area with total costs equal to total assembly costs plus total processing costs. Figure 2.11 shows the cost structure of the discrete approach. As the number of plants in a market area increases, the total assembly costs decrease because each plant assembles the raw product from a smaller geographic area. Total processing costs increase as the number of plants increases since more plants would be processing the same amount of raw product. See

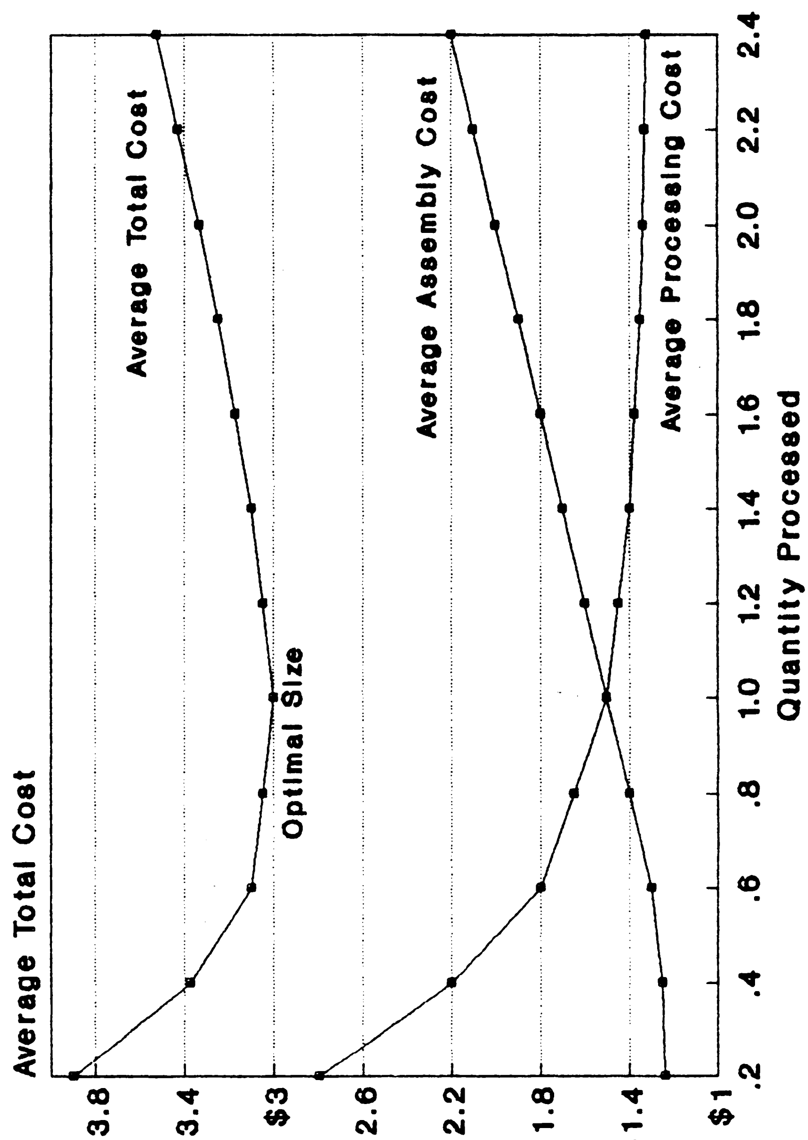


Figure 2.10 - The Continuous Approach for Determining Minimum Average Total Costs per Store

Source: Hulslander

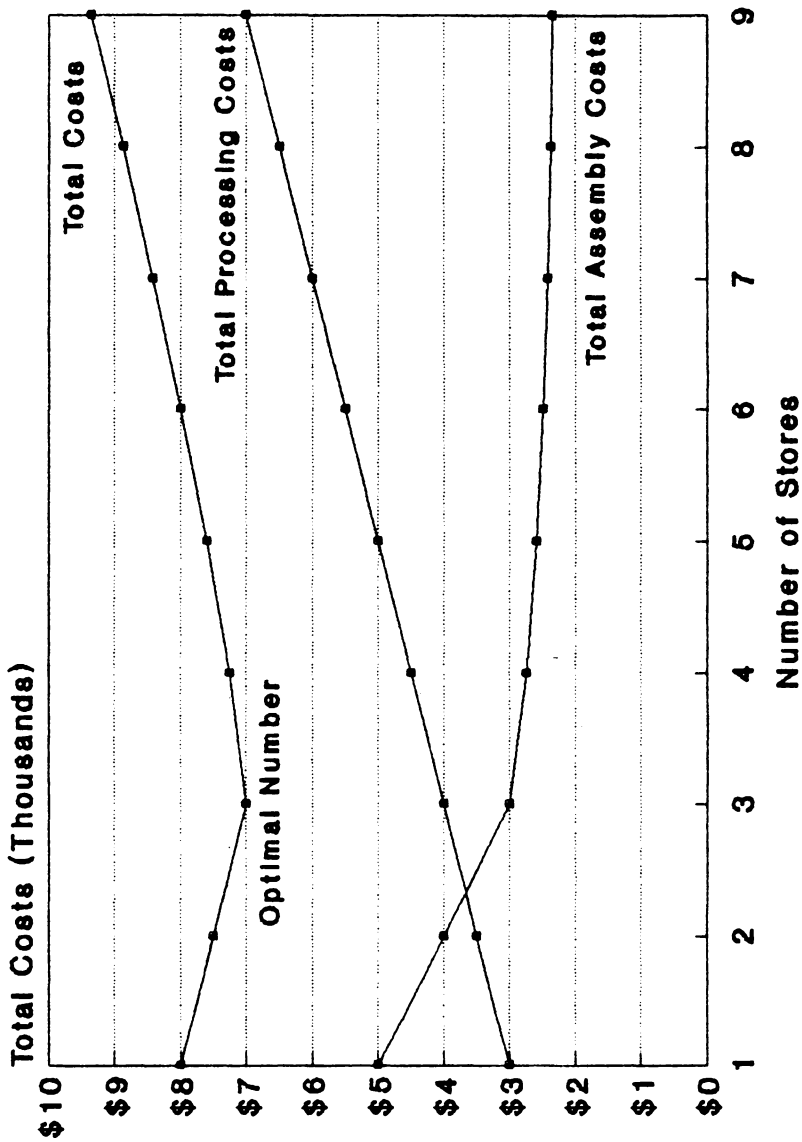


Figure 2.11 - The Discrete Approach for Determining the Least Total Cost Plant Locations

Source: Hulslander

Bressler and King (pages 155-159) for the mathematical procedure for summing the assembly and processing cost relationships.

Several problems with the discrete approach should be pointed out [Hulslander]. First, all stores retain the same function for processing costs. Differences in capital equipment and employee efficiency would give stores different processing cost functions. This problem was also present in the continuous approach. Second, cost functions cannot take economies of size and scale into account. As a processing plant expands in size, certain cost advantages are realized. The discrete approach cannot model these cost advantages. Third, due to data restrictions, uniform density of supply and demand is assumed within regional subdivisions. Uniform density is definitely the exception to the rule. Last, Hoch showed that there is always the possibility of a concave total assembly cost function and, hence, a concave total cost function. A concave cost function has a unique maximum point but no unique minimum point. This would result in no minimum optimal solution to the problem.

These two approaches to determining the efficient organization within a market find the optimal size and location of new processing plants. However, some of their principles and limitations are important in the study of the reorganization of existing assets.

2.4 Consumer Behavior and Price Theory

Consumer behavior is defined by Walters as "those decisions and related activities of persons involved specifically in buying and using economic goods and services (products)." In traditional economic analysis, consumers are assumed to be completely rational and have perfect knowledge of the market. This leaves only price, income, quantities, and the availability of sellers as the consumer's decision determinants. However, perfect knowledge and complete rationality are present only in this economic utopia. Consumers are rational when they purchase the goods and services which maximize their welfare. In reality, purchasing decisions are sometimes made irrationally by internal emotions and external influences. Perfect knowledge is difficult to achieve because of the high cost of information acquisition. Unfortunately, the impact of these decision influences is largely immeasurable since all consumers differ in their emotions and how they perceive external influences. Economists must give up a certain measure of reality in order to concentrate on the measurable factors influencing consumer purchasing decisions.

Of these measurable factors, price is most easily observed by consumers. Price conveys important information to the consumer about the characteristics of the product. These are characteristics dealing with space (transfer costs), time (storage costs), and form (product quality and processing costs) [Bressler and King]. Price also gives some indication of the availability of the product. Of two firms selling the same product, with all other factors assumed equal, the consumer should purchase the product from the firm with the lowest price. Several studies have looked at the effects of price on consumer behavior. Devine and Marion; and Uhl conducted studies in the retail grocery market. They provided consumers with in depth price reports and recorded their buying patterns. Devine and Marion found that 43 percent of consumers switched stores because of price differences. This suggests that price has a great impact on consumer behavior. However, Uhl reported that few consumers switched. This may imply that other factors, besides price, influence consumer behavior. Unfortunately, in many cases, price differences may be the only data available to researchers who study the consumer's buying decisions.

The costs of distribution, whether the product is delivered to the consumer by the firm or picked up by the consumer, should be included in the price of the product. This point is critical when analyzing changes in distribution structure and problems of firm location. When a reorganization of location and/or distribution occurs, some consumers might incur added costs for transporting the product. Consequently, a decrease in demand might occur given the fact that, if two stores have similar pricing schemes, consumers will purchase goods at the closest location, ceteris paribus [Hulslander].

McCloskey presents a good discussion of the influence of transport costs on net price and consumer behavior. Figure 2.12 shows demand curves which can be estimated using various price levels at a location. A uniform density of demand in both directions which uses distance as a proxy for quantity is assumed. Three stores (A, B, C) each have an associated price at that store's door. The added cost of travel from the store to the consumer is represented by the delivered price lines. The realized price is the combination of the store's price plus the cost of travel. In the top example, consumers living 15 miles from store A, depending on their direction, will have an equal realized price at either store B or C. These two points are known as indifference points where the consumer can elect to purchase from any of the equidistant stores. Store A will have no sales beyond 15 miles since it is at a price disadvantage relative to stores B and C. The bottom figure shows that store A has a 100 percent market share at a distance up to 15 miles and a zero market share beyond that.

The relationship between price, location, and consumer preferences in the farm supply market has been studied. Chambonnet surveyed farm operators from six eastern Indiana counties to determine the characteristics of farms and farm supply purchasing patterns for that sample area. He found that 55 percent of major farm supplies in the area were purchased from cooperatives in 1985, double the estimated national market share in 1983. Anhydrous ammonia, agricultural chemicals, and seed were most often picked up and applied by the farmer while petroleum was almost entirely delivered by the supplier. Feed, liquid fertilizer, and dry fertilizer transport was evenly split between the farmer and the supplier.

The farmer survey also asked for the distance from the farm to the farm suppliers. The average distance travelled by fertilizer and chemicals (either delivered by the supplier or picked up by the farmer) was 7.1 miles and 7.4 miles one way,

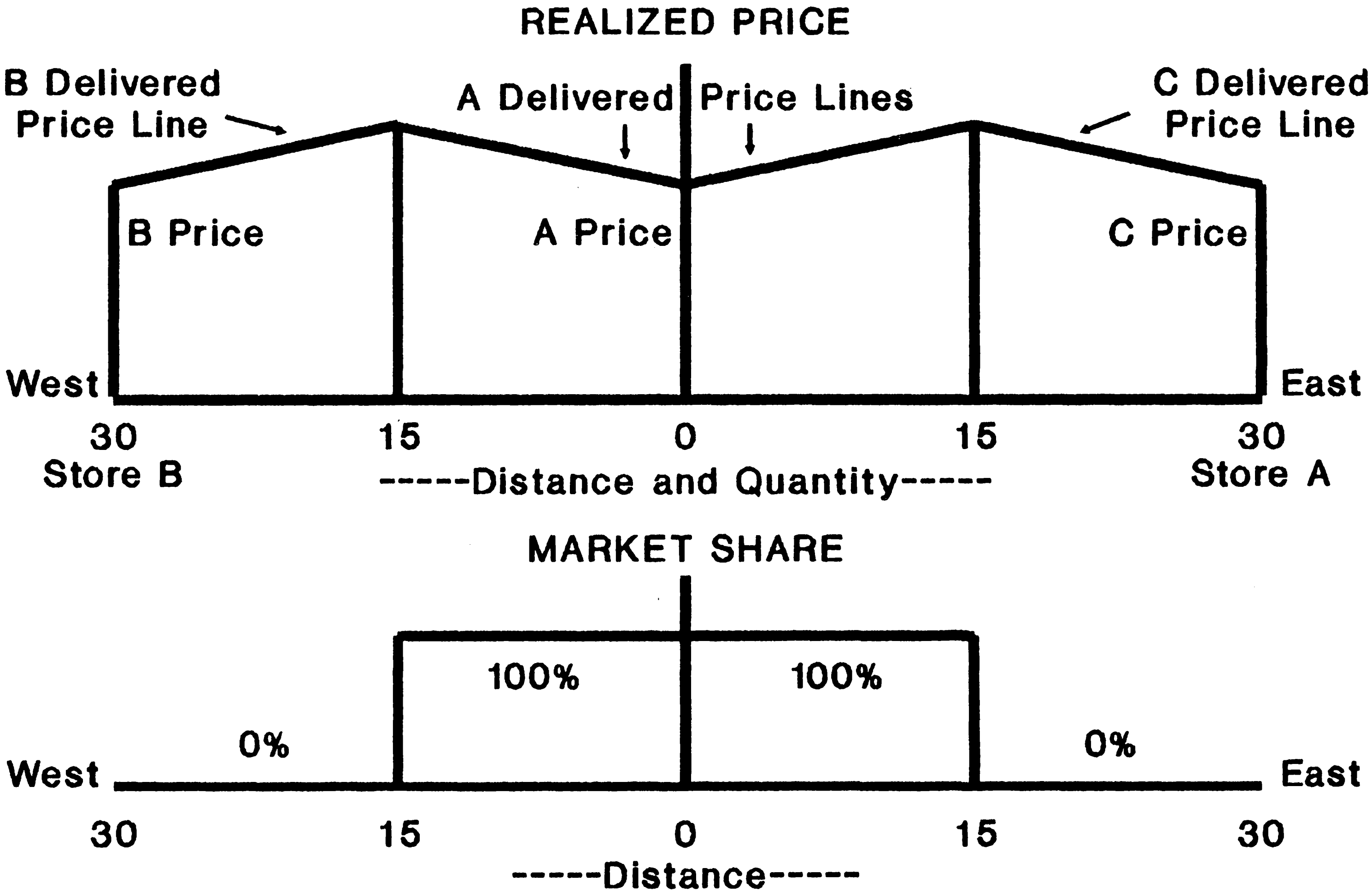


Figure 2.12 - Product Price and Firm Market Share Due to Location

Source: McCloskey

respectively. The closest retail fertilizer plant was an average of 4.9 miles away and the closest chemical outlet was an average of 4.6 miles away. Hence, the farmers' principle source for fertilizer and agricultural chemicals was 45 and 61 percent further, respectively, than their nearest supplier. Cooperatives were the closest supplier to 45 percent of the farms surveyed. Cooperatives made up 22 of the 39 firms in the study area. Respondents indicated that for a two percent lower price, they would buy fertilizer from 14.8 miles away on average and they would buy chemicals from 17.8 miles away on average. Large operators (over 250 acres) were more willing to travel farther than small farm operators for a two percent price decrease. These survey results suggest that, at least in this area, reorganization to save costs which are then passed on as lower prices will be accepted by farmers even thought transport costs will increase.

2.5 The Linear Programming Transportation Model

The most common application of linear programming (LP) involves allocating limited resources among competing activities in the best possible way [Hillier and Lieberman]. The two sections of a linear programming model are the objective function and the constraints. The objective function can be optimized either by maximization or minimization of the activities (also known as decision variables) multiplied by profit or cost coefficients. The constraints limit the values of the decision variables above, below, or equal to certain values (known as right hand sides). The equations representing the objective function and the constraints must be linear.

Linear programming is used widely to determine the optimal distribution pattern from one level of a market system to another at the lowest cost while using no more than the resources available. This type of application is called a transportation model. A transportation model can be represented mathematically as follows:

$$\text{Minimize } Z = \sum_{i=1}^{m} \sum_{j=1}^{n} c_{ij} x_{ij}$$

subject to:

$$\sum_{j=1}^{n} x_{ij} = s_i, \quad \text{for } i = 1, 2, \ldots, m$$

$$\sum_{i=1}^{m} x_{ij} = d_j, \quad \text{for } j = 1, 2, \ldots, n$$

$$\text{and} \quad x_{ij} \geq 0, \quad \text{for all } i \text{ and } j$$

where Z is the total distribution cost, x_{ij} ($i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$) is the number of units distributed from source i to destination j, c_{ij} is the cost per unit of distribution for source i to destination j, s_i is the supply available from source i, and d_j is the number of units demand by destination j. When a solution is determined which is the best within the bounds of the constraints, it is known as the optimal feasible solution. However, it is possible to have multiple optimal solutions. This occurs when one or more constraints have the same slope as the objective function.

Every linear programming problem has associated with it another linear programming problem. This associated LP problem is called the dual. One might think of the dual as the opposite of the original problem (called the primal). If the primal minimizes its objective function, the dual will maximize its objective function. The right hand sides of the primal become the objective function coefficients of the dual. The shadow prices of the primal become the decision making variables of the dual problem. Shadow prices are determined in the LP solution process. They measure the marginal value of the resources (right hand sides) in the primal. Shadow prices can identify the most and least profitable (or costly) resources in the problem.

The relationship between the primal problem and its dual are also useful in conducting sensitivity analysis. Sensitivity analysis involves investigation of the effects of changes in the model parameters on the objective function. In other words, it tests the sensitivity of the optimal solution to changes in a parameter. In the standard transportation model, the parameters are c_{ij}, s_i, and d_j. One of the assumptions of LP is that the parameter values are known. However, most parameter values are only estimates based on a prediction of future conditions. Since the model's parameters are uncertain, a test for stability of the solution is critical. Sensitivity analysis of the objective function coefficients (c_{ij}) will provide a range of values which can be used for these coefficients over which the solution will not change. This is the range of profit contribution (or cost increase) each activity can provide before the solution changes. Sensitivity analysis of the right hand side coefficients (s_i and d_j) provides a range of values for the right hand sides over which the shadow prices will not change. In other words, it is the range of resource capacities which have the same marginal values to the solution.

Without the primal-dual relationships, new parameter values would have to be entered manually and the model would have to be resolved to test the sensitivity of the optimal solution to changes in parameter values. These relationships eliminate this costly, time consuming process. See Hillier and Lieberman (chapter 6, pages 133-168) for a more complex discussion of linear programming, duality, and sensitivity analysis.

2.6 Retail Distribution Models

The following section discusses the literature on retail distribution analysis. Since consumer demand is so difficult to model, most models have concentrated more on assembly and processing in retail structuring decisions. One of the first studies to include distribution costs in the analysis was by Cobia and Babb. They used a continuous space model to determine the equilibrium size of marketing firms in a spacial market applied to the processing and distribution of packaged fluid milk. The solution of the model resulted in the determination of the size of plants associated with minimizing average processing and distribution costs to the firm.

Distribution costs in the Cobia and Babb model were composed of costs associated with volume (unloading and fixed costs) and costs associated with distance (fuel, tires, etc.). They did not consider volume related distribution costs in the model since they would have no effect on the size of the sales region. The authors assumed uniform topography and a transportation method of semitrailers making one trip per day. Further, they assumed that sales density was uniform throughout a plant's sales region (consistent with the continuous space approach) so that increased volume had to be marketed in an expanded sales area. The authors also assumed that all customers were charged a uniform price regardless of distance from the plant. Another important assumption was that all raw milk costs were uniform among plants.

The model consisted of a system of equations for: 1) processing costs and 2) distribution costs. By minimizing the combined cost of these two activities, the optimal sales volume was determined. The results showed the gains in economies of size for large plants greatly outweighed the higher distribution costs associated with the corresponding growth in sales area. The size of plant was limited not by increasing distribution costs. However, economies of size advantages no longer occurred after a certain plant size. Thus, the most important factors in expanding volume and sales area were expected prices and customer volume in the expanded area, not increased distribution costs.

Certain limitations in the distribution section of the Cobia and Babb model should be recognized. First, a discriminating price for the finished product would probably be charged in reality due to varying distances from the plant to the retailers. Second, sales density would not be uniform throughout the market region due to urban areas of dense population. These two facts mean that the demand for the finished product would not necessarily be constant throughout a sales region.

Polopolus extended the one-product discrete location model to analyze the multiproduct situation. The Polopolus model attempted to find the optimal number, size, and location of vegetable processing plants in Louisiana by minimizing total transportation and processing costs. The model analyzed three raw and final products coming from 25 production regions and going to 10 potential processing locations. These product, production region, and processing location limitations were due to the lack of computing power at the time. Aggregate plant and assembly costs at one location were found by summing the individual product processing and assembly costs. However, some joint costs are involved in a multiproduct processing plant where identical productive inputs are used for two or more products. Polopolus accounted for these joint costs in the model to avoid double counting.

Polopolus found that, as plant numbers increase, processing costs increase at a much greater rate than assembly costs decrease. Thus, one plant was found to be preferable to any other number of plants in terms of overall minimum total costs. Polopolus also found that one plant processing the three products had much lower costs than three plants, each processing one product. This suggests that multiproduct processing has economic advantages over single product processing. The Polopolus model had the same deficiencies that were present in the discrete approach for efficient market organization. These include constant cost functions for all processing plants, no recognition of economies of size advantages, and uniform density of supply and demand.

A study by Bell, Henderson, and Perkins focused on the fertilizer industry in the United States with special emphasis on distribution in Michigan. The authors developed a linear programming model to simulate the U.S. fertilizer industry. The model was used for three types of analysis. The first type found a short run optimum which identified the best possible uses for existing facilities. This type of analysis is important when a "quick fix" solution is needed or if the firms involved do not wish to invest in a complete relocation of facilities. The second type of analysis identified the optimal organization of the industry in the long run. This allows for the use of existing facilities, building new ones, or using a combination of the two. The third type of analysis was the evaluation of the effects of changes in a number of factors upon the optimal organization of the industry. These factors included, but were not limited to, input price variations and demand changes.

The results of this study were published in a report by Bell, Armstrong, Perkins, and Henderson. They found the cost of meeting consumer demand for fertilizer in Michigan could be reduced by about 25 percent in the short run and by nearly 33 percent in the long run. These savings would be distributed between fertilizer firms and farmers. The authors also determined that farmers, not the fertilizer firms, represented the primary force in reorganizing the fertilizer industry. Farmers bought higher-cost fertilizer due to preference, insufficient information, and other factors. Thus, they blocked industry efforts to improve performance. Farmers could have stimulated the transition to better industry performance by buying low-cost products. However, this would have meant a substantial change in farmers' purchasing behavior.

Menzie, Schrader, and Preckel developed a model to determine the least cost organization of cooperative feed manufacturing and distribution to patrons. The model used nonlinear programming to permit the recognition of economies of size advantages. However, nonlinear models can only guarantee a local optimal, not a global optimal. Thus, the solution might seem like the best available but that is not guaranteed. The model included both commercial mill and on-farm total processing costs. It determined the optimal location of processing facilities, the volume of each product form processed at each mill, the flow of each feed product from mills to demand sites, and the volume of feed processed on farms.

The model was applied to a regional cooperative in the midwest. The authors found that distribution costs accounted for about 23 percent of the total processing costs and distribution costs in the model solution. On-farm preparation of feed using premixes accounted for a large portion of the total feed demand. This result is consistent with the industry trend. Hence, excesses in feed capacity are likely to continue.

Chambonnet also studied retail distribution from the cooperative perspective. He used the discrete approach for analyzing efficient market organization to assess the optimal organization of grain marketing and fertilizer operations in a given area. Unlike most optimum organization studies, Chambonnet considered farmers' preferences and transport costs incurred by farmers in the analysis.

The Chambonnet study used several discrete approach models to analyze three sectors of the retail fertilizer business; dry bulk fertilizer, liquid fertilizer, and anhydrous ammonia. Long run average plant costs were determined using both economic-engineering techniques and statistical methods. Distribution costs include those costs incurred both by the cooperative and the farmer. However, purchase price, the other cost to the farmer for buying fertilizer, was not considered. Chambonnet found that consolidation would represent substantial cost savings to the cooperative. However, he stressed the importance of maintaining consumer demand after the reorganization. Farmers would have to realize that the reorganization is for their benefit. The cooperative would have to immediately prove this by offering lower prices than competitors.

Hulslander also studied retail distribution of farm supplies. Hulslander's analysis included both linear and integer programming in order to assess the effects of reorganization on the profitability of cooperatives. The model maximized the net revenue (profit) to a set of nine cooperative stores in Maryland subject to consumer demand, physical capacities, and revenue constraints. This was a change from the firm cost minimization techniques used by most previous market organization models.

Revenue, expenses, and assets were the building blocks of Hulslander's model. Since this model considers restructuring using existing assets, the relationship between the three blocks were critical. The objective function of the model maximized net revenue for the entire region instead of for each individual store in order to reduce interstore competition. It consists of dollar sales for each of 8 products (bagged feed, bulk feed, mixed feed, bagged fertilizer, bulk fertilizer, lime, seed, and farm supplies) minus 11 expense items (wages, depreciation, utilities, repairs, taxes & license, insurance, opportunity cost, gas/lube/oil, advertizing, other general, and bad debt). Revenue constraints were included in the model to put a cap on the amount of sales each region could handle and how much each store could sell to each region. Sales regions were broken up as 68 zip code areas. Without these revenue constraints, the model would increase sales infinitely as it maximized net revenue. Constraints representing the physical limitations of assets such as storage facilities, processing equipment, and transportation equipment were included. The model also could add new capital equipment and facilities beyond what was currently present.

Hulslander's goal in conducting this research was to attempt to model the workings of the marketplace and important relationships within a distribution system. However, the model erred significantly in replicating the net revenues for the test region. Several limitations of the model might have contributed to this fact. The model could not account for nonlinear relationships of distribution such as seasonality of sales and inventory or gains from economies of size. The nature of the objective function caused other limitations. For instance, a cooperative might supply a product line if the patrons call for it even when costs exceed revenues for the cooperative. However, a revenue maximizing model discontinues these product lines as they yield negative revenues. Also, a high margin product will help the model increase net revenue substantially but, realistically, patrons would shy away from high priced items. Last, Hulslander's model was originally meant for use in the field for more cooperative reorganization analysis but it was so large, cumbersome, and costly to use that it was not practical for field work.

The Hulslander model differs from the other models discussed here in several ways. The Hulslander model concentrates on the reorganization of a distribution system while the other models were more concerned with the analysis of a newly formed distribution system. The other models minimized costs and found the optimal size of processing plants. Hulslander's model maximized net revenues using the current set of fixed assets and a limited amount of new assets. Yet, Hulslander's model improved upon the success of other distribution structure studies by concentrating more on the marketplace and consumer demand.

This is only a small sample of the vast collection of retail distribution literature. French lists many studies pertaining to efficient organization within a market area. Several of these discuss retail distribution including Haskell and Manuel (petroleum distribution), Clay and Martin (retail farm equipment), and King and Logan (beef processing and distribution).

2.7 Conclusions

The model in this research will simulate product flows by minimizing the cost of the product to the patron. It will not determine the optimal structure of the cooperative trade area. That is the job of the model's user. The user can simulate different situations by modifying supply structure to see how the product is distributed and how the economic viability of the trade area is affected.

This chapter has discussed several of the factors considered in the model's development. The review of cooperative theory displayed the unique situation in which they operate. Key reasons why this research is important and why so much concern is placed on the welfare of the patrons as well as the welfare of the cooperative were discussed. The discussion of efficient organization within a market gave some insight on how one should determine the restructuring of the trade area. The consumer behavior and price theory section demonstrated the importance of purchasing habits and location of the consumer on the success of a supply firm.

Product distribution to the consumer is very difficult to model since they have the independent control of choice [Hulslander]. Thus, very few studies on the structure of retail distribution systems exist. Most market area structure models have concentrated on assembly and processing and much less on retail distribution. Even fewer models have looked at retail restructuring based on the purchasing behavior of consumers. The restructuring decision depends heavily on the consumer's net buying price. Models analyzing the reorganization of a distribution system should simulate distribution based on minimizing the cost to the consumer of purchasing and transporting the product. Any model which only accounts for the firm's costs and profits in the structure decision and not the consumer's purchasing behavior after restructuring has missed a major part of the problem.

CHAPTER 3
THE MODEL

3.1 Introduction

This chapter will outline the model used in this research. The first section of the chapter explains the logic of the model and the reasons for certain conventions used in it. The second section describes the pieces of the model including the objective function, the demand constraints, and the capacity constraints. The model on diskette is located in Appendix 2 and the user's manual is Appendix 3.

3.2 Logic of the Model

One potential objective of this research could be to develop a simulation model to determine the optimal organization of a cooperative trade area. However, this process would be lengthy and expensive since many solutions would have to be evaluated for each scenario before an optimal solution was found. Simulation does not identify an optimal solution unless every possible solution is evaluated for each scenario. Thus, the user is not guaranteed of that any solution is optimal.

Furthermore, other types of models facilitate further analysis of the solution better than simulation techniques.

The use of an optimization technique would help to solve these problems. Optimization techniques find the optimal solution of a given scenario without analyzing each possible solution. Cost minimization to the firm has often been the optimization choice of previous studies where stores seek to minimize distribution, assembly, and processing costs [French]. However, Hulslander used profit maximization in his model since it includes cost minimization and also considers revenue implications.

Yet, these types of models have one serious flaw; they do not consider the purchasing behavior of the patron. A model may not accurately simulate retail distribution by considering only the costs and revenues to the firm and not the costs to the consumer of purchasing the product. In the agricultural supply market, the individual firm is highly dependent upon the consumer's purchasing behavior for sales because that consumer has many other firms from which to buy the product. Hence, cost minimization of purchase and transportation to the patron is the proper choice for this model.

A major consideration in constructing the model was its proposed use in the field by cooperative management to look at consolidation. This research follows the work of Hulslander in the area of cooperative retail distribution. As was mentioned in Chapter 2 (Section 2.6), the Hulslander model was large, cumbersome, and expensive to use. It modelled all sections of a farm supply cooperative in great detail. The Hulslander model could only be solved on a mainframe computer. This made the model difficult to use in the field. The model for this project needed to be scaled down to a more manageable size. It had to be small and concise, yet address the necessary factors related to consolidation. This model had to be microcomputer based so that the hardware limitations of the Hulslander model could be overcome. The model also needed to be easy to use because most of the users would not have vast experience using this type of model.

Linear programming (LP) was chosen as the modelling technique over other programming methods such as nonlinear programming and integer programming for two major reasons. First, it is easier to implement, understand, and interpret LP models than other programming models. Second, LP models are solved in much less time and with less computer memory. This helps save manpower and computer time and money. Thus, using the same computing facilities, LP models can be more complex than alternative models. However, with each benefit comes a cost. The most evident weakness of LP is its difficulty in modelling nonlinear relationships such as economies of size and seasonality of sales. Another important drawback of linear programming is that integer relationships such as number of trucks or number of employees cannot be represented. Fortunately, the integer limitations of LP do not represent a serious problem in this model.

The model was not designed to find the optimal retail structure of a cooperative trade area in one run. It was built to use a scenario defined by the user and report the distribution of the products to the patrons given that scenario. There are two important reasons for this design. First, while a model which finds the optimal structure in one run is feasible, it is impractical. This type of model would suffer the Hulslander syndrome. It would be cumbersome, time consuming and expensive to solve, and would violate the hardware constraints discussed earlier. Second, this type of restructuring decision is not simply decided by minimum costs or optimal distributions. Other factors are involved which are difficult to model. Some are as obvious as the age of capital equipment or as subtle as patron or board of director loyalty to a certain cooperative store and its manager. These factors should be analyzed by the user, not by the model. Thus, the restructuring of the trade area will be decided by the user. The model will report the impact of that decision.

To summarize the last few paragraphs, this model will use the scenario defined by the user to replicate actual trade/product flows between supply sites and demand regions using minimum cost to the patrons as the criterion. Using this optimum distribution, the model will produce three types of reports from which the user will determine the effectiveness of the scenario. These three reports are listed below.

1) Financial statements - These are operating statements which include all revenues and expenses for the supply site.
2) Asset utilization statements - These will detail the amount of the supply site's assets (capacities) that are used.
3) Product distribution statements - These will report the amount of each product line that is sold from each supply site to each demand region.

The user can utilize these reports to assess the financial health of the trade area and to help decide which other scenarios merit analysis. If a store is utilizing very little of its assets or if it has a negative net income, it may is candidate for change.

Another characteristic of this model is the ability to conduct "what-if" analysis based on changes in consumer demand. The importance of this function becomes apparent when the basic concept of consolidation is considered. Consolidation attempts to lower the production and overhead costs of store operations at the expense of higher transportation costs to both the patron and the cooperative and potentially lower consumer demand. This applies whether entire stores or only product lines are consolidated. The consumer behavior and price theory section of Chapter 2 (Section 2.4) helped explain the effect of consolidation on consumer demand. As a store in a trade area is closed, consumers closest to that store pay a higher net price (cost of the product at the store plus transportation costs) because they now have to travel farther to buy the product. In fact, the net price might rise enough to force the consumer to patronize a competing store. Demographic changes such as increasing urbanization in the trade area also affect the sales potential of the supply sites. These and other factors might cause consumers to change their purchasing habits. This variability makes predicting consumer demand difficult. Thus, a method for changing demand and viewing the effects on the trade area was incorporated.

This demand sensitivity to supply structure and demographic changes is represented in the model by a percentage increase or decrease in the product demanded by patrons over certain segments of the trade area. The same analysis could be accomplished by changing the dollars of product demanded for certain products in certain demand regions. However, the method used in this model is much easier to perform and understand. The model contains demand sensitivity inputs for all situations. The situation might be as general as a change in demand for all products throughout the entire trade area due to general price inflation, or a change in the demand for fertilizer throughout the entire trade area since a new competitor opened. It could be as specific as analyzing a change in demand for fertilizer in a particular demand region because of a large new patron account.

The final characteristic deals with the actual application of this model in the field. For representation in the model, a trade area is broken down into three segments; product lines, supply sites, and demand regions. Hardware and software constraints limit the model to five supply sites selling five product lines to fifteen demand regions. However, these three segments will be very different for each trade area analyzed. For instance, a product line can be as specific as anhydrous ammonia or as general as all fertilizers grouped together. A supply site can carry a full line of agricultural supplies or it could be an agronomic center, carrying only fertilizers and related crop supplies. Demand regions can vary in size and could be rural or urban. The model needs to be flexible in order to address the varying characteristics of different trade areas.

Incorporating flexibility into a model can present some problems. The most difficult of these is to maintain a consistent unit for all product lines. For example, a trade area might be broken down to three products lines; feed, fertilizer, and other farm supplies. It would be simple to find a common unit for each different type of feed and fertilizer such as tons or pounds. However, the farm supply category is much more difficult because animal health products and seed would be measured in very different ways. Since no assumptions about the type of product line can be made, all five products must have a common unit of measure. The only units common to all products sold by an agricultural supply store would be dollars of product sold.

3.3 General Framework of the Model

The model resembles the classic linear programming transportation model (explained in Chapter 2, Section 2.5) in many respects. However, it differs in the goal of the objective function. While the classic transportation model minimizes the cost of production and distribution to the firm, this model minimizes the cost to the consumer of purchasing and transporting the product. Thus, the model attempts to simulate consumer behavior based on the net price of the product. Other than that, the model finds the optimal distribution of the products within the supply constraints of the firm and the demand constraints of the consumer, just as in the classic transportation model. The following sections will describe the model as it is broken down into its four parts; 1) the objective function, 2) the demand constraints, 3) the capacity constraints, and 4) the transfer constraints. As each part of the model is discussed, its mathematical representation will also be shown. The mathematical representation of the entire model and the definition of the variables are shown in Table 3.1 at the end of the discussion. The examples in this section use fertilizer to illustrate important concepts. However, most of these concepts apply to other product lines as well.

3.3.1 Objective Function

As previously mentioned, the objective function of this model minimizes the net price paid by the consumer. Hence, the objective function is broken down into three parts; 1) the price of the product, 2) the charge for delivery to the consumer, and 3) the cost of pickup by the consumer. The objective function is shown below.

$$\text{Minimize } Z = \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} w_{ijk}$$

$$+ \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} b_{ij}\, m_{jk}\, x_{ijk}$$

$$+ \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} c_i\, m_{jk}\, y_{ijk}$$

where:

i is the product,
j is the supply site, and
k is the demand region.

w_{ijk} are the units of product i bought from site j by region k.

x_{ijk} are the units of product i delivered from site j to region k.

y_{ijk} are the units of product i picked up from site j to region k.

b_{ij} is the delivery charge for product i for delivery from site j.

c_i is the pickup cost for product i.

m_{jk} is the mileage from site j to region k.

Delivery occurs when the cooperative transports the product to the farm. Pickup occurs when the patron transports the product to the farm. The delivery charge will apply only to those units delivered by the store and the pickup cost will apply only to those units picked up by the patron. The following paragraphs explain the three parts of the objective function in more detail.

The most common representation for price of the product is price per unit such as $180 per ton for fertilizer. However, this representation cannot be used in order to maintain the model's flexibility. The units for all products are total dollars sold, or, in other words, total dollars purchased by the patron. Hence, the patron can guarantee that he/she bought the product for the lowest price if the total dollars purchased is minimized.

The second section of the objective function represents the charge paid by the patron to the supply site for delivery of the product to the farm. Mathematically, delivery charge is equal to the dollars of product delivered multiplied by the delivery charge per dollar per mile and the round trip mileage travelled. All of this is summed over all product lines, supply sites, and demand regions. The dollars delivered is the decision variable determined by the model. Note that delivery charge (paid by the patron) is used in the objective function instead of delivery cost (paid by the cooperative). This is consistent with the goal of the objective function.

The cooperative usually charges patrons for delivery on a per unit basis, a lump sum basis, or some other means which is not per mile. For instance, delivery and spreading of bulk fertilizer is usually charged on a per acre basis, regardless of the farm's distance from the cooperative store. Farm supply deliveries (such as seed and farm chemicals) are usually charged on a lump sum basis, such as $10 per trip.

This presents a unique problem in the model which is best illustrated with an example. Store A and store B both charge the same per acre rate for the delivery and spreading of bulk fertilizer. Furthermore, store A charges $1 more per ton for the same fertilizer. A farmer operates a farm 5 miles from store A and 50 miles from store B.

Realistically, one would expect the farmer to purchase the fertilizer from store A since store B would probably refuse to travel the 50 miles to the farm (especially if store A and store B were part of the same cooperative). Also, the farmer would incur some added costs (telephone, etc.) by buying from the more distant store. However, the model would still select store B to deliver to the farmer based on the lower price since it is attempting to minimize her net purchase price. To remedy this problem, all delivery charges are represented on a per dollar per mile basis. This would allow the model to select the higher priced store (store A) to deliver to a demand region based on lower delivery charges and, consequently, lower total costs to the patron.

Per acre charges (used with many fertilizer operations) also present a problem. Since each farm has fields of different sizes, a farm with a 100 acre field located 1 mile from the cooperative will incur more delivery (application) charges than a farm with a 20 acre field located 20 miles from the cooperative. However, delivery is also based on volume sold. Since the 100 acre field requires more fertilizer, its total delivery charge will be greater.

A problem also arises when two fields of the same size are located at different distances from the supply site. For example, assuming similar application rates, the supply site will charge the same for delivery to a 100 acre field located 1 mile from the site as a 100 acre field located 20 miles from the store. This means that the per mile charges in this case varies for different situations. However, the model uses a constant per mile delivery charge for all situations. Hence, the model will charge more to the patron located farther away. By assuming that field sizes are evenly distributed throughout all demand regions, then the problems with constant per mile delivery charges are overcome.

Pickup cost is the final segment of the objective function. It is also the most straight forward. Pickup cost per unit per mile is the cost incurred by the patrons when they uses their own vehicles to pick up the product. It is represented as the dollars of product picked up by the patron multiplied by the cost per dollar per mile and the round trip mileage. The decision variable is units picked up while the other coefficients are entered by the user. Mileage is the distance travelled round trip from the farm to the store.

It is assumed that the patron always travels from the farm to the supply site for the sole purpose of purchasing products from that site. The model cannot take into account those situations when a patron might travel to the town of a more distant site for some reason and happens to buy products at that site. In this case, the patron actually may be minimizing the net price of the product by purchasing at a more distant site. The model also cannot account for the instances where the patron is located in one demand region and the farm where the products are delivered is in another region. This limitation exists because cooperatives usually keep records of the patron's mailing address, not the address of the farm.

In conclusion, the objective function value (minimum of the combined three sections) represent the total net cost to the patrons of purchasing the products sold. The section representing the price of the product gives the actual cost of the product to the patron. The transportation segments represent the costs of transport.

3.3.2 Demand Constraints

The demand constraints function as the "driving" force of the model. They represent the product demand of the patrons, or in other words, how much the patrons will buy. Since this is a cost minimizing model, the lowest cost alternative would be for the patrons not to buy any product and the supply sites not to sell any product. However, these constraints force the sites to sell enough product to satisfy the purchasing needs of the patrons. The demand constraints consist of two equations; 1) delivery demand and 2) pickup demand. The demand constraint portion of the model is shown below.

$$\sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} a_{ij}\, x_{ijk} \geq d_{ik}$$

$$\sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} a_{ij}\, y_{ijk} \geq p_{ik}$$

where:

i is the product,
j is the supply site, and
k is the demand region.

w_{ijk} are the units of product i bought from site j by region k.

x_{ijk} are the units of product i delivered from site j to region k.

y_{ijk} are the units of product i picked up from site j to region k.

a_{ij} is the markup ratio for product i at site j.

d_{ik} are the units of product i demanded for delivery in region k.

p_{ik} are the units of product i demanded for pickup in region k.

Delivery demand is the dollars of product that the farmers in the demand region want delivered to the farm. Pickup demand is the dollars of product that farmers in the demand region want to pick up at the cooperative. The sum of the delivery demand and the pickup demand is equal to the total demand.

The delivery and pickup demand constraints dictate that the amount of product demanded for delivery and pickup must be greater than or equal to the amount of product demanded for delivery and pickup respectively, summed over all product lines and demand regions. The model assumes that the supply sites carry no excess inventory; in other words, all product supplied by the cooperative is purchased by the patron. Any excess inventories increase the cost to the patron and, hence, increases the objective function value. Thus, even though the demand constraints are greater than or equal to, the product supplied (for delivery and for pickup) will be equal to the product demanded (for delivery and for pickup).

The demand constraints are not as straight forward as one might expect. A problem arises because of the price differences between each supply site; one dollar of fertilizer from site A is not the same as one dollar of fertilizer from site B if the two sites charge different prices. Consequently, when demand region 1 demands $100,000 of fertilizer, is this site A dollars or site B dollars? Obviously, no one of the individual store's dollars are correct. Thus, a method for standardizing each store's dollars to a consistent dollar unit for demand over the entire trade area was developed. Price markups, the percentage of the cost of goods sold that the cooperative adds to cover costs and investment, can differentiate the relative cost of a product from different stores.

The following ratio, hereafter called the markup ratio, will be used as a proxy for the price of the product.

(3.1) (1 + GENERAL PRICE MARKUP) / (1 + STORE PRICE MARKUP)

The total dollars units sold for each product line from one supply site is multiplied by the markup ratio to convert the store's dollars to general trade area dollars in both sets of demand constraints. This conversion allows both sides of each demand constraint to represent the same dollars.

General price markup is a standard markup for the product line for the entire trade area. It can be represented as the average of all store markups, the markup suggested by upper management for the product, or the markup of one of the stores within the trade area. When the store markup is high, the product is more expensive to the patron. Therefore, patrons cannot buy as many physical units (tons of fertilizer, etc.) with the same amount of money at a store with a high price margin as they can at a store with a low price margin. For example, store A has a price markup for fertilizer of 25 percent and store B has a price markup of 18 percent. Assume that the general price markup for the trade area is 20 percent. The markup ratio for fertilizer at store A is 0.96 and the markup ratio at store B is 1.02. A markup ratio of 1.0 represents the standard price markup. Hence, one trade area dollar at store A can only buy $0.96 worth of fertilizer while it can buy $1.02 worth of fertilizer at store B.

In order to use price markups, cost of goods sold must be assumed constant for each of the cooperative stores so that accurate comparisons can be made. Cost of goods sold (COGS) is the cost the cooperative (site) pays for the goods they sell. An example will help to explain the need for this assumption. Suppose store 1 has a 25 percent price markup and a $140 per ton COGS for fertilizer. Store 2 has a 35 percent price markup and a $125 per ton COGS. Using the different COGS, store 2 has the highest markup and the model would show the patron choosing to purchase from store 1 (assuming zero transportation costs). However, when calculating the final price on a per ton basis (COGS multiplied by the price markup), the price at store 1 is $175 per ton while store 2 has a price of $168.75 per ton. Thus, the model would have actually selected the higher priced store based on the price markup. Maintaining a constant cost of goods sold would solve this problem.

Constant COGS is an acceptable assumption for two reasons. First, the differences in assembly costs (cost of transporting the wholesale product or the raw products to the cooperative store) should be small since trade areas are usually relatively small and cooperative stores are close together. Second, since the cooperatives stores work together, the price paid for wholesale and raw products should be very similar.

Demand should be standardized to general trade area dollars using the markup ratio before it is entered into the model. All sales records are in store dollars for the store at which the sale was made. After demand for each product line from each store is determined, it must be multiplied by the markup ratio to convert it to general dollars. For instance, assume the store A price markup for fertilizer is 25 percent and the general markup is 20 percent. The markup ratio in this case equals 0.96. If the store sold $10,000 to demand region 1, the standardized dollars sold is ($10,000 * 0.96) or

$9600. This result makes sense because the store's higher price for one ton of fertilizer is greater than the general trade area price. Hence, the total sales in standardized dollars would be less than total sales in store A dollars.

3.3.3 Capacity Constraints

The capacity constraints of the model restrict each supply site to selling or delivering no more product than their physical facilities can handle. These constraints are divided into two categories: production/storage, and delivery. They are shown below.

$$\sum_{j=1}^{5} \sum_{i=1}^{5} \sum_{k=1}^{15} w_{ijk} \leq s_{ij}$$

$$\sum_{j=1}^{5} \sum_{i=1}^{5} \sum_{k=1}^{15} x_{ijk} \leq e_{ij}$$

where:

i is the product,
j is the supply site, and
k is the demand region.

w_{ijk} are the units of product i bought from site j by region k.

x_{ijk} are the units of product i delivered from site j to region k.

s_{ij} are the maximum units of product i which can be stored at site j.

e_{ij} are the maximum units of product i which can be delivered from site j.

The production/storage constraints represent the most restricting capacity between production facilities and storage facilities. Production facilities include assets such as fertilizer blending facilities and feed hammer mills. Storage facilities include assets such as warehouses and showrooms. For instance, suppose that the annual warehouse capacity for bulk fertilizer is $950,000 and the annual blending capacity is $1,100,000. Then the storage capacity is the most restricting and $950,000 is the constraint for bulk fertilizer. These constraints will define the total sales potential (delivery plus pickup) of each individual cooperative store.

The delivery capacity constraints restrict the amount of product which each supply site can deliver. This capacity is strictly a function of vehicle capacity, not a function of labor or any other related factor. The user must realize that delivery capacity is also constrained by production/storage capacity. For example, suppose the fertilizer delivery capacity at a supply site is $500,000 and the fertilizer storage capacity is $400,000. Then the effective delivery capacity is actually $400,000 since the supply site can deliver no more than it can store.

3.3.4 Transfer Constraints

The transfer constraints are never seen by the user but they are integral in the ability of the model to find a feasible solution. They are shown below.

$$\sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} x_{ijk} + y_{ijk} - w_{ijk} = 0$$

where:

i is the product,
j is the supply site, and
k is the demand region.

w_{ijk} are the units of product i bought from site j by region k.

x_{ijk} are the units of product i delivered from site j to region k.

y_{ijk} are the units of product i picked up from site j to region k.

The transfer constraints simply require the total amount of product sold to equal the sum of the amount delivered and the amount picked up. These constraints make sense because the only two methods of product distribution are delivery by the site and patron pickup.

The model is relatively simple in structure. It contains all of the essential parts of the classic transportation problem; a minimized objective function, demand constraints, capacity constraints, and transfer constraints. The entire model and the variable definitions are shown in Table 3.1.

3.4 Conclusions

The purpose of this model is to report the effects of consolidation on the economic viability of a cooperative trade area subject to a given level of consumer demand. The model accomplishes this by solving for the optimal retail product distribution at the minimum net price to the patrons. It is essentially a microcomputer based linear programming transportation model. It has the capacity for a trade area with no more than five supply sites selling five product lines to 15 demand regions. The concepts behind the development of the model are relatively easy to understand. However, building flexibility into the model increased its complexity.

Table 3.1 - Mathematical Representation of the Model

The Objective Function

$$\text{Minimize } Z = \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} w_{ijk}$$

$$+ \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} b_{ij}\, m_{jk}\, x_{ijk}$$

$$+ \sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} c_{i}\, m_{jk}\, y_{ijk}$$

subject to:

The Demand Constraints

$$\sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} a_{ij}\, x_{ijk} \geq d_{ik}$$

$$\sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} a_{ij}\, y_{ijk} \geq p_{ik}$$

The Capacity Constraints

$$\sum_{j=1}^{5} \sum_{i=1}^{5} \sum_{k=1}^{15} w_{ijk} \leq s_{ij}$$

$$\sum_{j=1}^{5} \sum_{i=1}^{5} \sum_{k=1}^{15} x_{ijk} \leq e_{ij}$$

The Transfer Constraint

$$\sum_{i=1}^{5} \sum_{j=1}^{5} \sum_{k=1}^{15} x_{ijk} + y_{ijk} - w_{ijk} = 0$$

Table 3.1 - Mathematical Representation of the Model (continued)

where: i is the product,
j is the supply site, and
k is the demand region.

Decision Variables

w_{ijk} are the units of product i bought from site j by region k.

x_{ijk} are the units of product i delivered from site j to region k.

y_{ijk} are the units of product i picked up from site j to region k.

Objective Function Coefficients

b_{ij} is the delivery charge for product i for delivery from site j.

c_i is the pickup cost for product i.

m_{jk} is the mileage from site j to region k.

Demand Constraint Coefficient

a_{ij} is the markup ratio for product i at site j.

Right Hand Sides of the Demand Constraints

d_{ik} are the units of product i demanded for delivery in region k.

p_{ik} are the units of product i demanded for pickup in region k.

Right Hand Sides of the Capacity Constraints

s_{ij} are the maximum units of product i which can be stored at site j.

e_{ij} are the maximum units of product i which can be delivered from site j.

CHAPTER 4
DATA

4.1 Introduction

The model used in this research simulates product/trade flows in a cooperative trade area by minimizing the net cost of the product to the patron. This chapter is a discussion of the data required to complete a consolidation analysis. For this research, the data will be used to create a baseline scenario which will simulate the actual situation of the trade area. The chapter begins with a discussion of the characteristics of the trade area and the products sold by the cooperatives. Next, the data required for model solution are explained. Thirdly, the data needed for the financial statements are discussed. Finally, the calculations needed to create the reports are presented. All of the inputs for the revised baseline model are in Appendix 1.

4.2 Cluster and Trade Area Characteristics

The cooperative stores in the test trade area make up Central Service Cooperative. The regional cooperative of which Central Service is a part is a large, multi-state farm supply and grain marketing cooperative. The regional cooperative refers to the stores in Central Service as a cluster. This chapter follows that convention while the region that the cluster serves is called the trade area. The cluster consists of five supply sites (branch stores): Boyle (located in Danville), Harrodsburg, Lancaster, Liberty, and Stanford. Danville, designated as the center of the trade area, is located about 40 miles southwest of a major metropolitan area. The Boyle branch is the "mother" store and is where the cluster manager is located.

The five supply sites are located in five adjacent counties: Boyle, Mercer (Harrodsburg), Garrard (Lancaster), Casey (Liberty), and Lincoln (Stanford). The major agricultural products of the area are dairy, beef, and tobacco. Danville and Harrodsburg have populations of over 10,000 people. Danville is the largest retail center for the area outside of the large metropolitan area.

This region was chosen as the test trade area because the regional cooperative had recently conducted an analysis of the cluster. The five stores were joined together by the regional cooperative as Central Service only a few years ago. Prior to that time, the stores were independent of each other. The regional cooperative conducted the study to consider the advantages and possible results of creating the cluster. The regional cooperative analysis helped make data more accessible since much of the same data that was used for the cluster analysis was used for this study. The analysis also helped give the managers of the five stores an appreciation for this type of analysis and, hence, help make them more willing to assist in the data collection for this study. The test trade area also fits the model's size limitations of five product lines, five supply sites, and fifteen demand regions well.

4.3 Product Characteristics

The cluster offers a full range of agricultural supplies for its patrons. For the purposes of this study, all sales are split into five product lines: agricultural chemicals, farm supplies, feed, fertilizer, and petroleum. The regional cooperative splits all products into these product groups. The breakdown of these product groups into the five product lines for this study is shown in Table 4.1. However, the users of this model may define the product lines in any manner they choose. The product groups for service are not included in any product line for this study because they are generally included in the delivery revenues for its respective product line.

Agricultural chemicals include all pesticides used for crops and miscellaneous chemicals for other uses. No store in the cluster offers custom application of agricultural chemicals. Also, very little of the agricultural chemicals sold in the trade area are delivered by the stores. Hence, all agricultural chemicals are assumed to be picked up by the patron.

The farm supplies product line is very diversified, ranging from building supplies to animal health products to clothing. The farm supplies line is almost a "catch-all" category for those product groups that did not fit in the other product lines. As with agricultural chemicals, all farm supplies are assumed to be picked up by the patron. This assumption is made because most individual sales from the farm supplies line are small in dollar volume and the stores deliver very little of this product line.

Feed has both a delivery and a pickup component. Unfortunately, the records of the cluster do not differentiate between delivered feed and feed that is picked up by the patron. Thus, it is assumed that all bagged feed is picked up and all bulk feed is delivered. The store managers verified that this assumption closely represents the actual sales of their stores.

The feed product line is different from the other product lines since feed deliveries do not originate from the supply sites. The regional cooperative operates regional feed mills where most bagged and bulk feed is produced. Bagged feed is then moved to the stores for patron pickup. Bulk feed is delivered directly from the regional mills to the patrons. A regional mill in Park City serves the Liberty store while a regional mill in Winchester serves the other four stores in the cluster. Three stores (Harrodsburg, Lancaster, and Stanford) have feed facilities for custom feed

Table 4.1 - Product Group Descriptions and Product Line Breakdowns

Farm Supplies

Code	Name
1	TIRES
2	TIRES ACCESSORIES AND MISCELLANEOUS TIRES
3	BATTERIES
5	OIL AND GREASE
8	AUTO AND FARM SUPPLY PARTS
9	BARN AND DAIRY EQUIPMENT
11	WATER SYSTEMS
13	PLUMBING
15	ELECTRICAL
17	GENERAL HARDWARE
18	GENERAL HARDWARE (CONTINUED)
19	HARDWARE - CENTRAL WAREHOUSE ROANOKE
21	ROPE AND TWINE
23	FENCING AND POSTS
24	ELECTRIC FENCE PRODUCTS AND HIGH TENSILE PRODUCTS
25	NAILS AND STAPLES
26	CONSTRUCTION & BUILDING MATERIALS
27	ROOFING AND ACCESSORIES
28	EXTERIOR PAINT
29	INTERIOR PAINTS AND SPECIAL PAINTS
30	PAINT SUPPLIES
31	ASPHALT AND ASBESTOS PRODUCTS
33	FARM AND GARDEN TOOLS
35	LAWN, GARDEN AND OUTDOOR POWER EQUIPMENT
36	LAWN AND GARDEN (MISC.)
37	LAWN AND GARDEN SUPPLIES
39	POULTRY EQUIPMENT
41	STOCK EQUIPMENT
43	DUSTERS AND SPRAYERS
45	ORTHO PRODUCTS
49	ANIMAL HEALTH, SALT AND OYSTER SHELLS
53	HEATING AND COOLING EQUIPMENT
55	MAJOR HOME APPLIANCES & GAS GRILLS
57	HOUSEHOLD SUPPLIES
58	FOOD AND PAPER PRODUCTS
59	WAREHOUSE SUPPLIES
63	FARM EQUIPMENT
65	WEARING APPAREL AND PROTECTIVE EQUIPMENT
67	PET, HORSE & SMALL ANIMAL SUPPLIES
68	CATALOG
69	MISCELLANEOUS
94	LEGUMES & GRASSES
95	FIELD - GRAIN
96	HYBRID CORN
97	VEGETABLE/TOBACCO SEED
98	NURSERY

Ag Chemicals

Code	Name
47	AGRICULTURAL CHEMICALS
51	MISCELLANEOUS CHEMICALS

Feed

Bulk

Code	Name
80	DAIRY BULK
83	SWINE BULK
87	GRAIN, INGREDIENTS, BULK

Bagged

Code	Name
50	MISCELLANEOUS FEEDS
81	DAIRY BAG
82	HORSE AND SPECIALTY
84	SWINE BAG
85	PET FOODS
86	POULTRY
88	GRAIN, INGREDIENTS BAG
89	BEEF, STOCK, SHEEP

Fertilizer

Bulk

Code	Name
91	BULK FERTZ-MIXED/MATL'S

Bagged

Code	Name
90	BAGGED FERTZ-MIXED/MATL'S
92	LIME AND LAND PLASTER

Petroleum

Code	Name
66	PETROLEUM LIQUIDS/DIESEL
75	PETROLEUM LIQUIDS/GASOLINE
76	PETROLEUM LIQUIDS/F.O. KEROSENE
77	PETROLEUM LIQUIDS/LP GAS
78	BURNER SERVICE PARTS
79	PETROLEUM EQUIPMENT

Services

Code	Name
70	FARM SUPPLY SERVICES
71	PETROLEUM SERVICES
72	FEED SERVICES
73	FERTILIZER SERVICES
74	SEED SERVICES

grinding while two of those stores (Harrodsburg and Stanford) have bulk feed trucks for custom feed hauling. However, these facilities are rarely used for grinding and hauling bulk feed from the regional mills. Hence, these feed facilities and trucks are not included as part of the bulk feed enterprise.

The fertilizer product line also has delivery and pickup components. Unfortunately, the bulk and bagged categories for fertilizer do not break down as conveniently as they did with feed. Most bagged fertilizer is picked up by the patrons. Thus, the assumption that all bagged fertilizer is picked up is justifiable. However, bulk fertilizer is more difficult to categorize. Bulk fertilizer is transported and spread on fields in two ways: 1) Delivered and spread by the store using a spreader truck, and 2) Picked up by the patron and spread using a fertilizer buggy. Therefore, it cannot be assumed that all bulk fertilizer is delivered without further analysis. Each of the five stores have one spreader truck and several fertilizer buggies. The Liberty store also has a fertilizer tender truck for hauling fertilizer for the spreader truck. Liberty stores all of its bulk fertilizer in a facility at Hustonville (about 14 miles northeast of Liberty), and the tender truck is needed to cut down on travel time for big jobs.

The final product line, petroleum, is the only one not sold at all five stores. Boyle, Harrodsburg, and Liberty all sell petroleum products. Boyle offers a full line of petroleum products for both delivery and pickup. Harrodsburg only fills small liquid petroleum gas tanks for patron pickup while Liberty only offers kerosene for patron pickup. Together, these two stores sell less than one percent of the cluster's petroleum products and there is no indication that these sales will substantially increase. Therefore, it was assumed that petroleum is sold only by the Boyle site. Petroleum has delivered and picked up components since the Boyle site has service pumps for filling cars and trucks with gasoline and diesel fuel. Boyle has one petroleum delivery truck for gasoline and diesel fuel and two liquid petroleum (LP) gas delivery trucks. The distinction between delivered petroleum and picked up petroleum is discussed in Section 4.4.1.2 of this chapter.

4.4 Model Data

This section is a discussion of the data required and the mathematical manipulations needed to transform the data into coefficients for the model. Sources of the data included the financial records of the supply sites for the 1987-1988 fiscal year, interviews with the managers of each site and the cluster manager, interviews with the management of the regional cooperative, and sales data from the regional cooperative.

The sales data was collected from the regional cooperative's mainframe computer. Unfortunately, the sales data fiscal year (1988-1989) is one year later than the fiscal year of the cluster's financial records. This situation was unavoidable due to the high cost of retrieving data from past years. However, this inconsistency in time periods did not seriously affect the quality of the analysis. The sales data included every transaction for all five supply sites for three time periods; 1) October 10-31, 1988, 2) January 9-31, 1989, and 3) March 6-22, 1989. The sales data was broken down into each product group sold (shown in Table 4.1). For example, if a farmer bought fence posts and dog food in one transaction, it was split into two line items, one for each product group, in the sales data. Sales of seeds (included in the farm supplies product line), agricultural chemicals, fertilizer, and other agricultural supplies are seasonal with peak sales occurring in the spring and in the fall for fertilizer and some seeds. The March time period in the sales data represents the spring sales season and the October time period represents the fall sales season.

The time period for this analysis was one year. The annual analysis has several advantages. First, data was readily available on an annual basis. Second, a monthly analysis would be deceiving due to seasonal sales. The annual time period includes both the high and low sales months.

4.4.1 Objective Function Coefficients

The coefficients needed to construct the objective function include the delivery charge, the pickup cost, and the mileage from the supply site to the demand region. No coefficient was needed to represent the price of the product since the objective function simply minimizes the total dollars of product sold (see Chapter 3, Section 3.3.1).

4.4.1.1 Delivery Charge

The delivery charge is the charge which the patron pays the supply site to deliver products to his/her farm. The delivery charge is also revenue for the supply site. The units for the delivery charge coefficient (as well as for all the other transport costs) are charges (or costs) per dollar of product transported per mile travelled. The delivery charge is supply site and product specific; in other words, each product line at each supply site may have its own delivery charge. Since agricultural chemicals and farm supplies are assumed to only be picked up by the patron, there is no associated delivery charge with these two product lines. Feed is delivered from the regional mills directly to the farm. Fertilizer delivery also includes spreading on the field. Petroleum is delivered from the Boyle supply site to the farm.

None of the stores in the cluster charge the patron directly for feed delivery. Instead, the delivery charge was included in the price of the feed. However, a coefficient for each delivery charge had to be entered into the model in order for a solution to be found. A delivery charge is needed or else the model might have the supply site deliver products for great distances to patrons for a very small price difference. For instance, if no delivery charge is included, the model might have a patron purchase delivered products from a supply site 50 miles away instead of purchasing from a supply site 5 miles away for a $1 price difference. This situation is unrealistic and the inclusion of a delivery charge would solve the problem. The costs incurred by the supply site for delivering feed was chosen as a substitute for the feed delivery charge. This substitution makes sense because the supply site should set delivery charges at a level which offsets its delivery costs.

Since feed is delivered from the regional mill to the patron with the mill's trucks, the supply site does not directly incur delivery costs. The costs to the site for delivery come in the form of a delivery charge paid by the site to the regional mill. Therefore, this mill delivery charge was used as both the delivery cost to the supply site and the delivery charge to the patron. The regional mill charges the supply site for delivery on a charge per ton basis. The following equations illustrate the conversions of the mill delivery charge to a charge per dollar transported per mile travelled basis. This value is the objective function coefficient.

(4.1) CHARGE PER TON * TONS PER LOAD = CHARGE PER LOAD

(4.2) CHARGE PER LOAD / ROUND TRIP MILES TO MILL = CHARGE PER MILE

(4.3) TONS PER LOAD * PRICE PER TON = DOLLARS PER LOAD

(4.4) CHARGE PER MILE / DOLLARS PER LOAD = CHARGE PER DOLLAR PER MILE

Table 4.2 is a summary of the data and the calculation of the feed delivery charge. When broken down to a charge for delivery per mile travelled, the great differences between the supply sites' charges become apparent. These differences are confusing for two reasons. First, four of the five supply sites are served by the same regional mill. Those four sites should be charged virtually the equal amounts for delivery per mile. Only the Liberty site should have a substantially different delivery charge since

Table 4.2 - Feed Delivery Charges from the Regional Mills

	BOYLE	HARRODSBURG	LANCASTER
CHARGE PER TON	$11.50	$13	$17
TONS PER LOAD	18	18	18
CHARGE PER LOAD	$207	$234	$306
ROUND TRIP MILES TO MILL	81	80	68
CHARGE PER MILE	$2.5555556	$2.9250000	$4.5000000
TONS PER LOAD	18	18	18
DOLLARS PER TON	$185	$190	$170
DOLLARS PER LOAD	$3,330	$3,420	$3,060
CHARGE PER DOLLAR PER MILE	$0.0007674	$0.0008553	$0.0014706

	LIBERTY	STANFORD	STANDARD
CHARGE PER TON	$15	$13	$13.13
TONS PER LOAD	18	18	18
CHARGE PER LOAD	$270	$234	$236
ROUND TRIP MILES TO MILL	124	82	91.8
CHARGE PER MILE	$2.1774194	$2.8536585	$2.5749319
TONS PER LOAD	18	18	18
DOLLARS PER TON	$200	$180	$188.75
DOLLARS PER LOAD	$3,600	$3,240	$3,398
CHARGE PER DOLLAR PER MILE	$0.0006048	$0.0008808	$0.0007579

it is served by another mill. Second, both regional mills use the same type of delivery vehicle, 18 ton semitrailer trucks. Hence, the cost per mile incurred by regional mills, a major determinant in the mills' delivery charges, should be similar for each site.

The wide differences in delivery charges creates problems, both philosophically for the cooperative and for the baseline model solution. Cooperative principles assure the patrons that they will all be paying the same price for equal quantities of the same product. This rule should also apply to the supply sites in this situation. Each site should have the same delivery charge for feed, especially since their feed supplier is also owned by their regional cooperative. The baseline model solution also might suffer due to the differences in delivery charges. This point applies to all delivered products, not just feed. The delivery charge differences might cause the model to distribute products much differently than dictated by actual patron purchasing patterns. For instance, Table 4.2 shows that Lancaster's feed delivery charge ($0.0014706 per dollar per mile) is almost twice as much as Boyle's delivery charge ($0.0007674 per dollar per mile). Thus, the model might distribute feed to Lancaster's own demand region from the Boyle site due to lower delivery charges when, in actuality, Lancaster supplies its own demand region.

In order to overcome these problems, all delivery charges were assumed constant throughout the cluster for each product. The averages of each input line (charge per ton, tons per load, etc.) were used to calculate the standard feed delivery charge for the cluster. However, the Lancaster input lines for the feed delivery charge were excluded from the averages because its delivery charge was drastically different from those of the other four supply sites. To the calculate the standard feed delivery charge, the four input lines (charge per ton, tons per load, round trip miles to the mill, and dollars per ton) for four supply sites (Lancaster excluded) were averaged individually. These averaged input lines were then used in the feed delivery charge formulas to derive the standard feed delivery charge. The standard feed delivery charge used for all five supply sites is $0.0007579 per dollar delivered per mile travelled.

The delivery charge for fertilizer is perhaps the most difficult delivery charge to determine. Many of the problems with delivery charges discussed in Chapter 3 (per acre charges, etc.) occurred in the fertilizer product line. As was discussed earlier in this chapter (Section 4.3), the major problem was to differentiate between delivered fertilizer and picked up fertilizer. Supply site records make it difficult to accurately estimate the amount of bulk fertilizer picked up by patrons and spread by a fertilizer buggy because delivered fertilizer and picked up fertilizer were not differentiated in the records. The bulk fertilizer picked up can be estimated accurately at the supply site level but not at the demand region level. Thus, if bulk fertilizer is split into its delivered and picked up components, the accuracy of the demand estimates will suffer.

If all bulk fertilizer is assumed to be delivered, then some of the realism of the baseline model is lost. However, this option does have one major advantage. The supply sites charge the patrons for buggy rentals. If bulk fertilizer spread by buggies is defined as picked up by the patrons, the buggy rental cannot be counted as revenue to the supply site by the model. Hence, the assumption that all bulk fertilizer is delivered was chosen because it does not compromise the demand estimates and it allows buggy rentals to be realized as revenues by the supply sites.

The following equations were used to calculate the delivery charge for fertilizer.

(4.5) SPREADER TRUCK REVENUE + BUGGY RENTAL REVENUES = TOTAL REVENUES

(4.6) SPREADER TRUCK MILES * BUGGY TONS AS A PERCENT OF TOTAL BULK TONS = BUGGY MILES

(4.7) BUGGY MILES + SPREADER TRUCK MILES = TOTAL MILES

(4.8) TOTAL REVENUE / TOTAL MILEAGE = CHARGE PER MILE

(4.9) (DOLLARS PER SPREADER LOAD * SPREADER TONS AS A PERCENT OF TOTAL BULK TONS) + (DOLLARS PER BUGGY LOAD * BUGGY TONS AS A PERCENT OF TOTAL BULK TONS) = DOLLARS PER AVERAGE LOAD

(4.10) CHARGE PER MILE / DOLLARS PER AVERAGE LOAD = CHARGE PER DOLLAR PER MILE

Table 4.3 is a list of the data and the calculations. The delivery charge for spreading with the spreader truck was on a per acre basis while the buggy rental was on a per ton basis. By using the total revenues for bulk fertilizer spreading and buggy rental, these charges could be calculated on a charge per dollar delivered per mile travelled basis. The mileage travelled by the buggies was not known by the supply site managers so Formula 4.6 (shown above) was used to derive a reasonable estimate. Formula 4.9 represents the average load size regardless of the delivery vehicle. Spreader truck loads and buggy loads are of different sizes and the average load size would fall somewhere between these two load sizes. The average load size formula makes sense because, if more fertilizer was spread with the larger spreader truck, then the average load size would be biased upward. For example, Boyle has a higher average fertilizer load size ($1,088 per average load) than Harrodsburg ($960 per average load) because Boyle delivers more bulk fertilizer using the larger spreader truck.

The differences in delivery charges occur in fertilizer as they did in feed. The highest charge ($0.0030212 per dollar per mile at Stanford) is considerably higher than the lowest charge ($0.0003452 per dollar per mile at Harrodsburg). Yet, the delivery charges should be similar because all five sites use the same size spreader trucks and the same size buggies. The problem with this great difference in charges was discussed in the feed delivery charge section. As with feed, a standard fertilizer delivery charge was used as the fertilizer delivery charge for all five supply sites to provide consistency. The standard was calculated as the average of each individual input line (just as feed's standard delivery charge) without the Stanford data. Since the Stanford delivery charge was almost 500 percent higher than the next highest delivery charge (Boyle's), Stanford was considered an outlier.

Table 4.3 - Fertilizer Delivery Charges

	BOYLE	HARRODSBURG	LANCASTER
SPREADER REVENUES	$3,560	$5,187	$4,937
BUGGY REVENUES	$2,134	$2,460	$960
TOTAL REVENUES	$5,694	$7,647	$5,897
SPREADER TRUCK MILES	6,400	12,000	12,800
PERCENT BUGGY SALES	22.50%	48.00%	8.00%
BUGGY MILES	1,858	11,077	1,113
TOTAL MILES	8,258	23,077	13,913
CHARGE PER MILE	$0.6895078	$0.3313700	$0.4238469
DOLLARS PER SPREADER LOAD	$1,200	$1,200	$1,080
PERCENT SPREADER SALES	77.50%	52.00%	92.00%
DOLLARS PER BUGGY LOAD	$700	$700	$630
PERCENT BUGGY SALES	22.50%	48.00%	8.00%
DOLLARS PER AVERAGE LOAD	$1,088	$960	$1,044
CHARGE PER DOLLAR PER MILE	$0.0006340	$0.0003452	$0.0004060

	LIBERTY	STANFORD	STANDARD
SPREADER REVENUES	$7,279	$13,200	$5,241
BUGGY REVENUES	$889	$8,133	$1,611
TOTAL REVENUES	$8,168	$21,333	$6,852
SPREADER TRUCK MILES	19,000	6,400	12,550
PERCENT BUGGY SALES	7.30%	8.00%	21.45%
BUGGY MILES	1,496	557	3,427
TOTAL MILES	20,496	6,957	15,977
CHARGE PER MILE	$0.3985124	$3.0666188	$0.4288329
DOLLARS PER SPREADER LOAD	$1,080	$1,050	$1,140
PERCENT SPREADER SALES	92.70%	92.00%	78.55%
DOLLARS PER BUGGY LOAD	$630	$613	$665
PERCENT BUGGY SALES	7.30%	8.00%	21.45%
DOLLARS PER AVERAGE LOAD	$1,047	$1,015	$1,038
CHARGE PER DOLLAR PER MILE	$0.0003806	$0.0030212	$0.0004131

Petroleum was another product line where the delivery charge was included in the price of the product. Thus, for the same reasons explained in the feed delivery charge section, the petroleum delivery cost to the supply site was used as a substitute for the delivery charge. The Boyle site delivery cost was used since it is assumed to be the only petroleum distributor. The equations below were used to derive the petroleum delivery cost.

(4.11) GALLONS PER GAS/DIESEL TRUCK LOAD + (GALLONS PER LP GAS TRUCK LOAD * 2) = GALLONS PER TOTAL LOAD

(4.12) GALLONS PER TOTAL LOAD * PRICE PER GALLON = DOLLARS PER TOTAL LOAD

(4.13) MILES PER WEEK FOR GAS/DIESEL TRUCK * WEEKS PER SEASON = MILES PER YEAR FOR GAS/DIESEL TRUCK

(4.14) (MILES PER WEEK FOR LP GAS TRUCK * 2) * WEEKS PER SEASON = MILES PER YEAR FOR LP GAS TRUCKS

(4.15) GAS/DIESEL TRUCK MILES + LP GAS TRUCK MILES = TOTAL MILES PER YEAR

(4.16) TOTAL MILES PER YEAR / COST PER YEAR = COST PER MILE

(4.17) COST PER MILE / DOLLARS PER TOTAL LOAD = COST PER DOLLAR PER MILE

Table 4.4 is a list of the data and the calculations used for determining the petroleum delivery cost/charge. The cost per year for the petroleum vehicles includes only variable costs such as fuel, oil, and repairs but excludes fixed costs such as depreciation, insurance, and taxes. The season for LP gas is eights month long at four weeks per month and six days per week.

4.4.1.2 Pickup Cost

The calculation of the pickup cost for each product line is relatively simple. The equation is shown below.

(4.18) DOLLARS PER LOAD PICKED UP / COST PER MILE = COST PER DOLLAR PER MILE

The pickup costs for all product lines are shown in Table 4.5. Most farmers use a pickup truck to pickup all five product lines. Thus, a reasonable cost per mile for pickup trucks was found in the United States income tax code. The cost per mile used is the allowance for business travel, $0.24 per mile. This figure is applicable since it is used by farmers to deduct the use of a pickup truck as a business expense.

The dollars per pickup load was found using the sales data from the regional cooperative. Each line item in the sales data gives the dollars spent on each particular product group. Thus, to avoid double counting, those transactions which contain more than one product group (each of which is a different line item) in the same product line were combined. For instance, if a patron bought tobacco seed (product group 97) and grass seed (product group 94) in the same transaction, those sales would be combined as one pickup load.

Double counting was also a problem in transactions where product groups from different product lines were picked up in the same load. However, the amount of multiple product line transactions (20 percent of all transactions and 30 percent of all sales) was relatively small. The possible solutions to the double counting problem were found to be ineffective. Thus, the double counting of multiproduct line transactions in the average pickup sizes was allowed.

Table 4.4 - Petroleum Delivery Costs at Boyle

GALLONS PER GAS/DIESEL TRUCK LOAD	2,500
GALLONS PER LP GAS LOAD * 2	4,500
GALLONS PER TOTAL LOAD	7,000
PRICE PER GALLON	$0.812
DOLLARS PER TOTAL LOAD	$5,684
MILES PER WEEK FOR GAS/DIESEL TRUCK	650
WEEKS PER SEASON	52
MILES PER SEASON FOR GAS/DIESEL TRUCK	33,800
MILES PER WEEK FOR LP GAS TRUCK * 2	1,000
WEEKS PER SEASON	32
MILES PER SEASON FOR LP GAS TRUCK	32,000
TOTAL MILES PER YEAR	65,800
COST PER YEAR	$20,148
COST PER MILE	$0.30620
COST PER DOLLAR PER MILE	$0.0000539

Table 4.5 - Pickup Costs

	AG CHEMICALS	FARM SUPPLIES	FERTILIZER
DOLLARS PER LOAD	$28.05	$41.47	$39.69
COST PER MILE	$0.24	$0.24	$0.24
COST PER DOLLAR PER MILE	$0.0085561	$0.0057873	$0.0060469

	FEED	PETROLEUM
DOLLARS PER LOAD	$40.67	$11.50
COST PER MILE	$0.24	$0.24
COST PER DOLLAR PER MILE	$0.0059012	$0.0208696

The separation of delivered product from picked up product has been explained for all product lines except petroleum. Since most deliveries of petroleum fuels are large purchases, a cutoff sales amount was chosen to differentiate deliveries from pickup sales. A cutoff of $30 in petroleum sales for one transaction was chosen since most dual-tank pickup trucks usually fill up with less than $30 dollars of fuel at the service pump. The frequency distribution of petroleum sales in the regional cooperative's sales data (Table 4.6) helps justify this cutoff. There is a noticeable decline in the number of transactions with sales above $30.

4.4.1.3 Mileage

Mileage from the cooperative store to the demand region is the least complicated input to determine. It can be measured in three ways. The first method is to measure mileage using a road map. This is the most realistic representation of mileage. It is also the most difficult to measure accurately because all roads may not be shown on road maps. The second method is to measure mileage in airline miles. This is the easiest method to measure accurately. However, it does not account for geographical barriers (rivers, mountains, etc.). The third method is to use an equation for the area in question that adjusts the airline mileage to road mileage. Unfortunately, these equations are not widely available. The method used depends on the topography of the trade area, the availability of a good map, and the availability of an adjustment equation.

For this research, the mileage was measured in airline miles for two reasons. First, the topography of the region should not cause the airline miles to differ significantly for the road mileage. Second, no adjustment equation was available for the area. The mileages for the trade area are shown in Table 4.7. Mileage was measured as the distance from the cooperative to the center of each demand region.

Table 4.6 - Frequency Distribution of Petroleum Sales

Sales Total	Frequency
≤ $10	212
$11-20	226
$21-30	66
$31-40	28
$41-50	20
$51-60	17
$61-70	12
$71-80	30
$81-90	12
$91-100	26
≥ $101	376

Table 4.7 - Mileage from Supply Sites to Demand Regions

DEMAND REGION	ZIP CODE	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD
HARRODSBURG	40330	12.0	9.0	21.0	31.5	22.0
SALVISA	40372	18.5	10.0	24.5	40.0	28.0
CRAB ORCHARD	40419	20.0	29.0	13.5	24.0	10.0
DANVILLE	40422	5.5	9.0	10.5	24.0	10.0
HUSTONVILLE	40437	12.0	19.5	18.5	11.0	11.5
LANCASTER	40444	11.0	16.5	8.0	31.0	11.0
STANFORD	40484	10.0	18.5	7.0	21.0	5.0
WAYNESBURG	40489	20.5	30.0	18.0	16.5	11.5
LIBERTY	42539	26.0	32.0	30.5	10.0	23.5
EAST		21.5	28.0	12.0	32.0	14.0
	40409	26.0	34.0	17.0	31.0	16.5
	40442	18.0	26.0	16.5	14.5	10.0
	40461	20.0	26.5	9.5	32.0	12.0
	40475	27.0	30.0	18.5	46.5	25.5
NORTH		25.0	20.0	27.0	48.5	32.0
	40308	19.5	11.0	26.0	41.0	29.0
	40310	9.0	5.5	14.0	33.0	17.0
	40502	29.0	26.0	26.0	53.0	33.5
	40503	28.0	24.0	25.5	51.5	33.0
	40524	31.0	27.0	29.5	55.5	36.0
	40601	40.5	33.0	45.0	63.0	49.5
SOUTH		26.0	33.0	26.5	11.0	21.5
	40009	22.0	25.0	30.0	12.0	24.5
	40448	14.5	22.0	16.0	12.0	8.5
	42501	44.5	53.5	40.5	31.0	35.0
	42516	23.5	31.0	24.0	9.0	16.5
	42528	33.5	40.5	26.5	10.5	28.5
	42541	20.0	28.0	22.0	8.0	14.5
	42565	35.5	43.5	38.0	13.5	31.0
	42566	21.0	29.0	23.5	6.5	15.5
	42733	35.5	39.0	43.0	15.5	36.0
WEST		11.5	13.0	21.0	19.0	18.0
	40328	18.0	18.0	27.0	18.5	23.5
	40440	10.0	14.5	18.5	15.5	14.5
	40452	11.5	13.0	22.0	20.0	18.0
	40464	8.0	11.0	17.0	19.0	13.5
	40468	9.0	9.0	20.0	22.0	18.0

However, this means that mileage might be zero for patrons in a supply site's own demand region. Hence, for demand regions in which a store is located, mileage from that store to its own demand region was measured from the store to the farthest edge of the region.

There are four demand regions (North, South, East, and West) which contain smaller regions (zip code areas in this case) in different locations. The definitions of the demand regions shown in Table 4.7 are explained in the total demand section (Section 4.4.2.2). The mileages for these directional demand regions are weighted averages of the actual mileages from the supply site to the zip codes within the demand region. The weights used were the sales to each zip code as a percent of the total sales in the directional demand region.

4.4.2 Demand Constraint Coefficients and Right Hand Sides

The only demand constraint coefficient is the markup ratio. The markup ratio is used to represent product price differences between supply sites. The right hand sides of the demand constraints represent the total demand, delivery demand, and pickup demand of the trade area. However, only data for total demand and pickup demand are needed. Delivery demand can be calculated using this data.

4.4.2.1 Markup Ratio

The markup ratio was used to standardize the sales of each product line from each supply site to general trade area dollars. A detailed explanation of the markup ratio is given in Section 3.3.2 of Chapter 3. The equation for the markup ratio is given below.

(4.19) (1 + GENERAL PRICE MARKUP) / (1 + STORE PRICE MARKUP)

A markup ratio was needed for each product line at each supply site.

Price markup is the difference between cost of goods sold (COGS) and retail price as a percent of cost of goods sold. In other words, it is the percentage by which COGS is increased to arrive at the retail price. However, cooperative financial records (including those of this test cluster) normally use price margins instead of price markups. Price margin is the difference between the retail price and the COGS. For this model, the price margin of the product as a percentage of the retail price was used. It was readily obtainable from the records of the supply sites. The price margins for services were left out of the product line price margins since some of the services such as delivery charges were accounted for in their own category. Double counting of these service revenues would occur if the service price margins were included in the product line price margins. The other service price margins, such as custom feed grinding and hauling revenues, were excluded from the study. By ignoring these services, the concentration of the study was on the distribution and revenues of the product. The services not associated with delivery accounted for about $84,000, or about six percent of the trade area's total gross margin. Though these exclusions lower the product lines' price margins, the total revenue was not seriously affected (as is demonstrated in Chapter 5).

Next, cost of goods sold was calculated as a percentage of the retail price. It equals one minus the percent price margin. Though the actual COGS in dollars per physical unit was assumed to be equal for all supply sites, the retail prices for the sites were not equal. Therefore, COGS as a percent of retail price is not equal for all supply sites. Finally, price markup was calculated as the percent price margin divided by the percent COGS. Hence, both percent COGS and percent price markup can be calculated using the percent price margin.

The general price markup is considered the standard price markup for the trade area. It was calculated by using a general price margin in much the same way as the individual price markups. Logical choices for the general price margins are the average price margins for all stores in the trade area, the minimum price margins in the trade area for each product, or the recommended price margins suggested by the cooperative's upper management. For this study, the price margins of the Boyle supply site, the "mother cooperative" of the cluster, were chosen as the general price margins. The individual price margins and price markups, the general price margins and price markups, and the markup ratios are given in Table 4.8.

4.4.2.2 Total Demand

Consumer demand is the most uncertain factor of the model. This model determines the optimal distribution of products based on a certain level of consumer demand. However, determining the levels of demand for each product is another project in itself. Fortunately, most cooperatives have a fairly good indicator of the buying patterns of its patrons in the near future - the records of the past purchases of its patrons. The regional cooperative's sales data included the name and location (zip code) of the patrons and their purchases for patronage refund reasons.

Defining the location of the demand regions is important to the accuracy of the model's results. Two possible geographical divisions for demand regions are zip code areas and counties. The size and number of demand regions are influenced by the desired accuracy of the model's results, the time constraints of the analysis, and the completeness of the cooperative's records. Defining many small demand regions (as with zip codes) paints a more accurate picture of distribution but also causes more data manipulation problems and adds to the model's computer computation time and memory requirements. Fewer large demand regions (such as counties) alleviate these

Table 4.8 - Price Margins, Price Markups, and Markup Ratios

PRICE MARGINS	General	Boyle	Harrodsburg	Lancaster	Liberty	Stanford
Ag Chemicals	13.05%	13.05%	13.20%	14.51%	12.79%	14.15%
Farm Supplies	25.14%	25.14%	22.44%	22.01%	19.06%	22.86%
Feed	14.06%	14.06%	12.51%	7.37%	9.20%	8.89%
Fertilizer	20.45%	20.45%	22.35%	19.76%	16.98%	21.45%
Petroleum	26.62%	26.62%	NA	NA	NA	NA

PRICE MARKUPS	General	Boyle	Harrodsburg	Lancaster	Liberty	Stanford
Ag Chemicals	15.01%	15.01%	15.21%	16.97%	14.67%	16.48%
Farm Supplies	33.58%	33.58%	28.93%	28.22%	23.55%	29.63%
Feed	16.36%	16.36%	14.30%	7.96%	10.13%	9.76%
Fertilizer	25.71%	25.71%	28.78%	24.63%	20.45%	27.31%
Petroleum	36.28%	36.28%	NA	NA	NA	NA

MARKUP RATIOS	Boyle	Harrodsburg	Lancaster	Liberty	Stanford
Ag Chemicals	1	0.998274	0.983208	1.002990	0.987349
Farm Supplies	1	1.036067	1.041811	1.081218	1.030456
Feed	1	1.018035	1.077845	1.056551	1.060158
Fertilizer	1	0.976115	1.008673	1.043620	0.987429
Petroleum	1	NA	NA	NA	NA

problems but decrease the accuracy of distributions and transportation costs because the mileage distances between supply sites and demand regions are less precise.

The availability of sales data on a zip code area basis and the desire for greater accuracy of distributions led to the decision to define the demand regions as zip codes areas. The sales data were sorted by zip code, product line, and supply site origin. Walk-in sales, those sales without an associated zip code, were separated from the zip code areas. Walk-in sales accounted for a major portion of total sales (10 percent of total sales) and usually had the first or second highest sales of all zip code areas from each supply site. These sales usually occurred when nonpatrons or patrons in a rush bought items without having their names and addresses recorded. Since the origin of these walk-in sales were unknown, they were assumed to be distributed amongst the zip code areas according to their sales as a percent of the total sales. The argument can be made that most walk-in traffic would come from the closest zip code area to the respective supply site.

With the walk-in sales distributed, the remaining sales data were sorted by product line and supply site. Then, the sales of each product line to each zip code area from each supply site as a percent of the total sales of the respective product line at the supply site in question was calculated. For instance, zip code area 40422 purchased $1,353 of agricultural chemicals for the Boyle site in the time periods covered by the sales data. This accounted for 60.11 percent of the $2,251 sales of agricultural chemicals at Boyle for those same time periods. This percentage was multiplied by the total 1987-1988 sales for the respective product line at each supply site to derive the total annual sales for each zip code area. Then, these totals were summed across the supply sites. The totalled sales figures are shown in Table 4.9.

Since the model only accommodates 15 demand regions, some of the zip code areas had to be eliminated. First, the top nine zip code areas in total sales for all product lines were chosen to be individual demand regions. This defined the cutoff for individual demand regions as those having greater than two percent of total sales.

Table 4.9 - Sales to Zip Code Areas from the Five Supply Sites and the Percent of Total Cluster Sales to Each Zip Code Area

ZIP CODE	AG CHEMICALS	FARM SUPPLIES	FEED	FERTILIZER	PETROLEUM	TOTAL	PERCENT
40330	$59,157	$389,038	$630,494	$188,964	$94,623	$1,362,276	17.33%
40444	$72,601	$262,945	$452,917	$424,471	$48,879	$1,261,813	16.05%
40422	$129,722	$380,118	$162,274	$311,663	$273,543	$1,257,319	16.00%
40484	$54,807	$222,377	$276,218	$179,138	$132,699	$865,239	11.01%
42539	$45,412	$215,434	$240,731	$271,544	$1,966	$775,088	9.86%
40489	$10,512	$42,270	$85,364	$182,145	$55,635	$375,927	4.78%
40372	$14,212	$60,161	$210,038	$33,347	$25,926	$343,684	4.37%
40419	$21,029	$37,814	$109,710	$77,665	$88,095	$334,314	4.25%
40437	$17,182	$49,702	$38,491	$51,876	$17,084	$174,335	2.22%
TOP NINE	$424,635	$1,659,858	$2,206,236	$1,720,815	$738,450	$6,749,995	85.87%
40461	$3,773	$28,275	$31,404	$57,479		$120,932	1.54%
40468	$2,511	$21,678	$14,435	$22,005	$32,662	$93,291	1.19%
40328	$3,013	$20,261	$2,802	$19,914	$30,851	$76,841	0.98%
40502	$1,556	$6,592	$60,807		$147	$69,102	0.88%
40464	$11,706	$14,544	$19,155	$3,205	$19,213	$67,823	0.86%
40440	$13,057	$22,270	$7,099	$4,734	$17,237	$64,397	0.82%
40308	$14,923	$12,964	$22,243	$555	$7,161	$57,845	0.74%
42528	$4,481	$12,660	$3,641	$27,979		$48,761	0.62%
42516		$3,152	$40,228	$4,008		$47,388	0.60%
42541	$2,577	$19,889	$12,342	$12,011	$432	$47,251	0.60%
40310	$132	$16,499	$15,008		$172	$31,810	0.40%
40009	$618	$10,127	$4,915	$13,793	$184	$29,637	0.38%
08758	$395	$3,255		$24,453		$28,103	0.36%
40601					$25,933	$25,933	0.33%
40524			$6,282	$14,031	$4,707	$25,019	0.32%
40475	$439	$3,890	$2,516	$12,967		$19,811	0.25%
40409		$4,272	$5,398	$5,948	$4,174	$19,792	0.25%
40448		$1,787	$16,096		$1,471	$19,354	0.25%
40452	$837	$1,327	$152	$190	$15,223	$17,729	0.23%
40503		$1,852	$13,289		$791	$15,932	0.20%
42565				$15,372		$15,372	0.20%
40442	$2,949	$9,013	$760	$419	$1,140	$14,281	0.18%
42733	$2,159	$1,207	$186	$8,954		$12,507	0.16%
42566	$6,920	$2,607	$378	$1,002		$10,907	0.14%
42501	$1,857	$3,543	$2,044	$279	$1,701	$9,424	0.12%
MIDDLE 25	$73,904	$221,663	$281,179	$249,299	$163,199	$989,242	12.60%
40342		$66			$7,382	$7,448	0.09%
42728	$882	$1,002	$4,795	$228		$6,908	0.09%
40515		$6,603				$6,603	0.08%
43812	$1,420	$4,237	$284	$353		$6,294	0.08%
40031		$3,396	$2,534			$5,930	0.08%
42734		$1,937		$3,957		$5,894	0.07%
45203		$4,748				$4,748	0.06%
40456					$4,431	$4,431	0.06%
40403		$440	$454	$2,907		$3,801	0.05%
40439	$146	$12	$1,731		$1,765	$3,653	0.05%
42546	$1,088	$2,475	$83			$3,645	0.05%
99999					$3,153	$3,153	0.04%
40501	$1,566	$1,252		$279		$3,097	0.04%
40314		$465	$2,359			$2,824	0.04%
42141		$2,590				$2,590	0.03%
40356		$1,782	$578		$202	$2,562	0.03%
32711		$2,526				$2,526	0.03%
40433					$2,427	$2,427	0.03%
41098	$1,347	$737	$178	$130		$2,393	0.03%
40033		$681			$1,646	$2,326	0.03%
28739	$1,232	$844		$230		$2,306	0.03%
40040			$2,253			$2,253	0.03%
42753	$1,904	$191	$124			$2,219	0.03%
47025					$2,160	$2,160	0.03%
28768		$1,287	$739	$130		$2,157	0.03%
40078		$363	$48		$1,719	$2,130	0.03%
40318					$1,839	$1,839	0.02%

Table 4.9 - Sales to Zip Code Areas from the Five Supply Sites and the Percent of Total Cluster Sales to Each Zip Code Area (continued)

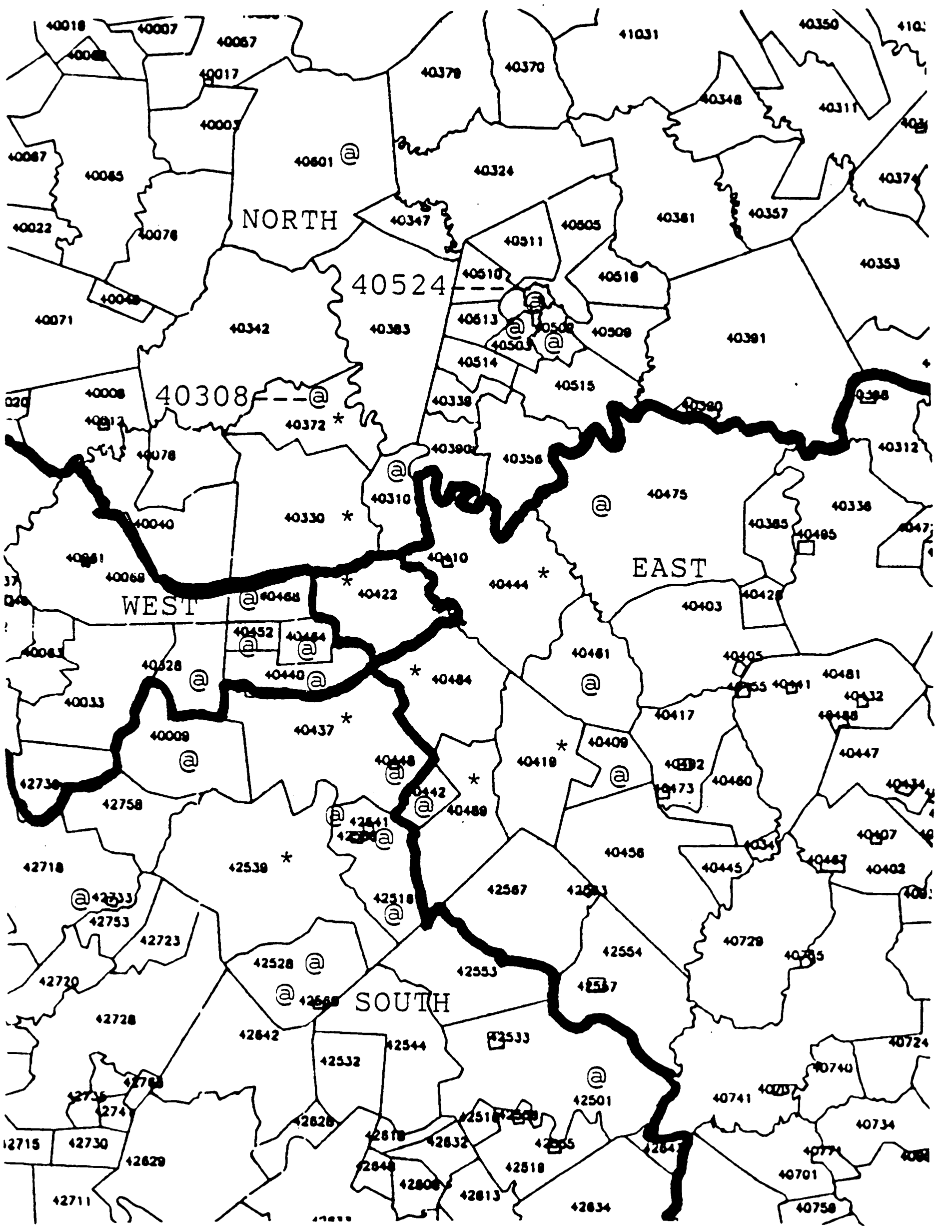
ZIP CODE	AG CHEMICALS	FARM SUPPLIES	FEED	FERTILIZER	PETROLEUM	TOTAL	PERCENT
70815	$921	$679		$205		$1,805	0.02%
40383		$490	$1,184			$1,674	0.02%
42543	$789	$670		$140		$1,599	0.02%
45241		$983	$528			$1,511	0.02%
40004		$681			$735	$1,416	0.02%
48013		$339	$1,018			$1,357	0.02%
42718		$970			$211	$1,181	0.02%
40022		$133	$502	$203		$838	0.01%
33704	$527	$94		$86		$706	0.01%
42134					$703	$703	0.01%
41097		$459	$236			$694	0.01%
77000		$596				$596	0.01%
23260			$560			$560	0.01%
40507		$528				$528	0.01%
40500		$326	$198			$524	0.01%
40584		$31	$455			$486	0.01%
40206		$264	$218			$482	0.01%
24565		$265		$216		$481	0.01%
40508		$465				$465	0.01%
97402		$408				$408	0.01%
40485			$396			$396	0.01%
42723		$280	$89			$369	0.00%
32748		$346				$346	0.00%
40454		$153	$164			$317	0.00%
45223		$302				$302	0.00%
42526	$46	$177	$76			$299	0.00%
40410		$44	$70	$103		$216	0.00%
40405			$191			$191	0.00%
40505			$175			$175	0.00%
40213		$171				$171	0.00%
40594		$132				$132	0.00%
37046		$124				$124	0.00%
27008					$120	$120	0.00%
40390			$105			$105	0.00%
19046		$94				$94	0.00%
40417		$88				$88	0.00%
42724		$85				$85	0.00%
40222			$77			$77	0.00%
45152	$73					$73	0.00%
20008		$12		$56		$67	0.00%
40504			$61			$61	0.00%
44685		$59				$59	0.00%
20010			$48			$48	0.00%
BOTTOM 70	$11,942	$48,082	$22,511	$9,224	$28,493	$120,246	1.54%
TOTALS	$510,481	$1,929,607	$2,509,930	$1,979,330	$930,142	$7,859,490	100.00%

These nine zip code areas accounted for almost 86 percent of total sales. Twenty four of the next 25 zip code areas were chosen to make up the four directional demand regions. The cutoff for these zip code areas was one tenth of one percent of total sales. These zip code areas accounted for 12.6 percent of total sales in the trade area. The directional demand regions were incorporated because 7.9 percent of total sales would be unaccounted for if the top 15 zip code areas were used as demand regions. Zip code area 08758 was considered an outlier because it is located outside of the state. By using the directional demand regions, only about 1.5 percent of total sales are unallocated to demand regions. Those zip code areas below one tenth of one percent sales and zip code area 08758 were eliminated and their sales were distributed among the other zip code areas on the basis of total sales. The lines in Table 4.9 show the cutoffs for the top nine zip code areas and for those zip code areas included in the four directional demand regions.

The sales figures had to be standardized to the same dollar units before they could be used as demand constraint right hand sides. The sales for each product line to each zip code area from each supply site were multiplied by its respective markup ratio to standardize the sales to general trade area dollars. The standardized sales were then summed across all supply sites to arrive at the demand figures shown in Table 4.10. Figure 4.2 is a map of the trade area after the demand regions were defined. Notice that zip code areas 40308 and 40524 were not on the original zip code map. Zip code area 40524 is in the heart of the nearby metropolitan area and is too small to be shown on the map. Zip code area 40308 was combined with zip code area 40372 sometime in the past few years. Though this zip code area no longer exists in the eyes of the US Postal Service, it is still recorded by the regional cooperative. Since its location is known, zip code area 40308 is considered an independent zip code area in this study. The zip code areas with sales below two percent of total sales were assigned to directional demand regions only partially on the basis of direction from Danville, the designated center of the trade area. They were also assigned so the directional

Table 4.10 - Final Standardized Demands by Product Line

NAME	ZIP CODE	AG CHEM	F SUPPLY	FEED	FERT	PETRO	TOTAL	PERCENT
HARRODSBURG	40330	$59,198	$412,130	$647,227	$184,641	$97,782	$1,400,978	17.43%
SALVISA	40372	$14,188	$63,556	$215,735	$32,550	$27,031	$353,061	4.39%
CRAB ORCHARD	40419	$21,658	$40,097	$116,689	$77,261	$90,823	$346,528	4.31%
DANVILLE	40422	$130,476	$392,486	$165,368	$311,588	$282,066	$1,281,985	15.95%
HUSTONVILLE	40437	$18,100	$54,216	$41,015	$57,006	$17,605	$187,943	2.34%
LANCASTER	40444	$73,508	$277,853	$485,492	$428,019	$50,392	$1,315,264	16.36%
STANFORD	40484	$57,211	$236,216	$293,107	$181,721	$136,808	$905,062	11.26%
WAYNESBURG	40489	$11,002	$44,861	$90,786	$182,263	$57,358	$386,270	4.81%
LIBERTY	42539	$47,814	$241,468	$260,206	$301,673	$1,966	$853,127	10.61%
SUBTOTAL		$433,154	$1,762,883	$2,315,626	$1,756,723	$761,831	$7,030,217	87.47%
EAST	40461	$3,813	$29,934	$33,875	$58,476		$126,098	1.57%
	40409		$4,522	$5,754	$5,887	$4,303	$20,465	0.25%
	40475	$443	$4,118	$2,718	$12,835		$20,114	0.25%
	40442	$3,112	$10,096	$821	$465	$1,175	$15,668	0.19%
SUBTOTAL		$7,368	$48,670	$43,167	$77,662	$5,478	$182,345	2.27%
NORTH	40502	$1,642	$7,006	$64,852		$152	$73,651	0.92%
	40308	$14,897	$13,745	$22,846	$541	$7,383	$59,412	0.74%
	40310	$133	$17,494	$15,430		$237	$33,294	0.41%
	40601					$26,736	$26,736	0.33%
	40524			$6,452	$13,695	$4,852	$25,000	0.31%
	40503		$1,964	$13,679		$815	$16,458	0.20%
SUBTOTAL		$16,672	$40,208	$123,259	$14,237	$40,175	$234,550	2.92%
SOUTH	42528	$4,729	$14,196	$3,935	$31,083		$53,944	0.67%
	42541	$2,720	$22,249	$13,337	$13,344	$445	$52,095	0.65%
	42516		$3,535	$43,483	$4,453		$51,470	0.64%
	40009	$628	$10,615	$5,231	$15,293	$190	$31,956	0.40%
	40448		$1,857	$17,122		$1,516	$20,495	0.25%
	42565				$17,077		$17,077	0.21%
	42733	$2,279	$1,348	$201	$9,948		$13,776	0.17%
	42566	$7,302	$2,923	$409	$1,113		$11,747	0.15%
	42501	$1,943	$3,845	$2,196	$276	$1,753	$10,013	0.12%
SUBTOTAL		$19,600	$60,569	$85,914	$92,586	$3,905	$262,574	3.27%
WEST	40468	$2,527	$22,391	$14,753	$22,005	$33,674	$95,350	1.19%
	40328	$3,033	$21,045	$2,868	$19,914	$31,807	$78,666	0.98%
	40464	$11,857	$15,084	$19,634	$3,205	$19,808	$69,589	0.87%
	40440	$13,142	$22,978	$7,213	$4,701	$17,770	$65,804	0.82%
	40452	$842	$1,428	$156	$211	$15,695	$18,332	0.23%
SUBTOTAL		$31,401	$82,926	$44,623	$50,037	$118,753	$327,741	4.08%
TOTALS		$508,194	$1,995,255	$2,612,590	$1,991,245	$930,142	$8,037,427	100.00%



* - Nine major zip code areas
@ - Directional zip code areas

Figure 4.1 - Demand Region in Central Service Trade Area

demand regions would have similar levels of total demand and so the directional demand regions were close to the bottom of all demand regions in total demand. Thus, the demand of these demand regions is recognized but they do not greatly influence the model solution.

Past sales for the supply sites is not the only measure of demand that could be used for this model. Total potential demand potential for the trade area could have been used. This measurement would include the possible increases and decreases in sales for the trade area. However, total potential demand would also include the demand for competitors' products. Thus, the sales for the cluster could be overestimated. The best demand measure is to use historic demand data for the cluster and adjust it for possible increases or decreases in the future.

4.4.2.3 Delivery Demand and Pickup Demand

Demand must be further broken down into the mode of transportation; either delivery or pickup. This model differentiates the amount transported by each mode by using the percentage of total sales to each demand region which is picked up by the patron. The right hand side of the delivery and pickup demand constraints were found using the following formulas.

(4.20) TOTAL DEMAND * (1 - PERCENT OF TOTAL SALES PICKED UP) = DELIVERY DEMAND

(4.21) TOTAL DEMAND * (PERCENT OF TOTAL SALES PICKED UP) = PICKUP DEMAND

The percent of total demand picked up for each product was found using the regional cooperative's sales data and the delivery/pickup definitions for each product explained earlier in this chapter. The pickup percentages are shown in Table 4.11. All of the agricultural chemicals and farm supplies are assumed to be picked up so their pickup percentage for all demand regions are 100 percent. The pickup percentages of the other three product lines were found by summing the sales of those transactions which qualified as pickup sales for each zip code area and dividing that summation by the total sales (both pickup and delivery) for that zip code area.

4.4.3 Capacity Constraints

The capacity constraint right hand sides place a limit on the total amount of product in dollars per year that each supply site can sell or deliver. Total annual product sold in dollars is constrained by the production/storage capacity limit. If an enterprise involves both production and storage, then the most limiting activity is used (see Chapter 3, Section 3.3.3). The delivery limitations represent the maximum total annual product delivered in dollars by the delivery vehicles available to the supply site. Seasonality of sales and deliveries present a problem since this model does not represent non-linear relationships. The incorporation of non-linear characteristics would increase the model's size beyond the capabilities of a microcomputer. Hence, both capacity values were determined based on the peak time periods (seasons) for the product in question. For example, fertilizer sales and deliveries in most agricultural areas are greatest in the spring months of March, April, and May and the fall months of October and November. These months received special consideration in the calculation of the capacity limits.

Table 4.11 - Pickup Percentages

DEMAND REGION	AG CHEMICALS	FARM SUPPLIES	FEED	FERTILIZER	PETROLEUM
40330	100.00%	100.00%	20.60%	23.63%	4.11%
40372	100.00%	100.00%	19.93%	42.10%	4.41%
40419	100.00%	100.00%	22.18%	15.98%	1.40%
40422	100.00%	100.00%	85.47%	5.60%	10.16%
40437	100.00%	100.00%	25.10%	24.48%	1.98%
40444	100.00%	100.00%	44.20%	25.94%	64.70%
40484	100.00%	100.00%	25.23%	12.73%	0.31%
40489	100.00%	100.00%	22.81%	3.69%	0.57%
42539	100.00%	100.00%	35.07%	22.90%	100.00%
EAST	100.00%	100.00%	61.26%	6.21%	0.00%
NORTH	100.00%	100.00%	18.76%	3.80%	0.87%
SOUTH	100.00%	100.00%	31.16%	15.87%	16.26%
WEST	100.00%	100.00%	73.66%	21.17%	6.53%

4.4.3.1 Production/Storage Capacities

Agricultural chemicals, farm supplies, fertilizer, and petroleum were constrained by storage facilities. Based on the cluster's record keeping system, the following method to calculate these constraints was used. First, an estimate of the full capacity of storage at one time for the product was obtained by interviewing the supply site managers. If a storage facility was used for more than one product line (such as warehouses or showrooms), the manager estimated how much of the facility was used for each product line. Next, the number of times this full inventory could be sold annually was determined. For example, the regional cooperative's upper management recommends that its stores turn over their farm supply inventories 3 times annually. Where the regional cooperative recommends a range for the turnover rate, the median of the range was used. Multiplying the maximum storage capacity by the inventory turnover rate yielded the annual storage capacity in store units. To calculate the annual storage capacity in dollars, the annual storage capacity in store units was multiplied by the price per unit. Table 4.12 shows the calculations for agricultural chemicals, farm supplies, and petroleum storage capacities while Table 4.13 shows the calculations for fertilizer capacities. Notice that fertilizer storage capacity is broken down into its bulk and bagged components because these components are stored separately.

The feed product line has a combination of storage and production limitations. Bagged feed was limited by storage facilities and the storage capacity was calculated by the same method described above. Bulk feed is limited by the production capacity of the regional mill. Thus, the production capacity of the mill which could be allocated to each supply site was used as the production capacities of the supply sites. This production capacity was calculated using each site's bulk feed sales in tons from the

Table 4.12 - Storage Capacities for Agricultural Chemicals, Farm Supplies, and Petroleum

AGRICULTURAL CHEMICALS

	BOYLE	HARRODSBURG	LANCASTER
FULL INVENTORY	$75,000	$80,000	$75,000
TURNS PER YEAR	3	3	3
ANNUAL STORAGE CAPACITY	$225,000	$240,000	$225,000

	LIBERTY	STANFORD
FULL INVENTORY	$70,000	$50,000
TURNS PER YEAR	3	3
ANNUAL STORAGE CAPACITY	$210,000	$150,000

FARM SUPPLIES

	BOYLE	HARRODSBURG	LANCASTER
FULL INVENTORY	$385,000	$400,000	$145,000
TURNS PER YEAR	3	3	3
ANNUAL STORAGE CAPACITY	$1,155,000	$1,200,000	$435,000

	LIBERTY	STANFORD
FULL INVENTORY	$136,000	$225,000
TURNS PER YEAR	3	3
ANNUAL STORAGE CAPACITY	$408,000	$675,000

PETROLEUM

	BOYLE
GALLONS INVENTORY	65,000
DOLLARS PER GALLON	$0.812
FULL INVENTORY	$52,780
TURNS PER YEAR	39
ANNUAL STORAGE CAPACITY	$2,058,420

Table 4.13 - Fertilizer Storage Capacities

	BOYLE	HARRODSBURG	LANCASTER
FULL BULK INVENTORY IN TONS	1,550	1,350	1,000
DOLLARS PER TON	$200	$200	$180
FULL BULK INVENTORY IN DOLLARS	$310,000	$270,000	$180,000
TURNS PER YEAR	7	7	7
ANNUAL BULK STORAGE CAPACITY	$2,170,000	$1,890,000	$1,260,000
FULL BAGGED INVENTORY	$22,800	$22,000	$36,500
TURNS PER YEAR	7	7	7
ANNUAL BAGGED STORAGE CAPACITY	$159,600	$154,000	$255,500
ANNUAL FERTILIZER CAPACITY	$2,329,600	$2,044,000	$1,515,500

	LIBERTY	STANFORD
FULL BULK INVENTORY IN TONS	675	1,400
DOLLARS PER TON	$180	$175
FULL BULK INVENTORY IN DOLLARS	$121,500	$245,000
TURNS PER YEAR	7	7
ANNUAL BULK STORAGE CAPACITY	$850,500	$1,715,000
FULL BAGGED INVENTORY	$44,000	$30,000
TURNS PER YEAR	7	7
ANNUAL BAGGED STORAGE CAPACITY	$308,000	$210,000
ANNUAL FERTILIZER CAPACITY	$1,158,500	$1,925,000

regional mills as a percent of the total bulk sales in tons from the mills. The sales figures are given in Table 4.14. The potential capacities were estimates from the regional cooperative. The percent of total regional mill bulk sales for each supply site was multiplied by the total potential bulk feed production capacity to derive the bulk production capacity for each supply site. These production capacities for bulk feed were added to the storage capacities for bagged feed to determine the total production/storage capacities for feed (shown in Table 4.15).

4.4.3.2 Delivery Capacity

Delivery capacities for the test cluster apply only to feed, fertilizer, and petroleum since these are the only product lines which have delivery components. Since all feed is delivered by semitrailers from the regional mills, the feed delivery capacity is calculated in the same way as the bulk feed production capacity; the percent bulk sales of the mill's total sales for each supply site was multiplied by the mill's delivery potential. These delivery capacities are given in Table 4.14.

The fertilizer delivery capacity was slightly more complicated. The calculations were based on the number and capacity of the delivery vehicles (spreaders and buggies) and the maximum trips those vehicles can make during a during a certain time period. The equations for determining the fertilizer delivery capacity are listed below.

(4.22) NUMBER OF VEHICLES * CAPACITY IN TONS PER VEHICLE = CAPACITY OF ALL VEHICLES IN TONS

(4.23) MAXIMUM TRIPS PER VEHICLE PER DAY * CAPACITY OF ALL VEHICLES IN TONS = CAPACITY OF ALL VEHICLES PER DAY IN TONS

(4.24) CAPACITY OF ALL VEHICLES PER DAY IN TONS * PRICE PER TON = CAPACITY OF ALL VEHICLES PER DAY IN DOLLARS

Table 4.14 - Bulk Feed Capacities for Production/Storage and Delivery

Winchester Regional Mill 85,000 tons annual production capacity
75,000 tons annual transportation capacity
46,805 total annual sales

	Annual Sales	Percent of Total	Tons Prod Cap	Tons Del Cap	Feed Price	Dollars Prod Cap	Dollars Del Cap
Boyle	879	1.88%	1,598	1,410	$185	$295,630	$260,850
Harrodsburg	3,549	7.58%	6,443	5,685	$190	$1,224,170	$1,080,150
Lancaster	1,893	4.04%	3,434	3,030	$170	$583,780	$515,100
Stanford	3,846	8.22%	6,987	6,165	$180	$1,257,660	$1,109,700

Park City Regional Mill 55,000 tons annual production capacity
55,000 tons annual transportation capacity
38,123 total annual sales

	Annual Sales	Percent of Total	Tons Prod Cap	Tons Del Cap	Feed Price	Dollars Prod Cap	Dollars Del Cap
Liberty	1,518	3.98%	2,189	2,189	$200	$437,800	$437,800

Table 4.15 - Feed Storage Capacities

	BOYLE	HARRODSBURG	LANCASTER
BAGGED FULL INVENTORY	$25,000	$9,200	$11,000
TURNS PER YEAR	24	24	24
BAGGED STORAGE CAPACITY	$600,000	$220,800	$264,000
REGION MILL CAPACITY	$295,630	$1,224,170	$583,780
TOTAL ANNUAL CAPACITY	$895,630	$1,444,970	$847,780

	LIBERTY	STANFORD
BAGGED FULL INVENTORY	$14,000	$21,000
TURNS PER YEAR	24	24
BAGGED STORAGE CAPACITY	$336,000	$504,000
REGION MILL CAPACITY	$437,800	$1,257,660
TOTAL ANNUAL CAPACITY	$773,800	$1,761,660

(4.25) CAPACITY OF ALL VEHICLES PER DAY IN DOLLARS * DAYS PER SEASON = CAPACITY OF ALL VEHICLES PER SEASON IN DOLLARS

These equations were calculated for each type of vehicle, spreaders and buggies, and the answers to equation 4.25 were summed. The data and calculations are shown in Table 4.16. The season consists of four months at four weeks per month and six days per week. The loads per day estimates were the opinions of the supply site managers.

The petroleum delivery capacity was calculated in much the same way as the fertilizer delivery capacity. However, it is less complicated because only one supply site (Boyle) delivers petroleum. The same equations for fertilizer delivery capacity were used for petroleum except gallons were substituted for tons as the physical units. These equations were calculated for each delivery truck; one gas/diesel truck and two liquid petroleum gas trucks. The data and calculations are shown in Table 4.17. The LP gas sales season is eight months long at four weeks per month and six days per week. The gas/diesel sales season is year-round.

4.5 Financial Statement Data

Three types of supply site costs were needed to complete the financial statements. They were variable costs, fixed costs, and delivery costs. These costs were not used in the linear programming model; they were only used in conjunction with the model solution for the financial analysis.

Table 4.16 - Fertilizer Delivery Capacities

	BOYLE	HARRODSBURG	LANCASTER
NUMBER OF BUGGIES	12	11	9
TONS PER BUGGY	3.5	3.5	3.5
TONS FOR ALL BUGGIES	42	38.5	31.5
MAXIMUM TRIPS PER DAY	5	5	5
MAXIMUM TONS PER DAY	210	192.5	157.5
PRICE PER TON	$200	$200	$180
MAXIMUM DOLLARS PER DAY	$42,000	$38,500	$28,350
DAYS PER SEASON	96	96	96
CAPACITY PER SEASON FOR BUGGIES	$4,032,000	$3,696,000	$2,721,600
TONS FOR SPREADER	10	10	10
MAXIMUM TRIPS PER DAY	6	6	6
MAXIMUM TONS PER DAY	60	60	60
PRICE PER TON	$200	$200	$180
MAXIMUM DOLLARS PER DAY	$12,000	$12,000	$10,800
DAYS PER SEASON	96	96	96
CAPACITY PER SEASON FOR SPREADER	$1,152,000	$1,152,000	$1,036,800
TOTAL FERTILIZER DELIVERY CAPACITY	$5,184,000	$4,848,000	$3,758,400

	LIBERTY	STANFORD
NUMBER OF BUGGIES	12	11
TONS PER BUGGY	3.5	3.5
TONS FOR ALL BUGGIES	42	38.5
MAXIMUM TRIPS PER DAY	5	5
MAXIMUM TONS PER DAY	210	192.5
PRICE PER TON	$180	$175
MAXIMUM DOLLARS PER DAY	$37,800	$33,688
DAYS PER SEASON	96	96
CAPACITY PER SEASON FOR BUGGIES	$3,628,800	$3,234,000
TONS FOR SPREADER	10	10
MAXIMUM TRIPS PER DAY	6	6
MAXIMUM TONS PER DAY	60	60
PRICE PER TON	$180	$175
MAXIMUM DOLLARS PER DAY	$10,800	$10,500
DAYS PER SEASON	96	96
CAPACITY PER SEASON FOR SPREADER	$1,036,800	$1,008,000
TOTAL FERTILIZER DELIVERY CAPACITY	$4,665,600	$4,242,000

Table 4.17 - Petroleum Delivery Capacity at Boyle

	PETROLEUM TRUCK	LP GAS TRUCK
NUMBER OF VEHICLES	1	2
GALLONS PER VEHICLE	2,500	2,250
	-----------	-----------
GALLONS FOR ALL VEHICLES	2,500	4500
MAXIMUM TRIPS PER DAY	2	2
	-----------	-----------
GALLONS PER DAY FOR ALL VEHICLES	5,000	9,000
PRICE PER GALLON	$0.812	$0.812
	-----------	-----------
DOLLARS PER DAY FOR ALL VEHICLES	$4,060	$7,308
DAYS PER SEASON	312	192
	-----------	-----------
DOLLARS PER SEASON	$1,266,720	$1,403,136

TOTAL DELIVERY CAPACITY

$2,669,856

4.5.1 Variable Costs

Variable costs were used as a percentage of retail price. Manipulating the cost records of the supply sites to transform the variable costs to a percentage of retail price was a two-step process. The first step was to categorize each cost category (ie. wages, salaries, repairs, utilities, insurance, depreciation, etc.) as fixed or variable. For the purposes of this study, a cost category was variable if it varied directly with the amount of product sold, independent of causality. For example, one might argue that increased advertising, and hence, increased advertising costs, causes increased sales. However, advertising costs were still categorized as variable costs. Fixed costs may or may not have been known but they did not vary directly with product sold. For example, computer service expenses were not known but they did not necessarily increase as product sold increased. The fixed and variable cost breakdown is given in Table 4.18.

Several of the cost categories in Table 4.18 require further explanation. Wages were paid to employees who could be laid off as volume sold decreased. Hence, wages were classified as variable costs. Salaries were paid to the supply site managers who could be laid off only if the site was closed. Thus, salaries were classified as fixed costs. The related employee expense categories (other employee costs; and pension and insurance for employees) were allocated to fixed and variable costs according to the wage and salary percentages of the total payroll (wages plus salaries). Other employee costs include items such as uniforms, evening classes at community colleges, and moving expenses.

Bad debt expenses and collection expenses are somewhat connected. Bad debts are those bill left unpaid by customers. Collection expenses are the costs of attempting to collect overdue bills before they are classified as bad debts. Some supply site

Table 4.18 - Division of Costs

NAME	FIXED	VARIABLE
Administrative Services		X
Advertising		X
Bad Debt		X
Cash over and Short		X
Collection Expenses		X
Computer Expenses	X	
Depreciation	X	
Insurance	X	
Meeting Expenses	X	
Miscellaneous Expenses		X
Other Employee Costs	X	X
Pensions and Insurance Employees	X	X
Rent	X	
Repairs		X
Salaries	X	
Wages		X
Stationary and Postage		X
Taxes and License	X	
Telephone		X
Travel Expenses	X	
Truck Expenses		X
Utilities		X
Travel - Business Meals	X	
Specialized Services	X	X

financial statements showed negative bad debt figures. These figures represent bad debts from previous years which were collected in the year of the current financial statements. Negative bad debts actually represent revenues instead of expenses. Since they were revenues from previous years, negative bad debts were set at zero.

Cash over and short includes money in cash registers which is unaccounted for at the end of each business day. For example, if the employee attending the cash register accidentally gives a patron $10 in change instead of $1, the cash over and short expense is $9. Cash over and short should be zero at the end of each business day if the employees attending the cash registers performed their jobs correctly. If cash over and short for the fiscal year at any supply site was negative, it was set at zero for this study because it was actually a revenue instead of an expense.

Specialized services costs were split into fixed and variable components. This category represents the services of two specialized employees, an area salesman and a fertilizer equipment repairman. The portion assigned to the repairman was considered as a variable cost because wear and tear on fertilizer equipment and the associated repairs needed usually change proportionately with the fertilizer volume sold. The salesman's salary was considered fixed because it did not change as volume changed.

The truck expenses which could be allocated to the delivery of products to the patron were included in the delivery costs. However, other truck costs were incurred by the supply site for such tasks as inter-site deliveries. These truck costs not associated specifically with delivery to patrons were included in the variable costs of the supply site.

Two cost categories were not included in this analysis. Income taxes were excluded because they are incurred after the financial analysis of each supply site is completed. Furthermore, income taxes are usually beyond the control of the cooperative. Interest expenses were also excluded from this study. Interest expenses were considered a factor of managerial efficiency, not overall supply site efficiency.

The later was the concern of this study. Hence, all net incomes reported in this study are before income taxes and interest expenses.

The second step in determining variable costs was to allocate the costs among the products. Unfortunately, the supply sites lump all cost records together for all products. Unless the site manager could allocate variable costs among products, they were allocated according to each product's total dollar volume as a percent of the store's overall dollar volume for all products. All variable costs were allocated according to percent volumes except for wages at Boyle and Harrodsburg and the variable cost portion of specialized services. Both sites assign wage employees specifically to high volume product lines. Thus, extra wage expenses were allocated to petroleum at Boyle and to feed at Harrodsburg according to each site manager's estimates. The repairman's portion of specialized services was assign to the fertilizer product line of each site. The variable costs are were summed and divided by the total dollar volume for the product to determine variable costs as a percent of dollar volume. The variable costs are given in Table 4.19.

Since variable costs were defined to increase proportionally with dollar volumes, this cost allocation method seems logical. However, this allocation may not be totally correct. For instance, the fertilizer enterprise of one supply site, with a volume of $500,000, might include a blending facility which uses a great amount of electricity to operate. On the other hand, the petroleum enterprise, with a volume of $1,000,000, consists mostly of storage facilities and trucks. The fertilizer enterprise uses much more electricity but the petroleum enterprise is charged for a majority of the electricity due to its higher volume. Unfortunately, since variable costs were not allocated to product lines by the supply sites, this situation could not be corrected.

As is shown in Table 4.19, the average variable costs for feed are higher than the average price margins for feed. According to the rules of economics, the firm should not produce when variable costs are higher than margins. However, cooperatives have a responsibility to their patrons. Some cooperatives supply products

Table 4.19 - Variable and Overhead Costs

AG CHEMICALS

	VARIABLE COSTS		OVERHEAD COSTS
BOYLE	12.37%	BOYLE	$162,568
HARRODSBURG	10.07%	HARRODSBURG	$105,549
LANCASTER	9.24%	LANCASTER	$73,127
LIBERTY	10.73%	LIBERTY	$77,933
STANFORD	9.99%	STANFORD	$82,995
AVERAGE	10.80%		

FARM SUPPLIES

BOYLE	12.37%
HARRODSBURG	10.07%
LANCASTER	9.24%
LIBERTY	10.73%
STANFORD	9.99%
AVERAGE	10.66%

FEED

BOYLE	12.37%
HARRODSBURG	12.11%
LANCASTER	9.24%
LIBERTY	10.73%
STANFORD	9.99%
AVERAGE	11.00%

FERTILIZER

BOYLE	12.48%
HARRODSBURG	11.95%
LANCASTER	9.24%
LIBERTY	11.15%
STANFORD	10.52%
AVERAGE	10.99%

PETROLEUM

BOYLE	11.31%
HARRODSBURG	0.00%
LANCASTER	0.00%
LIBERTY	0.00%
STANFORD	0.00%
AVERAGE	11.31%

at a loss in order to satisfy the needs of the patron and remain price competitive with other firms. In the case of this cluster, feed is supplied to the patrons at a loss. However, the regional cooperative reimburses enough money to the supply sites to make up the difference between the price margin and the variable costs and give them a reasonable return. This reimbursement is accounted for in the financial statements of the sites.

4.5.2 Fixed Costs

Fixed costs were split into two categories, allocated fixed costs and unallocated fixed costs or overhead costs. Allocated fixed costs were the fixed costs that could be assigned to a product line at the supply site by the manager. For instance, the depreciation for the petroleum truck would be part of the allocated fixed costs of the petroleum enterprise. This breakdown is important. If one supply site discontinues sales of a product line, these allocated fixed costs can be eliminated. Allocated fixed costs as a total dollar amount were used in generating the financial statements.

Overhead costs, defined as the unallocated fixed costs, are supply site specific. When a product line at one supply site is discontinued, these costs may still be incurred by the site. Overhead costs as a lump sum for each supply site were used in the analysis. The overhead costs were allocated according to each product's total gross margin in dollars as a percentage of the store's overall total gross margin in dollars for all products given by the model solution. In this way, the high margin product lines absorb much of the overhead costs. In reality, this is usually true. Supply sites cannot simply shut down low or negative margin product lines because they are obligated to meet the needs of the patrons. Thus, these products usually require most of their margins to cover variable costs. The high margin products take up much of the slack for overhead costs.

Cooperative management, both in the cluster and in the regional cooperative, felt that very little of the fixed costs of the supply sites could be allocated to any particular product line. They also felt that very few fixed costs could be eliminated if only one or two product lines in a supply site were discontinued. This opinion was based primarily on the fact that most product-specific assets (such as bulk fertilizer storage facilities) are almost fully depreciated. Thus, all fixed costs were considered to be overhead costs. Overhead costs are given in Table 4.19.

4.5.3 Delivery Costs

This category is the final supply site cost required for the financial analysis. Delivery costs are those costs incurred by the supply site for delivering products to the patrons. Delivery costs were used in the analysis in the same form as delivery charges; costs per dollars of product delivered per mile travelled. The delivery costs for feed and petroleum were explained previously in this chapter (Section 4.4.1.1). The delivery costs for fertilizer were calculated using the same equations that were used for the fertilizer delivery charges except that spreader truck costs were substituted in the place of total delivery revenues. Buggies have almost no associated variable costs so the spreader truck costs equal the total fertilizer delivery costs. The data and calculations for fertilizer delivery costs are shown in Table 4.20.

Delivery costs, as with delivery revenues, were considered constant for all supply sites in the cluster. The reasoning behind constant feed delivery costs was explained in the delivery charge section of this chapter (Section 4.4.1.1). All five supply sites use the same type of fertilizer spreader truck. Thus, all per mile fertilizer delivery costs should be similar. Yet, the costs per miles shown in Table 4.20 are far from similar. To correct this problem, a standard fertilizer delivery cost was used for all supply sites. The standard used an average of the input lines from all the supply

Table 4.20 - Fertilizer Delivery Costs

	BOYLE	HARRODSBURG	LANCASTER
SPREADER COSTS	$5,756	$6,200	$1,968
BUGGY COSTS	$0	$0	$0
TOTAL COSTS	$5,756	$6,200	$1,968
SPREADER TRUCK MILES	6,400	12,000	12,800
PERCENT BUGGY SALES	22.50%	48.00%	8.00%
BUGGY MILES	1,858	11,077	1,113
TOTAL MILES	8,258	23,077	13,913
COST PER MILE	$0.6970156	$0.2686667	$0.1414500
DOLLARS PER SPREADER LOAD	$1,200	$1,200	$1,080
PERCENT SPREADER SALES	77.50%	52.00%	92.00%
DOLLARS PER BUGGY LOAD	$700	$700	$630
PERCENT BUGGY SALES	22.50%	48.00%	8.00%
DOLLARS PER AVERAGE LOAD	$1,088	$960	$1,044
COST PER DOLLAR PER MILE	$0.0006409	$0.0002799	$0.0001355

	LIBERTY	STANFORD	STANDARD
SPREADER COSTS	$8,744	$3,857	$6,139
BUGGY COSTS	$0	$0	$0
TOTAL COSTS	$8,744	$3,857	$6,139
SPREADER TRUCK MILES	19,000	6,400	$10,950
PERCENT BUGGY SALES	7.30%	8.00%	21.45%
BUGGY MILES	1,496	557	2,990
TOTAL MILES	20,496	6,957	13,940
COST PER MILE	$0.4266152	$0.5544438	$0.4404001
DOLLARS PER SPREADER LOAD	$1,080	$1,050	$1,133
PERCENT SPREADER SALES	92.70%	92.00%	78.55%
DOLLARS PER BUGGY LOAD	$630	$613	$661
PERCENT BUGGY SALES	7.30%	8.00%	21.45%
DOLLARS PER AVERAGE LOAD	$1,047	$1,015	$1,031
COST PER DOLLAR PER MILE	$0.0004074	$0.0005462	$0.0004270

sites except Lancaster. It had the lowest fertilizer delivery cost and was considered an outlier. These averages were then calculated using the same formulas as were used with the individual site delivery charges.

4.6 Conclusions

This chapter is a discussion of the data used in this study and the calculations used to transform that data into usable coefficients for the model. These data and calculations may not apply in the analyses of other trade areas. Other cooperatives will have different record keeping systems and other calculation methods will need to be developed for those situations.

CHAPTER 5
RESULTS

5.1 Introduction

The results of this thesis are addressed in this chapter. First, the scenarios discussed in this chapter test the model's accuracy in replicating consumer purchasing behavior and the cluster's financial situation. Second, the effects of changes in supply structure (through consolidation) and consumer demand on the economic viability of the cooperatives are analyzed.

The data presented in Chapter 4 was used to create the scenarios discussed in this chapter. Adjustments to the data were required to correct for potential problems in subsequent scenarios. The baseline scenario which simulates the actual situation of the trade area is analyzed first. It is required to provide a test of the model's accuracy and also serves as the base for the consolidation scenarios. Next, possible consolidation scenarios for the trade area are discussed. Two consolidation scenarios are presented which combine the feed and fertilizer product lines of the cluster into one supply site. The first scenario represents the consolidation in the short run while the second scenario represents the consolidation in the long run. Sales trends of the cluster are projected forward and simulated with the model to replicate the effects of potential demand changes. A store closure scenario is also analyzed. Finally, the long run consolidation and demand trend scenarios are combined to create a picture of the future.

Product distribution, net incomes, and asset utilizations are used as yardsticks to compare each scenario to the actual cluster situation or the baseline case. Product distribution represents the purchasing patterns of the patrons. Net incomes and asset utilizations indicate the effects of that distribution pattern on the supply site and the cluster as a whole. The model's outputs for the revised baseline model are located in Appendix 1.

5.2 Reports

The reports generated by this model are relatively simple but they contain enough detail to adequately display the effects of consolidation on the economic viability of a farm supply cooperative trade area. The three types of reports created by this model are financial statements, asset utilization statements, and product distribution statements. An example of each report is given in Table 5.1. These statements are relatively straight forward. The four categories of financial and asset utilization statements that are generated include: 1) those which are both supply site and product specific, 2) those which are supply site specific but encompass all products, 3) those which are product specific but encompass all supply sites, and 4) those which encompass all products and all supply sites in the trade area. The product distribution statements are in three forms: 1) distribution of delivered products, 2) distribution of picked up products, and 3) distribution of total product.

The financial statements are very general. Sales are determined by the model and represent the total amount of product sold by a supply site to all demand areas. Delivery revenues are a factor of the amount of product delivered (also determined by the model). They equal the delivery charge multiplied by the dollars of product

Table 5.1 - Sample Reports Generated by the Model

FINANCIAL STATEMENT - SITE: BOYLE PRODUCT: AG CHEMICALS

SALES	$0
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$0
GROSS MARGIN	$0
VARIABLE COSTS	$0
FIXED COSTS	$0
OVERHEAD COSTS	$0
DELIVERY COSTS	$0
TOTAL EXPENSES	$0
NET INCOME	$0

ASSET UTILIZATION STATEMENT - SITE: BOYLE PRODUCT: AG CHEMICALS

PRODUCTION	
CAPACITY AVAILABLE	$0
CAPACITY USED	$0
CAPACITY UNUSED	$0
PERCENT OF CAPACITY USED	0.00%
TRANSPORTATION	
CAPACITY AVAILABLE	$0
CAPACITY USED	$0
CAPACITY UNUSED	$0
PERCENT OF CAPACITY USED	0.00%

PRODUCT DISTRIBUTION FOR DELIVERY AND PICKUP - AG CHEMICALS

DEMAND	SUPPLY SITE					
REGION	BOYLE	HARRODSBU	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$0	$0	$0	$0	$0
40372	$0	$0	$0	$0	$0	$0
40419	$0	$0	$0	$0	$0	$0
40422	$0	$0	$0	$0	$0	$0
40437	$0	$0	$0	$0	$0	$0
40444	$0	$0	$0	$0	$0	$0
40484	$0	$0	$0	$0	$0	$0
40489	$0	$0	$0	$0	$0	$0
42539	$0	$0	$0	$0	$0	$0
EAST	$0	$0	$0	$0	$0	$0
NORTH	$0	$0	$0	$0	$0	$0
SOUTH	$0	$0	$0	$0	$0	$0
WEST	$0	$0	$0	$0	$0	$0
TOTAL	$0	$0	$0	$0	$0	$0

delivered and the miles travelled for delivery. Cost of goods sold equals the percent COGS multiplied by the total dollars of product sold. Product margin is then calculated as the sum of sales and delivery revenues minus COGS. Total expenses are the sum of four cost categories: 1) variable costs - the percent variable costs multiplied by the total dollars of product sold, 2) allocated fixed costs - the lump sum amount for the product line, 3) delivery costs - the cost per dollars delivered per mile travelled multiplied by the amount delivered in dollars and the miles travelled, and 4) overhead costs - the total overhead costs for the store multiplied by the gross margin for the product as a percentage of total gross margin. The net income is then calculated as the gross margin minus the total expenses. It represents the profit realized by the supply site from that product.

The asset utilization statements report the percent of total capacity of both production/storage and delivery used in the given scenario. These statements are very straight forward and the equations are essentially the same for both production/storage and delivery. Determination of the available capacities are discussed in Chapter 4 (Section 4.4.3). Capacity used for production/storage is the total amount sold for that product as determined by the model while capacity used for delivery is the amount delivered as determined by the model. Capacity unused is simply the subtraction of the capacity used from the capacity available while percent of capacity used is capacity used divided by capacity available. Percent of capacity used is the telltale value used to determine if a supply site is making good use of its assets.

The product distribution statements simply report which supply site is supplying product to which demand regions. These distribution values are all determined by the model and are given in store dollars, not standardized dollars. Hence, the total from the product distribution statements will not necessarily match the amount demanded. Distribution is reported this way because this study is concerned with the distribution of product from the supply site perspective.

5.3 Actual Trade Area Situation

The actual production distribution for the trade area (shown in Table 5.2) indicates that some competition between supply sites may exist. All supply sites sell some product to nearly every demand region. However, this distribution is not even throughout the trade area; each demand region has one supply site as its major supplier of products. The Boyle site supplies a substantial amount of product to each demand region because it is the only major supplier of petroleum products. Notice that the five demand regions which also contain supply sites (Boyle - 40422, Harrodsburg - 40330, Lancaster - 40444, Liberty - 42539, and Stanford - 40484) clearly demand the largest portion of product sold.

The net incomes of the cluster (shown in Table 5.3) reveal some interesting information. First, the agricultural chemicals and feed product lines at all supply sites have negative net incomes. This situation occurs because these two product lines have low price margins. Two supply sites have negative net incomes for the entire site. Harrodsburg sells a large amount of feed, a low margin product line, which accounts for much of its $3,818 income loss. Liberty has lower price margins for most product lines than the other supply sites and, thus, has the worst net income in the cluster (-$26,095).

The actual total asset utilization for production/storage (shown in Table 5.4) is fairly consistent throughout the entire cluster. Liberty's total utilization at 48.2 percent is somewhat higher than that of the other supply sites. On a product line basis, total asset utilizations are also fairly consistent. All product lines use less than 50 percent of their allocated capacity. Of these, fertilizer uses the least capacity at 22.1 percent.

Table 5.2 - Actual Product Distribution

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - ALL PRODUCTS

DEMAND REGION	SUPPLY SITE					
	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$158,327	$1,211,709	$5,646	$1,414	$3,503	$1,380,599
40372	$35,261	$312,799	$0	$69	$0	$348,129
40419	$101,020	$386	$23,359	$9,742	$204,978	$339,485
40422	$1,201,645	$51,452	$5,520	$615	$21,085	$1,280,317
40437	$20,086	$0	$6,945	$94,753	$58,804	$180,588
40444	$78,379	$141,916	$899,139	$632	$155,134	$1,275,200
40484	$166,274	$80	$16,185	$66,013	$633,994	$882,546
40489	$58,785	$0	$3,245	$21,237	$297,895	$381,162
42539	$4,612	$0	$325	$802,510	$948	$808,395
EAST	$5,478	$0	$119,292	$13,643	$38,585	$176,998
NORTH	$42,291	$127,405	$27,232	$2,503	$29,243	$228,674
SOUTH	$16,488	$0	$161	$212,078	$21,747	$250,474
WEST	$290,421	$23,316	$3,150	$3,558	$6,478	$326,923
TOTAL	$2,179,067	$1,869,063	$1,110,199	$1,228,767	$1,472,394	$7,859,490

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - AG CHEMICALS

DEMAND REGION	SUPPLY SITE					
	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$13,984	$42,849	$2,480	$0	$0	$59,313
40372	$0	$14,212	$0	$0	$0	$14,212
40419	$5,813	$0	$4,757	$6,083	$5,132	$21,785
40422	$113,980	$14,781	$879	$0	$886	$130,526
40437	$0	$0	$0	$14,438	$3,666	$18,104
40444	$1,264	$568	$68,019	$0	$4,862	$74,713
40484	$2,443	$0	$1,420	$2,125	$51,896	$57,884
40489	$0	$0	$0	$561	$10,572	$11,133
42539	$2,190	$0	$0	$45,487	$0	$47,677
EAST	$0	$0	$4,329	$3,103	$0	$7,432
NORTH	$0	$14,923	$135	$1,637	$0	$16,695
SOUTH	$506	$0	$0	$17,101	$1,968	$19,575
WEST	$29,148	$0	$316	$0	$1,968	$31,432
TOTAL	$169,328	$87,333	$82,335	$90,535	$80,950	$510,481

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FARM SUPPLIES

DEMAND REGION	SUPPLY SITE					
	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$13,390	$381,652	$1,679	$343	$1,166	$398,230
40372	$8,230	$53,400	$0	$0	$0	$61,630
40419	$3,036	$127	$5,968	$2,498	$27,184	$38,813
40422	$373,473	$7,506	$1,704	$397	$8,765	$391,845
40437	$2,422	$0	$1,149	$27,581	$20,163	$51,315
40444	$18,251	$16,107	$217,642	$428	$15,245	$267,673
40484	$7,581	$80	$4,768	$16,888	$199,257	$228,574
40489	$421	$0	$3,191	$2,116	$37,680	$43,408
42539	$456	$0	$255	$221,871	$830	$223,412
EAST	$0	$0	$29,744	$9,341	$7,358	$46,443
NORTH	$53	$35,769	$1,921	$359	$685	$38,787
SOUTH	$10,582	$0	$91	$43,888	$2,369	$56,930
WEST	$75,898	$1,523	$1,857	$2,849	$420	$82,547
TOTAL	$513,793	$496,164	$269,969	$328,559	$321,122	$1,929,607

Table 5.2 - Actual Product Distribution (continued)

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FEED

DEMAND REGION	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
	SUPPLY SITE					
40330	$32,012	$602,690	$1,211	$99	$232	$636,244
40372	$0	$211,840	$0	$69	$0	$211,909
40419	$1,212	$259	$2,992	$0	$105,633	$110,096
40422	$126,238	$27,860	$2,817	$218	$7,075	$164,208
40437	$59	$0	$0	$4,399	$34,248	$38,706
40444	$1,379	$49,052	$289,305	$204	$115,205	$455,145
40484	$18,646	$0	$2,597	$9,939	$246,342	$277,524
40489	$733	$0	$54	$1,035	$83,858	$85,680
42539	$0	$0	$70	$246,088	$118	$246,276
EAST	$0	$0	$27,160	$753	$12,355	$40,268
NORTH	$2,063	$62,128	$25,176	$507	$28,558	$118,432
SOUTH	$1,222	$0	$70	$62,898	$17,131	$81,321
WEST	$20,680	$21,793	$684	$507	$457	$44,121
TOTAL	$204,244	$975,622	$352,136	$326,716	$651,212	$2,509,930

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FERTILIZER

DEMAND REGION	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
	SUPPLY SITE					
40330	$1,159	$184,518	$276	$972	$2,105	$189,030
40372	$0	$33,347	$0	$0	$0	$33,347
40419	$136	$0	$9,642	$1,161	$67,029	$77,968
40422	$305,888	$1,305	$120	$0	$4,359	$311,672
40437	$0	$0	$5,796	$48,335	$727	$54,858
40444	$7,093	$76,189	$324,173	$0	$19,822	$427,277
40484	$796	$0	$7,400	$37,061	$136,499	$181,756
40489	$273	$0	$0	$17,525	$165,785	$183,583
42539	$0	$0	$0	$289,064	$0	$289,064
EAST	$0	$0	$58,059	$446	$18,872	$77,377
NORTH	$0	$14,585	$0	$0	$0	$14,585
SOUTH	$273	$0	$0	$88,191	$279	$88,743
WEST	$45,942	$0	$293	$202	$3,633	$50,070
TOTAL	$361,560	$309,944	$405,759	$482,957	$419,110	$1,979,330

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - PETROLEUM

DEMAND REGION	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
	SUPPLY SITE					
40330	$97,782	$0	$0	$0	$0	$97,782
40372	$27,031	$0	$0	$0	$0	$27,031
40419	$90,823	$0	$0	$0	$0	$90,823
40422	$282,066	$0	$0	$0	$0	$282,066
40437	$17,605	$0	$0	$0	$0	$17,605
40444	$50,392	$0	$0	$0	$0	$50,392
40484	$136,808	$0	$0	$0	$0	$136,808
40489	$57,358	$0	$0	$0	$0	$57,358
42539	$1,966	$0	$0	$0	$0	$1,966
EAST	$5,478	$0	$0	$0	$0	$5,478
NORTH	$40,175	$0	$0	$0	$0	$40,175
SOUTH	$3,905	$0	$0	$0	$0	$3,905
WEST	$118,753	$0	$0	$0	$0	$118,753
TOTAL	$930,142	$0	$0	$0	$0	$930,142

Table 5.3 - Net Income for the Actual Trade Area Situation

Total Costs

	AG CHEM	F SUPPLY	FEED	FERT	PETRO	TOTAL
BOYLE	$28,102	$105,394	$34,565	$74,945	$204,989	$447,995
HARRODSBURG	$12,671	$87,347	$159,153	$66,499	$0	$325,670
LANCASTER	$12,530	$49,480	$43,226	$72,488	$0	$177,724
LIBERTY	$14,556	$61,450	$47,641	$96,898	$0	$220,545
STANFORD	$12,178	$58,280	$85,738	$80,009	$0	$236,205
TOTAL	$80,037	$361,951	$370,323	$390,839	$204,989	$1,408,139

Total Revenues

	AG CHEM	F SUPPLY	FEED	FERT	PETRO	TOTAL
BOYLE	$22,099	$129,179	$28,717	$79,941	$247,640	$507,576
HARRODSBURG	$11,550	$111,354	$122,023	$76,925	$0	$321,852
LANCASTER	$11,946	$59,432	$25,945	$86,063	$0	$183,386
LIBERTY	$11,575	$62,625	$30,092	$90,158	$0	$194,450
STANFORD	$11,458	$73,410	$57,898	$111,245	$0	$254,011
TOTAL	$68,628	$436,000	$264,675	$444,332	$247,640	$1,461,275

Net Income

	AG CHEM	F SUPPLY	FEED	FERT	PETRO	TOTAL
BOYLE	-$6,003	$23,785	-$5,848	$4,996	$42,651	$59,581
HARRODSBURG	-$1,121	$24,007	-$37,130	$10,426	$0	-$3,818
LANCASTER	-$584	$9,952	-$17,281	$13,575	$0	$5,662
LIBERTY	-$2,981	$1,175	-$17,549	-$6,740	$0	-$26,095
STANFORD	-$720	$15,130	-$27,840	$31,236	$0	$17,806
TOTAL	-$11,409	$74,049	-$105,648	$53,493	$42,651	$53,136

Table 5.4 - Actual Storage/Production Utilization

BOYLE	UTILIZATION
AG CHEMICALS	75.3%
FARM SUPPLIES	44.5%
FEED	22.8%
FERTILIZER	15.5%
PETROLEUM	45.2%
ALL	32.7%
HARRODSBURG	
AG CHEMICALS	36.4%
FARM SUPPLIES	41.3%
FEED	79.7%
FERTILIZER	15.2%
PETROLEUM	0.0%
ALL	39.7%
LANCASTER	
AG CHEMICALS	36.6%
FARM SUPPLIES	62.1%
FEED	39.7%
FERTILIZER	26.8%
PETROLEUM	0.0%
ALL	36.2%

LIBERTY	UTILIZATION
AG CHEMICALS	43.1%
FARM SUPPLIES	80.5%
FEED	42.2%
FERTILIZER	41.7%
PETROLEUM	0.0%
ALL	48.2%
STANFORD	
AG CHEMICALS	54.0%
FARM SUPPLIES	47.6%
FEED	51.8%
FERTILIZER	21.8%
PETROLEUM	0.0%
ALL	36.7%
CLUSTER	
AG CHEMICALS	48.6%
FARM SUPPLIES	49.8%
FEED	43.9%
FERTILIZER	22.1%
PETROLEUM	45.2%
ALL	36.3%

5.4 Baseline Scenario

The negative net incomes of some supply sites and product lines coupled with high excess capacities suggest that consolidation might help the financial situation of this cluster. However, the baseline scenario must be analyzed before consolidation is considered. The baseline scenario simulates the actual situation of the trade area and is the basis for all consolidation scenarios. Thus, the baseline scenario should closely replicate the actual situation or else the consolidation scenarios will be less meaningful.

The regional cooperative has already taken steps to correct for some of the inefficiencies mentioned in Chapter 1, Section 1.3. For example, to correct for long supply lines with too many handlers of the product, the regional cooperative is delivering bulk feed directly from regional feed mills to the patrons. The supply sites act only as order takers in this system. A further explanation of the bulk feed distribution system is given in Chapter 4, Section 4.3. However, for the purposes of this analysis, it was assumed that each supply site stores bulk feed and delivers it to the patrons themselves. This assumption makes the consolidation decisions later in the analysis easier to explain and makes the discussion of the effects of these decisions more meaningful.

Significant differences in product distribution between the actual situation and the baseline scenario indicate some problems. Table 5.5 is a comparison of the trade area's actual product distribution and that of the baseline scenario. These differences in distribution can be attributed to the inconsistency in price margins within each product line. Agricultural chemicals' distribution at each supply site is fairly similar between the actual situation and the baseline scenario. The most discrepancy occurs at Stanford where the baseline scenario sells 12.4 percent more than was actually sold. Notice that the price margins for agricultural chemicals at each supply site are also fairly consistent. However, feed distribution is simulated

Table 5.5 - Product Distribution Comparison of the Actual Situation and the Baseline Scenario

BOYLE	ACTUAL PRODUCT DISTRIBUTION	BASELINE PRODUCT DISTRIBUTION	BASELINE-ACTUAL DIFFERENCE	PERCENT DIFFERENCE
AG CHEMICALS	$169,328	$161,877	-$7,451	-4.40%
FARM SUPPLIES	$513,793	$392,486	-$121,307	-23.61%
FEED	$204,244	$0	-$204,244	-100.00%
FERTILIZER	$361,560	$28,042	-$333,518	-92.24%
PETROLEUM	$930,142	$930,142	$0	0.00%
TOTAL	$2,179,067	$1,512,548	-$666,519	-30.59%
HARRODSBURG				
AG CHEMICALS	$87,333	$90,214	$2,881	3.30%
FARM SUPPLIES	$496,164	$577,974	$81,810	16.49%
FEED	$975,622	$228,212	-$747,410	-76.61%
FERTILIZER	$309,944	$46,604	-$263,340	-84.96%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	$1,869,063	$943,004	-$926,059	-49.55%
LANCASTER				
AG CHEMICALS	$82,335	$82,257	-$78	-0.09%
FARM SUPPLIES	$269,969	$313,419	$43,450	16.09%
FEED	$352,136	$847,780	$495,644	140.75%
FERTILIZER	$405,759	$658,587	$252,828	62.31%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	$1,110,199	$1,902,043	$791,844	71.32%
LIBERTY				
AG CHEMICALS	$90,535	$85,259	-$5,276	-5.83%
FARM SUPPLIES	$328,559	$329,492	$933	0.28%
FEED	$326,716	$337,338	$10,622	3.25%
FERTILIZER	$482,957	$1,158,500	$675,543	139.88%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	$1,228,767	$1,910,589	$681,822	55.49%
STANFORD				
AG CHEMICALS	$80,950	$91,023	$10,073	12.44%
FARM SUPPLIES	$321,122	$311,678	-$9,444	-2.94%
FEED	$651,212	$1,047,127	$395,915	60.80%
FERTILIZER	$419,110	$42,694	-$376,416	-89.81%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	$1,472,394	$1,492,522	20,128	1.37%
TRADE AREA				
AG CHEMICALS	$510,481	$510,630		
FARM SUPPLIES	$1,929,607	$1,925,049		
FEED	$2,509,930	$2,460,458		
FERTILIZER	$1,979,330	$1,934,427		
PETROLEUM	$930,142	$930,142		
TOTAL	$7,859,490	$7,760,706		

poorly in the baseline scenario. Boyle, which has the highest price margin for feed, sells no feed in the baseline scenario. Harrodsburg, with the second highest feed price margin, sells almost $750,000 less feed in the baseline scenario than in actuality. Lancaster and Stanford, both which have low price margins, sell substantially more feed ($495,644 and $395,915, respectively) in the baseline scenario.

Fertilizer sales and, to a lesser extent, farm supplies sales exhibit the same problem. Liberty sells $675,543 (almost 140 percent) more fertilizer and Lancaster sells $252,828 (about 62 percent) more in the baseline scenario than in actuality because of substantially lower price margins. Yet, Boyle, Harrodsburg, and Stanford sell much less in the baseline scenario ($333,518, $263,340, and $376,416 less, respectively) due to their higher price margins.

The asset utilization of the baseline scenario (shown in Table 5.6) further illustrates the problem. Lancaster utilizes 100 percent of its feed production/storage capacity since it has the lowest price margin. The same phenomena occurs at Liberty in fertilizer. The overall asset utilization at Lancaster and Liberty increased substantially in the baseline scenario because they have the lowest price margins in many product lines.

The effects of patron demand changes on the results of the model analysis are critical to the confidence of those results. If small changes in patron demand can alter the distribution pattern of the scenario, then the results of the scenario are less meaningful. One capability of linear programming models is the ability to perform sensitivity analysis. This LP sensitivity analysis (discussed in Section 2.5 of Chapter 2) should not be confused with the model sensitivity analysis (discussed in Section 3.2 of Chapter 3). Though both analyses address the same issue (confidence in the model's results), they approach it from different directions. LP sensitivity analysis may be generated in the LP solution process. It provides a range of values within which consumer demand can increase or decrease before the basis of the LP model changes. A basis change causes the distribution pattern of the scenario to change. The model

Table 5.6 - Storage/Production Utilization Comparison of the Actual Situation and the Baseline Scenario

BOYLE	ACTUAL UTILIZATION	BASELINE UTILIZATION
AG CHEMICALS	75.3%	72.0%
FARM SUPPLIES	44.5%	34.0%
FEED	22.8%	0.0%
FERTILIZER	15.5%	1.2%
PETROLEUM	45.2%	45.2%
ALL	32.7%	22.7%
HARRODSBURG		
AG CHEMICALS	36.4%	37.6%
FARM SUPPLIES	41.3%	48.2%
FEED	79.7%	15.8%
FERTILIZER	15.2%	2.3%
PETROLEUM	0.0%	0.0%
ALL	39.7%	19.1%
LANCASTER		
AG CHEMICALS	36.6%	36.6%
FARM SUPPLIES	62.1%	72.1%
FEED	39.7%	100.0%
FERTILIZER	26.8%	43.5%
PETROLEUM	0.0%	0.0%
ALL	36.2%	62.9%
LIBERTY		
AG CHEMICALS	43.1%	40.6%
FARM SUPPLIES	80.5%	80.8%
FEED	42.2%	43.6%
FERTILIZER	41.7%	100.0%
PETROLEUM	0.0%	0.0%
ALL	48.2%	74.9%
STANFORD		
AG CHEMICALS	54.0%	60.7%
FARM SUPPLIES	47.6%	46.2%
FEED	51.8%	59.4%
FERTILIZER	21.8%	2.2%
PETROLEUM	0.0%	0.0%
ALL	36.7%	33.1%
CLUSTER		
AG CHEMICALS	48.6%	48.6%
FARM SUPPLIES	49.8%	46.7%
FEED	43.9%	43.0%
FERTILIZER	22.1%	21.6%
PETROLEUM	45.2%	45.2%
ALL	36.3%	35.8%

sensitivity analysis is a manual process where the user defines the demand increase or decrease and solves the model again. This model sensitivity analysis shows exact changes in the distribution pattern and the financial statements. Scenarios presented later in this chapter (Sections 5.7 and 5.8) will illustrate the usefulness of model sensitivity analysis. LP sensitivity analysis is the focus of this section.

The range of demand which leaves the distribution pattern unchanged is directly linked to available production/storage and delivery capacities. The distribution patterns of a given scenario will change with demand changes in the following situations.

1) The pickup or delivery demand from a demand region decreases to zero. This causes the supply site which served that demand region to cease doing so.
2) The pickup or delivery demand from a demand region increases sufficiently to use all available production/storage capacity at the most expensive supply site which currently serves that demand region. Hence, another more expensive site will supply the added demand.
3) If a demand region is served by two or more supply sites, the pickup or delivery demand from that site decreases sufficiently to no longer require products from the most expensive site which serves that demand region. That supply site will no longer serve the demand region.
4) The delivery demand from a demand region increases sufficiently to use all available delivery capacity from the most expensive supply site which currently serves that demand region. Another more expensive supply site will meet the additional demand.

The most expensive site is defined as that site where the net cost to the patron is highest. Delivery demand and pickup demand must be treated separately in this sensitivity analysis. Unfortunately, the analysis can only consider one type of demand (delivery or pickup) at one demand region at a time. It cannot provide any information about changes of many demand combinations at once on the distribution pattern of a scenario. Yet, by using the rules above, the user can make some common sense judgments about the effects of total demand changes on the distribution pattern.

An example will help clarify the instances when these situations apply to multiple supply sites servicing a single demand region. The least expensive supply site will serve a demand region until all available capacity is used. Then the second least expensive site will serve that demand region until its available capacity is used. This pattern continues until the demand region's product demand is satisfied. Hence, when the demand at a region changes, the most expensive site for that region will be affected first.

Agricultural chemicals, farm supplies, and petroleum distribution patterns are very stable in the baseline scenario. The term "stable" in this context means that small changes in demand (10 percent or less) will not effect the distribution pattern of the product in question. Demand can decrease by 100 percent (down to zero) in all demand regions for these three product lines before distribution changes in the baseline scenario. Demand can increase substantially for each product line before the distribution pattern is altered. Demand could increase greatly in any demand region before the distribution pattern changes.

Two product lines in the baseline scenario, feed and fertilizer, have multiple supply sites which serve a single demand region. Hence, the most expensive of these multiple sites will be affected first by changes in the distribution pattern. The fertilizer product distribution is relatively stable since demand changes of less than 10 percent would not affect distribution. Feed is also relatively stable for pickup demand. However, feed is relatively unstable for delivery demand. Delivery demand could decrease by only two percent or increase by only four percent before a distribution pattern change occurs. Therefore, the feed product line needs more analysis before an accurate picture of its distribution can be seen. However, the poor simulation of the current situation by the baseline scenario makes further analysis unnecessary.

There are two possible reasons for this poor simulation of actual distribution by the baseline scenario. The differences in the supply sites' price margins used in the baseline scenario might reflect a substantially different product group mix at each supply site. For example, Lancaster's low price margin for feed may reflect the fact that it sells mostly bulk dairy feed, a very low margin product group. On the other hand, Boyle might sell mostly pet food, a high margin product group. Thus, Boyle's overall price margin would reflect these high margin sales. This reason for discrepancies between the baseline scenario and the actual situation makes sense since each product line contains many diverse product groups with substantially different price margins.

Second, recall that the model replicates consumer purchasing behavior given that the consumer buys the product for the lowest net price (the price of the product plus the costs of transport). Thus, the baseline scenario may not replicate the actual situation well because consumers in this trade area might be making their purchasing decisions using alternative criterion besides minimum net price. However, the theory of price and location (Chapter 2, Section 2.4) states that consumers do attempt to minimize net price. Thus, the model follows this theory. The numeric results of the LP sensitivity analysis for the original baseline scenario are given in Appendix 4.

5.5 Revised Baseline Scenario

Since consolidation scenarios based on a poor simulation of reality would be of limited value, a revised baseline scenario was analyzed. However, a solution to the price margin inconsistency was needed. One solution to the problem was to use a consistent product group mix for each product line for all supply sites. This would more accurately represent the price differences for product lines between supply sites. The regional cooperative's sales data included the cost of goods sold in dollars as well as the total dollar sales for each product group for each line item. With these data, percent price margins were derived for each product group sold at each supply site. Then, those product groups for one product line which each site sold regularly were selected to represent a standard product mix. The average price margins for these product groups together represented the price margin for the product line. Yet, even these price margins (shown in Table 5.7) exhibited great inconsistency across supply sites.

The best alternative solution was to choose a standard price margin for each product group. The weighted average price margin (using volume sold as the weights) for each product line from the original data was chosen as the standard. These average price margins for the cluster are:

(1) 13.44 percent for agricultural chemicals,
(2) 22.59 percent for farm supplies,
(3) 10.54 percent for feed,
(4) 19.99 percent for fertilizer, and
(5) 26.62 percent for petroleum.

The original baseline scenario general price margins were changed to the cluster's average price margins. The original baseline scenario used demand figures standardized using the markup ratios to overcome differences in dollar units. Since the general price margin were then the same as each supply site's price margins in the revised baseline scenario, the markup ratios for all sites were equal to one. Markup ratios of one mean that no price differences exist between the supply sites and, hence, the dollar units for each supply site and the entire trade area are equal. Thus, the original unstandardized total demand figures (given the Table 5.8) were used for the revised baseline scenario since all dollar units were consistent.

The revised baseline scenario is a much better simulator of the actual product distribution than the original baseline scenario. The actual distribution is compared to the two baseline scenarios in Table 5.9. The distributions of feed and fertilizer

Table 5.7 - Price Margins from the Regional Cooperative's Sales Data

FARM SUPPLIES	PRODUCT GROUP	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD
General Hardware	17	17.13%	21.72%	15.33%	22.10%	29.46%
Fencing and Posts	23	20.54%	18.62%	20.49%	21.29%	22.77%
Electric Fence Products	24	23.74%	21.04%	24.80%	18.96%	28.29%
Stock Equipment	41	15.16%	19.93%	21.56%	17.97%	14.40%
Animal Health	49	31.21%	21.00%	18.95%	13.94%	28.23%
Legume and Grass Seed	94	29.07%	23.68%	23.51%	15.51%	23.86%
Field Grain Seed	95	9.05%	13.07%	16.23%	18.58%	22.29%
Vegetable-Tobacco Seed	97	26.23%	21.95%	23.47%	24.26%	25.60%
Average		22.71%	20.33%	19.91%	17.82%	25.24%

AGRICULTURAL CHEMICALS	PRODUCT GROUP	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD
Agricultural Chemicals	47	14.52%	15.37%	14.39%	10.75%	14.74%

FEED	PRODUCT GROUP	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD
Miscellaneous Feed	50	23.53%	17.15%	21.69%	12.39%	27.28%
Dairy Bulk Feed	80	0.16%	0.94%	-23.57%	0.19%	-0.54%
Dairy Bag Feed	81	47.37%	17.81%	8.67%	15.16%	11.69%
Swine Bag Feed	84	21.85%	20.25%	13.76%	12.24%	15.81%
Pet Foods	85	27.36%	28.13%	29.35%	21.31%	26.32%
Grain, Ingredients Bag	88	21.13%	19.50%	14.17%	17.80%	17.64%
Beef, Stock, Sheep Feed	89	19.52%	20.50%	20.63%	19.19%	16.73%
Average		24.73%	8.60%	-0.21%	6.75%	3.05%

FERTILIZER	PRODUCT GROUP	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD
Bagged Fertilizer	90	24.78%	11.53%	18.70%	15.56%	22.64%
Bulk Fertilizer	91	13.54%	18.56%	21.38%	18.20%	18.52%
Average		14.85%	16.13%	20.95%	17.67%	19.01%

PETROLEUM	PRODUCT GROUP	BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD
Diesel	66	36.32%				
Gasoline	75	10.94%				
Kerosene	76	22.28%				
LP Gas	77	52.17%				
Average		36.66%				

Table 5.8 - Unstandardized Final Demands by Product and Demand Region Used in the Revised Baseline Scenario

NAME	ZIP	AG CHEM	F SUPPLY	FEED	FERT	PETRO	TOTAL	PERCENT
HARRODSBURG	40330	$59,314	$398,231	$636,243	$189,030	$97,782	$1,380,600	17.57%
SALVISA	40372	$14,212	$61,630	$211,911	$33,347	$27,031	$348,131	4.43%
CRAB ORCHARD	40419	$21,784	$38,812	$110,097	$77,969	$90,823	$339,485	4.32%
DANVILLE	40422	$130,528	$391,845	$164,208	$311,673	$282,066	$1,280,320	16.29%
HUSTONVILLE	40437	$18,103	$51,314	$38,706	$54,857	$17,605	$180,585	2.30%
LANCASTER	40444	$74,713	$267,673	$455,145	$427,276	$50,392	$1,275,198	16.22%
STANFORD	40484	$57,885	$228,573	$277,524	$181,756	$136,808	$882,545	11.23%
WAYNESBURG	40489	$11,134	$43,408	$85,679	$183,582	$57,358	$381,162	4.85%
LIBERTY	42539	$47,678	$223,412	$246,277	$289,064	$1,966	$808,397	10.29%
SUBTOTAL		$435,350	$1,704,899	$2,225,789	$1,748,554	$761,831	$6,876,423	87.49%
EAST	40461	$3,878	$28,726	$31,545	$57,973		$122,122	1.55%
	40409		$4,388	$5,418	$5,961	$4,303	$20,071	0.26%
	40475	$451	$3,983	$2,527	$12,997		$19,958	0.25%
	40442	$3,103	$9,346	$776	$446	$1,175	$14,846	0.19%
SUBTOTAL		$7,431	$46,444	$40,267	$77,377	$5,478	$176,997	2.25%
NORTH	40502	$1,637	$6,742	$61,100		$152	$69,630	0.89%
	40308	$14,923	$13,263	$22,441	$555	$7,383	$58,564	0.75%
	40310	$135	$16,885	$15,146		$237	$32,402	0.41%
	40601					$26,736	$26,736	0.34%
	40524			$6,338	$14,031	$4,852	$25,221	0.32%
	40503		$1,898	$13,408		$815	$16,120	0.21%
SUBTOTAL		$16,695	$38,787	$118,432	$14,585	$40,175	$228,674	2.91%
SOUTH	42528	$4,715	$13,130	$3,723	$29,784		$51,352	0.65%
	42541	$2,712	$20,622	$12,623	$12,786	$445	$49,188	0.63%
	42516		$3,269	$41,155	$4,266		$48,691	0.62%
	40009	$628	$10,454	$5,016	$14,665	$190	$30,953	0.39%
	40448		$1,844	$16,150		$1,516	$19,511	0.25%
	42565				$16,364		$16,364	0.21%
	42733	$2,272	$1,250	$190	$9,532		$13,244	0.17%
	42566	$7,280	$2,704	$387	$1,067		$11,438	0.15%
	42501	$1,968	$3,655	$2,076	$279	$1,753	$9,731	0.12%
SUBTOTAL		$19,574	$56,928	$81,321	$88,743	$3,905	$250,471	3.19%
WEST	40468	$2,527	$22,342	$14,595	$22,005	$33,674	$95,143	1.21%
	40328	$3,033	$20,902	$2,842	$19,914	$31,807	$78,497	1.00%
	40464	$11,887	$14,973	$19,342	$3,205	$19,808	$69,215	0.88%
	40440	$13,142	$22,960	$7,189	$4,744	$17,770	$65,806	0.84%
	40452	$842	$1,372	$153	$203	$15,695	$18,265	0.23%
SUBTOTAL		$31,431	$82,549	$44,121	$50,071	$118,753	$326,926	4.16%
TOTALS		$510,481	$1,929,607	$2,509,930	$1,979,330	$930,142	$7,859,490	100.00%

Table 5.9 - Product Distribution Comparison of the Actual Situation, the Original Baseline Scenario, and the Revised Baseline Scenario

BOYLE	ACTUAL DISTRIBUTION	ORIGINAL BASELINE DISTRIBUTION	REVISED BASELINE DISTRIBUTION	ACTUAL-REVISED DIFFERENCE
AG CHEMICALS	$169,328	$161,877	$161,959	-$7,369
FARM SUPPLIES	$513,793	$392,486	$474,394	-$39,399
FEED	$204,244	$0	$208,329	$4,085
FERTILIZER	$361,560	$8,042	$361,744	$184
PETROLEUM	$930,142	$930,142	$930,142	$0
TOTAL	$2,179,067	$1,512,547	$2,136,568	-$42,499
HARRODSBURG				
AG CHEMICALS	$87,333	$90,214	$90,221	$2,888
FARM SUPPLIES	$496,164	$577,974	$498,648	$2,484
FEED	$975,622	$228,212	$966,586	-$9,036
FERTILIZER	$309,944	$46,604	$236,962	-$72,982
PETROLEUM	$0	$0	$0	$0
TOTAL	$1,869,063	$943,004	$1,792,417	-$76,646
LANCASTER				
AG CHEMICALS	$82,335	$82,257	$82,144	-$191
FARM SUPPLIES	$269,969	$313,419	$314,117	$44,148
FEED	$352,136	$847,780	$495,412	$143,276
FERTILIZER	$405,759	$658,587	$504,653	$98,894
PETROLEUM	$0	$0	$0	$0
TOTAL	$1,110,199	$1,902,043	$1,396,326	$286,127
LIBERTY				
AG CHEMICALS	$90,535	$85,259	$85,355	-$5,180
FARM SUPPLIES	$328,559	$329,492	$331,654	$3,095
FEED	$326,716	$337,338	$366,304	$39,588
FERTILIZER	$482,957	$1,158,500	$432,664	-$50,293
PETROLEUM	$0	$0	$0	$0
TOTAL	$1,228,767	$1,910,589	$1,215,977	-$12,790
STANFORD				
AG CHEMICALS	$80,950	$91,023	$90,803	$9,853
FARM SUPPLIES	$321,122	$311,678	$310,793	-$10,329
FEED	$651,212	$1,047,127	$473,300	-$177,912
FERTILIZER	$419,110	$42,694	$443,307	$24,197
PETROLEUM	$0	$0	$0	$0
TOTAL	$1,472,394	$1,492,522	$1,318,203	-$154,191
TRADE AREA				
AG CHEMICALS	$510,481	$510,630	$510,482	
FARM SUPPLIES	$1,929,607	$1,925,049	$1,929,606	
FEED	$2,509,930	$2,460,457	$2,509,931	
FERTILIZER	$1,979,330	$1,934,427	$1,979,330	
PETROLEUM	$930,142	$930,142	$930,142	
TOTAL	$7,859,490	$7,760,705	$7,859,491	

changed between the baseline scenarios. Although the revised baseline seems to distribute agricultural chemicals in a slightly different manner, close observation shows that the supply sites distribute the product to the same demand regions. These differences are due to the price margins differences (also meaning retail price differences) between the original and revised baseline scenarios. Thus, the quantity of agricultural chemicals distributed did not change between the original baseline and revised baseline scenarios.

When the product distribution from the revised baseline is compared to the actual distribution, the most noticeable difference is the restricted delivery of the revised baseline scenario. The distribution breakdown on a demand region basis for the revised baseline scenario is given in Table 5.10. In actuality, every supply site delivers to many demand regions. However, in the revised baseline scenario, each supply site only delivers to a few demand regions. This observation can be explained by both the theory of consumer behavior and the functions of a linear programming model.

Though consumers theoretically purchase products from the least cost location, in reality, other factors are involved in the purchase decision. The most important of these factors is the patron's opportunity cost of time. The opportunity cost of the patron's time spent travelling to a supply site to purchase products is the value of the next best use of that time. The opportunity cost of the patron's time is not included in the model because the next best alternative for each patron is different. The model was built on the assumption that the patron travels to a supply site solely for the purpose of buying products at that site. In other words, the patron has no alternative uses for that time. In reality, this isn't the case and, hence, a patron might purchase the product at a supply site with a higher price if his/her opportunity cost of time is high.

The second reason for the distribution differences is due to the linear nature of the programming model. By the rules of linear programming, the model will

Table 5.10 - Revised Baseline Scenario Product Distribution

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - ALL PRODUCTS

DEMAND REGION	BOYLE	HARRODSBURG	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$97,782	$1,282,818	$0	$0	$0	$1,380,600
40372	$27,031	$321,100	$0	$0	$0	$348,131
40419	$90,823	$0	$0	$0	$248,662	$339,485
40422	$1,280,320	$0	$0	$0	$0	$1,280,320
40437	$17,605	$0	$0	$162,980	$0	$180,585
40444	$50,392	$0	$1,224,807	$0	$0	$1,275,199
40484	$136,808	$0	$0	$0	$745,738	$882,546
40489	$57,358	$0	$0	$0	$323,803	$381,161
42539	$1,966	$0	$0	$806,431	$0	$808,397
EAST	$5,478	$0	$171,519	$0	$0	$176,997
NORTH	$40,175	$188,499	$0	$0	$0	$228,674
SOUTH	$3,905	$0	$0	$246,566	$0	$250,471
WEST	$326,925	$0	$0	$0	$0	$326,925
TOTAL	$2,136,568	$1,792,417	$1,396,326	$1,215,977	$1,318,203	$7,859,491

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - AG CHEMICALS

DEMAND REGION	BOYLE	HARRODSBURG	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$59,314	$0	$0	$0	$59,314
40372	$0	$14,212	$0	$0	$0	$14,212
40419	$0	$0	$0	$0	$21,784	$21,784
40422	$130,528	$0	$0	$0	$0	$130,528
40437	$0	$0	$0	$18,103	$0	$18,103
40444	$0	$0	$74,713	$0	$0	$74,713
40484	$0	$0	$0	$0	$57,885	$57,885
40489	$0	$0	$0	$0	$11,134	$11,134
42539	$0	$0	$0	$47,678	$0	$47,678
EAST	$0	$0	$7,431	$0	$0	$7,431
NORTH	$0	$16,695	$0	$0	$0	$16,695
SOUTH	$0	$0	$0	$19,574	$0	$19,574
WEST	$31,431	$0	$0	$0	$0	$31,431
TOTAL	$161,959	$90,221	$82,144	$85,355	$90,803	$510,482

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FARM SUPPLIES

DEMAND REGION	BOYLE	HARRODSBURG	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$398,231	$0	$0	$0	$398,231
40372	$0	$61,630	$0	$0	$0	$61,630
40419	$0	$0	$0	$0	$38,812	$38,812
40422	$391,845	$0	$0	$0	$0	$391,845
40437	$0	$0	$0	$51,314	$0	$51,314
40444	$0	$0	$267,673	$0	$0	$267,673
40484	$0	$0	$0	$0	$228,573	$228,573
40489	$0	$0	$0	$0	$43,408	$43,408
42539	$0	$0	$0	$223,412	$0	$223,412
EAST	$0	$0	$46,444	$0	$0	$46,444
NORTH	$0	$38,787	$0	$0	$0	$38,787
SOUTH	$0	$0	$0	$56,928	$0	$56,928
WEST	$82,549	$0	$0	$0	$0	$82,549
TOTAL	$474,394	$498,648	$314,117	$331,654	$310,793	$1,929,606

Table 5.10 - Revised Baseline Scenario Product Distribution (continued)

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FEED

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$636,243	$0	$0	$0	$636,243
40372	$0	$211,911	$0	$0	$0	$211,911
40419	$0	$0	$0	$0	$110,097	$110,097
40422	$164,208	$0	$0	$0	$0	$164,208
40437	$0	$0	$0	$38,706	$0	$38,706
40444	$0	$0	$455,145	$0	$0	$455,145
40484	$0	$0	$0	$0	$277,524	$277,524
40489	$0	$0	$0	$0	$85,679	$85,679
42539	$0	$0	$0	$246,277	$0	$246,277
EAST	$0	$0	$40,267	$0	$0	$40,267
NORTH	$0	$118,432	$0	$0	$0	$118,432
SOUTH	$0	$0	$0	$81,321	$0	$81,321
WEST	$44,121	$0	$0	$0	$0	$44,121
TOTAL	$208,329	$966,586	$495,412	$366,304	$473,300	$2,509,931

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FERTILIZER

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$189,030	$0	$0	$0	$189,030
40372	$0	$33,347	$0	$0	$0	$33,347
40419	$0	$0	$0	$0	$77,969	$77,969
40422	$311,673	$0	$0	$0	$0	$311,673
40437	$0	$0	$0	$54,857	$0	$54,857
40444	$0	$0	$427,276	$0	$0	$427,276
40484	$0	$0	$0	$0	$181,756	$181,756
40489	$0	$0	$0	$0	$183,582	$183,582
42539	$0	$0	$0	$289,064	$0	$289,064
EAST	$0	$0	$77,377	$0	$0	$77,377
NORTH	$0	$14,585	$0	$0	$0	$14,585
SOUTH	$0	$0	$0	$88,743	$0	$88,743
WEST	$50,071	$0	$0	$0	$0	$50,071
TOTAL	$361,744	$236,962	$504,653	$432,664	$443,307	$1,979,330

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - PETROLEUM

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$97,782	$0	$0	$0	$0	$97,782
40372	$27,031	$0	$0	$0	$0	$27,031
40419	$90,823	$0	$0	$0	$0	$90,823
40422	$282,066	$0	$0	$0	$0	$282,066
40437	$17,605	$0	$0	$0	$0	$17,605
40444	$50,392	$0	$0	$0	$0	$50,392
40484	$136,808	$0	$0	$0	$0	$136,808
40489	$57,358	$0	$0	$0	$0	$57,358
42539	$1,966	$0	$0	$0	$0	$1,966
EAST	$5,478	$0	$0	$0	$0	$5,478
NORTH	$40,175	$0	$0	$0	$0	$40,175
SOUTH	$3,905	$0	$0	$0	$0	$3,905
WEST	$118,753	$0	$0	$0	$0	$118,753
TOTAL	$930,142	$0	$0	$0	$0	$930,142

distribute product from the supply with the lowest net price until all available capacity is used. In reality, this is not always the case. In actuality, consumers do not always purchase the product for the lowest net price. Factors such as product availability, product quality, convenience, and personality of the cooperative employees play an important role. Yet, the model cannot account for other purchase decision factors.

On a supply site and product line basis, the overall product distribution of the revised baseline model matches the actual distribution fairly well (as is shown in Table 5.9). Of course, the petroleum product line matches perfectly since only one supply site (Boyle) distributes petroleum. The agricultural chemicals and farm supplies distributions for each supply site are fairly similar in the revised baseline scenario and actual situation. However, there are some differences in the product distribution of the feed and fertilizer product lines. In dollars of feed sold, Lancaster showed the largest increase ($143,276) while Stanford showed the largest decrease ($177,912) in the revised baseline scenario over the actual situation. Thus, many of the patrons who buy feed from Stanford in reality, bought feed from Lancaster in the revised baseline scenario. This would suggest that there is some inter-cooperative competition between Lancaster and Stanford. The same phenomena occurs to a lesser extent in fertilizer. Lancaster and Stanford sold more feed ($98,894 and $24,197 more, respectively) in the revised baseline scenario than in the actual situation while Harrodsburg and Liberty sold less feed ($72,982 and $50,293 less, respectively). Thus, many patrons who purchase fertilizer from Harrodsburg and Liberty in actuality, purchase it from Stanford and Lancaster in the revised baseline scenario. Lancaster also sells more farm supplies in the revised baseline than in actuality.

The asset utilizations from the revised baseline scenario indicate that Lancaster sells much more product in the revised baseline scenario than in actuality (as is shown in Table 5.11). Lancaster utilizes 10 percent more of its assets in the revised baseline than in actuality. Stanford utilizes about 7.5 percent less of its assets while the rest of

Table 5.11 - Storage/Production Utilization Comparison of the Actual Situation and Revised Baseline Scenario

BOYLE	ACTUAL SITUATION UTILIZATION	REVISED BASELINE UTILIZATION
AG CHEMICALS	75.3%	72.0%
FARM SUPPLIES	44.5%	41.1%
FEED	22.8%	23.3%
FERTILIZER	15.5%	15.5%
PETROLEUM	45.2%	45.2%
ALL	32.7%	32.1%
HARRODSBURG		
AG CHEMICALS	36.4%	37.6%
FARM SUPPLIES	41.3%	41.6%
FEED	79.7%	66.9%
FERTILIZER	15.2%	11.6%
PETROLEUM	0.0%	0.0%
ALL	39.7%	36.4%
LANCASTER		
AG CHEMICALS	36.6%	36.5%
FARM SUPPLIES	62.1%	72.2%
FEED	39.7%	58.4%
FERTILIZER	26.8%	33.3%
PETROLEUM	0.0%	0.0%
ALL	36.2%	46.2%
LIBERTY		
AG CHEMICALS	43.1%	40.7%
FARM SUPPLIES	80.5%	81.3%
FEED	42.2%	47.3%
FERTILIZER	41.7%	37.4%
PETROLEUM	0.0%	0.0%
ALL	48.2%	47.7%
STANFORD		
AG CHEMICALS	54.0%	60.5%
FARM SUPPLIES	47.6%	46.0%
FEED	51.8%	26.9%
FERTILIZER	21.8%	23.0%
PETROLEUM	0.0%	0.0%
ALL	36.7%	29.2%
CLUSTER		
AG CHEMICALS	48.6%	48.6%
FARM SUPPLIES	49.8%	49.8%
FEED	43.9%	43.9%
FERTILIZER	22.1%	22.1%
PETROLEUM	45.2%	45.2%
ALL	36.3%	36.3%

the supply sites' asset utilizations are very similar between the revised baseline scenario and the actual situation.

The net income differences between the actual situation and the revised baseline scenario (shown in Table 5.12) follow the differences between product distribution. The net income for agricultural chemicals are of similar magnitude between the revised baseline (-$10,764) and the actual situation (-$11,409). This occurs because the switch to constant price margins in the revised baseline scenario did not affect the agricultural chemicals product line since the original price margins were very similar between supply sites. However, the differences in agricultural chemicals net incomes for the supply sites between the revised baseline and actual situation are in the opposite direction. For example, Liberty sold $5,180 less agricultural chemicals in the revised baseline scenario that in the actual situation but that site had a net income which was $1,067 greater. Stanford sold $9,853 more in the revised baseline but its net income fell by $732. This evidence shows that agricultural chemicals is a losing product line because as sales increase, net income decreases. The price margin for agricultural chemicals is so low that the margins cannot cover all the costs.

For three product lines, the changes in net incomes between the actual situation and the revised baseline scenario can be attributed to two factors: 1) the changes in price margins when they were made constant for all supply sites, and 2) the changes in product distribution between the actual situation and the revised baseline scenario. For example, the net income that Lancaster attributes to farm supplies was $9,911 higher in the revised baseline than it was in the actual situation. Both factors mentioned above are partial causes. The original price margin for farm supplies at Lancaster was 22.01 percent while the price margin for the revised baseline scenario was 22.59 percent. Thus, even if the farm supplies distribution for the actual situation and the revised baseline were the same, the farm supplies net income at Lancaster would have increased since the price margin was higher. In fact, the amount of farm supplies sold did

Table 5.12 - Net Income Comparison of the Actual Situation and the Revised Baseline Scenario

BOYLE	ACTUAL SITUATION NET INCOME	REVISED BASELINE NET INCOME	REVISED - ACTUAL DIFFERENCE	ORIGINAL BASELINE PRICE MARGIN
AG CHEMICALS	-$6,003	-$5,783	$220	13.05%
FARM SUPPLIES	$23,785	$11,479	-$12,306	25.14%
FEED	-$5,848	-$11,394	-$5,546	14.06%
FERTILIZER	$4,996	$2,087	-$2,909	20.54%
PETROLEUM	$42,651	$56,908	$14,257	26.62%
TOTAL	$59,581	$53,296	-$6,285	
HARRODSBURG				
AG CHEMICALS	-$1,121	-$1,630	-$509	13.20%
FARM SUPPLIES	$24,007	$19,041	-$4,966	22.44%
FEED	-$37,130	-$54,418	-$17,288	12.51%
FERTILIZER	$10,426	$704	-$9,722	22.35%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	-$3,818	-$36,303	-$32,485	
LANCASTER				
AG CHEMICALS	-$584	$16	-$568	14.51%
FARM SUPPLIES	$9,952	$19,863	$9,911	22.01%
FEED	-$17,281	-$9,802	-$7,479	7.37%
FERTILIZER	$13,575	$22,689	$9,114	19.76%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	$5,662	$32,766	$27,104	
LIBERTY				
AG CHEMICALS	-$2,981	-$1,914	$1,067	12.79%
FARM SUPPLIES	$1,175	$11,726	$10,551	19.06%
FEED	-$17,549	-$14,923	-$2,626	9.20%
FERTILIZER	-$6,740	$6,189	$12,929	16.98%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	-$26,095	$1,078	$27,173	
STANFORD				
AG CHEMICALS	-$720	-$1,452	-$732	14.15%
FARM SUPPLIES	$15,130	$12,784	-$2,346	22.86%
FEED	-$27,840	-$16,138	$11,702	8.89%
FERTILIZER	$31,236	$8,502	-$22,734	21.45%
PETROLEUM	$0	$0	$0	0.00%
TOTAL	$17,806	$3,695	-$14,111	
TRADE AREA				
AG CHEMICALS	-$11,409	-$10,764	$645	
FARM SUPPLIES	$74,049	$74,893	$844	
FEED	-$105,648	-$106,675	$1,027	
FERTILIZER	$53,493	$40,170	-$13,323	
PETROLEUM	$42,651	$56,908	$14,257	
TOTAL	$53,136	$54,532	$1,396	

increase. Lancaster sold $44,148 more farm supplies in the revised baseline scenario than it did in the actual situation.

Overall, Lancaster and Liberty had much higher net incomes in the revised baseline scenario than in the actual situation. Harrodsburg and Stanford had much lower net incomes in the revised baseline scenario while Boyle's net income fell only slightly. The net incomes of agricultural chemicals, farm supplies, and feed were similar between the actual situation and the revised baseline scenario. Fertilizer net income was much lower in the revised baseline while petroleum net income was higher. Many of these net income differences are due to the adjusted price margins. Overall, the total net incomes for the actual situation and the revised baseline scenario were fairly similar, differing by only $1,396.

The revised baseline scenario is very stable in its product distribution. LP sensitivity analysis shows that pickup or delivery demand for all product lines can decrease by 100 percent (down to zero) before any change in the distribution pattern occurs. This situation exists because no demand region is served by more than one supply site in the revised baseline scenario. On the upward range, the lowest percentage by which pickup or delivery could increase for any product is 34 percent for any one demand region before any changes in the product distribution pattern occur. The LP sensitivity analysis results for the revised baseline scenarios are given in Appendix 4.

5.6 Consolidation Scenarios

The results from the revised baseline scenario provided some insight on possible consolidation scenarios. For this study, the revised baseline scenario, not the actual situation, was used as the basis for all consolidation decisions. Each consolidation scenario is based on the revised baseline scenario. The consolidation scenarios should demonstrate the impacts of consolidation on the actual situation of the cluster.

5.6.1 Store Closure Consolidation

Consolidation can be implemented in one or both of two ways. First, entire supply sites can be closed, forcing patrons to travel further for the products which they pick up. The second method of consolidation is product line consolidation. The candidates for store closure can be selected using three criterion. The most logical criterion is net income. This criterion dictates that the least profitable sites would be closed. In the revised baseline scenario, Harrodsburg was the only unprofitable site while Liberty and Stanford had relatively low net incomes. Another criterion is low utilization of assets. Boyle and Stanford utilized the least of their production/storage assets in the revised baseline scenario. A third criterion for consolidation is to close the sites where consumer demand (volume sold) is lowest. Liberty, Stanford, and Lancaster sold the least in total dollar volume in the revised baseline scenario.

Yet, other factors must be considered by cooperative management in the consolidation decision. The most important of these may be the potential loss of demand after consolidation. Patrons might be alienated from the cooperative if they feel that consolidation will result in worse service. Furthermore, they might simply find another supplier which is closer to their farm. These are important points since Coffey [1984] found that 90 percent of Southern States patrons preferred to visit the store rather than use the telephone or some other means.

Using combinations of these three criterion, only one supply site stood out as a feasible candidate for consolidation. Clearly, the Boyle site cannot be closed since it is the only supplier of petroleum. Yet, Boyle does not have enough storage capacity for agricultural chemicals and farm supplies to be the only supply site in the trade area.

Each of the other sites showed advantages and disadvantages for closure. Harrodsburg was the least profitable store but it sold the most feed and had the second highest total sales in the cluster. Lancaster was the second most profitable site but lacked the sales of the top two sites (Boyle and Harrodsburg). Liberty had the lowest total sales and a poor net income but it is also farthest from the center of the trade area. Its patrons could easily be lost to competitors if it were closed. Stanford would be the most likely candidate for closure since it is close to the center of the trade area and has low total sales, low net income, and low utilization of assets.

A scenario simulating the closure of the Stanford supply site was analyzed to illustrate the impact of supply site consolidation on the financial health of the cluster. The closure of the Stanford site was simulated in the model by reducing its costs and capacities to zero. Hence, Stanford could no longer sell any products since it had no storage capacities. All fixed and variable costs for Stanford were also eliminated in this scenario. This fixed and overhead cost elimination represents the firing of all employees and the sale of the site's assets and property. The costs and capacities of the other supply sites remained unchanged. There might be some gains from the sale of the site's assets since their market value may exceed their book value. However, this study is concerned only with the assets' book value.

As was previously mentioned, this consolidation would probably result in a decrease in the demand for all products from some of the demand regions which Stanford served in the revised baseline scenario. Hulslander developed a table (Table 5.13) which shows the maximum sales potential for a demand region based on its distance from the supplier. The maximum sales percentage represents the percentage of original demand which would still be demanded after consolidation. The percentages in the right hand column were used as the percent of the actual demand which would be lost after consolidation. In other words, the demand would decrease by 100 percent minus the maximum sales potential. According to the Hulslander table, no demand decrease should occur unless the demand region is over 16 miles from the

Table 5.13 - Maximum Sales Potentials Based on Distance for the Supply Site

DISTANCE (MILES)	MAXIMUM SALES POTENTIAL	DEMAND DECREASE
0	100%	0%
1	100%	0%
2	100%	0%
3	100%	0%
4	100%	0%
5	100%	0%
6	100%	0%
7	100%	0%
8	100%	0%
9	100%	0%
10	100%	0%
11	100%	0%
12	100%	0%
13	100%	0%
14	100%	0%
15	100%	0%
16	100%	0%
17	88.5%	11.5%
18	75%	25%
19	60%	40%
20	45%	55%
21	30%	70%
22	15%	85%
> 23	0%	100%

supply site. Stanford supplied three demand regions in the revised baseline scenario, zip code areas 40419, 40484, and 40489. In order to determine which (if any) of these demand regions would experience a decrease in demand, the store closure scenario had to be solved using the revised baseline demand data so that the distribution pattern could be analyzed. The only demand region previously served by Stanford which was located more than 16 miles from its new supplier was zip code area 40484. It was served by Liberty, located 18.5 miles away, in the store closure consolidation. The Hulslander table shows that demand regions located 18.5 miles away from the new supply site would experience a 32.5 percent demand decrease. Hence, the demand for all products from zip code area 40489 was decreased by 32.5 percent for the store closure scenario. Total demand was decreased using the sensitivity analysis explained in Chapter 3, Section 3.2.

The product distribution for the store closure method (shown in Table 5.14) resembles that of the revised baseline scenario except that the demand regions previously served by Stanford are now served by other supply sites. In most cases, Lancaster now serves zip code areas 40419 and 40484 while Liberty serves zip code area 40489. However, in the case of farm supplies and feed, Lancaster does not possess enough production/storage capacity to serve the added demand regions. Boyle also sells some farm supplies to zip code area 40484. In feed, Lancaster supplies all of the demand from zip code area 40484. However, Boyle supplies some feed to zip code area 40444, which was previously supplied totally by Lancaster in the revised baseline scenario. Thus, the cost of feed to the patron at Lancaster is less for those patrons in Stanford's demand region (zip code area 40484) than for those patrons in Lancaster's own demand region (zip code area 40444).

The asset utilizations for the store closure scenario (Table 5.15) show that this distribution pattern utilizes all of the capacity at the Lancaster site for farm supplies and almost all of the capacity for feed (98.5 percent). Total asset utilization at Lancaster increased to over 70 percent in this scenario. The only other capacity which

Table 5.14 - Product Distribution for the Store Closure Scenario

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - ALL PRODUCTS

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$97,782	$1,282,818	$0	$0	$0	$1,380,600
40372	$27,031	$321,100	$0	$0	$0	$348,131
40419	$90,823	$0	$248,662	$0	$0	$339,485
40422	$1,280,320	$0	$0	$0	$0	$1,280,320
40437	$17,605	$0	$0	$162,980	$0	$180,585
40444	$98,045	$0	$1,177,154	$0	$0	$1,275,199
40484	$283,310	$0	$599,236	$0	$0	$882,546
40489	$57,358	$0	$0	$218,567	$0	$275,925
42539	$1,966	$0	$0	$806,431	$0	$808,397
EAST	$5,478	$0	$171,519	$0	$0	$176,997
NORTH	$40,175	$188,499	$0	$0	$0	$228,674
SOUTH	$3,905	$0	$0	$246,566	$0	$250,471
WEST	$326,925	$0	$0	$0	$0	$326,925
TOTAL	$2,330,723	$1,792,417	$2,196,571	$1,434,544	$0	$7,754,255

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - AG CHEMICALS

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$59,314	$0	$0	$0	$59,314
40372	$0	$14,212	$0	$0	$0	$14,212
40419	$0	$0	$21,784	$0	$0	$21,784
40422	$130,528	$0	$0	$0	$0	$130,528
40437	$0	$0	$0	$18,103	$0	$18,103
40444	$0	$0	$74,713	$0	$0	$74,713
40484	$0	$0	$57,885	$0	$0	$57,885
40489	$0	$0	$0	$7,515	$0	$7,515
42539	$0	$0	$0	$47,678	$0	$47,678
EAST	$0	$0	$7,431	$0	$0	$7,431
NORTH	$0	$16,695	$0	$0	$0	$16,695
SOUTH	$0	$0	$0	$19,574	$0	$19,574
WEST	$31,431	$0	$0	$0	$0	$31,431
TOTAL	$161,959	$90,221	$161,813	$92,870	$0	$506,863

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FARM SUPPLIES

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$398,231	$0	$0	$0	$398,231
40372	$0	$61,630	$0	$0	$0	$61,630
40419	$0	$0	$38,812	$0	$0	$38,812
40422	$391,845	$0	$0	$0	$0	$391,845
40437	$0	$0	$0	$51,314	$0	$51,314
40444	$0	$0	$267,673	$0	$0	$267,673
40484	$146,502	$0	$82,071	$0	$0	$228,573
40489	$0	$0	$0	$29,300	$0	$29,300
42539	$0	$0	$0	$223,412	$0	$223,412
EAST	$0	$0	$46,444	$0	$0	$46,444
NORTH	$0	$38,787	$0	$0	$0	$38,787
SOUTH	$0	$0	$0	$56,928	$0	$56,928
WEST	$82,549	$0	$0	$0	$0	$82,549
TOTAL	$620,896	$498,648	$435,000	$360,954	$0	$1,915,498

Table 5.14 - Product Distribution for the Store Closure Scenario (continued)

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FEED

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$636,243	$0	$0	$0	$636,243
40372	$0	$211,911	$0	$0	$0	$211,911
40419	$0	$0	$110,097	$0	$0	$110,097
40422	$164,208	$0	$0	$0	$0	$164,208
40437	$0	$0	$0	$38,706	$0	$38,706
40444	$47,653	$0	$407,492	$0	$0	$455,145
40484	$0	$0	$277,524	$0	$0	$277,524
40489	$0	$0	$0	$57,833	$0	$57,833
42539	$0	$0	$0	$246,277	$0	$246,277
EAST	$0	$0	$40,267	$0	$0	$40,267
NORTH	$0	$118,432	$0	$0	$0	$118,432
SOUTH	$0	$0	$0	$81,321	$0	$81,321
WEST	$44,121	$0	$0	$0	$0	$44,121
TOTAL	$255,982	$966,586	$835,381	$425,137	$0	$2,482,085

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - FERTILIZER

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$0	$189,030	$0	$0	$0	$189,030
40372	$0	$33,347	$0	$0	$0	$33,347
40419	$0	$0	$77,969	$0	$0	$77,969
40422	$311,673	$0	$0	$0	$0	$311,673
40437	$0	$0	$0	$54,857	$0	$54,857
40444	$0	$0	$427,276	$0	$0	$427,276
40484	$0	$0	$181,756	$0	$0	$181,756
40489	$0	$0	$0	$123,918	$0	$123,918
42539	$0	$0	$0	$289,064	$0	$289,064
EAST	$0	$0	$77,377	$0	$0	$77,377
NORTH	$0	$14,585	$0	$0	$0	$14,585
SOUTH	$0	$0	$0	$88,743	$0	$88,743
WEST	$50,071	$0	$0	$0	$0	$50,071
TOTAL	$361,744	$236,962	$764,378	$556,582	$0	$1,919,666

DISTRIBUTION MATRIX FOR DELIVERY AND PICKUP - PETROLEUM

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBURG	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	$97,782	$0	$0	$0	$0	$97,782
40372	$27,031	$0	$0	$0	$0	$27,031
40419	$90,823	$0	$0	$0	$0	$90,823
40422	$282,066	$0	$0	$0	$0	$282,066
40437	$17,605	$0	$0	$0	$0	$17,605
40444	$50,392	$0	$0	$0	$0	$50,392
40484	$136,808	$0	$0	$0	$0	$136,808
40489	$57,358	$0	$0	$0	$0	$57,358
42539	$1,966	$0	$0	$0	$0	$1,966
EAST	$5,478	$0	$0	$0	$0	$5,478
NORTH	$40,175	$0	$0	$0	$0	$40,175
SOUTH	$3,905	$0	$0	$0	$0	$3,905
WEST	$118,753	$0	$0	$0	$0	$118,753
TOTAL	$930,142	$0	$0	$0	$0	$930,142

Table 5.15 - Storage/Production Utilization Comparison of the Revised Baseline Scenario and the Store Closure Scenario

BOYLE	REVISED BASELINE UTILIZATION	STORE CLOSURE UTILIZATION
AG CHEMICALS	72.0%	72.0%
FARM SUPPLIES	41.1%	53.8%
FEED	23.3%	28.6%
FERTILIZER	15.5%	15.5%
PETROLEUM	45.2%	45.2%
ALL	32.1%	35.0%
HARRODSBURG		
AG CHEMICALS	37.6%	37.6%
FARM SUPPLIES	41.6%	41.6%
FEED	66.9%	66.9%
FERTILIZER	11.6%	11.6%
PETROLEUM	0.0%	0.0%
ALL	36.4%	36.4%
LANCASTER		
AG CHEMICALS	36.5%	71.9%
FARM SUPPLIES	72.2%	100.0%
FEED	58.4%	98.5%
FERTILIZER	33.3%	50.4%
PETROLEUM	0.0%	0.0%
ALL	46.2%	72.7%
LIBERTY		
AG CHEMICALS	40.7%	44.2%
FARM SUPPLIES	81.3%	88.5%
FEED	47.3%	54.8%
FERTILIZER	37.4%	48.0%
PETROLEUM	0.0%	0.0%
ALL	47.7%	56.3%
STANFORD		
AG CHEMICALS	60.5%	0.0%
FARM SUPPLIES	46.0%	0.0%
FEED	26.9%	0.0%
FERTILIZER	23.0%	0.0%
PETROLEUM	0.0%	0.0%
ALL	29.2%	0.0%
CLUSTER		
AG CHEMICALS	48.6%	56.3%
FARM SUPPLIES	49.8%	59.9%
FEED	43.9%	62.6%
FERTILIZER	22.1%	27.2%
PETROLEUM	45.2%	45.2%
ALL	36.3%	45.2%

nears full utilization is for farm supplies at Liberty. The store closure scenario utilizes almost 90 percent of that production/storage capacity.

The net incomes of the store closure scenario (compared with the revised baseline scenario in Table 5.16) reflect the elimination of Stanford's fixed and overhead costs and the transfer of its sales to more profitable supply sites. As the sales of Boyle, Lancaster, and Liberty rose, each site obtained more sales volume over which to spread their fixed costs. Boyle's sales due to the Stanford closure rose only slightly, so its overall net income also rose modestly ($14,101). The sales of Lancaster and Liberty increase substantially due to the closure so their net incomes reflected the increase. Lancaster's net income rose $51,717 from the revised baseline scenario to the store closure scenario. Liberty's net income rose $14,418 even with the demand decrease due to increased distance travelled by some of Stanford's former patrons. The net income of Harrodsburg was unchanged since in received none of Stanford's sales. The overall net income for the entire cluster increased by $76,540. This increase illustrates the potential financial advantages of store closure consolidation.

5.6.2 Product Line Consolidation

The second method of consolidation is to eliminate certain product lines in some sites and consolidate their sales into fewer sites. Consolidation of product lines may be a better choice for this trade area than store closure. The net income advantages for this cluster are greater in product line consolidation (as will be shown in Section 5.6.2.2 of this chapter). Also, the patrons might be better served if no supply sites were closed. Similar criterion could be used in considering the product line consolidation method as are used in store closure consolidation. Using the net income approach, feed and agricultural chemicals are the least profitable product lines. The net income from these

Table 5.16 - Net Income Comparison of the Revised Baseline Scenario and the Store Closure Scenario

BOYLE	REVISED BASELINE NET INCOME	STORE CLOSURE NET INCOME	REVISED - STORE DIFFERENCE
AG CHEMICALS	-$5,783	-$5,220	$563
FARM SUPPLIES	$11,479	$18,652	$7,173
FEED	-$11,394	-$13,303	-$1,909
FERTILIZER	$2,087	$3,957	$1,870
PETROLEUM	$56,908	$63,312	$6,404
TOTAL	$53,296	$67,397	$14,101
HARRODSBURG			
AG CHEMICALS	-$1,630	-$1,630	$0
FARM SUPPLIES	$19,041	$19,041	$0
FEED	-$54,418	-$54,418	$0
FERTILIZER	$704	$704	$0
PETROLEUM	$0	$0	$0
TOTAL	-$36,303	-$36,303	$0
LANCASTER			
AG CHEMICALS	$16	$2,389	$2,373
FARM SUPPLIES	$19,863	$38,159	$18,296
FEED	-$9,802	-$6,983	$2,819
FERTILIZER	$22,689	$50,917	$28,228
PETROLEUM	$0	$0	$0
TOTAL	$32,766	$84,483	$51,717
LIBERTY			
AG CHEMICALS	-$1,914	-$1,374	$540
FARM SUPPLIES	$11,726	$17,389	$5,663
FEED	-$14,923	-$14,742	-$181
FERTILIZER	$6,189	$14,223	$8,034
PETROLEUM	$0	$0	$0
TOTAL	$1,078	$15,496	$14,418
STANFORD			
AG CHEMICALS	-$1,452	$0	$1,452
FARM SUPPLIES	$12,784	$0	-$12,784
FEED	-$16,138	$0	$16,138
FERTILIZER	$8,502	$0	-$8,502
PETROLEUM	$0	$0	$0
TOTAL	$3,695	$0	-$3,695
TRADE AREA			
AG CHEMICALS	-$10,764	-$5,836	$4,928
FARM SUPPLIES	$74,893	$93,241	$18,348
FEED	-$106,675	-$89,446	$17,229
FERTILIZER	$40,170	$69,801	$29,631
PETROLEUM	$56,908	$63,312	$6,404
TOTAL	$54,532	$131,072	$76,540

product lines could be improved through consolidation. The asset utilization of fertilizer is the lowest by far while the others used a similar quantity of assets.

The delivered product lines, feed and fertilizer, were consolidated into one location for the product line consolidation scenario. This scenario would allow for better utilization of production/storage assets (especially with fertilizer). It would also help prevent demand decreases due to the consolidation. The other four sites would remain open to sell agricultural chemicals and farm supplies and would also act as service centers where farmers could order feed and fertilizer. Thus, patrons could visit a site to order but the product would be delivered from one location for the trade area.

The pickup components (bagged feed and fertilizer) were also consolidated into one site. This action was more of a modelling decision than a consolidation decision. Even though it might be preferable to sell bagged feed and fertilizer at the four service centers, modelling difficulties make this option difficult. Bagged feed and fertilizer have higher price margins than their bulk counterparts. Thus, in order to split up the bulk and bagged components (leaving bagged feed and fertilizer in the service centers and consolidating only the bulk sales), the price margins for both would have to be adjusted (bagged upward and bulk downward). The Boyle site would have substantially lower price margins for feed and fertilizer because its lower bulk price margins would bias the overall feed and fertilizer price margins downward. These modified margins could create an unrealistic distribution pattern much like was displayed in the original baseline scenario. Thus, the entire feed and fertilizer product lines were consolidated to one site.

Boyle was chosen as the consolidation site for several reasons. First, consolidation of products into Boyle makes sense from a managerial viewpoint since it is the "mother cooperative" for the cluster. Hence, the cluster manager can more easily track the progress of the consolidation and assist in sales interactions with the large farmers. Second, it is located closest to the center of the trade area. Thus, deliveries to all parts of the trade area are more equidistant from the Boyle site than from any site. Third, Boyle is the only site which has sufficient fertilizer storage capacity to handle the sales for the entire trade area. Additional facilities would have to be built for any other supply site to be the trade area's sole supplier of fertilizer.

The production/storage capacity of feed is less critical. Though we have assumed that each site supplies its patrons directly (instead of the regional mills), bulk feed capacity should still be considered liquid (transferable between sites) since no supply site actually has bulk feed storage. Thus, the new feed production/storage capacity at Boyle for the consolidation scenarios will equal $4,399,040, which is the total bulk capacity for the cluster plus Boyle's original bagged storage capacity.

The delivery capacity for both product lines is also considered liquid since rolling stock can be transferred between supply sites. All feed delivery capacity was summed to arrive at Boyle's delivery capacity in the consolidation scenarios. In other words, Boyle's feed delivery capacity in the consolidation scenarios equals the entire trade area's feed delivery capacity in the revised baseline scenario. Since the rolling stock actually belongs to the regional mills and is used for several other trade areas, no reduction in feed rolling stock was made.

Fertilizer rolling stock was utilized to only about eight percent of its capacity in the revised baseline scenario. Also, no more product can be delivered than the site can produce/store. If all fertilizer rolling stock were moved to Boyle for consolidation, over $21,000,000 worth of delivery capacity would go unused. This is two and one half times the fertilizer storage capacity. Hence, fertilizer rolling stock was reduced. While Boyle's rolling stock was kept, the rolling stock from the other sites was "sold." In other words, Boyle's fertilizer delivery capacity was held constant for consolidation.

Though no supply site can have more delivery capacity than storage capacity in the model, excess delivery capacity may be necessary in actuality due to weather conditions. For example, in a rain shortened spring planting season, all patrons might demand fertilizer buggies in a two week period instead of the regular four week season.

Thus, more buggies (and more delivery capacity) would be demanded in this shorter season to deliver the same amount of fertilizer.

As was previously mentioned, this consolidation would probably result in a decrease in the demand for bagged feed and fertilizer. Using the Hulslander table, the demand decreases for bagged feed and fertilizer were estimated. Both the total demand and percentage picked up for feed and fertilizer had to be decreased in order to represent the lower pickup demand. Table 5.17 contains both the percent demand decreases and the new pickup percentages for feed and fertilizer.

5.6.2.1 First Consolidation Scenario

This scenario illustrates the effects of consolidation in the short run. The advantages of consolidation are not realized immediately. The results of lower overhead and variable costs are seen over time. However, losses in demand are almost immediate. Thus, the management of a consolidating cluster must realize that a period of poor net income will occur after consolidation.

The first consolidation scenario includes the changes in capacities for feed and fertilizer and the decreases in pickup demand. The variable costs and overhead costs are unchanged from the revised baseline scenario to illustrate the short run consolidation effects. The product distribution (Table 5.18) shows that the agricultural chemicals, farm supplies, and petroleum distributions are unchanged from the revised baseline scenario. However, the feed and fertilizer distribution reflects the consolidation and related demand changes. The overall demand for the two product lines decreased and is sold from Boyle.

More interesting are the changes in net income when comparing the revised baseline and first consolidation scenarios (shown in Table 5.19). The overall net income is much lower ($71,584 lower) in the consolidation scenario. The four service centers

Table 5.17 - Demand Decreases in Feed and Fertilizer for the Consolidation Scenarios

	FEED		FERTILIZER	
DEMAND REGION	NEW PICKUP PERCENTAGE	DEMAND DECREASE	NEW PICKUP PERCENTAGE	DEMAND DECREASE
40330	20.60%	0.00%	23.63%	0.00%
40372	13.46%	6.48%	2.84%	1.37%
40419	9.98%	12.20%	7.19%	8.79%
40422	85.47%	0.00%	5.60%	0.00%
40437	25.10%	0.00%	24.48%	0.00%
40444	44.20%	0.00%	25.94%	0.00%
40484	25.23%	0.00%	12.73%	0.00%
40489	8.55%	14.26%	1.38%	2.31%
42539	0.00%	35.07%	0.00%	22.90%
EAST	13.78%	47.48%	1.40%	4.81%
NORTH	0.00%	18.76%	0.00%	3.80%
SOUTH	0.00%	31.16%	0.00%	15.87%
WEST	73.66%	0.00%	21.17%	0.00%

Table 5.18 - Product Distribution Comparison of the Revised Second Baseline Scenario and the First Consolidation Scenario

BOYLE	REVISED BASELINE DISTRIBUTION	FIRST CONSOLIDATION DISTRIBUTION
AG CHEMICALS	$161,959	$161,959
FARM SUPPLIES	$474,394	$474,394
FEED	$208,329	$2,317,504
FERTILIZER	$361,744	$1,883,224
PETROLEUM	$930,142	$930,142
TOTAL	$2,136,568	$5,767,223
HARRODSBURG		
AG CHEMICALS	$90,221	$90,221
FARM SUPPLIES	$498,648	$498,648
FEED	$966,586	$0
FERTILIZER	$236,962	$0
PETROLEUM	$0	$0
TOTAL	$1,792,417	$588,869
LANCASTER		
AG CHEMICALS	$82,144	$82,144
FARM SUPPLIES	$314,117	$314,117
FEED	$495,412	$0
FERTILIZER	$504,653	$0
PETROLEUM	$0	$0
TOTAL	$1,396,326	$396,261
LIBERTY		
AG CHEMICALS	$85,355	$85,355
FARM SUPPLIES	$331,654	$331,654
FEED	$366,304	$0
FERTILIZER	$432,664	$0
PETROLEUM	$0	$0
TOTAL	$1,215,977	$417,009
STANFORD		
AG CHEMICALS	$90,803	$90,803
FARM SUPPLIES	$310,793	$310,793
FEED	$473,300	$0
FERTILIZER	$443,307	$0
PETROLEUM	$0	$0
TOTAL	$1,318,203	$401,596
TRADE AREA		
AG CHEMICALS	$510,482	$510,482
FARM SUPPLIES	$1,929,606	$1,929,606
FEED	$2,509,931	$2,317,504
FERTILIZER	$1,979,330	$1,883,224
PETROLEUM	$930,142	$930,142
TOTAL	$7,859,491	$7,570,958

Table 5.19 - Net Income Comparison of the Revised Baseline Scenario and the First Consolidation Scenario

BOYLE	REVISED BASELINE NET INCOME	FIRST CONSOLIDATION NET INCOME	FIRST - REVISED DIFFERENCE
AG CHEMICALS	-$5,783	-$1,815	$3,968
FARM SUPPLIES	$11,479	$31,013	$19,534
FEED	-$11,394	-$82,229	-$70,835
FERTILIZER	$2,087	$78,746	$76,659
PETROLEUM	$56,908	$102,042	$45,134
TOTAL	$53,296	$127,757	$74,461
HARRODSBURG			
AG CHEMICALS	-$1,630	-$7,217	-$5,587
FARM SUPPLIES	$19,041	-$32,861	-$51,902
FEED	-$54,418	$0	$54,418
FERTILIZER	$704	$0	-$704
PETROLEUM	$0	$0	$0
TOTAL	-$36,303	-$40,078	-$3,775
LANCASTER			
AG CHEMICALS	$16	-$6,396	-$6,412
FARM SUPPLIES	$19,863	-$21,347	-$41,210
FEED	-$9,802	$0	$9,802
FERTILIZER	$22,689	$0	-$22,689
PETROLEUM	$0	$0	$0
TOTAL	$32,766	-$27,743	-$60,509
LIBERTY			
AG CHEMICALS	-$1,914	-$8,035	-$6,121
FARM SUPPLIES	$11,726	-$28,250	-$39,976
FEED	-$14,923	$0	$14,932
FERTILIZER	$6,189	$0	-$6,189
PETROLEUM	$0	$0	$0
TOTAL	$1,078	-$36,285	-$37,363
STANFORD			
AG CHEMICALS	-$1,452	-$9,158	-$7,706
FARM SUPPLIES	$12,784	-$31,545	-$44,329
FEED	-$16,138	$0	$16,138
FERTILIZER	$8,502	$0	-$8,502
PETROLEUM	$0	$0	$0
TOTAL	$3,695	-$40,703	-$44,398
TRADE AREA			
AG CHEMICALS	-$10,764	-$32,621	-$21,857
FARM SUPPLIES	$74,893	-$82,990	-$157,883
FEED	-$106,675	-$82,229	$24,446
FERTILIZER	$40,170	$78,746	$38,576
PETROLEUM	$56,908	$102,042	$45,134
TOTAL	$54,532	-$17,052	-$71,584

(Harrodsburg, Lancaster, Liberty, and Stanford) have negative net incomes while Boyle's net income increased in the first consolidation scenario. These differences can be explained by the allocation of overhead costs. Since overhead costs were not decreased in this short run scenario, the same overhead costs were allocated to greatly lower sales in the four service centers. In other words, these sites did not have enough volume over which to spread the overhead costs. Meanwhile, Boyle had greater volume over which to spread its overhead costs, resulting in a higher net income. Yet, the net result for the entire cluster is a lower total net income than in the revised baseline scenario. Thus, a cluster should expect to experience some lean times before the benefits of consolidation are realized.

5.6.2.2 Second Consolidation Scenario

This scenario illustrates the gains from consolidation in the long run through lower variable and fixed costs. As was mentioned in Chapter 4, Section 4.5.2, the regional cooperative's management felt that very few fixed costs could be eliminated through the closure of certain product lines. Yet, most clusters will be able to allocate fixed costs to specific product lines and eliminate some of these fixed costs if the product lines are discontinued. Hence, to illustrate this effect in the test cluster, some adjustments to fixed costs were made. The overhead costs of Boyle were held constant while those of the other four sites were set at zero. Then, the allocation of overhead costs to the agricultural chemicals and farm supplies product lines for the service centers in the revised baseline scenario were used as allocated fixed costs in the second consolidation scenario. These changes simply represent the elimination of fixed costs for feed and fertilizer in the four service centers. The allocated fixed costs for the two consolidated product lines (feed and fertilizer) were also set at zero in all the service centers to represent the elimination of those fixed costs.

Since the volume sold by Boyle in feed and fertilizer rose so much due to consolidation, it is assumed in the second consolidation scenario that managers for those two product lines will be hired in the long run. These product managers would be better able to organize the distribution of deliveries, leaving the site manager to take care of the other operations. The product managers could also interact better with large farmers who want to purchase large quantities of the products under their supervision. This helps correct one of the inefficiencies mentioned in Chapter 1, Section 1.3. The salaries of these managers were considered as allocated fixed costs since their work is specific to the feed and fertilizer product lines. The salary levels were set at $26,967 per year. This figure was the national average for assistant site managers at cooperatives as determined from a survey of fertilizer dealers in 1988 [Taylor and Akridge].

Variable costs were also lowered to represent economies of size that result from consolidation. Boyle had the highest variable costs for feed and fertilizer in the cluster in the revised baseline scenario. This was probably due to the added costs of its "mother store" responsibilities. Logically, the variable costs would decrease at least to the average of the trade area. Thus, feed and fertilizer variable costs were set at that level. The cost changes for the second consolidation scenario are shown in Table 5.20.

The product distribution for the second consolidation is the same as for the first consolidation scenario since the cost changes affected the financial statements, not the model solution. The net incomes for the second consolidation scenario are drastically different than those of the first consolidation. Table 5.21 is a comparison of the net incomes of the revised baseline, first consolidation, and second consolidation scenarios. The net incomes of the four service centers improved dramatically between the revised baseline and the second consolidation scenarios. This is due to the lower fixed costs from discontinuing the feed and fertilizer sales at these sites. The net income at Boyle increased only modestly (about $6,000) from the first consolidation scenario. This implies that the decrease in variable costs is greater than the increase

Table 5.20 - Cost Changes for the Second Consolidation Scenario

FIXED COSTS

	AG CHEMICALS	FARM SUPPLIES	FEED	FERTILIZER	PETROLEUM
BOYLE	$0	$0	$26,967	$26,967	$0
HARRODSBURG	$4,671	$43,390	$0	$0	$0
LANCASTER	$3,434	$22,072	$0	$0	$0
LIBERTY	$4,227	$27,608	$0	$0	$0
STANFORD	$4,585	$26,376	$0	$0	$0

OVERHEAD COSTS

BOYLE	$162,568
HARRODSBURG	$0
LANCASTER	$0
LIBERTY	$0
STANFORD	$0

VARIABLE COSTS

	FEED	FERTILIZER
BOYLE	11.00%	10.99%

Table 5.21 - Net Income Comparison of the Revised Baseline, the First Consolidation Scenario, and the Second Consolidation Scenario

BOYLE	REVISED BASELINE NET INCOME	FIRST CONSOLIDATION NET INCOME	SECOND CONSOLIDATION NET INCOME	SECOND - REVISED DIFFERENCE
AG CHEMICALS	-$5,783	-$1,815	-$1,815	$3,968
FARM SUPPLIES	$11,479	$31,013	$31,013	$19,534
FEED	-$11,394	-$82,229	-$77,446	-$66,052
FERTILIZER	$2,087	$78,746	$79,839	$77,752
PETROLEUM	$56,908	$102,042	$102,042	$45,134
TOTAL	$53,296	$127,757	$133,633	$80,337
HARRODSBURG				
AG CHEMICALS	-$1,630	-$7,217	-$1,630	$0
FARM SUPPLIES	$19,041	-$32,861	$19,041	$0
FEED	-$54,418	$0	$0	$54,418
FERTILIZER	$704	$0	$0	-$704
PETROLEUM	$0	$0	$0	$0
TOTAL	-$36,303	-$40,078	$17,409	$53,712
LANCASTER				
AG CHEMICALS	$16	-$6,396	$16	$0
FARM SUPPLIES	$19,863	-$21,347	$19,863	$0
FEED	-$9,802	$0	$0	$9,802
FERTILIZER	$22,689	$0	$0	-$22,689
PETROLEUM	$0	$0	$0	$0
TOTAL	$32,766	-$27,743	$19,879	-$12,887
LIBERTY				
AG CHEMICALS	-$1,914	-$8,035	-$1,914	$0
FARM SUPPLIES	$11,726	-$28,250	$11,726	$0
FEED	-$14,923	$0	$0	$14,932
FERTILIZER	$6,189	$0	$0	-$6,189
PETROLEUM	$0	$0	$0	$0
TOTAL	$1,078	-$36,285	$9,812	$8,734
STANFORD				
AG CHEMICALS	-$1,452	-$9,158	-$1,452	$0
FARM SUPPLIES	$12,784	-$31,545	$12,784	$0
FEED	-$16,138	$0	$0	$16,138
FERTILIZER	$8,502	$0	$0	-$8,502
PETROLEUM	$0	$0	$0	$0
TOTAL	$3,695	-$40,703	$11,332	$7,637
TRADE AREA				
AG CHEMICALS	-$10,764	-$32,621	-$6,796	$3,968
FARM SUPPLIES	$74,893	-$82,990	$94,426	$19,533
FEED	-$106,675	-$82,229	-$77,446	$29,229
FERTILIZER	$40,170	$78,746	$79,839	$39,669
PETROLEUM	$56,908	$102,042	$102,042	$45,134
TOTAL	$54,532	-$17,052	$192,065	$137,533

in fixed costs from hiring the product managers. Overall, the net income for the cluster of $192,065 in the second consolidation scenario is a great increase compared to the other two scenarios. Hence, consolidation seems to have a positive financial effect in the longer run.

The asset utilization of all product lines remained constant except in fertilizer. Since the capacities were altered, the percentage of asset utilized also changed. Production/storage capacity for fertilizer was over 80 percent utilized, thus cutting down on the extreme excess capacity for that product line in the revised baseline scenario. Fertilizer delivery capacity was also better utilized in this scenario than in the revised baseline with 32 percent of the delivery assets utilized.

5.7 Demand Change Scenario

The effects of consolidation are not the only concern of the cluster after such a task has begun. The old saying holds true that "change is the only thing that stays the same." Chapter 1, Section 1.1 explained some of the problems cooperatives face in the highly dynamic world of agriculture. The small part of that dynamic world on which this section will focus is the effects of changes in demand on the financial well being of a cooperative trade area.

There are many factors to consider when attempting to determine future changes in demand for farm inputs. These include such factors as changing technology, urbanization trends, and demographic changes (number of farms, size of farms, etc.). However, an analysis which considers all of these factors is beyond the scope of this research. The best data available which could be used to estimate future demand trends were historic sales figures. The regional cooperative's management supplied this data for 1982 to 1988. No data before 1982 were used because sales trends were very different before the 1980's than during these years. By fitting a trend line through the sales figure of the past seven years, the demand for each product line in 1989 was estimated. The historic sales data and price index used to deflate it are shown in Appendix 5. The sales data were available only on a supply site basis, not on a demand region basis. Thus, the trends shown in Table 5.22 were estimated for each supply site and applied to those demand regions served by that supply site in the revised baseline scenario. The trends were used in a model sensitivity analysis of the revised baseline in order to illustrate their effects on the present situation. Overall demand in the trade area seems to be decreasing, lead by petroleum and fertilizer. Demand for agricultural chemicals, farm supplies, and feed seems to be holding steady.

The total sales to each demand region and from each supply site changed due the demand trends. However, the general distribution pattern remains constant, with supply sites selling to the same demand regions as they did in the revised baseline scenario. The sales volumes for the trade area are shown in Table 5.23. The net income of the cluster decreased by just over $30,000 (shown in Table 5.24) from the revised baseline scenario due to the future demand trends. Thus, the decreasing demand for farm inputs is adversely affecting the financial well being of the cluster. Boyle had the largest decrease, losing almost $25,000 in net income from the revised baseline to the demand change scenario. Harrodsburg, Lancaster, and Stanford also lost net income due to the demand trends. However, Liberty gained almost $5,500 in net income since the demand for most products at Liberty increased. Yet, the estimation of overall lower future demand helps confirm the need for a cost-saving strategy such as consolidation.

5.8 Combined Scenario

This scenario simply uses the demand trends from the previous section and applies them to the consolidation situation (the second consolidation scenario). The

Table 5.22 - Future Demand Trends for the Trade Area

DEMAND REGION	AGRICULTURAL CHEMICALS	FARM SUPPLIES	FEED	FERTILIZER	PETROLEUM
40330	-3.26%	1.32%	0.38%	-12.37%	-13.86%
40372	-3.26%	1.32%	0.38%	-12.37%	-13.86%
40419	-5.10%	-3.04%	3.59%	-5.40%	-13.86%
40422	4.75%	-1.80%	-19.09%	-18.08%	-13.86%
40437	-0.56%	9.70%	11.96%	4.61%	-13.86%
40444	-9.39%	-0.18%	-4.87%	-9.83%	-13.86%
40484	-5.10%	-3.04%	3.59%	-5.40%	-13.86%
40489	-5.10%	-3.04%	3.59%	-5.40%	-13.86%
42539	-0.56%	9.70%	11.96%	4.61%	-13.86%
EAST	-9.39%	-0.18%	-4.87%	-9.83%	-13.86%
NORTH	-3.26%	1.32%	0.38%	-12.37%	-13.86%
SOUTH	-0.56%	9.70%	11.96%	4.61%	-13.86%
WEST	4.75%	-1.80%	-19.08%	-18.08%	-13.86%

Table 5.23 - Product Distribution Comparison of the Revised Baseline Scenario and the Demand Change Scenario

BOYLE	REVISED BASELINE DISTRIBUTION	DEMAND CHANGE DISTRIBUTION	DEMAND - REVISED DIFFERENCE
AG CHEMICALS	$161,959	$169,652	$7,693
FARM SUPPLIES	$474,394	$465,855	-$8,539
FEED	$208,329	$168,559	-$39,770
FERTILIZER	$61,744	$296,341	$234,597
PETROLEUM	$930,142	$801,224	-$128,918
TOTAL	$2,136,568	$1,901,631	-$234,937
HARRODSBURG			
AG CHEMICALS	$90,221	$87,280	-$2,941
FARM SUPPLIES	$498,648	$505,230	$6,582
FEED	$966,586	$970,259	$3,673
FERTILIZER	$236,962	$207,650	-$29,312
PETROLEUM	$	$0	$0
TOTAL	$1,792,417	$1,770,419	-$21,998
LANCASTER			
AG CHEMICALS	$82,144	$74,431	-$7,713
FARM SUPPLIES	$314,117	$313,552	-$565
FEED	$495,412	$471,285	-$24,127
FERTILIZER	$504,653	$455,046	-$49,607
PETROLEUM	$0	$0	$0
TOTAL	$1,396,326	$1,314,314	-$82,012
LIBERTY			
AG CHEMICALS	$85,355	$84,877	-$478
FARM SUPPLIES	$331,654	$363,824	$32,170
FEED	$366,304	$410,114	$43,810
FERTILIZER	$432,664	$452,610	$19,946
PETROLEUM	$0	$0	$0
TOTAL	$1,215,977	$1,311,425	$95,448
STANFORD			
AG CHEMICALS	$90,803	$86,172	-$4,631
FARM SUPPLIES	$310,793	$301,345	-$9,448
FEED	$473,300	$490,292	$16,992
FERTILIZER	$443,307	$419,368	-$23,939
PETROLEUM	$0	$0	$0
TOTAL	$1,318,203	$1,297,177	-$21,026
TRADE AREA			
AG CHEMICALS	$510,482	$502,412	-$8,070
FARM SUPPLIES	$1,929,606	$1,949,806	$20,200
FEED	$2,509,931	$2,510,509	$578
FERTILIZER	$1,979,330	$1,831,015	-$148,315
PETROLEUM	$930,142	$801,224	-$128,918
TOTAL	$7,859,491	$7,594,966	-$264,525

Table 5.24 - Net Income Comparison of the Revised Baseline Scenario and the Demand Change Scenario

BOYLE	REVISED BASELINE NET INCOME	DEMAND CHANGE NET INCOME	DEMAND CHANGE - REVISED BASELINE DIFFERENCE
AG CHEMICALS	-$5,783	-$7,046	-$1,263
FARM SUPPLIES	$11,479	$6,714	-$4,765
FEED	-$11,394	-$9,989	$1,405
FERTILIZER	$2,087	-$857	-$2,944
PETROLEUM	$56,908	$39,782	-$17,126
TOTAL	$53,296	$28,604	-$24,692
HARRODSBURG			
AG CHEMICALS	-$1,630	-$1,651	-$21
FARM SUPPLIES	$19,041	$18,578	-$463
FEED	-$54,418	-$55,265	-$847
FERTILIZER	$704	$357	-$347
PETROLEUM	$0	$0	$0
TOTAL	-$36,303	-$37,981	-$1,678
LANCASTER			
AG CHEMICALS	$16	-$177	-$193
FARM SUPPLIES	$19,863	$18,472	-$1,391
FEED	-$9,802	-$10,275	-$473
FERTILIZER	$22,689	$18,718	-$3,971
PETROLEUM	$0	$0	$0
TOTAL	$32,766	$26,738	-$6,028
LIBERTY			
AG CHEMICALS	-$1,914	-$1,611	$303
FARM SUPPLIES	$11,726	$14,970	$3,244
FEED	-$14,923	-$15,600	-$677
FERTILIZER	$6,189	$8,793	$2,604
PETROLEUM	$0	$0	$0
TOTAL	$1,078	$6,552	$5,474
STANFORD			
AG CHEMICALS	-$1,452	-$1,494	-$42
FARM SUPPLIES	$12,784	$11,711	-$1,073
FEED	-$16,138	-$17,237	-$1,099
FERTILIZER	$8,502	$7,201	-$1,301
PETROLEUM	$0	$0	$0
TOTAL	$3,695	$181	-$3,514
TRADE AREA			
AG CHEMICALS	-$10,764	-$11,979	-$1,215
FARM SUPPLIES	$74,893	$70,445	-$4,448
FEED	-$106,675	-$108,365	-$1,690
FERTILIZER	$40,170	$34,212	-$5,958
PETROLEUM	$56,908	$39,782	-$17,126
TOTAL	$54,532	$24,096	-$30,436

combined scenario illustrates the effects of both consolidation and future demand trends on the financial health of the cluster. The combined scenario product distribution totals (shown in Table 5.25) for the product lines reflect the future demand changes of the trade area. Sales of all product lines except farm supplies are lower than in the second consolidation scenario and total sales for the entire trade area decreased by about $250,000. Liberty and Harrodsburg showed total sales increases over the second consolidation scenario of $31,692 and $3,641, respectively.

The net income comparison between the second consolidation scenario and the combined scenario (shown in Table 5.26) also reflect the demand changes for the future. Each product line except farm supplies showed a decrease in net income from the second consolidation scenario to the combined scenario. The total net income for the cluster decreased by $29,156 due to future demand changes. Boyle's net income was almost $32,000 lower in the combined scenario than in the second consolidation scenario. This decrease makes sense because Boyle sells the most product by far and would feel most of the pressure of falling demand. Harrodsburg and Liberty actually showed increased net incomes ($726 and $3,803, respectively) due to future demand changes. Increased farm supplies sales accounted for the increase.

Though the future demand changes adversely effected the net incomes of the consolidation, the combined scenario still showed improvement over both the revised baseline and demand change scenarios. In the face of lower patron demand, the Central Service cluster might need to improve its economic viability. Consolidation proved to be a useful method in improving the net income of the cluster.

5.9 Conclusions

The revised baseline scenario simulated the agricultural supply marketplace of the Central Service trade area rather well. The baseline case must replicate the trade

Table 5.25 - Product Distribution Comparison of the Second Consolidation Scenario and the Combined Scenario

BOYLE	SECOND CONSOLIDATION DISTRIBUTION	COMBINED SCENARIO DISTRIBUTION	COMBINED SECOND DIFFERENCE
AG CHEMICALS	$161,959	$169,652	$7,693
FARM SUPPLIES	$474,394	$465,855	-$8,539
FEED	$2,317,504	$2,309,416	-$8,088
FERTILIZER	$1,883,224	$1,755,491	-$127,733
PETROLEUM	$930,142	$801,224	-$128,918
TOTAL	$5,767,223	$5,501,638	-$265,585
HARRODSBURG			
AG CHEMICALS	$90,221	$87,280	-$2,941
FARM SUPPLIES	$498,648	$505,230	$6,582
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$588,869	$592,510	$3,641
LANCASTER			
AG CHEMICALS	$82,144	$74,431	-$7,713
FARM SUPPLIES	$314,117	$313,552	-$565
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$396,261	$387,983	-$8,278
LIBERTY			
AG CHEMICALS	$85,355	$84,877	-$478
FARM SUPPLIES	$331,654	$363,824	$32,170
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$417,009	$448,701	$31,692
STANFORD			
AG CHEMICALS	$90,803	$86,172	-$4,631
FARM SUPPLIES	$310,793	$301,345	-$9,448
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$401,596	$387,517	-$14,079
TRADE AREA			
AG CHEMICALS	$510,482	$502,412	-$8,070
FARM SUPPLIES	$1,929,606	$1,949,806	$20,200
FEED	$2,317,504	$2,309,416	-$8,088
FERTILIZER	$1,883,224	$1,755,491	-$127,733
PETROLEUM	$930,142	$801,224	-$128,918
TOTAL	$7,570,958	$7,318,349	-$252,609

Table 5.26 - Net Income Comparison of the Second Consolidation and the Combined Scenario

BOYLE	SECOND CONSOLIDATION NET INCOME	COMBINED SCENARIO NET INCOME	COMBINED - SECOND DIFFERENCE
AG CHEMICALS	-$1,815	-$2,146	-$331
FARM SUPPLIES	$31,013	$29,326	-$1,687
FEED	-$77,446	-$79,883	-$2,437
FERTILIZER	$79,839	$68,792	-$11,047
PETROLEUM	$102,042	$85,610	-$16,432
TOTAL	$133,633	$101,699	-$31,934
HARRODSBURG			
AG CHEMICALS	-$1,631	-$1,730	-$99
FARM SUPPLIES	$19,040	$19,865	$825
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$17,409	$18,135	$726
LANCASTER			
AG CHEMICALS	$16	-$308	-$324
FARM SUPPLIES	$19,863	$19,787	-$76
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$19,879	$19,479	-$400
LIBERTY			
AG CHEMICALS	-$1,914	-$1,927	-$13
FARM SUPPLIES	$11,726	$15,542	$3,816
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$9,812	$13,615	$3,803
STANFORD			
AG CHEMICALS	-$1,452	-$1,612	-$160
FARM SUPPLIES	$12,784	$11,593	-$1,191
FEED	$0	$0	$0
FERTILIZER	$0	$0	$0
PETROLEUM	$0	$0	$0
TOTAL	$11,332	$9,981	-$1,351
TRADE AREA			
AG CHEMICALS	-$6,796	-$7,723	-$927
FARM SUPPLIES	$94,426	$96,113	$1,687
FEED	-$77,446	-$79,883	-$2,437
FERTILIZER	$79,839	$68,792	-$11,047
PETROLEUM	$102,042	$85,610	-$16,432
TOTAL	$192,065	$162,909	-$29,156

area's actual product distribution well before consolidation analysis can be considered. The store closure scenario improved the net income of the cluster by $76,540 over that of the revised baseline scenario. However, product line consolidation proved to be the best choice for this trade area. The first consolidation scenario showed that the benefits of consolidation are not immediate. It showed a $71,584 lower net income than that of the revised baseline scenario. The second consolidation scenario demonstrated the financial advantages of consolidation. The net income of the revised baseline scenario was increased $137,533 in the second consolidation scenario. Future demand trends indicate that the Central Service cluster may need to find some method of increasing net income. The demand change scenario applied the demand trends to the revised baseline scenario and found that net income decreased by over $30,000 as a result. The combined scenario helped prove that consolidation is one possible solution to the demand declines in the agricultural supply market. The combined effects of product line consolidation and future demand changes showed an increase in net income of over $100,000.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 Introduction

The primary objective of this research was to analyze the effects of changes in supply, demand, and supply structure on the economic viability of farm supply cooperatives. Economic viability for the cooperatives was defined as serving the patrons' needs while maintaining a level of sales and income sufficient to cover all costs. A microcomputer based linear programming model was built to simulate the product/trade flows of a cooperative trade area by minimizing the net costs to the patrons. The model was then applied to a sample trade area to test its applicability and accuracy in simulating product flows. Several consolidation scenarios were analyzed to demonstrate the financial consequences of each scenario. It was also used to analyze changes on the financial situation of the cooperative caused by changing demographics. The remainder of this chapter is a summary of the strengths and weaknesses of the model, its coefficients (the data), and the scenarios (the results). Policy implications of consolidation decisions for cooperative are discussed. Finally, the needs for future research are explained.

6.2 Model Summary

A user-friendly, microcomputer based linear programming model was developed which uses a given set of assets to simulate the retail distribution of products from a group of farm supply cooperatives to the patrons of a trade area. It finds the optimal distribution of products based on the minimum net cost (price of the product plus transport costs) to the patrons using given levels of assets and consumer demand. Several assumptions about the trade area situation are used to allow for flexibility in the analysis. The cost of goods sold is assumed to be constant for all supply sites in the trade area so that the model can account for price differences between the sites. No excess inventory can exist at the site since all product is distributed to the patrons. The sites will sell only what the patrons demand. It is also assumed that the patron travels from the farm to the supply site solely for the purpose of purchasing products at that site. This makes minimum net cost of the product to the patron the only factor in the purchase decision. Finally, it is assumed that field sizes are evenly distributed throughout a trade area. This assumption addresses the problems of per acre delivery charges which are commonly used in fertilizer spreading and agricultural chemical spraying. These per acre charges must be converted to per mile charges for the model.

The model is not perfect; no simulation of reality can be free of imperfections. The model's limitations are listed below.

1) The assumptions of linearity and divisibility in linear programming make nonlinear relationships (such as seasonality of sales) and integer relationships difficult to model. Hence, these relationships are not represented in this model.

2) The hardware and software limitations of the model may restrict the user to very general analyses. The model is limited to five supply sites, five product lines, and fifteen demand regions.
3) This model will not solve for the optimal supply structure of the cooperative for a trade area. It simulates product distribution using a set of assets defined by the user.
4) Every delivery charge in the model is based on mileage. Delivery charges cannot be on a per trip or per acre basis.

The strengths of the model make it a valuable analysis tool. These strengths are:

1) The model closely simulates the real marketplace since it accounts for the consumer's purchasing behavior.
2) The consolidation decision is left to the user. The model simulates patron purchases based on that decision. Thus, the user has ultimate control of the consolidation analysis.
3) The model is very flexible in its definition of supply sites, product lines, and demand regions.
4) The ability to analyze the effects of changes in consumer demand is built into the model.
5) The model is portable; it can be used in the field and is not restricted to the fastest and largest computers.

6.3 Data Summary

The model was tested using a sample trade area. The Central Service cluster consists of five supply sites (Boyle, Harrodsburg, Lancaster, Liberty, and Stanford) selling five product lines (agricultural chemicals, farm supplies, feed, fertilizer, and petroleum). The data collected for this study was the best available from the trade area. The regional cooperative has recently revised their record keeping system to accommodate this type of analysis. However, the data are not perfect. Many of the weaknesses in this study are data related. Price margin differences between the supply sites which caused problems in the original baseline scenario and differences in delivery charges and costs between the sites had to be corrected. The lack of some demand data on a zip code area basis limited the accuracy of the simulations. Finally, the difficulty of allocating costs to product lines caused problems. Yet, adjustments were made to correct for these data deficiencies.

6.4 Results Summary

A baseline scenario was built using the data collected from the trade area and the upper management of the regional cooperative. However, inconsistencies in the data resulted in a poor simulation by this original baseline scenario. Hence, adjustments were needed to help the baseline case better conform to reality. This step was necessary because the consolidation cases could not be compared to reality unless their predecessor (the baseline case) was a reasonable representation of reality. The revised baseline scenario simulated the actual trade area situation quite well.

Three consolidation scenarios were analyzed to illustrate both the advantages and disadvantages of consolidation. The store closure scenario considered the closure of one store (Stanford) in the trade area. The net income for the cluster (the five supply sites combined) increased by $76,540 over the revised baseline scenario. The sales of the feed and fertilizer product lines were consolidated into one central site (Boyle) for the other two consolidation scenarios. The other four supply sites remained open as service centers, selling agricultural chemicals and farm supplies and taking orders for feed, fertilizer, and petroleum. The first product line consolidation scenario retained the fixed costs for all five supply sites. This scenario represented the short run situation in which fixed costs are not yet eliminated. Some losses in demand for feed and fertilizer were included since some patrons would have to travel further to purchase these products. The first product line scenario showed a decrease in net income of $71,584 compared to the revised baseline scenario. Some fixed and variable costs were decreased in the second product line consolidation scenario to help illustrate the long run effects of consolidation. This scenario showed an increase in net income of $137,533 over that of the revised baseline scenario. Comparison of the product line scenarios and the revised baseline scenario showed that consolidation does not yield immediate benefits. However, consolidation benefits do appear in the long run.

Finally, the effects of demand trends were analyzed to show the full implications of consolidation in the future. These demand trends were applied to both the revised baseline case and the second product line (long run) consolidation case so a true comparison could be made. The trends indicate that future demand for agricultural supplies in the trade area could decrease substantially. Consolidation is an attractive choice to help decrease the costs of serving the patrons and improve the net income to the cooperative in the face of decreasing demand.

6.5 Policy Implications for the Cooperative

This research has shown that consolidation can address some of the inefficiencies which cooperatives face and improve the economic viability of the cooperatives. Consolidation of either product lines or entire supply sites helps solve the problems of small store size, too many supply sites, misallocation of assets, long supply lines, and inexperienced managers. Furthermore, consolidation may benefit the patron in the form of better services and lower prices.

The ultimate goal of consolidation must be determined before the analysis begins. Some of the possible goals are: 1) Improved profitability for the cooperative, 2) Improved prices for the patron, 3) Specialization to a certain segment of the patrons (such as large farmers), 4) Gaining an edge on a competitor, or 5) Reactions to changes in laws and government regulations. The goal of consolidation has a great impact on the decision of how to consolidate.

The reduction of fixed costs is critical to the success of consolidation. The first product line consolidation showed that consolidation can even be detrimental to the financial situation of the cooperative if few fixed costs can be eliminated. An accurate estimate of those fixed costs which can be eliminated after consolidation is needed before a worthwhile consolidation scenario can be analyzed.

More factors than the net income of the cooperative should be considered in the consolidation decision. One of the most important of these is the reaction of patrons. Will they be receptive to the idea of consolidation or will they consider it a loss of services? Can patron loyalty to the cooperative help overcome adverse feelings toward consolidation? For consolidation to be successful and demand to be maintained, the majority of the patrons must realize that consolidation is in the best interest of both the cooperative and the patrons. They must be willing to travel further to buy agricultural supplies at a lower price. However, a loss in demand is inevitable because not all patrons will be convinced of the merits of consolidation. The goal is to keep that demand loss at a minimum.

Competition in the trade area should also be considered. Losses in demand are more likely if many purchasing alternatives are available to the patrons. In the case of many competitors, the product line consolidation presented in this research might be a better alternative than whole supply site consolidation. Small service sites which act as order centers can help alleviate potential demand decreases.

The simulation capabilities of the model make it useful in many situations besides the consolidation and demand sensitivity analyses. The impact of competition could be considered by replacing one or more of the five supply sites with competitors. The affects of price changes can also be analyzed by simply entering test price margins for the supply sites. The contribution of new product lines such as nursery supplies can be considered. The model can be used for these and many more types of analyses because it simulates the workings of a cooperative trade area and does not simply find the optimal supply structure of a trade area.

6.6 Future Research

The weaknesses of the model and the data should be the concentration of future research. The most obvious weakness which could be corrected is the model's size limitations. New software is becoming available which could be used to create several models of this type and link them together for the final analysis of results. Though this type of model would increase the time required for data collection and computer computation, the trade area could be analyzed more thoroughly. The problems of too many diverse product groups in one product line would be alleviated because the product lines could be broken down more finely. This would allow for a better analysis of separate product lines and their influences on the financial situation of the cooperative. Also, more supply sites and demand regions could be analyzed as cooperative trade areas increase in size.

The unusual units of the model's coefficients make the development of a front end loader program desirable for the users of the model. The loader program would assist the user in making the correct calculations for converting cost, price, and capacity data into model coefficients. The program would help streamline the data collection and calculation process which is arguably the most time consuming part of the consolidation analysis.

A possibility for further research is to apply this model to wholesale distribution problems. The model is now tailored to retail distribution but some refinements could be made so it can address wholesale distribution questions. Wholesale distribution usually includes fewer products and more demand regions. The nature of the objective function might have to be altered depending on the recipients of the wholesale products. Minimizing costs to the cooperative should be the goal if the wholesale network distributes to retail cooperative stores. However, if the network also supplies large farmers, the goal should be much the same as in the retail distribution model.

One of the continuing struggles of economists is the problem of imperfect data. A possibility for further research could be to concentrate on the data collection process. This could include the development of a cooperative record keeping system which would facilitate the breakdown of costs by product line.

The presence of large price margin differences and losing product lines (those with price margins less than variable costs) demonstrates the need for research in cooperative pricing strategies. The problem of losing product lines is particularly distressing given the current financial status of some cooperatives (explained in Chapter 1). A cooperative usually supplies a product line at a loss to remain competitive with other firms (usually investor oriented firms) in the trade area. This suggests that farmers are highly price sensitive and previous research (detailed in Chapter 2) supports this suggestion. Further research of cooperative pricing strategies might help answer the following questions. What factors influence the pricing decisions of cooperatives? How do the goals and purposes of a cooperative affect their pricing strategies in comparison to investor oriented firms? How many cooperatives sell product lines at a loss? Which product lines are typically sold at a loss? Is it worthwhile for cooperatives to retain losing product lines?

Another area of possible research could pertain to the attitudes of cooperative managers toward decision support models such as the model discussed in this thesis. How many managers use these models? What managerial level should these models be targeted toward? What should the "ease of use" level of these models be in order to be useful for managers? Obtaining answers to these questions would help the developers of these models to better target the needs of the end user.

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APPENDIX 1

REVISED BASELINE SCENARIO INPUTS AND RESULTS

COST, PRICE, AND CAPACITY INPUTS

SITE: BOYLE   PRODUCT: AG CHEM

VARIABLE COSTS		12.37%
FIXED COSTS		$0
PRICE MARGIN		13.44%
PRICE MARKUP		15.53%
COST OF GOODS SOLD		86.56%
DELIVERY COSTS	$	0
DELIVERY CHARGES	$	0
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$225,000
DELIVERY		$0

COST, PRICE, AND CAPACITY INPUTS

SITE: HARRODSBURG   PRODUCT: AG CHEM

VARIABLE COSTS		10.07%
FIXED COSTS		$0
PRICE MARGIN		13.44%
PRICE MARKUP		15.53%
COST OF GOODS SOLD		86.56%
DELIVERY COSTS	$	0
DELIVERY CHARGES	$	0
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$240,000
DELIVERY		$0

COST, PRICE, AND CAPACITY INPUTS

SITE: LANCASTER   PRODUCT: AG CHEM

VARIABLE COSTS		9.24%
FIXED COSTS		$0
PRICE MARGIN		13.44%
PRICE MARKUP		15.53%
COST OF GOODS SOLD		86.56%
DELIVERY COSTS	$	0
DELIVERY CHARGES	$	0
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$225,000
DELIVERY		$0

COST, PRICE, AND CAPACITY INPUTS

SITE: LIBERTY   PRODUCT: AG CHEM

VARIABLE COSTS		10.73%
FIXED COSTS		$0
PRICE MARGIN		13.44%
PRICE MARKUP		15.53%
COST OF GOODS SOLD		86.56%
DELIVERY COSTS	$	0
DELIVERY CHARGES	$	0
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$210,000
DELIVERY		$0

COST, PRICE, AND CAPACITY INPUTS

SITE: STANFORD PRODUCT: AG CHEM

VARIABLE COSTS	9.99%
FIXED COSTS	$0
PRICE MARGIN	13.44%
PRICE MARKUP	15.53%
COST OF GOODS SOLD	86.56%
DELIVERY COSTS $	0
DELIVERY CHARGES $	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$150,000
DELIVERY	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: BOYLE PRODUCT: FARM SUPPLIES

VARIABLE COSTS	12.37%
FIXED COSTS	$0
PRICE MARGIN	22.59%
PRICE MARKUP	29.18%
COST OF GOODS SOLD	77.41%
DELIVERY COSTS $	0
DELIVERY CHARGES $	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$1,155,000
DELIVERY	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: HARRODSBURG PRODUCT: FARM SUPPLIES

VARIABLE COSTS	10.07%
FIXED COSTS	$0
PRICE MARGIN	22.59%
PRICE MARKUP	29.18%
COST OF GOODS SOLD	77.41%
DELIVERY COSTS $	0
DELIVERY CHARGES $	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$1,200,000
DELIVERY	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: LANCASTER PRODUCT: FARM SUPPLIES

VARIABLE COSTS	9.24%
FIXED COSTS	$0
PRICE MARGIN	22.59%
PRICE MARKUP	29.18%
COST OF GOODS SOLD	77.41%
DELIVERY COSTS $	0
DELIVERY CHARGES $	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$435,000
DELIVERY	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: LIBERTY — PRODUCT: FARM SUPPLIES

VARIABLE COSTS	10.73%
FIXED COSTS	$0
PRICE MARGIN	22.59%
PRICE MARKUP	29.18%
COST OF GOODS SOLD	77.41%
DELIVERY COSTS ($)	0
DELIVERY CHARGES ($)	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$408,000
DELIVERY	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: STANFORD — PRODUCT: FARM SUPPLIES

VARIABLE COSTS	9.99%
FIXED COSTS	$0
PRICE MARGIN	22.59%
PRICE MARKUP	29.18%
COST OF GOODS SOLD	77.41%
DELIVERY COSTS ($)	0
DELIVERY CHARGES ($)	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$675,000
DELIVERY	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: BOYLE — PRODUCT: FEED

VARIABLE COSTS	12.37%
FIXED COSTS	$0
PRICE MARGIN	10.54%
PRICE MARKUP	11.78%
COST OF GOODS SOLD	89.46%
DELIVERY COSTS ($)	0.0007579
DELIVERY CHARGES ($)	0.0007579
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$895,630
DELIVERY	$260,850

COST, PRICE, AND CAPACITY INPUTS

SITE: HARRODSBURG — PRODUCT: FEED

VARIABLE COSTS	12.11%
FIXED COSTS	$0
PRICE MARGIN	10.54%
PRICE MARKUP	11.78%
COST OF GOODS SOLD	89.46%
DELIVERY COSTS ($)	0.0007579
DELIVERY CHARGES ($)	0.0007579
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE	$1,444,970
DELIVERY	$1,080,150

COST, PRICE, AND CAPACITY INPUTS

SITE: LANCASTER PRODUCT: FEED

VARIABLE COSTS		9.24%
FIXED COSTS		$0
PRICE MARGIN		10.54%
PRICE MARKUP		11.78%
COST OF GOODS SOLD		89.46%
DELIVERY COSTS	$	0.0007579
DELIVERY CHARGES	$	0.0007579
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$847,780
DELIVERY		$515,100

COST, PRICE, AND CAPACITY INPUTS

SITE: LIBERTY PRODUCT: FEED

VARIABLE COSTS		10.73%
FIXED COSTS		$0
PRICE MARGIN		10.54%
PRICE MARKUP		11.78%
COST OF GOODS SOLD		89.46%
DELIVERY COSTS	$	0.0007579
DELIVERY CHARGES	$	0.0007579
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$773,800
DELIVERY		$437,800

COST, PRICE, AND CAPACITY INPUTS

SITE: STANFORD PRODUCT: FEED

VARIABLE COSTS		9.99%
FIXED COSTS		$0
PRICE MARGIN		10.54%
PRICE MARKUP		11.78%
COST OF GOODS SOLD		89.46%
DELIVERY COSTS	$	0.0007579
DELIVERY CHARGES	$	0.0007579
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$1,761,600
DELIVERY		$1,109,700

COST, PRICE, AND CAPACITY INPUTS

SITE: BOYLE PRODUCT: FERTILIZER

VARIABLE COSTS		12.48%
FIXED COSTS		$0
PRICE MARGIN		19.99%
PRICE MARKUP		24.98%
COST OF GOODS SOLD		80.01%
DELIVERY COSTS	$	0.0004074
DELIVERY CHARGES	$	0.0003806
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$2,329,600
DELIVERY		$5,184,000

COST, PRICE, AND CAPACITY INPUTS

SITE: HARRODSBURG PRODUCT: FERTILIZER

VARIABLE COSTS		11.95%
FIXED COSTS		$0
PRICE MARGIN		19.99%
PRICE MARKUP		24.98%
COST OF GOODS SOLD		80.01%
DELIVERY COSTS	$	0.0004074
DELIVERY CHARGES	$	0.0003806
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$2,044,000
DELIVERY		$4,848,000

COST, PRICE, AND CAPACITY INPUTS

SITE: LANCASTER PRODUCT: FERTILIZER

VARIABLE COSTS		9.24%
FIXED COSTS		$0
PRICE MARGIN		19.99%
PRICE MARKUP		24.98%
COST OF GOODS SOLD		80.01%
DELIVERY COSTS	$	0.0004074
DELIVERY CHARGES	$	0.0003806
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$1,515,500
DELIVERY		$3,758,400

COST, PRICE, AND CAPACITY INPUTS

SITE: LIBERTY PRODUCT: FERTILIZER

VARIABLE COSTS		11.15%
FIXED COSTS		$0
PRICE MARGIN		19.99%
PRICE MARKUP		24.98%
COST OF GOODS SOLD		80.01%
DELIVERY COSTS	$	0.0004074
DELIVERY CHARGES	$	0.0003806
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$1,158,500
DELIVERY		$4,664,800

COST, PRICE, AND CAPACITY INPUTS

SITE: STANFORD PRODUCT: FERTILIZER

VARIABLE COSTS		10.52%
FIXED COSTS		$0
PRICE MARGIN		19.99%
PRICE MARKUP		24.98%
COST OF GOODS SOLD		80.01%
DELIVERY COSTS	$	0.0004074
DELIVERY CHARGES	$	0.0003806
CAPACITY LIMITATIONS		
PRODUCTION/STORAGE		$1,925,000
DELIVERY		$4,242,000

COST, PRICE, AND CAPACITY INPUTS

SITE: BOYLE PRODUCT: PETROLEUM

VARIABLE COSTS................................	11.31%
FIXED COSTS...................................	$0
PRICE MARGIN..................................	26.62%
PRICE MARKUP..................................	36.28%
COST OF GOODS SOLD............................	73.38%
DELIVERY COSTS..............................$	0.0000539
DELIVERY CHARGES............................$	0.0000539
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE......................	$2,058,420
DELIVERY................................	$2,669,856

COST, PRICE, AND CAPACITY INPUTS

SITE: HARRODSBURG PRODUCT: PETROLEUM

VARIABLE COSTS................................	0.00%
FIXED COSTS...................................	$0
PRICE MARGIN..................................	0.00%
PRICE MARKUP..................................	0.00%
COST OF GOODS SOLD............................	0.00%
DELIVERY COSTS..............................$	0
DELIVERY CHARGES............................$	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE......................	$0
DELIVERY................................	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: LANCASTER PRODUCT: PETROLEUM

VARIABLE COSTS................................	0.00%
FIXED COSTS...................................	$0
PRICE MARGIN..................................	0.00%
PRICE MARKUP..................................	0.00%
COST OF GOODS SOLD............................	0.00%
DELIVERY COSTS..............................$	0
DELIVERY CHARGES............................$	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE......................	$0
DELIVERY................................	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: LIBERTY PRODUCT: PETROLEUM

VARIABLE COSTS................................	0.00%
FIXED COSTS...................................	$0
PRICE MARGIN..................................	0.00%
PRICE MARKUP..................................	0.00%
COST OF GOODS SOLD............................	0.00%
DELIVERY COSTS..............................$	0
DELIVERY CHARGES............................$	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE......................	$0
DELIVERY................................	$0

COST, PRICE, AND CAPACITY INPUTS

SITE: STANFORD PRODUCT: PETROLEUM

VARIABLE COSTS................................	0.00%
FIXED COSTS..................................	$0
PRICE MARGIN.................................	0.00%
PRICE MARKUP.................................	0.00%
COST OF GOODS SOLD...........................	0.00%
DELIVERY COSTS..............................$	0
DELIVERY CHARGES............................$	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE.......................	$0
DELIVERY................................	$0

DEMAND IN EACH DEMAND REGION FOR AG CHEM

40330	(DEMAND REGION 1)...............	$59,314
40372	(DEMAND REGION 2)...............	$14,212
40419	(DEMAND REGION 3)...............	$21,784
40422	(DEMAND REGION 4)...............	$130,528
40437	(DEMAND REGION 5)...............	$18,103
40444	(DEMAND REGION 6)...............	$74,713
40484	(DEMAND REGION 7)...............	$57,885
40489	(DEMAND REGION 8)...............	$11,134
42539	(DEMAND REGION 9)...............	$47,678
EAST	(DEMAND REGION 10)..............	$7,431
NORTH	(DEMAND REGION 11)..............	$16,695
SOUTH	(DEMAND REGION 12)..............	$19,574
WEST	(DEMAND REGION 13)..............	$31,431

DEMAND IN EACH DEMAND REGION FOR FARM SUPPLIES

40330	(DEMAND REGION 1)...............	$398,231
40372	(DEMAND REGION 2)...............	$61,630
40419	(DEMAND REGION 3)...............	$38,812
40422	(DEMAND REGION 4)...............	$391,845
40437	(DEMAND REGION 5)...............	$51,314
40444	(DEMAND REGION 6)...............	$267,673
40484	(DEMAND REGION 7)...............	$228,573
40489	(DEMAND REGION 8)...............	$43,408
42539	(DEMAND REGION 9)...............	$223,412
EAST	(DEMAND REGION 10)..............	$46,444
NORTH	(DEMAND REGION 11)..............	$38,787
SOUTH	(DEMAND REGION 12)..............	$56,928
WEST	(DEMAND REGION 13)..............	$82,549

DEMAND IN EACH DEMAND REGION FOR FEED

40330	(DEMAND REGION 1)...............	$636,243
40372	(DEMAND REGION 2)...............	$211,911
40419	(DEMAND REGION 3)...............	$110,097
40422	(DEMAND REGION 4)...............	$164,208
40437	(DEMAND REGION 5)...............	$38,706
40444	(DEMAND REGION 6)...............	$455,145
40484	(DEMAND REGION 7)...............	$277,524
40489	(DEMAND REGION 8)...............	$85,679
42539	(DEMAND REGION 9)...............	$246,277
EAST	(DEMAND REGION 10)..............	$40,267
NORTH	(DEMAND REGION 11)..............	$118,432
SOUTH	(DEMAND REGION 12)..............	$81,321
WEST	(DEMAND REGION 13)..............	$44,121

DEMAND IN EACH DEMAND REGION FOR FERTILIZER

40330	(DEMAND REGION 1)..............	$189,030
40372	(DEMAND REGION 2)..............	$33,347
40419	(DEMAND REGION 3)..............	$77,969
40422	(DEMAND REGION 4)..............	$311,673
40437	(DEMAND REGION 5)..............	$54,857
40444	(DEMAND REGION 6)..............	$427,276
40484	(DEMAND REGION 7)..............	$181,756
40489	(DEMAND REGION 8)..............	$183,582
42539	(DEMAND REGION 9)..............	$289,064
EAST	(DEMAND REGION 10)..............	$77,377
NORTH	(DEMAND REGION 11)..............	$14,585
SOUTH	(DEMAND REGION 12)..............	$88,743
WEST	(DEMAND REGION 13)..............	$50,071

DEMAND IN EACH DEMAND REGION FOR PETROLEUM

40330	(DEMAND REGION 1)..............	$97,782
40372	(DEMAND REGION 2)..............	$27,031
40419	(DEMAND REGION 3)..............	$90,823
40422	(DEMAND REGION 4)..............	$282,066
40437	(DEMAND REGION 5)..............	$17,605
40444	(DEMAND REGION 6)..............	$50,392
40484	(DEMAND REGION 7)..............	$136,808
40489	(DEMAND REGION 8)..............	$57,358
42539	(DEMAND REGION 9)..............	$1,966
EAST	(DEMAND REGION 10)..............	$5,478
NORTH	(DEMAND REGION 11)..............	$40,175
SOUTH	(DEMAND REGION 12)..............	$3,905
WEST	(DEMAND REGION 13)..............	$118,753

PERCENT PICKED UP FOR EACH DEMAND REGION OF AG CHEM

40330	(DEMAND REGION 1)..............	100.00%
40372	(DEMAND REGION 2)..............	100.00%
40419	(DEMAND REGION 3)..............	100.00%
40422	(DEMAND REGION 4)..............	100.00%
40437	(DEMAND REGION 5)..............	100.00%
40444	(DEMAND REGION 6)..............	100.00%
40484	(DEMAND REGION 7)..............	100.00%
40489	(DEMAND REGION 8)..............	100.00%
42539	(DEMAND REGION 9)..............	100.00%
EAST	(DEMAND REGION 10)..............	100.00%
NORTH	(DEMAND REGION 11)..............	100.00%
SOUTH	(DEMAND REGION 12)..............	100.00%
WEST	(DEMAND REGION 13)..............	100.00%

PERCENT PICKED UP FOR EACH DEMAND REGION OF FARM SUPPLIES

40330	(DEMAND REGION 1)..............	100.00%
40372	(DEMAND REGION 2)..............	100.00%
40419	(DEMAND REGION 3)..............	100.00%
40422	(DEMAND REGION 4)..............	100.00%
40437	(DEMAND REGION 5)..............	100.00%
40444	(DEMAND REGION 6)..............	100.00%
40484	(DEMAND REGION 7)..............	100.00%
40489	(DEMAND REGION 8)..............	100.00%
42539	(DEMAND REGION 9)..............	100.00%
EAST	(DEMAND REGION 10)..............	100.00%
NORTH	(DEMAND REGION 11)..............	100.00%
SOUTH	(DEMAND REGION 12)..............	100.00%
WEST	(DEMAND REGION 13)..............	100.00%

PERCENT PICKED UP FOR EACH DEMAND REGION OF FEED

40330	(DEMAND REGION 1)...............	20.60%
40372	(DEMAND REGION 2)...............	19.93%
40419	(DEMAND REGION 3)...............	22.18%
40422	(DEMAND REGION 4)...............	85.47%
40437	(DEMAND REGION 5)...............	25.10%
40444	(DEMAND REGION 6)...............	44.20%
40484	(DEMAND REGION 7)...............	25.23%
40489	(DEMAND REGION 8)...............	22.81%
42539	(DEMAND REGION 9)...............	35.07%
EAST	(DEMAND REGION 10)..............	61.26%
NORTH	(DEMAND REGION 11)..............	18.76%
SOUTH	(DEMAND REGION 12)..............	31.16%
WEST	(DEMAND REGION 13)..............	73.66%

PERCENT PICKED UP FOR EACH DEMAND REGION OF FERTILIZER

40330	(DEMAND REGION 1)...............	23.63%
40372	(DEMAND REGION 2)...............	4.21%
40419	(DEMAND REGION 3)...............	15.98%
40422	(DEMAND REGION 4)...............	5.60%
40437	(DEMAND REGION 5)...............	24.48%
40444	(DEMAND REGION 6)...............	25.94%
40484	(DEMAND REGION 7)...............	12.73%
40489	(DEMAND REGION 8)...............	3.69%
42539	(DEMAND REGION 9)...............	22.90%
EAST	(DEMAND REGION 10)..............	6.21%
NORTH	(DEMAND REGION 11)..............	3.80%
SOUTH	(DEMAND REGION 12)..............	15.87%
WEST	(DEMAND REGION 13)..............	21.17%

PERCENT PICKED UP FOR EACH DEMAND REGION OF PETROLEUM

40330	(DEMAND REGION 1)...............	4.11%
40372	(DEMAND REGION 2)...............	4.41%
40419	(DEMAND REGION 3)...............	1.40%
40422	(DEMAND REGION 4)...............	10.16%
40437	(DEMAND REGION 5)...............	1.98%
40444	(DEMAND REGION 6)...............	6.47%
40484	(DEMAND REGION 7)...............	0.31%
40489	(DEMAND REGION 8)...............	0.57%
42539	(DEMAND REGION 9)...............	100.00%
EAST	(DEMAND REGION 10)..............	0.00%
NORTH	(DEMAND REGION 11)..............	0.87%
SOUTH	(DEMAND REGION 12)..............	16.26%
WEST	(DEMAND REGION 13)..............	6.53%

MILEAGE FIGURES TO DEMAND REGIONS FOR BOYLE

40330	(DEMAND REGION 1)...............	12
40372	(DEMAND REGION 2)...............	18.5
40419	(DEMAND REGION 3)...............	20
40422	(DEMAND REGION 4)...............	5.5
40437	(DEMAND REGION 5)...............	12
40444	(DEMAND REGION 6)...............	11
40484	(DEMAND REGION 7)...............	10
40489	(DEMAND REGION 8)...............	20.5
42539	(DEMAND REGION 9)...............	26
EAST	(DEMAND REGION 10)..............	21.5
NORTH	(DEMAND REGION 11)..............	25
SOUTH	(DEMAND REGION 12)..............	26
WEST	(DEMAND REGION 13)..............	11.5

MILEAGE FIGURES TO DEMAND REGIONS FOR HARRODSBURG

40330	(DEMAND REGION 1)...............	9
40372	(DEMAND REGION 2)...............	10
40419	(DEMAND REGION 3)...............	29
40422	(DEMAND REGION 4)...............	9
40437	(DEMAND REGION 5)...............	19.5
40444	(DEMAND REGION 6)...............	16.5
40484	(DEMAND REGION 7)...............	18.5
40489	(DEMAND REGION 8)...............	30
42539	(DEMAND REGION 9)...............	32
EAST	(DEMAND REGION 10)..............	28
NORTH	(DEMAND REGION 11)..............	20
SOUTH	(DEMAND REGION 12)..............	33
WEST	(DEMAND REGION 13)..............	13

MILEAGE FIGURES TO DEMAND REGIONS FOR LANCASTER

40330	(DEMAND REGION 1)...............	21
40372	(DEMAND REGION 2)...............	24.5
40419	(DEMAND REGION 3)...............	13.5
40422	(DEMAND REGION 4)...............	10.5
40437	(DEMAND REGION 5)...............	18.5
40444	(DEMAND REGION 6)...............	8
40484	(DEMAND REGION 7)...............	7
40489	(DEMAND REGION 8)...............	18
42539	(DEMAND REGION 9)...............	30.5
EAST	(DEMAND REGION 10)..............	12
NORTH	(DEMAND REGION 11)..............	27
SOUTH	(DEMAND REGION 12)..............	26.5
WEST	(DEMAND REGION 13)..............	21

MILEAGE FIGURES TO DEMAND REGIONS FOR LIBERTY

40330	(DEMAND REGION 1)...............	31.5
40372	(DEMAND REGION 2)...............	40
40419	(DEMAND REGION 3)...............	24
40422	(DEMAND REGION 4)...............	24
40437	(DEMAND REGION 5)...............	11
40444	(DEMAND REGION 6)...............	31
40484	(DEMAND REGION 7)...............	21
40489	(DEMAND REGION 8)...............	16.5
42539	(DEMAND REGION 9)...............	10
EAST	(DEMAND REGION 10)..............	32
NORTH	(DEMAND REGION 11)..............	48.5
SOUTH	(DEMAND REGION 12)..............	11
WEST	(DEMAND REGION 13)..............	19

MILEAGE FIGURES TO DEMAND REGIONS FOR STANFORD

40330	(DEMAND REGION 1)...............	22
40372	(DEMAND REGION 2)...............	28
40419	(DEMAND REGION 3)...............	10
40422	(DEMAND REGION 4)...............	10
40437	(DEMAND REGION 5)...............	22.5
40444	(DEMAND REGION 6)...............	11
40484	(DEMAND REGION 7)...............	5
40489	(DEMAND REGION 8)...............	11.5
42539	(DEMAND REGION 9)...............	23.5
EAST	(DEMAND REGION 10)..............	14
NORTH	(DEMAND REGION 11)..............	32
SOUTH	(DEMAND REGION 12)..............	21.5
WEST	(DEMAND REGION 13)..............	18

GENERAL PRICE MARGINS

AG CHEM	(PRODUCT 1)......................	13.44%
FARM SUPPLIES	(PRODUCT 2)......................	22.59%
FEED	(PRODUCT 3)......................	10.54%
FERTILIZER	(PRODUCT 4)......................	19.99%
PETROLEUM	(PRODUCT 5)......................	26.62%

PICKUP COSTS

AG CHEM	(PRODUCT 1)....................$	0.0085561
FARM SUPPLIES	(PRODUCT 2)....................$	0.0057873
FEED	(PRODUCT 3)....................$	0.0059012
FERTILIZER	(PRODUCT 4)....................$	0.0060469
PETROLEUM	(PRODUCT 5)....................$	0.0208696

OVERHEAD COSTS

BOYLE	(SUPPLY SITE 1)..................	$162,568
HARRODSBURG	(SUPPLY SITE 2)..................	$105,549
LANCASTER	(SUPPLY SITE 3)..................	$73,127
LIBERTY	(SUPPLY SITE 4)..................	$77,933
STANFORD	(SUPPLY SITE 5)..................	$82,995

SUMMARY PAGE FOR SALES VOLUMES

PRODUCT	BOYLE	HARRODSBURG	LANCASTER
AG CHEM	$161,959	$90,221	$82,144
FARM SUPPLIES	$474,394	$498,648	$314,117
FEED	$208,329	$966,586	$495,412
FERTILIZER	$361,744	$236,962	$504,653
PETROLEUM	$930,142	$0	$0
TOTAL	$2,136,568	$1,792,417	$1,396,326

PRODUCT	LIBERTY	STANFORD	TOTAL
AG CHEM	$85,355	$90,803	$510,482
FARM SUPPLIES	$331,654	$310,793	$1,929,606
FEED	$366,304	$473,300	$2,509,931
FERTILIZER	$432,664	$443,307	$1,979,330
PETROLEUM	$0	$0	$930,142
TOTAL	$1,215,977	$1,318,203	$7,859,491

SUMMARY PAGE FOR NET INCOME

PRODUCT	BOYLE	HARRODSBURG	LANCASTER
AG CHEM	-$5,783	-$1,630	$16
FARM SUPPLIES	$11,479	$19,041	$19,863
FEED	-$11,394	-$54,418	-$9,802
FERTILIZER	$2,087	$704	$22,689
PETROLEUM	$56,908	$0	$0
TOTAL	$53,296	-$36,303	$32,766

PRODUCT	LIBERTY	STANFORD	TOTAL
AG CHEM	-$1,914	-$1,452	-$10,764
FARM SUPPLIES	$11,726	$12,784	$74,893
FEED	-$14,923	-$16,138	-$106,675
FERTILIZER	$6,189	$8,502	$40,170
PETROLEUM	$0	$0	$56,908
TOTAL	$1,078	$3,695	$54,532

SUMMARY PAGE FOR PRODUCTION/STORAGE UTILIZATION

PRODUCT	BOYLE	HARRODSBURG	LANCASTER
AG CHEM	71.98%	37.59%	36.51%
FARM SUPPLIES	41.07%	41.55%	72.21%
FEED	23.26%	66.89%	58.44%
FERTILIZER	15.53%	11.59%	33.30%
PETROLEUM	45.19%	0.00%	0.00%
TOTAL	32.06%	36.36%	46.19%

PRODUCT	LIBERTY	STANFORD	TOTAL
AG CHEM	40.65%	60.54%	48.62%
FARM SUPPLIES	81.29%	46.04%	49.82%
FEED	47.34%	26.87%	43.85%
FERTILIZER	37.35%	23.03%	22.06%
PETROLEUM	0.00%	0.00%	45.19%
TOTAL	47.68%	29.22%	36.26%

SUMMARY PAGE FOR DELIVERY UTILIZATION

PRODUCT	BOYLE	HARRODSBURG	LANCASTER
AG CHEM	0.00%	0.00%	0.00%
FARM SUPPLIES	0.00%	0.00%	0.00%
FEED	13.60%	71.39%	52.33%
FERTILIZER	6.44%	3.93%	10.35%
PETROLEUM	32.96%	0.00%	0.00%
TOTAL	15.39%	16.22%	15.41%

PRODUCT	LIBERTY	STANFORD	TOTAL
AG CHEM	0.00%	0.00%	0.00%
FARM SUPPLIES	0.00%	0.00%	0.00%
FEED	55.93%	32.38%	49.37%
FERTILIZER	7.27%	9.45%	7.28%
PETROLEUM	0.00%	0.00%	32.96%
TOTAL	11.44%	14.21%	14.64%

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR ALL PRODUCTS

DEMAND			SUPPLY SITE			
REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	97,782	1,282,818	0	0	0	1,380,600
40372	27,031	321,100	0	0	0	348,131
40419	90,823	0	0	0	248,662	339,485
40422	1,280,320	0	0	0	0	1,280,320
40437	17,605	0	0	162,980	0	180,585
40444	50,392	0	1,224,807	0	0	1,275,199
40484	136,808	0	0	0	745,738	882,546
40489	57,358	0	0	0	323,803	381,161
42539	1,966	0	0	806,431	0	808,397
EAST	5,478	0	171,519	0	0	176,997
NORTH	40,175	188,499	0	0	0	228,674
SOUTH	3,905	0	0	246,566	0	250,471
WEST	326,925	0	0	0	0	326,925
TOTAL	2,136,568	1,792,417	1,396,326	1,215,977	1,318,203	7,859,491

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR AG CHEM

DEMAND			SUPPLY SITE			
REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	59,314	0	0	0	59,314
40372	0	14,212	0	0	0	14,212
40419	0	0	0	0	21,784	21,784
40422	130,528	0	0	0	0	130,528
40437	0	0	0	18,103	0	18,103
40444	0	0	74,713	0	0	74,713
40484	0	0	0	0	57,885	57,885
40489	0	0	0	0	11,134	11,134
42539	0	0	0	47,678	0	47,678
EAST	0	0	7,431	0	0	7,431
NORTH	0	16,695	0	0	0	16,695
SOUTH	0	0	0	19,574	0	19,574
WEST	31,431	0	0	0	0	31,431
TOTAL	161,959	90,221	82,144	85,355	90,803	510,482

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR FARM SUPPLIES

DEMAND REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	398,231	0	0	0	398,231
40372	0	61,630	0	0	0	61,630
40419	0	0	0	0	38,812	38,812
40422	391,845	0	0	0	0	391,845
40437	0	0	0	51,314	0	51,314
40444	0	0	267,673	0	0	267,673
40484	0	0	0	0	228,573	228,573
40489	0	0	0	0	43,408	43,408
42539	0	0	0	223,412	0	223,412
EAST	0	0	46,444	0	0	46,444
NORTH	0	38,787	0	0	0	38,787
SOUTH	0	0	0	56,928	0	56,928
WEST	82,549	0	0	0	0	82,549
TOTAL	474,394	498,648	314,117	331,654	310,793	1,929,606

(SUPPLY SITE: BOYLE through STANFORD)

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR FEED

DEMAND REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	636,243	0	0	0	636,243
40372	0	211,911	0	0	0	211,911
40419	0	0	0	0	110,097	110,097
40422	164,208	0	0	0	0	164,208
40437	0	0	0	38,706	0	38,706
40444	0	0	455,145	0	0	455,145
40484	0	0	0	0	277,524	277,524
40489	0	0	0	0	85,679	85,679
42539	0	0	0	246,277	0	246,277
EAST	0	0	40,267	0	0	40,267
NORTH	0	118,432	0	0	0	118,432
SOUTH	0	0	0	81,321	0	81,321
WEST	44,121	0	0	0	0	44,121
TOTAL	208,329	966,586	495,412	366,304	473,300	2,509,931

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR FERTILIZER

DEMAND REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	189,030	0	0	0	189,030
40372	0	33,347	0	0	0	33,347
40419	0	0	0	0	77,969	77,969
40422	311,673	0	0	0	0	311,673
40437	0	0	0	54,857	0	54,857
40444	0	0	427,276	0	0	427,276
40484	0	0	0	0	181,756	181,756
40489	0	0	0	0	183,582	183,582
42539	0	0	0	289,064	0	289,064
EAST	0	0	77,377	0	0	77,377
NORTH	0	14,585	0	0	0	14,585
SOUTH	0	0	0	88,743	0	88,743
WEST	50,071	0	0	0	0	50,071
TOTAL	361,744	236,962	504,653	432,664	443,307	1,979,330

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR PETROLEUM

DEMAND REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
	SUPPLY SITE					
40330	97,782	0	0	0	0	97,782
40372	27,031	0	0	0	0	27,031
40419	90,823	0	0	0	0	90,823
40422	282,066	0	0	0	0	282,066
40437	17,605	0	0	0	0	17,605
40444	50,392	0	0	0	0	50,392
40484	136,808	0	0	0	0	136,808
40489	57,358	0	0	0	0	57,358
42539	1,966	0	0	0	0	1,966
EAST	5,478	0	0	0	0	5,478
NORTH	40,175	0	0	0	0	40,175
SOUTH	3,905	0	0	0	0	3,905
WEST	118,753	0	0	0	0	118,753
TOTAL	930,142	0	0	0	0	930,142

DELIVERY DISTRIBUTION IN DOLLARS FOR ALL PRODUCTS

DEMAND REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
	SUPPLY SITE					
40330	93,763	649,539	0	0	0	743,302
40372	25,839	201,620	0	0	0	227,459
40419	89,551	0	0	0	151,187	240,739
40422	571,487	0	0	0	0	571,487
40437	17,256	0	0	70,419	0	87,675
40444	47,132	0	570,411	0	0	617,543
40484	136,384	0	0	0	366,123	502,507
40489	57,031	0	0	0	242,943	299,975
42539	0	0	0	382,776	0	382,776
EAST	5,478	0	88,171	0	0	93,649
NORTH	39,825	110,245	0	0	0	150,070
SOUTH	3,270	0	0	130,641	0	133,911
WEST	162,091	0	0	0	0	162,091
TOTAL	1,249,108	961,404	658,583	583,836	760,254	4,213,184

DELIVERY DISTRIBUTION IN DOLLARS FOR AG CHEM

DEMAND REGION	BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
	SUPPLY SITE					
40330	0	0	0	0	0	0
40372	0	0	0	0	0	0
40419	0	0	0	0	0	0
40422	0	0	0	0	0	0
40437	0	0	0	0	0	0
40444	0	0	0	0	0	0
40484	0	0	0	0	0	0
40489	0	0	0	0	0	0
42539	0	0	0	0	0	0
EAST	0	0	0	0	0	0
NORTH	0	0	0	0	0	0
SOUTH	0	0	0	0	0	0
WEST	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0

DELIVERY DISTRIBUTION IN DOLLARS FOR FARM SUPPLIES

DEMAND REGION	BOYLE	HARRODSBUR	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	0	0	0	0	0
40372	0	0	0	0	0	0
40419	0	0	0	0	0	0
40422	0	0	0	0	0	0
40437	0	0	0	0	0	0
40444	0	0	0	0	0	0
40484	0	0	0	0	0	0
40489	0	0	0	0	0	0
42539	0	0	0	0	0	0
EAST	0	0	0	0	0	0
NORTH	0	0	0	0	0	0
SOUTH	0	0	0	0	0	0
WEST	0	0	0	0	0	0
TOTAL	0	0	0	0	0	0

DELIVERY DISTRIBUTION IN DOLLARS FOR FEED

DEMAND REGION	BOYLE	HARRODSBUR	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	505,177	0	0	0	505,177
40372	0	169,677	0	0	0	169,677
40419	0	0	0	0	85,677	85,677
40422	23,859	0	0	0	0	23,859
40437	0	0	0	28,991	0	28,991
40444	0	0	253,971	0	0	253,971
40484	0	0	0	0	207,505	207,505
40489	0	0	0	0	66,136	66,136
42539	0	0	0	159,908	0	159,908
EAST	0	0	15,599	0	0	15,599
NORTH	0	96,214	0	0	0	96,214
SOUTH	0	0	0	55,981	0	55,981
WEST	11,621	0	0	0	0	11,621
TOTAL	35,481	771,068	269,570	244,880	359,318	1,680,317

DELIVERY DISTRIBUTION IN DOLLARS FOR FERTILIZER

DEMAND REGION	BOYLE	HARRODSBUR	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	144,362	0	0	0	144,362
40372	0	31,943	0	0	0	31,943
40419	0	0	0	0	65,510	65,510
40422	294,219	0	0	0	0	294,219
40437	0	0	0	41,428	0	41,428
40444	0	0	316,441	0	0	316,441
40484	0	0	0	0	158,618	158,618
40489	0	0	0	0	176,808	176,808
42539	0	0	0	222,868	0	222,868
EAST	0	0	72,572	0	0	72,572
NORTH	0	14,031	0	0	0	14,031
SOUTH	0	0	0	74,659	0	74,659
WEST	39,471	0	0	0	0	39,471
TOTAL	333,690	190,336	389,012	338,956	400,936	1,652,931

DELIVERY DISTRIBUTION IN DOLLARS FOR PETROLEUM

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	93,763	0	0	0	0	93,763
40372	25,839	0	0	0	0	25,839
40419	89,551	0	0	0	0	89,551
40422	253,408	0	0	0	0	253,408
40437	17,256	0	0	0	0	17,256
40444	47,132	0	0	0	0	47,132
40484	136,384	0	0	0	0	136,384
40489	57,031	0	0	0	0	57,031
42539	0	0	0	0	0	0
EAST	5,478	0	0	0	0	5,478
NORTH	39,825	0	0	0	0	39,825
SOUTH	3,270	0	0	0	0	3,270
WEST	110,998	0	0	0	0	110,998
TOTAL	879,937	0	0	0	0	879,937

PICKUP DISTRIBUTION IN DOLLARS FOR ALL PRODUCTS

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	4,019	633,279	0	0	0	637,298
40372	1,192	119,480	0	0	0	120,672
40419	1,272	0	0	0	97,475	98,746
40422	708,833	0	0	0	0	708,833
40437	349	0	0	92,561	0	92,910
40444	3,260	0	654,395	0	0	657,656
40484	424	0	0	0	379,615	380,039
40489	327	0	0	0	80,860	81,186
42539	1,966	0	0	423,655	0	425,621
EAST	0	0	83,348	0	0	83,348
NORTH	350	78,254	0	0	0	78,604
SOUTH	635	0	0	115,925	0	116,560
WEST	164,834	0	0	0	0	164,834
TOTAL	887,460	831,013	859,167	746,124	557,949	3,881,713

PICKUP DISTRIBUTION IN DOLLARS FOR AG CHEM

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	59,314	0	0	0	59,314
40372	0	14,212	0	0	0	14,212
40419	0	0	0	0	21,784	21,784
40422	130,528	0	0	0	0	130,528
40437	0	0	0	18,103	0	18,103
40444	0	0	74,713	0	0	74,713
40484	0	0	0	0	57,885	57,885
40489	0	0	0	0	11,134	11,134
42539	0	0	0	47,678	0	47,678
EAST	0	0	7,431	0	0	7,431
NORTH	0	16,695	0	0	0	16,695
SOUTH	0	0	0	19,574	0	19,574
WEST	31,431	0	0	0	0	31,431
TOTAL	161,959	90,221	82,144	85,355	90,803	510,482

PICKUP DISTRIBUTION IN DOLLARS FOR FARM SUPPLIES

DEMAND REGION	BOYLE	HARRODSBUR	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	398,231	0	0	0	398,231
40372	0	61,630	0	0	0	61,630
40419	0	0	0	0	38,812	38,812
40422	391,845	0	0	0	0	391,845
40437	0	0	0	51,314	0	51,314
40444	0	0	267,673	0	0	267,673
40484	0	0	0	0	228,573	228,573
40489	0	0	0	0	43,408	43,408
42539	0	0	0	223,412	0	223,412
EAST	0	0	46,444	0	0	46,444
NORTH	0	38,787	0	0	0	38,787
SOUTH	0	0	0	56,928	0	56,928
WEST	82,549	0	0	0	0	82,549
TOTAL	474,394	498,648	314,117	331,654	310,793	1,929,606

PICKUP DISTRIBUTION IN DOLLARS FOR FEED

DEMAND REGION	BOYLE	HARRODSBUR	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	131,066	0	0	0	131,066
40372	0	42,234	0	0	0	42,234
40419	0	0	0	0	24,420	24,420
40422	140,349	0	0	0	0	140,349
40437	0	0	0	9,715	0	9,715
40444	0	0	201,174	0	0	201,174
40484	0	0	0	0	70,019	70,019
40489	0	0	0	0	19,543	19,543
42539	0	0	0	86,369	0	86,369
EAST	0	0	24,668	0	0	24,668
NORTH	0	22,218	0	0	0	22,218
SOUTH	0	0	0	25,340	0	25,340
WEST	32,500	0	0	0	0	32,500
TOTAL	172,848	195,518	347,266	235,406	113,982	1,065,020

PICKUP DISTRIBUTION IN DOLLARS FOR FERTILIZER

DEMAND REGION	BOYLE	HARRODSBUR	SUPPLY SITE LANCASTER	LIBERTY	STANFORD	TOTAL
40330	0	44,668	0	0	0	44,668
40372	0	1,404	0	0	0	1,404
40419	0	0	0	0	12,459	12,459
40422	17,454	0	0	0	0	17,454
40437	0	0	0	13,429	0	13,429
40444	0	0	110,835	0	0	110,835
40484	0	0	0	0	23,138	23,138
40489	0	0	0	0	6,774	6,774
42539	0	0	0	66,196	0	66,196
EAST	0	0	4,805	0	0	4,805
NORTH	0	554	0	0	0	554
SOUTH	0	0	0	14,084	0	14,084
WEST	10,600	0	0	0	0	10,600
TOTAL	28,054	46,626	115,641	93,708	42,371	326,399

PICKUP DISTRIBUTION IN DOLLARS FOR PETROLEUM

DEMAND REGION	SUPPLY SITE BOYLE	HARRODSBUR	LANCASTER	LIBERTY	STANFORD	TOTAL
40330	4,019	0	0	0	0	4,019
40372	1,192	0	0	0	0	1,192
40419	1,272	0	0	0	0	1,272
40422	28,658	0	0	0	0	28,658
40437	349	0	0	0	0	349
40444	3,260	0	0	0	0	3,260
40484	424	0	0	0	0	424
40489	327	0	0	0	0	327
42539	1,966	0	0	0	0	1,966
EAST	0	0	0	0	0	0
NORTH	350	0	0	0	0	350
SOUTH	635	0	0	0	0	635
WEST	7,755	0	0	0	0	7,755
TOTAL	50,205	0	0	0	0	50,205

INCOME STATEMENT - ENTIRE TRADE AREA FOR ALL PRODUCTS

SALES..	$7,859,491
DELIVERY REVENUES..............................	$36,076
COST OF GOODS SOLD.............................	$6,447,166
GROSS MARGIN...................................	$1,448,402
VARIABLE COSTS.................................	$854,852
FIXED COSTS....................................	$0
OVERHEAD COSTS.................................	$502,172
DELIVERY COSTS.................................	$36,846
TOTAL EXPENSES.................................	$1,393,869
NET INCOME.....................................	$54,532

INCOME STATEMENT - ENTIRE TRADE AREA FOR AG CHEM

SALES..	$510,482
DELIVERY REVENUES..............................	$0
COST OF GOODS SOLD.............................	$441,873
GROSS MARGIN...................................	$68,609
VARIABLE COSTS.................................	$54,939
FIXED COSTS....................................	$0
OVERHEAD COSTS.................................	$24,433
DELIVERY COSTS.................................	$0
TOTAL EXPENSES.................................	$79,373
NET INCOME.....................................	-$10,764

INCOME STATEMENT - ENTIRE TRADE AREA FOR FARM SUPPLIES

SALES..	$1,929,606
DELIVERY REVENUES..............................	$0
COST OF GOODS SOLD.............................	$1,493,708
GROSS MARGIN...................................	$435,898
VARIABLE COSTS.................................	$204,555
FIXED COSTS....................................	$0
OVERHEAD COSTS.................................	$156,450
DELIVERY COSTS.................................	$0
TOTAL EXPENSES.................................	$361,005
NET INCOME.....................................	$74,893

INCOME STATEMENT - ENTIRE TRADE AREA FOR FEED

SALES	$2,509,931
DELIVERY REVENUES	$24,010
COST OF GOODS SOLD	$2,245,384
GROSS MARGIN	$288,557
VARIABLE COSTS	$275,187
FIXED COSTS	$0
OVERHEAD COSTS	$96,035
DELIVERY COSTS	$24,010
TOTAL EXPENSES	$395,233
NET INCOME	-$106,675

INCOME STATEMENT - ENTIRE TRADE AREA FOR FERTILIZER

SALES	$1,979,330
DELIVERY REVENUES	$10,932
COST OF GOODS SOLD	$1,583,662
GROSS MARGIN	$406,600
VARIABLE COSTS	$214,970
FIXED COSTS	$0
OVERHEAD COSTS	$139,758
DELIVERY COSTS	$11,701
TOTAL EXPENSES	$366,429
NET INCOME	$40,170

INCOME STATEMENT - ENTIRE TRADE AREA FOR PETROLEUM

SALES	$930,142
DELIVERY REVENUES	$1,134
COST OF GOODS SOLD	$682,538
GROSS MARGIN	$248,738
VARIABLE COSTS	$105,199
FIXED COSTS	$0
OVERHEAD COSTS	$85,497
DELIVERY COSTS	$1,134
TOTAL EXPENSES	$191,830
NET INCOME	$56,908

INCOME STATEMENT - SITE: BOYLE FOR ALL PRODUCTS

SALES	$2,136,568
DELIVERY REVENUES	$3,113
COST OF GOODS SOLD	$1,665,761
GROSS MARGIN	$473,920
VARIABLE COSTS	$254,832
FIXED COSTS	$0
OVERHEAD COSTS	$162,568
DELIVERY COSTS	$3,224
TOTAL EXPENSES	$420,624
NET INCOME	$53,296

INCOME STATEMENT - SITE: BOYLE PRODUCT: AG CHEM

SALES	$161,959
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$140,192
GROSS MARGIN	$21,767
VARIABLE COSTS	$20,034
FIXED COSTS	$0
OVERHEAD COSTS	$7,516
DELIVERY COSTS	$0
TOTAL EXPENSES	$27,550
NET INCOME	-$5,783

INCOME STATEMENT - SITE: BOYLE PRODUCT: FARM SUPPLIES

SALES	$474,394
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$367,228
GROSS MARGIN	$107,166
VARIABLE COSTS	$58,683
FIXED COSTS	$0
OVERHEAD COSTS	$37,004
DELIVERY COSTS	$0
TOTAL EXPENSES	$95,686
NET INCOME	$11,479

INCOME STATEMENT - SITE: BOYLE PRODUCT: FEED

SALES	$208,329
DELIVERY REVENUES	$401
COST OF GOODS SOLD	$186,371
GROSS MARGIN	$22,359
VARIABLE COSTS	$25,770
FIXED COSTS	$0
OVERHEAD COSTS	$7,582
DELIVERY COSTS	$401
TOTAL EXPENSES	$33,754
NET INCOME	-$11,394

INCOME STATEMENT - SITE: BOYLE PRODUCT: FERTILIZER

SALES	$361,744
DELIVERY REVENUES	$1,577
COST OF GOODS SOLD	$289,431
GROSS MARGIN	$73,890
VARIABLE COSTS	$45,146
FIXED COSTS	$0
OVERHEAD COSTS	$24,969
DELIVERY COSTS	$1,688
TOTAL EXPENSES	$71,803
NET INCOME	$2,087

INCOME STATEMENT - SITE: BOYLE PRODUCT: PETROLEUM

SALES	$930,142
DELIVERY REVENUES	$1,134
COST OF GOODS SOLD	$682,538
GROSS MARGIN	$248,738
VARIABLE COSTS	$105,199
FIXED COSTS	$0
OVERHEAD COSTS	$85,497
DELIVERY COSTS	$1,134
TOTAL EXPENSES	$191,830
NET INCOME	$56,908

INCOME STATEMENT - SITE: HARRODSBURG FOR ALL PRODUCTS

SALES	$1,792,417
DELIVERY REVENUES	$13,826
COST OF GOODS SOLD	$1,518,400
GROSS MARGIN	$287,843
VARIABLE COSTS	$204,670
FIXED COSTS	$0
OVERHEAD COSTS	$105,549
DELIVERY COSTS	$13,928
TOTAL EXPENSES	$324,147
NET INCOME	-$36,303

INCOME STATEMENT - SITE: HARRODSBURG PRODUCT: AG CHEM

SALES	$90,221
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$78,095
GROSS MARGIN	$12,126
VARIABLE COSTS	$9,085
FIXED COSTS	$0
OVERHEAD COSTS	$4,671
DELIVERY COSTS	$0
TOTAL EXPENSES	$13,756
NET INCOME	-$1,630

INCOME STATEMENT - SITE: HARRODSBURG PRODUCT: FARM SUPPLIES

SALES	$498,648
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$386,003
GROSS MARGIN	$112,645
VARIABLE COSTS	$50,214
FIXED COSTS	$0
OVERHEAD COSTS	$43,390
DELIVERY COSTS	$0
TOTAL EXPENSES	$93,604
NET INCOME	$19,041

INCOME STATEMENT - SITE: HARRODSBURG PRODUCT: FEED

SALES	$966,586
DELIVERY REVENUES	$12,381
COST OF GOODS SOLD	$864,708
GROSS MARGIN	$114,259
VARIABLE COSTS	$117,054
FIXED COSTS	$0
OVERHEAD COSTS	$39,243
DELIVERY COSTS	$12,381
TOTAL EXPENSES	$168,677
NET INCOME	-$54,418

INCOME STATEMENT - SITE: HARRODSBURG PRODUCT: FERTILIZER

SALES	$236,962
DELIVERY REVENUES	$1,446
COST OF GOODS SOLD	$189,593
GROSS MARGIN	$48,814
VARIABLE COSTS	$28,317
FIXED COSTS	$0
OVERHEAD COSTS	$18,246
DELIVERY COSTS	$1,548
TOTAL EXPENSES	$48,111
NET INCOME	$704

INCOME STATEMENT - SITE: HARRODSBURG PRODUCT: PETROLEUM

SALES	$0
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$0
GROSS MARGIN	$0
VARIABLE COSTS	$0
FIXED COSTS	$0
OVERHEAD COSTS	$0
DELIVERY COSTS	$0
TOTAL EXPENSES	$0
NET INCOME	$0

INCOME STATEMENT - SITE: LANCASTER FOR ALL PRODUCTS

SALES	$1,396,326
DELIVERY REVENUES	$5,953
COST OF GOODS SOLD	$1,161,230
GROSS MARGIN	$241,049
VARIABLE COSTS	$129,021
FIXED COSTS	$0
OVERHEAD COSTS	$73,127
DELIVERY COSTS	$6,136
TOTAL EXPENSES	$208,283
NET INCOME	$32,766

INCOME STATEMENT - SITE: LANCASTER PRODUCT: AG CHEM

SALES	$82,144
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$71,104
GROSS MARGIN	$11,040
VARIABLE COSTS	$7,590
FIXED COSTS	$0
OVERHEAD COSTS	$3,434
DELIVERY COSTS	$0
TOTAL EXPENSES	$11,024
NET INCOME	$16

INCOME STATEMENT - SITE: LANCASTER PRODUCT: FARM SUPPLIES

SALES	$314,117
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$243,158
GROSS MARGIN	$70,959
VARIABLE COSTS	$29,024
FIXED COSTS	$0
OVERHEAD COSTS	$22,072
DELIVERY COSTS	$0
TOTAL EXPENSES	$51,096
NET INCOME	$19,863

INCOME STATEMENT - SITE: LANCASTER PRODUCT: FEED

SALES	$495,412
DELIVERY REVENUES	$3,364
COST OF GOODS SOLD	$443,196
GROSS MARGIN	$55,580
VARIABLE COSTS	$45,776
FIXED COSTS	$0
OVERHEAD COSTS	$16,242
DELIVERY COSTS	$3,364
TOTAL EXPENSES	$65,382
NET INCOME	-$9,802

INCOME STATEMENT - SITE: LANCASTER PRODUCT: FERTILIZER

SALES	$504,653
DELIVERY REVENUES	$2,590
COST OF GOODS SOLD	$403,773
GROSS MARGIN	$103,470
VARIABLE COSTS	$46,630
FIXED COSTS	$0
OVERHEAD COSTS	$31,379
DELIVERY COSTS	$2,772
TOTAL EXPENSES	$80,781
NET INCOME	$22,689

INCOME STATEMENT - SITE: LANCASTER PRODUCT: PETROLEUM

SALES	$0
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$0
GROSS MARGIN	$0
VARIABLE COSTS	$0
FIXED COSTS	$0
OVERHEAD COSTS	$0
DELIVERY COSTS	$0
TOTAL EXPENSES	$0
NET INCOME	$0

INCOME STATEMENT - SITE: LIBERTY FOR ALL PRODUCTS

SALES	$1,215,977
DELIVERY REVENUES	$6,509
COST OF GOODS SOLD	$1,004,487
GROSS MARGIN	$218,000
VARIABLE COSTS	$132,292
FIXED COSTS	$0
OVERHEAD COSTS	$77,933
DELIVERY COSTS	$6,697
TOTAL EXPENSES	$216,922
NET INCOME	$1,078

INCOME STATEMENT - SITE: LIBERTY PRODUCT: AG CHEM

SALES	$85,355
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$73,883
GROSS MARGIN	$11,472
VARIABLE COSTS	$9,159
FIXED COSTS	$0
OVERHEAD COSTS	$4,227
DELIVERY COSTS	$0
TOTAL EXPENSES	$13,386
NET INCOME	-$1,914

INCOME STATEMENT - SITE: LIBERTY PRODUCT: FARM SUPPLIES

SALES	$331,654
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$256,733
GROSS MARGIN	$74,921
VARIABLE COSTS	$35,586
FIXED COSTS	$0
OVERHEAD COSTS	$27,608
DELIVERY COSTS	$0
TOTAL EXPENSES	$63,194
NET INCOME	$11,726

INCOME STATEMENT - SITE: LIBERTY PRODUCT: FEED

SALES	$366,304
DELIVERY REVENUES	$3,841
COST OF GOODS SOLD	$327,696
GROSS MARGIN	$42,449
VARIABLE COSTS	$39,304
FIXED COSTS	$0
OVERHEAD COSTS	$14,227
DELIVERY COSTS	$3,841
TOTAL EXPENSES	$57,372
NET INCOME	-$14,923

INCOME STATEMENT - SITE: LIBERTY PRODUCT: FERTILIZER

SALES	$432,664
DELIVERY REVENUES	$2,668
COST OF GOODS SOLD	$346,174
GROSS MARGIN	$89,158
VARIABLE COSTS	$48,242
FIXED COSTS	$0
OVERHEAD COSTS	$31,871
DELIVERY COSTS	$2,856
TOTAL EXPENSES	$82,969
NET INCOME	$6,189

INCOME STATEMENT - SITE: LIBERTY PRODUCT: PETROLEUM

SALES	$0
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$0
GROSS MARGIN	$0
VARIABLE COSTS	$0
FIXED COSTS	$0
OVERHEAD COSTS	$0
DELIVERY COSTS	$0
TOTAL EXPENSES	$0
NET INCOME	$0

INCOME STATEMENT - SITE: STANFORD FOR ALL PRODUCTS

SALES	$1,318,203
DELIVERY REVENUES	$6,674
COST OF GOODS SOLD	$1,097,288
GROSS MARGIN	$227,589
VARIABLE COSTS	$134,038
FIXED COSTS	$0
OVERHEAD COSTS	$82,995
DELIVERY COSTS	$6,861
TOTAL EXPENSES	$223,894
NET INCOME	$3,695

INCOME STATEMENT - SITE: STANFORD PRODUCT: AG CHEM

SALES	$90,803
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$78,599
GROSS MARGIN	$12,204
VARIABLE COSTS	$9,071
FIXED COSTS	$0
OVERHEAD COSTS	$4,585
DELIVERY COSTS	$0
TOTAL EXPENSES	$13,656
NET INCOME	-$1,452

INCOME STATEMENT - SITE: STANFORD PRODUCT: FARM SUPPLIES

SALES	$310,793
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$240,585
GROSS MARGIN	$70,208
VARIABLE COSTS	$31,048
FIXED COSTS	$0
OVERHEAD COSTS	$26,376
DELIVERY COSTS	$0
TOTAL EXPENSES	$57,425
NET INCOME	$12,784

INCOME STATEMENT - SITE: STANFORD PRODUCT: FEED

SALES	$473,300
DELIVERY REVENUES	$4,024
COST OF GOODS SOLD	$423,414
GROSS MARGIN	$53,910
VARIABLE COSTS	$47,283
FIXED COSTS	$0
OVERHEAD COSTS	$18,741
DELIVERY COSTS	$4,024
TOTAL EXPENSES	$70,048
NET INCOME	-$16,138

INCOME STATEMENT - SITE: STANFORD PRODUCT: FERTILIZER

SALES	$443,307
DELIVERY REVENUES	$2,650
COST OF GOODS SOLD	$354,690
GROSS MARGIN	$91,267
VARIABLE COSTS	$46,636
FIXED COSTS	$0
OVERHEAD COSTS	$33,292
DELIVERY COSTS	$2,837
TOTAL EXPENSES	$82,765
NET INCOME	$8,502

INCOME STATEMENT - SITE: STANFORD PRODUCT: PETROLEUM

SALES	$0
DELIVERY REVENUES	$0
COST OF GOODS SOLD	$0
GROSS MARGIN	$0
VARIABLE COSTS	$0
FIXED COSTS	$0
OVERHEAD COSTS	$0
DELIVERY COSTS	$0
TOTAL EXPENSES	$0
NET INCOME	$0

UTILIZATION STATEMENT - ENTIRE TRADE AREA FOR ALL PRODUCTS

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$21,677,800
CAPACITY USED	$7,859,491
CAPACITY UNUSED	$13,818,309
PERCENT OF CAPACITY USED	36.26%

DELIVERY

CAPACITY AVAILABLE	$28,770,656
CAPACITY USED	$4,213,184
CAPACITY UNUSED	$24,557,472
PERCENT OF CAPACITY USED	14.64%

UTILIZATION STATEMENT - ENTIRE TRADE AREA FOR AG CHEM

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$1,050,000
CAPACITY USED	$510,482
CAPACITY UNUSED	$539,518
PERCENT OF CAPACITY USED	48.62%

DELIVERY

CAPACITY AVAILABLE	$0
CAPACITY USED	$0
CAPACITY UNUSED	$0
PERCENT OF CAPACITY USED	0.00%

UTILIZATION STATEMENT - ENTIRE TRADE AREA FOR FARM SUPPLIES

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$3,873,000
CAPACITY USED	$1,929,606
CAPACITY UNUSED	$1,943,394
PERCENT OF CAPACITY USED	49.82%

DELIVERY

CAPACITY AVAILABLE	$0
CAPACITY USED	$0
CAPACITY UNUSED	$0
PERCENT OF CAPACITY USED	0.00%

UTILIZATION STATEMENT - ENTIRE TRADE AREA FOR FEED

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$5,723,780
CAPACITY USED	$2,509,931
CAPACITY UNUSED	$3,213,849
PERCENT OF CAPACITY USED	43.85%

DELIVERY

CAPACITY AVAILABLE	$3,403,600
CAPACITY USED	$1,680,317
CAPACITY UNUSED	$1,723,283
PERCENT OF CAPACITY USED	49.37%

UTILIZATION STATEMENT - ENTIRE TRADE AREA FOR FERTILIZER

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$8,972,600
CAPACITY USED	$1,979,330
CAPACITY UNUSED	$6,993,270
PERCENT OF CAPACITY USED	22.06%

DELIVERY

CAPACITY AVAILABLE	$22,697,200
CAPACITY USED	$1,652,931
CAPACITY UNUSED	$21,044,269
PERCENT OF CAPACITY USED	7.28%

UTILIZATION STATEMENT - ENTIRE TRADE AREA FOR PETROLEUM

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$2,058,420
CAPACITY USED	$930,142
CAPACITY UNUSED	$1,128,278
PERCENT OF CAPACITY USED	45.19%

DELIVERY

CAPACITY AVAILABLE	$2,669,856
CAPACITY USED	$879,937
CAPACITY UNUSED	$1,789,919
PERCENT OF CAPACITY USED	32.96%

UTILIZATION STATEMENT - SITE: BOYLE FOR ALL PRODUCTS

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$6,663,650
CAPACITY USED	$2,136,568
CAPACITY UNUSED	$4,527,082
PERCENT OF CAPACITY USED	32.06%

DELIVERY

CAPACITY AVAILABLE	$8,114,706
CAPACITY USED	$1,249,108
CAPACITY UNUSED	$6,865,598
PERCENT OF CAPACITY USED	15.39%

UTILIZATION STATEMENT - SITE: BOYLE PRODUCT: AG CHEM

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$225,000
CAPACITY USED................................	$161,959
CAPACITY UNUSED..............................	$63,041
PERCENT OF CAPACITY USED.....................	71.98%

DELIVERY

CAPACITY AVAILABLE...........................	$0
CAPACITY USED................................	$0
CAPACITY UNUSED..............................	$0
PERCENT OF CAPACITY USED.....................	0.00%

UTILIZATION STATEMENT - SITE: BOYLE PRODUCT: FARM SUPPLIES

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$1,155,000
CAPACITY USED................................	$474,394
CAPACITY UNUSED..............................	$680,606
PERCENT OF CAPACITY USED.....................	41.07%

DELIVERY

CAPACITY AVAILABLE...........................	$0
CAPACITY USED................................	$0
CAPACITY UNUSED..............................	$0
PERCENT OF CAPACITY USED.....................	0.00%

UTILIZATION STATEMENT - SITE: BOYLE PRODUCT: FEED

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$895,630
CAPACITY USED................................	$208,329
CAPACITY UNUSED..............................	$687,301
PERCENT OF CAPACITY USED.....................	23.26%

DELIVERY

CAPACITY AVAILABLE...........................	$260,850
CAPACITY USED................................	$35,481
CAPACITY UNUSED..............................	$225,369
PERCENT OF CAPACITY USED.....................	13.60%

UTILIZATION STATEMENT - SITE: BOYLE PRODUCT: FERTILIZER

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$2,329,600
CAPACITY USED................................	$361,744
CAPACITY UNUSED..............................	$1,967,856
PERCENT OF CAPACITY USED.....................	15.53%

DELIVERY

CAPACITY AVAILABLE...........................	$5,184,000
CAPACITY USED................................	$333,690
CAPACITY UNUSED..............................	$4,850,310
PERCENT OF CAPACITY USED.....................	6.44%

UTILIZATION STATEMENT - SITE: BOYLE PRODUCT: PETROLEUM

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$2,058,420
CAPACITY USED	$930,142
CAPACITY UNUSED	$1,128,278
PERCENT OF CAPACITY USED	45.19%

DELIVERY

CAPACITY AVAILABLE	$2,669,856
CAPACITY USED	$879,937
CAPACITY UNUSED	$1,789,919
PERCENT OF CAPACITY USED	32.96%

UTILIZATION STATEMENT - SITE: HARRODSBURG FOR ALL PRODUCTS

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$4,928,970
CAPACITY USED	$1,792,417
CAPACITY UNUSED	$3,136,553
PERCENT OF CAPACITY USED	36.36%

DELIVERY

CAPACITY AVAILABLE	$5,928,150
CAPACITY USED	$961,404
CAPACITY UNUSED	$4,966,746
PERCENT OF CAPACITY USED	16.22%

UTILIZATION STATEMENT - SITE: HARRODSBURG PRODUCT: AG CHEM

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$240,000
CAPACITY USED	$90,221
CAPACITY UNUSED	$149,779
PERCENT OF CAPACITY USED	37.59%

DELIVERY

CAPACITY AVAILABLE	$0
CAPACITY USED	$0
CAPACITY UNUSED	$0
PERCENT OF CAPACITY USED	0.00%

UTILIZATION STATEMENT - SITE: HARRODSBURG PRODUCT: FARM SUPPLIES

PRODUCTION/STORAGE

CAPACITY AVAILABLE	$1,200,000
CAPACITY USED	$498,648
CAPACITY UNUSED	$701,352
PERCENT OF CAPACITY USED	41.55%

DELIVERY

CAPACITY AVAILABLE	$0
CAPACITY USED	$0
CAPACITY UNUSED	$0
PERCENT OF CAPACITY USED	0.00%

UTILIZATION STATEMENT - SITE: HARRODSBURG PRODUCT: FEED

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$1,444,970
CAPACITY USED...............................	$966,586
CAPACITY UNUSED.............................	$478,384
PERCENT OF CAPACITY USED....................	66.89%

DELIVERY

CAPACITY AVAILABLE..........................	$1,080,150
CAPACITY USED...............................	$771,068
CAPACITY UNUSED.............................	$309,082
PERCENT OF CAPACITY USED....................	71.39%

UTILIZATION STATEMENT - SITE: HARRODSBURG PRODUCT: FERTILIZER

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$2,044,000
CAPACITY USED...............................	$236,962
CAPACITY UNUSED.............................	$1,807,038
PERCENT OF CAPACITY USED....................	11.59%

DELIVERY

CAPACITY AVAILABLE..........................	$4,848,000
CAPACITY USED...............................	$190,336
CAPACITY UNUSED.............................	$4,657,664
PERCENT OF CAPACITY USED....................	3.93%

UTILIZATION STATEMENT - SITE: HARRODSBURG PRODUCT: PETROLEUM

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$0
CAPACITY USED...............................	$0
CAPACITY UNUSED.............................	$0
PERCENT OF CAPACITY USED....................	0.00%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED...............................	$0
CAPACITY UNUSED.............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: LANCASTER FOR ALL PRODUCTS

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$3,023,280
CAPACITY USED...............................	$1,396,326
CAPACITY UNUSED.............................	$1,626,954
PERCENT OF CAPACITY USED....................	46.19%

DELIVERY

CAPACITY AVAILABLE..........................	$4,273,500
CAPACITY USED...............................	$658,583
CAPACITY UNUSED.............................	$3,614,917
PERCENT OF CAPACITY USED....................	15.41%

UTILIZATION STATEMENT - SITE: LANCASTER PRODUCT: AG CHEM

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$225,000
CAPACITY USED................................	$82,144
CAPACITY UNUSED..............................	$142,856
PERCENT OF CAPACITY USED.....................	36.51%

DELIVERY

CAPACITY AVAILABLE...........................	$0
CAPACITY USED................................	$0
CAPACITY UNUSED..............................	$0
PERCENT OF CAPACITY USED.....................	0.00%

UTILIZATION STATEMENT - SITE: LANCASTER PRODUCT: FARM SUPPLIES

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$435,000
CAPACITY USED................................	$314,117
CAPACITY UNUSED..............................	$120,883
PERCENT OF CAPACITY USED.....................	72.21%

DELIVERY

CAPACITY AVAILABLE...........................	$0
CAPACITY USED................................	$0
CAPACITY UNUSED..............................	$0
PERCENT OF CAPACITY USED.....................	0.00%

UTILIZATION STATEMENT - SITE: LANCASTER PRODUCT: FEED

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$847,780
CAPACITY USED................................	$495,412
CAPACITY UNUSED..............................	$352,368
PERCENT OF CAPACITY USED.....................	58.44%

DELIVERY

CAPACITY AVAILABLE...........................	$515,100
CAPACITY USED................................	$269,570
CAPACITY UNUSED..............................	$245,530
PERCENT OF CAPACITY USED.....................	52.33%

UTILIZATION STATEMENT - SITE: LANCASTER PRODUCT: FERTILIZER

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$1,515,500
CAPACITY USED................................	$504,653
CAPACITY UNUSED..............................	$1,010,847
PERCENT OF CAPACITY USED.....................	33.30%

DELIVERY

CAPACITY AVAILABLE...........................	$3,758,400
CAPACITY USED................................	$389,012
CAPACITY UNUSED..............................	$3,369,388
PERCENT OF CAPACITY USED.....................	10.35%

UTILIZATION STATEMENT - SITE: LANCASTER PRODUCT: PETROLEUM

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$0
CAPACITY USED..............................	$0
CAPACITY UNUSED............................	$0
PERCENT OF CAPACITY USED....................	0.00%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED..............................	$0
CAPACITY UNUSED............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: LIBERTY FOR ALL PRODUCTS

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$2,550,300
CAPACITY USED..............................	$1,215,977
CAPACITY UNUSED............................	$1,334,323
PERCENT OF CAPACITY USED....................	47.68%

DELIVERY

CAPACITY AVAILABLE..........................	$5,102,600
CAPACITY USED..............................	$583,836
CAPACITY UNUSED............................	$4,518,764
PERCENT OF CAPACITY USED....................	11.44%

UTILIZATION STATEMENT - SITE: LIBERTY PRODUCT: AG CHEM

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$210,000
CAPACITY USED..............................	$85,355
CAPACITY UNUSED............................	$124,645
PERCENT OF CAPACITY USED....................	40.65%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED..............................	$0
CAPACITY UNUSED............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: LIBERTY PRODUCT: FARM SUPPLIES

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$408,000
CAPACITY USED..............................	$331,654
CAPACITY UNUSED............................	$76,346
PERCENT OF CAPACITY USED....................	81.29%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED..............................	$0
CAPACITY UNUSED............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: LIBERTY PRODUCT: FEED

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$773,800
CAPACITY USED...............................	$366,304
CAPACITY UNUSED.............................	$407,496
PERCENT OF CAPACITY USED....................	47.34%

DELIVERY

CAPACITY AVAILABLE..........................	$437,800
CAPACITY USED...............................	$244,880
CAPACITY UNUSED.............................	$192,920
PERCENT OF CAPACITY USED....................	55.93%

UTILIZATION STATEMENT - SITE: LIBERTY PRODUCT: FERTILIZER

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$1,158,500
CAPACITY USED...............................	$432,664
CAPACITY UNUSED.............................	$725,836
PERCENT OF CAPACITY USED....................	37.35%

DELIVERY

CAPACITY AVAILABLE..........................	$4,664,800
CAPACITY USED...............................	$338,956
CAPACITY UNUSED.............................	$4,325,844
PERCENT OF CAPACITY USED....................	7.27%

UTILIZATION STATEMENT - SITE: LIBERTY PRODUCT: PETROLEUM

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$0
CAPACITY USED...............................	$0
CAPACITY UNUSED.............................	$0
PERCENT OF CAPACITY USED....................	0.00%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED...............................	$0
CAPACITY UNUSED.............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: STANFORD FOR ALL PRODUCTS

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$4,511,600
CAPACITY USED...............................	$1,318,203
CAPACITY UNUSED.............................	$3,193,397
PERCENT OF CAPACITY USED....................	29.22%

DELIVERY

CAPACITY AVAILABLE..........................	$5,351,700
CAPACITY USED...............................	$760,254
CAPACITY UNUSED.............................	$4,591,446
PERCENT OF CAPACITY USED....................	14.21%

UTILIZATION STATEMENT - SITE: STANFORD PRODUCT: AG CHEM

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$150,000
CAPACITY USED...............................	$90,803
CAPACITY UNUSED.............................	$59,197
PERCENT OF CAPACITY USED....................	60.54%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED...............................	$0
CAPACITY UNUSED.............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: STANFORD PRODUCT: FARM SUPPLIES

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$675,000
CAPACITY USED...............................	$310,793
CAPACITY UNUSED.............................	$364,207
PERCENT OF CAPACITY USED....................	46.04%

DELIVERY

CAPACITY AVAILABLE..........................	$0
CAPACITY USED...............................	$0
CAPACITY UNUSED.............................	$0
PERCENT OF CAPACITY USED....................	0.00%

UTILIZATION STATEMENT - SITE: STANFORD PRODUCT: FEED

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$1,761,600
CAPACITY USED...............................	$473,300
CAPACITY UNUSED.............................	$1,288,300
PERCENT OF CAPACITY USED....................	26.87%

DELIVERY

CAPACITY AVAILABLE..........................	$1,109,700
CAPACITY USED...............................	$359,318
CAPACITY UNUSED.............................	$750,382
PERCENT OF CAPACITY USED....................	32.38%

UTILIZATION STATEMENT - SITE: STANFORD PRODUCT: FERTILIZER

PRODUCTION/STORAGE

CAPACITY AVAILABLE..........................	$1,925,000
CAPACITY USED...............................	$443,307
CAPACITY UNUSED.............................	$1,481,693
PERCENT OF CAPACITY USED....................	23.03%

DELIVERY

CAPACITY AVAILABLE..........................	$4,242,000
CAPACITY USED...............................	$400,936
CAPACITY UNUSED.............................	$3,841,064
PERCENT OF CAPACITY USED....................	9.45%

UTILIZATION STATEMENT - SITE: STANFORD PRODUCT: PETROLEUM

PRODUCTION/STORAGE

CAPACITY AVAILABLE...........................	$0
CAPACITY USED................................	$0
CAPACITY UNUSED..............................	$0
PERCENT OF CAPACITY USED.....................	0.00%

DELIVERY

CAPACITY AVAILABLE...........................	$0
CAPACITY USED................................	$0
CAPACITY UNUSED..............................	$0
PERCENT OF CAPACITY USED.....................	0.00%

APPENDIX 2

USER'S MANUAL

COOPERATIVE RESTRUCTURING SIMULATOR

USER'S MANUAL

Release 1.01
November, 1989

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Disclaimer

The Cooperative Restructuring Simulator and the accompanying files and manual are provided "as-is" without warranty of any kind as to performance, accuracy, or freedom from error. Virginia Polytechnic Institute and State University is not liable for the use or maintenance of this program or any results it may produce.

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References

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Section I

Overview of the Cooperative Restructuring Simulator

The Cooperative Restructuring Simulator (CRS) is a spreadsheet/linear programming based decision support system designed to help cooperative managers assess possible restructuring alternatives. It uses a linear programming model to simulate product distribution based on patron purchasing behavior. In this program, it is assumed that the patron buys products for the lowest net cost (purchase plus transport costs). Thus, this program helps the user weigh the impacts of patron purchase costs versus transport costs.

For representation in CRS, a cooperative's decision domain is broken down into three segments; products lines (products), supply sites (outlets), and demand regions. CRS can simulate a trade area with up to five supply sites selling up to five product lines to up to fifteen demand regions. These three segments can be very different for each trade area analyzed. For instance, a product can be as specific as anhydrous ammonia or as general as all fertilizers grouped together. A supply site can carry a full line of agricultural supplies or it could be an agronomic center, carrying only fertilizers and related crop supplies. Demand regions can vary in size and could be rural or urban. The program is flexible in order to address the varying characteristics of different trade areas.

A consistent unit of measure was needed for all product types in order to incorporate flexibility into CRS. For example, a trade area might be broken down to three products lines; feed, fertilizer, and other farm supplies. It would be simple to find a common unit for each different type of feed and fertilizer such as tons or pounds. However, the farm supply category is much more difficult because animal health products and seed would be measured in very different ways. Since no assumptions about the type of product could be made, all five products needed to have a common unit of measure. The only units common to all products sold by an agricultural supply store would be dollars of product sold. Thus, dollars of product sold are used in favor of physical units of measure such as weight.

CRS uses cost, price, capacity, demand, and mileage data to calculate coefficients for the linear programming model. These data are readily available from the financial reports of most cooperatives. The linear programming model is then solved to determine the optimal product distribution within the scenario parameters defined by the user. CRS was not designed to find the optimal retail structure of a cooperative trade area. It was built to use a scenario defined by the user and report the distribution of the products to the patrons for that scenario. The restructuring decision is not simply decided by minimum costs or optimal distributions. Other factors are involved which are difficult to model. Some are as obvious as the age of capital equipment or as subtle as board of director or patron loyalty to a certain cooperative store and its manager. These factors should be analyzed by the user, not by the program. Thus, the restructuring of the trade area will be decided by the user. The program will report the impact of that decision.

Using this simulated product distribution, CRS produces three types of reports to be used in assessing the effectiveness of a given scenario.

1. Financial Statements
2. Asset Utilization Statements
3. Product Distribution Statements

These reports help to isolate those supply sites and products which are less profitable or have low asset utilizations and, thus, are candidates for restructuring.

An important characteristic of CRS is the ability to conduct "what-if" analysis based on changes in patron demand. This "what-if" analysis is referred to as demand sensitivity analysis. The importance of this function becomes apparent when the basic concept of restructuring is considered. Restructuring attempts to lower the production and overhead costs of supply site operations. This applies whether entire sites are closed or product lines are consolidated. As a site in a trade area is closed, patrons closest to that site pay a higher net price (cost of the product at the store plus transportation costs) because they now have to travel farther to buy the product. In fact, the net price might rise enough to force the patron to purchase from a competing site. This and other factors might cause patrons to change their purchasing habits. Changes in demand due to demographic changes can also be analyzed using this demand sensitivity analysis. Demand sensitivity analysis can be performed for each product line in each demand region, for all products in each demand region, for each product in the entire trade area, and for all products in the entire trade area. The mechanics of sensitivity analysis in CRS are discussed later in this manual.

CRS can be used to analyze other management decisions besides restructuring. The impact of new product lines in the trade area can be assessed as well as the impact of competition. The simulation capabilities of CRS give it the flexibility to analyze many situations.

CRS utilizes Lotus 1-2-3 as its data input and results reporting facility. The macro capabilities of 1-2-3 help make CRS easy for both the novice and experienced computer operator to use. Super VINO is used to optimize the linear programming model since it is specially designed to work with 1-2-3.

Section II

Trade Area Analysis

The trade area analysis should begin with a scenario which simulates the actual situation faced by the cooperatives. This scenario (referred to as the baseline scenario) is the base for all of the restructuring scenarios which will follow. These scenarios will be compared to the actual situation faced by the trade area (the baseline scenario) to analyze their effectiveness.

Trade area restructuring can be implemented in one of two ways. First, entire supply sites might be closed and their sales consolidated into one or more other sites. This restructuring method should eliminate the most variable and fixed costs but also might cause more losses in patron demand since some patrons will be located further from the sites still open.

The second restructuring method is to consolidate some product lines into fewer, more centralized locations. The product lines which are consolidated could be those which are delivered. All (or most) of the supply sites would stay open but most would act as order centers for the delivered products and still sell the products which farmers pick up. This method should cause lower losses in demand but would probably not lower costs as much as the store closure method. The only way to test which restructuring method is best for a given trade area is to analyze and compare scenarios using both methods.

The candidates for store closure can be selected using three criterion. The most logical criterion is net income. This criterion dictates that the least profitable sites would be closed. Another criterion is low utilization of assets. This indicates that those sites are less that efficient. The final criterion is to close those sites where patron demand is lowest. The costs eliminated by closing these sites should outweigh possible demand losses. Of course, other more subjective criterion should also be evaluated in deciding the proper scenarios to analyze. CRS was developed so that these criterion could be considered.

The final step in a trade area analysis is to consider the possibilities of future demand increases or decreases due to demographic changes. The two main concerns with these demand changes are:

1) How will the demand changes affect the product flows? Are most of the assets at any sites close to fully analyzed and would these sights be able to handle unforseen demand increases?
2) How will the net incomes of the sites and the trade area as a whole be effected by future demand changes?

It is important that any demand sensitivity analysis be performed last. The scenarios should be compared to the baseline scenario without the future demand changes first.

Section III

Data Inputs and Reports

3.1 Introduction

This section is a discussion of the type of data needed and the form (units) of the data for CRS. Two important points should be discussed as this section begins. First, much of the data actually entered into the program will be very general and will be in unusual units. The flexibility of the program discussed previously section is the cause. Thus, much of the data gathered must be modified to fit the program. Second, some of the data inputs are not used in the optimization process, specifically the cost inputs for the supply site. Since this program minimizes costs to the patron, supply site costs are only needed to support the site financial statements. Appendix A contains forms which assist in the collection and calculation of data inputs.

3.2 Cost, Price, and Capacity Inputs

A sample cost, price, and capacity input page is shown as Table 3.1. These inputs are specific to one supply site and one product. Some of the numbers are entered by the user (shown as normal type) while others are calculated by the program (shown in bold type). The first part of the table contains cost and price inputs for the product. Variable costs are entered as a percentage of retail price while fixed costs are entered as the total dollars associated with the product. Manipulating the cost records of most cooperatives to these forms is a two-step process. The first step is to categorize each cost category (wages, salaries, repairs, utilities, insurance, depreciation, etc.) as fixed or variable. The second step is to allocate these costs among the products. Unless the cooperative keeps product line account statements, variable costs can be allocated according to each product's total dollar volume as a percent of the store's overall dollar volume for all products. The variable costs are then summed and divided by the total dollar volume for the product to determine variable costs as a percent of dollar volume. This form eliminates any units problems presented by using a dollar per unit form for variable costs and eases program calculations using variable costs.

Table 3.1 - Sample Cost, Price, and Capacity Inputs

COST, PRICE, AND CAPACITY INPUTS

SITE: Store A PRODUCT: Product 1

VARIABLE COSTS................................	12.37%
FIXED COSTS...................................	$0
PRICE MARGIN..................................	13.44%
PRICE MARKUP..................................	**15.53%**
COST OF GOODS SOLD............................	**86.56%**
DELIVERY COSTS...............................$	0
DELIVERY CHARGES.............................$	0
CAPACITY LIMITATIONS	
PRODUCTION/STORAGE.........................	$225,000
DELIVERY...................................	$0

Since variable costs are defined to increase proportionally with dollar volumes, this method seems logical. However, it may not be totally correct. For instance, the fertilizer enterprise of a cooperative store, with a volume of $500,000, might include a blending facility which uses a great amount of electricity to operate. On the other hand, the petroleum enterprise, with a volume of $1,000,000, consists mostly of storage facilities and trucks. The fertilizer enterprise uses much more electricity but the petroleum enterprise is charged for a majority of the electricity due to its higher volume. Unfortunately, due to the lack of detailed records at most cooperatives, this situation cannot be corrected.

Fixed costs can be split into two categories. The first is allocated fixed costs and is listed on the cost, price, and capacity input page as fixed costs. These are the fixed costs that can be assigned to one product of the supply site by the manager. For instance, if the petroleum truck is covered by its own special insurance policy, the cost of that policy should be part of the allocated fixed costs of the petroleum enterprise. This breakdown is important. If one supply site discontinues sales of a product line, these allocated fixed costs may be eliminated. Allocated fixed costs should be entered as a total dollar amount. Hereafter, allocated fixed costs are simply referred to as fixed costs. The second category is overhead costs. These are unallocated fixed costs. Overhead costs are discussed later in this section.

The price margin of the product is entered as a percentage of the retail price. Price margin is the difference between the retail price and the cost of goods sold (COGS). It is readily obtainable from the records of most supply cooperatives. COGS is calculated as a percentage of the retail price and equals 1 minus the percent price margin.

Price markup is the other variable calculated using the percent price margin. Price markup is the difference between COGS and retail price as a percentage of COGS. In other words, it is the percentage by which COGS is increased to arrive at the retail price. In the program, price markup equals the percent price margin divided by the percent COGS. It is important to remember the difference between percent price margin and percent price markup. Price margin is the variable entered because most cooperatives regularly record price margins instead of price markups. Price markup is used along with the general price markup (explained later) to calculate a proxy for the product price.

Three types of transportation costs are needed for the program. One type, delivery costs, are incurred by the cooperative as the cost of delivering product to the patron. These costs do not have any affect on the scenario solution but do have a great impact on the restructuring decision through the income statements. Two costs, pickup costs and delivery charges, are incurred by the patron and affect both the scenario solution and the restructuring decision. Note that the delivery charge is treated both as a cost to the patron and as income for the cooperative store. All transportation costs are in a cost per dollar of product transported per mile travelled basis. These are unusual units but they can be derived using the records of most cooperatives. Pickup costs are not supply site specific so they will be discussed later.

Delivery cost in cost per dollars delivered per mile is relatively easy to calculate. First, capacity in dollars for each delivery vehicle is found by multiplying the vehicle capacity by the price per unit. Next, the cost per mile of operating the vehicle is calculated as the total variable costs per year of operation multiplied by the mileage per year the vehicle travelled. Variable costs of operation include fuel costs, oil and lube costs, and repair costs. They exclude fixed costs such as insurance, depreciation, taxes, and license. Finally, the cost per mile is divided by the capacity in dollars to find the cost per dollar per mile for delivery. If the supply site has many delivery vehicles (such as a flatbed truck and a spreader truck for fertilizer), some type of weighted average would have to be derived using the percentage of total deliveries by each vehicle.

The delivery charge calculations are not quite as straight forward. Most cooperatives do not charge a per mile fee for delivery but, as was explained earlier in this chapter, delivery charge must be on a per mile basis. The easiest method of calculating delivery charges as the amount charged per dollar transported per mile travelled is to follow the same steps as described for delivery costs but to replace the total variable costs of delivery per year with the total charges (or income) for delivery per year. The delivery charge is critical in the optimization of a scenario. You should always enter a delivery charge for delivered products even if the delivery charge is normally included in the price of the product.

The final lines of the supply site inputs are the capacity limitations. These values place a limit on the total amount of product in dollars per year that each supply site can sell or deliver. Total annual product sold in dollars is constrained by the production/storage capacity limit. If an enterprise involves both production and storage, then the most limiting activity is entered because a supply site can produce no more than it can store and vice versa. The delivery limitation represents the maximum total annual product delivered in dollars by the delivery vehicles available to the supply site. Seasonality of sales and deliveries present a problem since the program cannot represent non-linear relationships. Hence, both capacity values should represent the peak time periods for the product in question. For example, fertilizer sales and deliveries in most agricultural areas are greatest in the spring months of March, April, and May and the fall months of October and November. These months should receive special consideration in the calculation of the capacity limits.

Many methods can be used to calculate the production/storage limitations depending on the cooperative's record keeping system. One method for each is outlined below. Production capacity is dependent on the peak months of the year so start by determining the full capacity of the production facility in a busy month. This value should be the opinion of the store manager instead of an engineering estimate of the equipments' capacity. The monthly full capacity multiplied by the price per unit yields the capacity per month in total dollars. Annual capacity is then calculated as the monthly capacity multiplied by the months in the production period for the year. The time definitions can be changed from monthly to weekly or daily if desired.

Storage capacity is more difficult to derive. First, an estimate on the full capacity of storage at one time for the product is needed. If a storage facility is used for more than one product line (such as warehouses or showrooms), the manager needs to estimate how much of the facility is used for each product line. Next, determine the number of times this maximum storage capacity will be sold annually. The upper management of many cooperatives recommend a good inventory turnover rate for most product lines. Multiplying the maximum storage capacity by the inventory turnover rate will yield the annual storage capacity in store units. To calculate the annual storage capacity in dollars, simply multiply the annual storage capacity in store units by the price per unit.

The calculations for delivery limits are much the same as those for the production limits. The manager's estimate on the maximum number of loads per day is multiplied by the number of days in the delivery season. For instance, if fertilizer is delivered 5 months out of the year, the maximum loads per day would be multiplied by 120 days (20 weeks at 6 days per week). This value is then multiplied by the units per load and the price per unit to obtain the annual capacity of delivery in dollars.

3.3 Supply Site and Product Specific Inputs

Table 3.2 shows the inputs which are specific to one supply site and apply to all products and those which are specific to one product and apply to all supply sites. One product specific input is the general price margin (GPM). Since no physical units can be used in CRS, a price per physical unit (such as price per ton) cannot be used. Percent price markups alone cannot be used to represent price differences between the sites since they are a percentage of the relative price. The general price markups (calculated using the general price margin) is used with the site price markups to calculate a proxy for the relative price of the product. This proxy is called the price markup and us calculated using the following formula.

(1 + GENERAL PRICE MARKUP) / (1 + PRODUCT PRICE MARKUP)

If the site price markup equals the general price markup, then the markup ratio is equal to one. Always enter a general price margin or else the program may not will not return a valid product distribution. The markup ratio can be used as a proxy for retail price because the COGS in dollars has been assumed to be constant for all supply sites. The markup ratio should also be used to standardize the dollars of supply site sales to trade area dollars. This point is explained in the Demand Inputs section.

Table 3.2 - Sample Supply Site and Product Specific Inputs

	GENERAL PRICE MARGINS	
Product 1	(PRODUCT 1)......................	13.44%
Product 2	(PRODUCT 2)......................	22.59%
Product 3	(PRODUCT 3)......................	10.54%
Product 4	(PRODUCT 4)......................	19.99%
Product 5	(PRODUCT 5)......................	26.62%
	PICKUP COSTS	
Product 1	(PRODUCT 1).....................$	0.0085561
Product 2	(PRODUCT 2).....................$	0.0057873
Product 3	(PRODUCT 3).....................$	0.0059012
Product 4	(PRODUCT 4).....................$	0.0060469
Product 5	(PRODUCT 5).....................$	0.0208696
	OVERHEAD COSTS	
Store A	(SUPPLY SITE 1)..................	$162,568
Store B	(SUPPLY SITE 2)..................	$105,549
Store C	(SUPPLY SITE 3)..................	$73,127
Store D	(SUPPLY SITE 4)..................	$77,933
Store E	(SUPPLY SITE 5)..................	$82,995

Using a meaningful GPM provides a benchmark from which to judge the performance of the supply sites. If the price margins for all products at one supply site in the trade area (such as a "mother store") is used, it is regarded as the benchmark for the trade area. Other logical choices for the GPM's are the average price margins for all stores in the trade area, the minimum price margins in the trade area for each product, or the price margin recommended by the cooperative's upper management.

Pickup cost, the cost of picking the product up at the supply site, is product specific. The pickup cost per dollar of product picked up per mile is constant, regardless which supply site is the point of origin. One method of determining this cost is to target one type of pickup vehicle for each product and determine the cost per mile of operating that vehicle. For instance, a pickup truck would be used to pick up most farm supplies, bagged feed, and bagged fertilizer. Next, determine the average amount of product in dollars picked up by the patron on each trip. This value is not easily determined because most cooperatives do not record whether a patron's purchase is picked up or delivered. Other records may help give a good estimate of the average amount of product picked up. Then divide the cost per mile by the dollars of product picked up to find the cost per dollar picked up per mile travelled.

Overhead costs, defined as the unallocated fixed costs, are supply site specific. When a product line at one supply site is discontinued, these costs are still incurred by the site. Since the cooperative records do not allocate these costs to a certain product line, CRS allocates them for the user. Overhead costs are entered as a lump sum for each supply site. They are then allocated by each product's total margin in dollars as a percentage of the store's overall product margin in dollars by the program after it is solved. In this way, the high margin product lines will absorb much of the overhead costs. In reality, this is usually true. Cooperatives cannot simply shut down low or negative margin product lines because they are obligated to meet the needs of the patrons. Thus, these products usually require most of their margins to cover variable costs. The high margin products take up much of the slack for overhead costs.

3.4 Mileage Inputs

Mileage from the cooperative store to the demand region (shown in table 3.3) is the least complicated input to determine. It can be measured in three ways. The first method is to measure mileage using a road map. This is the most realistic representation of mileage. It is also the most difficult to measure accurately. The second method is to measure mileage in airline miles. This is the easiest method to measure accurately. However, it does not account for geographical barriers (rivers, mountains, etc.). The third method is to use an equation for the area in question that adjusts the airline mileage to road mileage. Unfortunately, these equations are not widely available. The method used depends on the topography of the trade area, the availability of a good map, and the availability of an adjustment equation.

Table 3.3 - Sample Mileage Inputs

MILEAGE FIGURES TO DEMAND REGIONS FOR Store A

11111	(DEMAND REGION 1)...............	12
22222	(DEMAND REGION 2)...............	18.5
33333	(DEMAND REGION 3)...............	20
44444	(DEMAND REGION 4)...............	5.5
55555	(DEMAND REGION 5)...............	12
66666	(DEMAND REGION 6)...............	11
77777	(DEMAND REGION 7)...............	10
88888	(DEMAND REGION 8)...............	20.5
99999	(DEMAND REGION 9)...............	26
EAST	(DEMAND REGION 10)..............	21.5
NORTH	(DEMAND REGION 11)..............	25
SOUTH	(DEMAND REGION 12)..............	26
WEST	(DEMAND REGION 13)..............	11.5

Regardless of the method, mileage can be measured as the distance from the cooperative to the center of each demand region. However, this means that mileage might be zero for patrons in a supply site's own demand region. Hence, for demand regions in which a store is located, mileage from that store to its own demand region could be measured from the store to the edge of the region. The user of the program could adjust these measurements to compensate for the concentration of patrons or a city with low farm supply demand in one section of a demand region.

Determining the location of these demand regions is important to the accuracy of the program's results. The definition of the demand regions is left to the discretion of the user. Two possible geographical divisions for demand regions are zip code areas and counties. The size and number of demand regions defined by the user are factors of the desired accuracy of the models results, the time restraints of the analysis, and the completeness of the cooperative's records. Defining many small demand regions (as with zip codes) paints a more accurate picture of distribution but also cause more data manipulation problems and adds to the program computation time. Fewer large demand regions (such as counties) alleviate these problems but decrease the accuracy of distributions and transportation costs because the mileage distances between supply sites and demand regions are less precise.

3.5 Demand Inputs

Patron demand, shown in table 3.4, is the most uncertain factor of the program. This program determines the optimal distribution of products based on a certain level of patron demand. However, determining the levels of demand for each product is another project in itself. Fortunately, most cooperatives have a good indicator of the future buying patterns of its patrons - the records of the past purchases of its patrons. Though there are no assurances of constant demand from year to year, cooperative managers should have an ideas of the changes in purchasing tendencies from one year to the next. For instance, a manager should realize that if another farm supply firm opens in the county, sales will suffer. The best method for determining patron demand for the next period is to use the previous periods sales records revised by the judgement of the cooperative manager's sales expectations for the next period. Most cooperatives record the name and location of the patrons and their purchases for patronage refund reasons.

Table 3.4 - Sample Demand Inputs

DEMAND IN EACH DEMAND REGION FOR Product 1

11111	(DEMAND REGION 1)................	$59,314
22222	(DEMAND REGION 2)................	$14,212
33333	(DEMAND REGION 3)................	$21,784
44444	(DEMAND REGION 4)................	$130,528
55555	(DEMAND REGION 5)................	$18,103
66666	(DEMAND REGION 6)................	$74,713
77777	(DEMAND REGION 7)................	$57,885
88888	(DEMAND REGION 8)................	$11,134
99999	(DEMAND REGION 9)................	$47,678
EAST	(DEMAND REGION 10)...............	$7,431
NORTH	(DEMAND REGION 11)...............	$16,695
SOUTH	(DEMAND REGION 12)...............	$19,574
WEST	(DEMAND REGION 13)...............	$31,431

Demand should be standardized to general trade area dollars using the markup ratio before entry. All sales records are in store dollars for the store at which the sale was made. After demand for each product from each store is determined, it must be multiplied by the markup ratio to convert it to general dollars. For instance, assume the store A price markup for feed is 25% and the general markup is 20%. The markup ratio in this case equals 0.96 (1.20/1.25). If the store sold $10,000 to demand region 1, the standardized dollars sold is ($10,000 * 0.96) or $9600. This result makes sense because the store's higher price for one ton of feed is greater than the general trade area price. Hence, the total sales in standardized dollars would be less than total sales in store A dollars.

3.6 Pickup Percentage Inputs

Demand must be further broken down into the mode of transportation; either delivery or pickup. The user specifies the amount transported by each mode by entering the percentage of total sales to each demand region which is picked up by the patron. Table 3.5 is an example of the percent picked up for each demand region. Since all product sold is either delivered or picked up, the percent delivered is equal to 100% (total sales) minus the percent picked up. The quantity of sales that are picked up and delivered are not recorded by most cooperatives so some other indirect means of determining one of these values must be used. For instance, by knowing the total delivery income (income generated from the charges of delivering product to the patron) and the per unit charge for delivery, the amount of product delivered and the amount picked up can be calculated.

Table 3.5 - Sample Pickup Percentage Inputs

```
  PERCENT PICKED UP FOR EACH DEMAND REGION OF Product 1

11111          (DEMAND REGION 1)...............      100.00%
22222          (DEMAND REGION 2)...............      100.00%
33333          (DEMAND REGION 3)...............      100.00%
44444          (DEMAND REGION 4)...............      100.00%
55555          (DEMAND REGION 5)...............      100.00%
66666          (DEMAND REGION 6)...............      100.00%
77777          (DEMAND REGION 7)...............      100.00%
88888          (DEMAND REGION 8)...............      100.00%
99999          (DEMAND REGION 9)...............      100.00%
EAST           (DEMAND REGION 10)..............      100.00%
NORTH          (DEMAND REGION 11)..............      100.00%
SOUTH          (DEMAND REGION 12)..............      100.00%
WEST           (DEMAND REGION 13)..............      100.00%
```

3.7 Sensitivity Analysis Inputs

The final section of inputs allows the user to compensate for possible demand changes due to supply restructuring. This ability is critical to the successful application of this type of program. Consolidating retail operations and, as a result, making some patrons travel farther to buy the product will affect the purchases by those patrons. This demand sensitivity to supply structure changes is represented in the program as a percentage increase or decrease in the product demanded by patrons over certain segments of the trade area. The same analysis could be accomplished by changing the dollars of product demanded for certain products in certain demand regions. However, the method used in this program is much easier to perform and understand. For example, if the user wishes to analyze the effects of a 5% decrease in demand for fertilizer in the entire trade area, table 3.6 shows the input line to change. Otherwise, the demand inputs for fertilizer in each trade area would have to be decreased by five percent. The program contains demand sensitivity inputs for all situations, as shown in table 3.6. This is as general as an input line for changes in demand for all products throughout the entire trade area due to general price inflation, or a change in the demand for fertilizer throughout the entire trade area since a new competitor opened. It could be as specific as analyzing a change in demand for fertilizer in a demand region because of a large new patron account.

Table 3.6 - Sample Sensitivity Analysis Inputs

```
SENSITIVITY ANALYSIS FOR THE ENTIRE TRADE AREA....      0.00%


SENSITIVITY ANALYSIS FOR EACH PRODUCT IN ALL DEMAND REGIONS

AG CHEM        (PRODUCT 1)....................          0.00%
FARM SUPPLIES  (PRODUCT 2)....................          0.00%
FEED           (PRODUCT 3)....................          0.00%
FERTILIZER     (PRODUCT 4)....................          0.00%
PETROLEUM      (PRODUCT 5)....................          0.00%


           SENSITIVITY ANALYSIS FOR ALL PRODUCTS

11111          (DEMAND REGION 1)...............         0.00%
22222          (DEMAND REGION 2)...............         0.00%
33333          (DEMAND REGION 3)...............         0.00%
44444          (DEMAND REGION 4)...............         0.00%
55555          (DEMAND REGION 5)...............         0.00%
66666          (DEMAND REGION 6)...............         0.00%
77777          (DEMAND REGION 7)...............         0.00%
88888          (DEMAND REGION 8)...............         0.00%
99999          (DEMAND REGION 9)...............         0.00%
EAST           (DEMAND REGION 10)..............         0.00%
NORTH          (DEMAND REGION 11)..............         0.00%
SOUTH          (DEMAND REGION 12)..............         0.00%
WEST           (DEMAND REGION 13)..............         0.00%


           SENSITIVITY ANALYSIS FOR Product 1

11111          (DEMAND REGION 1)...............         0.00%
22222          (DEMAND REGION 2)...............         0.00%
33333          (DEMAND REGION 3)...............         0.00%
44444          (DEMAND REGION 4)...............         0.00%
55555          (DEMAND REGION 5)...............         0.00%
66666          (DEMAND REGION 6)...............         0.00%
77777          (DEMAND REGION 7)...............         0.00%
88888          (DEMAND REGION 8)...............         0.00%
99999          (DEMAND REGION 9)...............         0.00%
EAST           (DEMAND REGION 10)..............         0.00%
NORTH          (DEMAND REGION 11)..............         0.00%
SOUTH          (DEMAND REGION 12)..............         0.00%
WEST           (DEMAND REGION 13)..............         0.00%
```

3.8 Reports

The reports generated by CRS are relatively simple but they contain enough detail to adequately display the effects of restructuring on the economic viability of a farm supply cooperative trade area. The three types of output reports created by this program are financial statements, asset utilization statements, and product distribution statements. These statements are relatively straight forward and easy to compute. Four categories of financial and asset utilization statements are generated: 1) those which are both supply site and product specific, 2) those which are supply site specific but encompass all products, 3) those which are product specific but encompass all supply sites, and 4) those which encompass all products and all supply sites in the trade area. The product distribution statements are in three forms: 1) distribution of delivered products, 2) distribution of picked up products, and 3) distribution of total product.

The financial statements are quite general and only differentiate delivery revenues and costs. Table 3.7 shows an example of a product specific - supply site specific financial statement. Sales are determined by the program and represent the total amount of product sold by that supply site to all demand areas. Delivery revenues are a factor of the amount of product delivered (also determined by the program). It equals the delivery charge multiplied by the dollars of product delivered and the miles travelled for delivery. Cost of goods sold equals the percent COGS from the input pages multiplied by the total dollars of product sold. Product margin is then calculated as the sum of sales and delivery revenues minus COGS. Total expenses are the sum of four cost categories: 1) variable costs - the percent variable costs from the input pages multiplied by the total dollars of product sold, 2) fixed costs - the amount entered directly on the input pages, 3) delivery costs - the cost per dollars delivered per mile multiplied by the amount delivered in dollars and the miles travelled, and 4) overhead costs - the total overhead costs for the store multiplied by the gross margin for the product as a percentage of total gross margin. The net margin is then calculated as the product margin minus the total expenses. It represents the profit realized by the supply site from that product using the given scenario.

Table 3.7 - Sample Income Statement

INCOME STATEMENT - SITE: Store A PRODUCT: Product 1

SALES..	$161,959
DELIVERY REVENUES..............................	$0
COST OF GOODS SOLD.............................	$140,192
GROSS MARGIN...................................	$21,767
VARIABLE COSTS.................................	$20,034
FIXED COSTS....................................	$0
OVERHEAD COSTS.................................	$7,516
DELIVERY COSTS.................................	$0
TOTAL EXPENSES.................................	$27,550
NET INCOME.....................................	($5,783)
BREAKEVEN SALES................................	$702,445

The breakeven point is shown at the bottom of the report. It is calculated by the program to give the user some insight on the profitability of the product for the store. The breakeven point is defined as the point at which income generated from sales just equals the total costs incurred from those sales. It is calculated as total fixed costs (both allocated fixed and overhead) divided by the contribution to overhead. Contribution to overhead is the profit generated by one dollar of sales and is equal to $1 of sales minus the cost of goods sold and the variable costs associated with $1 of sales. These calculations are straight forward in the program since fixed costs are entered in total dollars and the COGS and variable costs are entered as percentages, a form readily converted to dollars. Thus, the formula for the breakeven point is:

TOTAL FIXED COSTS / (1 - PERCENT COGS - PERCENT VARIABLE COSTS).

Breakeven analysis can give a quick reference to how a supply site is expected to operate solely on the basis of costs. A site with a relatively low breakeven point has a very good chance of turning a profit. Sites with a high breakeven point is dependent on higher sales in order to make a profit. A zero breakeven point means that the store incurs higher costs than returns per unit and cannot make a profit on that product.

The asset utilization statements (shown in table 3.8) report the percent of total capacity of both production/storage and delivery used in the given scenario. These statements are very straight forward and the equations are essentially the same for both production/storage and delivery. The capacity available is the value entered on the supply site input pages. Capacity used for production/storage is the total amount sold for that product as determined by the program while capacity used for delivery is the amount delivered as determined by the program. Capacity unused is simply the subtraction of the capacity used from the capacity available while percent of capacity used is capacity used divided by capacity available. Percent of capacity used is the telltale value that the user looks at to determine if a supply site is making good use of its assets.

Table 3.8 - Sample Asset Utilization Statement

UTILIZATION STATEMENT - SITE: Store A PRODUCT: Product 1

PRODUCTION

CAPACITY AVAILABLE............................	$225,000
CAPACITY USED.................................	$161,959
CAPACITY UNUSED...............................	$63,041
PERCENT OF CAPACITY USED......................	71.98%

TRANSPORTATION

CAPACITY AVAILABLE............................	$0
CAPACITY USED.................................	$0
CAPACITY UNUSED...............................	$0
PERCENT OF CAPACITY USED......................	0.00%

The product distribution statements (table 3.9) report which supply site is supplying product to which demand regions. These distribution values are all determined by the program and are given in store dollars, not standardized dollars. Hence, the total from the product distribution statements will not necessarily match them amount demanded as entered in the input pages.

Table 3.9 - Sample Product Distribution Statement

TOTAL PRODUCT DISTRIBUTION IN DOLLARS FOR Product 1

DEMAND			SUPPLY SITE			
REGION	Store A	Store B	Store C	Store D	Store E	TOTAL
11111	0	59,314	0	0	0	59,314
22222	0	14,212	0	0	0	14,212
33333	0	0	0	0	21,784	21,784
44444	130,528	0	0	0	0	130,528
55555	0	0	0	18,103	0	18,103
66666	0	0	74,713	0	0	74,713
77777	0	0	0	0	57,885	57,885
88888	0	0	0	0	11,134	11,134
99999	0	0	0	47,678	0	47,678
EAST	0	0	7,431	0	0	7,431
NORTH	0	16,695	0	0	0	16,695
SOUTH	0	0	0	19,574	0	19,574
WEST	31,431	0	0	0	0	31,431
TOTAL	161,959	90,221	82,144	85,355	90,803	510,482

Section IV

User's Guide

4.1 User's Guide Conventions

This guide uses several conventions for keystrokes and commands. These conventions are listed below.

1. All commands which are to be typed on the keyboard are on a separate line in a different type style. An example is given below.

   COPY A:*.* B:<ENTER>

2. Any word encased in < > represent a special key on the keyboard such as

   <ESC>

   for the escape key.

3. Any combinations of keystrokes will be represented by a hyphen between two words encased in < >. These combination keystrokes instruct you to press the second key (the word after the hyphen) while holding down the first key (the word before the hyphen). For example,

   <CTRL-BREAK>

   means to press the break key while holding down the control key.

4. CRS menu options as well as Lotus 1-2-3 commands will be represented by small case letters. For example, the command

   /fr

   represents selecting the / **FILE RETRIEVE** commands in Lotus 1-2-3.

4.2 Hardware and Software Requirements

CRS requires the following hardware and software to function.

- IBM PC, PC/XT, PC/AT, PS/2, or any MS-DOS compatible computer.
- 640K RAM with no TSR (memory resident) programs loaded.
- One floppy disk drive and a hard disk drive with at least 2 megabytes free for the CRS files.
- MS-DOS (or PC-DOS) 2.0 or higher.

- Lotus 1-2-3 Release 2, 2.01 or 2.2. Though CRS should operate with Lotus 1-2-3 Release 3, this has not been tested.
- Super VINO.
- A printer.

An IBM compatible computer based on the 80286 (PC/AT compatible) or the 80386 processor is recommended. A math coprocessor is also VERY HIGHLY recommended. Table 4.1 contains estimates of the optimization time required for a full analysis (five supply sites and five products). The uses of systems with a math coprocessor GREATLY speed optimization times.

Table 4.1 - Optimization Time for Various Computer Systems

System	Optimization Time
IBM PC (4.77 MHz) - no math coprocessor	13 hours
IBM PC (4.77 MHz) - math coprocessor	1 hour
IBM PS/2 Model 50 - no math coprocessor	4 hours 30 minutes
IBM PS/2 Model 50 - math coprocessor	21 minutes
Compaq Deskpro 386/20 - math coprocessor	10 minutes

4.3 Installation Procedures

A hard disk drive is required to operate CRS. Included on CRS Disk 1 (Input Section) is an installation batch file. Follow these simple steps to install CRS on your hard drive. It is assumed that you will install CRS from floppy drive A onto hard drive C.

1. Turn on your computer. Always enter the correct time and date (unless your computer has a real time clock) before using CRS because they appear on top of all of all CRS printouts.

2. Make a backup copy of each CRS disk. For a system with two floppy drives, place CRS Disk 1 in drive A and a blank, formatted diskette in drive B. Type

   COPY A:*.* B:<RETURN>

   Repeat this procedure for each CRS disk.

3. Place CRS Disk 1 in drive A and make it the default drive by typing

   A:<RETURN>

4. Run the installation batch file by typing

   INSTALL<RETURN>

   Two subdirectories will be created on your hard disk. Super VINO and the CRS program and temporary files will be in the **C:\VINO** subdirectory. The scenario files will be in the **C:\VINO\SCENARIO** subdirectory. You will be instructed to place each CRS disk in drive A after the previous disk has been installed. CRS consists of four files. The first file is called **CRS.WK1** and contains the Input Section of the program. The second file is called **MODEL.WK1** and contains the Model Section of the program. The third file is called **RESULTS.WK1** and contains the Results Section of the program. The fourth and final file is called **EXAMPLE.WK1** and contains an example scenario file for reference purposes. All examples used in this manual are from the example scenario. A batch file for running the Super VINO - Lotus 1-2-3 combination for CRS will be copied to the root directory of your hard disk.

5. Next, you will be instructed to put the Super VINO disk in drive A for installation. If Super VINO is already installed in the **C:\VINO** subdirectory on your hard disk, type **<CTRL-BREAK>** to quit installation at this point. If you continue with the Super VINO installation, you will be asked which release of Lotus 1-2-3 that you use. Answer NO when you are asked if you uses Lotus 1-2-3, Release 1 or 1A. Then specify that you use Release 2 even though you might use Release 2.01 or 2.2. The Super VINO installation will then ask you for the subdirectory in which Lotus 1-2-3 and Super VINO are located. The Super VINO files will be in the C:\VINO subdirectory. The Super VINO manual explains installation of that program in more detail.

6. A bug is present in the Super VINO program which can easily be corrected. The Super VINO program automatically loads your version of Lotus 1-2-3 when you run CRS. However, Super VINO tries to execute a file called **123.COM** when the file name is actually called **123.EXE**. This will result in an error when you load CRS. To correct this error, simply rename **123.EXE** to **123.COM** by using the following commands. If Lotus 1-2-3 is located in the **C:\LOTUS** subdirectory, type

```
C:<RETURN>
CD \LOTUS<RETURN>
RENAME 123.EXE 123.COM<RETURN>
CD \<RETURN>
```

Renaming this file will not effect the way that Lotus 1-2-3 runs with your other worksheets or with the Lotus Access System. However, hopefully you have Lotus 1-2-3 backed up in case of errors.

4.4 Getting Started

Starting CRS is a two step process. First, you must start the Super VINO/Lotus 1-2-3 combination and then you must load the CRS program into Lotus 1-2-3. This process is outlined below.

1. First, make sure that no memory resident programs are loaded into memory. You might want to check your **AUTOEXEC.BAT** to see if any memory resident programs are loaded automatically when you turn on your computer. If so, you can copy the AUTOEXEC.BAT file to another name such as **AUTOEXEC.OLD** using the following command.

```
COPY AUTOEXEC.BAT AUTOEXEC.OLD
```

Then edit your **AUTOEXEC.BAT** file so that it does not load any memory resident program. Next, you should reboot your computer by pressing **<CTRL-ALT-DEL>**.

After you are finished using CRS, copy **AUTOEXEC.OLD** back to **AUTOEXEC.BAT** by switching the names in the command above.

2. Second, load Super VINO/Lotus 1-2-3 by typing

   C:
**CD **
CRS<RETURN>

   If the root directory is in the PATH statement of your **AUTOEXEC.BAT**, then you can perform this step while in any subdirectory of your hard disk. For more information on the **AUTOEXEC.BAT** file and the PATH statement, consult your DOS manual.

3. If you are using Lotus 1-2-3 Release 2.2 and your computer has 640K or less (no expanded memory), you must disable the UNDO option in 1-2-3 before loading CRS. Use the following commands to disable UNDO.

   /WGDOUDUQ

   Since CRS is a large program, computers with 640K or less do not have sufficient memory to run CRS and also use the UNDO option. After you have finished using CRS, you may enable UNDO using the following commands.

   /WGDOUEUQ

4. Next, you must load CRS from within Lotus 1-2-3. Type the following command to load CRS.

   /FR
X<ESC>
C:\VINO\CRS<RETURN>

   If CRS is the only Lotus 1-2-3 application which you use, you should make the **C:\VINO** subdirectory the default subdirectory by typing the following command.

   /WGDD<ESC>
C:\VINO<RETURN>
UQ

   This makes the **C:\VINO** subdirectory the one which Lotus 1-2-3 uses by default. Then you can load CRS by typing

   /FRCRS<RETURN>

   The CRS title page and the Input Section main menu will appear after CRS is loaded.

4.5 Structure of CRS

CRS is split into three sections; the Input Section, the Model Section, and the Results Section. The Inputs Section is the main section of CRS. In this section, you enter the input data, prepare for optimization, print the input data, perform sensitivity analysis, and perform file functions. The Model Section is not seen by the user. It is the section where calculations occur in preparation for and after optimization by Super VINO. The Results Section is where you can view or print the results of the analysis.

CRS is completely a menu-driven Lotus 1-2-3 template program. The Input Section and the Results Section each have their own independent menu system. These menus are explained in detail later in this chapter and are shown graphically in Appendix B. Menus and macros are used to automate the tedious but necessary tasks related to the analysis. Experienced 1-2-3 users will recognize the familiar menu structure used in CRS. These menus appear in the upper panel of the computer screen. Menu choices can be selected in one of two ways. You can select a menu choice by simply typing the first letter of your choice or by using the right and left cursor keys to highlight the appropriate choice and pressing the enter key. As you highlight each menu choice, a short explanation for that choice appears under the menu. The first choice in almost every menu is the Return option. This choice always returns you to the main menu of the section which you are using. When used in the menu system, the escape key almost always backs you up to the previous menu.

The input data is entered in special screens called input screens. CRS only allows you to enter data into certain cells. You can move between these cells using the arrow keys. Enter all percentages as decimals (50% should be entered as .50). When you are finished entering data, you can leave that input screen by pressing the enter or the escape key. After each input screen, CRS displays a menu and gives you a chance to check the screen to make sure that no mistakes were made. Select the Continue option to go on, select the Edit option to edit the data you just entered, or press **<ESC>** to return to the Input menu.

CRS produces audible beeps in only three cases.

1) When a special menu or prompt is shown on the screen. These menus and prompts are usually safety reminders to you about important operations which should be performed such as saving the current file.

2) When a long operation is finished. These include loading or saving files, transferring between the sections of CRS, and when Super VINO finishes the optimization. Be patient during these operations because they may take a few seconds depending on the speed of you computer.

3) When an error occurs. Pay attention to these beeps. If an error does occur, remember the section and menu in which you were working (such as the Print menu of the Results section) and consult Appendix C of this manual for possible causes.

Though CRS is easy to use for novice Lotus 1-2-3 users, it is to your advantage to be familiar with 1-2-3 and its functions. Since CRS is a Lotus 1-2-3 template program, it is bound by 1-2-3's abilities. It is to your advantages to know such information as how to edit cell entries, how to load files, and the basics of input ranges.

At any time, if you seem to no longer be in the menu system, type **<ALT-M>** to return to the main menu of the current CRS section. One way to determine if you are no longer in the menu system is to use the cursor keys to move around the screen. If you can scroll to rows or columns off the current screen, then you are out of the menu system. If any peculiar errors occur while using CRS, please report these to the authors listed in the Distribution and Program Support Information section on page ii of this manual.

If you wish to alter any of the macros in CRS, please realize that you are doing so at your own risk. The authors are not responsible for any errors which occur from such alterations. You can exit the menu system in two ways. In the Inputs and Results Sections, choose the Quit option and press **<CTRL-BREAK>**. In the Model and Results Sections, turn on Lotus 1-2-3's Step Mode by pressing **<ALT-F2>** and then load the appropriate section. If you can exit the menu system in any other ways, please notify the authors.

4.6 Input Section

This is the main section of CRS. In this section, you specify the parameters of the scenario, enter the input data, prepare for optimization, print the input data, perform sensitivity analysis, and perform file operations. The menu system of the input section is outlined below. The graphical representation of the input menus are given in Appendix B.

4.6.1 Defaults

In this section, the scenario parameters are specified. Each choice of the default menu is discussed below.

4.6.1.1 Names

The Names menu choice is used to specify the supply site, product, and demand region names. This is a very important operation because here you specify how many sites, products, and demand regions are in the trade area. Be sure to leave the unused name cells blank (ie, if your analysis only uses four products, leave Product 5 blank). Otherwise, you will see several unneeded input screens, result screens, and printed pages in your analysis. The time require to optimize will also increase. However, do not leave any blank name cells between those which are full. For example, if you enter four product names, enter the names for products 1 through 4 and leave product 5 blank. Do not enter names for products 1,2,4, and 5 and leave product 3 blank. You should specify these names once for a trade area analysis and then use the Scenario option to close sites and products in restructuring scenarios. The combined length for the product names (including spaces) must be less that 44 characters so that their names can be used in other menus. The same is true of the supply site names. The names of the demand regions can be either numbers (such as zip codes) or words but the product and site names can only be words. If you want to use a number as a product or site name, you must precede the number with an apostrophe when entering it.

4.6.1.2 Scenario

This choice allows you give a name and a description to the current scenario and to close product lines or supply sites in the current scenario. This option should be edited for each restructuring scenario in a trade area analysis so that you can be sure of the purpose of that scenario. The scenario name will appear at the top of all printed result pages. The scenario name should be limited to 35 characters (including spaces) so that it can fit at the top of the printed pages. The scenario description can consist of four lines of less than 65 characters per line.

The open and closed sites and products are defined in a grid like the one shown Table 4.2. This set of open and closed sites and products will be referred to in this manual as the scenario definition.

Table 4.2 - Sample Scenario Definition

	Site 1	Site 2	Site 3	Site 4	Site 5
Product 1	Y	Y	Y	N	Y
Product 2	Y	Y	Y	N	Y
Product 3	Y	N	N	N	N
Product 4	Y	N	N	N	N

The Y's designate those products which are sold at the designated sites. For instance, Site 4 has been closed in this scenario because there are only N's in that column. Only Site 1 sells Products 3 and 4 since the only Y's in that column are in the rows for Products 3 and 4. By placing an N for a product at a certain site, you have effectively reduced the site's capacity to sell that product to zero. Thus, that site will sell none of the given product and, hence, will incur no variable costs, delivery costs, or overhead costs, and will receive no income for that product. However, the site will still incur the associated fixed costs for that product unless you go to the appropriate input screen and adjust it. Whether or not you do so is a management decision. Though no overhead costs will be incurred for the closed product at the site, the total overhead costs for the site will not be reduced. The total overhead costs are simply reallocated to the other products sold by the site. If the site is closed completely (only N's in its column), the total overhead costs are still charged to the site but not to any one product. Again, the overhead costs must be adjusted manually and the magnitude of that adjustment is a management decision.

4.6.1.3 Clear

This menu choice clears the current scenario and allow you to begin a new analysis. ALL INPUT DATA WILL BE LOST WHEN THIS OPTION IS SELECTED. So make sure that the current scenario has been saved before this option is selected. Remember, you don't have to use the Clear option for each new scenario. If only a few data inputs will be changed, simply edit the current scenario or a previously saved scenario. However, if you begin a new trade area analysis, use the Clear option.

4.6.2 Inputs

All of the input data are entered or edited through this menu. The input data is divided into five sections - Costs, Prices, and Capacities; Demand; Pickup Demand; Mileage; and Other Inputs. Each menu option is explained below.

4.6.2.1 All

This option is self explanatory. By selecting the All option, you can enter all of the inputs. It will first take you through all the cost input pages by product, then though the rest of the input pages in the following sequence - demand; pickup demand; mileage; and other inputs. Each of these input sections are explained below.

4.6.2.2 Costs

The cost input pages include the following inputs for each product at each supply site variable costs, fixed costs, price margin, delivery costs, delivery charges, production/storage capacity, and delivery capacity. The price markup and the cost of goods sold are calculated using the variable costs and the price margin. After the costs have been entered, CRS gives you a chance to see the calculated price markup and COGS.

Two submenus of the Costs option are used to further specify the site and product for which you wish to enter data. The first submenu is the site submenu. It contains an All option and an option for each supply site in the scenario. By choosing All, you have specified that you wish to enter the cost inputs for all sites. By choosing one of the site options, you have specified that you wish to enter the cost inputs for only that site. The second submenu is the product submenu which contains an All option and an option for each product in the scenario. By choosing All, you have specified that you wish to enter the cost inputs for all products for the site (or all sites) which you previously selected. By choosing one of the product options, you have specified that you wish to enter the cost inputs for only that product for the site (or all sites) that you previously selected. You can enter the cost inputs for all products at all sites by selecting the All option for both submenus.

4.6.2.3 Demand

The demand input pages specify the amount of each product demanded by the patrons of each demand regions. The product demanded must be in dollars sold. The demand submenu includes an All option and an option for each product.

4.6.2.4 Pickup

The pickup demand input pages are used to specify the amount of total product demanded which is picked up by the patron at the supply site. Pickup demand is specified as a percentage of total demand which is picked up. Delivery demand is then calculated by CRS as 100 percent minus the pickup percentage. If all product demanded is to be delivered, then the pickup percentage should be 0%. If all product demanded is to be picked up, then the pickup percentage should be 100%. The pickup submenu contains an All option and an option for each product.

4.6.2.5 Miles

The mileage between each supply site and each demand regions are specified in these input pages. The miles submenu contains an All option and an option for each site.

4.6.2.6 Other

This option allows you to enter data for three different product or site specific inputs. The product specific inputs are the general price margins (the standard price margin for each product for the entire trade area) and the pickup costs (the cost to the patron for picking up each product). The site specific input is the overhead costs (the fixed costs which are not allocated to any one product). Always enter general price margins for all products in the scenario or else the program may not return the correct product distribution.

4.6.3 Optimize

This menu option allows you to check for the possibility of an infeasible scenario solution or for multiple optimal solutions. The infeasible solution can occur when there is insufficient capacity (production/storage or delivery) to supply the product demand of the patrons. Multiple optimal solutions can occur when two different supply sites can supply product to any one demand region for the same net price. The Optimize option allows you to print and/or view a series of check pages to assess the possibility for an infeasible solution or multiple optimal solutions.

The first check page compares the production/storage and delivery capacities against the patron's total demand and delivery demand to check for the possibility of infeasible solutions. The check page compares the production/storage capacity against the total demand for each product and the delivery capacity against the delivery demand for each product. The production/storage capacity is also compared to the delivery demand for each product since a site cannot deliver any more than it can produce/store. When a "YES" is returned for all comparisons, then there is adequate capacity to meet the patron demand. However, if a "NO" is returned, the program will not return a feasible solution and the capacity in the comparison which returned the "NO" is the cause.

The next several pages check for the possibility of multiple optimal solutions by comparing the net cost (purchase price plus transport costs) for the delivery and pickup of each product at each supply site. If the net cost of a product is identical at two or more sites, then the patron is indifferent as to the source of the product between those sites. However, unless those sites with identical prices are supplying product to any demand region, there is no problem with multiple optimal solutions. Thus, you cannot be sure that you have a multiple optimal solution problem until after the scenario has been solved. An example of a multiple optimal check page is given in Table 4.3.

Table 4.3 - Sample Multiple Optimal Solution Check Page

TEST FOR POSSIBLE MULTIPLE OPTIMAL SOLUTIONS
IN THE PICKUP OF Product 1

DEMAND			SUPPLY SITES			
REGION	Store A	Store B	Store C	Store D	Store E	DUPLICATES
11111	1.1027	1.0770	1.1797	1.2695	1.1882	
22222	1.1583	1.0856	1.2096	1.3422	1.2396	
33333	1.1711	1.2481	1.1155	1.2053	1.0856	
44444	1.0471	1.0770	1.0898	1.2053	1.0856	
55555	1.1027	1.1668	1.1583	1.0941	1.0984	
66666	1.0941	1.1412	1.0684	1.2652	1.0941	<===
77777	1.0856	1.1583	1.0599	1.1797	1.0428	
88888	1.1754	1.2567	1.1540	1.1412	1.0984	
99999	1.2225	1.2738	1.2610	1.0856	1.2011	
EAST	1.1840	1.2396	1.1027	1.2738	1.1198	
NORTH	1.2139	1.1711	1.2310	1.4150	1.2738	
SOUTH	1.2225	1.2824	1.2267	1.0941	1.1840	
WEST	1.0984	1.1112	1.1797	1.1626	1.1540	

The DUPLICATES column shows that one demand region (66666) has identical prices at two sites (Sites A and E). The possibility for multiple optimal solutions exists. However, demand region 66666 is supplied with ag chemicals for pickup by Store C, the lowest priced site. Thus, the problem of multiple optimal solutions is not present in this case. If Site A or Site E supplied any picked up ag chemicals to demand region 66666, then multiple optimal solutions would exist. When a site (column) returns all zeros, then that site does not sell the corresponding product using the given transportation method in this scenario. The scenario solution is not affected in this case. If more than one site returns all zeros, the arrows will appear even though the possibility of multiple optimal solutions does not exist.

If multiple optimal solutions do exist, first check your inputs to make sure that they are correct. If they are correct, then some adjustments to the inputs must be made. In order to make the net cost of the product to the patron different at the sites involved, increase the mileage from the demand region in question to one of the sites. You must decide which supply site to choose. Understand that this action will cause the program to have the other site (where the mileage was not changed) supply the product to the demand region in question. Hence, increase the mileage for that site which you believe is least likely to supply the given demand region.

The final check page shows the current scenario name and description so you can confirm that you have remembered to specify the parameters of that scenario. A menu will appear at the top of the screen with three options - Abort, Save, Optimize. Use the Abort option when you wish to edit the scenario name, description, or input data. Use the save option to save the scenario before optimization. ALWAYS SAVE BEFORE OPTIMIZATION IN CASE OF PROBLEMS. When you use the Save option, possible scenario names will appear. You may type in the name under which you wish to save the scenario or you can highlight a scenario name using the cursor keys and press **<ENTER>**. Use the Optimize option if you have already saved the scenario using the File Save option (explained later).

Optimization will take some time depending on the speed of your computer and hard drive (see the System Requirements Section) so you may want to do some other tasks during this time. During optimization, Super VINO will report whether there is an infeasible solution. In order to find the source of the infeasibility, look for site which supply negative amounts of products to one or more demand region. These sites and products usually have insufficient capacities to satisfy demand. Super VINO will also report that the problem is poorly scaled because there is a great difference in the magnitude of the model's coefficients. Scaling does not cause problems in this program. After optimization is completed, CRS will take you directly to the Results Section to view and/or print the results. The Results Section menus are discussed later in this manual.

Whenever any changes in the input data are made, the scenario must be optimized again except in the case of four input variables. Changes in fixed costs, variable costs, and delivery costs (not delivery charges) can be made and the results can be analyzed without optimizing the scenario again. All of these inputs are on the cost input screens. Overhead costs can also be changed and the results analyzed without optimization. Overhead costs are located on the other inputs screen. Notice that all of these inputs are costs to the cooperative, not to the patrons. Since the scenarios are simulated to represent patron demand (lowest net price), costs to the cooperative have no effect on the purchasing pattern of the patron unless they are also costs to the patron. However, these cooperative costs do have a great bearing on the restructuring analysis.

4.6.4 Results

This menu option simply takes you to the Results Section where you can analyze the impact of restructuring on the trade area. Remember that the scenario must be optimized before any results can be analyzed. Hence, use this option only in two cases. First, use the Results menu option if you wish to make data changes only in the variable costs, fixed costs, delivery costs, or overhead costs. These changes do not require optimization of the scenario. Second, if you have already optimized the scenario and you are going to the Results Section to view or print the results again, use the Results option. The menus of the Results Section are discussed later in this manual.

4.6.5 Print

The Print option allows you to print the inputs of your scenario. Each printed page has a header which includes the date and time, scenario name, and page number. In order to assure that the date and time are current, please enter the correct date and time using the DOS DATE and TIME commands before loading CRS unless your computer has a real-time clock. After you select the inputs which you want to print, CRS always prompts you to check to see that your printer is on and on line and that your paper is set at the top of a page. During the longer print jobs (such as All options), you can press **<ESC>** to interrupt printing. You will have to wait a few seconds before printing will end. You will then be returned to the Print menu. Interrupt printing only if you notice a mistake in the inputs since you cannot resume printing at the point where it was interrupted.

The Print menu options include - All, Defaults, Inputs. The All option simply prints the defaults and all of the inputs. The defaults printed include the name and description of the scenario, the scenario definition, and the names of the supply sites, products, and demand regions. The Inputs submenu under the Print menu includes all of the same options as the Input menu for entering the input data. Every input screen can be printed using the All option in the Input submenu. Specific inputs can be printed using the other options. These inputs can only be printed in groups. For example, the cost inputs for Product 1 at Supply Site 4 cannot be printed alone. You must print either all products at Supply Site 4 or Product 1 at all supply sites. The same is true for the other inputs screens. Only the inputs for the products and supply sites which you specify in the defaults will be printed. For example, if the trade area only sells three products, no printouts for products 4 and 5 will be printed.

4.6.6 Sensitivity

This option allows you to analyze the effects of changes in demand due to demographics on the financial health of the trade area. The Sensitivity menu has two options - Input, Print. The print option will print all of the sensitivity input pages. The input option is used for analysis. You can analyze demand changes for the all products over the entire trade area (Trade Area option), for each product over the entire trade area (Trade Area option), for each demand region over all products (Demand Region option), and for each demand region for each product (Products option). There is also an All option under the Sensitivity Input submenu but this option should be seldom used.

The concept of the sensitivity inputs is relatively simple. You enter a percentage demand increase or decrease for the portion of the trade area which you specify. For example, if you wish to analyze the effects of a three percent demand decrease in Product 1 over the entire trade area, you should select the Trade Area option in the Sensitivity Input submenu. Sensitivity analysis should only be conducted after the baseline scenario and the restructuring scenarios are completed. It should be the last part of the analysis.

4.6.7 File

This option simply allows you to perform the necessary file functions such as saving, loading, or erasing files, or viewing a list of the scenario files. MAKE SURE THAT THE CURRENT SCENARIO IS SAVED BEFORE YOU LOAD A NEW SCENARIO FILE. When using the Load, Save, or Erase options, you may select a scenario file by typing in the scenario names or by highlighting a scenario names using the cursor keys and pressing **<ENTER>**. In order to print a list of the scenario files, simply choose the File Directory option and hit **<SHIFT-PRTSC>** (**<PRTSC>** on the enhanced keyboards). Remember, one of the best forms of insurance against file loss is frequent saves of the scenario.

4.6.8 Quit

This option allows you to leave CRS and Lotus 1-2-3 when you are finished with you current analysis. REMEMBER TO SAVE THE CURRENT SCENARIO BEFORE EXITING.

4.7 Model Section

This section is largely unseen by the user. The calculations necessary to convert the input data into linear programming model coefficients occur in this section.

4.8 Results Section

The Results section serves only one purpose - to allow the user to analyze the results of the scenario simulation, either on the screen or on paper. There are four types of results in this section. They include the Product Distribution Statements of the scenario, the Financial Statements of the cooperatives, the Asset Utilization Statements of the cooperatives, and the Summary pages of the preceding statements. The four Results menu options are discussed below.

4.8.1 View

This option allows you to view the scenario results on the computer screen. Only the results for the products and supply sites which you specified in the scenario defaults can be viewed. The results are viewed in groups; individual screens cannot be viewed. After you have viewed a results screen, you can press **<ENTER>** to continue to the next results screen or press **<ESC>** to return to the View menu. Hence, if you are only interested in one results screen, you can go through the appropriate section until you get to the correct screen and then escape to the main menu. The view menu contains an All option for viewing all the results.

4.8.1.1 Summary

These screens simply report the sales, net income, production/storage utilization, and delivery utilization for the scenario. The pages report these figures for each product at each supply site, the totals for each product and supply site, and the trade area total.

4.8.1.2 Distribution

The Product Distribution Statements can be viewed using this option. There are three categories of distribution screens - Total distribution, Delivery distribution, and Pickup distribution. You can view all of the distribution screens, the summaries of distribution screens (the total, delivery, and pickup distributions for all products and all supply sites), the total distribution screens, the delivery distribution screens, or the pickup distribution screens.

4.8.1.3 Financial

The financial statements include the sales, delivery revenues, cost of goods sold, variable costs, fixed costs, overhead costs, and delivery costs. They also include a breakeven sales volume. These statements can be viewed on a total, supply site or a product basis. The Financial submenu includes an All option to view all of the financial statements. It also contains a Totals option to view the financial statements for each product over all sites and for each site over all products. The totals can be viewed on a supply site or a product basis. The Site and Product options allow you to view the financial statements for all products at each individual site and for each product at all sites.

4.8.1.4 Utilization

The utilization statements include the potential capacity, the capacity used and unused, and the percent capacity used for production/storage and delivery. The menu system for the Utilization option is exactly the same as for the Financial option.

4.8.2 Print

All of the same comments for the Input Section Print option apply to the Results Section Print option. The menus are the same as in the View Option.

4.8.3 Save

This menu option allows you to save the scenario and then continue analyzing the results. This option exists for safety reasons. If you plan to go to the Input Section after saving, use the Input option of the Results Section main menu to go to the Inputs Section and then save the scenario by selecting the File Save option.

4.8.4 Inputs

This choice allows you to go to the Input Section in order to edit the scenario input data, analyze a new scenario, print the inputs, or perform file operations. You do not have to save the scenario before going to the Input Section but you should save it before you analyze another scenario.

4.8.5 Quit

The Quit option in the Results Section allows you to exit CRS and Lotus 1-2-3. REMEMBER TO SAVE THE CURRENT SCENARIO BEFORE QUITTING.

Appendix A - Forms

DIVISION OF COSTS

SUPPLY SITE____________________ PRODUCT________________________

COST	VARIABLE	FIXED
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
____________________	$____________	$____________
TOTAL........................	$____________	$____________

(A) TOTAL VARIABLE COSTS...................$____________

(B) SALES..................................$____________

(C) VARIABLE COSTS AS A PERCENT OF SALES ____________%

Enter (C) in the Variable Cost row of the Cost, Price, and Capacity Sheet.

DELIVERY COST WORKSHEET

SUPPLY SITE ________________ PRODUCT__________________

(A) TRUCK CAPACITY....................______________________units

(B) PRICE PER UNIT...................$______________________

(C) CAPACITY IN DOLLARS..............$______________________ (A*B)

==

(D) TOTAL COST PER YEAR..............$______________________

(E) MILEAGE PER YEAR..................______________________miles

----

(F) COST PER MILE....................$______________________ (D/E)

==

(G) COST PER DOLLAR PER MILE.........$______________________ (F/C)

Enter (G) in for Delivery Cost in the Cost, Price, and Capacity sheet.

DELIVERY CHARGE WORKSHEET

SUPPLY SITE ________________ PRODUCT__________________

(A) TRUCK CAPACITY....................____________________units

(B) PRICE PER UNIT...................$____________________

(C) CAPACITY IN DOLLARS..............$____________________ (A*B)

===

(D) TOTAL CHARGES PER YEAR...........$____________________

(E) MILEAGE PER YEAR..................____________________miles

----

(F) CHARGE PER MILE..................$____________________ (D/E)

===

(G) CHARGE PER DOLLAR PER MILE.......$____________________ (F/C)

Enter (G) in for Delivery Charge in the Cost, Price, and Capacity sheet.

PRODUCTION/STORAGE CAPACITY WORKSHEET

PRODUCTION CAPACITY:

SITE______________________ PRODUCT__________________________

(A) FULL CAPACITY IN A BUSY MONTH
WITH NO OVERTIME....._____________________units

(B) PRICE PER UNIT ....$_____________________

(C) CAPACITY PER MONTH IN DOLLARS....$_____________________ (A*B)

===

(D) LENGTH OF SEASON IN MONTHS PER
PER YEAR............$_____________________

(E) PRODUCTION CAPACITY PER YEAR
IN DOLLARS..........$_____________________ (C*D)

STORAGE CAPACITY:

SITE______________________ PRODUCT__________________________

(F) FULL CAPACITY AT ANY ONE TIME....._____________________units

(G) PRICE PER UNIT ....$_____________________

(H) FULL CAPACITY AT ONE TIME
IN DOLLARS..........$_____________________ (F*G)

(I) ANNUAL TURNOVER RATE.............._____________________times

===

(J) STORAGE CAPACITY PER YEAR
IN DOLLARS..........$_____________________ (H*I)

Enter the minimum between (E) and (J) in the Cost, Price, and Capacity sheet for the Production/Storage Capacity.

DELIVERY CAPACITY

SITE_______________________ PRODUCT___________________________

(A) FULL CAPACITY IN A BUSY WEEK
WITH NO OVERTIME....._______________________units

(B) PRICE PER UNIT ....$_______________________

(C) CAPACITY PER WEEK IN DOLLARS.....$_______________________ (A*B)

==

(D) LENGTH OF SEASON IN WEEKS PER
PER YEAR............$_______________________

(E) PRODUCTION CAPACITY PER YEAR
IN DOLLARS..........$_______________________ (C*D)

Enter (E) in the Cost, Price, and Capacity sheet for Delivery Capacity.

COST, PRICE, AND CAPACITY INPUTS

SITE: ________________ PRODUCT: ________________

VARIABLE COSTS................................______________%

FIXED COSTS.................................$______________

PRICE MARGIN................................______________%

DELIVERY COSTS..............................$______________

DELIVERY CHARGES............................$______________

CAPACITY LIMITATIONS

PRODUCTION/STORAGE......................$______________

DELIVERY................................$______________

PICKUP COST WORKSHEET

PRODUCT ______________________

(A) TRUCK CAPACITY....................____________________units

(B) PRICE PER UNIT...................$____________________

(C) CAPACITY IN DOLLARS..............$____________________ (A*B)

==

(D) COST PER MILE....................$____________________

==

(E) COST PER DOLLAR PER MILE.........$____________________ (D/C)

Enter (G) for the correct product in the Pickup Cost sheet.

GENERAL PRICE MARGINS

______________ (PRODUCT 1)....................______________%

______________ (PRODUCT 2)....................______________%

______________ (PRODUCT 3)....................______________%

______________ (PRODUCT 4)....................______________%

______________ (PRODUCT 5)....................______________%

PICKUP COSTS

______________ (PRODUCT 1)...................$______________

______________ (PRODUCT 2)...................$______________

______________ (PRODUCT 3)...................$______________

______________ (PRODUCT 4)...................$______________

______________ (PRODUCT 5)...................$______________

OVERHEAD COSTS

______________ (SUPPLY SITE 1)...............$______________

______________ (SUPPLY SITE 2)...............$______________

______________ (SUPPLY SITE 3)...............$______________

______________ (SUPPLY SITE 4)...............$______________

______________ (SUPPLY SITE 5)...............$______________

MILEAGE FIGURES TO DEMAND REGIONS FOR ______________

______________ (DEMAND REGION 1)............... ______________

______________ (DEMAND REGION 2)............... ______________

______________ (DEMAND REGION 3)............... ______________

______________ (DEMAND REGION 4)............... ______________

______________ (DEMAND REGION 5)............... ______________

______________ (DEMAND REGION 6)............... ______________

______________ (DEMAND REGION 7)............... ______________

______________ (DEMAND REGION 8)............... ______________

______________ (DEMAND REGION 9)............... ______________

______________ (DEMAND REGION 10).............. ______________

______________ (DEMAND REGION 11).............. ______________

______________ (DEMAND REGION 12).............. ______________

______________ (DEMAND REGION 13).............. ______________

______________ (DEMAND REGION 14).............. ______________

______________ (DEMAND REGION 15).............. ______________

DEMAND IN EACH DEMAND REGION FOR ________________

______________ (DEMAND REGION 1)..............$______________

______________ (DEMAND REGION 2)..............$______________

______________ (DEMAND REGION 3)..............$______________

______________ (DEMAND REGION 4)..............$______________

______________ (DEMAND REGION 5)..............$______________

______________ (DEMAND REGION 6)..............$______________

______________ (DEMAND REGION 7)..............$______________

______________ (DEMAND REGION 8)..............$______________

______________ (DEMAND REGION 9)..............$______________

______________ (DEMAND REGION 10).............$______________

______________ (DEMAND REGION 11).............$______________

______________ (DEMAND REGION 12).............$______________

______________ (DEMAND REGION 13).............$______________

______________ (DEMAND REGION 14).............$______________

______________ (DEMAND REGION 15).............$______________

PERCENT PICKED UP FOR EACH DEMAND REGION OF _______________

_____________ (DEMAND REGION 1)..............._____________%

_____________ (DEMAND REGION 2)..............._____________%

_____________ (DEMAND REGION 3)..............._____________%

_____________ (DEMAND REGION 4)..............._____________%

_____________ (DEMAND REGION 5)..............._____________%

_____________ (DEMAND REGION 6)..............._____________%

_____________ (DEMAND REGION 7)..............._____________%

_____________ (DEMAND REGION 8)..............._____________%

_____________ (DEMAND REGION 9)..............._____________%

_____________ (DEMAND REGION 10).............._____________%

_____________ (DEMAND REGION 11).............._____________%

_____________ (DEMAND REGION 12).............._____________%

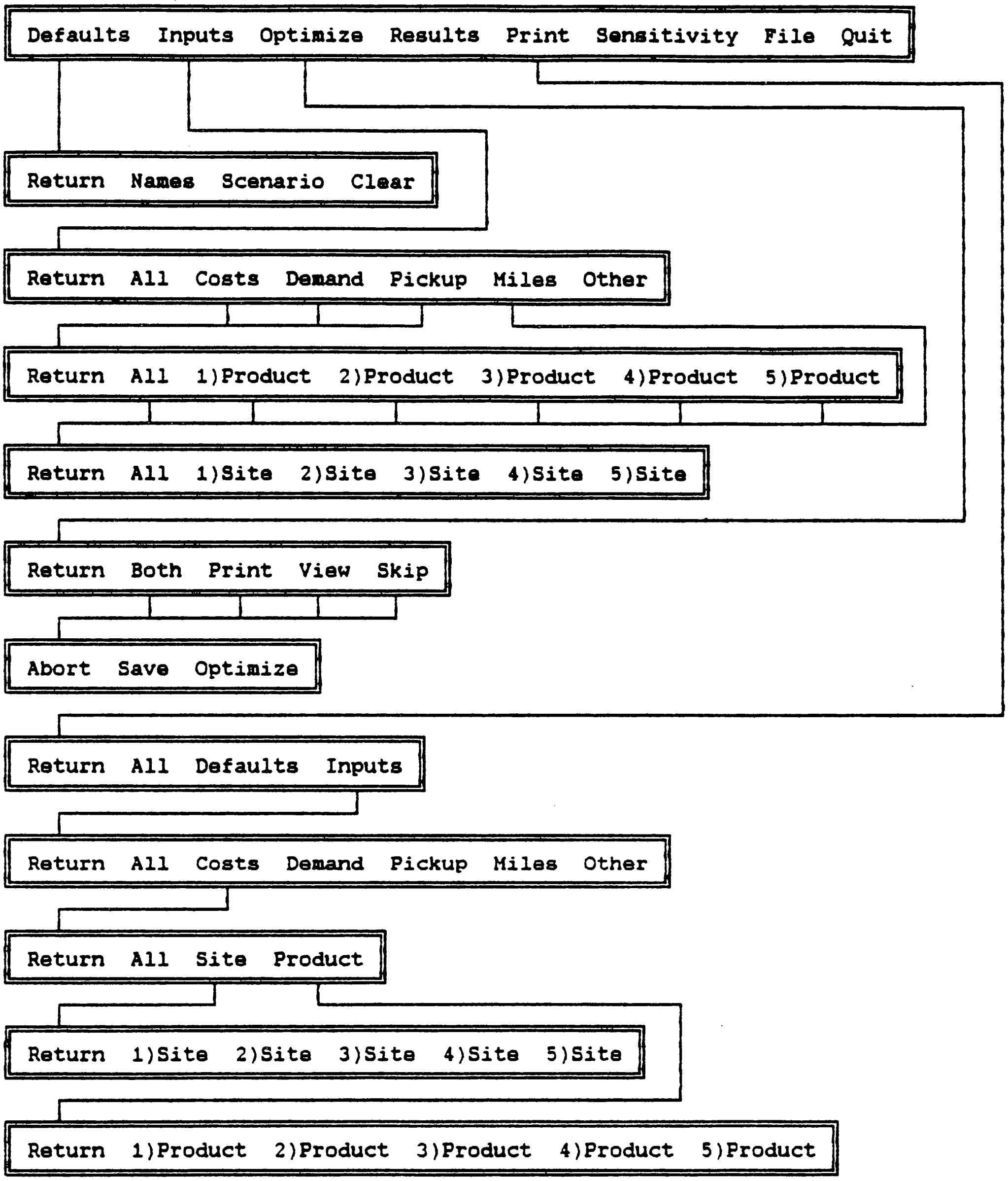
_____________ (DEMAND REGION 13).............._____________%

_____________ (DEMAND REGION 14).............._____________%

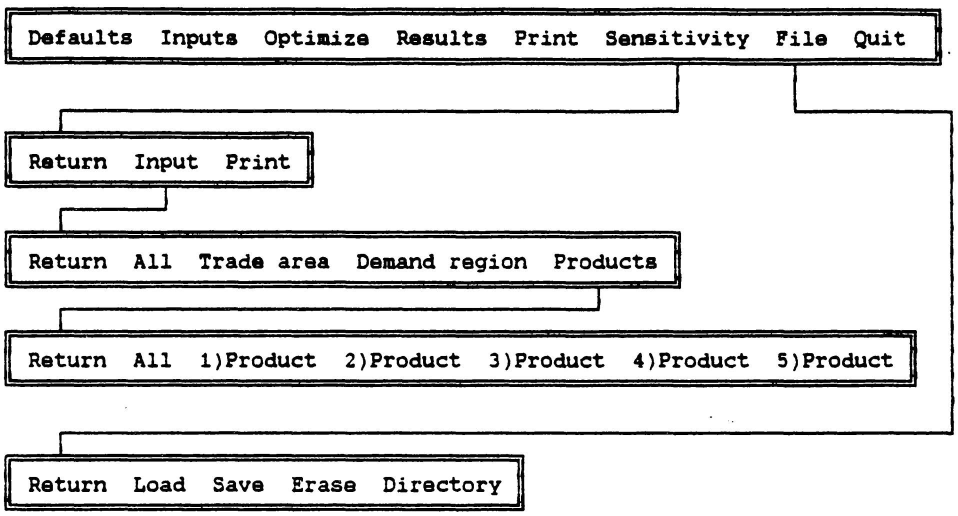
_____________ (DEMAND REGION 15).............._____________%

Appendix B - CRS Menu System

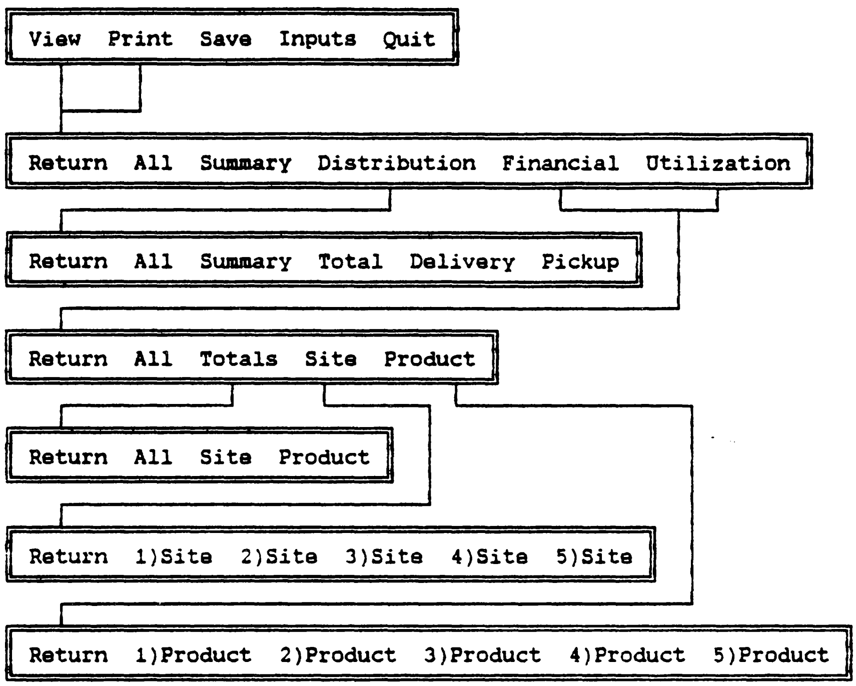
Input Section Menus



Input Section Menus (continued)



Results Section Menus



Appendix C - Possible CRS Errors

This section helps troubleshoot possible errors which might occur during the operation of the Cooperative Restructuring Simulator. The heading signifies the part of the program in which your are working when the error occurred. It is assumed that your copy of Lotus 1-2-3 is installed for your computer system and printer. If it is not, refer to your 1-2-3 manual for installation procedures. If you encounter problems while not in 1-2-3 or CRS, then the problem is related to Super VINO. Refer to you VINO manual for possible solutions.

Loading CRS

1. You might not have used the installation procedure when you loaded CRS on your hard disk. Follow the installation procedure given in Section 4.3.
2. Your hard drive might not have the required 2 megabytes of empty space. Erase some of the unnecessary files from the hard disk to get the required space.
3. You may have memory resident programs loaded in memory. Change your **AUTOEXEC.BAT** if necessary, and reboot your computer.
4. If you are using Lotus 1-2-3 Release 2.2, the UNDO feature may be enabled. Disable the UNDO feature.
5. You might not have renamed **123.EXE** to **123.COM**. Do so according to the installation procedure.

Operating CRS

1. You may be out of the CRS menu system. Press **<ALT-M>** to return to the menu system.

Optimizing a Scenario, Saving a File, or Going to the Results Section

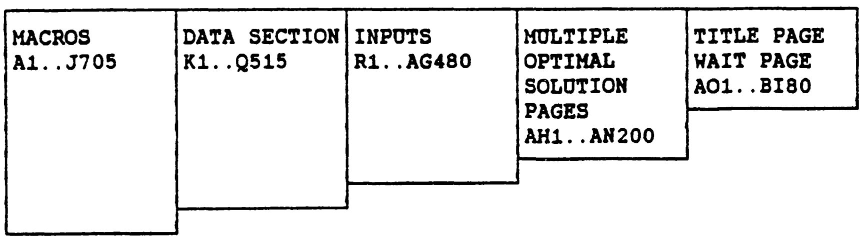
1. Your hard drive might not have the required 2 megabytes of empty space. Erase some of the unnecessary files from the hard disk to get the required space.
2. You may have memory resident programs loaded in memory. Change your **AUTOEXEC.BAT** if necessary, and reboot your computer.

Printing

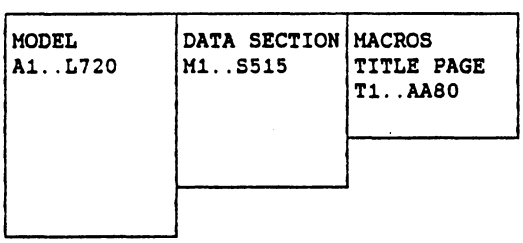
1. Your printer may not be turned on. Turn it on and try again.
2. Your printer may not be on line. Place it on line and try again.

Appendix D - Program Schematics

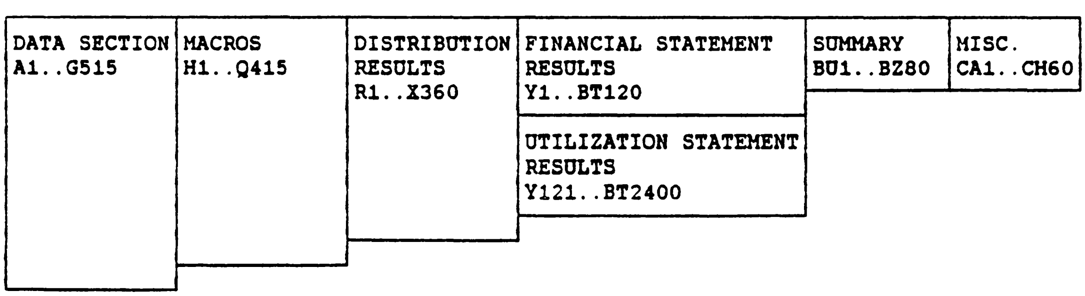
Input Section Schematic



Model Section Schematic



Results Section Schematic



Appendix E - Range Name Documentation

INPUT SECTION

Range Names	Address
ALL_BOTH	B246

A for-loop used to enter cost inputs for all sites and all products in the Input-Costs-All menu choice.

ALL_DEM_PU B274

A macro used to enter all demand inputs or all pickup inputs in the Input-Demand-All or the Input-Pickup-All menu choices.

ALL_INPUTS B294

A macro used to enter all inputs in the Input-All menu choice.

ALL_MILE B281

A macro used to enter all of the mileage inputs in the Input-Miles-All menu choice.

ALL_PROD B242

A for-loop used to enter cost inputs for all products in the Input-Costs-Product menu choice.

ALL_SENS B417

A macro used to enter all of the sensitivity inputs in the Sensitivity-Inputs-All menu choice.

ALL_SITE B244

A for-loop used to enter cost inputs for all supply sites in the Inputs-Costs-Site menu choice.

CHECK_CAPS B334

A macro used to view the capacity check page in the Optimize menu choice.

CHECK_DEFAULTS B38

A menu macro used to show the check menu for the Defaults menu choice.

CHECK_INPUT B248

A menu macro used to show the check menu for the Inputs menu choice.

CHECK_MENU B310

A menu macro which shows the initial menu for the Optimize menu choice.

CHECK_MESSAGE B361..B363

A message shown just before optimization for the Optimize menu choice.

CHECK_NAMES B51

A macro which is used to check the combined length of the product names so that they can fit in the menus. It is used in the Defaults-Names menu choice.

CHECK_PAGE AO21..BD40

The location of the capacity check page.

CHECK_PRINT B315

A macro which prints the scenario definition page and the capacity check page for the Optimize-Print or the Optimize-Both menu choices.

CHECK_SENS B445

A menu macro used to show the check menu for the sensitivity input pages for the Sensitivity-Input menu choice.

CHECK_SITES B47

A macro which is used to check the combined length of the supply site names so that they can fit in the menus. It is used in the Defaults-Names menu choice.

CHOOSE_KEY B218

A flag used in the Input menu choice.

CHOOSE_OTHER B263

A macro used to choose the correct macro for the Input menu choice.

CLEAR B59

A menu macro used to make sure the user knows that the scenario is about to be cleared in the Defaults-Clear menu choice.

CODE B386

A flag used in the Print macros.

CONTINUE B330

A menu macro used to prompt the user during the check pages in the Optimize menu choice.

COPY_NAMES B67

A macro used to make sure that the correct number of supply sites, products, and demand regions are displayed on the input pages after using the Defaults-Names menu choice.

COST_INPUT B222..B230

A macro used to display the correct cost input page for the Inputs-Costs menu choice.

COUNT B354

A counter used in several for-loops.

DEFAULT_MENU B25

A menu macro for the Defaults menu choice.

DESCRIPTION L166..L169

The location of the scenario description in the data transfer section.

DIR B387

A flag used in the Print macros.

DMP_INPUT B254..B261

A menu macro used to display to correct demand, pickup, or mileage input page for the Inputs-Demand, Inputs-Pickup, or Inputs-Miles menu choices.

DOWN_NUM B383

A flag used in the display of the check pages for the Optimize menu choice.

DO_FLAGS B184

A macro which displays the scenario definition page for the Defaults-Scenario menu choice.

DO_FLAGS_2 B191

A macro which displays the scenario definition page for the Defaults-Scenario menu choice if the user chooses to edit the previously entered scenario definition.

DR_NAMES BI43..BI57

The location of the demand region names.

D_NAME_1 BI43

The location of the name of demand region 1. The next several range names are the locations of the other demand region names.

D_NAME_2	BI44
D_NAME_3	BI45
D_NAME_4	BI46
D_NAME_5	BI47
D_NAME_6	BI48
D_NAME_7	BI49
D_NAME_8	BI50
D_NAME_9	BI51
D_NAME_10	BI52
D_NAME_11	BI53

D_NAME_12 BI54
D_NAME_13 BI55
D_NAME_14 BI56
D_NAME_15 BI57

EDIT_NOTE B152

A menu macro which clears or leaves the previous scenario name and description intact for the Defaults-Scenario menu choice.

ENTER_NAMES B31

A macro used to display the supply site, product, and demand region names input page for the Defaults-Names menu choice.

ENTER_SCEN B161

A macro used to display the scenario name and description input page for the Defaults-Scenario menu choice.

ERASE_DR B128

A macro used to display the correct number of demand regions in the input pages for the Defaults-Names menu choice.

ERASE_MENU B619

A menu macro used to make sure the user really wants to erase a scenario file for the Files-Erase menu choice.

ERASE_P B140

A macro used to display the correct number of products in the input pages for the Defaults-Names menu choice.

ERASE_S B134

A macro used to display the correct number of supply sites in the input pages for the Defaults-Names menu choice.

ERROR B689

A macro used when an error occurs.

ERROR_MENU B692

A menu macro used to display the error message when an error occurs.

FILE_MENU B595

A menu macro used to display the menu for the Files menu choice.

FINISH_FLAGS B167

A macro which returns the user to the main menu after the Defaults-Scenario menu choice is finished.

FLAG_PAGE AO1..BD20

The location of the scenario definition page.

FLAG_P_1 L162

A flag located in the data transfer section which tells the Model Section whether product 1 is used in the scenario. The next several range names are the locations of these flags for the other products.

FLAG_P_2	M162
FLAG_P_3	N162
FLAG_P_4	O162
FLAG_P_5	P162

FLAG_S_1 AQ9..AQ13

The location of the scenario definition for supply site 1. The next several range names are the locations for the other supply sites.

FLAG_S_2	AT9..AT13
FLAG_S_3	AW9..AW13
FLAG_S_4	AZ9..AZ13
FLAG_S_5	BC9..BC13

FOR_MENU B357

A menu macro used to display the prompt for the check pages for the Optimize menu choice.

FOR_STEP B338

A macro which displays the next check page for the Optimize menu choice.

GET_OUTPUTS B631

A macro used to display the appropriate warning menus when retrieving the Results Section for the Results menu option.

GOTO_OUTPUTS B643

A macro used to go to the Results Section for the Inputs Section for the Results menu choice.

INPUTS R1..AG480

The location of all of the input pages for the Inputs Section.

INPUT_CHOOSE B233

A macro which chooses the appropriate macro for the Inputs menu choice.

INPUT_FORMS K1..Q188

The location of the input part of the data transfer section.

INPUT_MENU B196

A menu macro which displays the menu for the Inputs menu choice.

INP_1_1 R1..Y18

The location of the costs input page for product 1 and supply site 1. The next several range names are the locations of the other costs input pages. The first number represents the product and the second number represents the supply site.

INP_1_2	Z1..AG18
INP_1_3	R41..Y58
INP_1_4	Z41..AG58
INP_1_5	R81..Y98
INP_2_1	R141..Y158
INP_2_2	Z141..AG158

INP_2_3	R161..Y178
INP_2_4	Z161..AG178
INP_2_5	R181..Y198
INP_3_1	R221..Y238
INP_3_2	Z221..AG238
INP_3_3	R241..Y258
INP_3_4	Z241..AG258
INP_3_5	R261..Y278
INP_4_1	R301..Y318
INP_4_2	Z301..AG318
INP_4_3	R321..Y338
INP_4_4	Z321..AG338
INP_4_5	R341..Y358
INP_5_1	R381..Y398
INP_5_2	Z381..AG398
INP_5_3	R401..Y418
INP_5_4	Z401..AG418
INP_5_5	R421..Y438

INP_1_DEM R121..Y139

The location of the demand input page for product 1. The next several range names are the locations of the other demand input pages. The number represents the product.

INP_2_DEM	R201..X218
INP_3_DEM	R281..Y299
INP_4_DEM	R361..Y379
INP_5_DEM	R441..Y459

INP_1_PU Z101..AG119

The location of the pickup input page for product 1. The next several range names are the locations of the other pickup input pages. The number represents the product.

INP_2_PU	Z201..AG219
INP_3_PU	Z281..AG299
INP_4_PU	Z361..AG379
INP_5_PU	Z441..AG459

INP_1_SA Z81..AG99

The location of the sensitivity input page for product 1. The next several range names are the locations of the other sensitivity input pages. The number represents the product.

INP_2_SA	Z181..AG199
INP_3_SA	Z261..AG279
INP_4_SA	Z341..AG359

INP_5_SA Z421..AG439

INP_D_NAMES L172..L186

The location of the demand region names in the data transfer section.

INP_MF_1 R21..Y39

The location of the mileage input pages for supply site 1. The next several range names are the locations of the other mileage input pages. The number represents the supply site.

INP_MF_2 Z21..AG39
INP_MF_3 R61..Y79
INP_MF_4 Z61..AG79
INP_MF_5 R101..Y119

INP_P_NAMES P172..P176

The location of the product names in the data transfer section.

INP_S_NAMES N172..N176

The location of the supply site names in the data transfer section.

KEY B479

A flag used in the Print macros.

LENGTH_P B45

The formula which determines the combined lengths of the product names.

LENGTH_S B44

The formula which determines the combined lengths of the supply site names.

LOAD B602

A macro which loads a new scenario file for the File-Load menu choice.

MACROS A1..J702

The location of the Input Section macros.

MAIN_MENU B19

The menu macro for the Input Section main menu.

MENU B13

A macro which accesses the main menu macro.

MENU_NAME BF4

The location of the running menu indicator on the title page.

MESSAGE BF22..BF24

The location of the message on the scenario name and description input page.

MULT AH1..AN200

The location of the multiple optimal check pages.

MULT_FOR B342

A macro which contains the for-loop for viewing the multiple optimal check pages for the Optimize menu choice.

NAME L164

The location of the scenario name.

NAMES BE41..BI58

The location of the input page where the names of the products, supply sites, and demand regions are entered.

NAME_ERROR B55

A menu macro which tells the user that the combined lengths of the supply site or product lines names are too long. Used in the Defaults-Names menu choice.

NO_ERASE B65

A macro which clears the scenario if no temporary model file is present. Used in the Defaults-Clear menu choice.

NO_OPT B635

A menu macro which warns the user when the present scenario has not been optimized before going to the Results Section. Used in the Results menu choice.

NO_TEMPMOD B380

A macro which retrieves the Model Section when no temporary model file is present. Used in the Optimize menu choice.

NUM B355

A counter used in the viewing of the check pages for the Optimize menu choice.

OPT B373

A macro which retrieves the temporary model section for optimization. Used in the Optimize menu choice.

OPTIMIZE B306

A macro which displays the optimize information page and displays the Optimize menu.

OPT_CODE B371

A flag which reports whether the current scenario has been optimized.

OPT_MENU B365

A menu macro which is the final warning before optimization for the Optimize menu.

OPT_WARN A041

The location of the optimize information page.

OTHER B287

A macro which displays the pickup cost, general price margin, and overhead cost input page for the Inputs-Other menu choice.

OTHER_PG Z121..AG140

The location of the inputs mentioned above.

OUTPUT_FORMS K188..Q515

The location of the outputs in the data transfer section.

OUT_CHECK B648

A macro which checks to see if the user is retrieving the Input Section or using the Save menu choice of the Results Section.

OUT_CODE B629

A flag which reports if the user has selected the Save menu choice of the Results Section.

OUT_MENU B639

A menu macro which reminds the user to save the current scenario before going to the Results Section. Used in the Results menu option.

PAGE_BREAK B503

A macro which lets the printer know where to put page breaks. Used throughout all print macros.

PRE_OPT B347

A macro which displays the last warning menu before optimization. Used in the Optimization menu choice.

PRINTOFF B672

A macro which turns off the print wait screen. Used throughout the print macros.

PRINTON B668

A macro which turns on the print wait screen. Used throughout the print macros.

PRINT_ALL B469

A macro which prints all inputs pages. Used in the Print menu choice.

PRINT_ALL_INP B508

A macro which prints all inputs (excluding the default pages). Used in the Print-Inputs menu choice.

PRINT_COST_ALL B586

A macro which prints all cost inputs. Used in the Print-Inputs-Costs menu choice.

PRINT_COST_MENU B521

A menu macro which displays the Print-Inputs-Costs menu.

PRINT_COUNT B478

A flag used by the print macros.

PRINT_DEF B488

A macro used by the Print-Defaults menu option which prints the default pages.

PRINT_DMP B551..B559

A macro used to print the demand, pickup, or mileage input pages. Used by the Print-Inputs menu option.

PRINT_INP_MENU B493

A menu macro which contains the menu for the Print-Inputs option.

PRINT_INP_PROD B575..B584

A macro which prints the cost inputs for given products. Used by the Print-Inputs-Costs menu option.

PRINT_INP_SITE B564..B573

A macro which prints the cost inputs for given supply sites. Used by the Print-Inputs-Costs menu option.

PRINT_MENU B462

A menu macro for the Print option of the main menu.

PRINT_MESSAGE B675..B676

A message displayed during printing.

PRINT_MULT B322

A macro which prints the multiple optimal solution pages for the Optimize menu choice.

PRINT_OTHER B561

A macro which prints the other inputs page (pickup cost, overhead cost, and general price margins). Used in the Print-Inputs-Other option.

PRINT_PREP B482..B486

A macro which puts the header into each printed page. Used by all print macros.

PRINT_PROD B540

A menu macro which displays the products for printing the cost inputs by product. Used by the Print-Inputs-Costs menu.

PRINT_SITE B529

A menu macro which displays the supply sites for printing the cost inputs by supply site. Used by the Print-Inputs-Costs menu.

PRINT_WARN B684

A menu macro which reminds the user to make sure the printer is ready before printing.

PROD B220

A flag used by the input and print macros.

PROD_MENU B204

A menu macro used by the input macros to choose the correct product for which to enter inputs.

PROD_SENS B406

A menu macro used by the Sensitivity-Inputs-Product option to choose the correct product for which to enter sensitivity inputs.

P_FLAGS L162..P162

The location of all of the flags which signify whether a product is sold in a scenario.

P_NAMES BG50..BG54

The location of the product names.

P_NAME_1 BG50

The location of product name 1. The next few range names are the locations of the other product names.

P_NAME_2	BG51
P_NAME_3	BG52
P_NAME_4	BG53
P_NAME_5	BG54

QUIT_MENU B624

A menu macro which checks to see if the user actually wants to leave CRS. Used by the Quit option.

REPLACE B613

A menu macro which checks to see if the user wants to replace a scenario file when saving or cancel the command to give the scenario a new name. Used by the File-Save option.

SAVE B606

A macro for saving a scenario. Used by the File-Save option.

SAVE_RES B696

A macro for saving a scenario from the Results Section. Used by the Save menu choice from the Results Section.

SA_ALL Z461..AG479

The location of the general trade area sensitivity inputs.

SA_INPUT B435..B443

A macro which displays the sensitivity inputs for the Sensitivity-Inputs menu option.

SA_PROD R461..Y479

The location of the sensitivity inputs for all products for each product line.

SCENARIO B146

A macro which displays the scenario name and description for the Defaults-Scenario option.

SCEN_MESSAGE B157..B159

A message which is displayed during the entry of the scenario name and description for the Defaults-Scenario option.

SCEN_NAME BF13

The location of the scenario name.

SCEN_NOTE BF16..BF19

The location of the scenario description.

SCEN_PAGE BE11..BI25

The location of the input page for the scenario name and description.

SENS_CODE B428

A flag used in the sensitivity macros.

SENS_MENU B389

A menu macro for the Sensitivity menu choice.

SENS_MENU_2 B396

A menu macro for the Sensitivity-Input choice.

SENS_PRINT B450

A macro for printing all of the sensitivity input pages for the Sensitivity-Print option.

SITE B219

A flag used by the input and print macros.

SITE_MENU B213

A menu macro for entering inputs on a site basis. Used by several input options.

START B6

A macro for starting the Inputs section of CRS.

STOP B382

A flag for stopping for-loops.

STOP_PRINT B474

A macro for interrupting long print jobs.

S_NAMES BG43..BG47

The location of the supply site names.

S_NAME_1 BG43

The location of the names of supply site 1. The next few range names are the locations of the other supply site names.

S_NAME_2 BG44
S_NAME_3 BG45
S_NAME_4 BG46
S_NAME_5 BG47

TA_SENS B430

A macro for entry of the sensitivity analysis for the entire trade area. Used in the Sensitivity-Input-Trade Area option.

TEST B385

A flag formula used in the print macros.

TIME B480

A formula used to display the time in the header of all printouts.

TITLE B15

A macro for displaying the title page.

TITLE_PAGE BE1

The location of the title page.

TRANSFER B589

A macro for transferring the data transfer section to the Results Section.

TYPE B384

A flag used by the print macros.

UNPRO_FLAGS B171

A macro which readies the scenario definition page for input entry.

WAITOFF B664

A macro which turns the wait page off.

WAITON B658

A macro which turns the wait page on.

WAIT_MESSAGE BF72..BF73

The location for messages on the wait page.

WAIT_PAGE BE61

The location of the wait page.

WIN B703

A macro which controls the windowson and windowsoff process.

\0 B3

The autoexec macro.

\M B9

The macro which starts the main menu.

MODEL SECTION

Range Name	Address
&FIX_ALL	M1..Y720

The location of the model section which is not optimized by Super VINO.

ABORT U56

A macro which aborts from the Model Section if any errors occur.

CREATE_NAME U28

A macro which creates &FIX range names for those products which are not sold in the trade area.

DELETE_NAME U35

A macro which deletes the &FIX range names created by CREATE_NAME.

DESCRIPTION N166..N169

The location of the scenario description in the data transfer section.

ERROR U46

A macro in case of errors.

ERROR_AGAIN U58

Another macro in case of errors.

ERROR_MENU U50

A menu shown in case of errors.

ERROR_NOTE U44

A message in case of errors.

FLAG_P_1 N162

The location of the flag which reports which products are sold. The next few range names are these same flags for the other products.

FLAG_P_2 O162
FLAG_P_3 P162
FLAG_P_4 Q162
FLAG_P_5 R162

INPUT_FORMS M1..S188

The location of the inputs section of the data transfer section.

MIN A2

The location of the objective function of the LP model.

NAME N164

The location of the scenario name in the data transfer section.

OPT U6

A macro used to prepare the model for optimization.

OPT_CODE U4

A flag which reports whether the model has been optimized.

OPT_NOTE U42

A message displayed prior to optimization.

OUT U19

A macro used to prepare for the Results Section after optimization.

OUTPUT_FORMS M188..S514

The location of the outputs section of the data transfer section.

OUT_NOTE U43

A message displayed after optimization.

PROD_1 A4..L146

The location of the product 1 portion of the model. The next several range names are the locations of the other products in the model.

PROD_2 A148..L290
PROD_3 A292..L434
PROD_4 A436..L578
PROD_5 A580..L721

SCEN_NAME IV8192

The location of the scenario name on the title page.

SCEN_NOTE U76..U79

The location of the scenario description on the title page.

TITLE_NOTE U76

The location of the messages on the title page.

TITLE_PAGE T61..AA80

The location of the title page.

\0 U1

The autoexec macro.

\M U1

A macro which displays the main menu.

RESULTS SECTION

Range Names	Addresses

ALL_FIN BR95

A macro which contains the for-loop for displaying all of the results screens for the View-Financial-All or the View-Utilization-All options.

ALL_FIN_FOR BR101

A macro which displays the results screens for the View-Financial-All or the View-Utilization-All options. Called by the for-loop in ALL_FIN.

ALL_RESULTS BR44

A macro which displays all results screens for the View-All option.

CHOOSE_KEY BR31

A flag used in the view macros.

CODE BR126

A flag used in the view macros.

COUNT BR34

A counter used in several for-loops.

DESCRIPTION B166..B169

The location of the scenario description in the data transfer section.

DIR BR127

A flag used in the view macros.

DIST_DEL_1 H141..N160

The location of the delivery distribution page for product 1. The next several range names are the locations of these pages for the other products.

DIST_DEL_2 H161..N180
DIST_DEL_3 H181..N200

DIST_DEL_4 H201..N220
DIST_DEL_5 H221..N240

DIST_DEL_ALL H121..N140

The location of the delivery distribution page for all products combined.

DIST_GO BR81

A macro which contains a for-loop for viewing the distribution pages for the View-Distribution option.

DIST_MENU BR71

A menu macro for the View-Distribution option.

DIST_PU_1 H261..N280

The location of the pickup distribution page for product 1. The next several range names are the locations of these pages for the other products.

DIST_PU_2 H281..N300
DIST_PU_3 H301..N320
DIST_PU_4 H321..N340
DIST_PU_5 H341..N360

DIST_PU_ALL H241..N260

The location of the pickup distribution page for all products.

DIST_TOT_1 H21..N40

The location of the total distribution page for product 1. The next several range names are the locations of these pages for the other products.

DIST_TOT_2 H41..N60
DIST_TOT_3 H61..N80
DIST_TOT_4 H81..N100
DIST_TOT_5 H101..N120

DIST_TOT_ALL H1..N20

The location of the total distribution page for all products.

DOWN_NUM BR79

A counter used in the for-loops of the view macros.

DR_NAMES B172..B186

The location of the demand region names in the data transfer section.

D_NAME_1 B172

The location of the name for demand region 1. The next several range names are the locations of the other demand region names.

D_NAME_2	B173
D_NAME_3	B174
D_NAME_4	B175
D_NAME_5	B176
D_NAME_6	B177
D_NAME_7	B178
D_NAME_8	B179
D_NAME_9	B180
D_NAME_10	B181
D_NAME_11	B182
D_NAME_12	B183
D_NAME_13	B184
D_NAME_14	B185
D_NAME_15	B186

ERROR BR373

A macro used when an error occurs.

ERROR_MENU BR376

A menu macro used in case of errors.

FIN_MENU BR88

A menu macro used for the View-Financial and View-Utilization options.

FOR_MENU BR67

A menu macro which displays the prompt when viewing results pages.

FOR_STEP	BR63

A macro used to display the next results page during viewing.

INC_1_1	W21..AD40

The location of the financial statement for product 1 and supply site 1. The next several range names are the locations of the financial statements for the other products and supply sites. The first number represents the product and the second number represents the supply site.

INC_1_2	AE21..AL40
INC_1_3	AM21..AT40
INC_1_4	AU21..BB40
INC_1_5	BC21..BJ40
INC_2_1	W41..AD60
INC_2_2	AE41..AL60
INC_2_3	AM41..AT60
INC_2_4	AU41..BB60
INC_2_5	BC41..BJ60
INC_3_1	W61..AD80
INC_3_2	AE61..AL80
INC_3_3	AM61..AT80
INC_3_4	AU61..BB80
INC_3_5	BC61..BJ80
INC_4_1	W81..AD100
INC_4_2	AE81..AL100
INC_4_3	AM81..AT100
INC_4_4	AU81..BB100
INC_4_5	BC81..BJ100
INC_5_1	W101..AD120
INC_5_2	AE101..AL120
INC_5_3	AM101..AT120
INC_5_4	AU101..BB120
INC_5_5	BC101..BJ120

INC_1_ALL	O21..V40

The location of the financial statement for all supply sites for product 1. The next several range names are the locations of these pages for the other products.

INC_2_ALL	O41..V60
INC_3_ALL	O61..V80
INC_4_ALL	O81..V100
INC_5_ALL	O101..V120

INC_ALL_1 W1..AD20

The location of the financial statements for all products for supply site 1. The next several range names are the locations of these pages for the other products.

INC_ALL_2 AE1..AL20
INC_ALL_3 AM1..AT20
INC_ALL_4 AU1..BB20
INC_ALL_5 BC1..BJ20

INC_ALL_ALL O1..V20

The location of the financial statement for all products and all supply sites.

INPUT_FORMS A1..G188

The location of the input data in the data transfer section.

KEY BR188

A flag used in the print macros.

MACROS BQ1..BZ379

The location of the macros.

MAIN_MENU BR25

A menu macro for the main menu.

MENU BR20

A macro which call the main menu.

MENU_NAME CB4

The location of the menu indicator on the title page.

NAME B164

The location of the scenario name in the data transfer section.

NUM BR35

A counter used in the view macros.

OUTPUTS O1..BP360

The location of the results pages.

OUTPUT_FORMS A188..G515

The location of the results in the data transfer section.

OUT_CODE BR351

A flag used in the Save option.

PAGE_BREAK BR197

A macro used in the Print options to place page breaks in the correct locations.

PRINTOFF BR361

A macro which turns off the print wait screen.

PRINTON BR357

A macro which turns on the print wait screen.

PRINT_ALL_DIST BR245

A macro which prints all of the distribution pages for the Print-Distribution-All option.

PRINT_ALL_FIN BR275

A macro which prints all of the financial statements or utilization statements for the Print-Financial-All or Print-Utilization-All options.

PRINT_ALL_RES BR209

A macro which prints all of the results pages for the Print-All menu choice.

PRINT_ALL_TOT BR336

A macro which prints all of the total financial statements or total utilization statements for the Print-Financial-Totals-All or Print-Utilization-Totals-All menu choices.

PRINT_COUNT BR187

A counter used for print for-loops.

PRINT_DIST BR234..BR243

A macro used to print the distribution pages for the Print-Distribution choice.

PRINT_DIST_MENU BR224

A menu macro used for the Print-Distribution menu choice.

PRINT_FIN BR255..BR265

A macro used to print the financial statements or the utilization statements for the Print-Financial or the Print-Utilization statements.

PRINT_FIN_UTIL BR267

A menu macro used by the Print-Financial and the Print-Utilization choices.

PRINT_MESSAGE BR365..BR366

A message displayed on the print wait screen.

PRINT_PREP BR191..BR195

A macro which places the header on each printed page.

PRINT_PROD_FIN BR295

A menu macro used for the Print-Financial-Product and the Print-Utilization-Product menu choices.

PRINT_RES_MENU BR202

A menu macro used for the Print menu choice.

PRINT_SITE_FIN BR305

A menu macro used for the Print-Financial-Site and the Print-Utilization-Site menu choices.

PRINT_SUMM BR217

A macro which prints the summary results pages for the Print-Summary option.

PRINT_TOT BR317..BR334

A macro used to print the total financial or utilization statements for the Print-Financial-Total or the Print-Financial-Total options.

PRINT_TOT_FIN BR283

A menu macro used for the Print-Financial-Total and the Print-Utilization-Total menu choices.

PRINT_WARN BR368

A menu macro which reminds the user to make sure that the printer is ready before printing.

PROD BR33

A flag used in the view and print macros.

PROD_FIN_MENU BR154

A menu macro used in the View-Financial-Product and View-Utilization-Product menu options.

P_NAMES F172..F176

The location of the product names.

P_NAME_1 F172

The location of the name of product 1. The next several macros are the locations of the other product names.

P_NAME_2 F173
P_NAME_3 F174
P_NAME_4 F175
P_NAME_5 F176

QUIT_MENU BR342

A menu macro which warns the user before leaving CRS.

RESULTS_MENU BR37

A menu macro used for the View menu option.

SAVE BR347

A macro used to save the current scenario. Used by the Save option.

SCEN_NAME CB13

The location of the scenario name on the title page.

SCEN_NOTE CB16..CB19

The location of the scenario description on the title page.

SITE BR32

A flag used in the view and print macros.

SITE_FIN_MENU BR166

A menu macro used in the View-Financial-Site and the View-Utilization-Site menu choices.

STOP BR78

A counter used by the view and print for-loops.

STOP_PRINT BR183

A macro for interrupting long print jobs.

SUMMARY BR58

A macro for viewing the summary results pages for the View-Summary option.

SUMM_1 BK1..BP20

The location of the summary page for sales volumes.

SUMM_2 BK21..BP40

The location of the summary page for net incomes.

SUMM_3 BK41..BP60

The location of the summary page for product/storage utilization.

SUMM_4 BK61..BP80

The location of the summary page for delivery utilization.

S_NAMES D172..D176

The location of the supply site names.

S_NAME_1 D172

The location of the name of supply site 1. The next several range names are the locations of the other supply site names.

S_NAME_2 D173
S_NAME_3 D174
S_NAME_4 D175
S_NAME_5 D176

TEST BR125

A flag formula used by the view and print macros.

TIME BR189

A formula for placing the time in the header of the printed pages.

TITLE BR22

A macro for displaying the title page.

TITLE_PAGE CA1

The location of the title page.

TOT_ALL BR141

A macro for displaying the total financial or total utilization statements for the View-Financial-Total or the View Utilization-Total options.

TOT_MENU BR107

A menu macro used for the View-Financial-Total and the View-Utilization-Total menu choices.

TOT_START BR117

A macro which start the viewing process for the total financial or total utilization statements for the View-Financial-Total or the View-Utilization-Total options.

TYPE BR124

A flag used by the print and view macros.

UTIL_1_1 W141..AD158

The location of the utilization statement for product 1 and supply site 1. The next several range names are the locations of the other utilization statements. The first number represents the product and the second number represents the supply site.

UTIL_1_2	AE141..AL158
UTIL_1_3	AM141..AT158
UTIL_1_4	AU141..BB158
UTIL_1_5	BC141..BJ158
UTIL_2_1	W161..AD178
UTIL_2_2	AE161..AL178
UTIL_2_3	AM161..AT178
UTIL_2_4	AU161..BB178
UTIL_2_5	BC161..BJ178
UTIL_3_1	W181..AD198
UTIL_3_2	AE181..AL198
UTIL_3_3	AM181..AT198
UTIL_3_4	AU181..BB198
UTIL_3_5	BC181..BJ198
UTIL_4_1	W201..AD218
UTIL_4_2	AE201..AL218
UTIL_4_3	AM201..AT218
UTIL_4_4	AU201..BB218
UTIL_4_5	BC201..BJ218
UTIL_5_1	W221..AD238
UTIL_5_2	AE221..AL238
UTIL_5_3	AM221..AT238
UTIL_5_4	AU221..BB238
UTIL_5_5	BC221..BJ238

UTIL_1_ALL O141..V158

The location of the utilization statement for all supply sites for product 1. The next several range names are the locations of these statements for the other products.

UTIL_2_ALL	O161..V178
UTIL_3_ALL	O181..V198
UTIL_4_ALL	O201..V218
UTIL_5_ALL	O221..V238

UTIL_ALL_1 W121..AD138

The location of the utilization statement for all products for supply site 1. The next several range names are the locations for these statements for the other supply sites.

UTIL_ALL_2	AE121..AL138
UTIL_ALL_3	AM121..AT138
UTIL_ALL_4	AU121..BB138
UTIL_ALL_5	BC121..BJ138

UTIL_ALL_ALL O121..V138

The location of the utilization statement for all products and all supply sites.

VIEW_IT BR129

A macro used to view the results pages. Used by several view macros.

VIEW_MENU BR137..BR139

A menu macro used for the View option.

VIEW_START BR178

A macro used to start the view process. Used by several view macros.

VIEW_STEP BR133

A macro used for the view process. Used by several view macros.

WAITON BR353

A macro which turns on the wait screen.

WAIT_MESSAGE CB52..CB53

A location of the message displayed on the wait screen.

WAIT_PAGE CA41

The location of the wait screen.

WIN I413

A macro which controls the windowson and windowsoff process.

\0 BR3

The autoexec macro.

\M BR16

The macro which calls the main menu.

APPENDIX 3

COOPERATIVE RESTRUCTURING SIMULATOR

This appendix includes the diskette for the Cooperative Restructuring Simulator. The scenario file for the revised baseline scenario is included. You must supply your own copy of Super VINO and Lotus 1-2-3 in order to use CRS.

If this diskette is missing, please contact Dr. William J. Taylor at the address given in the help section at beginning of Appendix 2.

Please see the librarian for a copy of the diskette.

APPENDIX 4
DEMAND SENSITIVITY ANALYSIS

Original Baseline Scenario

AGRICULTURAL CHEMICALS

	Delivery		Pickup	
Demand Region	Range up	Range Down	Range up	Range Down
40330	$0	$0	$149,528	$59,198
40372	$0	$0	$149,528	$14,188
40419	$0	$0	$58,231	$21,658
40422	$0	$0	$63,123	$130,476
40437	$0	$0	$125,114	$18,100
40444	$0	$0	$140,346	$73,508
40484	$0	$0	$58,231	$57,211
40489	$0	$0	$58,231	$11,002
42539	$0	$0	$125,114	$47,814
EAST	$0	$0	$140,346	$7,368
NORTH	$0	$0	$149,528	$16,672
SOUTH	$0	$0	$125,114	$19,600
WEST	$0	$0	$63,123	$31,401

FARM SUPPLIES

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$0	$0	$644,461	$412,130
40372	$0	$0	$644,461	$63,556
40419	$0	$0	$374,387	$40,097
40422	$0	$0	$762,514	$392,486
40437	$0	$0	$84,884	$54,216
40444	$0	$0	$126,665	$277,853
40484	$0	$0	$374,387	$236,213
40489	$0	$0	$374,387	$44,861
42539	$0	$0	$84,884	$241,468
EAST	$0	$0	$126,665	$48,670
NORTH	$0	$0	$644,461	$40,208
SOUTH	$0	$0	$84,884	$60,569
WEST	$0	$0	$644,461	$82,926

FEED

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$210,672	$513,938	$1,238,704	$133,339
40372	$11,419	$5,304	$1,238,704	$42,996
40419	$210,672	$90,807	$757,455	$25,882
40422	$210,672	$24,028	$757,455	$23,794
40437	$210,672	$30,720	$461,144	$10,295
40444	$11,419	$5,304	$117,546	$23,794
40484	$210,672	$219,156	$757,455	$73,951
40489	$210,672	$70,078	$757,455	$20,708
42539	$234,463	$168,952	$461,144	$91,254
EAST	$210,672	$5,304	$117,546	$23,794
NORTH	$11,419	$5,304	$1,238,704	$23,123
SOUTH	$234,463	$59,143	$461,144	$26,771
WEST	$210,672	$11,754	$1,238,704	$32,869

FERTILIZER

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$44,093	$114,495	$1,951,898	$43,631
40372	$865,325	$31,180	$1,951,898	$1,370
40419	$44,093	$64,915	$1,860,749	$12,346
40422	$44,093	$114,495	$2,301,558	$17,449
40437	$44,093	$43,051	$44,093	$13,955
40444	$865,325	$316,991	$865,325	$111,028
40484	$865,325	$114,495	$1,860,749	$23,133
40489	$44,093	$114,495	$1,860,749	$6,726
42539	$44,093	$114,495	$44,093	$69,083
EAST	$865,325	$72,839	$865,325	$4,823
NORTH	$865,325	$13,696	$1,951,898	$541
SOUTH	$44,093	$77,893	$44,093	$14,693
WEST	$44,093	$39,444	$2,301,558	$10,593

PETROLEUM

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$1,128,278	$93,763	$1,128,278	$4,019
40372	$1,128,278	$25,839	$1,128,278	$1,192
40419	$1,128,278	$89,551	$1,128,278	$1,272
40422	$1,128,278	$253,408	$1,128,278	$28,658
40437	$1,128,278	$17,256	$1,128,278	$349
40444	$1,128,278	$47,132	$1,128,278	$3,260
40484	$1,128,278	$136,384	$1,128,278	$424
40489	$1,128,278	$57,031	$1,128,278	$327
42539	$0	$0	$1,128,278	$1,966
EAST	$1,128,278	$5,478	$0	$0
NORTH	$1,128,278	$39,825	$1,128,278	$350
SOUTH	$1,128,278	$3,270	$1,128,278	$635
WEST	$1,128,278	$110,998	$1,128,278	$7,755

Revised Baseline Scenario

AGRICULTURAL CHEMICALS

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$0	$0	$149,528	$59,198
40372	$0	$0	$149,528	$14,188
40419	$0	$0	$58,231	$21,658
40422	$0	$0	$63,123	$130,476
40437	$0	$0	$125,114	$18,100
40444	$0	$0	$140,346	$73,508
40484	$0	$0	$58,231	$57,211
40489	$0	$0	$58,231	$11,002
42539	$0	$0	$125,114	$47,814
EAST	$0	$0	$140,346	$7,368
NORTH	$0	$0	$149,528	$16,672
SOUTH	$0	$0	$125,114	$19,600
WEST	$0	$0	$63,123	$31,401

FARM SUPPLIES

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$0	$0	$644,461	$412,130
40372	$0	$0	$644,461	$63,556
40419	$0	$0	$374,387	$40,097
40422	$0	$0	$762,514	$392,486
40437	$0	$0	$84,884	$54,216
40444	$0	$0	$126,665	$277,853
40484	$0	$0	$374,387	$236,213
40489	$0	$0	$374,387	$44,861
42539	$0	$0	$84,884	$241,468
EAST	$0	$0	$126,665	$48,670
NORTH	$0	$0	$644,461	$40,208
SOUTH	$0	$0	$84,884	$60,569
WEST	$0	$0	$644,461	$82,926

FEED

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$210,672	$513,938	$1,238,704	$133,339
40372	$11,419	$5,304	$1,238,704	$42,996
40419	$210,672	$90,807	$757,455	$25,882
40422	$210,672	$24,028	$757,455	$23,794
40437	$210,672	$30,720	$461,144	$10,295
40444	$11,419	$5,304	$117,546	$23,794
40484	$210,672	$219,156	$757,455	$73,951
40489	$210,672	$70,078	$757,455	$20,708
42539	$234,463	$168,952	$461,144	$91,254
EAST	$210,672	$5,304	$117,546	$23,794
NORTH	$11,419	$5,304	$1,238,704	$23,123
SOUTH	$234,463	$59,143	$461,144	$26,771
WEST	$210,672	$11,754	$1,238,704	$32,869

FERTILIZER

Demand Region	Delivery Range up	Delivery Range Down	Pickup Range up	Pickup Range Down
40330	$44,093	$114,495	$1,951,898	$43,631
40372	$865,325	$31,180	$1,951,898	$1,370
40419	$44,093	$64,915	$1,860,749	$12,346
40422	$44,093	$114,495	$2,301,558	$17,449
40437	$44,093	$43,051	$44,093	$13,955
40444	$865,325	$316,991	$865,325	$111,028
40484	$865,325	$114,495	$1,860,749	$23,133
40489	$44,093	$114,495	$1,860,749	$6,726
42539	$44,093	$114,495	$44,093	$69,083
EAST	$865,325	$72,839	$865,325	$4,823
NORTH	$865,325	$13,696	$1,951,898	$541
SOUTH	$44,093	$77,893	$44,093	$14,693
WEST	$44,093	$39,444	$2,301,558	$10,593

PETROLEUM

	Delivery		Pickup	
Demand Region	Range up	Range Down	Range up	Range Down
40330	$1,128,278	$93,763	$4,019	$1,128,278
40372	$1,128,278	$25,839	$1,192	$1,128,278
40419	$1,128,278	$89,551	$1,272	$1,128,278
40422	$1,128,278	$253,408	$28,658	$1,128,278
40437	$1,128,278	$17,256	$349	$1,128,278
40444	$1,128,278	$47,132	$3,260	$1,128,278
40484	$1,128,278	$136,384	$424	$1,128,278
40489	$1,128,278	$57,031	$327	$1,128,278
42539	$0	$0	$1,966	$1,128,278
EAST	$1,128,278	$5,478	$0	$0
NORTH	$1,128,278	$39,825	$350	$1,128,278
SOUTH	$1,128,278	$3,270	$635	$1,128,278
WEST	$1,128,278	$110,998	$7,755	$1,128,278

APPENDIX 5
HISTORIC SALES AND PRICE INDEX

Sales of the Five Supply Sites for 1981-1988 in dollars

	FEED VOLUME							
SUPPLY SITE	1988	1987	1986	1985	1984	1983	1982	1981
Boyle	108,564	176,497	192,145	227,283	308,527	278,550	231,175	300,070
Harrodsburg	994,899	437,367	900,659	689,007	638,372	745,211	748,628	765,477
Lancaster	354,714	348,905	314,209	241,813	455,900	386,035	343,487	304,976
Liberty	326,716	247,896	183,841	157,036	164,677	98,052	93,810	
Stanford	695,954	657,152	568,505	510,403	661,956	523,418	425,176	524,633

	FERTILIZER VOLUME							
SUPPLY SITE	1988	1987	1986	1985	1984	1983	1982	1981
Boyle	341,733	322,970	356,204	377,817	459,974	383,708	499,380	413,822
Harrodsburg	317,591	318,456	349,662	405,243	387,145	426,770	460,418	487,497
Lancaster	411,666	368,605	366,557	436,541	504,707	444,716	516,448	503,971
Liberty	491,125	453,701	395,227	446,071	325,688	340,562	300,834	
Stanford	440,473	359,421	374,508	436,090	497,787	392,057	458,354	400,881

	SEED VOLUME							
SUPPLY SITE	1988	1987	1986	1985	1984	1983	1982	1981
Boyle	87,652	100,259	122,993	93,260	122,870	135,862	100,861	96,479
Harrodsburg	106,558	81,901	119,709	73,855	83,843	87,974	76,091	86,322
Lancaster	62,626	69,348	77,867	76,075	96,355	88,821	78,991	75,810
Liberty	86,627	90,475	70,408	74,240	59,911	53,998	38,294	
Stanford	94,382	99,836	83,905	77,018	92,570	85,879	77,033	72,683

	AG CHEMICAL VOLUME							
SUPPLY SITE	1988	1987	1986	1985	1984	1983	1982	1981
Boyle	147,507	158,191	213,541	195,903	160,500	141,615	165,881	158,463
Harrodsburg	87,333	105,827	142,557	113,619	116,031	127,366	119,735	149,855
Lancaster	82,335	96,076	104,643	107,413	144,302	137,908	124,807	111,926
Liberty	90,535	80,793	96,046	94,323	65,900	84,952	107,781	
Stanford	80,950	69,422	70,481	80,317	82,413	95,283	98,506	71,721

Sales of the Five Supply Sites for 1981-1988 in dollars (continued)

	NET FARM SUPPLY VOLUME							
SUPPLY SITE	1988	1987	1986	1985	1984	1983	1982	1981
Boyle	227,310	395,135	408,474	399,671	402,097	408,108	445,180	476,182
Harrodsburg	396,117	208,978	388,539	315,315	281,893	332,456	347,691	357,177
Lancaster	208,476	206,570	210,363	199,267	213,015	260,703	262,629	204,937
Liberty	241,965	189,902	187,768	181,502	105,014	121,726	104,232	
Stanford	227,338	221,668	210,414	207,601	222,749	294,236	295,908	255,897

	PETROLEUM VOLUME							
SUPPLY SITE	1988	1987	1986	1985	1984	1983	1982	1981
Boyle	492,736	874,005	898,569	1,174,468	1,263,967	1,177,835	1,026,790	1,404,636
Harrodsburg	2,568	844	1,924	2,683	4,123	5,725	8,604	9,571
Lancaster	15	0	0	0	0	0	0	0
Liberty	2,227	2,740	4,023	3,932	2,075	859	0	
Stanford	99	120	316	393	380	1,129	2,049	2,448

SOURCE: SOUTHERN STATES COOPERATIVE

Index of Prices Paid by Farmers for Selected Farm Inputs

FARM INPUTS	1982	1983	1984	1985	1986	1987	1988*
FEED 77	122	134	135	116	108	103	128
FEED 81	100	110	111	95	89	84	105
FERTILIZER 77	144	137	143	135	124	118	130
FERTILIZER 81	100	95	99	94	86	82	90
AG CHEMICALS 77	119	125	128	128	127	124	126
AG CHEMICALS 81	100	105	108	108	107	104	106
ENERGY AND FUELS 77	210	202	201	201	162	161	166
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* 1988 FIGURES ARE PRELIMINARY
NOTE: THE 1981 INDEX WAS CALCULATED USING THE 1977 INDEX
SOURCE: USDA 1987, 1989

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the scanned document