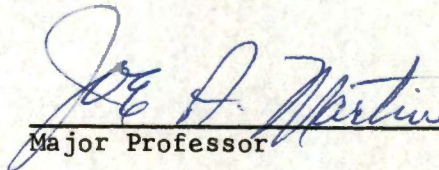


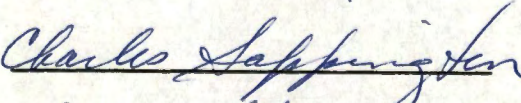
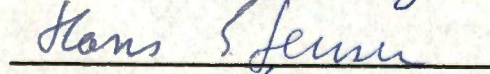
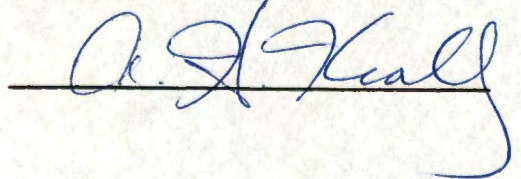
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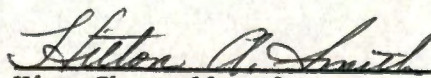
I am submitting herewith a dissertation written by Harry B. Strawn entitled "The Effects of Alternative Modes of Transportation on the Optimum Number, Sizes and Locations of Major Corn Handling Facilities in the Southeast." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Agricultural Economics.


Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:


Vice Chancellor for
Graduate Studies and Research

THE EFFECTS OF ALTERNATIVE MODES OF TRANSPORTATION ON THE OPTIMUM
NUMBER, SIZES AND LOCATIONS OF MAJOR CORN HANDLING
FACILITIES IN THE SOUTHEAST

A Dissertation
Presented to
the Graduate Council of
The University of Tennessee

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

by
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ABSTRACT

This study was designed to achieve the following objectives:

(1) to determine the optimum number, sizes and locations of major corn handling facilities in the Southeast under 1964 and projected 1975 conditions, (2) to impute costs of employing sub-optimum routes in each case, and (3) to estimate the stability of each of the solutions obtained above relative to decreases in transportation costs. A secondary objective was to determine the validity of a reactive programming plant location model when applied to a wide-area problem.

The Continental United States was divided into 36 domestic and four export markets. Surpluses or deficits of corn were determined in every market for 1964 and 1975. The trading system for 1964 consisted of 12 surplus markets and 24 deficit markets. Projections for 1975 indicated 13 surplus markets and 23 deficit markets. For both years the number of potential sites for corn handling capacity remained constant at 23.

Data collection and processing were carried out under the auspices of the Southern Regional Grain Marketing Committee Project SM-29 entitled "Optimal Adjustments of Marketing Facilities to Present and Future Conditions." Results of this study are expected to contribute to the Committee's regional objectives.

Data required for 1964 and 1975 included assembly and distribution costs from each origin through every plant site and to all markets. For 1964 the following modes of transport were considered: Least-cost

mode, barge least-cost rail, barge weighted-average rail, barge-truck, least-cost rail, weighted-average rail, truck and highest-cost mode. Transportation modes for 1975 remained the same except for least-cost rail which was dropped in favor of Gainesville rail rates and Rent-A-Train rates. The new rates resulted in decreased rail shipping costs and were expected to be available in major southern markets by 1975. There were a total of eight modes considered for 1964 and nine for 1975.

Plant costs were obtained through the Southern Regional Grain Marketing Committee for 2,500, 5,000 and 10,000 bushels per hour corn handling facilities. These costs were used as relevant plant costs throughout the study. A 300-day operating season was assumed in all cases.

Three separate computer programs were employed in the analysis. The first program utilized assembly and distribution costs for each mode to compute the minimum-cost route from each origin through a plant and to each market. Output from this program was fed into a conventional transportation model to obtain optimum flows of corn under each set of transfer cost and market demand assumptions. Equilibrium price differentials and imputed costs of utilizing sub-optimum routes were calculated from these transportation model solutions.

The transport modes were then re-examined, and four were selected as being indicative of changes occurring in transfer costs for corn. These modes were least-cost mode 1964, least-cost mode 1975, Rent-A-

Train rate 1975 and Gainesville rail rate 1975. The effects of these modes on the optimum number, sizes and locations of corn handling capacity was then investigated by means of a plant location model.

This plant location model employed corn supply estimates, market demand functions, plant costs and transfer costs to determine the optimum number, sizes and locations of corn handling facilities from the set of pre-selected potential plant sites.

An absence of demand functions for corn at all markets required the creation of pseudo demand curves from actual corn requirements and equilibrium market price differentials. These pseudo demand curves were required to allocate the proper amount of corn to the several markets and maintain the price differentials between them. These curves were not assumed to possess any additional economic significance, however.

Together the 1964 and 1975 plant location solutions included four transportation modes and two sets of corn surplus-deficit assumptions. The quantity of corn in the system also nearly doubled due to increased production in the Midwest. Two market points shifted from deficit to surplus, and one market point changed from surplus to deficit.

With the least-cost mode of transportation 1964, the model indicated that corn should be handled at 13 of the 23 potential sites. The 1975 plant location solution which utilized the Gainesville rail rate indicated that 16 of the 23 locations would be active. In the 1975 Rent-A-Train rate solution corn handling capacity was distributed

among 12 of the 23 locations. According to the plant location solutions which utilized the least-cost mode 1975, corn should be handled at 15 of the 23 possible locations.

Only six of the 23 possible Southeastern corn handling locations were active in every case. Three locations remained inactive under all conditions considered. Three other locations were utilized with only one mode of transportation. Four sites appeared twice in the optimum solutions, and seven sites appeared three times. The 13 sites which were active in three or more solutions were concluded to possess the highest potential from the viewpoint of transportation.

To estimate the sensitivity of computed corn flows to general changes in the freight rate structure, optimum flows of corn with the least-cost mode and the highest cost mode were obtained from transportation models and compared for 1964 and 1975.

It was concluded that a high degree of stability existed within plant location solutions for 1964 and 1975. This stability declined rather sharply, however, as the location determinants were allowed to vary over time.

Average cost of utilizing sub-optimum routes with each type of transportation was between five and six cents per bushel of corn. Since the maximum operating margin assumed for corn handling facilities in this study was eight cents per bushel, it was concluded that considerable pressure existed for firms to employ minimum-cost routes to move their corn.

Empirical application of a reactive programming plant location model to a problem of practical size was a secondary objective of this study.

The theoretical basis of the reactive programming plant location model appeared sound. Plant number and size determinations depended on supply estimates, market demand functions, plant costs and transfer costs. The solution was obtained from a set of preselected potential plant sites on the basis of a spatial equilibrium criterion.

Shortcomings of the computer formulation of the model concerned its treatment of fixed plant costs, however. Only one plant cost could be considered in a given computer run. This resulted in considering only one size of plant at all potential locations. Interarea differences in plant costs were also neglected. Closely allied with these problems was the requirement of only one plant per location. This would preclude determination of optimum plant number when requirements at any site exceed the capacity of one plant.

This model, however, is an advantage over current formulation of the Stollsteimer Plant Location Model in economizing computer time. The Stollsteimer model computes all possible combinations of assembly and distribution costs for origins, plants and markets. These computations can become very substantial with large problems.

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CHAPTER I

INTRODUCTION

Present agricultural marketing firms operate in a very dynamic, technological and economic environment. Substantial investments in physical facilities are constantly being made by these firms. Such investments represent sunk costs for the economic lives of the facilities. Since substantial sums of capital must often be committed for extended periods, long range planning and capital budgeting become crucial to firm survival.

This study is concerned with interdependencies in the marketing system which affect the numbers, sizes and locations of agricultural marketing firms in the Southeast.¹ It will provide a framework for isolating the impact of changes in transportation rates, types of carriers, surplus-deficit relationships and economies of size on potential locations for corn handling firms. Such information would be beneficial to firm managers in their long run decision making and capital budgeting activities.

I. TRANSPORTATION MODES

In general, domestic grain transportation occurs by barges, railroads and motor trucks. Each type of transportation possesses unique advantages and disadvantages depending on the nature of the commodity

¹The states included are Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina and Tennessee.

involved, type of regulation, length and direction of haul and services required. Important characteristics of these transportation modes will be discussed in turn.

Navigable Waterways

There are currently about 25,000 miles of inland waterways in the Continental United States which are navigable for commercial shipping² (Figure 1). The total volume of agricultural commodities moved via these waterways is relatively small when compared to the other modes.³ Water transportation is often the most economical, however, in situations involving heavy or bulky commodities when speed is of secondary importance.⁴ Most grain shipments would fit this category.

Principal disadvantages of inland waterways lie in their geographical (locational) limitations, their lack of speed in moving goods and the relatively expensive docking facilities required to load and unload cargo. Barge transportation also generally involves joint use of other transportation modes because goods must be hauled to river ports for loading on barges and from barge unloading points to final destinations.

The Mississippi River System, including the Tennessee River with its Tennessee Valley Authority dams and locks, provides the water route

²Transportation Economics Group, Marketing Economics Division, United States Department of Agriculture, "Water," Agricultural Markets in Change, Agricultural Economics Report Number 95 (Washington: Government Printing Office, July 1966), p. 99.

³Richard L. Kohls, Marketing of Agricultural Products (Third edition; New York: The Macmillan Company, 1967), p. 304.

⁴Ibid.



Figure 1. Tennessee River and interconnected inland waterway system.

Source: Navigation Engineering Branch, Tennessee Valley Authority, Knoxville, Tennessee. Revised June 1964.

for moving grain from the Midwest into the Southeast.⁵ During the period from 1955 through 1964 the volume of corn moving through the Tennessee River ports increased from 420,581 to 994,942 short tons.⁶

Railroads

Railroads are generally considered to be intermediate or long-distance transporters of goods. Railroads are characterized by a very high proportion of fixed costs in their cost structures relative to the other modes under consideration.⁷ Because of this fact, they are under considerable pressure to obtain maximum utilization of their terminal facilities and rolling stock.⁸ Historically, railroads have also offered transit privileges on certain categories of freight.

Railroad transit privilege has been of considerable importance to grain shippers. It allows them to pay only the through rate even if they stop their shipments for intermediate processing. There is also a reassignment privilege which permits shippers, within limits, to divert their shipments enroute if another market appears advantageous.⁹ Both of these factors have played a part in the development of the corn marketing system.

⁵Ibid.

⁶Tennessee Valley Authority data.

⁷D. Philip Locklin, Economics of Transportation (Sixth edition; Homewood, Illinois: Richard D. Irwin, Inc., 1966), p. 130.

⁸Ibid.

⁹Kohls, op. cit., p. 306.

In response to severe intermodal competition, railroad companies have offered customers a variety of new specialized equipment.¹⁰ For the purpose of this study, however, the most important improvement is the covered hopper car which will carry 100 tons of payload. These cars were initiated by the Southern Railway System in 1961 and are commonly called "Big John" cars.¹¹

Coincident with installation of these cars, Southern petitioned the Interstate Commerce Commission for a rate reduction of 60 per cent on grain shipments consisting of at least 450 tons (five cars) originating at Ohio River loading points and destined for the Southeast.¹² After subsequent appeal action and litigation, the case was decided in favor of Southern. The rates then became effective in May 1964. Other railroads followed suit by substituting nine regular cars to obtain the required volume of grain.¹³ Since that time reduced rail rates

¹⁰United States Department of Agriculture, "Transportation Developments," Marketing and Transportation Situation, Number 153 (Washington: Government Printing Office, May 1964), p. 12.

¹¹Ibid.

¹²Conditions under which the Big John rates become effective are listed as follows: (taken from "The 'Big John' Hopper Car Case," Agricultural Markets in Change, pp. 93-95): (1) originally designated for five-car minimum shipments; but were later extended to include single car, five-car, ten-car and 20-car shipments; (2) only minimum loading and unloading times allowed; (3) no transit privilege; (4) minimum distance of 346 miles (taken from "Grain in Multiple Car Shipments--River Crossing to the South," Investigation and Suspension Docket Number 157, Interstate Commerce Commission Reports, 318:641-718, January 1963).

¹³"The Cincinnati, New Orleans and Texas Pacific Railway Company et al., Plaintiffs, vs. United States of America et al., Defendants," Federal Supplement, 229:572-580, May 1964.

have spread to other areas and have been initiated for single carloads of grain.

Motor Truck Transportation

The principal advantages of motor trucks lie in their inherent flexibility in routing and relative freedom in rate making. Many small grain marketing firms deal in truckload lots due to limited storage capacity and special back-haul rates often used by truckers. Trucks hauling agricultural commodities are also exempt from Interstate Commerce Commission regulation.¹⁴

An important inefficiency historically associated with truck transportation is the wide variation in truck weight and length regulations among states. This often gives truckers the alternatives of traveling partially loaded for an entire trip or transferring cargo to additional trucks when an excessively restrictive state is encountered. Progress has been made in equalizing the length and weight regulations among states however.¹⁵

II. GENERAL EFFECTS OF IMPROVED TRANSPORTATION

ON GRAIN MARKETING

Many marketing functions are based on costs of transporting raw and finished products. As railroads, for example, continue to move

¹⁴T. Q. Hutchinson, "Trucking Under the Agricultural Exemption," Marketing and Transportation Situation, Number 157 (Washington: Government Printing Office, May 1965), p. 29.

¹⁵Agricultural Markets in Change, pp. 97-99.

selectively from "value-of-service" to "cost oriented" rates in response to intermodal competition, the competitive positions of many areas may be affected.¹⁶ Lower rates on raw materials tend to push processing facilities toward consuming areas. De-emphasis on transit privilege through lower rates for large direct shipments a la carte should tend to accelerate this transition.¹⁷ Unit train and multiple car rates offer firms with sufficient handling capacity significant cost reductions and a relative advantage ceteris paribus.¹⁸ The net effect of these rate structure changes should be to increase the demand for storage facilities at terminal points and decrease the demand for them at intermediate locations. The number, sizes and locations of grain handling firms would, therefore, be affected in the long run.

III. CHANGING PRODUCTION--UTILIZATION BALANCES FOR CORN

Five grains are produced by southeastern farmers in significant quantities. They are corn, wheat, oats, grain sorghum, and soybeans.¹⁹ These grains are currently the subject of a regional investigation of which this report is an outgrowth.²⁰

¹⁶Ibid., pp. 104-105.

¹⁷Ibid.

¹⁸Ibid.

¹⁹Soybeans are generally classified as an oilseed, but for analytical purposes they were considered to be a grain by the Southern Regional Grain Marketing Committee.

²⁰"Optimal Adjustments of Southern Grain Marketing Facilities to Present and Future Conditions." This project involves ten southern states (see footnote 1, page 1), the Tennessee Valley Authority and the United States Department of Agriculture, and is financed through Hatch funds.

Feed grain production has suffered relative declines in all southeastern states except Florida and Georgia during the past 20 years (Figure 2). Corn is the most important feed grain produced in the area both in terms of acreage and income to farmers. For example, farmers in Tennessee harvested over 39.3 million bushels of corn in 1964. More than 19.3 million bushels of this corn was sold as cash grain.²¹ Since corn is a major component of manufactured animal and poultry feed and feed concentrate, production-utilization balances must also consider the number of grain consuming animal units²² in an area.

There has been a large increase in livestock and poultry production in the Southeast during the same period. The tremendous expansion of broiler production has accounted for a large portion of these gains. The relative change in number of animal units for the years 1956-1965 is shown in Figure 3. It should be noted that a relative decline in grain consuming animal units occurred in only one state, and the leading state exhibited over a 100 per cent increase.

This decline in local supply and increase in demand have resulted in a large increase in grain shipments into the Southeast. Large traders

²¹United States Department of Commerce, Bureau of the Census, 1964 United States Census of Agriculture, I, Part 31; Tennessee (Washington: Government Printing Office, 1964), p. 14.

²²"An animal unit is a computed measure for purposes of comparison which represents an average mature horse or cow, or the equivalent in any other class of livestock. The conversion of livestock numbers other than horses or cows is based on the average amount of feed consumed" (from J. Norman Efferson, Principles of Farm Management (New York: McGraw-Hill Book Company, 1953), p. 227).

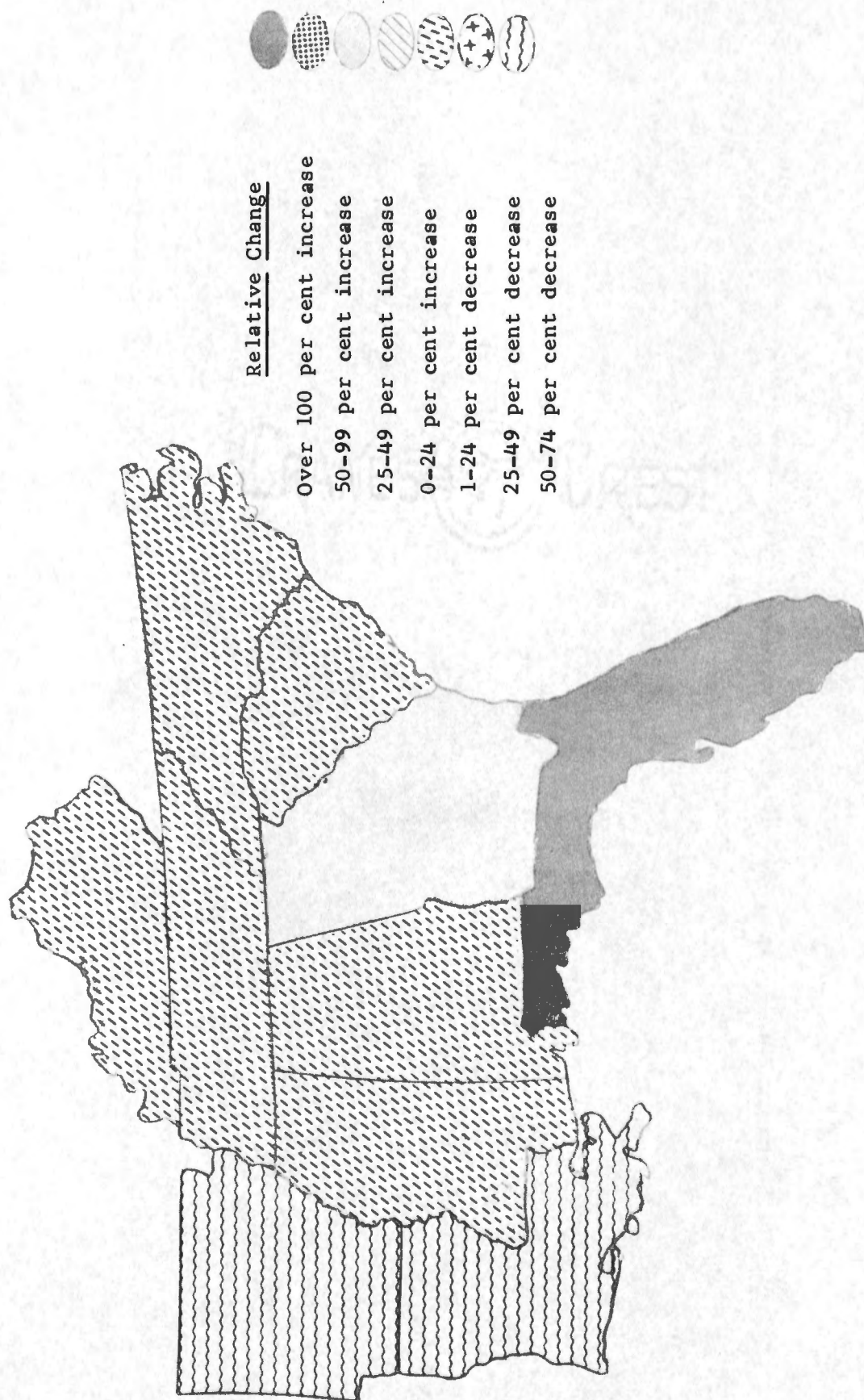


Figure 2. Relative change in feed grain production, Southeast 1956-1965.

Source: Calculated from SM-29 data.

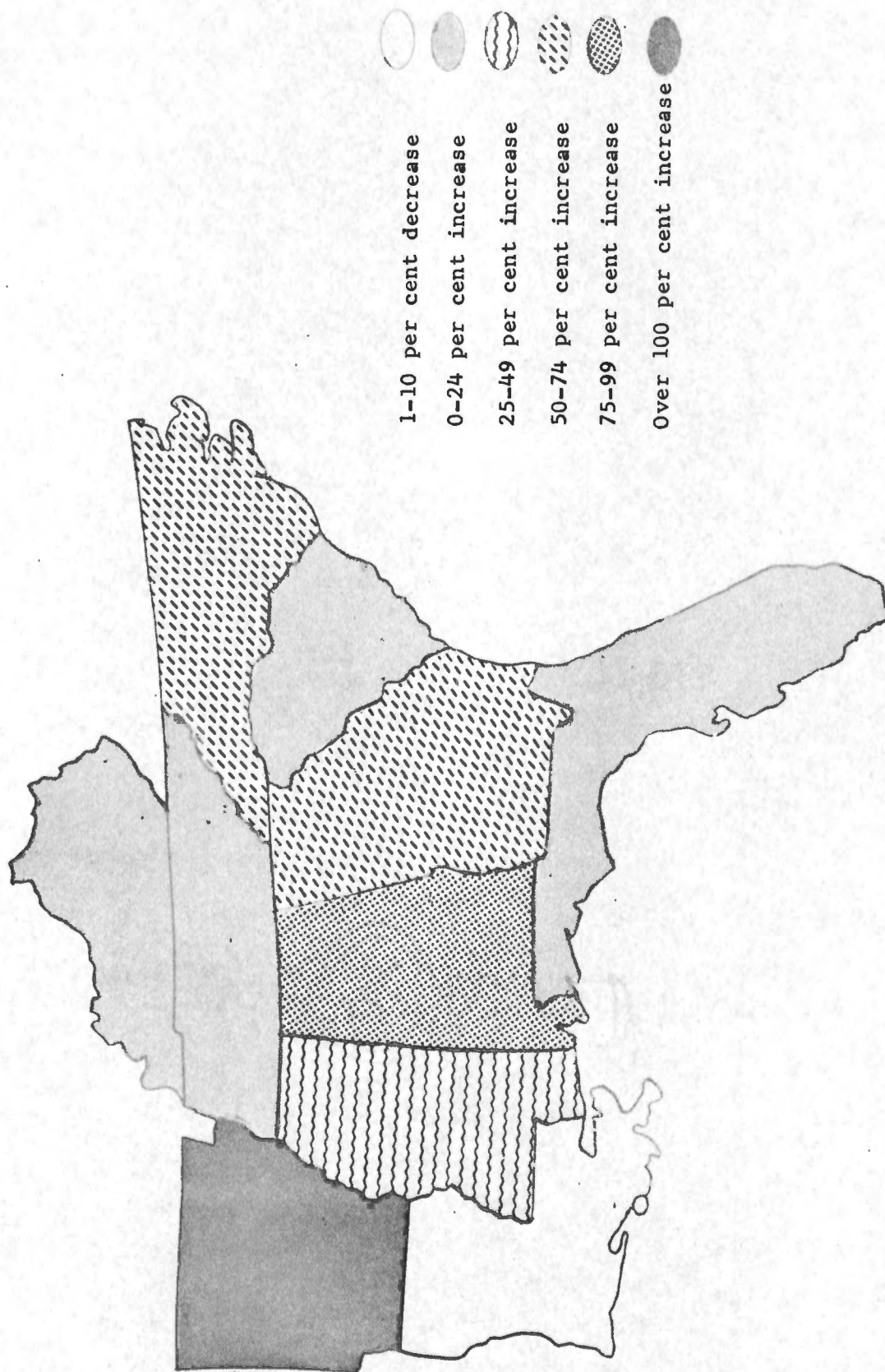


Figure 3. Relative change in number of grain consuming animal units, Southeast 1956-1965.

Source: Calculated from SM-29 data.

have found it advantageous to renovate their handling and storage equipment where necessary and take advantage of new freight rates to more fully serve this expanding market. Additional changes are expected to occur in response to future changes in transport rates and production-utilization balances for corn in the Southeast.

IV. STATEMENT OF THE PROBLEM

Changing costs in assembling, handling and distributing corn pose short and long term decision making problems for marketing firm managers. This study is concerned with long run adjustments in the optimum number, sizes and locations of major corn handling facilities caused by changing transport costs and changing production-utilization balance for corn. From a managerial standpoint relevant questions would include: (1) what sizes of plants to build, (2) where to locate new plants, and (3) how much consideration to give extra-economic factors, i.e., costs of non-optimum actions.

V. OBJECTIVES OF THE STUDY

The specific objectives of this study may be listed as follows:

1. To determine the optimum number, sizes and locations of major corn handling facilities in the Southeast under 1964 and projected 1975 conditions.
2. To impute costs of employing sub-optimum routes in each case.
3. To estimate the stability of each solution relative to decreases in rail transportation costs.

A secondary objective of this study was to determine the validity of a reactive programming plant location model when applied to a wide-area problem.

CHAPTER II

REVIEW OF LITERATURE

The present population explosion in spatial equilibrium analysis is the result of crossing two well-known parents and hence the offspring would appear legitimate. On the mother's side the inheritance stems from the classical, neoclassical and modern trade theory and on the father's side from location theory.¹

The purpose of this section is to delineate several of the more important ancestors of present-day location and interregional competition theories.² No claim for completeness is made because the author has only included those works which, in his judgment, have pointed the way toward current theory.

I. CONCEPTUAL FRAMEWORK

The roots of current interregional competition theories can be traced back to the classical economists. Adam Smith outlined the idea of absolute advantage when he said:³

. . . If a foreign country can supply us with a commodity cheaper than we ourselves can make it, better buy it of them

¹Stanley K. Seaver, "Spatial Research-Measurement for What?" Journal of Farm Economics, 46(5):1365, December 1964.

²Heavy reliance has been placed on the ideas of Melvin L. Greenhut, Plant Location in Theory and Practise: The Economics of Space (Chapel Hill: The University of North Carolina Press, 1956) in structuring this chapter.

³Adam Smith, An Inquiry Into the Nature and Causes of the Wealth of Nations (New York: The Modern Library, 1937), p. 424.

with some parts of the produce of our own industry, employed in a way in which we have some advantage. . . . It (a nation's industry) is certainly not employed to the greatest advantage when it is . . . directed towards an object which it can buy cheaper than it can make.

The idea was later refined into the concept of comparative advantage by the pen of David Ricardo and used to explain which commodities would enter international commerce.⁴ It remained for John Stuart Mill, however, to provide the nomenclature; he called it "comparative cost."⁵

The development of location theory as a discipline lay largely outside the mainstream of economic thought in the classical and early neo-classical periods. German economists were largely responsible for its initial form.

Johann Heinrich von Thunen, writing in 1826, conceived a treatise on the importance of transportation costs to the location of agricultural production (Der Isolierte Staat in Beziehung Auf Landwirtschaft Und Nationalökonomie). In this book he assumed:⁶ (1) homogeneous land, (2) a consuming-manufacturing center located in the middle of the area, (3) a competitive environment for agricultural production, (4) uniform transportation facilities, (5) constant technology, (6) that transportation costs were a function of distance and

⁴David Ricardo, The Principles of Political Economy and Taxation (London: J. M. Dent and Sons, Ltd., 1948), pp. 77-93.

⁵John Stuart Mill, Principles of Political Economy with Some of Their Applications to Social Philosophy (Revised edition; New York: The Colonial Press, 1960), II, p. 94.

⁶Greenhut, op. cit., pp. 5-7.

(7) that each farmer could sell all he produced at the market price. Given these assumptions, rent would be solely a function of distance from the market, i.e., transfer costs. Following through with his analysis, Thunen derived a series of concentric circles of production around the central market with intensity of land use decreasing as distance from the market increased. The only exceptions were the excessively bulky or perishable crops. This analysis was cost oriented.

Writing over 80 years later, Alfred Weber made a long stride forward by discussing what amounted to a group of principles of industrial location.⁷ This has been called the methodological reverse of Thunen's work.⁸ Weber based his theory on three factors: transportation cost, labor cost, and what he called agglomerating forces.⁹ It is immediately apparent that Weber has broadened the determinants of location from Thunen's single factor. The first two factors are generally self-explanatory, but the agglomerating (degglomerating) forces need elaboration.¹⁰ Broadly speaking, these forces are somewhat analogous to the present-day economist's definition of external economies and diseconomies of scale when related to alternative locations of

⁷Alfred Weber, Theory of the Location of Industries, translated with an introduction and notes by Carl J. Friedrich (Chicago: The University of Chicago Press, 1929).

⁸Greenhut, op. cit., pp. 8-9.

⁹Ibid., p. 9.

¹⁰For a more thorough discussion of agglomerating and degglomerating factors, see Walter Isard, Location and Space Economy (New York: John Wiley and Sons, Inc., 1956), pp. 172-206.

production. Weber's contributions to the development of location theory were in the following areas: (1) deriving "principles" of location for simple manufacturing processes, (2) broadening the list of important location variables and (3) adding the concepts of weight triangles, isotims and isodapanes to the location economist's tool kit. His location theories remained cost-oriented, however.

Another step forward was made by August Losch.¹¹ He emphasized the endogenous determination of the firm's market area¹² and attempted to replace the partial equilibrium theories of the "minimum cost location theorists" with a concept of general equilibrium.¹³ In making his analysis he assumed:¹⁴ (1) homogeneous land and other raw materials, (2) no natural or political boundaries and (3) a uniform distribution of agricultural population. A firm (farmer) could now determine the maximum distance at which it would be profitable to sell his output.¹⁵ Under his assumptions and in the absence of competition, the relevant area would be circular in nature. When competition was allowed, however, the areas became hexagons. He reasoned as follows:¹⁶

¹¹August Losch, The Economics of Location, translated from the second revised edition by William H. Woglom and Wolfgang F. Stolper (New Haven: Yale University Press, 1954).

¹²Ibid., pp. 101-114.

¹³R. J. Amick, "A Review of Research in Interregional Competition," Workshop on Interregional Competition, Southern Farm Management Research Committee (Stillwater: Oklahoma State University, 1966), p. 53.

¹⁴Losch, loc. cit.

¹⁵Ibid.

¹⁶Ibid., p. 110.

Geometrically speaking there are two other possibilities (besides hexagons) for utilizing the corners between market circles: triangular or square economic regions can be imagined. But the hexagon has the advantage of being nearest to the ideal circular form. Consequently, among all three possibilities the demand per unit of area is greatest with the hexagon.

With respect to his general equilibrium concepts, Losch's argument proceeds through successive aggregations of individual market areas to achieve systems of market areas or economic regions. In fact, he summed the results up by saying:¹⁷

. . . An area from which our assumptions have actually wiped out all differences can be divided on purely economic considerations into regions that do not represent simply homogeneous logical constraints, but form, if the expression be allowed, an organic whole.

Hence, he felt that he had defined locational equilibrium conditions for firms with spatial dimensions within the constraints of his model.

Edgar M. Hoover, in his book The Location of Economic Activity,¹⁸ expressed many ideas which seem to be linear descendants of the earlier writings of Thunen and Weber, with some elements of dynamics injected. He indicated that location problems should be approached from the standpoint of individuals as producers and consumers.¹⁹ The assorted locational pulls might be either competitive or complementary.²⁰

¹⁷Ibid., p. 137.

¹⁸Edgar M. Hoover, The Location of Economic Activity (New York: McGraw-Hill Book Company, 1948).

¹⁹Ibid., p. 5.

²⁰Ibid.

Hoover breaks the cost factors emphasized by earlier German writers down into procurement, processing and distribution costs. Each factor had peculiar characteristics and was generally present in locational decision-making though factors may vary in relative importance.²¹

Some of the neo-classical competitive assumptions are eased as he calls attention to imperfect knowledge of managers as obstacles to optimum location decisions.²² In interjecting his dynamic concepts of location theory, Hoover stated that locational equilibrium was never attained in reality. He listed seasonal changes, cyclical changes, structural changes and differential growth and industrial relocation rates over time to substantiate this claim.²³

Due to the many similarities in these assumptions and general methodological approaches, Thunen, Weber and to a lesser extent Hoover and their disciples might be considered to represent a "least cost" oriented theory of plant location.²⁴ Though these writers often mentioned demand, the thread of cost continually ran through their analyses. General characteristics of this school are:²⁵ (1) substitution among factor costs to arrive at the optimum location, (2) demand assumed to be a parameter unaffected by firm location, and (3) no firm

²¹Ibid., p. 7.

²²Ibid., p. 9.

²³Ibid., pp. 145-165.

²⁴Greenhut, op. cit., pp. 253-254.

²⁵Ibid., p. 257.

interdependence considered. The general equilibrium ideas of Losch and his emphasis on the crucial importance of demand in determination of the size of the market area prevent his being solidly classified with this school.

As an anti-thesis to these cost-oriented theories, another group of writers have advanced ideas postulated on imperfect competition. The product market is emphasized over the factor market, and the analysis is precipitated in an atmosphere of locational interdependence.

Frank Fetter,²⁶ in 1924, postulated an "Economic Law of Market Areas." This law emphasized the interdependence determining market areas as follows:²⁷

The boundary line between the territories tributary to two geographically competing markets for like goods is a hyperbolic curve. At each point on this line the difference between freights from the two markets is just equal to the difference between the market prices, whereas on either side of this line the freight difference and price differences are unequal. The relation of prices in the two markets determines the location of the boundary line: the lower the relative price the larger the tributary area.

Hence, the area included in geographical markets is a function of relative F. O. B. mill prices if freight rates are constant and freight rates if the delivered prices remain unchanged.²⁸ In the case where transportation rates are not a simple function of distance, the

²⁶Frank A. Fetter, "The Economic Law of Market Areas," Quarterly Journal of Economics, 38:520-529, May 1924.

²⁷Ibid., p. 525.

²⁸Ibid., p. 527.

symmetry of the market boundary might not be disturbed, but its location might change.²⁹

In 1929 Harold Hotelling expressed some ideas on the subject.³⁰ He first stated explicitly the idea that consumers located around a firm make each entrepreneur a monopolist over a limited class and region.³¹ In contrast to most previous writers, Hotelling considered all buyers to be located on a line of length L .³² The problem was to determine the optimum locations of sellers on this line. The objective was to locate between a firm's competitors and a mass of customers.

Two additional noteworthy contributions were made by Hotelling. First, he considered the possibility of discrimination among customers or selling goods at delivered prices instead of the normal F. O. B. mill plus transportation to the customer.³³ Secondly, the effects of price elasticity of demand were considered.³⁴ Hence, the amount of a product demanded by customers could be a function of prices charged by firms. Now both the size of the market and the portions going to various firms were considered variable.

Chamberlin, emphasizing retail competition, said:³⁵

²⁹Ibid.

³⁰Harold Hotelling, "Stability in Competition," A. E. A. Readings in Price Theory, Vol. IV (Homewood, Illinois: Richard D. Irwin, Inc., 1952), pp. 467-484, reprinted from The Economic Journal, 39:41-57, 1929.

³¹Ibid., p. 471.

³²Ibid., p. 472.

³³Ibid., p. 483.

³⁴Ibid., pp. 483-484.

³⁵Edward Chamberlin, The Theory of Monopolistic Competition (Harvard Economic Studies, Vol. XXXVIII; Cambridge: Harvard University Press, 1935), pp. 194-197.

The problem of pure spatial competition is defined very simply. Just as a seller's market is large or small depending on the price he sets, so it varies with the location he chooses.

.....

There is a strong tendency to group products which are jointly demanded, such as different kinds of groceries, of drugs, of clothing, etc. and . . . to group products which form a composite supply, i.e., which are substitutes for each other such as different brands or varieties of the same general class of goods.

Therefore, Chamberlin also gave demand a central role in his concept of location. In keeping with his general ideas of monopolistic competition, cost occupied a practically insignificant role in his analysis.

Lerner and Singer, in an article written a few years later, continued to abstract from costs and emphasize demand.³⁶ They contended that, in general, plant location was determined by:³⁷ (1) the geographical "length" of the market, (2) the transportation rate and (3) the "demand price."³⁸ Once more the idea of mutual interdependence is pointed out with exposition and examples including the case of exploitation of nearby customers by charging equal delivered prices.³⁹ Uneven density of customers is compensated for by measuring the geographical extent of the market in customers rather than miles.⁴⁰

³⁶A. P. Lerner and H. W. Singer, "Some Notes on Oligopoly and Spatial Competition," Journal of Political Economy, 45(2):145-186, April 1937.

³⁷Ibid., p. 148.

³⁸The "Demand Price" is the total delivered price that buyers would pay for the commodity (Lerner and Singer, op. cit., p. 148).

³⁹Ibid., p. 184.

⁴⁰Ibid., p. 186.

Because of their emphasis on the importance of demand over that of costs as the primary determinant of plant location, the previous four writers might be considered the nucleus of a demand-oriented or "interdependence" school of location theorists.⁴¹

II. A MODERN THEORY OF LOCATION AND TRADE

Interregional trade arises because of the existence of a prospective profit through trade greater than the transportation costs among regions. This profit arises through regional differences in demand and costs of production. To succeed in interregional competition, therefore, a rational firm would wish to locate where the magnitude of the difference between product prices and production costs is maximized. Considering location inputs to possess the same characteristics as other inputs, this would fall within conventional profit maximization theory.

From the standpoint of cost differentials, the following factors are generally considered important:⁴² (1) relative scarcity of production factors, (2) technical input-output relationships, (3) factor prices, (4) internal and external economies and diseconomies of scale and (5) site expenses such as taxes, insurance and rent.

⁴¹Greenhut, op. cit., p. 257.

⁴²Joseph Webb McLeary, "Optimum Interregional Shipments of Beef, Pork, Broilers, and Eggs, and the Predicted Effects of the Interstate Highway System on the Equilibrium Movement Patterns of These Commodities" (unpublished Doctoral dissertation, The University of Tennessee, Knoxville, December 1965), p. 21.

The demand for a given product is considered to be a function of population, income, tastes and preferences and prices of substitute products.⁴³ From the standpoint of the firm both the location and the slope of the demand curve are important. Another factor worthy of consideration by the firm is the existence of producers of substitute products near its proposed location and the cross elasticity relationships that might be involved.

Samuelson has graphically represented "modern" trade theory as it has been applied to agriculture and other problems of interregional trade.⁴⁴ Briefly, the representation depicts supply and demand for a product in each of two regions with the graphs placed back-to-back (Figure 4). Pure competition is assumed within each region, and the only barrier to interregional shipments is the cost of transportation from the low-price area to the high-price area. This effect is accomplished by vertically offsetting the graph of the exporting region by an amount equal to the transportation cost. By horizontally subtracting demand from supply in each area at a series of prices, a curve showing "excess supply" is derived. Excess supply can be either positive or negative depending on whether the quantity supplied in an area exceeds or is less than the quantity demanded at each price. The intersection of excess supply curves for two areas indicates the quantity traded and the equilibrium price under the assumptions.

⁴³Ibid.

⁴⁴Paul Samuelson, "Spatial Price Equilibrium and Linear Programming," American Economic Review, 42(3):283-303, June 1952.

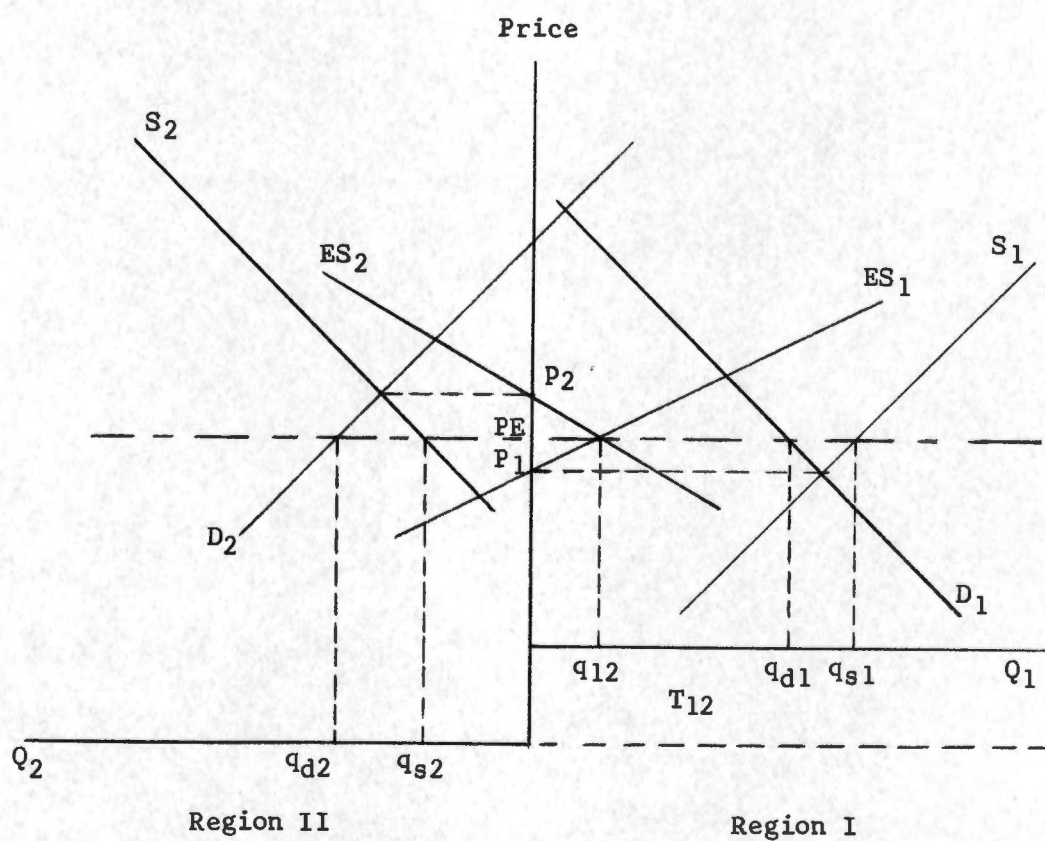


Figure 4. Representation of equilibrium interregional trade for the two-region case when transfer costs are considered.

Source: Paul Samuelson, "Spatial Price Equilibrium and Linear Programming," American Economic Review, 42(3):286, June 1952.

Interregional trade, therefore, is a function of technology and factor costs which affect regional supply, any item which affects the height and/or slope of the demand function and any change in transport technology or pricing policies.

Modern location theory is composed of several facets. These facets include area characteristics, availability and type of transport services, various nonquantitative factors, traditional or inherent factors and general factors. Table I summarizes the most common locational determinants.

III. EMPIRICAL WORK

Mighell and Black,⁴⁵ in 1936, initiated one of the first empirical studies of "Interregional Competition and Comparative Advantage" in the field of agriculture.⁴⁶ The study involved competition between New England and Lake States dairy farmers for the Northeastern Milk Market. Since no sophisticated computer hardware was available, the study involved delineation of regions, budgeting of individual farms and aggregation of supply and demand data manually to indicate regional surpluses and deficits.⁴⁷ After several years a check of available data against their projections indicated reasonable agreement in many

⁴⁵Ronald L. Mighell and John D. Black, Interregional Competition in Agriculture: With Special Reference to Dairy Farming in the Lake States and New England, Vol. LXXXIX of Harvard Economic Studies (Cambridge: Harvard University Press, 1951).

⁴⁶Amick, op. cit., p. 54.

⁴⁷Mighell and Black, op. cit., pp. 38-57.

TABLE I

MAJOR VARIABLES ANALYZED BY LOCATION THEORY

Area	Transportation	Nonquantitative	Traditional	Generality
1. Size of factor supply area	1. The transport network	1. Nonmonetary preferences of producers for particular sites	1. Economies of size a. Factors b. Products	1. Number a. Factors b. Products
2. Location of factor supply area	2. Supply of transportation services	2. Nonmonetary preferences at sites for producers	2. Indivisibility a. Factors b. Products	2. Time
3. Size of factor demand area	3. Demand for transportation services	3. Public policy of regulation on factors and products	3. Demand a. Factors b. Products	3. Uncertainty
4. Location of factor demand area			4. External economies a. Factors b. Products	4. Welfare
5. Size of product supply area			5. Supply a. Factors b. Products	
6. Location of product supply area			6. Rent a. Factors b. Products	
7. Size of product demand area				

TABLE I (continued)

Area	Transportation	Nonquantitative	Traditional	Generality
8. Location of product demand area				
9. Location and number of possible sites for use in production or consumption				
10. Proximity to competitors				

Source: B. R. Miller and R. A. King, Models for Measuring the Impact of Technological Change on Location of Marketing Facilities, Agricultural Economics Information Series No. 115 (Raleigh: North Carolina State University, 1964), p. 7.

cases.⁴⁸ This indicated that meaningful empirical research in inter-regional competition was possible.

By the mid 1950's studies of interregional competition had become rather commonplace among researchers in agricultural marketing. Since the main purpose of the present study is plant location, extensive treatment of specific interregional competition studies will be foregone in favor of recent work in plant location.⁴⁹

Stollsteimer developed one of the first models for determining the optimum number, sizes and locations of processing plants which would lend itself to general application.⁵⁰ Inputs for his model included a given number of raw material production areas, quantities of raw material available in each area, possible plant sites and a transportation cost matrix containing unit transfer costs of shipping from each supply area to every designated plant site. The objective was to determine the number, sizes and locations of plants that minimized the combined assembly and processing costs inherent in the input data.⁵¹ The model is, essentially, an extension of the general point-trading transportation model in which plant numbers and locations are allowed

⁴⁸Amick, op. cit., p. 55.

⁴⁹For a guide in the study of applied interregional competition models, the author recommends Amick, op. cit., pp. 51-85.

⁵⁰John F. Stollsteimer, "The Effect of Technological Change and Output Expansion on the Optimum Number, Size and Location of Pear Marketing Facilities in a California Pear Marketing Region" (unpublished Doctoral dissertation, The University of California at Berkeley, 1961).

⁵¹J. F. Stollsteimer, "A Working Model for Plant Numbers and Locations," Journal of Farm Economics, 45(3):631-632, August 1963.

to vary.⁵² His technique involved determining all possible combinations of plants and selecting the combination which yielded the minimum total transfer plus plant cost.⁵³ With large problems this process required extensive computer time.

Stollsteimer assumed constant marginal processing costs in any given plant and a positive intercept for the plant cost function. Hence, total fixed processing cost for the group of plants would be a vertical summation of the individual plant cost curves as plant numbers were varied. Transportation costs were assumed to increase at a decreasing rate with mileage. Summation of total processing and total transfer costs over a varying number of plants would yield the aggregate cost function represented in Figure 5.

Stollsteimer's procedure was somewhat analogous to the classical inventory model.⁵⁴ The inventory model, however, assumed constant demand for output and minimized the sum of inventory holding cost plus procurement cost. Stollsteimer assumed a constant total quantity of commodity available for processing and minimized the sum of assembly and processing costs.

He outlined the conditions and solution procedure for three additional cases of firm costs. All four cases can be catalogued as follows:⁵⁵

⁵²Ibid., p. 644.

⁵³Ibid., p. 634.

⁵⁴Elwood S. Buffa, Models for Production and Operations Management (New York: John Wiley and Sons, Inc., 1963), pp. 428-433.

⁵⁵Stollsteimer, op. cit., pp. 633-639.

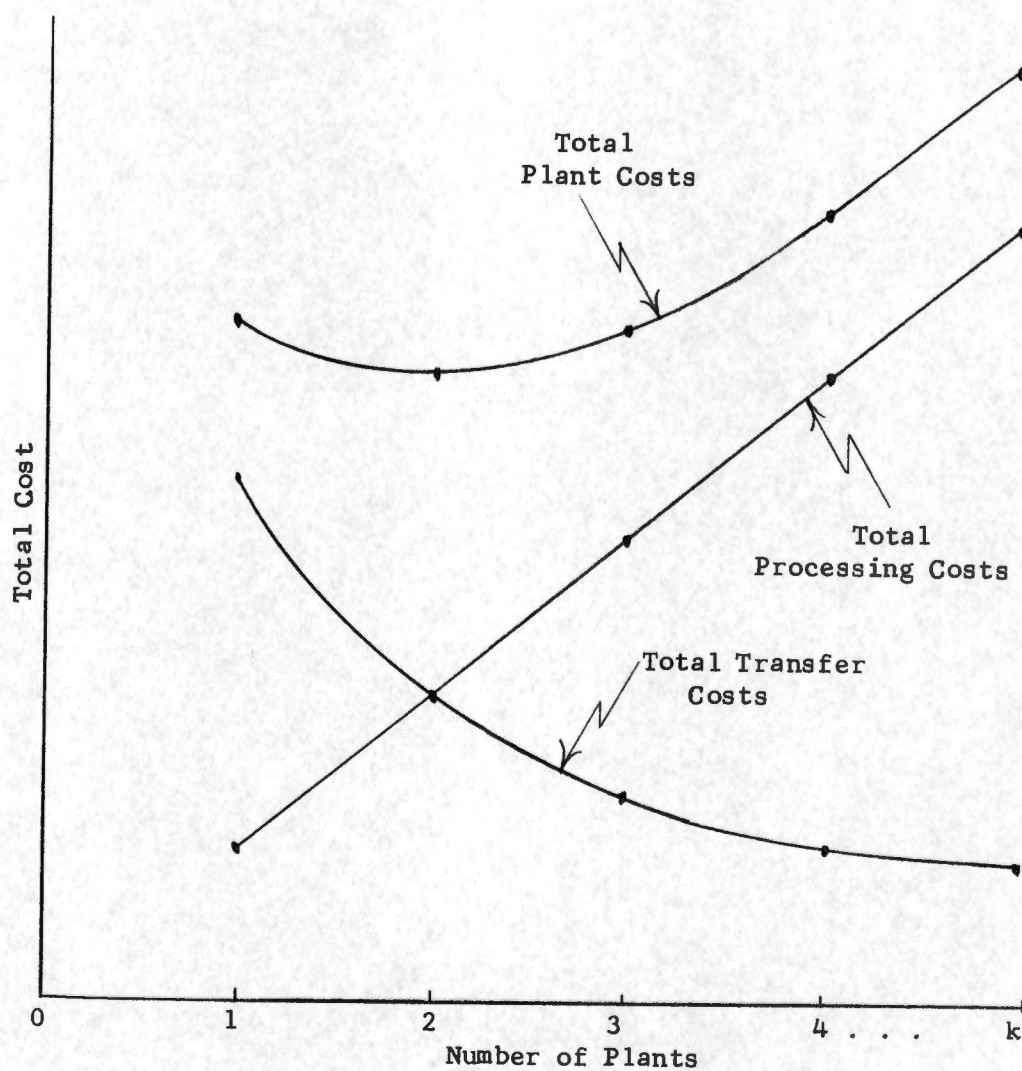


Figure 5. Conceptual relation between transfer costs, processing costs and total plant costs in the Stollsteimer model.

Source: John F. Stollsteimer, "Fixed Production--Fixed Consumption Models with Processing Introduced," Interregional Competition Research Methods, Richard A. King, ed. (The Agricultural Policy Institute, Raleigh: North Carolina State University, n.d.), p. 44.

1. Economies of scale in plant operations with plant costs independent of plant locations.
2. Economies of scale in plant operations with plant costs varying among locations.
3. No economies of scale in plant operations with plant costs independent of locations.
4. No economies of scale in plant operations with plant costs varying among locations.

As an empirical example, Stollsteimer applied his model to a feasibility study of one of the major pear producing regions of California under assumed 1970 conditions.⁵⁶ In an area where five plants were in existence, he varied the number in his model from one to twelve and found that one plant would be optimum under his assumptions.⁵⁷

An application of the Stollsteimer technique to the sweet potato industry in North Carolina was made by R. A. King and others in a comprehensive study.⁵⁸ The relevant variables were total sweet potato production, density of production, assembly costs and processing costs.

They made the following assumptions:⁵⁹ (1) sweet potato price was \$2.00 at all plant sites, (2) F. O. B. plant prices of processed

⁵⁶Ibid., pp. 639-645.

⁵⁷Ibid.

⁵⁸Gene A. Mathia and Richard A. King, Selection of the Optimum Number, Size and Location of Processing Plants in Eastern North Carolina, Vol. 3 of Planning Data for the Sweet Potato Industry. 4 vols.; Agricultural Economics Information Series No. 97 (Raleigh: North Carolina State University, Department of Agricultural Economics, December 1962).

⁵⁹Ibid., p. 12.

potatoes at all sites were equal, (3) factor prices were equal at all sites, (4) all production in each area occurred at a single point, (5) each potential plant site possessed the required transportation net and factor supplies, (6) each plant allocated its pack according to the national average for the year and (7) similar conversion rates existed in all possible plants.

The procedure employed was to first determine optimum plant locations for one to twenty-two possible plants relative to assembly costs. Plant numbers were then compared with total production to estimate capacity. Next, processing costs were added. Given these combined costs, the optimum number of plants was determined by inspection.⁶⁰ They found that one plant located at Faison, North Carolina, was optimum.⁶¹ Percentage deviations were calculated by comparing the costs of employing non-optimum plant numbers and locations to the base (optimum) costs.⁶² Imputed net farm prices were estimated by deducting assembly costs from potato prices at the plants.⁶³

G. A. King and L. F. Schrader employed a spatial equilibrium procedure on Samuelson's earlier constructions⁶⁴ to consider the optimum location of cattle feeding.⁶⁵ Their problem was "to determine

⁶⁰Ibid., p. 3.

⁶¹Ibid.

⁶²Ibid., p. 41.

⁶³Ibid.

⁶⁴Samuelson, op. cit., pp. 283-303.

⁶⁵G. A. King and L. F. Schrader, "Regional Location of Cattle Feeding: A Spatial Equilibrium Analysis," Hilgardia 34(10):331-416, July 1963.

the regional location of cattle feeding, intermediate and final product shipping patterns and beef prices that would result under competition."⁶⁶ Variables specified in their model were:⁶⁷ (1) factor supply (supplies of feeder cattle, roughage and other inputs), (2) the production process, (3) regional demands for beef and (4) transfer costs for intermediate and final products.

The model was solved under four sets of assumptions relating to interregional feeding efficiency, feed costs and demand for beef. Equilibrium flows were obtained by utilizing a set of regional product prices and quantities demanded. Next imputed product prices were compared with the assumed prices. If the two sets of prices were not equal, a revised set of prices was employed in an interactive process to converge on equilibrium. The final solution yielded⁶⁸ (1) the location of cattle feeding, (2) types of feeding in each region, (3) interregional feed shipments and (4) levels of regional beef consumption.

A new computational process called reactive programming was described by Tramel and Seale in 1959.⁶⁹ They defined reactive programming as ". . . a means of obtaining the equilibrium flows of a commodity between areas with given transportation cost functions, given demand schedules in each of the several areas of consumption and given supply

⁶⁶Ibid., p. 336.

⁶⁷Ibid., pp. 336-340.

⁶⁸Ibid., pp. 403-407.

⁶⁹Thomas E. Tramel and A. D. Seale, Jr., "Reactive Programming of Supply and Demand Relations--Applications to Fresh Vegetables," Journal of Farm Economics, 41(5):1012-1022, December 1959.

schedules in each of the several areas of production."⁷⁰

This process, therefore, provided a systematic means for solving problems in which supply, demand and transfer costs could all vary. Reactive programming was based on the idea that "an equilibrium exists for a group of areas when each producing area or supply point is in equilibrium with all possible markets."⁷¹

Required computations involved systematically determining equilibrium market allocations for each area and reiterating the system until no further change occurred.⁷² The reactive programming technique was first employed in an analysis of the competitive position of Mississippi in the production of watermelons.⁷³

In another interesting analysis, B. R. Miller and R. A. King explored nine basic models for their usefulness in determining the optimum number, sizes and locations of peanut grading and shelling plants in North Carolina.⁷⁴ Three of the nine models were actually used to

⁷⁰Ibid., p. 1012.

⁷¹Thomas E. Tramel and A. D. Seale, Jr., "Reactive Programming--Recent Developments," Interregional Competition Research Methods, Richard A. King, editor (Raleigh: North Carolina State University, The Agricultural Policy Institute, n.d.), p. 59.

⁷²Ibid.

⁷³Tramel and Seale, "Reactive Programming of Supply and Demand Relations--Applications to Fresh Vegetables," p. 1017.

⁷⁴B. R. Miller and R. A. King, Models for Measuring the Impact of Technological Change on Location of Marketing Facilities, Agricultural Economics Series No. 115 (Raleigh: North Carolina State University, September 1964).

analyze data on the peanut industry. Table II indicates common names and characteristics of the nine models studied. The model employed in the present study is based upon one of the models presented by Miller and King.

Miller and King found that a two-stage transportation model with no volume restraint did not provide a good solution to the plant location problem if used alone, but it did provide an upper limit to the possible number of optimum plants from which other models could proceed.⁷⁵ A reactive program which included economies of scale in processing and variable final demands was applied to the original solution.⁷⁶ This reduced the number of plants to a magnitude more nearly approaching an "optimum." The advantage of performing the operation in two steps lay in the reduction of computer time required to reach a solution. The third model employed was similar to the Stollsteimer model discussed previously with the assembly cost matrix modified to include both assembly and distribution costs.⁷⁷ Solutions of the latter two models exhibited much similarity.⁷⁸ Hence, the more complex third model should only be used in situations where the second model proves inadequate for a particular task.

In 1955, Fox and Taeuber applied a spatial equilibrium model to the livestock-feed economy under "normal" conditions. The effects of a midwestern drought and a general freight rate increase on

⁷⁵Ibid., pp. 29-30.

⁷⁷Ibid., pp. 39-41.

⁷⁶Ibid.

⁷⁸Ibid., p. 47.

TABLE II
COMPARISON OF TRANSPORTATION MODELS WITH RESPECT TO SELECTED FACTORS INFLUENCING
THE LOCATION OF MARKETING FACILITIES

Model ^a	Number of Stages		Final Demands	First Stage Processing Plants ^b			Distribution Costs Vary With Origin	No. of Destinations	Second Stage Processing Plants ^c	
	Transportation	Processing		Volume Restricted	Costs Vary With Location	Cost, a Function of Volume			Costs Vary With Location	Cost, a Function of Volume
Two-stage transportation model: No processing volume restraint	2	1	Fixed	No	No	No	Yes	>1	n.a. ^d	n.a.
N-stage transportation model: Plant size restrained	N	N-1	Fixed	Yes	Yes	No	Yes	>1	n.a.	n.a.
Two-stage transportation model with equal distribution cost ^e	2	1	Fixed	No	Yes	Yes	No	1	n.a.	n.a.
Two-stage transportation model: Distribution costs vary with origin ^e	2	1	Fixed	No	Yes	Yes	Yes	1	n.a.	n.a.
Two-stage transportation model with multiple final destinations ^e	2	1	Fixed	No	Yes	Yes	Yes	>1	n.a.	n.a.
Two-stage transportation model with multiple single-stage locations: No economies of scale	2	1	Variable	No	Yes	No	Yes	>1	n.a.	n.a.
Two-stage transportation model with multiple single-stage locations: Economies of scale permitted	2	1	Variable	No	Yes	Yes	Yes	>1	n.a.	n.a.
Two-stage transportation model with economies of scale and multiple stage processing	2	2	Fixed	No	Yes	Yes	Yes	>1	n.a.	n.a.

TABLE II (continued)

Model ^a	First Stage Processing Plants ^b				Distri- bution	Second Stage Processing Plants ^c		
	Number of Stages		Costs			No. of Desti- nations	Costs Vary With Location	Cost, a Function of Volume
	Trans- portation	Pro- cessing	Final Demands	Volume Restricted				
N-stage transportation model with economies of scale and multiple stage processing	N	N-1	Fixed	Yes	Yes	Yes	n.a.	n.a.

^aRaw product supplies are assumed fixed in all models.

^bIf K = number of plants and L = number of destinations, $K \leq L$.

^cFinal stage processing occurs at S final demand sites which are different from the K initial processing sites.

^dn.a. means not applicable.

^eEconomies of scale in production are allowed.

Source: B. R. Miller and R. A. King, Models for Measuring the Impact of Technological Change on Location of Marketing Facilities, Agricultural Economics Information Series No. 115 (Raleigh: North Carolina State University, 1964), pp. 10-11.

equilibrium flows were then considered.⁷⁹ Input data were for the years 1949-1950. Livestock prices and production within each region were considered to be mutually dependent variables. Supply and demand functions for livestock products and freight rates were other required inputs. Output consisted of⁸⁰ (1) production, consumption prices and interregional shipments of livestock and (2) prices, consumption and interregional shipments of feed.

From the point of view of the current study, the most significant part of Fox and Taeuber's work lay in the secondary analysis of a 50 per cent general increase in freight rates. Few changes in trading partners were noted, but substantial changes did occur in feed price differentials and volumes of shipments among areas.⁸¹ After all adjustments were completed, freight revenues from feed rose only 25 per cent in response to the 50 per cent increase in rates.⁸²

T. D. Phillips and R. A. King employed a space-time model and the perfect market concept to analyze spatial and seasonal variations in North Carolina corn prices for the periods 1953-54 and 1957-58.⁸³ They found that although reported corn prices tended to conform to

⁷⁹K. A. Fox and R. C. Taeuber, "Spatial Equilibrium Models for the Livestock--Feed Economy," American Economic Review, 45(4):584-608, September 1955.

⁸⁰Ibid., p. 586.

⁸¹Ibid., p. 605.

⁸²Ibid.

⁸³Travis D. Phillips and Richard A. King, A Spatial and Seasonal Analysis of Corn Prices in North Carolina, Agricultural Economics Information Series No. 95 (Raleigh: North Carolina State University, November 1962).

theoretical limits, weekly prices often displayed wide variation. Post-harvest storage would have paid off in a majority of instances. Their findings agreed with the commonly-held idea that grain elevators are low-margin, high-volume enterprises, hence anything which would reduce unit costs would contribute significantly to their profitability. Their studies also indicated that significant economies could be obtained by increasing the scale of plant.

Fuller⁸⁴ analyzed grain movements in the South in order to estimate the gross volume of various grains received by southern⁸⁵ dealers and processors, its sources and destinations, modes of transportation, calendar quarter, and the available storage capacity for the years 1959-60. Most existing bulk and total storage capacity was found to be located in states which have historically provided river or ocean port facilities.

Eickhoff and Padgett, in studying the effects of decreases in transportation rates for feed grain made the following observations:⁸⁶

(1) Reductions in rail rates have caused significant changes in modes of transportation used for corn imported into Georgia. (2) The margins

⁸⁴C. E. Fuller, Grain Movements in the South, Southern Cooperative Series Bulletin No. 91 (Knoxville: The University of Tennessee, Agricultural Experiment Station, September 1966).

⁸⁵Grains involved were corn, oats, wheat, soybeans, sorghum and barley. Participating states were the same as those given in footnote 1, page 1, except for Florida and Kentucky.

⁸⁶W. D. Eickhoff and J. H. Padgett, The Effects of Decreases in Transportation Rates on Feed Grain Prices in Georgia, Mimeo Series N. S. 226 (Athens: University of Georgia, Agricultural Experiment Station, May 1965).

between prices paid to farmers in Georgia and the Midwest decreased in 1964 relative to 1960. (3) Feed grain cost savings are being substantially passed on to consumers by handlers.

The previously discussed authors have proved that meaningful empirical research in interregional competition and plant location is possible. The present study builds on the assumptions and methodology of these authors by applying a reactive programming plant location model to a wide-area problem.

No corn marketing feasibility studies of the types discussed above have been published in the Southeast. Most studies of grain marketing and transportation have been either descriptive in nature, have budgeted costs and returns of various facilities or have involved use of a single-stage transportation model or similar technique to estimate optimum sources or destinations of grain.

CHAPTER III

METHODOLOGY

This chapter presents the methodology employed in the application of a reactive programming plant location model to a situation involving several transportation modes and fixed market demands. The model first requires that the Continental United States be divided into several marketing areas, and a "representative" market point designated within each area. Next, the corn surplus or deficit position of each area is estimated for the years 1964 and 1975. Transportation costs are then estimated for moving corn from every surplus area to each deficit area by rail, truck and barge under various sets of cost assumptions.¹ Fixed costs are also estimated for handling corn in three representative sizes of plants.

Supplies and demands for corn by areas, appropriate transfer costs and fixed plant costs are incorporated into a plant location model to yield information about the optimum number, sizes and locations of handling facilities under the stated assumptions. Each transport rate is analyzed to determine imputed costs of employing sub-optimum routes. This provides some insight into pressures for adjustment in the industry.

In the following sections attention is paid to more detailed procedures and explicit or implicit assumptions utilized in the study.

¹Including combinations of modes where applicable.

I. DELINEATION OF MARKET AREAS

The very nature of interregional analysis presupposes that a given macro-area can be sub-divided into two or more micro-areas according to some meaningful criterion. Heady has said:²

The question of aggregation in interregional analysis gives rise to two types of problems: conceptual and practical. Relatively, the conceptual problem is simple. More difficult is the practical problem of aggregation over commodities, inputs and regions. Taking regions alone, if the aggregation is too broad, the results will have little application for policy, education or other programs aimed at stimulating or restricting change.

The necessary conceptual condition for regional delineation is homogeneity with respect to the characteristics or commodities under consideration, in this case, corn. Empirical constraints, however, would include data availability, capacity of data processing equipment and the uses for which results are intended.

Areas used in this study were delineated by consensus of representatives from the ten participating states, Tennessee Valley Authority and the United States Department of Agriculture.³ The criterion for division is homogeneity of agricultural economy, resource base and market facilities.⁴ These marketing areas have undergone several

²Earl O. Heady, "Aggregation and Related Problems in Models for Analysis of Interregional Competition," Interregional Competition Research Methods, Richard A. King, editor (Raleigh: North Carolina State University, The Agricultural Policy Institute), p. 129.

³See footnote 20, page 7.

⁴These comments were based on discussions with Mr. Bruce McGehee, Navigation Economics Branch, Tennessee Valley Authority, February 1968.

revisions to reflect economic changes which have occurred over the life of the project. The present division is shown in Figure 6. Crop Reporting Districts were aggregated to "build up" these market areas. In some cases, parts or all of several states are combined to form a single area. This is especially true for states not directly participating in Project SM-29. These areas have been used for previous research, data collection and publications by members of the SM-29 Technical Committee. Since the current study contributes to general SM-29 objectives and relies heavily on SM-29 regional input data, these areas are accepted as parameters in the forthcoming analysis.

II. ESTIMATES OF SURPLUS AND DEFICIT AREAS

In order to determine the surplus-deficit positions of each marketing area, required information includes the volume of domestic production, net in-shipments or out-shipments and total disappearance of corn. The total disappearance equals domestic utilization plus exports. Domestic utilization is assumed to be a function of the number of grain consuming animal units in an area and their estimated rations as determined by the Southern Regional Grain Marketing Committee. No human consumption is considered.

Domestic production plus imports of corn must equal domestic utilization plus exports. Therefore an area would be declared surplus when local production exceeded local utilization. A corn deficit would occur when local corn production was less than utilization.

Figure 6. Grain marketing areas in the Continental United States delineated by the Southern Regional Grain Marketing Committee.

Area

Southern Region

Market Center

1 Eastern North Carolina, Eastern South Carolina	Wilson, N. C.
2 Western North Carolina, Northwestern South Carolina	Charlotte, N. C.
3 South and Southwestern South Carolina, Southern Georgia	Valdosta, Ga.
4 Northern Florida	Jacksonville, Fla.
5 Southern Florida	Tampa, Fla.
7 Southern Alabama, Northwestern Florida	Montgomery, Ala.
8 Northern Alabama	Guntersville, Ala.
9 Northern Georgia	Gainesville, Ga.
10 Eastern Tennessee	Chattanooga, Tenn.
11 Central Tennessee	Nashville, Tenn.
12 Western Tennessee, Northwestern Mississippi, Eastern Arkansas, Northwestern Louisiana	Memphis, Tenn.
13 Southern Mississippi, Southeastern Louisiana	Jackson, Miss.
14 Southwestern Louisiana	New Orleans, La.
15 Southwestern Arkansas, Northwestern Louisiana	Shreveport, La.
16 Northwestern Arkansas	Springdale, Ark.
17 Northcentral Arkansas	Little Rock, Ark.
18 Western Kentucky	Henderson, Ky.
19 Central Kentucky	Louisville, Ky.
20 Eastern Kentucky	Ashland, Ky.

Non-South Area

21 Virginia, West Virginia	Harrisonburg, Va.
22 Baltimore	Baltimore, Md.
23 Salisbury, Maryland	Salisbury, Md.
24 Norfolk, Virginia	Norfolk, Va.
25 Southern Ohio	Cincinnati, Ohio
26 Southern Indiana	Evansville, Ind.
27 Northern Ohio, Northern Indiana, Mainland Michigan	Indianapolis, Ind.
28 Wisconsin and Upper Michigan	Milwaukee, Wisc.
29 Illinois	Peoria, Ill.
30 Missouri	St. Louis, Mo.
31 Iowa	Davenport, Iowa
32 Minnesota, Dakotas	Minneapolis, Minn.
33 Nebraska	Omaha, Neb.
34 Kansas	Kansas City, Kansas
35 Texas	Fort Worth, Texas
36 Other Western States	Denver, Colo.

Figure 6 (continued)

40A New Orleans, Export
40B Pascagoula, Export
40C Mobile, Export
44 Charleston, Export
37 Other Midwest
38 Other
39 Unknown

New Orleans, La.
Pascagoula, Miss.
Mobile, Ala.
Charleston, S. C.

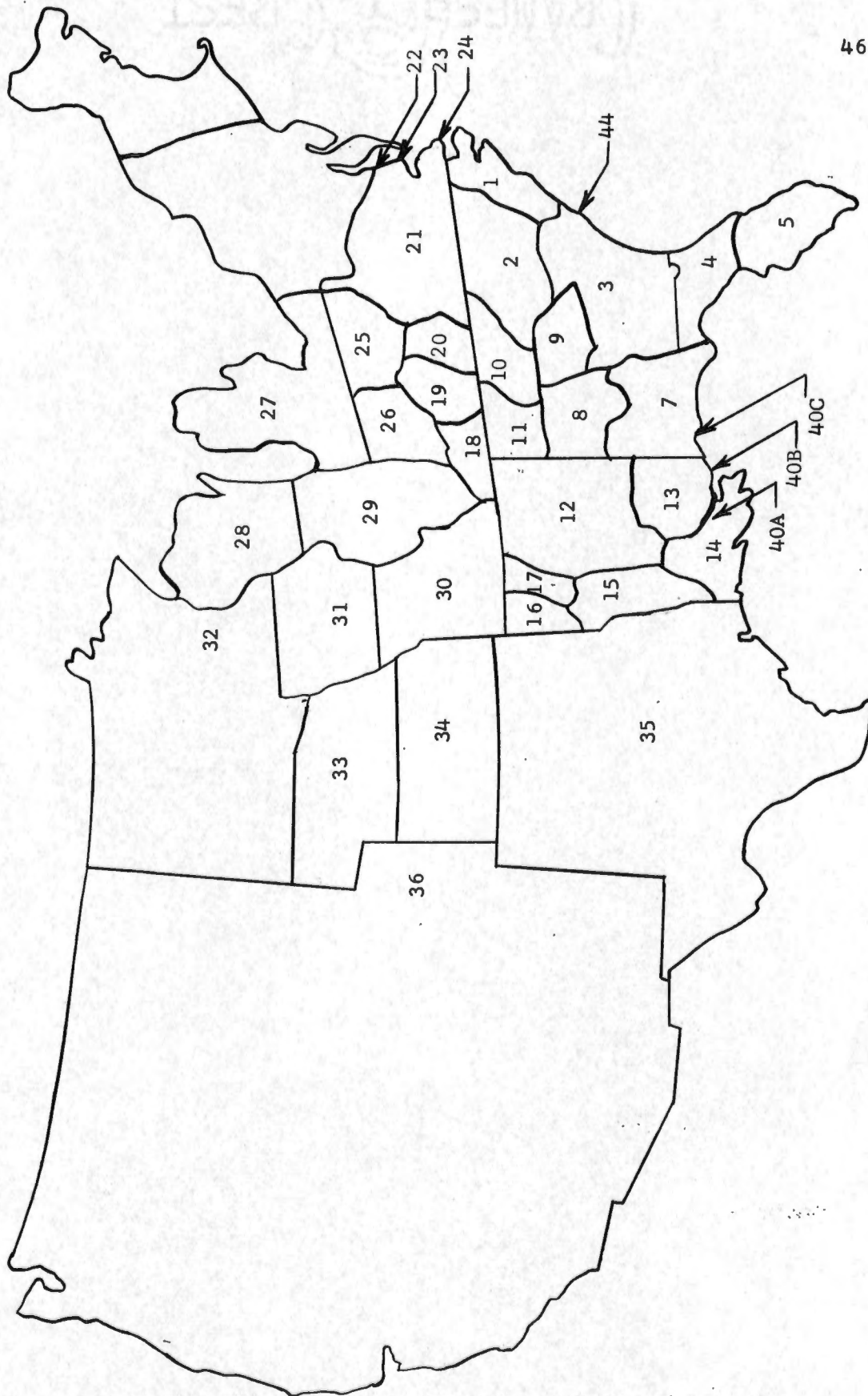


Figure 6

For 1964 corn surplus-deficit determinations were made by the Southern Regional Grain Marketing Committee through comparisons of corn production and disappearance by areas. For 1975 these determinations were made by independently projecting corn production, animal numbers and animal rations. These projections were combined to yield the desired corn balances.

III. TRANSPORTATION COSTS

Corn moves by rail, barge and truck, hence costs for all three modes singly and in combination, where appropriate, must be considered. Rail and barge rates were obtained for most required routes from Tennessee Valley Authority data. Due to a lack of more detailed data, published barge rates are likely to represent maximum rather than average charges for corn movements.

Trucking costs present an entirely different problem. As has been previously indicated, trucking costs for grain are not a matter of public record. This forced the derivation of a cost function relating trucking costs to distance traveled. The Southern Regional Grain Marketing Committee selected an equation in which transfer cost was a linear function of distance. Estimates of highway distances between various origins and destinations were based on mileage data published in the Rand McNally Standard Highway Mileage Guide.⁵

⁵Rand McNally Standard Highway Mileage Guide (New York: Rand McNally and Company, 1961), pp. 2-227.

IV. COSTS OF CORN HANDLING FACILITIES

Various types of grain elevators are important links in the southeastern corn marketing system. They sell the services of storing, cleaning, drying and/or blending of grain.⁶ Some elevators have docking stations for all three transportation modes. Elevators utilizing rail and truck transportation, however, are more common than those with additional barge facilities.

Appropriate fixed and variable plant costs were developed by the Southern Regional Grain Marketing Committee through review of accounting data from actual firms and through synthetic techniques. The synthetic method involved tracing the flow of grain through the elevator, dividing this flow into stages,⁷ determining proper types and capacities of required equipment according to the "Law of Harmony,"⁸ and estimating the type and amount of labor required in each stage. Plant costs were

⁶Harlon D. Traylor and Henry H. Bernard, Jr., Economic Feasibility of Shipping Grain and Soybeans by Water in Louisiana, D. A. E. Research Report Number 357 (Baton Rouge: Louisiana State University, Agricultural Experiment Station, September 1966), p. 5.

⁷A "stage" in production may be considered to be the aggregate of all units of a single or a group of closely cooperating factors in a productive process (from B. C. French, L. L. Sammet and R. G. Bressler, "Economic Efficiency in Plant Operations with Special Reference to the Marketing of California Pears," Hilgardia, 24(19):545, July 1956).

⁸According to the Law of Harmony, "To minimize the employment of all durable factors per plant unit, plant output must equal a common denominator of the capacities of all the durable factors employed by the plant" (from Hans Brems, "A Discontinuous Cost Function," American Economic Review, 42(4):580, September 1952).

then estimated by applying a wage scale to required labor and aggregating machine costs by stages. Machine and site maintenance costs, machine depreciation, administrative expenses and overhead were also included.

V. LOCATIONS OF CORN HANDLING CAPACITY

Flows of corn into the South from midwestern surplus areas are emphasized in this study. Corn shipments from origins within the 19 southern areas accounted for only a small proportion of total southern corn requirements in 1964 or estimates for 1975.

Adequate corn handling capacity at non-south shipping points was assumed to exist outside the model. Customers for corn handled through the southern facilities were assumed to possess adequate handling capacity for their requirements as part of their overall operations.

All potential locations for corn handling capacity were within the 19 southern areas, the three Gulf Coast ports and the Charleston, South Carolina export market. Corn was assumed to move into the South and be disbursed through one of these points. This provided a total of 23 possible locations for corn handling in 1964 and 1975.

VI. PLANT LOCATION MODEL

Contrary to conventional "spaceless" theory, a firm competing in a spatial market has more than one demand for its product.⁹ In

⁹Billy Ray Miller, "Economic Feasibility of Alternative Locations for Bulk Grading and Buying of Farmers' Stock Peanuts in North Carolina and Virginia" (unpublished Doctoral dissertation, North Carolina State University, Raleigh, 1963), p. 29.

reality, there are as many demands as there are geographically separated product markets.¹⁰ Because of this fact, determining the optimum number, sizes and locations of marketing firms can be considered a problem of equating long run product demands and factor supplies.

Reactive Programming

In the current problem reactive programming was employed to achieve more technical realism in the required computations.¹¹ This procedure has only recently been applied to problems of plant location.¹²

Employment of reactive programming permits much discretion on the part of the analyst in choice of parameters used. Demand functions with uniform slopes and predetermined supplies, demand functions with different slopes and predetermined supplies, demand and supply functions with different slopes and demand and supply functions with or without supply limits can all be dealt with through the use of reactive programming.¹³ Due to extreme limitations on comparable interarea data, especially relating to demand functions, a fixed quantity form was chosen for the current analysis.

¹⁰The crucial point is that the aggregation takes explicit account of space rather than simply summing the demands of individual consuming units.

¹¹See the discussion of reactive programming in Chapter II.

¹²Miller, op. cit., p. 29.

¹³A. D. Seale, Jr. and Thomas E. Tramel, op. cit., pp. 49-55.

Demand Functions

Use of fixed quantities demanded in all markets has the effect of substituting perfectly inelastic demand functions into the model. Since reactive programming is not capable of directly handling such functions, pseudo demand curves are used to replace the original perfectly inelastic demand functions. "These pseudo demand curves can be made to intersect the original inelastic demand functions at some positive price and to cross the quantity axis at a point that approaches the fixed quantity demanded in a particular market as closely as desired."¹⁴ These functions are required to satisfy two conditions: First, they must allocate proper amounts of corn to the several markets. Second, they must maintain price differentials consistent with transfer costs among markets.

Computational Scheme

The general computational scheme¹⁵ and data requirements for the reactive programming plant location model can be presented as follows:¹⁶ First, assume I locations of strategic factor (corn), K possible plant locations (major grain elevator sites) and J markets for corn. Also let Q_{ij} be the quantity of homogeneous factor or factor equivalent (corn) at origin i and moving to destination j and Q_{ik} be the amount

¹⁴Miller, op. cit., p. 34.

¹⁵See Appendix B for complete definitions and relations involved in the reactive programming plant location model and a computer format for an IBM 7040 computer.

¹⁶Miller and King, op. cit., pp. 58-59.

of factor originating at i and moving to the k^{th} intermediate plant. P_j is the price of factor (corn) equivalents at final destination j . Unit assembly costs from origin i to plant k are given by c_{ik} , and unit distribution costs from plant k to final market j are shown by c_{kj} .

Given the definitions presented above, the following relationships define the nature of the problem.¹⁷

$$P_j = f \left(\sum_{i=1}^I Q_{ij} \right) \quad \begin{array}{l} i = 1, 2, \dots, I \\ j = 1, 2, \dots, J \end{array} \quad (1)$$

The price at final destination j is solely a function of quantity of product arriving in the j^{th} market. For the present study, pseudo demand functions of the above form will be used.

$$AC_k = g_k \left(\sum_{i=1}^I Q_{ik} \right) \quad \begin{array}{l} k = 1, 2, \dots, K \\ i = 1, 2, \dots, I \end{array} \quad (2)$$

The unit cost of processing at the k^{th} plant is a function of the volume of product moving through the plant. Average variable costs are assumed to be equal and constant at all possible plant locations in the present application.

$$\begin{array}{ll} c_{ik} = \text{constant} & i = 1, 2, \dots, I \\ \text{and} & k = 1, 2, \dots, K \\ c_{kj} = \text{constant} & j = 1, 2, \dots, J \end{array} \quad (3)$$

Both unit assembly and unit distribution costs for given routes are considered to be constant regardless of the volume of commodity (corn) moving over them.

¹⁷Except for number 6 these equations are all based on Miller and King, op. cit., pp. 57-60.

$$s_i = \text{constant} \quad i = 1, 2, \dots, I \quad (4)$$

The quantity of corn supplied at each origin is constant, hence the total available quantity is constant.

Relations (1), (2), (3) and (4) summarize the input data requirements for the model. With these inputs, the task becomes one of determining the value of K which will result in the highest net revenue for the industry as a whole. In order to accomplish this task, the following relation also becomes critical.

$$NR_{ikj} = f_{ij} \left(\sum_{i=1}^I Q_{ij} \right) - g_k \left(\sum_{i=1}^I Q_{ik} \right) - c_{ik} - c_{kj} \quad (5)$$

where

$$\begin{aligned} i &= 1, 2, \dots, I \\ k &= 1, 2, \dots, K \\ j &= 1, 2, \dots, J \end{aligned}$$

Net revenue per unit of product (corn) is a function of price at the location of final demand, less unit processing costs, less unit assembly and distribution charges.

The computational system would involve $I \times K \times J$ of these equations, and the problem would be to choose K in such a manner as to satisfy the following criterion.

$$\sum_{i=1}^I \sum_{k=1}^K \sum_{j=1}^J NR_{ikj} = \text{maximum} \quad (6)$$

Certain additional conditions must be satisfied in the computational process, however.

$$\begin{aligned} Q_{ij} &\geq 0 \\ \text{and} \\ Q_{ik} &\geq 0 \end{aligned} \quad \begin{aligned} i &= 1, 2, \dots, I \\ k &= 1, 2, \dots, K \\ j &= 1, 2, \dots, J \end{aligned} \quad (7)$$

Only positive or zero shipments can be made in assembly and distribution. No reverse ($j \rightarrow i$) hauls are allowed.

For each i , k , and j appearing in the final solution

$$NR_{ikj} \geq NR_{i'k'j'} \quad \begin{array}{l} i = 1, 2 \dots I \\ k = 1, 2 \dots K \\ j = 1, 2 \dots J \end{array} \quad (8)$$

for all other possible combinations not appearing in the solution. In other words, all shipments will be supplied by the best origin, processed in the best plant and sold in the best market.

For all active routes:

$$NR_{ikj} \geq 0 \quad \begin{array}{l} i = 1, 2 \dots I \\ k = 1, 2 \dots K \\ j = 1, 2 \dots J \end{array} \quad (9)$$

No routes will be permitted to operate at a net loss.

$$\sum_{j=1}^J Q_{ij} \leq S_i \quad \begin{array}{l} j = 1, 2 \dots J \\ i = 1, 2 \dots I \end{array} \quad (10)$$

It is impossible to deliver a greater quantity to a given market from a particular origin than is initially available at that origin.

$$\sum_{k=1}^K Q_{ik} \leq S_i \quad \begin{array}{l} k = 1, 2 \dots K \\ i = 1, 2 \dots I \end{array} \quad (11)$$

No greater quantity can be assembled at an intermediate processing plant from a given origin than was initially available at that origin.

As the above relations indicate, the computational scheme is based upon the concept of a spatial market in equilibrium. The influence of location and magnitude of supply, assembly and distribution costs,

potential intermediate plant sites, in-plant cost reductions and market demands are all considered.

Economic Rationale of the Plant Location Model

When linear market demand curves are employed, the problem becomes one of maximizing a quadratic net revenue function. Conceptually the problem may be represented as follows:

$$NR = \sum_{j=1}^J (aQ - bQ^2) - k(V + hQ) - \sum C_1Q - \sum C_2Q \quad (12)$$

where

$(aQ - bQ^2)$ = total revenue in the j^{th} market

$(V + hQ)$ = total processing cost in the k^{th} plant

and

k = the number of active plants in the system.

Central to the Miller and King framework is the assumption that average variable cost is constant and equal at all possible plant locations for a particular size of plant.¹⁸ This would cause the variable component of plant costs to be deleted from consideration as a location determinant as illustrated below:

$$NR = \sum_{j=1}^J (aQ - bQ^2) - k(V) - \sum C_1Q - \sum C_2Q \quad (13)$$

¹⁸Miller and King, op. cit., p. 61.

It is now apparent that within this model, fixed plant costs¹⁹ are prime determinants of plant number. When differentiated with respect to Q , equation 13 yields equation 14.

$$\frac{\partial NR}{\partial Q} = \sum_{j=1}^J (a - 2bQ) - \sum C_1 - \sum C_2 \quad (14)$$

Therefore, if the market price intercept (a) is sufficiently large, the slope of the net revenue function will be positive. As output (Q) is increased, the slope will eventually reach zero then become negative. Net revenue will increase, reach a maximum then decline.²⁰

The number of plants, however, also affects net revenue. When equation 13 is differentiated with respect to k , equation 15 results.

$$\frac{\partial NR}{\partial k} = -V \quad (15)$$

Since V equals total fixed costs for a representative firm, these costs are included in the model. Fixed costs do not respond to changes in plant output, but they must be included in computations when the number of plants in the system can change.

An iterative process is required to determine the number of plants associated with maximum net revenue because both plant and transfer costs change with the number and locations of plants. Each possible

¹⁹Miller and King define fixed plant costs as "The minimum average annual long-run cost of running a plant. It is the sum of the figure representing aggregation of durable and variable inputs required to begin operation of the plant and the figure representing maintenance cost for a typical production period" (from Miller and King, op. cit., p. 80).

²⁰ $\frac{\partial^2 NR}{\partial Q^2} = -2 \sum b$. Since $\frac{\partial^2 NR}{\partial Q^2} < 0$, and assuming Marshallian demand curves, the net revenue function has a maximum.

combination of active plants has an associated set of assembly and distribution costs. The iterative process, therefore, determines the optimum geographical distribution of plants. Hence the objective is to choose the number and locations of active plant sites (k) from the set of possible plant sites (K) such that net revenue for the industry is maximized.

Reactive programming takes advantage of certain side conditions present in spatial equilibrium to solve this maximization problem.²¹ First, positive or zero net prices between all trading pairs are required. These net prices must be higher for every active route than for any inactive combination of trading partners. If a shipper sends goods to more than one destination, the goods are allocated so that he receives approximately equal net prices regardless of customer. Given these conditions and the non-negativity constraints, no trader can improve his position by changing allocations, and the system is in equilibrium.

This procedure can also be represented graphically. First assume a total cost function of a representative firm as shown in Figure 7. Next assume a total transfer cost function for a system of such firms in which transfer costs decrease as the number of plants increase (Figure 8). Then assume a fixed plant cost function for the system composed of a vertical summation of individual firm fixed costs. This function will begin at the origin and have a positive slope equal to

²¹Miller and King, op. cit., p. 88.

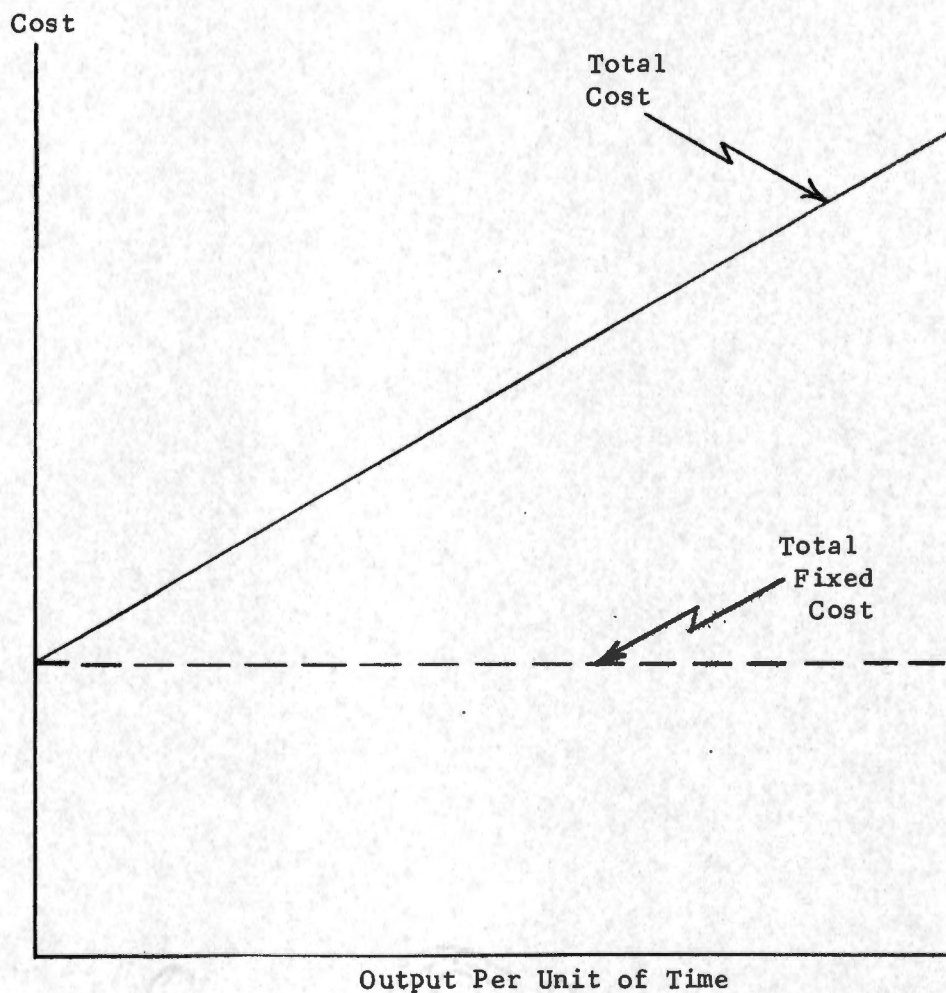


Figure 7. Conceptual representation of total costs for a representative corn handling firm.

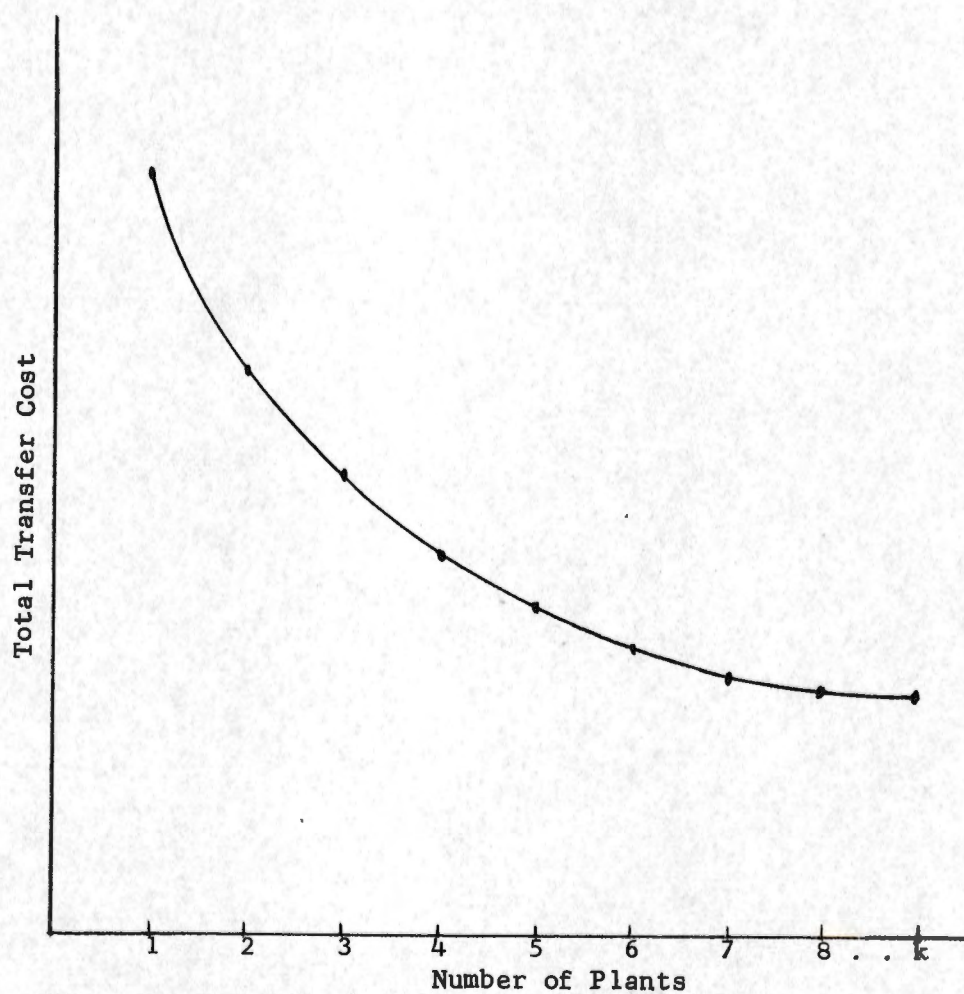


Figure 8. Conceptual relation between the number of plants and total transfer cost in a representative corn trading system.

the fixed cost for a single firm. Finally assume a composite function representing the vertical summation of total transfer costs and fixed plant costs for the system as plant number changes. The composite curve will decline, reach a minimum and increase again. The optimum number of plants is the point where this curve is minimized. This situation is represented in Figure 9.

For the reasons indicated previously, the plant location model computer program is unable to move directly to the equilibrium situation discussed above. The program converges on the optimum solution through an iterative process (Figure 10). It first computes a spatial equilibrium solution for the trading system which yields optimum flows of corn without considering any fixed plant costs. At this stage net revenue is maximized subject only to transfer costs (Figure 10A).

Next, fixed cost for a representative plant is introduced into computations. This cost is constant for each plant considered at a given time. It has been found advisable through experience to introduce this cost in a stepwise manner to circumvent the positively sloped derived-demand curve phenomenon at the plants.²² These increments are

²²In sample problems effects normally associated with positively-sloped demand curves have been observed in plants which were first subjected to zero average fixed costs then arbitrarily high average fixed costs which fell rapidly as additional product flowed through the plants. The results were unreasonably large plant sizes and consequent gross understatement of optimum plant numbers. These effects were thought to be caused by the discontinuous nature of the assumed plant cost function (this phenomenon was first observed by B. R. Miller and reported to the present author in 1968). Subsequent research substantiated the observations of Miller and his means of dealing with them. See Appendix B.

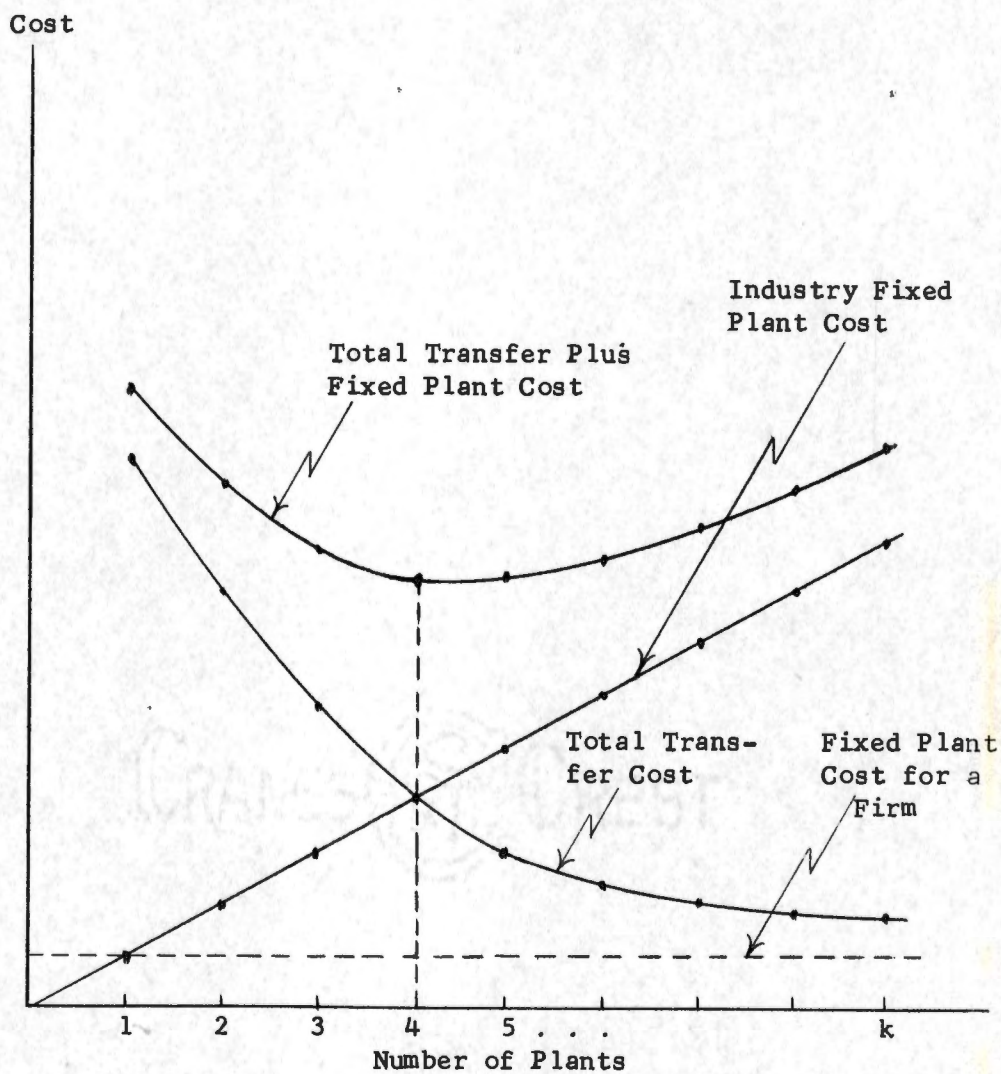


Figure 9. Graphic representation of the optimum number of plants obtained from the plant location model.

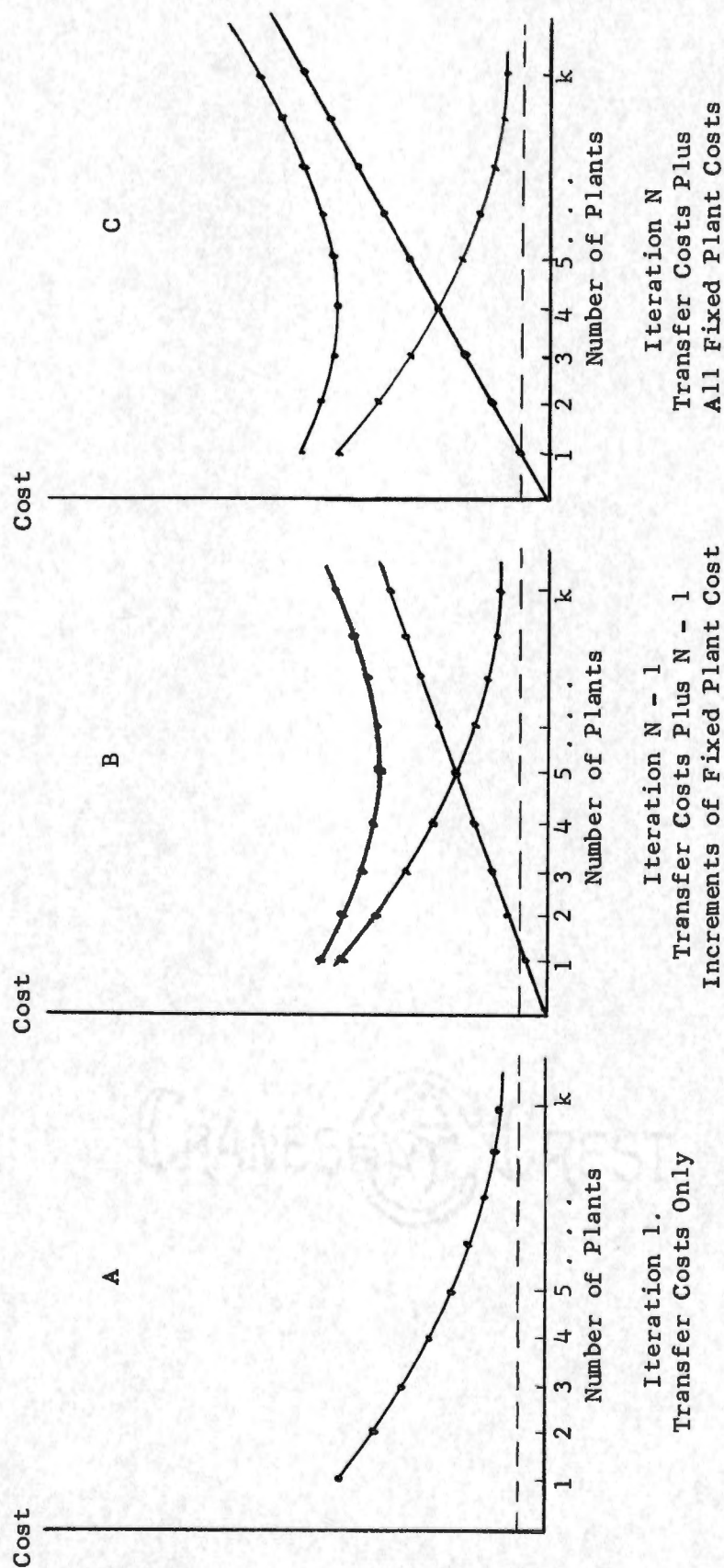


Figure 10. Graphic representation of the iteration process employed by the plant location model computer program to determine the optimum number of plants.

judgment values set by the researcher at the time computations are made. Trial runs and successive adjustments to these increments are often necessary to obtain satisfactory results.

Each time an increment of fixed plant cost is read into the program, a new spatial equilibrium solution is computed from the previous solution. Thus the system is permitted to react to every increment of plant cost. These increments continue until total fixed cost for a representative plant is included or until the number of plants becomes stable over a series of iterations. The program, therefore, converges on an optimum solution through a series of successive approximations (Figure 10B and C).

The effect of progressively imposing fixed plant cost on the net revenue function is illustrated by Figure 11. Initially net revenue is only constrained by transfer costs. As plant costs are introduced by successive increments, the net revenue function is progressively constrained until it is maximized subject to total transfer plus total fixed plant cost. This condition is required for the optimum solution of the problem.

An important technical limitation of this model should be noted, however. When it is employed in situations involving multiple plants at particular locations, the model only assumes a single plant cost at each location. This leads to understatement of investment and, therefore, to understatement of the true average fixed plant cost. The solution obtained by this procedure is only approximately optimum. Computed values of average fixed plant cost are accurate up to plant

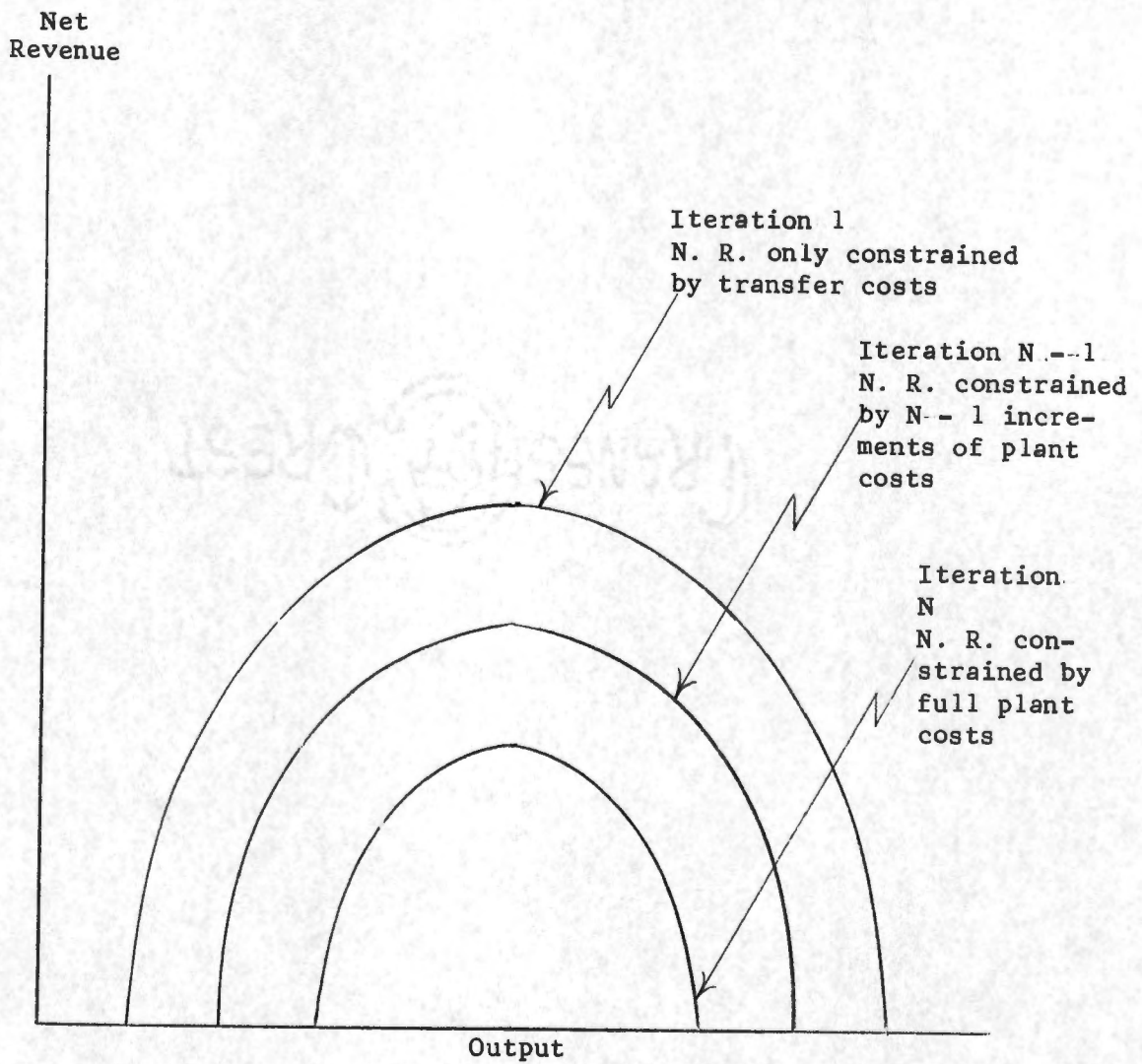


Figure 11. Effects of plant location model solution procedure on net revenue.

capacity for one plant, but understate true average fixed plant cost thereafter. The magnitude of this built-in error is directly proportional to total fixed plant cost. This error can be significant in wide-area analysis in situations where total plant costs are large relative to total transfer costs.

It is also impossible to realistically determine the number of plants required in a trading system when requirements at some active sites greatly exceed the capacity of one plant. Results from the present application of the model, therefore, consist of the optimum volume and locations of corn handling capacity within the range of plant capacities considered.

VII. GENERAL ASSUMPTIONS OF THIS STUDY

Specific assumptions underlying the present analysis are catalogued below. Additional assumptions dealing with particular calculations or relationships will be discussed at the time they become operative in the exposition.

1. Corn from the several areas represents an homogeneous product.
2. The areas delineated in this project represent realistic trading regions for the corn trading system.
3. There is no overlapping of market areas tributary to major elevators.
4. The demand for corn is fixed at specified levels for each area.

5. Total area demand for corn can be represented by a single location point in each area.
6. Supplies of corn are predetermined for each area.
7. Total area supply of corn can be represented by a single location point in each area.
8. Total production equals total disappearance for the system as a whole in each production period.
9. No corn handling facilities are present at the beginning of the analysis.
10. Economies of size²³ are present in corn storage and handling, but all transport occurs at programmed rates.
11. Marginal costs are equal and constant at all possible elevator sites.
12. The flow of corn through handling facilities is relatively constant throughout the year.
13. Pure competition remains the standard of market performance as market structure is altered by varying the number of competing firms.
14. All unspecified variables in the corn trading system remain constant for the duration of the analysis.

²³During this exposition the expressions "Economies of Size" and "Economies of Scale" will be used interchangeably.

CHAPTER IV

ESTIMATED COSTS OF ELEVATOR OPERATION

I. DESCRIPTION OF TERMINAL ELEVATORS

The purpose of this chapter is to present basic elevator costs which are utilized in conjunction with transportation costs and demand data to locate the plants. Terminal elevators are normally located near principal grain marketing centers and vary in size from a few hundred thousand bushels to over 50 million bushels. Location rather than size, however, is the characteristic used to classify them.¹

During the last 15 years the number of terminal elevators in the United States has undergone rather wide variation (Appendix C, Table XVIII). The location of existing storage capacity reflects the historical national development of grain marketing, particularly the influence of wheat (Appendix C, Table XIX).

II. RATED STORAGE CAPACITY AND CAPACITY TO MARKET GRAIN

Rated storage capacity and capacity to market grain are fundamental concepts to this study and deserve special treatment. First, it should be explicitly stated that they are not synonymous. The capacity of an elevator to market grain refers to the rate at which grain can

¹Carl J. Vosloh, Jr., "Grain Marketing," Agricultural Markets in Change, Agricultural Economic Report Number 95 (Washington: Government Printing Office, July 1966), p. 218.

flow through the facility per unit of time or to the total quantity handled during a given length of season. This capacity is, therefore, a function of the capacities of the several operations performed on the grain by the elevator.²

Rated storage capacity describes the volume of grain which can be held at a given time by the elevator's storage bins.³ Such storage capacity includes bins used in connection with drying or cleaning operations but primarily the greater volume that can be held by the large holding bins. Excluding government storage programs, the demand for intermediate-term storage space would vary inversely with the availability of transport services for out-movement. This only applies to space in excess of operating requirements for gathering shipping lots of various kinds and grades of grain.

There is no generally accepted quantitative relationship between handling capacity and storage capacity.⁴ The rated storage capacity maintained by a firm would depend on several factors. Primary consideration would be given to the expected frequency of stoppages at successive levels in the marketing system which would interfere with the elevator's merchandising operations. Since construction and maintenance of capacity involve substantial investments, the cost of capital to the firm would be very important in making decisions relative to building storage capacity.

²Production and Marketing Administration, United States Department of Agriculture, Factors to be Considered in Locating, Planning and Operating Country Elevators, Marketing Research Report Number 23 (Washington: Government Printing Office, June 1952), pp. 75-77.

³Ibid.

⁴Ibid.

Future changes in government grain storage programs cannot be forecast with sufficient accuracy to serve as a basis for economic analyses. For this reason the impact of such programs is not considered in this study.

III. ALLOCATED COSTS FOR THREE REPRESENTATIVE ELEVATORS

The representative elevators selected for use in this study were based on data published by members of the SM-29 Technical Committee.⁵ In these elevators, operating margins of two cents, five cents and eight cents were assumed to cover all costs of operation.⁶ These elevators were assumed to have unloading facilities for trucks and loading-out equipment for barges.⁷ Costs⁸ for this docking equipment were considered indicative of costs for rail equipment which was not explicitly included. Locations of few existing elevators permit simultaneous docking of grain from all three modes of transportation. No data dealing with simultaneous use of truck, rail and barge equipment have been published by the SM-29 Technical Committee.

In order to better understand pertinent intra-plant technical relationships and more realistically estimate and allocate plant costs,

⁵Harlon D. Traylor and Henry H. Bernard, Jr., Economic Feasibility of Shipping Grain and Soybeans by Water in Louisiana, D. A. E. Research Report Number 357 (Baton Rouge: Louisiana State University Agricultural Experiment Station, September 1966).

⁶Ibid., p. 4.

⁷Ibid., p. 3.

⁸All cost data presented subsequently in this chapter are based on published material by Traylor and Bernard, pp. 1-79 unless otherwise noted.

total plant operations were segmented into component stages. These stages were then aggregated and combined with non-allocated costs to estimate total plant costs. Derivation of plant costs by this method assumed additivity of stages.

Five operating stages common to grain elevators in this study were⁹ (1) receiving and dumping, (2) cleaning, (3) drying, (4) holding and (5) blending and loading out. Figure 12 is a process chart for a representative grain elevator.

A nucleus of buildings, labor and equipment must be present before elevator operations can begin. These allocated costs are summarized by production stages in Table III. In addition certain building costs were not allocated to the production stages. The most important of these relate to the elevator structure itself and necessary office facilities. Table IV indicates computed storage capacities, elevator and building costs and office housing costs. Certain elevator personnel are paid on a yearly basis, therefore, their salaries also constitute fixed costs to the firm (Table V).

The sum of annual fixed stage costs, non-allocated annual building costs and fixed salary expense represents total annual fixed costs to the firm. Table VI shows estimated total annual fixed costs for 2,500, 5,000 and 10,000 bushels per hour grain elevators.

⁹Ibid., pp. 7-19.

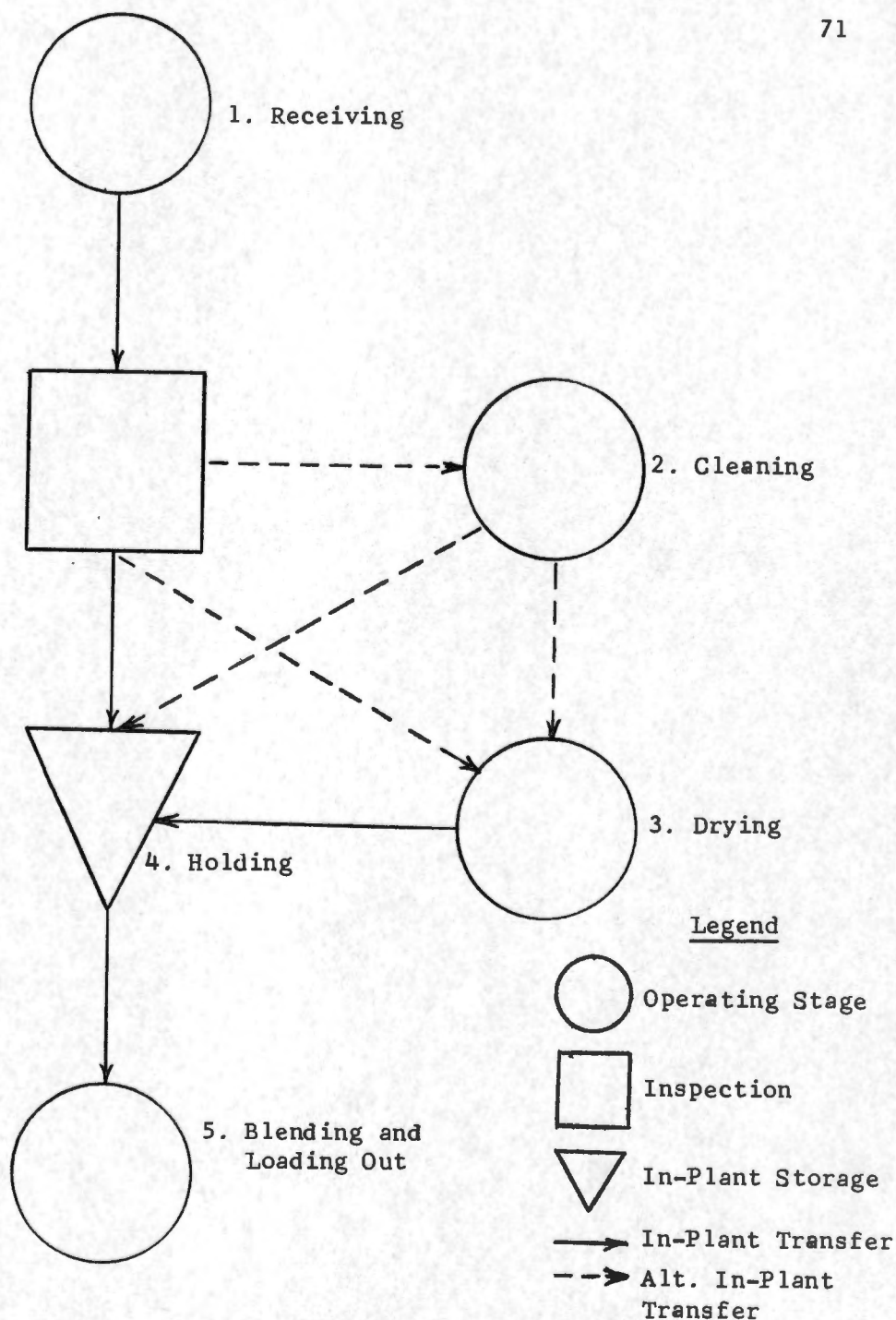


Figure 12. Flow of corn through a representative grain elevator.

Source: Adapted from Harlon D. Traylor and Henry H. Bernard, Jr., Economic Feasibility of Shipping Grain and Soybeans by Water in Louisiana, D. A. E. Research Report Number 357 (Baton Rouge: Louisiana State University Agricultural Experiment Station, September 1966), p. 56.

TABLE III

ALLOCATED ANNUAL FIXED PLANT COSTS BY STAGES FOR 2,500, 5,000 AND 10,000 BUSHELS
PER HOUR ELEVATORS

Size of Elevator Bushels/Hr.	Allocated Annual Fixed Plant Costs by Stages				
	I	II	III	IV	V
	-----Dollars-----				
2,500	4,222.29	586.22	976.75	4,953.18	5,490.10
5,000	4,374.94	658.95	1,508.99	6,766.28	5,950.45
10,000	4,896.77	744.97	2,015.33	11,790.89	6,436.36
					25,884.32

Source: Adapted from Harlon D. Traylor and Henry H. Bernard, Jr., Economic Feasibility of Shipping Grain and Soybeans by Water in Louisiana, D. A. E. Research Report Number 357 (Baton Rouge: Louisiana State University Agricultural Experiment Station, September 1966), pp. 7-18.

TABLE IV

ELEVATOR CAPACITIES, NON-ALLOCATED EQUIPMENT AND BUILDING COSTS AND OFFICE COSTS FOR
2,500, 5,000 AND 10,000 BUSHELS PER HOUR GRAIN ELEVATORS

Non-Allocated Equipment and Building Costs									
Size of Elevator		Equipment and Storage Costs		Elevator Building Costs		Office and Scale House Costs		Building and Storage Costs	
Capacity		Total	Annual	Total	Annual	Total	Annual	Total	Annual
Handling	Storage	-----Dollars-----							
Bu./Hr.	Bu.								
2,500	75,000	191,000	9,119.44	37,500	1,770.83	10,750	507.64	239,250	11,397.91
5,000	150,000	260,150	12,824.86	75,000	3,541.66	10,750	507.64	345,900	16,874.16
10,000	200,000	316,550	14,948.19	100,000	4,722.22	10,750	507.64	427,300	20,178.05

Source: Adapted from Harlon D. Traylor and Henry H. Bernard, Jr., Economic Feasibility of Shipping Grain and Soybeans by Water in Louisiana, D. A. E. Research Report Number 357 (Baton Rouge: Louisiana State University, Agricultural Experiment Station, September 1966), p. 22.

TABLE V

SALARIES OF FULL-TIME PERSONNEL FOR 2,500, 5,000, AND 10,000
BUSHELS PER HOUR ELEVATORS^a

Position	Salaries of Full Time Personnel					
	2,500 Bushels		5,000 Bushels		10,000 Bushels	
	Per Hour		Per Hour		Per Hour	
	Elevator		Elevator		Elevator	
	No.	Total Salaries ^b	No.	Total Salaries	No.	Total Salaries
Manager	1	6,400	1	7,040	1	7,680
Assistant Manager	1	5,248	1	5,760	1	6,656
Bookkeeper	1	4,224	1	4,608	1	5,120
Work Crew	2	7,040	2	7,040	2	7,040
Totals	5	22,912	5	24,448	5	26,496

Source: Adapted from Harlon D. Traylor and Henry H. Bernard, Jr., Economic Feasibility of Shipping Grain and Soybeans by Water in Louisiana, D. A. E. Research Report Number 357 (Baton Rouge: Louisiana State University, Agricultural Experiment Station, September 1966), p. 24.

^aEntires in the original table were adjusted to take account of the increase in minimum wage rates from \$1.00 to \$1.25 per hour. Each salary in the original table was multiplied by $1.00/1.25 = 1.28000$ to maintain pay differentials.

^bSalaries based on accounting data from existing firms.

^cSalaries were estimated on the basis of size in relation to the 10,000 bushels per hour plant.

TABLE VI

MAJOR COMPONENTS OF TOTAL ANNUAL FIXED COSTS FOR 2,500,
5,000 AND 10,000 BUSHELS PER HOUR GRAIN ELEVATORS

Size of Elevator Bu./Hr.	Major Components of Total Annual Fixed Costs			
	Annual Fixed Stage Costs ^a	Non-Allocated Annual Build- ing Costs ^b	Fixed Annual Salary Expense ^c	Total Annual Fixed Costs
	-----Dollars-----			
2,500	16,228.54	11,397.91	22,912.00	50,538.45
5,000	19,259.61	16,874.16	24,448.00	60,581.77
10,000	25,884.32	20,178.05	26,496.00	72,558.37

^aFrom Table III, page 72.

^bFrom Table IV, page 73.

^cFrom Table V, page 74.



IV. RELEVANT COSTS FOR PLANT LOCATION

The methodology of this study required the assumption that variable costs were constant throughout all relevant production ranges for each size of plant. It was also necessary to assume that variable costs were equal at all possible plant locations for any particular plant size. Under such assumptions, average fixed cost became the controlling factor in determining plant sizes, numbers and, within the framework of this model, plant locations. Hence, the fixed costs found in Table VI were used to determine the numbers, sizes and locations of corn handling capacity in this study.

An important technical limitation of the plant location model employed in this study is the fact that only one value can be used for total fixed plant cost at a given time. It is used for every plant in the system. This limitation precludes directly accounting for inter-area differences in plant costs and for variations in terminal costs associated with the employment of various modes of transportation among plants. These problems might be alleviated somewhat by using some type of weighted-average plant cost in the model. It must be recognized, however, that such a procedure would dull the model as an instrument for determining plant location in wide-area analysis. This model is still considered sufficiently accurate, however, to provide general guidelines for plant location.

CHAPTER V

TRANSFER COSTS FOR CORN BY MODE OF TRANSPORT

I. GENERAL CONSIDERATIONS

Transportation costs are costs to shippers for utilizing transport services regardless of the mode of transport or type of ownership of transport facilities. In this study, however, ownership of transportation equipment was assumed to be independent of all other marketing firms considered.

In general, movement of goods in one direction generates a joint product in the form of back-haul.¹ Agricultural commodities often make attractive back-hauls because of their exemption from rate regulation when moved by truck or barge. Occasionally, however, rigid time schedules of some specialized haulers preclude the vehicle laying over and contracting for a back-haul. Especially with respect to trucks, a rational operator would contract for a back-haul whenever load revenue is sufficient to cover associated variable costs and contribute something to the fixed costs of returning the vehicle.

Equal proportional decreases in transfer costs might be expected to aid producers most distant from a given market and act to the relative detriment of nearby producers.² This is true because transportation

¹Jack Thurman Lamkin, Jr., "Differential Pricing in the Transportation of Grain in the North Central Region of the United States" (unpublished Master's thesis, Texas Transportation Institute, Texas A and M University, College Station, Texas, 1967), p. 3.

²D. Philip Locklin, Economics of Transportation (Sixth edition; Homewood, Illinois: Richard D. Irwin, Inc., 1966), pp. 14-15.

charges account for a larger share of total production and marketing costs for the distant producers.

With respect to the area dependent on a given market, reduction in transport costs would enable more distant producers to profitably market their goods thus increasing the effective supply in the market. Theoretically, if market demand remained constant, however, price would fall to the point where the active production area decreased to a size consistent with market equilibrium.

II. TRUCKING COSTS

Trucking costs are generally considered to be variable with length-of-haul but inelastic with respect to size of payload for a given size of truck. For this reason the proportion of miles traveled laden becomes important. Truckers with a large proportion of unladen mileage must make corresponding adjustments in their tariffs. A sizable variation in utilization of rolling stock exists among different geographic areas of the country (Appendix C, Table XX). In calculating trucking costs it was assumed that all truck movements occurred with full loads, therefore no adjustments for partial-loading were necessary. Back-hauls received no special consideration.³ The exempt regulatory status and consequent lack of comparable cost data for truckers hauling corn over all routes precluded obtaining transfer costs directly (Chapter III, section III). This data insufficiency required transfer cost functions for moving corn to be estimated by least-squares regression

³Southern Regional Grain Marketing Committee.

techniques from sample data obtained by personal interviews of agricultural marketing firms utilizing trucks in all southern areas.⁴

The questionnaire contained the following categories: per cent of sales and receipts by truck both within and outside of the firm's home areas; type of charges, if any, for delivery and allowance for customer pickup. Transfer charges for the five largest receipts of grain including origin, distance and direction⁵ were also obtained.

Linear and logarithmic equation forms were derived, and the linear form was chosen. This function is presented below:

$$Y = 1.6357 + 0.0114X \quad (1)$$

where

Y = trucking costs in dollars per ton and

X = length of haul in miles.

This function yielded an r^2 of 0.7565, and a standard error of 0.7532.

Since the linear version was selected by the Southern Regional Grain Marketing Committee a modified version of equation (1) was used in the present study. This modification⁶ was necessary to maintain

⁴T. Q. Hutchinson, Economic Research Service, United States Department of Agriculture, memorandum to members of the Southern Regional Grain Marketing Committee (undated).

⁵The word "direction" in this case refers to an eight-point compass. "Direction-of-haul" as used previously indicated whether a given load was a forward (primary) or a back (secondary) haul.

⁶The conversion factor was 0.0357142. This was equivalent to dividing equation (1) by 35.7142 bushels per ton and multiplying by 1000 bushels.

comparability with other transport costs which were expressed in dollars per thousand bushels.⁷ This equation appears below:

$$Y = 45.7997 + 0.3192X \quad (2)$$

where

Y = trucking costs in dollars per thousand bushels and

X = length of haul in miles.

The resultant costs of moving corn by truck in 1964 and 1975 are shown in Appendix C, Tables XXII through XXIV.

III. RAIL COSTS

Rail costs for 1964 were divided into two major categories and several sub-categories. The first major category dealt with weighted-average rates. These costs reflected actual quantities of corn moving and the rates at which it moved over various routes. For present analytical purposes, however, these rates suffered from the limitation of not providing a complete transportation grid. In order to tie all origins, plants and destinations together these rates were supplemented by published rates for routes where no actual movement existed.⁸

⁷Initial rail and barge cost estimates were built up by Jim Boggs, Research Assistant, University of Georgia in 1967. Basic rail and barge rate data were obtained from Navigation Economics Branch, Tennessee Valley Authority. Handling cost estimates were derived from Costs of Storing and Handling Grain in Commercial Elevators, E. R. S., U. S. D. A. Bulletin 288, April 1966. Supplemental transfer cost estimates were made from the same sources by the present author in 1968.

⁸An equation was derived from the existing weighted-average rail rates by least squares regression techniques and used to estimate costs over routes for which no satisfactory rates could be found. This

Appendix C, Tables XXIII and XXIV represent transportation costs computed from 1964 and 1975 weighted-average rates utilized in this study. These rates were used in determining the maximum and minimum costs for corn moving over special routes.

The second major category of rail rates under which grain was assumed to move involved certain multiple car shipments utilizing "Big John" cars. These rates were the minimum rail tariffs at which corn was found to move over the specified routes. Other assumptions remained the same.⁹ Appendix C, Tables XXXI and XXXII represents these least-cost-rate shipments for 1964.

For 1975 certain "special rates" were also considered. A "Gainesville" rail rate was assumed to become effective between specified southeastern destinations and midwestern origins.¹⁰ This rate

equation appears below:

$$Y = 88.205 + 0.26159X$$

where

Y = weighted-average rail cost per thousand bushels of corn and

X = railroad distance in miles.

For this function, $r^2 = 0.5644$ and the standard error was 0.01462.

⁹To supplement existing data on least-cost rail charges, an equation was derived from existing cost data by least-squares regression techniques. Parameters of this equation appear as follows:

$$Y = 74.439 + 0.25300X$$

where

Y = least cost rail charges per thousand bushels of corn and

X = railroad distance in miles.

This equation yielded an r^2 of 0.5690 and a standard error of 0.01416.

¹⁰By 1975 the Gainesville rail rate is expected to be effective from the following Origins: 25, 26, 27, 29, 30, 31, 32, 33 and 34 to Destinations 2, 5, 8, 9, 13, 15, 16, 19 and 40A (David Culver, Acting Head, Long Run Projections Section, E. R. S., United States Department of Agriculture, memorandum to T. Q. Hutchinson dated May 29, 1968, p. 2).

consisted of a 10 per cent reduction in the line-haul components of the least-cost rail rates previously defined.

Also in response to intermodal competition, railroads are expected to initiate additional rate decreases such as the "Rent-A-Train"¹¹ program. In order to predict the impact of such rate reductions, it was decided to reduce certain existing rates¹² by 40 per cent, and reprogram the solution.

It should be noted at this point that only the line-haul components of rail costs underwent reduction. Estimated docking charges remained constant because it was impossible to predict materials handling innovations which might occur by 1975. Justification for this division was increased by the fact that line haul costs generally accounted for a larger share of total rail transfer costs than did docking charges. Transportation costs for corn with the Gainesville rail rate and the Rent-A-Train rate are presented in Appendix C, Tables XXXI through XXXIV.

¹¹The Rent-A-Train grain tariff applies to carload bulk movements of corn, oats, and wheat from shipping points in the Illinois Central Freight Association territory to selected southern points. Basic charges are \$1,000,000 per train per year if railroad-owned cars are used and \$700,000 per year if customer leased or owned cars are used. Line-haul costs are 1.5 mills per ton-mile with a minimum train charge of \$5.00 per mile whether the train is loaded or empty. These rates apply to a maximum weight of 8,600 tons in 86 cars or less, but up to 29 additional 100-ton cars can be added at specified rates (from George B. Tully, Chief, Navigation Economics Branch, Tennessee Valley Authority, letter to author dated April 23, 1969).

¹²The Rent-A-Train rate was assumed to be effective from Origins 25, 26, 27, 29, 30, 31, 32, 33 and 34 to Destinations 2, 8, 9, 13, 16 and 40A (David Culver, memorandum, May 28, 1968).

IV. BARGE COSTS

Charges for handling and transport of corn by water between selected ports were built up from barge rate schedules¹³ and corn handling costs¹⁴ by the Southern Regional Grain Marketing Committee. Due to the extremely limited number of these costs, the present author supplemented them from the same and from additional Interstate Commerce Commission sources. This was necessary to provide a more accurate picture of inherent advantages and disadvantages of water transportation in moving corn.

These costs were assumed to remain constant through 1975 for existing navigable waterways. The relatively small number of markets which could be supplied by barge alone necessitated combination of barge rates with weighted-average rail, least-cost rail and truck rates to obtain realistic transfer cost matrices (see Appendix C, Tables XXXV through XLVI).

By 1975, however, two additional major water links are expected to be operational. Channel improvements in the Arkansas River to Tulsa, Oklahoma will give Little Rock, Arkansas a direct water link with inland and Gulf Coast ports via the Mississippi River and its tributaries.¹⁵

¹³Arrow Transportation Company, Guide to Published Barge Rates on Bulk Grain, Schedules No. 3 and 6; Sheffield, Alabama, April 15, 1963 and July 1, 1968 respectively.

¹⁴United States Department of Agriculture, Costs of Storing and Handling Grain in Commercial Elevators, USDA Bulletin 288, April 1966.

¹⁵Information obtained in discussions with members of the Navigation Economics Branch, Tennessee Valley Authority, July 1968.

The second projected link is the Tennessee-Tombigbee Waterway connecting the Tennessee River at Pickwick Reservoir with the Warrior River at Demopolis, Alabama. This new link will give the Port of Mobile, Alabama a direct link with the inland waterway system.¹⁶

No comparable barge cost estimates for transporting corn through these new links have been made by the Southern Regional Grain Marketing Committee. This situation again required that indirect estimates be made. Recognizing the extreme limitations inherent in the approach, it was decided to derive an estimating equation by least squares regression techniques. The dependent variable was assumed to be barge costs, and the independent variable was geographic distance by waterways in miles. The resulting equation is shown below:

$$Y = 59.161 + 0.056539X \quad (3)$$

where

Y = barge costs in dollars per thousand bushels and

X = waterway distance between ports in miles.

This function resulted in an r^2 of 0.6120 and a standard error of 0.00538. The equation was employed to make estimates of transfer costs into areas 17 and 40C for 1975.

¹⁶Tennessee-Tombigbee Waterway Development Authority, "Physical Description of the Tennessee-Tombigbee Waterway," memorandum dated November 1967.

V. HIGHEST-COST MODE AND LEAST-COST MODE

In order to better understand the relation between corn flows and transfer cost, the rates for shipping corn over each route were examined. The minimum cost and the maximum cost of moving corn from each origin through every plant and to all destinations were obtained. These costs are presented in Appendix C, Tables XLVII through LIV.

For 1964 the transportation costs considered were least-cost rail, weighted-average rail, truck, barge least-cost rail (Big John car rates), barge weighted-average rail, and barge truck. The same breakdown was followed for 1975 except that the least-cost rail rate was dropped in favor of two special rates between designated origins and destinations. They were the Gainesville rail rate and the Rent-A-Train rate. There were, therefore, a total of eight sets of corn transfer costs considered for 1964 and nine sets for 1975.

Equilibrium flows of corn utilizing these maximum and minimum rates yield information about changes in optimum corn flows if shippers as a group select the cheapest or the most expensive means of moving their corn. Most actual corn movements would probably occur at some intermediate transfer cost. It is also true that most adjustments in transfer costs are made for specific routes rather than entire transportation nets. Identification of the extremes, therefore, should permit some generalizations to be made about the stability of optimum plant locations under conditions of varying transfer costs.

CHAPTER VI

SUPPLY AND DEMAND FOR CORN

I. COMPONENTS OF SUPPLY

The supply of corn available for utilization during a given period consists of total production during that period plus net changes in storage inventories plus net imports. The magnitude of each factor was examined to determine its contribution to total supply.

Production, Imports and Storage of Corn

During the past ten years annual United States corn production has exhibited a generally upward trend, but wide yearly variations have been observed. Over the same period total storage holdings have demonstrated no similar trend. Storage holdings at all levels amounted to approximately one billion bushels in 1955, reached a peak of slightly over two billion bushels in 1961; but by 1964 they had declined to only 840 million bushels. Table VII represents corn production, imports, storage inventories by level in the marketing system and domestic disappearance by category of use for the years 1955-1966. It is apparent that imports accounted for an insignificant portion of total corn supply.

It can also be seen from Table VII that domestic utilization of corn has also shown a gradual upward trend during this twelve year period. Present indications are that long term storage will play a

TABLE VII

CORN: PRODUCTION, STOCKS BY POSITION AND DISAPPEARANCE BY CATEGORY OF USE, UNITED STATES, 1955-66

Carryover October 1, Interior																
Year ^a	Farm	Terminal Market	Warehouse and Elevator Mill,	C.C.C. ^b	Total	Yearly Pro- duction	Domestic Disappearance						Seed	Live- stock Feed	Total	
							Imports	Break- fast Foods	Corn- meal and Grits ^e	Wet Process Products	Alcohol and Distilled Spirits	For Domestic Use				
-----Millions of Bushels-----																
1955	314	32	129	560	1,035	2,873	0.1	13	76	141	27	246	12	2,366	2,881	
1956	299	64	202	600	1,065	3,075	0.1	14	86	140	29	250	11	2,377	2,907	
1957	419	116	311	573	1,419	3,045	0.2	14	85	142	27	251	11	2,535	3,065	
1958	343		514 ^c	612	1,469	3,356		15	92	152	34	277	13	2,782	3,365	
1959	325		634	565	1,524	3,825	0.1	16	95	154	31	278	12	3,043	3,629	
1960	452		736	599	1,787	3,907	0.1	16	96	155	33	284	11	3,092	3,687	
1961	588		813	615	2,016	3,598	0.1	17	102	169	36	304	11	3,212	3,851	
1962	579		590	484	1,653	3,606	0.1	18	105	179	28	311	11	3,157	3,809	
1963	534		435	396	1,365	4,019	0.1	19	111	195	26	328	11	3,009	3,699	
1964	681		442	414	1,537	3,484	0.1	19	109	201	28	337	11	2,957	3,662	
1965	581		258	308	1,147	4,084	0.1	20	108	204	30	345	13	3,347	4,067	
1966	530		176	134	840	4,117	0.1	20	112	205	33	348	14	3,285	4,017	
1967	569		156	98	823	4,722	0.1									

^aMarketing year begins October 1.

^bOwned by C.C.C. and stored in bins or other storage owned or controlled by C.C.C. Additional C.C.C. stocks are included in off-farm positions.

^cTerminal market, interior mills, elevators and warehouses combined, beginning October 1, 1958.

^dPreliminary.

^eEstimated quantities used in producing cornmeal (including farm household use), flour, hominy grits and flakes for human food and for the production of fermented malt liquors. Based on reports of the Bureau of Census and Internal Revenue Service.

^fResidual includes minor uses and waste.

Source: United States Department of Agriculture, Agricultural Statistics, 1967 and 1968 (Washington: Government Printing Office, 1967 and 1968), pp. 41 and 34, respectively.

less significant role in the future than in the recent past. This trend toward a relative decline in long-term storage suggests that the requirement of the present analytical model that no storage take place for a term longer than one production period probably will not be violated to any great extent over the horizon of this study.

Regional corn production. During the ten years from 1957 to 1966 national corn production increased by approximately 20 per cent, Table VIII. This increase has not been shared equally among states, however. Iowa was the leading state in corn production for both 1957 and 1966 followed by Illinois and Minnesota. In 1957 all 48 contiguous states reported some corn production. By 1966 Maine, New Hampshire, Rhode Island and Nevada reported no production of corn. For the nation as a whole, 32 states reported decreases in corn production while only 16 reported increases. This indicates that the corn production sector is becoming significantly more concentrated.

Geographically, the distribution of corn production is continuing the trend toward increasing concentration in the midwestern "Corn Belt" states.¹ In fact, all of the national increase in corn production is accounted for by this area. The other census regions showed absolute declines for the period. This increase in geographical concentration and concurrent increase in grain-consuming animal population outside the area suggests that transportation may play a greater relative role in future corn marketing.

¹East North Central and West North Central census regions.

TABLE VIII

CORN PRODUCTION BY STATES AND REGIONS, CONTINENTAL
UNITED STATES, 1957-1966

State and Region	Corn Production by Years		Relative Change By Regions Per Cent
	1957	1966 ^a	
	-----1000 Bushels-----	-----	
Maine	440	--	
New Hampshire	460	--	
Vermont	2,950	76	
Massachusetts	1,500	144	
Rhode Island	252	--	
Connecticut	1,880	72	
New York	35,139	14,420	
New Jersey	4,756	2,438	
Pennsylvania	53,449	32,928	
North Atlantic	100,826	50,078	-50.3
Ohio	180,522	261,660	
Indiana	259,777	396,006	
Illinois	524,096	835,440	
Michigan	91,278	94,269	
Wisconsin	157,072	141,950	
East North Central	1,212,745	1,729,325	+42.6
Minnesota	327,192	341,544	
Iowa	633,516	901,748	
Missouri	151,052	176,328	
North Dakota	35,192	8,008	
South Dakota	129,855	113,475	
Nebraska	227,240	312,603	
Kansas	44,283	59,682	
West North Central	1,548,330	1,913,388	+23.6
Delaware	4,320	7,942	
Maryland	15,176	19,624	
Virginia	21,120	19,550	
West Virginia	6,216	2,256	
North Carolina	60,215	60,975	
South Carolina	23,816	14,508	
Georgia	71,188	58,824	
Florida	13,368	14,964	
South Atlantic	215,329	198,643	-7.7

TABLE VIII (continued)

State and Region	Corn Production by Years		Relative Change By Regions Per Cent
	1957	1966 ^a	
	-----1000 Bushels-----		
Kentucky	64,739	65,018	
Tennessee	45,229	36,864	
Alabama	57,772	26,070	
Mississippi	37,575	15,645	
Arkansas	13,932	2,318	
Louisiana	13,524	5,775	
Oklahoma	4,914	616	
Texas	40,020	19,008	
South Central	277,705	171,314	-38.3
Montana	3,843	320	
Idaho	4,260	1,386	
Wyoming	1,755	910	
Colorado	26,500	16,353	
New Mexico	1,650	546	
Arizona	1,500	648	
Utah	2,688	160	
Nevada	216	--	
Washington	3,388	1,980	
Oregon	2,520	792	
California	19,166	17,480	
Western	67,396	40,575	-39.8
Forty-eight States	3,422,331	4,103,323	+19.9

^aPreliminary.

Source: United States Department of Agriculture, Agricultural Statistics 1959 and 1967 (Washington: Government Printing Office, 1960 and 1967), pp. 30 and 36, respectively.

Corn production in SM-29 substate areas. Since the substate areas delineated by the Southern Regional Grain Marketing Committee follow state crop reporting district lines, it was a simple task to calculate corn production for 1964. This enabled satisfactory estimates to be made even though some SM-29 sub-regional areas crossed state lines. To equate the corn marketing year with the calendar year, two-thirds of the 1963 corn crop was added to one-third of the 1964 crop in the southern areas.

The quantities of corn available at the midwestern origins were determined by the Southern Regional Grain Marketing Committee from the following sources. (1) The quantity of corn received from the various midwestern origins by all southern areas, and (2) 150 per cent of published inspections of corn receipts at each market during 1964. The estimated quantity of corn available for shipment was assumed to be the larger of these two estimates for each midwestern market.²

Projections for 1975 corn production involved more serious problems, however. Each state project representative compiled statistics on past corn production and submitted them to a central computing station which derived estimates of 1975 corn production through least-squares regression techniques. These estimates were then given to the individual representatives for acceptance, rejection or adjustment on the basis of their personal knowledge of the various areas. The

²Letter from David W. Culver, Economic and Statistical Analysis Division, Economic Research Service, United States Department of Agriculture, Washington, D. C. to the author dated August 10, 1969.

resulting adjusted values became official SM-29 production data for subsequent research. Corn production for 1964 and 1975 for the SM-29 southern subregional areas is shown in Appendix C, Table LV.

The available corn at midwestern origins was estimated by a uniform expansion of the 1964 estimates for the various markets. The procedure employed by members of the Southern Regional Grain Marketing Committee was to independently project corn acreage and yields for the midwestern areas and combine the two components to obtain production estimates. The same proportions of total midwestern production were assumed to be available for shipment in 1964 and 1975. Utilizing this procedure, projected midwestern corn production was found to be 204.5 per cent of 1964 production. Therefore, an expansion factor of 2.045 was used to obtain corn surplus estimates at Origins 25-34.³ These data are accepted as parameters by the present author.

II. COMPONENTS OF DEMAND

From the demand side two basic components of aggregate demand for corn must be considered. These components are export demand and domestic demand. Each category has particular characteristics which merit further discussion.

Export Demand

Estimation of export demand involves many factors beyond the scope of this study such as the nature and magnitude of foreign aid

³Ibid.

programs, the possibility of wars among customers, changes in political ideology and shifts in terms of trade. Because of these factors which are very difficult to quantify, it was decided that a simple time series projection would yield sufficiently accurate results for the present study.

Use of this procedure implied that, on balance, conditions that existed during the sample period would continue to exist over the horizon of projection.⁴ Such an approach might be held suspect by some econometricians, but the difficulties in specifying and measuring even the most strategic variables required for an econometric forecasting model were considered beyond the scope of this study.

Due to their magnitude, exports of corn through southern regional ports are prime ingredients in this study. Omission of corn export requirements would alter corn flows and consequently the demand for corn handling facilities. Export data are a matter of record for 1964 but require projection to 1975. As indicated previously, simple time series projections were used to accomplish this.

Domestic Demand

It can be seen from Table VII, page 87, that the largest single category of domestic disappearance of corn considered is livestock feed. Human consumer demand was not considered in Project SM-29. The Southern Regional Grain Marketing Committee, therefore, considered livestock feed

⁴Milton H. Spencer, Colin G. Clark and Peter W. Hogue, Business and Economic Forecasting: An Econometric Approach (Homewood, Illinois: Richard D. Irwin, Inc., 1961), pp. 5-10.

to be strategic and selected it for further study. The procedure employed was to first determine the area population of specified farm animals,⁵ estimate ration requirements and combine the two. Corn utilization for 1964 and estimated disappearance for 1975 for the SM-29 southern areas is shown in Appendix C, Table LVI.

It is recognized that this approach abstracts from pertinent interrelationships such as the relation between the price of corn and animal prices. Collection of data for a demand estimating equation in the usual sense would have involved extensive conceptual and procedural problems and was considered beyond the scope of this study.

For 1975, animal populations and rations were independently projected then combined to yield estimated local corn requirements in each area. Comparison of these values with area supply estimates yields the surplus and deficit estimated used in the study (Table IX).

III. PSEUDO DEMAND CURVES FOR DEFICIT AREAS

Theoretical Considerations

One additional step was required to prepare the utilization estimates for analysis. The computational procedure of the plant location model computer program precluded use of point values (perfectly inelastic demand curves) for quantities of corn demanded. Pseudo demand curves were therefore substituted into the program. These

⁵Categories of animals included in the study were milk cows, other dairy, beef cows, beef cows fed, other beef, hogs, hens and pullets, broilers, turkeys, sheep, horses and mules.

TABLE IX

CORN: SURPLUSES AND DEFICITS BY SM-29 SUB-REGIONAL AREAS,
CONTINENTAL UNITED STATES 1964 AND 1975

Area	Market Point	Corn Surplus or Deficit Balances	
		1964	1975
		-----1,000 Bushels-----	
1	Wilson, N. C.	32,407	21,037
2	Charlotte, N. C.	-34,866	-49,583
3	Valdosta, Georgia	8,817	15,600
4	Jacksonville, Fla.	-2,879	583
5 ^a	Tampa, Florida	-14,858	-24,161
7	Montgomery, Ala.	-7,790	-14,038
8	Guntersville, Ala.	-19,031	-54,930
9	Gainesville, Ga.	-40,982	-71,983
10	Chattanooga, Tenn.	-6,867	-6,111
11	Nashville, Tenn.	-6,268	-5,257
12	Memphis, Tenn.	-1,378	-10,725
13	Jackson, Miss.	-31,494	-51,910
14	New Orleans, La. (Domestic)	-2,785	-6,530
15	Shreveport, La.	-11,243	-20,942
16	Springdale, Ark.	-21,629	-43,138
17	Little Rock, Ark.	-3,911	-7,265
18	Henderson, Ky.	7,886	-2,236
19	Louisville, Ky.	-16,924	36,307
20	Ashland, Ky.	-3,118	-2,000
21	Harrisonburg, Va.	-2,013	-2,013
22	Baltimore, Md.	-98	-98
23	Salisbury, Md.	-501	-501
24	Norfolk, Va.	-13,514	-13,514
25	Cincinnati, Ohio	15,847	32,407
26	Evansville, Ind.	74,812	152,991
27	Indianapolis, Ind.	30,831	63,049
28	Milwaukee, Wisc.	--	--
29	Peoria, Ill.	206,889	423,088
30	St. Louis, Mo.	159,920	327,036
31	Davenport, Iowa	9,056	18,520
32	Minneapolis, Minn.	85,642	175,138
33	Omaha, Neb.	44,151	90,289
34	Kansas City, Kansas	48,446	99,072
35	Fort Worth, Texas	--	--
36	Denver, Colo.	--	--
40A	New Orleans, La. (Export)	-227,931	-428,580

TABLE IX (continued)

Area	Market Point	Corn Surplus or Deficit Balances	
		1964	1975
-----1,000 Bushels-----			
40B	Pascagoula, Miss. (Export)	-51,906	-96,430
40C	Mobile, Ala. (Export)	-11,114	-64,287
44	Charleston, S. C. (Export)	-3,405	-3,405
	Totals	188,199	575,474

^aArea 6 was absorbed into other areas.

functions were required by the computational procedure and should be attributed no additional significance.

Two conditions must be met for these pseudo demand curves to be consistent with economic theory. These conditions are specified in Chapter III. If these conditions are met, no supplier or elevator could improve his relative position by changing trading partners; and the system would be in equilibrium.

The general form of common Marshallian demand curves is shown below:

$$P = a - bQ \quad (1)$$

where

P = price of commodity and

Q = quantity of commodity in the market.

In the present problem the quantities demanded (Q_j) are parameters as discussed previously. Theoretically (b) can range from slightly greater than zero to slightly less than infinity ($0 < b < \infty$). To aid in program iteration it was decided to assume identical slopes in all markets equal to one ($b = 1.0$). The resulting generalized demand function is shown below:

$$P = a - 1.0Q \quad (2)$$

In order to fulfill the equilibrium conditions previously set forth, only the values of (P) and (a) can be manipulated because (Q) is known for each market and (b) is fixed by assumption. According to economic logic the proper approach consists of first determining the price (P_j) required for equilibrium in every market then solving for (a).

The most direct method for accomplishing this task is through solution of a transportation model.⁶ Quantities supplied at each origin (S_i), quantities demanded in each market (D_j) and unit transfer costs from each origin to every market (C_{ij}) are inputs for the model. Output consists of the least-cost routing of supplies from origins to markets. This pattern of shipments would be expected to emerge under the assumption of pure competition. The dual of the optimum solution of the transportation model is a set of market price differentials based on equilibrium transfer costs.⁷ These price differentials with Gainesville, Georgia as a base are presented in Table X. Imputed market prices can now be obtained by adding the base transfer costs to all price differentials.

In the present problem some negative prices were present at this stage, therefore, it was necessary to determine the most negative implied price and add a constant to all prices such that this price became zero. In effect this area became the adjusted base area rather than Gainesville, Georgia.

In order to insure that movement into all markets was economically feasible, an additional adjustment was required. The highest cost for an active route moving into the adjusted base area was determined and added to all imputed prices. This shifted prices upward

⁶Robert Dorfman, Paul A. Samuelson and Robert M. Solow, Linear Programming and Economic Analysis (New York: McGraw-Hill Book Company, Inc., 1958), pp. 106-129.

⁷Ibid.

TABLE X

ESTIMATED PRICE DIFFERENTIALS FOR CORN AMONG GEOGRAPHICALLY SEPARATED DEFICIT MARKETS BY
MODE OF TRANSPORTATION WITH GAINESVILLE, GEORGIA AS A BASE, SM-29 DEFICIT AREAS
1964 AND 1975

SM-29 Area	Market Point	Mode of Transportation			
		Least-Cost Mode 1964	Least-Cost Mode 1975	Rent-A-Train Rate 1975	Gainesville Rate 1975
-----Dollars Per 1,000 Bushels-----					
2	Charlotte, N. C.	+26.04	+3.70	-19.32	-28.98
4	Jacksonville, Fla.	-10.42	a	a	a
5	Tampa, Fla.	-44.30	-10.61	+145.51	+100.46
7	Montgomery, Ala.	-11.16	+30.52	+71.54	+3.22
8	Guntersville, Ala.	-46.00	-19.43	-20.28	-26.90
9	Gainesville, Ga.	0.0	0.0	0.0	0.0
10	Chattanooga, Tenn.	-35.60	-1.91	+38.50	-25.98
11	Nashville, Tenn.	-77.70	-38.43	+45.50	-24.66
12	Memphis, Tenn.	-75.60	-41.91	+63.62	-14.92
13	Jackson, Miss.	0.90	-6.38	-7.23	-10.83
14	New Orleans, La. (Domestic)	-38.60	-4.91	+117.76	+58.30
15	Shreveport, La.	+40.73	+58.14	+60.86	-22.36
16	Springdale, Ark.	-60.13	-28.37	-37.14	-65.20
17	Little Rock, Ark.	-6.83	+24.93	+49.66	-16.20
18	Henderson, Ky.	a	-53.33	+14.78	-33.57
19	Louisville, Ky.	-103.93	a	a	a
20	Ashland, Ky.	-71.96	-48.01	+34.18	-27.56
21	Harrisonburg, Va.	+50.62	+86.89	+141.68	+42.54
22	Baltimore, Md.	+57.64	+91.35	+211.36	+200.64
23	Salisbury, Md.	+50.94	+84.21	+186.56	+171.02
24	Norfolk, Va.	+10.08	+46.35	+88.16	+72.62
40A	New Orleans, La. (Export)	-38.60	-4.91	+131.46	+58.30

TABLE X (continued)

SM-29 Area	Market Point	Mode of Transportation			
		Least-Cost Mode 1964	Least-Cost Mode 1975	Rent-A-Train Rate 1975	Gainesville Rate 1975
		-----Dollars Per 1,000 Bushels-----			
40B	Pascagoula, Miss. (Export)	-38.60	+34.09	+147.56	+97.30
40C	Mobile, Ala. (Export)	-38.60	+34.09	+147.56	+97.30
44	Charleston, S. C. (Export)	+20.80	+33.96	+96.00	+80.46

^aThis market was surplus.

sufficiently to permit corn movement over all routes which were active in the transportation model solutions. This would be consistent with the thoughts of Von Thunen⁸ relative to market areas.

Since the product underwent intermediate processing, these costs must also be incorporated in the imputed prices. A logical method for dealing with these costs would involve adding the unit costs of processing to the imputed prices calculated above. In situations where processing costs are a function of the quantity processed, several approximations might be required to achieve proper results. Thus an imputed product price covering costs of transportation and intermediate processing could be derived.

After the imputed prices have been determined for all markets, it is a straightforward task to algebraically solve for the price intercepts of the demand curves.

$$a = P + bQ \quad (3)$$

Once the (a) values have been calculated for all markets, the parameters are all specified and the pseudo demand curves are completely defined.

Empirical Application

With respect to the plant location problem currently under investigation, it is necessary to reduce the data from a two-stage⁹

⁸Melvin L. Greenhut, Plant Location in Theory and Practise: The Economics of Space (Chapel Hill: The University of North Carolina Press, 1956), pp. 5-7.

⁹In this case the term "two-stage" refers to a problem dealing with both assembly and distribution costs.

transportation problem to a single-stage problem to determine the optimum routing. This is accomplished by means of a combined cost matrix.¹⁰ This matrix yields the minimum cost route from a given origin to a specified market through one of several possible plants.

Combined cost matrices were computed for each set of transportation cost assumptions for 1964 and 1975. Output from each combined cost matrix served as input for a corresponding single-stage transportation model which was used as described previously in calculating the associated price differentials. Since average fixed plant costs vary with the amount of corn moving through each active plant, these costs had to be estimated beforehand and tested at several levels to obtain proper market allocations. Test runs were made with assumed average fixed plant costs ranging from one cent to three cents per bushel. A summary of the parameters thus obtained for 1964 and 1975 is presented in Appendix C, Table LVII.

This completes the input data required for the present formulation of the plant location problem which will be subsequently used to determine optimum locations of corn handling capacity.

¹⁰Miller and King define combined cost matrix solution as "A method of determining the minimum cost route from origin i ($i = 1, 2 \dots I$) through some plant k ($k = 1, 2 \dots K$) to destination j ($j = 1, 2 \dots J$) (Billy Ray Miller and R. A. King, Models for Measuring the Impact of Technological Change on Location of Marketing Facilities, Agricultural Economics Series Number 115 (Raleigh: North Carolina State University, September 1964), p. 65.

CHAPTER VII

OPTIMUM NUMBER, SIZES AND LOCATIONS OF MAJOR CORN HANDLING FACILITIES, 1964 AND 1975

This chapter draws the various location determinants together to investigate the relation between transfer costs and the volume and locations of corn handling capacity. Conditions assumed applicable for 1964 and 1975 were used in the analysis.

Three sizes of plants were considered. They would handle 2,500, 5,000 and 10,000 bushels of corn per hour. When operated at capacity for a 300-day season, these plants were assumed to handle 6, 12 and 24 million bushels of corn respectively. Annual fixed costs for the plants were estimated to be \$50,538.45, \$60,581.77 and \$72,558.37 respectively during both years. The increment by which these costs could enter computations during each iteration was set at \$10,000 for 1964 and 1975.¹

Utilization of four transportation rates was deemed sufficient to indicate the effects of transfer cost on location of corn handling capacity. For 1964 only the transportation cost associated with the least-cost mode was explored. The analysis for 1975 included rates for three transportation modes. They were the least-cost mode, the Gainesville rail rate and the Rent-A-Train rate. Other rates may be

¹Other increments of \$2,000, \$4,000; \$6,000, \$8,000; \$12,000 and \$14,000 were tested in trial runs and the results compared. Use of \$10,000 seemed to provide the best combination of accurate results and minimum computing time.

analyzed by utilizing the appropriate assembly and distribution costs presented in Appendix C.

The stability of solutions was investigated from two points of view. Alternative shipping patterns and costs of utilizing sub-optimum routes associated with each solution yielded insight into the stability of each solution relative to changes in transfer costs. Comparison of 1964 and 1975 solutions provided an indication of stability as supply, demand and transport costs varied over time.

I. OPTIMUM NUMBER, SIZES AND LOCATIONS OF CORN HANDLING FACILITIES UNDER 1964 CONDITIONS

The assumed marketing system for corn in 1964 consisted of 12 origins, 23 possible sites for handling facilities and 24 markets (Chapter III). All potential locations for corn handling facilities were located in the 19 southern areas and export markets. Linking each origin with every possible plant site required a 12 x 23 assembly cost matrix. A 23 x 24 distribution cost matrix was employed to join the plant sites with the markets. The problem was to choose the number and locations of active plant sites which would allow maximum revenue to accrue to the factor (corn) subject to the other costs in the system. This would provide a spatial equilibrium solution.

For computational purposes, the minimum allocations by which corn could move into a market was set at 1,000 units² per iteration.³

²One unit of corn equals 1,000 bushels.

³Other increments ranging from 500 to 2,000 units were tested, but cycling was encountered in some cases below 1,000 units.

The discontinuous nature of these increments did not permit precise determination of the pseudo demand curves. In most cases, however, final market allocations of corn fell within 10 per cent of the fixed quantities required in major markets (Table XI). If it had been possible to reduce the rate at which corn was incremented into the system at each step, closer approximations could have been obtained.

Results from computing the optimum volume and locations of plant capacity for the three plant sizes are presented in Table XII. With the least-cost mode of transportation the model indicated that corn should be handled at 13 of the 23 locations. The most obvious characteristic of this table is the constant distribution of required corn handling capacity as plant costs were allowed to change. These results were somewhat disturbing until plant costs were compared with total transfer costs. For plant sizes between 2,500 and 10,000 bushels per hour, annual fixed plant costs varied approximately \$20,000 per plant. The corresponding total transfer cost was shown to be approximately 63 million dollars for all sizes of plants.⁴

Intuitive comparison of the wide differences between plant costs and total transfer costs tended to strengthen the conclusions drawn from the model results. Economies of size within this range of plant sizes did not prove sufficient to concentrate required corn handling

⁴This value was computed by the plant location model. For the total transfer costs of the optimum shipping patterns for corn with all modes of transportation computed by the transportation model, see Appendix C, Table LVIII.

TABLE XI

CORN REQUIREMENTS AT DEFICIT MARKETS AND MARKET ALLOCATIONS BY THE PSEUDO DEMAND CURVES BY
PLANT SIZE UTILIZING THE LEAST-COST MODE OF TRANSPORTATION,
SM-29 SOUTHERN AREAS 1964

SM-29 Area	Market Point	Actual Demand	Market Allocations by Plant Size		
			2,500 Bu./Hr.	5,000 Bu./Hr.	10,000 Bu./Hr.
-----Thousands of Bushels-----					
2	Charlotte, N. C.	34,866	33,000	a	a
4	Jacksonville, Fla.	2,879	1,000	a	a
5	Tampa, Fla.	14,858	13,000	a	a
7	Montgomery, Ala.	7,790	6,000	a	a
8	Guntersville, Ala.	19,031	18,000	a	a
9	Gainesville, Ga.	40,982	40,000	a	a
10	Chattanooga, Tenn.	6,867	5,000	a	a
11	Nashville, Tenn.	6,268	5,000	a	a
12	Memphis, Tenn.	1,378	0	a	a
13	Jackson, Miss.	31,494	30,000	a	a
14	New Orleans, La. (Domestic)	2,785	1,000	a	a
15	Shreveport, La.	11,243	10,000	a	a
16	Springdale, Ark.	21,629	20,000	a	a
17	Little Rock, Ark.	3,911	2,000	a	a
19	Louisville, Ky.	16,924	15,000	a	a
20	Ashland, Ky.	3,118	2,000	a	a
21	Harrisonburg, Va.	2,013	1,000	a	a
22	Baltimore, Md.	98	0	a	a
23	Salisbury, Md.	501	0	a	a
24	Norfolk, Va.	13,514	12,000	a	a
40A	New Orleans, La. (Export)	227,931	226,000	a	a
40B	Pascagoula, Miss. (Export)	51,906	50,000	a	a

TABLE XI (continued)

SM-29 Area	Market Point	Actual Demand	Market Allocations by Plant Size		
			2,500 Bu./Hr.	5,000 Bu./Hr.	10,000 Bu./Hr.
			-----Thousands of Bushels-----		
40C	Mobile, Ala. (Export)	11,114	10,000	a	a
44	Charleston, S. C. (Export)	3,405	2,000	a	a
	Totals	536,505	502,000	a	a

^aAllocations were the same as those obtained from the 2,500 bushels per hour plant.

TABLE XII

OPTIMUM VOLUME AND LOCATIONS OF CORN HANDLING CAPACITY FOR 2,500, 5,000 AND 10,000 BUSHELS PER HOUR HANDLING FACILITIES AND THE LEAST-COST MODE OF TRANSPORTATION, SM-29 SOUTHERN AREAS 1964

SM-29 Area	Market Point	Optimum Volume of Handling Capacity by Size of Facility		
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a
-----Thousands of Bushels-----				
1	Wilson, N. C.	0	0	0
2	Charlotte, N. C.	15,000	15,000	15,000
3	Valdosta, Ga.	0	0	0
4	Jacksonville, Fla.	2,000	2,000	2,000
5	Tampa, Fla.	6,000	6,000	6,000
7	Montgomery, Ala.	0	0	0
8	Guntersville, Ala.	29,000	29,000	29,000
9	Gainesville, Ga.	0	0	0
10	Chattanooga, Tenn.	40,000	40,000	40,000
11	Nashville, Tenn.	2,000	2,000	2,000
12	Memphis, Tenn.	38,000	38,000	38,000
13	Jackson, Miss.	0	0	0
14	New Orleans, La. (Domestic)	5,000	5,000	5,000
15	Shreveport, La.	0	0	0
16	Springdale, Ark.	0	0	0
17	Little Rock, Ark.	0	0	0
18	Henderson, Ky.	260,000	260,000	260,000
19	Louisville, Ky.	0	0	0
20	Ashland, Ky.	51,000	51,000	51,000
40A	New Orleans, La. (Export)	31,000	31,000	31,000

TABLE XII (continued)

SM-29 Area	Market Point	Optimum Volume of Handling Capacity by Size of Facility			
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a	-----Thousands of Bushels-----
40B	Pascagoula, Miss. (Export)	21,000	21,000	21,000	
40C	Mobile, Ala. (Export)	0	0	0	
44	Charleston, S. C. (Export)	2,000	2,000	2,000	
	Totals	502,000	502,000	502,000	

^aAnnual grain handling capacity.

capacity at fewer locations. These results also suggested that plant numbers were stable relative to changes in plant costs within this range of plant sizes.

Determination of a truly optimum number of corn handling facilities was not possible because of the computer program requirement of one fixed plant cost at each active site. Consideration of only three plant sizes also contributed to the difficulty of estimating optimum plant sizes. The observed stability of plant capacity requirements as plant size varied from 2,500 to 10,000 bushels per hour⁵ suggested that, within this range, a plant could be built to the indicated size without departing from the optimum solution. Above 10,000 bushels per hour no information about stability was available.

Seven of the 13 active sites required less than the 24 million bushel maximum annual plant capacity. Plants of the specified sizes could, therefore, be constructed at these sites without disturbing the equilibrium solution.

In the present solution of the plant location model Henderson, Kentucky (Area 18) appeared to be a major staging point for midwestern corn moving into export channels through the Gulf Coast ports. Some corn handled through Henderson also appeared to move into Virginia and Maryland markets.

It is possible that a portion of the indicated corn handling capacity at Henderson could be due to the experimental design. Corn

⁵These hourly capacities indicate annual capacities of six million to 24 million bushels of corn.

was assumed to pass through only one handling stage in moving from origins to markets. All handling facilities were required to be located in the 19 southern SM-29 market areas and four export locations.

Since no handling capacity was permitted at the principal corn origins (Areas 25-34), corn had to move into the South and be disbursed through designated handling centers. Henderson was a major transshipment point for corn arriving from the Midwest by rail and truck and proceeding by river barge. No blocking costs (\$999.99) were used to prohibit corn from moving directly from domestic handling facilities into export markets and by-passing the export handling facilities.

Comparison of the handling capacity required for the New Orleans export market (Area 40A) with indicated corn handling facilities at New Orleans indicated that much corn was obtained from other sources. It is almost beyond question that much of the handling capacity indicated for Henderson should be transferred to New Orleans. The only logical alternative to this would involve a model allowing two-stage processing. This would permit the handling capacity to be duplicated at New Orleans.

The Port of Mobile, Alabama (Area 40C) was inactive as an intermediate handling point for corn in the present solution. The demand for corn at Mobile was satisfied by shipments from St. Louis, Missouri (Area 30); Minneapolis, Minnesota (Area 32); Omaha, Nebraska (Area 33) and Kansas City, Kansas (Area 34). Output from the computer program consisted of allocations from origins to markets and to plants but not from plants to markets. Therefore it was impossible to determine with

certainty which plants supplied the Mobile export market.

II. STABILITY OF THE 1964 PLANT LOCATION MODEL SOLUTIONS

The 1964 distribution of plant capacity was previously shown to be stable for changes in plant costs in the range of plant sizes from 2,500 to 10,000 bushels of corn per hour. Two additional aspects of stability were also examined. They were shipping patterns for corn and cost of utilizing sub-optimum routes to ship corn.

Shipping Patterns for Corn

The pattern of shipments associated with the least-cost mode of transportation was intended to approximate the pattern which would evolve under competitive conditions. This pattern was assumed to be the best that corn shippers as a group could do within the constraints of the system. In order to determine the optimum shipping pattern based on transfer costs alone, a transportation model⁶ was applied to the 1964 corn marketing system. The resulting shipping pattern is shown in Figure 13.

In the plant location solutions principal suppliers of corn for the southern areas were Southern Indiana, Illinois and Missouri (Areas 26, 29 and 30). Together these areas accounted for 72.7 per cent of all corn shipped into the South. In the transportation model solution Areas 26, 29 and 30 supplied 80.7 per cent of southern corn shipments.

⁶For optimum solution of transportation model, see Appendix C, Table LIX.

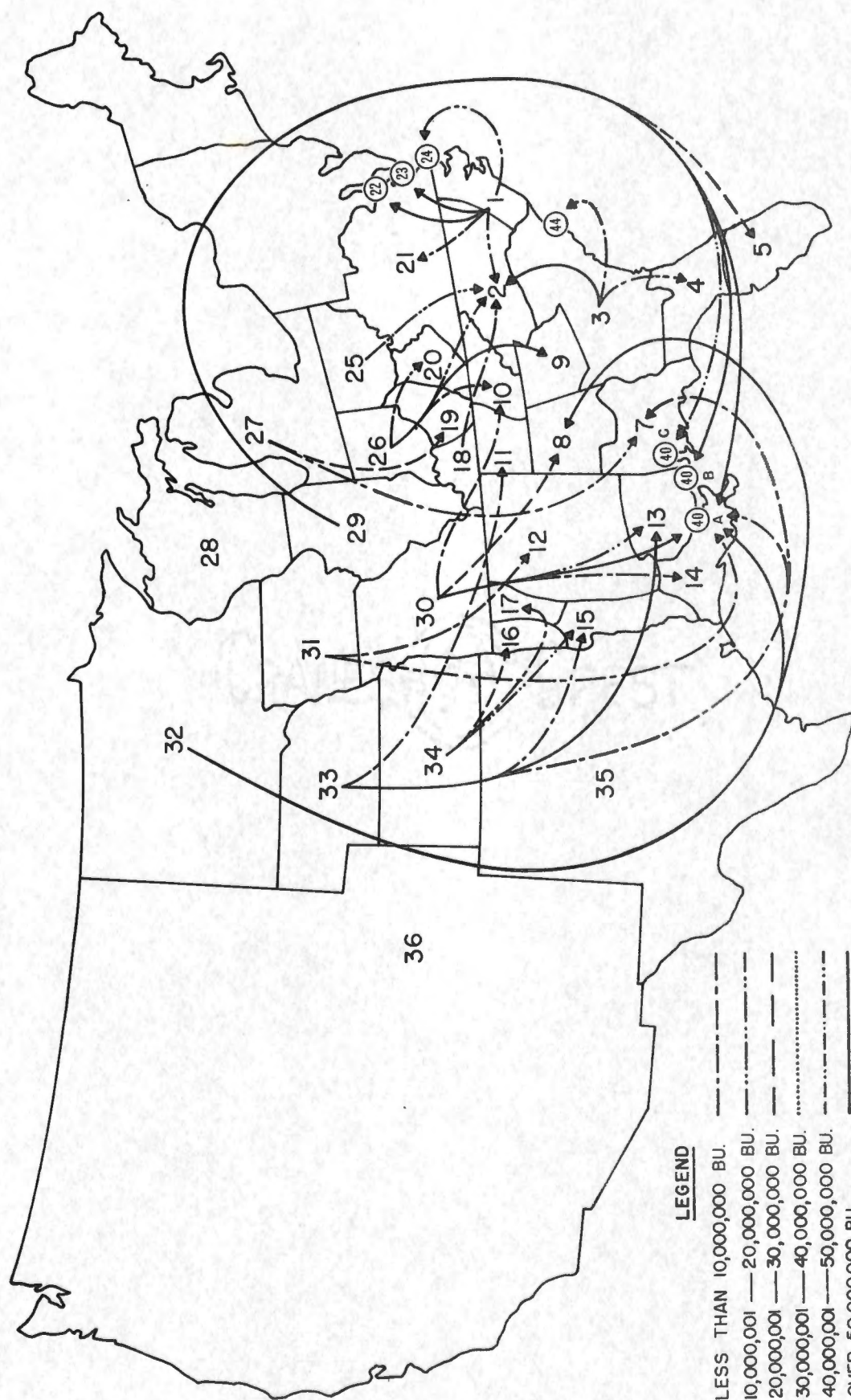


Figure 13. Optimum shipping pattern for corn utilizing the least-cost mode of transportation, 1964.

Most of this discrepancy can be accounted for by the pseudo demand curves and the 1,000 unit minimum allocation required by the plant location model compared to the fixed market demands and single unit allocations utilized in the transportation model. Some differences, however, are probably due to existence of plant costs in the system.

In order to further probe the stability of the plant location model solution, the transportation model solution was recomputed utilizing the highest-cost mode of transportation over each route for 1964.⁷ This solution yielded the pattern of shipments which would result if shippers as a group were to choose the most disadvantageous means of moving their corn. Considered alone this case has little economic significance, but it does provide the opposite end-point for the continuum of transfer costs when it is considered relative to the least-cost mode. The economic significance lies in possible changes in shipping patterns when compared to the least-cost mode. Shifts in trading partners occurring under these conditions should approximate shifts which would occur in response to increases in transfer costs.

Figure 14 represents the optimum shipping pattern associated with the highest-cost mode of transportation. Careful scrutiny of this solution revealed that only moderate changes in trading partners have occurred. Origins 26, 29 and 30 supplied 73.1 per cent of total southern shipments. Therefore the 1964 plant location solutions were assumed to be stable relative to changes in transfer costs for corn

⁷ For optimum solution of transportation model, see Appendix C, Table IX.

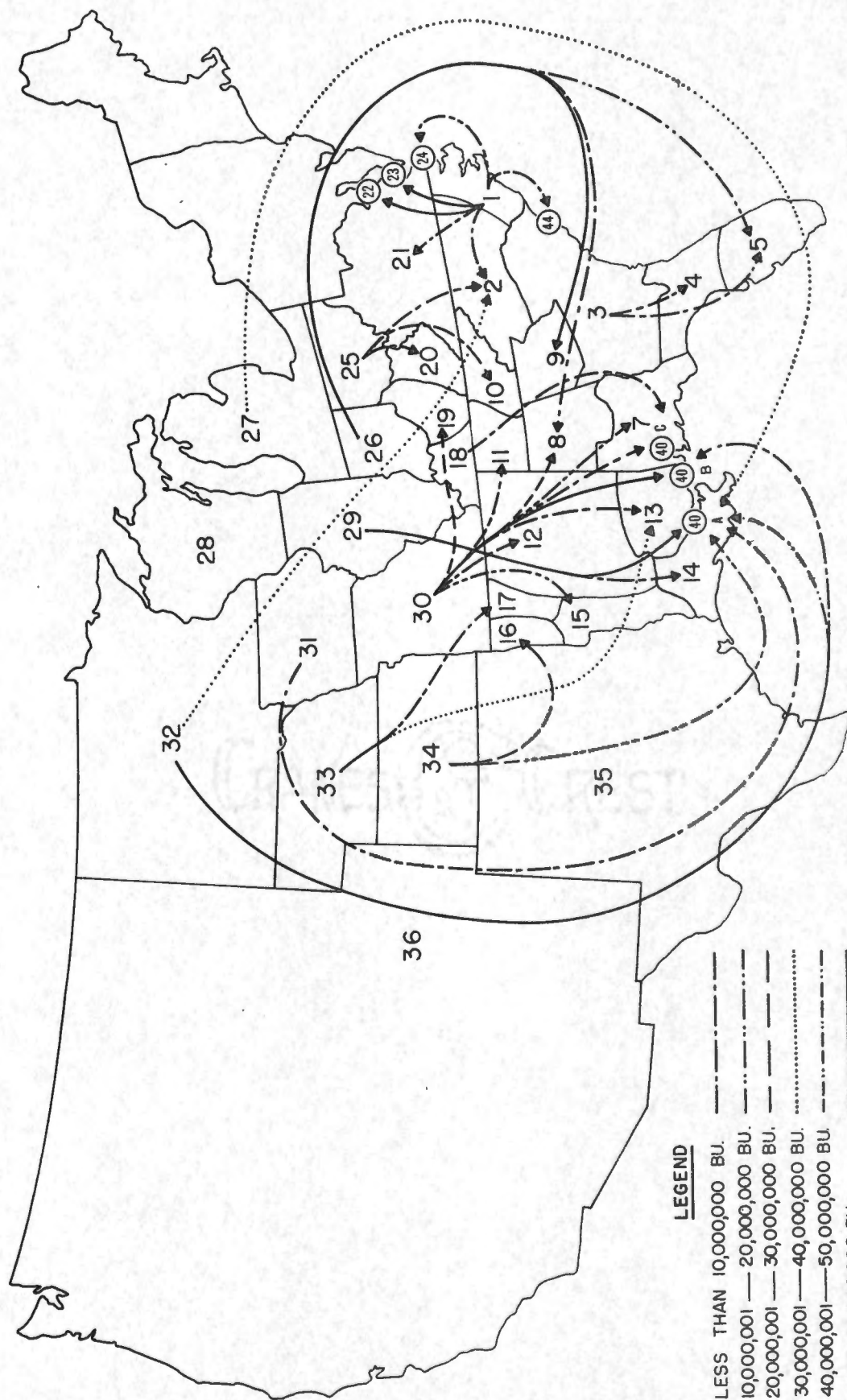


Figure 14. Optimum shipping pattern for corn utilizing the highest-cost mode of transportation, 1964.

between the least-cost mode and the highest-cost mode.

Cost of Utilizing Sub-Optimum Routes

An additional facet of the stability of the 1964 solutions dealt with the relative cost of shipping corn over sub-optimum routes. These costs were estimated by comparing the equilibrium transfer costs suggested by price differentials obtained from the duals of the transportation model solutions to the actual⁸ costs of moving corn. These additional costs would be incurred by shippers who moved corn over routes which did not appear in the transportation model solutions or certain alternate least-cost routes.

Relatively high costs of utilizing sub-optimum routes would indicate that shippers were under considerable pressure to discover and utilize the minimum cost routes. High costs would also suggest a relatively stable pattern of shipments because considerable reduction in plant or transfer costs or a considerable increase in corn prices in certain markets would be necessary to change the established trading pattern.

Calculation of these costs also provided a systematic means of comparing the equilibrium transfer cost for corn moving over specific routes with the actual cost of moving corn over the routes. Knowledge of optimum routes and costs of utilizing sub-optimum routes could provide corn shippers with a means of increasing their net revenue without additional expenditures for capital for plant and equipment.

⁸Actual costs refer to the assembly and distribution cost matrices in Appendix C.

These imputed costs of utilizing sub-optimum routes with the least-cost mode of transportation in 1964 are shown in Appendix C, Table LXI. Zeros which are underlined in this table indicate routes which were utilized in the optimum solutions of the transportation model. Zeros which are not underlined indicate alternate routes which would not increase total transfer costs. These routes provides flexibility in the pattern of shipments and a source of instability from the standpoint of the plant location model.

From the point of view of wide-area analysis, it is sufficient to discuss the implications of this table in terms of averages and extremes. An entrepreneur planning to locate a corn handling facility at a fixed point in space, however, should consider the table in terms of his suppliers and markets and those of his competitors.

It is apparent from the table that the cost of utilizing sub-optimum routes was generally small relative to the total price of corn. The average cost in this case was 5.49 cents per bushel. Approximately three-fourths of the costs were less than ten cents per bushel. A total of 11 alternate least-cost routes were observed. These routes were concentrated between Destinations 8-13, the Gulf Coast ports and Origins 29-32. There were no alternate least-cost routes joining corn surplus areas with the Virginia and Maryland markets.

It should now be remembered that grain marketing firms are traditionally low margin enterprises. In this study operating margins of two cents, five cents, and eight cents per bushel were assumed to cover all operating expenses (Chapter IV). It may now be seen that

the approximately five and one-half cent average cost of utilizing sub-optimum routes represents considerable pressure within the 1964 solution for firms to utilize least-cost routes. Hence the optimum shipping pattern was considered stable within the assumptions of this study.

III. OPTIMUM NUMBER, SIZES AND LOCATIONS OF CORN HANDLING FACILITIES UNDER 1975 CONDITIONS

The projected corn marketing system for 1975 consisted of 13 origins, 23 possible plant locations and 23 markets. Projections indicated that Jacksonville, Florida (Area 4) and Louisville, Kentucky (Area 19) would shift from deficit to surplus positions by 1975. Currently, Henderson, Kentucky (Area 18) would become deficit. Assembly costs, therefore, were represented by a 13 x 23 matrix; and distribution costs required a 23 x 23 matrix. The total volume of corn available for shipment also rose from 724.7 million bushels in 1964 to 1,455.1 million bushels in 1975 due to increased production in the midwestern surplus corn producing areas.

This increase in the volume of corn available for shipment required an upward adjustment in the increments by which corn could enter location computations. For all 1975 computations this value was set at 1,500 units per iteration. Use of a 1,000 unit increment similar to the one employed in 1964 computations resulted in problems of computer cycling in some cases.

These discrete steps in corn allocations again interfered with deriving pseudo demand curves which would precisely allocate

corn to the various markets. It was still possible, however, to obtain allocations within approximately 10 per cent of corn requirements in major markets by trial runs and successive adjustments to the curves (Table XIII).

The Gainesville Rail Rate

Results from computing the optimum volume and locations of plant capacity for the three plant sizes and the Gainesville rail rate are presented in Table XIV. A constant distribution of capacity was again obtained regardless of plant size. In this model seven of the sites were idle, and plants were required at sixteen sites.

For the reasons indicated previously, it was impossible to obtain an optimum solution for the number of plants required at all sites. Due to the indicated stability of required plant capacity relative to changes in plant costs, construction of one plant at each active site up to 24 million bushels of corn would be consistent with the equilibrium solution. This procedure would permit construction of plants at nine of the sixteen active sites. The present model yields no information for making projections beyond this range, however.

The Rent-A-Train Rail Rate

Computation of the necessary corn handling capacity with the Rent-A-Train rail rate yielded the results presented in Table XV. This capacity was distributed among 12 of the 23 sites. Once again the distribution of capacity was constant for the three plant sizes.

TABLE XIII

CORN REQUIREMENTS AT DEFICIT MARKETS AND MARKET ALLOCATIONS BY PSEUDO DEMAND CURVES
UTILIZING THREE TRANSPORTATION RATES, AND THREE SIZES OF CORN HANDLING
FACILITIES, SM-29 SOUTHERN AREAS 1975

Market Allocations by Transportation Mode and Plant Size																
SM-29 Area	Market Point	Actual Demand	Least-Cost Mode 1975						Rent-A-Train 1975				Gainesville Rail			
			2,500		5,000		10,000		2,500		5,000		10,000		Rate 1975	
			Bu.		Bu.		Bu.		Bu.		Bu.		Bu.		Bu.	
			-----Thousands of Bushels-----													
2	Charlotte, N. C.	49,583	51,000	a	a	a	49,500	a	a	a	49,500	a	a			
5	Tampa, Fla.	24,161	25,500	a	a	a	24,000	a	a	a	24,000	a	a			
7	Montgomery, Ala.	14,038	15,000	a	a	a	15,000	a	a	a	15,000	a	a			
8	Guntersville, Ala.	54,936	55,500	a	a	a	55,500	a	a	a	55,500	a	a			
9	Gainesville, Ga.	71,738	73,500	a	a	a	72,000	a	a	a	72,000	a	a			
10	Chattanooga, Tenn.	6,111	7,500	a	a	a	6,000	a	a	a	6,000	a	a			
11	Nashville, Tenn.	5,257	6,000	a	a	a	6,000	a	a	a	6,000	a	a			
12	Memphis, Tenn.	10,725	12,000	a	a	a	10,500	a	a	a	10,500	a	a			
13	Jackson, Miss.	51,910	52,500	a	a	a	52,500	a	a	a	52,500	a	a			
14	New Orleans, La.															
	(Domestic)	6,530	7,500	a	a	a	7,500	a	a	a	7,500	a	a			
15	Shreveport, La.	20,912	22,500	a	a	a	21,000	a	a	a	21,000	a	a			
16	Springdale, Ark.	43,138	45,000	a	a	a	43,500	a	a	a	43,500	a	a			
17	Little Rock, Ark.	7,265	9,000	a	a	a	7,500	a	a	a	7,500	a	a			
18	Henderson, Ky.	2,236	3,000	a	a	a	3,000	a	a	a	3,000	a	a			
20	Ashland, Ky.	2,000	3,000	a	a	a	3,000	a	a	a	3,000	a	a			
21	Harrisonburg, Va.	2,013	3,000	a	a	a	3,000	a	a	a	3,000	a	a			
22	Baltimore, Md.	98	0	a	a	a	0	a	a	a	0	a	a			
23	Salisbury, Md.	501	0	a	a	a	1,500	a	a	a	1,500	a	a			
24	Norfolk, Va.	13,574	15,000	a	a	a	13,500	a	a	a	13,500	a	a			

TABLE XIII (continued)

Market Allocations by Transportation Mode and Plant Size														
		Gainesville Rail												
SM-29 Area	Market Point	Actual Demand	Least-Cost Mode 1975				Rent-A-Train 1975				Rate 1975			
			2,500		5,000		10,000		2,500		5,000		10,000	
			Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	Bu.	
-----Thousands of Bushels-----														
40A	New Orleans, La. (Export)	428,580	430,500	a	a	a	429,000	a	a	429,000	a	a		
40B	Pascagoula, Miss. (Export)	96,430	97,500	a	a	a	97,500	a	a	97,500	a	a		
40C	Mobile, Ala. (Export)	64,287	66,000	a	a	a	64,500	a	a	64,500	a	a		
44	Charleston, S. C. (Export)	3,405	4,500	a	a	a	3,000	a	a	3,000	a	a		
	Totals	979,428	1,005,000	a	a	a	988,500	a	a	988,500	a	a		

^aAllocations were the same as those obtained from the 2,500 bushels per hour plant.

TABLE XIV

OPTIMUM VOLUME AND LOCATIONS OF CORN HANDLING CAPACITY FOR 2,500, 5,000 AND 10,000 BUSHELS PER HOUR HANDLING FACILITIES AND THE GAINESVILLE RAIL RATE, SM-29 SOUTHERN AREAS 1975

SM-29 Area	Market Point	Optimum Volume of Handling Capacity by Size of Facility		
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a
		-----Thousands of Bushels-----		
1	Wilson, N. C.	24,000	24,000	24,000
2	Charlotte, N. C.	81,000	81,000	81,000
3	Valdosta, Ga.	6,000	6,000	6,000
4	Jacksonville, Fla.	0	0	0
5	Tampa, Fla.	0	0	0
7	Montgomery, Ala.	136,500	136,500	136,500
8	Guntersville, Ala.	43,500	43,500	43,500
9	Gainesville, Ga.	21,000	21,000	21,000
10	Chattanooga, Tenn.	43,500	43,500	43,500
11	Nashville, Tenn.	7,500	7,500	7,500
12	Memphis, Tenn.	3,000	3,000	3,000
13	Jackson, Miss.	3,000	3,000	3,000
14	New Orleans, La. (Domestic)	3,000	3,000	3,000
15	Shreveport, La.	0	0	0
16	Springdale, Ark.	13,500	13,500	13,500
17	Little Rock, Ark.	0	0	0
18	Henderson, Ky.	0	0	0
19	Louisville, Ky.	0	0	0
20	Ashland, Ky.	0	0	0
40A	New Orleans, La. (Export)	429,000	429,000	429,000

TABLE XIV (continued)

SM-29 Area	Market Point	Optimum Volume of Handling Capacity by Size of Facility		
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a
-----Thousands of Bushels-----				
40B	Pascagoula, Miss. (Export)	97,500	97,500	97,500
40C	Mobile, Ala. (Export)	73,500	73,500	73,500
44	Charleston, S. C. (Export)	3,000	3,000	3,000
	Totals	988,500	988,500	988,500

^a Annual grain handling capacity.

TABLE XV

OPTIMUM VOLUME AND LOCATIONS OF CORN HANDLING CAPACITY FOR 2,500, 5,000 AND
10,000 BUSHELS PER HOUR HANDLING FACILITIES AND THE RENT-A-TRAIN
RAIL RATE, SM-29 SOUTHERN AREAS 1975

SM-29 Area	Market Point	Optimum Volumes of Handling Capacity by Size of Facility		
		2,500 Bu./Hr.	5,000 Bu./Hr.	10,000 Bu./Hr.
		(6,000,000 Bu.) ^a	(12,000,000 Bu.) ^a	(24,000,000 Bu.) ^a
-----Thousands of Bushels-----				
1	Wilson, N. C.	16,500	16,500	16,500
2	Charlotte, N. C.	127,500	127,500	127,500
3	Valdosta, Ga.	0	0	0
4	Jacksonville, Fla.	0	0	0
5	Tampa, Fla.	0	0	0
7	Montgomery, Ala.	31,500	31,500	31,500
8	Guntersville, Ala.	124,500	124,500	124,500
9	Gainesville, Ga.	24,000	24,000	24,000
10	Chattanooga, Tenn.	43,500	43,500	43,500
11	Nashville, Tenn.	0	0	0
12	Memphis, Tenn.	3,000	3,000	3,000
13	Jackson, Miss.	3,000	3,000	3,000
14	New Orleans, La. (Domestic)	0	0	0
15	Shreveport, La.	0	0	0
16	Springdale, Ark.	16,500	16,500	16,500
17	Little Rock, Ark.	0	0	0
18	Henderson, Ky.	0	0	0
19	Louisville, Ky.	0	0	0
20	Ashland, Ky.	0	0	0
40A	New Orleans, La. (Export)	436,500	436,500	436,500

TABLE XV (continued)

SM-29 Area	Market Point	Optimum Volumes of Handling Capacity by Size of Facility		
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a
-----Thousands of Bushels-----				
40B	Pascagoula, Miss. (Export)	97,500	97,500	97,500
40C	Mobile, Ala. (Export)	64,500	64,500	64,500
44	Charleston, S. C. (Export)	0	0	0
	Totals	988,500	988,500	988,500

^aAnnual grain handling capacity.

The 24 million bushel limitation again restricted plant construction to five of the 12 active sites. No projections could be made for the remaining seven active sites from the available data.

With the Rent-A-Train rate solution the Port of Charleston, South Carolina (Area 44) was idle as an intermediate grain handling facility. Corn requirements for the Charleston export market were supplied from Minneapolis, Minnesota (Area 32). It was impossible to determine with certainty the intermediate plant utilized in this allocation, however.

The Least-Cost Mode

Substitution of the rate associated with the least-cost mode of transportation and associated pseudo demand curves into the model led to the distribution of required corn handling capacity shown in Table XVI. This capacity was again constant for the range of plant sizes between 2,500 and 10,000 bushels per hour. According to these results corn should be handled at 15 of the 23 locations.

The constant distribution of required corn handling capacity indicated that plants could be constructed to handle the required flow of corn through active sites up to 24 million bushels. Seven of the 15 active sites would fall within this range.

In the present solution of the plant location model the Port of Mobile, Alabama (Area 40C) requires special attention. The indicated volume of corn handled by the intermediate handling facility is far in excess of the 66 million bushels allocated to the Mobile export market.

TABLE XVI

OPTIMUM VOLUME AND LOCATIONS OF CORN HANDLING CAPACITY FOR 2,500, 5,000 AND 10,000 BUSHELS PER HOUR HANDLING FACILITIES AND THE LEAST-COST MODE OF TRANSPORTATION, SM-29 SOUTHERN AREA 1975

SM-29 Area	Market Point	Optimum Volume of Handling Capacity by Size of Facility		
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a
-----Thousands of Bushels-----				
1	Wilson, N. C.	0	0	0
2	Charlotte, N. C.	33,000	33,000	33,000
3	Valdosta, Ga.	0	0	0
4	Jacksonville, Fla.	0	0	0
5	Tampa, Fla.	24,000	24,000	24,000
7	Montgomery, Ala.	31,500	31,500	31,500
8	Guntersville, Ala.	40,500	40,500	40,500
9	Gainesville, Ga.	13,500	13,500	13,500
10	Chattanooga, Tenn.	45,000	45,000	45,000
11	Nashville, Tenn.	0	0	0
12	Memphis, Tenn.	3,000	3,000	3,000
13	Jackson, Miss.	3,000	3,000	3,000
14	New Orleans, La. (Domestic)	3,000	3,000	3,000
15	Shreveport, La.	0	0	0
16	Springdale, Ark.	15,000	15,000	15,000
17	Little Rock, Ark.	0	0	0
18	Henderson, Ky.	0	0	0
19	Louisville, Ky.	0	0	0
20	Ashland, Ky.	115,500	115,500	115,500
40A	New Orleans, La. (Export)	448,500	448,500	448,500

TABLE XVI (continued)

SM-29 Area	Market Point	Optimum Volume of Handling Capacity by Size of Facility		
		2,500 Bu./Hr. (6,000,000 Bu.) ^a	5,000 Bu./Hr. (12,000,000 Bu.) ^a	10,000 Bu./Hr. (24,000,000 Bu.) ^a
-----Thousands of Bushels-----				
40B	Pascagoula, Miss. (Export)	97,500	97,500	97,500
40C	Mobile, Ala. (Export)	127,500	127,500	127,500
44	Charleston, S. C. (Export)	4,500	4,500	4,500
	Totals	1,005,000	1,005,000	1,005,000

^aAnnual grain handling capacity.

Comparison of total plant allocations to total market allocations for the entire system indicated that all corn had moved through the intermediate handling facilities to the markets. Output from the computer program did not provide any information relating to allocations from the Mobile intermediate handling facility to designated markets.

The possible existence of an error factor proportional to the total volume of corn handled through a plant was considered and rejected. The New Orleans export market (Area 40A) was the largest market in the system. Corn allocations to this market were approximately 4.4 times the market allocations to Mobile. Allocations to the New Orleans export handling facility were within 3 per cent of market allocations. A slight leakage evidently did occur at the New Orleans corn handling facility, but its magnitude was almost insignificant when compared to total plant allocations at New Orleans. There appeared to be no relation between the volume of corn handled and the overstatement of capacity requirements at Mobile.

Similar overstatements in indicated corn handling capacity at Mobile were observed in two additional computer runs utilizing the least-cost mode of transportation. Treatments in the first run consisted of decreasing the increments of fixed plant costs from \$10,000 to \$2,000 per iteration and increasing the minimum changes in corn allocations from 1,500 units to 2,000 units. The volume of corn allocated to the Mobile export market by the computer program remained constant at 66 million bushels. Total corn allocations to the Mobile export handling facility decreased three million bushels to 124 million.

Therefore, decreasing the plant cost increment and increasing the corn increment did not appear to significantly affect the discrepancy between the Mobile market allocations and intermediate handling facility allocations.

In the second computer run the minimum corn increment was held at 2,000 units, and plant costs were set at zero. Using proper pseudo demand curves the plant location program again allocated 66 million bushels of corn to the Mobile export market. Allocations to the Mobile corn handling facility were 114 million bushels. This was a drop in plant allocations of 13 million bushels of corn. Interrelationships among plant costs at the several active corn handling facilities might have been instrumental in causing the discrepancy, but most of it remains unexplained.⁹

Two explanations of this discrepancy appear possible. First, some corn might have leaked back into domestic channels from the export handling facility at Mobile. Unit transfer costs of \$999.99, however, were assigned to all routes from export facilities to domestic markets to prevent such movements. In the current model these costs were from 2.5 to 10 times as high as the transfer costs between domestic shipping points.

The second and more likely possibility is the positively-sloped derived demand curve phenomenon.¹⁰ This phenomenon has been shown to

⁹An additional plant location program with a minimum change in corn allocations of 750 units was attempted, but cycling occurred and no solution was reached.

¹⁰For explanations of the positively-sloped derived demand curve phenomenon, see footnote 22, page 60, and Appendix B.

cause similar results on a more general basis in test problems. The positively-sloped demand curves at the plants can be caused by interaction of the discontinuous increments of plant cost and allocations of commodity.

IV. STABILITY OF THE 1975 PLANT LOCATION MODEL SOLUTIONS

The 1975 distribution of required plant capacity was shown to be stable with each mode of transportation for changes in plant size from 2,500 to 10,000 bushels of corn per hour. Following the 1964 procedure, stability of movements was examined both in terms of shipping patterns and costs of utilizing sub-optimum routes.

Shipping Patterns for Corn

The optimum shipping patterns associated with the least-cost mode and the highest-cost mode of transportation were again obtained from transportation models.¹¹ Observed changes in these flows should indicate the direction of changes caused by shifts in freight rates for corn. Constant flows of corn would, therefore, indicate stability.

Optimum flows of corn with the least-cost mode and the highest-cost mode are presented in Figures 15 and 16 respectively. These flows revealed that few major changes in corn allocations to markets had occurred. Examination of the data underlying these flows indicated that Areas 26, 29 and 30 remained the major sources of corn moving into the South.

¹¹See Appendix C, Tables LXII and LXIII for the optimum flows of corn discussed in this section.

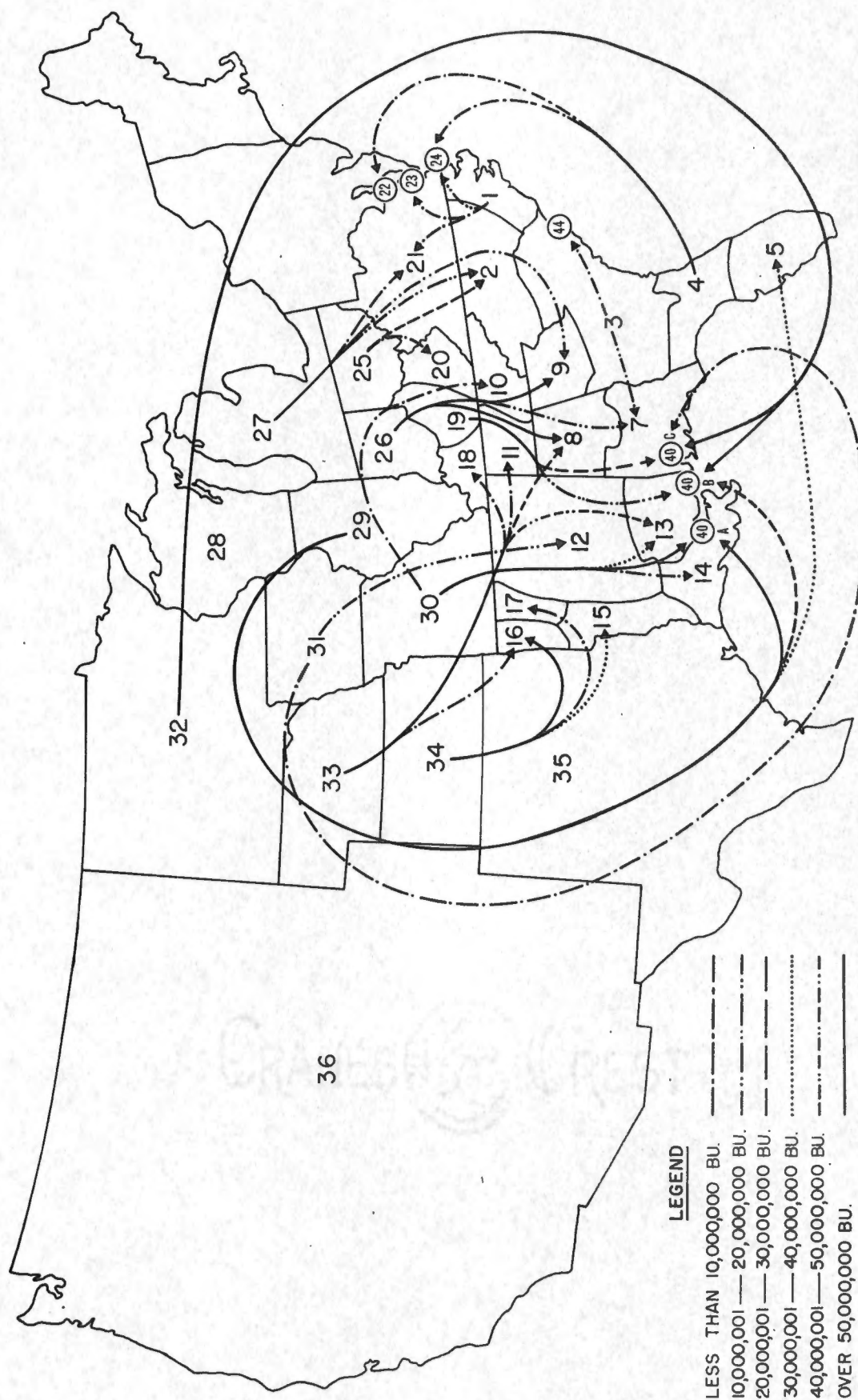


Figure 15. Optimum shipping pattern for corn utilizing the least-cost mode of transportation, 1975.

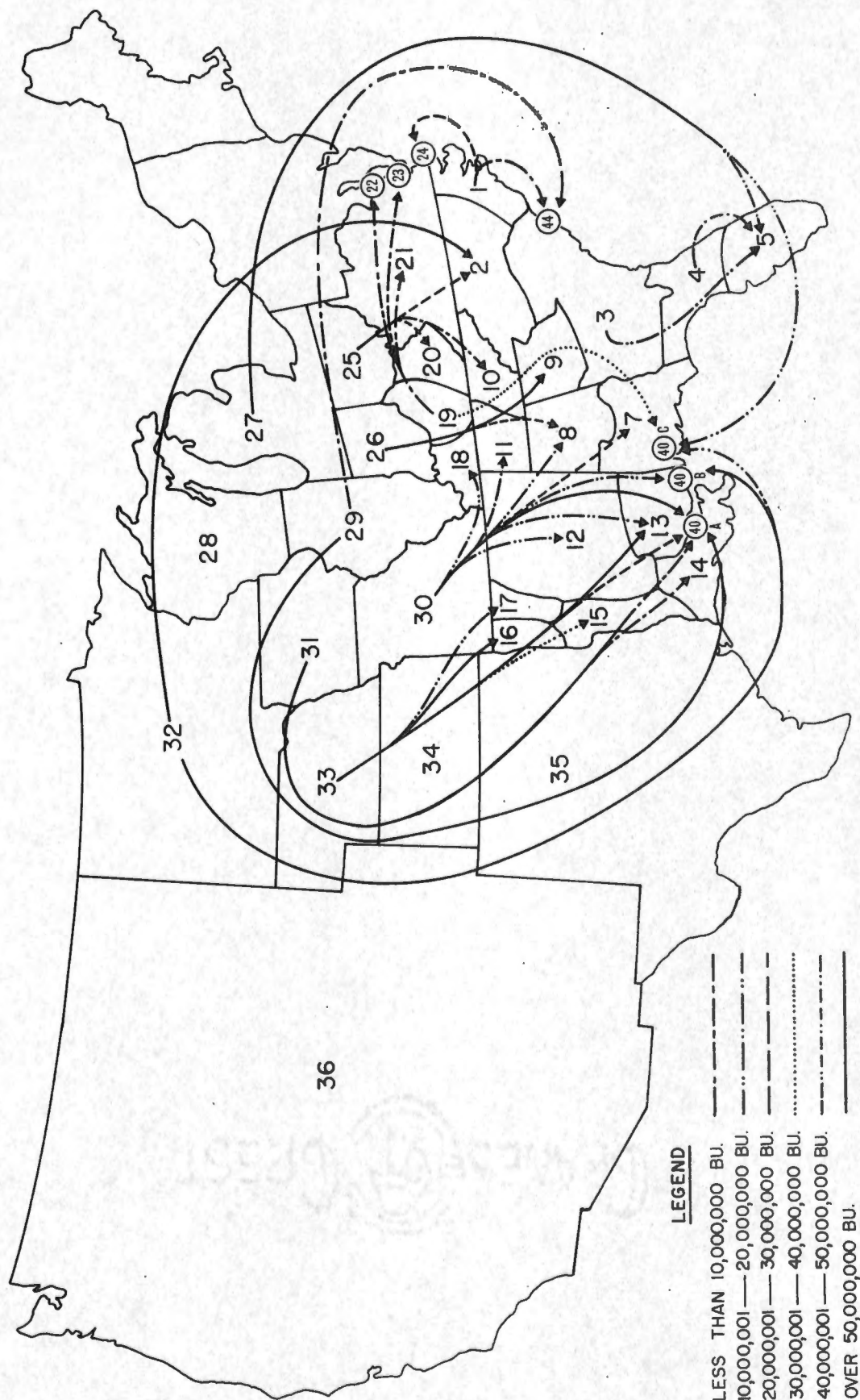


Figure 16. Optimum shipping pattern for corn utilizing the highest-cost mode of transportation, 1975.

With the Gainesville rail rate, Rent-A-Train rate and highest-cost mode, Origins 26, 29 and 30 accounted for 72.6 per cent of total shipments. With the least-cost mode, shipments from these origins increased to 82.6 per cent. This was due to increased flow of corn from Peoria, Illinois (Origin 29) to New Orleans export (Destination 40A). Total flows from Origins 29 and 30 were the same for all four modes even though some market allocations changed slightly. This was considered sufficient evidence to indicate considerable stability of the 1975 corn flows.

Cost of Utilizing Sub-Optimum Routes

Costs of utilizing sub-optimum routes were also calculated for the three modes utilized in 1975. The Gainesville rail rate (Appendix C, Table LXIV), produced a mean cost of utilizing sub-optimum routes equal to 5.95 cents per bushel. The highest cost was 40.23 cents per bushel and approximately three-fourths of the observations were below ten cents per bushel.

For the Rent-A-Train rate the mean cost of hauling corn over sub-optimum routes was 5.86 cents per bushel (Appendix C, Table LXV). The highest cost was 41.93 cents per bushel, and the majority of observations were below ten cents per bushel.

Consideration of the least-cost mode revealed a mean cost of 6.00 cents per bushel (Appendix C, Table LXVI). These costs ranged up to 36.46 cents per bushel for the most disadvantageous route, but approximately three-fourths of them were less than ten cents.

A significant number of alternate least-cost routes existed in the system with each transport mode. The geographical distribution

of these routes, however, appeared to be more concentrated in 1975 than 1964. Markets 13, 14, 40B and 40C enjoyed the most alternative sources of supply with Origins 29-32. The lack of alternative least-cost routes between the midwestern supply areas and the Virginia and Maryland markets (Areas 21-24) continued into 1975.

Initial results from analyzing these sub-optimum routes indicate that it will probably become increasingly important to select and utilize optimum or alternate least-cost routes in the future. During the period from 1964 to 1975 average costs of moving corn over sub-optimum routes increased nearly 20 per cent. According to data presented in this report approximately 40 million dollars per year in transfer charges might be saved in this way. This could be an additional source of net revenue to corn producers which could be tapped without additional expenditures for plant and equipment. Like 1964, the structure of these costs of sub-optimum routes suggests that shipping patterns for 1975 will be reasonably stable for each mode of transportation.

V. COMPARISON OF 1964 AND 1975 PLANT

LOCATION MODEL SOLUTIONS

Together the 1964 and 1975 plant location solutions included four transportation modes and two sets of corn surplus-deficit assumptions. The quantity of corn in the system also nearly doubled due to increased production in the Midwest. Two market points shifted from deficit to surplus, and one market point changed from surplus to

deficit. For long range planning implications it is necessary to consider the stability of solutions relative to this changing economic environment.

The distributions of required corn handling capacity by transportation modes for 1964 and 1975 are shown in Table XVII. It is apparent that considerable changes in the optimum locations of capacity are indicated. It is also apparent that a closer relation existed between the distributions of required capacity with the least-cost mode for 1964 and 1975 than among the three 1975 modes. This suggests that transportation did play a significant role in determining plant locations within the models.

Only six of the 23 possible corn handling locations were active in every case. Three locations remained inactive under all conditions considered. Three other locations were utilized with only one mode of transportation. Four sites appeared twice in the optimum solutions, and seven sites appeared three times.

In 1964 Henderson, Kentucky (Area 18) was a surplus corn producing area. With the least-cost mode of transportation Henderson appeared to be a major staging point for midwestern corn moving into export channels through the Gulf Coast ports and accounted for some corn moving into Virginia and Maryland markets. By 1975, however, Henderson had shifted to a corn deficit situation and did not appear in any plant location model solution. Ashland, Kentucky (Area 20) had become the major area shipping point with the least-cost mode. The location advantage of both of these market points, however,

TABLE XVII

OPTIMUM DISTRIBUTIONS OF REQUIRED ANNUAL CORN HANDLING CAPACITY BY TRANSPORTATION
MODE AND YEAR, SM-29 SOUTHERN AREAS 1964 AND 1975

SM-29 Area	Market Point	Distribution of Required Corn Handling Capacity by Mode and Year				Gainesville Rail Rate, 1975
		Least-Cost Mode, 1964	Least-Cost Mode, 1975	Rent-A-Train Rate, 1975		
		-----Thousands of Bushels-----				
1	Wilson, N. C.	0	0	16,500	24,000	
2	Charlotte, N. C.	15,000	33,000	127,500	81,000	
3	Valdosta, Ga.	0	0	0	6,000	
4	Jacksonville, Fla.	2,000	0	0	0	
5	Tampa, Fla.	6,000	24,000	0	0	
7	Montgomery, Ala.	0	31,500	31,500	136,500	
8	Guntersville, Ala.	29,000	40,500	124,500	43,500	
9	Gainesville, Ga.	0	13,500	24,000	21,000	
10	Chattanooga, Tenn.	40,000	45,500	43,500	43,500	
11	Nashville, Tenn.	2,000	0	0	7,500	
12	Memphis, Tenn.	38,000	3,000	3,000	3,000	
13	Jackson, Miss.	0	3,000	3,000	3,000	
14	New Orleans, La. (Domestic)	5,000	3,000	0	3,000	
15	Shreveport, La.	0	0	0	0	
16	Springdale, Ark.	0	15,000	16,500	13,500	
17	Little Rock, Ark.	0	0	0	0	
18	Henderson, Ky.	260,000	0	0	0	
19	Louisville, Ky.	0	0	0	0	
20	Ashland, Ky.	51,000	115,500	0	0	
40A	New Orleans, La. (Export)	31,000	448,500	436,500	429,000	

TABLE XVII (continued)

Distribution of Required Corn Handling Capacity by Mode and Year						Gainesville Rail Rate, 1975
SM-29 Area	Market Point	Least-Cost	Least-Cost	Rent-A-Train		
		Mode, 1964	Mode, 1975	Rate, 1975	Thousands of Bushels	
40B	Pascagoula, Miss. (Export)	21,000	97,500	97,500	97,500	
40C	Mobile, Ala. (Export)	0	127,500	64,500	73,500	
44	Charleston, S. C. (Export)	2,000	4,500	0	3,000	
Totals		502,000	1,005,000	988,500	988,500	

seemed to depend entirely on water transportation because neither of them appeared in any solution which depended solely on railroads.

The Port of Mobile, Alabama (Area 40C) did not appear in the 1964 solution. In spite of the discrepancy previously noted, Mobile will probably be a major corn receiving point in the 1975 solutions with the least-cost mode of transportation. This could be attributed to the Tennessee-Tombigbee Waterway which was assumed to be operational by that time. Results also indicated that Mobile would handle a considerable quantity of corn when the Rent-A-Train or the Gainesville rail rate was used.

Little Rock, Arkansas (Area 17) was among the inactive locations in all cases even though channel improvements to the Arkansas River would permit barge shipments by 1975. The Little Rock market was supplied from Minneapolis via Springdale, Arkansas.

Within the present analysis the potential of Wilson, North Carolina (Area 1) seemed closely tied to rail transportation. Wilson possessed active handling capacity in plant location solutions utilizing the Gainesville rail rate and the Rent-A-Train rate but was inactive with both least-cost modes.

With the 1975 Rent-A-Train rate Charlotte, North Carolina (Area 2) and Guntersville, Alabama (Area 8) were major handling points for corn. In this case they handled approximately twice the volume of corn they handled with any other rate. When corn was moved under the Gainesville rail rate, the advantage was shifted from Guntersville to Montgomery, Alabama (Area 7). Shifting to the Gainesville rate also

resulted in approximately one-third of the corn previously handled in Charlotte being disbursed to neighboring locations.

Comparison of the distributions of required corn handling capacity with all transportation modes for 1964 and 1975 revealed much wider variation in locations and magnitudes of capacity than were present in any of the individual 1964 solutions. The location of corn handling capacity appeared to be more dependent on the supply of corn and transfer costs than on plant costs.

On the basis of the comparisons presented above, there appeared to be only a moderate degree of over-all stability of plant locations present. It should be remembered, however, that the model was a partial equilibrium system with no sunk plant costs. The presence of sunk plant costs and consideration of the entire demand for corn should exert a stabilizing influence on the location of handling facilities. The presence of other goals besides profit maximization on the part of some entrepreneurs might also contribute to stability.

Results from the 1964 and 1975 plant location models also indicate that elevator costs are probably not as important as either transfer costs or corn surplus-deficit relationships in determining the optimum locations of corn handling capacity. Allowing plant size to vary from 2,500 bushels per hour to 10,000 bushels per hour did not affect the geographical distribution of plant capacity. Considerable changes in the distribution of corn handling facilities, however, were associated with using different transport rates for moving corn. Changing surplus-deficit relationships also appeared to affect the

location of intermediate corn handling facilities.

VI. EVALUATION OF THE PLANT LOCATION MODEL

By nature an economic model is a simplification of reality. Since real economic systems are generally much too complex for direct study, an economic model attempts to select strategic variables on the basis of economic theory and analyze their behavior to predict the behavior of the real system. Model building, therefore, provides a bridge between theoretical and empirical economics. In the present study location determinants were analyzed in an attempt to determine the optimum number, sizes and locations of corn handling facilities.

The Miller and King Plant Location Model

Empirical application of a reactive programming plant location model of the Miller and King variety to a problem of practical size was a secondary objective of this study. The theoretical basis of the model appeared sound. In a situation where average variable costs are equal and constant at all potential plant locations, average fixed cost is the prime determinant of the distribution of plants. Solution of the model is based on the idea that an equilibrium exists for a system when each origin in the system is in equilibrium with all possible markets and all possible plants.

Many unexpected technical difficulties, however, were encountered in adaptation and subsequent application of this model. Initial experimentation indicated that the computer program as

formulated by Miller and King yielded satisfactory results with sample problems up to size 7 (origins) x 6 (plants) x 3 (markets). Experience with larger problems (12 x 12 x 12), however, revealed a tendency of the program to cycle endlessly without converging on a solution. This problem was subsequently solved by modifying the program to permit prior setting of the increments by which it converged on a solution with each iteration.

As an added precaution against future cycling, provision of an upper limit on the number of times the machine could traverse a critical operation was also added to the program. There were, therefore, three separate adjustments which could be performed to permit the program to efficiently iterate to solution (Appendix B). Large problems often required considerable experimentation to determine the proper values for these increments to enable the machine to reach an acceptable solution.

Increasing the magnitude of the product increment had two effects on the solution procedure. Obviously if the value of the increment was increased, the rate of convergence was proportionally increased. The accuracy of the solution, however, declined. Accuracy was thus sacrificed for speed, and in some cases (large problems) it was sacrificed to enable a solution of any sort to be reached. This proved to be one of the most serious limitations of the procedure in the present study.

Another serious shortcoming of the plant location model concerned its treatment of fixed plant costs. The model required these

costs to be equal at all locations. In wide-area analysis this requirement can become quite restrictive. For example, there can often be wide differences in land values, property taxes, plant construction costs and fixed annual wage costs which would largely determine the advantage or disadvantage of an area as a potential location for a processing plant.

A second deficiency in the treatment of plant costs by the model is the requirement of only one plant per location. In the present study this situation prevented determination of the optimum number of plants required for the system. Closely allied with the requirement of one plant per location is the use of only one size of plant in a particular computer run. When geographic market requirements vary widely, it is unrealistic to consider processing systems utilizing only one plant size. Together these problems probably constitute the most limiting factors in applying this model to empirical problems.

The plant location model computer formulation employed in this study only printed allocations from origins to markets and from origins to plants. No allocations from plants to markets were printed. Therefore it was generally impossible to trace shipments of corn from origins, through plants and to markets. Such information would be valuable in interpreting model results.

The Miller and King model is an advantage over current formulations of the Stollsteimer plant location model in economizing computer time. The Stollsteimer model computes all possible combinations of assembly and distribution costs for origins, plants and markets. When

large problems are analyzed, these computations can become very substantial.

In summary, the Miller and King model can provide an acceptable tool for plant location analyses in rather small or homogeneous areas, but serious limitations are imposed by the model in wide-area analyses. These limitations generally involve total quantity of commodity which can move through the system, allocations to plants and markets and allowance for only one total fixed plant cost at all plant locations.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

I. SUMMARY

This study has dealt with the broad area of marketing efficiency and with interdependencies in the marketing system which affect the number, sizes and locations of agricultural marketing firms in the Southeast. The purpose was to apply a plant location model to the corn trading system in an attempt to draw some general conclusions about the impact of transportation costs on the optimum market structure.

Data collection and processing were carried out under the auspices of the Southern Regional Grain Marketing Committee, Project SM-29 entitled "Optimal Adjustments of Marketing Facilities to Present and Future Conditions." Results of this study are expected to contribute to the Committee's regional objectives.

In general, domestic grain transportation occurs by barges, railroads and trucks. Each type of transportation possesses unique advantages and disadvantages depending on the nature of the commodity involved, type of institutional regulation, length and direction of haul and services required. Comparable estimates of grain tonnage transported by the various modes are not directly available due to variations in regulatory and reporting practices.

Rapidly changing technology in the transport industries and accelerated competition between them for increased tonnage are expected to influence historical competitive positions of marketing firms employing their services in all regions of the United States.

During the last 20 years there has been a large increase in livestock and poultry production in the southeastern region, especially broiler production. Concurrently, feed grain production has suffered relative declines in most southern states. Combination of these factors has resulted in increased net grain in-shipments for the area as a whole.

Corn is the most important feed grain produced in the Southeast and is also the primary feed grain imported from the Midwest. Changes in delivered corn prices could have profound effects on the southern agricultural economy.

The objectives of the investigation were (1) to determine the optimum number, sizes and locations of major corn handling facilities under 1964 and projected 1975 conditions; (2) to impute costs of employing sub-optimum routes and modes in each case; (3) to estimate the stability of each solution obtained relative to decreases in rail and water transportation costs. A secondary objective was to test the validity of a plant location model of the Miller and King variety on a problem larger than 7 (origins) x 6 (plants) x 3 (markets).

The methodology employed in the study required that the continental United States be divided into several corn marketing areas with a "representative" market point designated in each area. A

total of 36 domestic areas and four export markets were considered. The surplus or deficit position of each area was estimated for 1964 and 1975 by the Southern Regional Grain Marketing Committee.

Twenty-three possible locations of corn handling capacity were considered for both years. These locations were situated in the 19 southern areas and four export markets emphasized in Project SM-29. Generalized corn handling costs were obtained from secondary data for 2,500, 5,000 and 10,000 bushels per hour corn handling facilities. These facilities were assumed to operate for 300 days per year and have annual capacities of six million, 12 million and 24 million bushels of corn respectively.

For 1964, six distinct and two composite transportation modes were initially considered. They were truck, least-cost rail (Big John multiple car shipments), weighted-average rail (weighted by the quantities of corn moving at various rates), barge-truck, barge least-cost rail, barge weighted-average rail, least-cost mode and highest-cost mode. The least-cost mode and highest-cost mode were composites of the other six rates. Utilizing each of these rates, assembly costs from each supply point to every designated plant site were calculated. By the same process distribution costs from every plant site to all markets were obtained.

For 1975, the same breakdown was followed except that least-cost rail (Big John) rates were dropped in favor of two special rates. These new rates were the Gainesville rail rate and the Rent-A-Train rate. They were approximated by reducing the line haul component of

the least-cost rail rate by 10 per cent and 40 per cent respectively between specified origins and destinations. This yielded a total of nine possible rates for moving corn.

Published rates were obtained for rail and barge to the extent possible. These costs were supplemented by rates computed from regression equations based on samples of existing rates and waterway and rail distances. Trucking costs for corn were obtained by applying an equation derived by members of the Southern Regional Grain Marketing Committee to standard highway mileages between shipping points.

Corn surpluses and deficits for the southern areas were obtained by members of the Southern Regional Grain Marketing Committee and taken as parameters in the present analysis. The Committee obtained the 1964 values from published sources. For 1975, however, they independently projected acreage and yields to estimate total production by areas. Next they projected animal numbers and rations to estimate corn utilization. Production and utilization estimates were then combined to obtain projected area supplies and demands. This procedure did not consider corn demand for human consumption.

Three separate computer programs were employed at various stages of the analysis. The first program involved calculation of a combined cost matrix. This program utilized assembly and distribution costs for each transport mode as inputs to compute the least-cost route from each origin through a plant and to each market. In a sense the technique reduced transfer costs from a two-stage transportation problem to a single-stage problem.

Output from the combined cost matrix was fed into a conventional transportation model program to obtain optimum flows of corn under each set of demand and transfer cost assumptions. Equilibrium price differentials among markets were obtained from the dual solution of each transportation model. Imputed costs for moving corn over sub-optimum routes in each case were estimated by comparing the equilibrium transfer cost suggested by the price differentials to the actual transfer cost of moving corn over specific routes.

The third program was the plant location model. Since the plant location model was unable to directly utilize point estimates of demand, the equilibrium market price differentials from the transportation model duals were employed to calculate pseudo demand curves for each market under each set of transfer cost and demand assumptions. These pseudo demand curves did not carry any economic significance in the normal sense of the word.

The plant location model utilized supply parameters, fixed plant costs, assembly and distribution costs and pseudo demand curves to arrive at the number, sizes and locations of grain handling capacity from the 23 possible sites designated in the Southeast. Primary output from this model consisted of the number of active plant locations and the capacity required at each location.

Four sets of transportation costs were selected and incorporated into the plant location model during various computer runs. They were least-cost mode 1964, least-cost mode 1975, Rent-A-Train rate 1975 and the Gainesville rail rate 1975. This yielded a total

of 12 plant location solutions.

For 1964 and 1975, stability of the plant location solutions was investigated from three viewpoints. Optimum corn flows were determined for both the least-cost mode and the highest-cost mode of transportation for both years to test the sensitivity of flow patterns to shifts in the freight rate structure. Costs of utilizing sub-optimum routes with each mode of transportation were also determined. The magnitude of these costs indicated the pressure on shippers to move their corn over minimum cost routes. The distributions of required plant capacity associated with the several solutions for 1964 and 1975 were then compared to estimate the stability of plant numbers, sizes and locations in a changing economic environment.

II. CONCLUSIONS

The results of this investigation should not be interpreted as simple predictions of the number, sizes and locations of corn handling facilities which will exist in 1975. Rather they represent the optimum number, sizes and locations which would result in a competitive environment with no sunk plant costs and only considering the demand for corn as animal feed and export demand. Hence the foregoing analysis has been a partial equilibrium analysis in the strict sense of the word. Recognizing these limitations the major results of this report are presented below.

Results from the 1964 Models

Economies of size in plant operations for plant sizes between 2,500 bushels of corn per hour and 10,000 bushels per hour were not sufficient to concentrate required corn handling capacity at fewer locations. With the least-cost mode of transportation, the model indicated that corn should be handled at 13 of the 23 potential sites. The required corn handling capacity at the active sites ranged from two million bushels to 260 million bushels per year. Determination of the optimum number of corn handling facilities for the system was not possible because of the computer program requirement of one fixed plant cost at each active site. The largest plant considered had an annual volume of 24 million bushels. The optimum size of plants, however, could be specified at seven of the 13 active sites.

Stability of the 1964 Solutions

Within the 1964 corn marketing system, flows were found to be stable relative to changes in transfer costs between the least-cost mode and the highest-cost mode.

Added costs associated with utilizing sub-optimum routes to move corn from shipping points to markets were not found to be high relative to the total price of corn. In the current solution these costs averaged slightly less than five and one-half cents per bushel. When compared to the maximum assumed operating margin for a corn handling facility of eight cents per bushel, however, these costs assumed additional significance. Shippers utilizing least-cost routes

could attain a considerable increase in net revenue without additional expenditure of capital. For this reason it was concluded that sufficient pressure existed to force shippers to use minimum cost routes. Hence the solutions were considered stable.

Alternate least-cost routes were not evenly distributed over the geographical area. They were concentrated between Origins 29-32 and Destinations 8-13. Firms in these markets should possess a competitive advantage over other firms because they often have several alternative sources of corn at substantially equal transfer costs. Conversely, the Virginia and Maryland markets (Destinations 21-24) appeared to be at a competitive disadvantage relative to other markets due to a lack of alternate sources of corn at substantially equal transfer cost.

Results from the 1975 Models

Economies of size in plant operations were not sufficient to concentrate the required plant capacity with any transport mode in the 1975 plant location solutions. Considerable variation did exist, however, in the optimum geographical distribution of handling capacity when the three transportation costs were considered. This indicated that transportation did play a significant role in determining the advantage of market points.

The Gainesville rail rate. Results from the plant location solutions with the Gainesville rail rate indicated that 16 of the 23 locations were active with all plant sizes. Required annual corn handling capacity at individual sites varied from three million

bushels to 429.0 million bushels of corn. Nine of the 16 active sites, however, had corn handling requirements within the 24 million bushel maximum plant size. Plants of the appropriate sizes constructed at these nine locations would be consistent with the equilibrium solution.

The Rent-A-Train rate. In the Rent-A-Train rate solution corn handling capacity was distributed among 12 of the 23 possible locations. The required annual corn handling capacity at active sites varied from three million bushels to 436.5 million bushels of corn. The 24 million bushel plant capacity limitation restricted plant construction to five of the 12 active plant locations.

The least-cost mode. According to the plant location solution which utilized the least-cost mode of transportation, corn should be handled at 15 of the 23 potential locations. Required corn handling capacity at the active sites ranged from three million bushels of corn per year to 448.5 million bushels. Seven of the 15 active sites were within the 24 million bushel limitation. Plants constructed at these locations would be consistent with an equilibrium solution.

Stability of the 1975 Solutions

Shipping patterns associated with both the 1964 and the 1975 solutions were found to be stable relative to general changes in freight rates for corn. Southern Indiana, Illinois and Missouri remained the major suppliers of corn in all cases. Together they consistently accounted for approximately three-fourths of the midwestern

corn moving into southern markets. There were no indications that this situation would change in the foreseeable future.

Average costs of utilizing sub-optimum routes with all three modes were between five and six cents per bushel. This was over half as much as the total operating margin of the corn handling facilities. These costs were considered sufficiently high to cause shippers to maintain their optimum shipping patterns even if moderate shifts in corn prices occurred in specific markets.

The presence of alternate least-cost routes provided a source of flexibility in shipping patterns. For certain firms these routes would provide increased bargaining power because corn could be obtained from several sources at substantially equal transfer cost. These routes appeared to be more concentrated in the 1975 solutions than in the 1964 solutions. In the 1975 marketing system, Southern Mississippi, Southeastern and Southwestern Louisiana, Pascagoula, Mississippi (export) and Mobile, Alabama (export) enjoyed the most alternative sources of corn with Illinois, Missouri, Iowa, Minnesota, and the Dakotas. The absence of alternate least-cost routes into Virginia and Maryland markets continued into 1975. These alternate routes did not seem prevalent enough in the corn trading system, however, to cause much instability in overall flow patterns.

Comparison of 1964 and 1975 Solutions

Between 1964 and 1975 corn supply, demand and transfer cost all changed. Under these conditions increased variability in corn handling

requirements was quite evident. Six locations were active, and three locations were inactive in all cases. Three other locations were utilized with only one transportation rate. Four sites appeared twice in the optimum solutions, and seven sites appeared three times. Since 13 of the locations appeared with at least three transportation rates, it was considered that they possessed the highest potential for future development.

It was concluded that a rather high degree of stability existed within particular plant location solutions for 1964 and 1975, but this stability declined rather sharply as the location determinants were allowed to change. The location of corn handling facilities appeared to be more closely associated with transfer costs and changing surplus-deficit relationships among markets than with plant costs for the range of plants considered.

Evaluation of the Plant Location Model

The basic logic underlying the Miller and King plant location model appeared sound. Plant number and size determinations were made on the basis of supply estimates, market demand functions, plant costs and transfer costs from a set of preselected potential plant locations on the basis of a spatial equilibrium criterion. The assumption was made that marginal cost and average variable cost were constant and equal at all locations. Hence average fixed cost became the controlling factor in plant sizes and numbers.

Reactive programming permitted corn allocations to be made on the same basis that entrepreneurs make marketing decisions (maximum net revenue). The system then reacted to each allocation and calculated new net prices which formed the basis for subsequent allocations. The process continued until zero net prices existed in all markets or the supply of commodity was exhausted.

The apparent shortcomings of the plant location model computer program were in its tendency to cycle with large problems and in the treatment of plant costs. The tendency to cycle was remedied by defining a variable to regulate the rate at which the program converged on a solution and setting a limit on the number of times it could traverse a critical operation. This procedure, however, reduced the accuracy of results obtained with large problems.

Difficulties with its treatment of plant costs were more fundamental. The program provided for only one plant cost to be used at any one time. This excluded the influence of geographical differences in plant costs as determinants of location. It also precluded consideration of more than one plant size in a given computer run. Only one plant per location was permitted. The possibility of multiple plants was ruled out. Therefore determinations of plant numbers could be made only up to the maximum capacity of one plant per location.

In summary, the Miller and King model can provide an acceptable tool for plant location analyses in rather small or homogeneous areas, but serious limitations are imposed by the model in wide-area analyses.

These limitations generally involve the total quantity of commodity which can move through the system, allocation to markets and allowance for only one total fixed plant cost at each plant location.

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APPENDIXES

APPENDIX A

COMBINED COST MATRIX COMPUTER PROGRAM

I. GENERAL DESCRIPTION

This program provides a procedure for determining the minimum cost route from origin i ($i = 1, 2, \dots, I$) through an intermediate plant l ($l = 1, 2, \dots, L$) at a fixed location to a possible market k ($k = 1, 2, \dots, K$). It provides a means of transforming a two-stage transportation problem into a single-stage framework in situations where it is possible to abstract from plant costs.

Each origin i has L alternative plants which will receive its shipments en route to a given destination k . The unit shipping cost from origin i to plant l is c_{il} (assembly cost), and the unit cost of shipping from plant l to market k is c_{lk} (distribution cost). Both assembly and distribution costs must be based on the same unit of measure, usually factor and factor-equivalent units respectively. The necessary computation for every i and k combination is the formation of L possible sums of $c_{il} + c_{lk}$ and choice of the minimum value for each i and k pair. This minimum can be designated c_{ik}^l . No ties are recorded in the present formulation, but the program can be modified if alternative optima are desired. This procedure would be equivalent to tracing each possible route from i to k and choosing the least-cost route in each case. In matrix terms the operation is equivalent to combining an $I \times L$ matrix with an $L \times K$ matrix to form an $I \times K$ matrix of minimum sums.

II. MACHINE REQUIREMENTS

This program was written in Fortran IV for an IBM 7040 computer. The maximum size of problem which can be handled by the current formulation is $I = 50$, $L = 50$, $K = 50$.

III. DATA INPUT INSTRUCTIONS

Card 1--Dimension

Cols. 1-5 L (number of plants), cols. 6-10 I (number of origins).

Cols. 11-15 K (number of markets).

All of the above are right-oriented integers.

Cards 2-L--Assembly costs

Each array of assembly costs is entered in a ten digit field (cols. 1-10 . . .) through column 70. Supplemental cards may be used up to the dimension limit. Values may be located anywhere in each field, but a decimal must be included.

Cards (L + 1) - K--Distribution costs

Each array of distribution costs is also entered in a ten digit field utilizing cols. 1-70 with supplementary cards where required. Decimals are required.

Note that all data are read in by plants. Any variation of this format without program modifications will yield incorrect results.

IV. OUTPUT FORMAT

The results are an I x K matrix of minimum total transfer costs under the title COMBINED COSTS. Only row identifications are currently provided, but the program can be easily modified to provide column identification if desired. The output format is listed as follows:

Col. 1 Origin identification (i = 1, 2, 3 . . . I).

Cols. 2 - (K + 1) Minimum combined costs for each (i x k) combination.

Combined cost matrix

```

DIMENSION ASSC (50,50), DISTC (50,50), COMBC (50,50)
READ (5,10) NPLANT, NORIGN, MARKET
10  FORMAT (3I5)
DO 100 I=1, NPLANT
100  READ (5,20) (ASSC(J,I), J=1, NORIGN)
20   FORMAT (7F10.5)
20   FORMAT (7F10.5)
110  READ (5,20) (DISTC(I,J), J=1, MARKET)
DO 80 I=1, NORIGN
DO 80 J=1, MARKET
TEMP=1.0 E+30
DO 60 K=1, NPLANT
TEMP1 = ASSC (I,K) + DISTC (K,J)
60  IF (TEMP1 .LT. TEMP)
1TEMP = TEMP1
80  COMBC(I,J)=TEMP
WRITE (6,22)
22  FORMAT (1H1, 15HCOMBINED COSTS.)
DO 90 I=1, NORIGN
90  WRITE (6,25) I, (COMBC(I,J), J=1, MARKET)
25  FORMAT (2X,I5, 10F10.5/4(7X, 10F 10.5/))
CALL EXIT

```

APPENDIX B

PLANT LOCATION MODEL COMPUTER PROGRAM

I. GENERAL DESCRIPTION

This program is designed to answer the following question: "If there are I origins, L feasible intermediate plant sites and K markets all connected by known transfer costs, how many plants should be constructed, what sizes should they be, and at which sites should they be located?" Determination of the optimum number, sizes and locations of these intermediate plants is made on purely economic grounds excluding possible collusion among firms and any initial sunk costs in the system.

The computer program is a reactive program for the IBM 7040 system written in Fortran IV. Input data include fixed quantities of supply available at each origin, constant assembly costs, total fixed costs at all plants, constant distribution costs, and demand functions for each market.

This formulation assumes identical linear total cost functions at all potential plant sites. The assumption of equal marginal and average variable costs at all plants makes average fixed cost the principal factor in determining the optimum number of plants, hence the program only considers fixed plant costs. Specifically, the objective of this program is to maximize the average net revenue which accrues to the factor in the system as a whole.

Due to the nature of the computations involved, it has been found desirable to begin from near-zero plant costs at all plants and build up to total fixed cost by small increments rather than all at once. This is true because very large increases in plant cost may have the effect of yielding positively-sloped derived-demand curves at the plant level. These positively-sloped derived-demand curves are thought to be an undesirable side effect of suddenly subjecting the optimum distribution pattern based on zero plant costs to the additional stress of economies of size in plant operations. In sample problems the program has been observed to understate the optimum number of plants under the above conditions. Prevention of this situation is the purpose of VV and AC in the program.

In larger problems and problems involving excessive amounts of goods, the program was found to require extensive computer time in reaching an optimum solution or to go into an endless cycle and never iterate to solution. In order to combat these conditions two steps were taken.

First a variable was defined which would regulate the amount of goods allocated in each iteration. This provides a means of regulating the rate of convergence of the program on an optimum solution. It should be noted that economies in computer time are obtained at the sacrifice of accuracy in the solution obtained.

A variable was also defined which would limit cycling within the computer. This variable places a trap at the maximum number of times that the machine can compute through a critical loop on a

particular run. If this limit is exceeded, the program is terminated; and the computer prints "TRAP ON OUTER LOOP." Appropriate manipulation of these two variables can enable satisfactory results to be obtained on most problems.

Four sense switch controls are provided. Sense switch three may be turned on for an intermediate print-out of allocations to plants and markets. If both sense switch three and sense switch two are turned on together, the computer will trace out the results of allowing average fixed cost to increase by at least a given amount A. C. Whenever sense switch two is off, the program only gives the final print-out. When sense switches three and two are both off, initially, the only print-out is for the situation where $A.F.C. + A.C. = T.F.C.$

II. DEFINITIONS

The following definitions were employed in writing the program:

I = number of origins

L = number of plants

K = number of destinations

V = total fixed cost

VV = a judgement value to enable total fixed costs to begin
from near zero

AC = a judgement value for incrementing V toward total fixed
costs during successive iterations

LIMOUT = a variable which sets a limit on the number of times
the program can cycle through the outer loop of com-
putations

XINC = a variable which sets the size of each increment in supply
with successive iterations

S1 (I,L) = allocations to plants

S(I,K) = allocations to destinations

C(K) = sum of allocations to destination K

P(L) = sum of allocations to plant L

T(L,K) = unit of transportation cost between L and K (distribution costs)

PLNT(L) = average fixed cost at plant L

DEST(L,K) = net plant price at L for quantity shipped to destination K

B(K) = slope of linear demand at destination (K)

D(K) = price intercept of linear demand at destination (K)

T2(I,L) = unit transportation cost between I and L (assembly costs)

R(L,K) = net farm price for quantity shipped to plant L. When plant L ships to more than one market K, net farm prices will be approximately equal for all active routes. The final print-out gives only R(L,K) for the last origin computed.

E(K) = a variable used to compute a new value of S(I,K)

G(L) = a variable used to compute a new value of S1(I,L)

Y(I) = fixed supply at origin I

AIC(I) = a variable used to insure that no more than Y(I) is shipped from origin (I)

$W(I)$ = total assembly and distribution costs of quantity shipped
from $Y(I)$

$UU(I,L)$, $U(I,K)$ = variables used to determine whether the $N-1$
iteration values of $S(I,L)$ and $S(I,K)$ are the
same as the N^{th} values

III. DATA INPUT INSTRUCTIONS

Card 1:

Cols. 1-4 sense switches, cols. 5-9 LIMOUT, cols. 10-19 XINC.

Sense switches and LIMOUT are integers, but XINC requires a
decimal somewhere in the field.

Card 2:

Cols. 1-8 I, cols. 9-16 L, cols. 17-24 K.

All variables are integers and require no decimals. I, L and K
are right oriented, i.e., the number always ends in col. 8, 16, or 24.

Card 3: Plant costs and adjustment factors

Cols. 1-14 V, cols. 15-28 VV, cols. 29-42 AC.

There must be a decimal point somewhere in each field. (V =
total cost intercept, VV = a number chosen to make V approach zero and
AC = judgement value for amount AFC will change with each iteration.)

Card 4: Initial allocations to markets

Cols. 1-14 $S(I,K)$

Allocations from each origin to every destination (one per card).
They must have a decimal point. This will require $I \times K$ cards. Note:
These values can all equal zero, but they must be in the program.

(All two-dimensional arrays are read row-wise.)

Card (I x K) + 1: Initial allocations to plants; assembly costs

Cols. 1-14 $S1(I,L)$, cols. 15-28 $T2(I,L)$

Must have decimal somewhere in each field. There will be $I \times L$ of these cards. $S1(I,L)$ can all equal zero, but they must be in the program.

Card (I x L) + 1: Supply

Cols. 1-14 $Y(I)$

Fixed supply at origin I . Decimal point must be present somewhere in the field. The number of cards must equal the number of origins.

Card I + 1: Distribution costs

Cols. 1-14 $T(L,K)$

A decimal is required. There must be $L \times K$ of these cards.

Card (L x K) + 1: Market demand

Cols. 1-14 $D(K)$ price intercept at each market

Cols. 15-28 $B(K)$ slope of linear demand function at each market

These values are parameters of demand functions in each market.

Decimals are required. There will be K of these cards. Note: $B(K)$ values are read in positive even though normal Marshallian demand curves are assumed.

This program can also be used to obtain an approximate solution to the two-stage transportation model case with perfectly inelastic demand curves. In order to handle this limiting case, however, pseudo demand curves must be read into the program. These curves have

arbitrarily great slopes less than infinity and can be made to intersect the fixed quantities demanded as closely as desired. Care should be used in choosing parameters, however, because two additional conditions must be met. These conditions are maintenance of the fixed quantities demanded in each market and maintenance of inter-market price differentials, consistent with spatial equilibrium.

V. OUTPUT FORMAT

Output values appear in three columns on the left side of the print-out sheet. The first column contains the magnitude of the value under consideration, and the second and third columns provide identification. The order of output is as follows:

A. Allocations to destinations.. There will be $I \times K$ lines with the following headings: ALLOC TO DEST, ORI AND DES.

B. Allocations to plants. There will be $I \times L$ of these lines with the headings ALLOC TO PLTS, ORI AND DES.

C. Total assembly and distribution costs by origins. There will be one value for each origin (I) under the headings ASSEB + DISTRI AND ORI.

D. Immediately following the last value above and without an identification will appear the revised value of VV. VV decreases by an amount AC with each iteration.

E. Sum of allocations to each plant. There will be one value for each plant (L), under the headings UTIL OF PLTS AND PLT.

F. Sum of total transfer costs plus total plant costs. This value gives an indication of how well the program is iterating toward an optimum solution. It also shows the savings which accrue from each successive elimination of one or more plants. Care should be exercised in interpreting this value as a strict indication of optimality because the object of the program is to maximize the average net revenue accruing to the system, not solely to minimize total costs. The two concepts would be equivalent only when allocations to markets do not change with successive iterations.

The sequence A-F will be repeated for each iteration until the optimal solution to the system has been reached. The following values will be printed out only after the final iteration.

G. Summary of final allocations to markets. There will be a value for each market (K) in the system. These entries can be identified by the following headings: FINAL DMD ALOC AND DES.

H. Net farm price from the final origin calculated. These are imputed net returns to producers shipping to each possible market through every possible plant (L x K). These values appear under the headings NET FARM PRICE FROM ORIGIN I, PLT AND DES. The program may be easily modified to yield similar data for all origins.

I. Average fixed cost at each optimum plant (L). The following headings identify these values: AFC AND PLT.

J. Net plant price at each possible plant (K x L). These are imputed plant prices given market prices and unit transfer costs. They

are identified by NET PLANT PRICE, DES AND PLT.

K. Immediately following the final "NET PLANT PRICE," the final "Total Transfer Cost" will be listed without title.

L. The final sum of total transfer costs and total plant costs is printed under the title TOTAL TRFR + PLT.

M. If the computer encounters the limiting value for computations through the outer loop, further computations will be terminated and the following statement printed: TRAP ON OUTER LOOP.

PLANT LOCATION PROGRAM

```

    DIMENSION D(50),T2(50,50),R(50,50),E(50),G(50),Y(50),
1  ALC(50)
    DIMENSION S1(50,50),S(50,50),C(50),P(50),T(50,50),
1  PLANT(50),DEST(50,50),B(50)
    DIMENSION W(50),U(50,50),UU(50,50)
    INTEGER SW1,SW2,SW3,SW4
    XIK = 0.0
    INTEGER OUTLOP,INLOOP
    OUTLOP=0
    READ 6000,SW1,SW2,SW3,SW4,LIMOUT,XINC
6000 FORMAT (4I1,I5,F10.5)
    READ 2,I1,L1,K1
    READ 3,V,VV,AC
    DO 49 I=1,I1
    DO 49 K=1,K1
49  READ 3,S(I,K)
    DO 51 I=1,I1
    DO 51 L=1,L1
51  READ 3,S1(I,L),T2(I,L)
    DO 54 I=1,I1
54  READ 3,Y(I)
    DO 56 K=1,K1
    DO 56 L=1,L1
56  READ 3,T(K,L)
    DO 57 K=1,K1
57  READ 3,D(K),B(K)
    2 FORMAT (I8,I8,I8)
    3 FORMAT (F14.5,F14.5,F14.5)
    DO 5 K=1,K1
    C(K)=0.
    DO 5 I=1,I1
    5 C(K)=C(K)+S(I,K)
    DO 6 L=1,L1
    P(L)=0.
    DO 6 I=1,I1
    6 P(L)=P(L)+S1(I,L)
14  VV=VV-AC
    4 OUTLOP=OUTLOP+1
    IF(OUTLOP.GT. LIMOUT) WRITE(6,8898)
    IF(OUTLOP.GT.LIMOUT) GO TO 130
    INLOOP=0
8898 FORMAT ('' TRAP ON OUTER LOOP'')
    DO 11 I=1,I1
    DO 550 K=1,K1
    E(K)=XINC
550  U(I,K)=S(I,K)
    DO 551 L=1,L1
    G(L)=XINC
551  UU(I,L)=S1(I,L)

```

```

      W(I)=0.
100 DO 7 K=1,K1
      DO 7 L=1,L1
        7 DEST(K,L)=D(K)-B(K)*(C(K)-S(I,K)+E(K))-T(K,L)
        DO 9 L=1,L1
9      PLNT(L)=(V-VV)/(P(L)-S1(I,L)+G(L))
        DO 10 L=1,L1
        DO 10 K=1,K1
10     R(L,K)=DEST(K,L)-PLNT(L)-T2(I,L)
        ALC(I)=0.
        DO 12 K=1,K1
12     ALC(I)=ALC(I)+E(K)
        FLK=XINC*FLOAT(K)
        A=(Y(I)+FLK)-ALC(I)
        IF(A)50,50,17
17     L11=1
        K11=1
        CH=R(1,1)
        DO 23 L=1,L1
        DO 23 K=1,K1
        IF(R(L,K)-CH)23,23,22
22     CH=R(L,K)
        L11=L
        K11=K
23     CONTINUE
        IF(CH)50,50,34
34     G(L11)=G(L11)+XINC
        E(K11)=E(K11)+XINC
        W(I)=W(I)+T2(I,L11)+T(K11,L11)
        GO TO 100
50     DO 87 K=1,K1
87     C(K)=C(K)-S(I,K)+E(K)-XINC
        DO 88 L=1,L1
88     P(L)=P(L)-S1(I,L)+G(L)-XINC
        DO 89 K=1,K1
89     S(I,K)=E(K)-XINC
        DO 90 L=1,L1
90     S1(I,L)=G(L)-XINC
11     CONTINUE
96     DO 93 I=1,I1
        DO 93 K=1,K1
        IF(U(I,K)-S(I,K))4,93,4
93     CONTINUE
        DO 94 I=1,I1
        DO 94 L=1,L1
        IF(UU(I,L)-S1(I,L))4,94,4
94     CONTINUE
        OUTLOP=0
        IF(SW3.EQ.0) GO TO 5000
130    PRINT 1008
        DO 801 I=1,I1

```



```

      DO 801 K=1,K1
801  PRINT 13,S(I,K),I,K
      PRINT 1007
      DO 802 I=1,I1
      DO 802 L=1,L1
802  PRINT 13,S1(I,L),I,L
      PRINT 1006
      DO 803 I=1,I1
803  PRINT 13,W(I),I
      PRINT 3,VV
5000 SW=0.0
      PRINT 1004
      PLTRFR = 0.0
      DO 505 L = 1,L1
      PLTRFR = PLTRFR + P(L) * PLNT(L)
505  PRINT 13,P(L),L
      DO 5050 I = 1,I1
5050 SW = SW + W(I)
      PLTRFR = PLTRFR + SW
      PRINT 1009,PLTRFR
      PRINT 3,SW
      IF(XIK.EQ.SW) GO TO 75
      XIK = SW
      IK = IK + 1
      IF(OUTLOP.GE.LIMOUT) CALL EXIT
      IF(IK.EQ.10) GO TO 75
      GO TO 14
75  PRINT 1003
      DO 506 K=1,K1
506  PRINT 13,C(K),K
      PRINT 1002,I1
      DO 507 L=1,L1
      DO 507 K=1,K1
      PLNT(L)=(V-VV)/P(L)
      DO 5070 I=1,I1
      DEST(K,L)=D(K)-B(K)*(C(K)-S(I,K)+E(K))-T(K,L)
5070 R(L,K)=DEST(K,L)-PLNT(L)-T2(I,L)
507  PRINT 13,R(L,K),L,K
      PLTRFR = 0.0
      PRINT 1001
      DO 707 L=1,L1
      PLTRFR = PLTRFR + PLNT(L)*P(L)
707  PRINT 13,PLNT(L),L
      PRINT 1000
      DO 605 K=1,K1
      DO 605 L=1,L1
605  PRINT 13,DEST(K,L),K,L
      SW=0.0
      DO 58 I=1,I1
58  SW=SW+W(I)
      PRINT 3,SW

```

```
PLTRFR = PLTRFR + SW
PRINT 1009,PLTRFR
CALL EXIT
13  FORMAT(F14.5,2I6)
1000 FORMAT(1X,15HNET PLANT PRICE,2X,3HDES,3X,3HPLT)
1001 FORMAT(7X,3HAFC,7X,3HPLT)
1002 FORMAT(1X,14HNET FARM PRICE,3X,3HPLT,
1 3HDES/12H FROM ORIGIN,I4)
1003 FORMAT(1X,15HFINAL DMD ALOC.,2X,3HDES)
1004 FORMAT(1X,13HUTIL OF PLTS,4X,3HPLT)
1006 FORMAT(1X,14HASSEB + DISTRI,3X,3HORI)
1007 FORMAT(1X,13HALLOC TO PLTS,4X,3HORI,3X,3HPLT)
1008 FORMAT(1X,13HALLOC TO DEST,4X,3HORI,3X,3HDES)
1009 FORMAT(1X,17HTOTAL TRFR + PLNT ,E16.7)
END
```


APPENDIX C

SUPPLEMENTARY TABLES

TABLE XVIII

TERMINAL GRAIN ELEVATORS: NUMBER OF ESTABLISHMENTS AND VALUE OF SALES, UNITED STATES, FOR SELECTED YEARS

Year	Terminal Grain Elevators	
	Establishments (Number)	Total Value of Sales (1000 Dollars)
1948 ^a	391	2,828,323
1954 ^a	460	1,793,728
1958	690	2,011,291
1963	650	3,000,000 ^a

^aData for Alaska and Hawaii are not included.

Source: Carl J. Vosloh, Jr., "Grain Marketing," Agricultural Markets in Change, Agricultural Economic Report Number 95 (Washington: Government Printing Office, July 1966), p. 219, citing U. S. Census of Business 1939-1965.

TABLE XIX

RANKING OF GRAIN MARKETS ACCORDING TO GREATEST STORAGE CAPACITY,
UNITED STATES FOR SELECTED YEARS^a

Markets	Rank of Grain Markets by Years					
	1929	1939	1949	1959	1963	1965
	-----Rank-----					
Minneapolis	1	1	1	1	1	1
Kansas City	5	2	2	2	2	2
Wichita	8	12	12	3	3	3
Fort Worth	9	8	9	8	4	4
Chicago	2	4	4	4	5	5
Duluth--Superior	4	5	5	5	6	6
Enid	-	-	7	6	7	7
Lubbock	-	-	-	11	8	8
Salina	-	-	-	10	9	9
Buffalo	3	3	3	9	10	11
Hutchinson	-	-	11	12	11	10
Portland (Ore.)	-	-	-	7	12	12
Milwaukee	12	6	6	-	-	-
Omaha						
Council Bluff	6	7	8	-	-	-
St. Louis	-	9	10	-	-	-
Albany	-	10	-	-	-	-
Baltimore	7	11	-	-	-	-
St. Joseph	10	-	-	-	-	-
New York	11	-	-	-	-	-

^aThe 12 largest grain markets had a combined total of 939,739,000 bushels of storage capacity in 1965.

Source: Carl J. Vosloh, Jr., "Grain Marketing," Agricultural Markets in Change, Agricultural Economic Report Number 95 (Washington: Government Printing Office, July 1966), p. 219, citing Walter G. Heid, Jr., "Grain Marketing--A General Description," paper presented at symposium on "Structure, Conduct and Performance of the Grain Markets of the United States," Lincoln, Nebraska, June 1, 1965.

TABLE XX

NUMBER OF TRUCKS, MILES TRAVELED LADEN AND EMPTY, AVERAGE MILES PER VEHICLE, AND PERCENTAGE OF MILES LADEN PER VEHICLE BY REGION OF TRUCKER'S HOME OFFICE, 1960

Region of Home Office	Total Tractors and Straight Trucks ^a	Laden		Unladen		Total		Per Cent Laden
		Miles	Average Per Vehicle	Miles	Average Per Vehicle	Miles	Average Per Vehicle	
North Atlantic	502	14,133,901	28,155	7,348,280	14,638	21,482,181	42,793	65.7
East North Central	775	21,141,767	27,280	11,918,054	15,378	33,059,821	42,658	63.9
West North Central	1,414	47,965,830	33,922	22,312,009	15,779	70,277,839	49,701	68.2
South Atlantic	1,070	43,869,257	40,999	17,571,441	16,422	61,440,698	57,421	71.4
South Central	718	36,881,519	51,367	14,323,553	19,949	51,205,072	71,316	72.0
Western	651	30,371,713	46,654	9,937,429	15,265	40,309,142	61,919	75.3
Total	5,130	194,363,987	37,888	83,410,766	16,529	227,774,753	54,147	69.9

^aFrom a survey taken in 1960.

Source: Mildred DeWolfe, Economic Research Service, United States Department of Agriculture, For Hire Motor Carriers Hauling Exempt Agricultural Commodities--Nature and Extent of Operations, Marketing Research Report Number 585 (Washington: Government Printing Office, 1963), p. 39.

TABLE XXI

ASSEMBLY COSTS FOR TRANSPORTING CORN BY MOTOR TRUCKS, UNITED STATES BY SM-29 MARKET AREAS, 1964

	Plant	Origin												
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
1	Wilson, N. C.	0.00	208.59	271.79	232.21	275.62	264.45	330.84	320.31	363.40	447.99	449.60	401.71	Wilson, N. C.
2	Charlotte, N. C.	104.85	164.22	214.66	187.20	217.85	221.68	289.03	272.43	320.95	412.56	407.77	353.83	
3	Valdosta, Ga.	208.59	0.00	247.53	267.64	251.36	282.65	330.21	297.01	361.49	467.14	436.50	372.02	
4	Jacksonville, Fla.	210.19	84.42	274.67	293.18	278.50	308.18	357.34	324.14	388.62	494.28	469.06	404.58	Valdosta, Ga.
5	Tampa, Fla.	268.92	120.17	320.63	342.02	324.46	357.02	403.30	370.11	434.58	540.24	506.40	441.93	
7	Montgomery, Ala.	238.92	120.81	188.80	225.51	192.63	229.66	271.47	228.62	297.33	403.62	364.36	299.88	
8	Guntersville, Ala.	216.57	154.01	144.75	176.03	148.26	183.69	225.51	187.84	255.51	361.17	328.29	264.13	Guntersville, Ala.
9	Gainesville, Ga.	152.73	135.81	175.08	187.52	178.91	206.36	257.75	243.38	289.03	394.68	369.47	308.82	
10	Chattanooga, Tenn.	207.00	158.16	138.38	155.28	311.37	280.73	347.12	355.74	250.73	356.38	331.16	267.64	
11	Nashville, Tenn.	232.45	200.61	93.67	138.37	96.55	139.64	175.39	142.20	206.68	312.33	287.11	223.59	Nashville, Tenn.
12	Memphis, Tenn.	302.76	226.47	129.75	198.70	132.94	184.97	189.12	139.64	212.74	315.84	257.75	193.27	
13	Jackson, Miss.	313.93	197.10	194.87	260.62	198.70	250.73	257.11	207.63	280.73	383.83	322.23	257.75	
14	New Orleans, La.													(Domestic)
	(Domestic)	345.85	193.59	246.58	307.54	250.73	302.76	313.29	265.41	338.51	441.61	491.08	308.82	
15	Shreveport, La.	384.15	367.32	234.13	303.71	237.96	289.99	279.45	225.19	298.16	366.59	282.33	223.59	
16	Springdale, Ark.	400.43	324.78	202.53	261.26	204.76	225.83	203.48	153.69	214.98	265.78	187.20	122.73	Springdale, Ark.
17	Little Rock, Ark.	346.17	268.92	173.48	243.06	176.35	225.19	212.74	158.48	231.89	309.14	240.51	176.03	

TABLE XXI (continued)

Plant	Origin													
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)		
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.		
18 Henderson, Ky.	271.79	247.53	0.00	109.63	49.63	98.15	129.75	96.55	163.26	268.92	247.53	183.06		
19 Louisville, Ky.	240.51	246.26	82.51	80.91	85.70	82.19	148.90	130.07	180.18	273.07	265.73	211.46		
20 Ashland, Ky.	189.76	259.34	148.56	88.25	151.77	122.73	190.08	196.14	221.06	310.10	308.82	277.54		
40A New Orleans, La. (Export)	345.85	193.59	246.37	307.54	250.73	302.76	313.29	265.41	338.51	441.61	491.08	308.82		
40B Pascagoula, Miss. (Export)	317.44	159.12	241.79	302.44	245.62	294.46	304.99	259.66	333.72	438.42	378.41	312.33		
40C Mobile, Ala. (Export)	302.76	146.35	226.15	274.03	229.34	275.94	292.22	248.81	317.76	424.05	373.30	308.82		
44 Charleston, S. C. (Export)	127.80	132.62	262.86	247.21	267.64	274.03	341.38	313.09	372.66	464.91	458.21	394.68		

TABLE XXII
DISTRIBUTION COSTS FOR TRANSPORTING CORN BY MOTOR TRUCKS,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
Wilson, N. C.		Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La.	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	104.85	0.00	164.22	170.93	228.70	182.42	151.14	100.06	147.94	180.50	239.87	255.19	289.35	300.99	338.51	284.24	214.66	190.08	158.16	
4	210.19	170.93	84.42	0.00	109.00	156.88	187.84	152.73	183.69	141.88	260.62	233.81	227.74	304.03	361.17	304.99	274.67	271.79	269.88	
5	268.92	228.70	120.17	109.00	0.00	187.84	212.42	193.59	232.53	273.71	294.46	260.30	251.04	330.53	393.09	336.91	320.63	320.63	326.70	
7	238.92	182.42	120.81	156.88	187.84	0.00	93.36	125.92	52.82	103.26	152.41	124.00	154.65	194.63	252.64	196.78	188.80	271.79	233.17	
8	216.57	151.14	154.01	187.84	229.98	93.36	0.00	86.98	71.02	106.45	124.00	139.96	178.59	214.66	223.59	168.69	144.74	147.30	192.95	
9	152.73	99.74	135.81	152.73	206.04	125.92	86.98	0.00	84.10	134.22	175.08	195.50	232.85	265.73	283.29	229.02	175.08	169.97	173.16	
10	207.00	147.94	158.16	183.69	232.53	52.82	71.02	96.55	0.00	89.85	145.39	171.24	205.40	241.47	244.02	189.76	138.37	133.90	162.95	
11	232.45	180.50	200.61	227.74	273.71	141.88	106.45	135.18	89.85	0.00	116.66	170.61	214.98	221.68	212.10	161.03	93.68	103.26	157.20	
12	302.76	240.54	226.47	260.62	294.46	152.41	124.96	181.46	145.39	116.66	0.00	113.79	171.56	150.82	144.43	90.17	129.75	163.58	221.04	
13	313.93	255.19	197.10	233.81	260.30	124.00	147.94	197.42	171.24	170.61	113.79	0.00	103.57	116.66	187.52	127.51	194.87	225.51	282.01	
14																				
(Domestic)	345.85	289.35	193.59	227.74	251.04	154.65	181.46	229.66	205.40	214.98	171.56	103.57	0.00	146.67	238.60	178.59	246.58	272.43	322.55	
15	384.15	325.42	267.32	304.03	330.53	194.23	221.04	265.73	241.47	221.68	150.82	116.66	146.67	0.00	148.26	112.51	234.13	268.60	326.06	
16	400.43	337.87	324.78	361.17	393.09	252.64	222.96	283.29	244.02	187.52	144.43	144.43	212.10	148.26	0.00	105.81	202.53	234.45	302.12	
17	346.17	284.24	268.92	304.99	336.91	196.78	172.84	226.15	189.76	161.03	90.17	127.51	178.59	112.51	105.81	0.00	173.48	207.95	265.41	
19	240.51	190.07	246.26	271.80	320.63	193.27	147.30	169.97	133.90	138.37	163.58	225.51	272.43	268.60	234.45	207.95	83.51	0.00	111.87	
20	189.76	158.16	259.34	269.88	326.70	233.17	186.57	181.46	162.95	157.20	221.04	282.01	322.55	326.06	302.12	265.41	148.26	111.87	0.00	
21	129.43	137.09	257.75	264.45	313.61	267.32	216.57	192.63	197.42	224.23	293.18	320.31	352.23	384.15	375.85	326.06	229.34	190.72	142.52	
22	136.45	177.63	296.05	298.92	358.93	314.25	269.24	323.53	250.73	277.22	348.08	376.17	410.33	446.40	407.45	392.45	274.02	238.60	183.37	
23	129.75	185.61	295.09	292.86	352.87	322.23	290.63	245.94	275.30	301.80	372.66	395.00	429.16	465.23	440.97	417.03	307.54	272.11	213.70	
24	88.89	145.07	254.56	252.32	312.33	281.69	251.68	198.38	240.19	267.64	338.51	354.47	388.62	424.69	433.95	382.87	300.84	262.22	196.78	
40A																				
(Export)	345.85	289.35	193.59	227.74	251.04	154.65	181.46	229.66	205.40	205.40	171.56	103.57	0.00	146.67	238.60	178.59	246.58	272.43	322.55	
40B																				
Pascagoula, Miss.																				
(Export)	317.44	259.66	159.12	193.27	214.98	212.45	170.29	199.02	183.06	196.04	163.90	155.92	76.44	171.88	235.08	184.97	241.79	249.77	306.59	
40C																				
Mobile, Ala.																				
(Export)	302.76	244.02	146.35	180.50	203.80	107.40	144.75	122.09	169.01	186.57	161.35	104.85	93.04	175.08	245.94	185.93	226.15	239.55	286.16	
44																				
Charleston, S. C.																				
(Export)	127.80	111.87	132.62	129.75	189.76	179.54	170.29	125.28	172.84	216.89	257.43	257.75	279.45	327.97	356.06	301.80	262.86	241.47	222.32	

TABLE XXIII

ASSEMBLY COSTS FOR TRANSPORTING CORN BY MOTOR TRUCKS, UNITED STATES BY SM-29 MARKET AREAS, 1975

Plant	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
1	Wilson, N. C.	0.00	208.59	211.14	240.71	232.21	275.62	264.45	330.84	320.31	363.40	447.99	449.60	401.71
2	Charlotte, N. C.	104.85	164.22	170.93	190.07	187.20	217.85	221.68	289.03	272.43	320.95	412.56	407.77	353.83
3	Valdosta, Ga.	208.59	0.00	84.42	246.26	267.64	251.36	282.65	330.21	297.01	361.49	467.14	436.50	372.02
4	Jacksonville, Fla.	210.19	84.42	0.00	271.79	293.18	278.50	308.18	357.34	324.14	388.62	494.28	469.06	404.58
5	Tampa, Fla.	268.92	120.17	109.00	320.63	342.02	324.46	357.02	403.30	370.11	434.58	540.24	506.40	441.93
7	Montgomery, Ala.	238.92	120.81	156.88	271.79	225.51	192.63	229.66	271.47	228.62	297.33	403.62	364.36	299.88
8	Guntersville, Ala.	216.57	154.01	187.84	147.30	176.03	148.26	183.69	225.51	187.84	225.51	361.17	328.29	264.13
9	Gainesville, Ga.	152.73	135.81	152.73	169.97	187.52	178.91	206.36	257.75	243.38	289.03	394.68	369.47	308.82
10	Chattanooga, Tenn.	207.00	158.16	183.69	133.90	155.28	311.37	280.73	347.12	355.74	250.73	356.38	331.16	267.64
11	Nashville, Tenn.	232.45	200.61	227.74	103.26	138.37	96.55	139.64	175.39	142.20	206.68	312.33	287.11	223.59
12	Memphis, Tenn.	302.76	226.47	260.62	163.58	198.70	132.94	184.97	189.12	139.64	212.74	315.84	257.75	193.27
13	Jackson, Miss.	313.93	197.10	233.81	225.51	260.62	198.70	250.73	257.11	207.63	280.73	383.83	322.23	257.75
14	New Orleans, La.													
(Domestic)														
15	Shreveport, La.	345.85	193.59	227.74	272.43	307.54	250.73	302.76	313.29	265.41	338.51	441.61	491.08	308.82
16	Springdale, Ark.	284.15	267.32	304.03	268.60	303.71	237.96	289.99	279.45	225.19	298.61	366.59	282.33	223.59
17	Little Rock, Ark.	400.43	324.78	361.17	234.45	261.26	204.76	225.83	203.48	153.69	214.98	265.78	187.20	122.73
18	Henderson, Ky.	346.17	268.92	304.99	207.95	243.06	176.35	225.19	212.74	158.48	231.89	309.14	240.51	176.03
19	Louisville, Ky.	271.79	247.53	274.67	82.51	109.63	49.63	98.15	129.75	96.55	163.26	268.92	247.53	183.06
20	Ashland, Ky.	240.51	246.26	271.80	0.00	80.91	85.70	82.19	148.90	130.07	180.18	273.07	265.73	211.46
40A	New Orleans, La.	189.76	259.34	269.88	111.87	88.25	151.77	122.73	190.08	196.14	221.36	310.10	308.82	277.54
(Export)														
40B	Pascagoula, Miss.	345.85	193.59	227.74	272.43	307.54	250.73	302.76	313.29	265.41	338.51	441.61	491.08	308.82
(Export)														
40C	Mobile, Ala.	317.44	159.12	193.27	249.77	302.44	245.62	294.46	304.99	259.66	333.72	438.42	378.41	312.33
(Export)														
44	Charleston, S. C.	302.76	146.35	180.50	239.55	274.03	229.34	275.94	292.22	248.81	317.76	424.05	373.30	308.82
(Export)														
44	Charleston, S. C.	127.80	132.62	129.75	241.47	247.21	267.64	274.03	341.38	313.29	372.66	464.91	458.21	394.68
(Export)														

TABLE XXV

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	Plant	Origin												
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
		Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.	
1	Wilson, N. C.	0.00	166.15	199.20	187.88	223.72	280.28	400.40	256.00	432.40	486.80	421.20	398.80	
2	Charlotte, N. C.	122.20	146.00	170.64	156.76	166.74	247.80	365.96	193.56	397.96	396.92	386.76	364.36	
3	Valdosta, Ga.	166.16	0.00	157.00	174.44	180.88	276.36	339.64	200.56	398.52	452.92	387.32	364.92	
4	Jacksonville, Fla.	162.52	135.64	215.16	217.28	211.68	293.72	385.84	241.44	417.84	472.24	406.64	384.24	
5	Tampa, Fla.	198.92	135.64	243.16	245.56	239.40	322.00	409.08	264.68	441.08	495.48	429.88	407.48	
7	Montgomery, Ala.	190.80	135.64	140.24	174.44	151.20	174.96	331.80	223.24	353.16	407.56	341.96	319.56	
8	Guntersville, Ala.	161.68	125.40	113.08	132.84	104.28	190.24	292.16	132.64	322.48	382.48	316.88	294.48	
9	Gainesville, Ga.	148.52	129.48	156.08	163.80	143.36	240.52	337.40	173.12	369.40	423.80	358.20	335.80	
10	Chattanooga, Tenn.	161.52	135.68	117.00	110.16	114.64	195.84	269.20	142.16	318.56	372.96	307.36	284.96	
11	Nashville, Tenn.	190.92	152.80	137.60	129.64	129.64	210.84	278.04	133.64	310.04	364.44	298.84	276.44	
12	Memphis, Tenn.	221.72	163.20	134.08	141.24	114.64	201.44	274.80	148.32	314.64	349.44	340.40	261.72	
13	Jackson, Miss.	219.16	163.64	158.60	192.08	148.12	252.84	306.32	160.24	338.32	394.96	329.36	306.40	
14	New Orleans, La. (Domestic)	236.84	150.88	182.24	208.72	178.20	272.56	328.56	184.16	360.56	414.96	349.36	326.96	
15	Shreveport, La.	319.72	261.20	280.96	313.32	276.64	373.80	368.20	226.60	403.00	457.40	305.00	226.60	
16	Springdale, Ark.	399.80	365.92	354.04	339.64	339.64	420.84	351.40	207.00	386.20	407.00	254.60	179.00	

TABLE XXV (continued)

Plant	Origin													
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)		
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.		
17 Little Rock, Ark.	322.52	264.00	239.24	259.84	233.24	320.04	320.60	176.20	355.40	407.00	293.80	215.40		
18 Henderson, Ky.	199.20	157.00	0.00	166.60	107.80	152.60	259.00	133.92	363.24	417.64	352.04	329.64		
19 Louisville, Ky.	191.76	186.16	203.00	116.20	136.96	130.19	239.40	133.92	363.24	417.64	352.04	325.63		
20 Ashland, Ky.	212.76	260.64	200.60	144.20	189.00	172.20	368.76	224.36	400.76	437.80	395.16	372.76		
40A New Orleans, La. (Export)	420.80	224.80	178.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00		
40B Pascagoula, Miss. (Export)	390.00	186.80	178.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00		
40C Mobile, Ala. (Export)	378.80	164.40	178.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00		
44 Charleston, S. C. (Export)	115.64	115.64	233.80	178.52	187.20	227.80	384.60	222.28	416.00	471.00	405.40	383.00		

TABLE XXVI

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Plant																																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)																	
Wilson, N. C.		Charlotte, N. C.		Valdosta, Ga.		Jacksonville, Fla.		Tampa, Fla.		Montgomery, Ala.		Guntersville, Ala.		Gainesville, Ga.		Chattanooga, Tenn.		Nashville, Tenn.		Memphis, Tenn.		Jackson, Miss.		New Orleans, La.		Shreveport, La.		Springdale, Ark.		Little Rock, Ark.		Henderson, Ky.		Louisville, Ky.		Ashland, Ky.
2	122.20	0.00	146.00	143.48	179.59	152.72	118.96	120.64	114.80	114.79	161.84	183.36	161.83	281.92	365.36	287.51	170.64	149.80	156.75																	
4	162.52	143.48	135.64	0.00	135.64	135.64	145.88	142.64	145.60	187.72	194.52	182.96	186.04	289.92	400.24	298.32	215.16	212.52	293.28																	
5	198.92	179.59	135.64	135.64	0.00	157.20	171.08	156.20	173.60	202.16	214.04	191.48	187.84	400.64	593.84	314.64	243.16	240.80	316.40																	
7	190.80	152.72	135.64	135.64	157.20	0.00	113.92	135.64	122.64	122.64	122.64	135.64	120.64	235.64	320.56	221.44	140.24	157.08	239.64																	
8	161.68	146.27	125.40	145.88	171.08	113.92	0.00	120.64	107.64	107.64	107.64	120.63	138.04	231.82	360.08	229.24	113.08	116.60	222.04																	
9	148.52	135.64	129.48	142.64	156.70	135.64	109.76	0.00	122.64	135.64	145.60	143.04	138.04	268.44	386.60	252.20	156.08	146.44	233.80																	
10	161.52	127.35	135.68	145.60	173.60	122.64	122.64	120.64	0.00	120.64	107.64	130.16	152.60	248.56	360.08	229.24	117.00	106.80	216.44																	
11	190.92	156.48	152.80	187.82	200.16	122.64	122.64	120.64	122.64	0.00	122.64	133.52	163.52	232.34	360.08	229.24	137.60	139.72	216.44																	
12	221.72	183.92	163.20	184.52	214.04	122.64	122.64	148.60	122.64	122.64	0.00	120.63	130.00	237.44	279.44	148.60	134.08	120.24	240.24																	
13	219.76	183.36	163.64	182.96	191.48	135.64	122.64	143.04	132.16	156.08	118.44	0.00	135.64	235.44	433.04	229.24	158.60	171.64	276.36																	
14	236.84	198.48	150.88	186.04	187.84	120.64	138.04	158.72	152.60	163.52	116.60	135.64	0.00	212.80	406.00	238.20	182.24	191.36	298.20																	
15	319.72	281.92	261.20	289.92	400.64	235.44	231.82	268.44	248.56	232.34	237.44	235.44	212.80	0.00	439.20	235.40	280.96	292.60	395.92																	
16	399.80	365.36	365.92	400.24	593.84	320.56	360.08	386.60	360.08	360.08	279.44	433.04	406.00	439.20	0.00	243.80	354.04	336.84	379.12																	
17	322.52	284.72	264.00	298.32	314.64	321.44	229.24	252.20	229.24	229.24	145.60	229.24	299.60	235.40	243.90	0.00	239.24	238.84	341.04																	
19	191.76	149.80	186.16	218.52	240.80	148.08	116.60	146.44	106.60	139.72	120.24	171.64	191.36	292.60	336.84	238.84	203.00	0.00	161.00																	
20	212.76	213.04	260.64	293.29	316.40	239.64	222.04	233.80	129.64	143.48	233.23	276.36	298.20	395.92	379.12	339.84	200.60	161.00	0.00																	
21	188.84	216.28	242.04	238.40	259.52	251.40	243.84	209.96	208.32	268.80	268.80	297.04	339.33	365.49	358.69	375.40	279.00	177.64	186.20																	
22	238.84	238.84	268.24	284.60	259.52	287.24	271.31	241.24	256.15	277.86	335.93	358.95	396.94	416.50	384.59	440.92	309.80	279.00	228.20																	
23	206.20	230.84	286.28	313.72	279.52	294.24	288.84	252.22	276.29	298.00	356.07	334.38	402.37	431.93	412.05	436.52	346.20	309.80	259.00																	
24	107.80	115.64	171.08	304.20	208.56	188.40	192.88	155.92	177.52	206.64	237.44	244.96	237.47	398.71	406.30	344.04	245.68	234.48	233.80																	
40A																																				
	420.80	362.00	224.80	261.20	345.20	161.60	228.40	252.00	242.40	172.40	131.80	154.79	0.00	188.40	406.00	187.80	178.40	172.40	348.60																	
40B																																				
40C																																				
44																																				
																										</										

TABLE XXVII

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING WEIGHTED-AVERAGE RAIL RATES, UNITED STATES BY SM-29 MARKET AREAS, 1975

	Plant	Origin													
		(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
		Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
1	Wilson, N. C.	0.00	166.15	162.52	206.75	187.88	223.72	280.28	400.40	256.00	432.40	486.80	421.20	398.80	
2	Charlotte, N. C.	122.20	146.00	143.48	149.80	156.76	166.74	247.80	365.96	193.56	397.96	396.92	386.76	364.36	
3	Valdosta, Ga.	166.16	0.00	135.64	170.80	174.44	180.88	276.36	339.64	200.56	398.52	452.92	387.32	364.92	
4	Jacksonville, Fla.	162.52	135.64	0.00	212.52	217.28	211.68	293.72	385.84	341.44	417.84	472.24	406.64	384.24	
5	Tampa, Fla.	198.92	135.64	135.64	240.80	245.56	239.40	322.00	409.08	264.68	441.08	495.48	429.88	407.48	
7	Montgomery, Ala.	190.80	135.64	135.64	157.08	174.44	151.20	174.96	331.80	223.24	353.16	407.56	341.96	319.56	
8	Guntersville, Ala.	161.68	125.40	145.88	116.60	132.84	104.28	190.24	292.16	132.64	322.48	382.48	316.88	294.48	
9	Gainesville, Ga.	148.52	129.48	142.64	146.44	163.80	143.36	240.52	337.40	173.12	369.40	423.80	358.20	335.80	
10	Chattanooga, Tenn.	161.52	135.68	145.60	106.80	110.16	114.64	195.84	269.20	142.16	318.56	372.96	307.36	284.96	
11	Nashville, Tenn.	190.92	152.80	187.72	139.72	129.64	129.64	210.84	278.04	133.64	310.04	364.44	298.84	276.22	
12	Memphis, Tenn.	221.72	163.20	184.52	120.24	141.24	114.64	201.44	274.80	148.32	314.64	349.44	340.40	261.72	
13	Jackson, Miss.	219.16	163.64	182.96	171.64	192.08	148.12	252.84	306.32	160.24	338.32	394.96	329.36	306.40	
14	New Orleans, La.														
	(Domestic)	236.84	150.88	186.04	191.36	208.72	178.20	272.56	328.56	184.16	360.56	414.96	349.36	326.96	
15	Shreveport, La.	319.72	261.20	289.92	292.60	313.32	276.64	373.80	368.20	226.60	403.00	457.40	305.00	226.60	
16	Springdale, Ark.	399.80	365.92	400.24	336.84	339.64	339.64	420.84	351.40	207.00	386.20	407.00	254.60	179.00	
17	Little Rock, Ark.	322.52	264.00	298.32	238.84	259.84	233.24	320.04	320.60	176.20	355.40	407.00	293.80	215.40	
18	Henderson, Ky.	199.20	157.00	215.16	203.00	166.60	107.80	152.60	259.00	133.92	363.24	417.64	352.04	329.64	
19	Louisville, Ky.	191.76	186.16	218.52	0.00	116.20	136.91	130.19	239.40	133.91	363.23	417.63	352.03	325.63	
20	Ashland, Ky.	212.76	260.64	293.28	161.00	144.20	189.00	172.20	368.76	224.36	400.76	437.80	395.16	372.76	
40A	New Orleans, La.														
	(Export)	420.80	224.80	304.20	172.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00	
40B	Pascagoula, Miss.														
	(Export)	390.00	186.80	261.20	172.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00	
40C	Mobile, Ala.														
	(Export)	378.80	164.40	261.20	172.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00	
44	Charleston, S. C.														
	(Export)	115.64	115.64	115.64	175.72	178.52	187.20	227.80	384.60	222.28	416.60	471.00	405.40	383.00	

TABLE XXVIII

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
Wilson, N. C.																				
Charlotte, N. C.																				
Tampa, Fla.																				
Montgomery, Ala.																				
Guntersville, Ala.																				
Gainesville, Ga.																				
Chattanooga, Tenn.																				
Nashville, Tenn.																				
Memphis, Tenn.																				
Jackson, Miss.																				
New Orleans, La.																				
(Domestic)																				
Shreveport, La.																				
Springdale, Ark.																				
Little Rock, Ark.																				
Henderson, Ky.																				
Ashland, Ky.																				
Harrisonburg, Va.																				
Baltimore, Md.																				
Salisbury, Md.																				
Norfolk, Va.																				
40A New Orleans, La.																				
(Export)																				
40B Pascagoula, Miss.																				
(Export)																				
40C Mobile, Ala.																				
(Export)																				
44 Charleston, S. C.																				
(Export)																				

TABLE XXIX

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING LEAST-COST RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Plant	Origin													
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)		
1 Wilson, N. C.	0.00	156.15	181.92	153.64	183.60	245.76	355.52	203.12	379.52	433.92	368.32	345.92	Wilson, N. C.	Kansas City, Kan./Mo.
2 Charlotte, N. C.	112.20	120.88	145.00	138.52	155.04	217.20	326.96	174.56	350.96	350.36	339.76	317.36		
3 Valdosta, Ga.	166.16	0.00	164.00	163.44	158.96	241.36	327.24	174.84	351.24	405.64	340.04	317.64	Valdosta, Ga.	Omaha, Neb.
4 Jacksonville, Fla.	162.52	112.20	178.56	178.28	173.52	217.56	343.48	191.08	367.48	421.88	356.28	333.88		
5 Tampa, Fla.	198.92	135.64	243.16	245.56	239.40	322.00	409.08	264.68	441.08	495.48	429.88	407.48	Tampa, Fla.	Minneapolis, Minn.
7 Montgomery, Ala.	190.80	112.20	128.44	142.44	123.12	209.36	287.48	135.08	311.48	365.88	300.28	277.88		
8 Guntersville, Ala.	161.68	109.68	106.32	113.32	101.28	187.24	274.04	121.64	298.04	352.44	286.84	264.44	Guntersville, Ala.	Davenport, Iowa
9 Gainesville, Ga.	148.52	106.60	134.04	133.76	129.00	211.04	303.16	150.76	327.16	381.56	315.96	293.56		
10 Chattanooga, Tenn.	139.36	109.40	105.20	98.20	98.20	179.40	266.20	113.80	290.20	344.60	279.00	256.60	Chattanooga, Tenn.	St. Louis, Mo.
11 Nashville, Tenn.	164.56	152.80	112.20	105.20	105.20	186.40	253.60	101.20	277.60	332.00	266.40	244.00		
12 Memphis, Tenn.	189.48	140.76	120.64	123.32	114.64	201.44	263.04	118.64	295.04	349.44	272.84	261.44	Memphis, Tenn.	Peoria, Ill.
13 Jackson, Miss.	219.16	163.64	144.12	192.08	137.12	218.32	291.12	138.72	315.12	369.52	303.92	281.52		
14 New Orleans, La. (Domestic)	236.84	148.88	182.64	202.08	178.20	269.28	328.56	184.16	360.56	414.96	349.36	326.96	New Orleans, La. (Domestic)	Indianapolis, Ind.
15 Shreveport, La.	287.48	256.40	258.92	313.32	276.64	333.12	368.20	226.20	399.00	457.40	305.00	226.60		
16 Springdale, Ark.	363.92	335.64	280.20	339.64	262.00	343.48	351.40	207.00	386.20	407.00	254.60	179.00	Springdale, Ark.	Evansville, Ind.
														Cincinnati, Ohio
														Henderson, Ky.
														Valdosta, Ga.
														Indianapolis, Ind.
														St. Louis, Mo.
														Davenport, Iowa
														Minneapolis, Minn.
														Omaha, Neb.
														Kansas City, Kan./Mo.

TABLE XXIX (continued)

Plant	Origin													
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)		
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.		
17 Little Rock, Ark.	290.28	241.56	239.24	259.84	233.24	320.04	320.60	176.20	355.40	407.00	293.80	215.40		
18 Henderson, Ky.	181.92	164.00	0.00	166.60	107.80	152.60	259.00	101.20	277.60	332.00	266.40	244.00		
19 Louisville, Ky.	164.56	159.80	105.20	116.20	105.19	119.19	239.40	120.47	296.87	351.27	285.67	248.27		
20 Ashland, Ky.	231.48	258.64	200.60	144.20	189.00	172.00	346.28	193.88	270.28	437.80	378.08	336.68		
40A New Orleans, La. (Export)	420.80	224.80	178.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00		
40B Pascagoula, Miss. (Export)	390.00	186.80	178.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00		
40C Mobile, Ala. (Export)	378.80	164.40	178.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00		
44 Charleston, S. C. (Export)	115.64	115.64	233.80	178.52	187.20	227.80	384.60	222.28	416.60	271.00	405.40	383.00		

TABLE XXX

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING LEAST-COST RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La.	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	112.20	0.00	120.88	130.96	157.04	152.72	98.80	107.20	114.79	145.84	161.83	183.36	161.83	256.40	335.36	263.44	145.00	136.00	138.52
4	Jacksonville, Fla.	162.52	130.96	112.20	0.00	122.20	122.00	112.52	142.64	112.24	177.72	144.72	172.96	176.04	263.40	358.88	264.52	178.56	174.36	277.68
5	Tampa, Fla.	198.92	164.83	135.64	122.20	0.00	157.20	171.08	156.20	173.60	202.16	208.04	191.48	187.84	400.64	447.48	314.64	243.16	240.80	316.40
7	Montgomery, Ala.	190.80	152.72	112.20	122.00	157.20	0.00	93.20	112.20	93.20	106.64	93.20	135.64	120.64	235.44	297.88	208.00	128.44	130.16	239.64
8	Guntersville, Ala.	161.68	121.15	109.68	112.52	169.08	105.20	0.00	107.20	86.20	86.20	86.20	120.63	138.04	210.02	325.64	215.80	106.32	106.04	222.04
9	Gainesville, Ga.	148.52	112.20	106.60	142.64	156.20	112.20	93.20	0.00	93.20	112.20	112.24	143.04	158.72	251.02	405.68	234.84	134.04	129.84	231.56
10	Chattanooga, Tenn.	139.36	110.79	109.40	112.24	171.60	93.20	109.20	107.20	0.00	109.20	86.20	130.16	152.60	231.55	365.64	215.80	105.20	98.20	203.00
11	Nashville, Tenn.	164.56	136.00	152.80	177.72	200.16	106.64	93.20	107.20	93.20	0.00	93.20	133.52	163.52	215.66	372.64	215.80	112.20	105.20	211.40
12	Memphis, Tenn.	189.48	157.84	140.76	144.72	206.04	93.20	109.20	126.24	109.20	109.20	0.00	120.63	130.00	224.00	279.44	148.60	120.64	120.24	225.40
13	Jackson, Miss.	219.16	181.36	163.64	172.96	191.48	135.64	122.64	143.04	132.16	156.08	93.20	0.00	122.64	235.44	360.07	215.80	144.12	137.12	260.12
14	New Orleans, La.																			
(Domestic)		236.14	196.48	148.88	176.04	187.84	120.64	138.04	158.72	152.60	163.52	116.20	135.64	0.00	210.80	406.00	238.20	182.64	188.08	298.20
15	Shreveport, La.	287.48	256.40	256.40	263.40	303.05	235.44	210.02	251.02	231.55	215.60	224.00	235.44	212.80	0.00	156.71	235.40	258.92	251.92	382.48
16	Springdale, Ark.	363.92	335.36	335.64	358.88	447.48	297.88	325.64	405.68	365.64	372.64	279.44	360.07	406.00	156.71	0.00	243.80	280.20	262.28	365.68
17	Little Rock, Ark.	290.28	258.64	241.56	264.52	314.64	208.00	215.80	234.84	215.80	215.80	145.60	215.80	299.60	235.40	243.80	0.00	239.24	238.84	326.20
19	Louisville, Ky.	164.56	136.00	159.80	181.36	240.80	130.16	106.04	129.84	98.20	105.20	120.24	137.12	188.08	251.92	262.28	238.84	105.20	0.00	161.00
20	Ashland, Ky.	231.48	213.04	258.64	277.68	316.40	239.64	222.04	231.56	129.64	143.48	226.51	260.12	298.20	382.48	365.68	325.00	200.60	161.00	0.00
21	Harrisonburg, Va.	165.40	179.40	210.96	228.40	259.52	251.40	209.96	141.68	164.60	231.00	231.00	297.04	320.49	346.42	299.47	337.60	260.80	177.64	186.20
22	Baltimore, Md.	238.84	230.68	250.32	259.48	259.52	287.24	253.85	224.37	238.98	260.26	317.16	339.71	367.13	396.10	352.78	418.80	309.80	279.00	228.20
23	Salisbury, Md.	206.20	207.68	286.28	256.96	271.36	283.60	271.02	235.14	258.72	279.99	336.89	354.83	382.76	411.22	372.08	451.28	346.20	309.80	259.00
24	Norfolk, Va.	107.80	107.48	171.08	161.76	208.56	188.40	192.88	155.92	177.52	237.44	237.44	244.96	349.71	378.67	345.09	344.04	234.76	243.48	233.80
40A	New Orleans, La.																			
(Export)		420.80	362.00	224.80	304.20	305.20	161.60	208.40	292.00	242.40	172.40	131.80	154.79	0.00	188.40	181.06	187.80	178.40	172.40	348.60
40B	Pascagoula, Miss.																			
(Export)		390.00	334.00	186.80	261.20	317.20	161.60	171.40	264.00	242.40	131.80	131.80	154.79	39.00	286.40	186.19	187.80	178.40	172.40	328.60
40C	Mobile, Ala.																			
(Export)		378.80	322.80	164.40	261.20	306.00	161.60	171.40	210.00	242.40	131.80	131.80	154.79	39.00	286.40	186.19	187.80	178.40	172.40	328.60
44	Charleston, S. C.																			
(Export)		115.64	115.64	115.64	115.64	135.48	131.88	195.32	120.64	121.12	220.80	170.43	244.62	262.05	301.01	279.99	302.04	233.80	175.72	282.12

TABLE XXXII

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING THE GAINESVILLE RAIL RATE,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La. (Domestic)	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	112.20	0.00	120.88	130.96	157.04	152.72	98.80	107.20	114.79	145.84	161.83	183.36	161.83	256.40	335.36	263.44	145.00	136.00	138.52
5	Tampa, Fla.	198.92	164.83	135.64	122.20	0.00	157.20	171.08	156.20	173.60	202.16	208.04	191.48	187.84	400.64	447.48	314.64	243.16	240.80	316.40
7	Montgomery, Ala.	190.80	152.72	112.20	122.00	157.20	0.00	93.20	112.20	93.20	106.64	93.20	135.64	120.64	235.44	297.88	208.00	128.44	130.16	239.64
8	Guntersville, Ala.	161.68	121.15	109.68	112.52	169.08	105.20	0.00	107.20	86.20	86.20	86.20	120.63	138.04	210.02	325.64	215.80	106.32	106.04	222.04
9	Gainesville, Ga.	148.52	112.20	106.60	142.64	156.20	112.20	93.20	0.00	93.20	112.20	112.24	143.20	158.20	251.02	405.68	234.84	134.04	129.84	231.56
10	Chattanooga, Tenn.	139.36	110.79	109.40	112.24	171.60	93.20	109.20	107.20	0.00	109.20	86.20	130.16	152.60	231.55	365.64	215.80	105.20	98.20	203.00
11	Nashville, Tenn.	164.56	136.00	152.80	177.72	200.16	106.64	93.20	107.20	0.00	93.20	133.52	163.52	215.66	372.64	215.80	112.20	105.20	211.40	
12	Memphis, Tenn.	189.48	157.84	140.76	144.72	206.04	93.20	109.20	126.24	109.20	109.20	0.00	120.63	130.00	224.00	279.44	148.60	120.64	120.64	225.40
13	Jackson, Miss.	219.16	181.36	163.64	172.96	191.48	135.64	122.64	143.04	132.16	156.08	93.20	0.00	122.64	235.44	360.07	215.80	144.12	137.12	260.12
14	New Orleans, La. (Export)	236.14	196.48	148.88	176.04	187.84	120.84	138.04	158.72	152.60	163.52	116.20	135.64	0.00	210.80	406.00	238.20	182.64	188.08	298.20
15	Shreveport, La.	287.48	256.40	256.40	263.40	303.05	235.44	210.02	251.02	231.55	215.66	224.00	235.44	212.80	0.00	156.71	235.40	258.92	251.92	382.48
16	Springdale, Ark.	363.92	335.36	335.36	358.88	447.48	297.88	325.64	405.68	365.64	372.64	279.44	360.07	406.00	156.71	0.00	243.80	280.20	262.28	365.68
17	Little Rock, Ark.	290.28	258.64	241.56	264.52	314.64	208.00	215.80	234.84	215.80	215.80	145.60	215.80	299.60	235.40	243.80	0.00	239.24	238.84	326.20
18	Henderson, Ky.	181.92	153.36	164.00	178.56	228.16	128.44	108.32	129.04	107.20	107.20	120.64	139.12	182.64	258.92	280.20	229.24	0.00	105.20	194.60
20	Ashland, Ky.	231.48	213.04	258.64	277.68	316.40	239.64	222.04	231.56	129.64	143.48	226.51	260.12	298.20	382.48	365.48	325.00	200.60	161.00	0.00
21	Harrisonburg, Va.	165.40	179.40	210.96	228.40	259.52	251.40	209.96	141.68	164.60	231.00	297.04	320.49	346.12	299.47	337.60	260.80	177.64	186.20	
22	Baltimore, Md.	238.84	230.68	250.32	259.48	259.52	287.24	253.85	224.37	238.98	260.26	317.16	339.71	367.13	396.10	352.78	418.80	309.80	279.00	228.20
23	Salisbury, Md.	206.20	207.68	286.28	256.96	271.36	283.60	271.02	235.14	258.72	279.99	336.89	354.83	382.26	411.22	372.08	451.28	346.20	309.80	259.00
24	Norfolk, Va.	107.80	107.48	171.08	161.76	208.56	188.40	192.88	155.92	177.52	237.44	237.44	244.86	349.71	378.67	345.09	344.04	234.76	243.48	233.80
40A	New Orleans, La. (Export)	420.80	362.00	224.80	304.20	305.20	161.60	208.40	292.00	242.40	172.40	131.80	154.79	0.00	188.40	181.06	187.80	178.40	172.40	348.60
40B	Pascagoula, Miss. (Export)	390.00	334.00	186.80	261.20	317.20	161.60	171.40	264.00	242.40	131.80	131.80	154.79	39.00	286.40	186.19	187.80	178.40	172.40	328.60
40C	Mobile, Ala. (Export)	378.80	322.80	164.40	261.20	306.00	161.60	171.40	210.00	242.40	131.80	131.80	154.79	39.00	286.40	186.19	187.80	178.40	172.40	328.60
44	Charleston, S. C. (Export)	115.64	115.64	115.64	115.64	135.48	131.88	195.32	120.64	121.12	220.80	170.43	244.62	262.05	301.01	279.99	302.04	233.80	175.72	282.12

TABLE XXXIII

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING THE RENT-A-TRAIN RAIL RATE,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Plant	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
Surplus amount	21,037	15,600	583	36,307	32,407	152,991	63,049	423,088	327,036	18,520	175,138	90,289	99,072	
1 Wilson, N. C.	0.00	156.15	162.52	171.56	153.64	183.60	245.76	355.52	203.12	379.52	433.92	368.32	345.92	
2 Charlotte, N. C.	112.20	120.88	130.96	136.00	98.31	108.22	145.52	211.38	118.34	244.18	224.82	217.46	204.02	
3 Valdosta, Ga.	116.16	0.00	122.20	159.80	163.44	158.96	241.36	327.24	174.84	351.24	405.64	340.04	317.64	
4 Jacksonville, Fla.	162.52	112.20	0.00	174.36	178.28	173.52	217.56	343.48	191.08	367.48	421.88	356.28	333.88	
5 Tampa, Fla.	198.92	135.64	122.20	240.80	245.56	239.40	322.00	409.08	264.68	441.08	495.48	429.88	407.48	
7 Montgomery, Ala.	190.80	112.20	132.00	128.16	142.44	123.12	209.36	287.48	135.08	311.48	365.88	300.28	277.88	
8 Guntersville, Ala.	161.68	109.68	112.52	106.04	80.39	73.17	124.74	176.82	83.78	189.62	223.86	182.90	169.46	
9 Gainesville, Ga.	148.52	106.60	142.64	129.84	95.46	92.60	141.82	197.10	104.06	209.90	244.14	203.18	189.74	
10 Chattanooga, Tenn.	139.36	109.40	112.24	98.20	98.20	98.20	179.40	266.20	113.80	290.20	344.60	279.00	256.60	
11 Nashville, Tenn.	164.56	152.80	177.42	105.20	105.20	105.20	186.40	253.60	101.20	277.60	332.00	266.40	244.00	
12 Memphis, Tenn.	189.48	140.76	144.72	120.24	123.32	114.64	201.44	263.04	118.64	295.04	349.44	272.84	261.44	
13 Jackson, Miss.	219.36	163.64	172.96	137.12	134.85	97.47	146.19	189.87	96.83	202.67	236.91	195.95	182.51	
14 New Orleans, La.														
(Domestic)	236.84	148.88	176.04	188.08	202.08	178.20	269.28	328.56	184.16	360.56	414.96	349.36	326.96	
15 Shreveport, La.	287.48	256.40	263.40	251.92	313.32	276.64	333.12	368.20	226.20	399.00	457.40	305.00	226.60	
16 Springdale, Ark.	363.92	335.64	358.88	262.28	223.38	172.40	221.29	230.44	145.40	252.92	207.00	173.96	128.60	
17 Little Rock, Ark.	290.28	241.56	264.52	238.84	259.84	233.24	320.04	320.60	176.20	355.40	407.00	293.80	215.40	
18 Henderson, Ky.	181.92	164.00	178.56	105.20	166.60	107.80	152.60	259.00	101.20	277.60	332.00	266.40	244.00	
19 Louisville, Ky.	164.56	159.80	181.36	0.00	116.20	105.19	119.19	239.40	120.47	296.87	351.27	285.67	248.27	
20 Ashland, Ky.	231.48	258.64	277.68	161.00	144.20	189.00	172.00	346.28	193.88	270.28	437.80	378.08	336.68	
40A New Orleans, La.														
(Export)	420.80	224.80	304.20	172.40	113.04	113.04	161.76	134.88	117.04	192.64	257.12	148.96	137.20	
40B Pascagoula, Miss.														
(Export)	390.00	186.80	261.20	172.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00	
40C Mobile, Ala.														
(Export)	378.80	164.40	261.20	172.40	172.40	172.40	253.60	208.80	176.40	302.40	407.20	229.60	210.00	
44 Charleston, S. C.														
(Export)	115.64	115.64	115.64	175.72	178.52	187.20	227.80	384.60	222.28	416.60	471.00	405.40	383.00	

TABLE XXXIV

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING THE RENT-A-TRAIN RAIL RATE,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																				(20)	(40A)	(40B)	(40C)	(44)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Deficit Amount	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La. (Domestic)	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
2	Charlotte, N. C.	49,583	112.20	0.00	120.88	130.96	157.04	152.72	98.80	107.20	114.79	145.84	161.83	183.36	161.83	256.40	335.36	263.44	145.00	136.00	138.52	999.99																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									

TABLE XXXV

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	Plant	Origin												
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
		Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.	
1	Wilson, N. C.	0.00	172.14	199.20	428.00	401.40	592.60	426.40	409.30	446.50	472.30	524.60	478.20	
2	Charlotte, N. C.	122.20	146.00	208.19	234.80	208.20	399.40	233.20	216.10	253.30	279.10	331.40	285.00	
3	Valdosta, Ga.	172.14	0.00	208.26	234.60	218.26	409.46	233.16	216.06	253.36	279.06	331.46	284.96	
4	Jacksonville, Fla.	195.90	135.64	249.68	255.58	228.98	420.18	264.28	236.78	274.08	294.78	352.18	305.68	
5	Tampa, Fla.	198.92	135.64	203.30	224.90	203.30	394.50	109.70	169.60	183.20	216.10	261.30	214.80	
7	Montgomery, Ala.	190.80	135.64	205.74	232.34	205.74	396.94	230.64	213.54	250.84	276.54	328.94	282.44	
8	Guntersville, Ala.	161.48	125.40	83.10	109.70	83.10	274.30	108.00	90.90	128.20	153.90	206.30	160.80	
9	Gainesville, Ga.	148.52	129.48	192.86	219.46	192.86	384.06	217.76	200.66	237.73	247.66	301.66	254.56	
10	Chattanooga, Tenn.	161.52	135.68	93.40	120.00	93.40	284.60	118.40	101.30	138.50	164.30	216.60	170.20	
11	Nashville, Tenn.	190.92	152.80	90.10	109.70	90.10	281.30	108.00	90.90	128.20	153.90	163.90	118.90	
12	Memphis, Tenn.	284.12	258.38	68.20	87.80	69.20	260.40	87.30	68.20	98.50	128.20	171.80	125.40	
13	Jackson, Miss.	219.16	163.64	215.84	237.44	215.84	407.04	232.34	215.84	249.44	278.24	319.44	272.94	
14	New Orleans, La. (Domestic)	322.16	318.48	98.30	117.90	98.30	289.50	115.40	98.30	135.50	161.30	203.00	156.50	
15	Shreveport, La.	481.22	455.38	330.64	352.24	330.64	521.84	347.14	330.64	364.24	393.04	434.24	387.74	
16	Springdale, Ark.	402.04	537.72	347.64	368.24	377.64	538.84	366.74	347.64	377.94	407.64	254.60	179.00	

TABLE XXXV (continued)

Plant	Origin													
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)		
17 Little Rock, Ark.	429.82	403.88	213.80	334.40	213.80	405.00	232.90	213.80	344.10	273.80	303.40	271.00		
18 Henderson, Ky.	199.20	208.26	0.00	84.00	59.84	251.04	101.55	76.90	109.40	136.95	149.00	116.50		
19 Louisville, Ky.	231.48	228.96	203.00	66.74	67.70	248.40	120.30	88.60	125.00	152.20	159.00	126.50		
20 Ashland, Ky.	231.48	258.64	57.60	46.60	57.04	248.24	146.60	115.80	151.10	176.80	203.20	156.70		
40A New Orleans, La. (Export)	420.80	224.80	98.30	117.70	98.30	289.50	115.40	98.30	135.50	147.30	203.00	156.50		
40B Pascagoula, Miss. (Export)	390.00	186.80	110.60	130.20	110.60	301.80	127.70	110.60	147.80	159.60	215.30	168.80		
40C Mobile, Ala. (Export)	378.80	164.40	110.60	130.20	110.60	301.80	127.70	110.60	147.80	159.60	215.30	168.80		
44 Charleston, S. C. (Export)	115.64	115.64	214.52	241.12	214.52	305.72	239.52	222.42	259.62	285.42	323.72	291.32		

Wilson, N. C.
Valdosta, Ga.
Henderson, Ky.
Cincinnati, Ohio
Evansville, Ind.
Indianapolis, Ind.
Peoria, Ill.
St. Louis, Mo.
Davenport, Iowa
Minneapolis, Minn.
Omaha, Neb.
Kansas City, Kan./Mo.

TABLE XXXVI

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
Wilson, N. C.																				
Charlotte, N. C.																				
Jacksonville, Fla.																				
Tampa, Fla.																				
Montgomery, Ala.																				
Guntersville, Ala.																				
Gainesville, Ga.																				
Chattanooga, Tenn.																				
Nashville, Tenn.																				
Memphis, Tenn.																				
Jackson, Miss.																				
New Orleans, La.																				
(Domestic)																				
Shreveport, La.																				
Springdale, Ark.																				
Little Rock, Ark.																				
Louisville, Ky.																				
Ashland, Ky.																				
Harrisonburg, Va.																				
Baltimore, Md.																				
Salisbury, Md.																				
Norfolk, Va.																				
New Orleans, La.																				
(Export)																				
Pascagoula, Miss.																				
(Export)																				
Mobile, Ala.																				
(Export)																				
Charleston, S. C.																				
(Export)																				

TABLE XXXVII

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Plant	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
1	Wilson, N. C.	0.00	172.14	195.90	422.20	428.00	401.40	592.60	426.40	409.30	446.50	472.30	524.60	478.20
2	Charlotte, N. C.	122.20	146.06	143.48	229.00	234.80	208.20	399.40	233.20	216.10	253.30	279.10	331.40	285.00
3	Valdosta, Ga.	172.14	0.00	135.64	228.96	234.60	218.26	409.46	233.16	216.06	253.36	279.06	331.46	284.96
4	Jacksonville, Fla.	195.90	135.64	0.00	249.68	255.58	228.98	420.18	264.28	236.78	274.08	294.78	352.18	305.68
5	Tampa, Fla.	198.92	135.64	135.64	215.40	224.90	203.30	394.50	109.70	169.60	183.20	216.10	261.30	214.80
7	Montgomery, Ala.	190.80	135.64	135.64	226.44	232.34	205.74	396.94	230.64	213.54	250.84	276.54	328.94	282.44
8	Guntersville, Ala.	161.48	125.40	145.88	103.80	109.70	83.10	274.30	108.00	90.90	128.20	153.90	206.30	160.80
9	Gainesville, Ga.	148.52	129.48	142.64	213.56	219.46	192.86	384.06	217.76	200.66	237.73	247.66	301.66	254.56
10	Chattanooga, Tenn.	161.52	135.68	145.60	114.20	120.00	93.40	284.60	118.40	101.30	138.50	164.30	216.60	170.20
11	Nashville, Tenn.	190.92	152.80	187.72	105.20	109.70	90.10	281.30	108.00	90.90	128.20	153.90	163.90	118.90
12	Memphis, Tenn.	284.12	258.38	256.68	83.40	87.80	69.20	260.40	87.30	68.20	98.50	128.20	171.80	125.40
13	Jackson, Miss.	219.16	163.64	182.96	217.94	237.44	215.84	407.04	232.34	215.84	249.44	278.24	319.44	272.94
14	New Orleans, La.													
	(Domestic)	322.16	318.48	228.98	108.40	117.90	98.30	289.50	115.40	98.30	135.50	161.30	203.00	156.50
15	Shreveport, La.	481.22	455.38	263.40	342.74	352.24	330.64	521.84	347.14	330.64	364.24	393.04	434.24	387.74
16	Springdale, Ark.	402.04	537.72	514.32	362.84	368.24	347.64	538.84	366.74	347.64	377.94	407.64	454.60	179.00
17	Little Rock, Ark.	361.30	335.56	380.48	160.58	164.98	146.38	337.58	164.48	145.38	175.68	205.38	248.98	202.58
18	Henderson, Ky.	199.20	208.26	249.68	203.00	84.00	59.84	251.04	101.55	76.90	109.40	136.95	149.00	116.50
19	Louisville, Ky.	231.48	228.96	294.28	0.00	66.74	67.70	248.10	120.30	88.60	125.00	152.20	159.00	126.50
20	Ashland, Ky.	231.48	258.64	277.68	55.00	46.60	57.04	248.24	146.60	115.80	151.10	176.80	203.20	156.70
40A	New Orleans, La.													
	(Export)	420.80	224.80	304.20	108.40	117.70	98.30	289.50	115.40	98.30	135.50	147.30	203.20	156.50
40B	Pascagoula, Miss.													
	(Export)	390.00	186.80	261.20	120.70	130.20	110.60	301.80	127.70	110.60	147.80	159.60	215.30	168.80
40C	Mobile, Ala.													
	(Export)	317.55	154.40	261.20	110.70	115.20	100.60	285.80	117.70	100.60	137.80	140.60	195.30	153.80
44	Charleston, S. C.													
	(Export)	115.64	115.64	115.64	235.32	241.12	214.52	305.72	239.52	222.42	259.62	285.42	323.72	291.32

TABLE XXXVIII

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND WEIGHTED-AVERAGE RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La.	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	122.20	0.00	146.06	143.48	179.59	152.72	118.96	120.64	114.80	114.79	237.40	391.05	310.15	447.05	529.39	314.58	208.19	229.00	156.76
5	Tampa, Fla.	198.92	179.59	135.64	135.64	0.00	157.20	171.08	156.20	173.60	202.16	169.60	191.48	79.00	307.90	473.34	315.20	203.30	215.40	316.40
7	Montgomery, Ala.	190.80	152.72	135.64	135.64	157.20	0.00	113.92	135.64	122.64	122.64	233.44	135.64	120.64	235.44	320.56	221.44	205.74	226.44	161.00
8	Guntersville, Ala.	161.48	146.27	125.40	145.88	171.08	113.92	0.00	109.76	107.64	107.64	110.80	122.64	171.00	307.90	390.24	256.40	83.10	103.80	224.04
9	Gainesville, Ga.	148.52	135.64	129.48	142.64	156.70	135.64	109.76	0.00	122.64	135.64	220.56	143.04	305.44	442.34	524.68	390.84	192.80	213.56	210.28
10	Chattanooga, Tenn.	161.52	127.35	135.68	145.60	173.60	122.64	122.64	0.00	120.64	81.20	263.70	182.80	319.70	402.04	268.20	93.40	114.20	129.64	
11	Nashville, Tenn.	190.92	114.79	152.80	187.72	200.16	122.64	122.64	120.64	0.00	91.20	156.08	151.40	394.94	370.64	168.38	90.10	105.20	143.48	
12	Memphis, Tenn.	284.12	237.40	258.38	256.68	91.20	233.44	110.80	220.56	122.60	91.20	0.00	188.94	81.20	303.74	279.44	77.18	68.20	83.40	82.80
13	Jackson, Miss.	219.16	391.05	163.64	182.96	191.48	135.64	122.64	143.04	263.70	156.08	188.94	0.00	221.64	235.44	408.38	334.54	215.84	217.94	190.84
14	New Orleans, La.																			
(Domestic)		322.16	310.15	318.48	228.98	79.00	120.64	171.00	305.44	182.80	151.40	81.20	221.64	0.00	193.70	360.64	262.60	98.30	108.40	82.24
15	Shreveport, La.	482.12	447.05	455.38	398.68	272.70	235.44	307.90	442.34	319.70	394.94	303.74	235.44	193.70	0.00	583.31	449.34	330.64	342.74	198.49
16	Springdale, Ark.	402.04	529.39	537.72	514.32	575.64	320.56	390.24	524.68	402.04	370.64	279.44	468.38	360.84	583.31	0.00	235.40	347.64	362.84	362.24
17	Little Rock, Ark.	361.30	314.58	335.56	380.48	441.80	271.44	256.40	297.74	199.78	168.38	77.18	266.12	262.00	449.34	235.40	0.00	145.38	160.58	159.98
18	Henderson, Ky.	199.20	220.75	208.26	249.68	203.30	205.74	83.10	215.84	93.40	90.10	77.50	215.84	98.30	330.64	347.64	154.68	0.00	203.00	57.60
20	Ashland, Ky.	231.48	213.04	258.64	272.68	316.40	161.00	222.04	210.28	129.64	143.48	82.80	190.84	82.24	198.49	362.24	159.98	57.60	55.00	0.00
21	Harrisonburg, Va.	188.84	216.28	242.04	238.40	259.52	251.40	152.80	171.80	164.60	231.00	231.00	297.04	339.33	365.49	358.69	308.18	279.00	177.64	186.20
22	Baltimore, Md.	238.84	238.84	268.24	114.00	249.64	287.24	271.31	241.24	256.15	277.86	335.93	358.95	386.94	416.50	384.59	413.11	309.80	279.00	228.20
23	Salisbury, Md.	230.84	230.84	286.28	124.00	259.64	294.24	288.84	252.22	276.29	298.00	356.07	374.38	402.37	431.93	412.05	433.25	346.20	309.80	259.00
24	Norfolk, Va.	115.64	115.64	171.08	69.00	204.64	188.40	192.88	155.92	177.52	206.64	237.44	244.96	237.47	398.71	406.30	314.62	245.68	234.48	233.80
40A	New Orleans, La.																			
(Export)		420.80	310.60	224.80	228.98	90.00	161.60	171.00	305.44	182.80	151.40	81.20	137.70	0.00	193.70	360.64	226.80	98.30	108.40	82.24
40B	Pascagoula, Miss.																			
(Export)		390.00	280.00	186.80	213.98	80.00	161.60	183.30	320.00	295.80	166.40	93.50	149.70	39.00	208.70	372.64	238.80	110.60	120.70	97.24
40C	Mobile, Ala.																			
(Export)		317.55	280.00	154.40	213.98	80.00	151.60	173.30	278.67	276.03	146.00	93.50	149.70	39.00	208.70	352.64	214.01	110.60	120.70	97.24
44	Charleston, S. C.																			
(Export)		115.64	115.64	115.64	115.64	135.48	131.88	195.32	120.64	121.12	121.12	202.32	384.82	342.52	440.82	449.87	279.50	214.52	235.32	282.12

TABLE XXXIX

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND LEAST-COST RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	Origin	Plant												
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.													
1	Wilson, N. C.	0.00	158.70	181.92	428.00	401.40	592.60	426.40	409.30	446.50	472.50	524.60	478.20	
2	Charlotte, N. C.	112.20	120.88	192.20	218.80	192.20	383.40	217.20	200.10	237.30	263.10	315.40	269.00	
3	Valdosta, Ga.	158.70	0.00	180.78	234.86	218.26	409.46	233.16	216.06	253.36	279.06	331.46	284.96	
4	Jacksonville, Fla.	193.10	122.20	195.67	255.58	228.98	420.18	264.28	236.78	274.08	294.78	352.18	305.68	
5	Tampa, Fla.	198.92	135.64	203.30	224.90	203.30	394.50	109.70	169.60	183.20	216.10	261.30	214.80	
7	Montgomery, Ala.	190.80	112.20	176.30	232.34	205.74	396.94	230.64	213.54	250.84	276.54	328.94	282.44	
8	Guntersville, Ala.	161.68	109.80	83.10	109.70	83.10	274.30	108.00	90.90	128.20	153.90	206.30	160.80	
9	Gainesville, Ga.	148.52	106.60	176.30	202.90	176.30	367.50	201.20	184.10	221.40	247.10	299.50	253.00	
10	Chattanooga, Tenn.	139.36	109.40	93.40	120.00	93.40	284.60	118.40	101.30	138.50	164.30	216.30	170.20	
11	Nashville, Tenn.	190.92	152.80	90.10	109.70	90.10	281.30	108.00	90.90	128.20	153.90	163.90	118.90	
12	Memphis, Tenn.	261.96	232.00	68.20	87.80	69.20	260.40	87.30	68.20	98.50	128.20	171.80	125.40	
13	Jackson, Miss.	219.16	163.64	215.84	237.44	215.84	407.04	232.34	215.84	249.44	278.24	319.44	272.94	
14	New Orleans, La.													
	(Domestic)	322.16	292.20	98.30	117.90	98.30	289.50	115.40	98.30	135.50	161.30	203.00	156.50	
15	Shreveport, La.	459.06	429.10	330.64	352.24	330.64	521.20	347.14	330.64	364.24	393.04	434.24	387.74	
16	Springdale, Ark.	379.72	537.72	348.25	368.24	347.64	538.84	366.74	347.64	377.94	407.64	254.60	179.00	
17	Little Rock, Ark.	429.60	377.60	213.80	233.40	213.80	405.00	232.90	213.00	344.10	273.80	303.40	271.00	

TABLE XXXIX (continued)

Origin	Plant												Mo.
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./	
18 Henderson, Ky.	181.92	180.78	0.00	84.00	59.84	251.04	101.55	76.90	109.40	136.95	149.00	116.50	
19 Louisville, Ky.	231.48	223.60	203.00	66.74	67.70	248.40	120.30	76.90	125.00	152.20	159.00	126.50	
20 Ashland, Ky.	212.76	258.64	57.60	46.60	57.04	248.24	146.60	115.80	151.10	176.80	203.20	156.70	
40A New Orleans, La. (Export)	420.80	224.80	98.30	117.70	98.30	289.50	115.40	98.30	135.50	147.50	203.00	156.50	
40B Pascagoula, Miss. (Export)	390.00	186.80	110.50	130.20	110.60	301.80	127.70	110.60	147.80	159.60	215.30	168.80	
40C Mobile, Ala. (Export)	378.80	164.40	110.60	130.20	110.60	301.80	127.70	110.60	147.80	159.60	215.30	168.80	
44 Charleston, S. C. (Export)	115.64	115.64	214.52	241.12	214.52	405.72	239.52	222.42	259.62	285.42	323.72	291.32	

TABLE XL

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND LEAST-COST RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
2 Charlotte, N. C.	112.20	0.00	120.88	130.96	157.04	152.72	118.96	107.20	114.79	185.84	221.40	183.36	161.83	389.09	512.83	378.99	192.20	213.00	138.52	
4 Jacksonville, Fla.	193.10	130.96	122.20	0.00	122.20	122.00	112.52	142.64	112.64	177.72	232.32	172.96	176.04	263.40	358.88	264.52	195.62	294.28	277.68	
5 Tampa, Fla.	198.92	164.83	135.64	122.20	0.00	157.20	157.20	156.20	173.60	202.16	169.60	191.48	79.00	272.70	418.64	315.20	203.30	215.40	316.40	
7 Montgomery, Ala.	190.80	152.72	112.20	132.00	157.20	0.00	93.20	112.20	93.20	106.64	204.00	135.64	165.64	235.44	297.88	208.00	176.30	226.44	176.30	
8 Guntersville, Ala.	161.68	121.15	109.08	112.52	169.08	93.20	0.00	107.20	86.20	86.20	110.80	120.63	171.00	308.90	524.68	252.90	83.10	103.80	222.04	
9 Gainesville, Ga.	148.52	112.20	106.60	142.64	156.20	112.20	135.64	0.00	93.20	112.20	204.00	418.74	290.00	412.90	509.24	375.40	176.30	197.00	210.28	
10 Chattanooga, Tenn.	139.36	110.79	109.40	112.24	171.60	93.20	122.64	107.20	0.00	109.20	122.60	311.54	182.80	319.70	268.60	268.20	93.40	114.20	129.64	
11 Nashville, Tenn.	190.92	136.00	152.80	177.72	200.16	106.64	122.64	107.20	93.20	0.00	91.20	133.50	152.40	264.30	370.64	236.80	90.10	105.20	143.48	
12 Memphis, Tenn.	261.96	191.99	232.00	232.32	169.60	204.80	110.80	229.80	122.60	99.20	0.00	188.94	81.20	221.10	279.44	148.60	68.20	83.40	82.80	
13 Jackson, Miss.	219.16	354.49	163.64	172.96	191.48	135.64	122.64	418.74	311.54	133.50	188.94	0.00	137.70	235.44	345.74	211.90	215.84	217.94	190.84	
14 New Orleans, La.																				
(Domestic)	322.16	293.59	292.20	176.04	79.00	165.64	171.00	290.00	182.80	152.40	81.20	137.70	0.00	193.70	360.64	262.00	98.30	108.40	82.24	
15 Shreveport, La.	459.06	389.09	429.10	263.40	272.70	235.44	308.90	412.90	319.70	264.30	303.74	235.44	193.70	0.00	500.54	366.70	330.64	342.74	246.84	
16 Springdale, Ark.	379.72	512.83	537.72	358.88	418.64	297.88	524.68	509.24	268.60	370.64	279.44	345.74	360.64	500.54	0.00	243.80	348.25	362.84	362.24	
17 Little Rock, Ark.	429.60	378.99	377.60	264.52	315.20	208.00	252.90	375.40	268.20	236.80	145.60	211.90	262.00	366.70	243.80	0.00	213.80	229.00	227.84	
19 Louisville, Ky.	231.48	213.00	223.60	294.28	215.40	148.08	103.80	197.00	114.20	105.20	83.40	217.94	108.40	342.74	362.84	229.00	203.00	0.00	55.00	
20 Ashland, Ky.	231.48	213.04	258.64	277.68	316.40	176.30	222.04	236.84	129.64	143.48	82.80	192.00	82.84	248.00	362.24	227.84	57.60	55.00	0.00	
21 Harrisonburg, Va.	165.40	179.40	210.96	228.40	259.52	251.40	152.80	171.80	164.60	231.00	231.00	297.04	346.72	346.12	299.47	337.60	260.80	177.64	186.20	
22 Baltimore, Md.	238.84	230.68	250.32	259.48	259.52	287.24	253.85	224.37	238.98	260.26	317.16	339.71	396.10	396.10	352.78	418.80	309.80	279.00	228.20	
23 Salisbury, Md.	206.20	207.68	286.28	256.96	271.36	283.60	271.02	235.14	258.72	279.99	336.89	354.83	411.22	411.22	372.08	451.28	346.20	309.80	259.00	
24 Norfolk, Va.	107.80	107.48	171.08	161.76	208.56	188.40	192.88	155.92	177.52	237.44	237.44	244.96	378.67	378.67	345.09	344.04	234.76	243.48	233.80	
40A New Orleans, La.																				
(Export)	420.80	293.59	224.80	304.20	79.00	161.60	171.00	289.60	203.40	172.40	81.20	137.70	0.00	193.70	360.64	226.80	98.30	108.40	82.24	
40B Pascagoula, Miss.																				
(Export)	390.00	280.00	186.80	261.20	69.00	161.60	183.30	302.30	215.70	184.70	93.50	149.70	39.00	208.70	372.64	238.80	110.60	120.70	97.24	
40C Mobile, Ala.																				
(Export)	378.80	268.80	164.40	261.20	69.00	161.60	183.30	302.30	215.70	184.70	93.50	149.70	39.00	208.70	372.64	238.80	110.60	120.70	97.24	
44 Charleston, S. C.																				
(Export)	115.64	115.64	115.64	115.64	135.48	131.88	195.32	120.64	121.12	220.80	170.43	359.37	394.92	504.73	449.87	319.03	214.52	235.32	282.12	

TABLE XLI

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND LEAST-COST RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Plant	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
1 Wilson, N. C.	0.00	158.70	193.10	422.20	428.00	401.40	592.60	426.40	409.30	446.50	472.50	524.60	478.20	
2 Charlotte, N. C.	112.20	120.88	130.96	213.00	218.80	192.20	383.40	217.20	200.10	237.30	263.10	315.40	269.00	
3 Valdosta, Ga.	158.70	0.00	122.20	228.96	234.86	218.26	409.46	233.16	216.06	253.36	279.06	331.46	284.96	
4 Jacksonville, Fla.	193.10	122.20	0.00	249.68	255.58	228.98	420.18	264.28	236.78	274.08	294.78	352.18	305.68	
5 Tampa, Fla.	198.92	135.64	122.20	215.40	224.90	203.30	394.50	109.70	169.60	183.20	216.10	261.30	214.80	
7 Montgomery, Ala.	190.80	112.20	132.00	226.44	232.34	205.74	396.94	230.64	213.54	250.84	276.54	328.94	282.44	
8 Guntersville, Ala.	161.68	109.08	112.52	103.80	109.70	83.10	274.30	108.00	90.90	128.20	153.90	206.30	160.80	
9 Gainesville, Ga.	148.52	106.60	142.64	197.00	202.90	176.30	367.50	201.20	184.10	221.40	247.10	299.50	253.00	
10 Chattanooga, Tenn.	139.36	109.40	112.24	114.20	120.00	93.40	284.60	118.40	101.30	138.50	164.30	216.30	170.20	
11 Nashville, Tenn.	190.92	152.80	177.72	105.20	109.70	90.10	281.30	108.00	90.90	128.20	153.90	163.90	118.90	
12 Memphis, Tenn.	261.96	232.00	223.32	83.40	87.80	69.20	260.40	87.30	68.20	98.50	128.20	171.80	125.40	
13 Jackson, Miss.	219.16	163.64	172.96	217.94	237.44	215.84	407.04	232.34	215.84	249.44	278.24	319.44	272.94	
14 New Orleans, La.														
(Domestic)	322.16	292.20	176.04	108.40	117.90	98.30	289.50	115.40	98.30	135.50	161.30	203.00	156.50	
15 Shreveport, La.	459.06	429.10	263.40	342.74	352.24	330.64	521.20	347.14	330.64	364.24	393.04	434.24	387.74	
16 Springdale, Ark.	379.72	537.72	514.32	362.84	368.24	347.64	538.84	366.74	347.64	377.94	407.64	454.60	379.00	
17 Little Rock, Ark.	339.14	309.18	300.50	160.58	164.98	146.38	337.58	164.48	145.38	175.68	205.38	248.98	202.58	
18 Henderson, Ky.	181.92	180.78	195.62	203.00	84.00	59.84	251.04	101.55	76.90	109.40	136.95	149.00	116.50	
19 Louisville, Ky.	231.48	223.60	294.28	0.00	66.74	67.70	248.40	120.30	76.90	125.00	152.20	159.00	126.50	
20 Ashland, Ky.	212.76	258.64	277.68	55.00	46.60	57.04	248.24	146.60	115.80	151.10	176.80	203.20	156.70	
40A New Orleans, La.														
(Export)	420.80	224.80	304.20	108.40	117.70	98.30	289.50	115.40	98.30	135.50	147.50	203.00	156.70	
40B Pascagoula, Miss.														
(Export)	390.00	186.80	261.20	120.70	130.20	110.60	301.80	127.70	110.60	147.80	159.60	215.30	168.80	
40C Mobile, Ala.														
(Export)	317.55	154.40	261.20	110.70	115.20	100.60	285.50	117.70	100.60	137.80	140.60	195.30	153.80	
44 Charleston, S. C.														
(Export)	115.64	115.64	115.64	235.32	241.12	214.52	405.72	239.52	222.42	259.62	285.42	323.72	291.32	

TABLE XLII

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND LEAST-COST RAIL RATES,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
1 Charlotte, N. C.	112.20	0.00	120.88	130.96	157.04	152.72	118.96	107.20	114.79	145.84	221.40	183.36	161.83	389.09	512.83	269.17	192.20	213.00	138.52	
5 Tampa, Fla.	198.92	164.83	135.64	122.20	0.00	157.20	157.20	156.20	173.60	202.16	169.60	191.48	79.00	272.70	418.64	315.20	203.30	215.40	316.40	
7 Montgomery, Ala.	190.80	152.72	112.20	122.00	157.20	0.00	93.20	112.20	93.20	106.64	204.00	135.64	165.64	235.44	297.88	208.00	176.30	197.30	776.30	
8 Guntersville, Ala.	161.68	121.15	109.08	112.52	169.08	93.20	0.00	107.20	86.20	86.20	110.80	120.63	171.00	308.90	524.68	252.90	83.10	103.80	222.04	
9 Gainesville, Ga.	148.52	112.20	106.60	142.64	156.20	112.20	135.64	0.00	93.20	112.20	204.00	418.74	290.00	412.90	509.24	281.18	176.30	197.00	210.28	
10 Chattanooga, Tenn.	139.36	110.79	109.40	112.24	171.60	93.20	122.64	107.20	0.00	109.20	122.60	315.54	182.80	319.70	268.60	199.78	93.40	114.20	129.64	
11 Nashville, Tenn.	190.92	136.00	152.80	177.72	200.16	106.64	122.64	107.20	93.20	0.00	91.20	133.50	152.40	264.30	370.64	168.38	90.10	105.20	132.48	
12 Memphis, Tenn.	261.96	191.99	232.00	232.32	169.60	204.00	110.80	229.80	122.60	91.20	0.00	188.94	81.20	221.10	279.44	77.18	68.20	83.40	82.80	
13 Jackson, Miss.	219.16	354.49	163.64	172.96	191.48	135.64	122.64	418.74	311.54	133.50	188.94	0.00	137.70	235.44	345.74	211.90	215.84	217.94	190.84	
14 New Orleans, La.																				
(Domestic)	322.16	293.59	292.20	175.04	79.00	165.64	171.00	290.00	182.80	152.40	81.20	137.70	0.00	193.70	360.64	262.00	98.30	108.40	87.24	
15 Shreveport, La.	459.06	389.09	429.10	263.40	272.70	235.44	308.90	412.90	319.70	264.30	303.74	235.44	193.70	0.00	500.54	366.70	330.64	342.74	246.84	
16 Springdale, Ark.	379.72	512.83	537.73	358.88	418.64	297.88	524.68	509.24	268.60	370.64	279.44	345.74	360.64	500.54	0.00	243.80	348.25	362.84	362.24	
17 Little Rock, Ark.	339.14	269.17	309.18	264.52	315.20	208.00	252.90	306.98	199.78	168.38	77.18	211.90	262.00	366.70	243.80	0.00	145.38	160.58	159.98	
18 Henderson, Ky.	181.92	204.19	180.78	195.62	203.30	176.30	216.04	176.30	93.40	90.10	77.50	215.84	98.30	265.26	348.25	145.38	0.00	203.00	57.60	
20 Ashland, Ky.	231.48	213.04	258.64	277.68	316.40	176.30	222.04	236.84	129.64	143.48	82.80	192.00	82.24	238.00	362.24	159.98	57.60	55.00	0.00	
21 Harrisonburg, Va.	165.40	179.40	210.96	228.40	259.52	251.40	152.80	171.80	164.60	231.00	231.00	297.04	346.72	346.12	299.47	308.18	260.80	177.64	186.20	
22 Baltimore, Md.	238.84	230.68	250.32	259.48	259.52	287.24	253.85	224.37	238.98	260.26	317.16	339.71	396.10	396.10	352.78	394.34	309.80	279.00	228.20	
223 Salisbury, Md.	206.20	207.68	286.28	256.96	271.36	283.60	271.02	235.14	258.72	279.99	336.89	354.83	411.22	411.22	372.08	414.07	346.20	309.80	259.00	
24 Norfolk, Va.	107.80	107.48	171.08	161.76	208.56	188.40	192.88	155.92	177.52	237.44	237.44	244.96	378.67	378.67	345.09	314.62	234.76	243.48	233.80	
40A New Orleans, La.																				
(Export)	420.80	293.59	224.80	304.20	79.00	161.60	171.00	289.60	203.40	172.40	81.20	137.70	0.00	193.70	360.64	226.80	98.30	108.40	82.24	
40B Pascagoula, Miss.																				
(Export)	390.00	280.00	186.80	261.20	69.00	161.60	183.30	302.30	215.70	184.70	93.50	149.70	39.00	208.70	372.64	238.80	110.60	120.70	97.24	
40C Mobile, Ala.																				
(Export)	317.55	280.00	154.40	261.20	69.00	151.60	173.30	278.67	205.70	164.70	93.50	149.70	39.00	208.70	352.64	214.80	110.60	120.70	97.24	
44 Charleston, S. C.																				
(Export)	115.64	115.64	115.64	115.64	135.48	131.88	195.32	120.64	121.12	220.80	170.43	359.37	394.72	504.73	449.87	247.67	214.52	235.32	282.12	

TABLE XLIII

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND TRUCK COSTS,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	Plant	Origin												
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
		Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.	
1	Wilson, N. C.	0.00	208.59	398.80	346.29	319.69	419.12	344.69	327.59	364.79	390.59	442.89	396.49	
2	Charlotte, N. C.	104.85	164.22	265.10	291.70	265.10	340.77	290.10	273.00	310.20	336.00	388.30	341.90	
3	Valdosta, Ga.	208.59	0.00	274.28	300.88	274.28	373.71	299.18	282.08	319.38	345.08	397.48	340.98	
4	Jacksonville, Fla.	210.19	84.42	320.20	326.10	299.50	398.93	334.80	307.30	344.60	370.30	422.70	376.20	
5	Tampa, Fla.	268.92	120.17	203.30	224.90	203.30	302.73	109.70	169.60	183.20	216.10	261.30	214.80	
7	Montgomery, Ala.	238.92	120.81	207.24	233.84	207.24	306.67	232.14	215.04	252.34	278.04	330.44	283.94	
8	Guntersville, Ala.	216.57	154.01	83.10	109.70	83.10	182.53	108.00	90.90	128.20	153.90	206.30	160.80	
9	Gainesville, Ga.	152.73	135.81	177.50	231.29	204.69	276.93	230.59	213.49	250.69	276.49	328.79	282.39	
10	Chattanooga, Tenn.	207.00	158.16	93.40	120.00	93.40	192.83	118.40	101.30	138.50	164.30	216.60	170.20	
11	Nashville, Tenn.	232.45	200.61	90.10	109.70	90.10	189.53	108.00	90.90	128.20	153.90	163.90	118.90	
12	Memphis, Tenn.	329.60	280.76	77.50	87.80	69.20	168.13	87.30	68.20	98.50	128.20	171.80	125.40	
13	Jackson, Miss.	313.60	197.10	169.71	200.01	178.41	251.84	194.91	178.41	212.01	240.81	282.01	235.51	
14	New Orleans, La. (Domestic)	410.80	361.96	98.30	117.90	98.30	197.13	115.40	98.30	135.50	161.30	203.00	156.50	
15	Shreveport, La.	478.35	429.51	216.95	246.61	225.01	299.08	241.51	225.01	258.61	287.41	328.61	282.11	
16	Springdale, Ark.	464.78	415.94	212.68	266.85	247.25	303.81	266.35	247.25	277.55	307.25	187.20	122.73	

TABLE XLIII (continued)

Plant	Origin												
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
17 Little Rock, Ark.	419.77	370.93	167.67	203.97	184.37	258.80	203.65	184.37	217.50	244.37	273.97	241.57	
18 Henderson, Ky.	398.80	274.28	0.00	84.00	59.84	134.27	101.55	76.90	109.40	136.95	149.00	116.50	
19 Louisville, Ky.	240.51	246.26	203.00	66.74	67.70	167.12	120.30	88.60	125.00	152.20	159.00	126.50	
20 Ashland, Ky.	189.76	259.34	57.60	46.60	57.04	156.46	146.60	115.80	151.10	176.80	203.20	156.70	
40A New Orleans, La. (Export)	410.80	361.96	158.50	117.70	98.30	197.73	115.40	98.30	135.50	147.30	203.00	156.50	
40B Pascagoula, Miss. (Export)	423.10	374.26	110.60	130.20	110.60	210.03	127.70	110.60	147.80	159.60	215.30	168.80	
40C Mobile, Ala. (Export)	423.10	374.26	110.60	130.20	110.60	210.03	127.70	110.60	147.80	159.60	215.30	168.80	
44 Charleston, S. C. (Export)	127.80	132.62	266.24	321.18	294.58	465.10	319.58	302.48	339.62	365.42	403.79	371.38	

TABLE XLIV

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND TRUCK COSTS,
UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La.	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	104.85	0.00	164.22	170.93	228.70	182.42	151.14	100.06	147.94	180.50	294.30	371.81	351.74	418.41	405.72	360.71	265.10	285.90	158.16
4	Jacksonville, Fla.	210.19	170.93	84.42	0.00	109.00	156.88	187.84	152.73	183.69	227.74	327.20	233.81	299.50	405.97	441.47	396.46	320.20	320.20	269.88
5	Tampa, Fla.	268.92	228.70	120.17	109.00	0.00	187.84	212.42	193.59	252.53	273.71	169.60	233.81	79.00	225.67	441.47	259.77	203.30	215.40	326.70
7	Montgomery, Ala.	238.92	182.42	120.81	156.88	84.84	0.00	93.36	125.92	52.82	141.88	234.94	124.00	154.65	194.23	293.24	176.78	207.24	227.94	233.17
8	Guntersville, Ala.	216.57	151.74	154.01	187.84	229.98	93.36	0.00	86.98	71.02	106.45	110.80	212.31	171.00	259.55	246.60	200.97	83.10	103.80	193.60
9	Gainesville, Ga.	152.73	99.74	135.81	152.73	206.04	125.92	86.98	0.00	84.10	134.22	234.79	308.21	232.85	355.45	341.88	296.87	117.50	225.47	317.59
10	Chattanooga, Tenn.	207.00	147.94	158.16	183.69	232.53	52.82	71.02	84.10	0.00	89.85	122.60	224.11	182.80	271.35	257.78	171.37	93.40	101.30	205.40
11	Nashville, Tenn.	232.45	180.50	200.61	227.74	273.71	141.88	106.45	134.22	89.85	0.00	91.20	192.71	172.40	239.95	226.38	181.37	90.10	105.20	174.00
12	Memphis, Tenn.	329.60	294.30	280.76	327.20	169.60	234.94	110.80	234.79	122.60	92.20	0.00	151.51	81.20	198.11	135.18	90.17	77.50	83.40	82.80
13	Jackson, Miss.	313.93	255.19	197.10	233.81	233.81	123.00	212.31	308.21	224.11	192.71	151.51	0.00	98.11	119.86	260.69	215.68	169.71	190.51	151.25
14	New Orleans, La.																			
(Domestic)		410.80	351.74	361.96	299.50	79.00	154.65	171.00	229.66	182.80	172.40	81.20	98.11	0.00	146.47	295.45	178.59	98.30	108.40	82.24
15	Shreveport, La.	478.35	419.29	429.51	405.97	225.67	194.23	259.55	355.45	271.35	239.95	198.11	119.86	146.67	0.00	307.93	262.92	216.95	237.11	198.49
16	Springdale, Ark.	464.78	405.72	415.94	441.47	441.47	293.24	246.60	341.88	257.78	226.38	135.18	260.69	295.45	307.93	0.00	105.81	212.68	262.45	302.12
17	Little Rock, Ark.	419.77	360.71	370.93	396.46	259.77	176.78	200.97	296.87	171.37	181.37	90.17	215.68	232.57	262.92	105.81	0.00	167.67	199.57	265.41
19	Louisville, Ky.	240.51	285.90	246.26	271.80	215.40	227.94	103.80	225.47	101.30	105.20	83.40	190.51	108.40	237.11	262.45	199.57	203.00	0.00	55.00
20	Ashland, Ky.	189.76	158.16	259.34	269.88	326.70	233.17	193.60	317.59	205.40	174.00	82.80	151.25	82.24	198.49	302.12	265.41	57.60	55.00	0.00
21	Harrisonburg, Va.	129.43	129.43	257.75	264.45	313.61	267.32	216.57	192.63	197.42	224.23	293.18	320.31	352.23	384.15	375.85	326.06	229.34	190.72	142.52
22	Baltimore, Md.	140.59	177.63	263.15	180.00	289.18	314.25	269.24	232.53	250.73	277.22	348.08	376.17	410.33	446.40	407.45	392.45	274.03	238.60	183.37
23	Salisbury, Md.	146.59	185.61	269.15	186.00	295.18	322.23	290.63	245.94	275.30	301.80	372.66	395.00	429.16	465.23	440.97	417.03	307.54	272.11	213.70
24	Norfolk, Va.	110.59	145.07	223.15	140.00	249.18	281.69	251.68	198.38	240.19	267.64	338.51	354.47	388.62	424.69	433.95	382.87	300.84	262.22	196.78
40A	New Orleans, La.																			
(Export)		410.80	322.64	361.96	299.50	95.00	154.65	171.00	229.69	182.80	172.40	81.20	98.11	0.00	146.47	225.63	171.37	158.50	108.40	82.24
40B	Pascagoula, Miss.																			
(Export)		423.10	364.04	374.26	388.40	85.00	169.65	186.00	122.09	216.10	184.70	93.50	113.11	39.00	161.47	237.93	183.67	110.60	120.70	97.24
40C	Mobile, Ala.																			
(Export)		423.10	244.02	374.26	288.40	85.00	169.65	186.00	122.09	216.10	184.70	93.50	113.11	39.00	161.47	237.93	183.67	110.60	120.70	97.24
44	Charleston, S. C.																			
(Export)		127.80	111.87	132.62	129.75	189.76	179.54	170.29	125.08	172.84	216.89	295.44	257.75	279.45	493.55	439.87	385.61	266.24	315.38	222.32

TABLE XLVI

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING A COMBINATION OF BARGE AND TRUCK COSTS,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La.	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	104.85	0.00	164.22	170.93	228.70	182.42	151.14	100.06	147.94	180.50	294.30	371.81	351.74	418.41	405.72	360.71	265.10	285.90	158.16
5	Tampa, Fla.	268.92	228.70	120.17	109.00	0.00	187.84	212.42	193.59	252.53	273.71	169.60	233.81	79.00	225.67	441.47	259.77	203.30	216.50	326.70
7	Montgomery, Ala.	238.92	182.42	120.81	156.88	84.84	0.00	93.36	125.92	52.82	141.88	234.94	124.00	154.65	194.23	293.24	176.78	207.24	227.94	233.17
8	Guntersville, Ala.	216.57	151.74	154.01	187.84	229.98	93.36	0.00	86.98	71.02	106.45	110.80	212.31	171.00	259.55	246.60	200.97	83.10	103.80	193.60
9	Gainesville, Ga.	152.73	99.74	135.81	152.73	206.04	125.92	86.98	0.00	84.10	134.22	234.79	308.21	232.85	355.45	341.88	296.87	177.50	225.47	317.59
10	Chattanooga, Tenn.	207.00	147.94	158.16	183.69	232.53	52.82	71.02	84.10	0.00	89.85	122.60	224.11	183.80	271.35	257.78	171.37	93.40	101.30	205.40
11	Nashville, Tenn.	232.45	180.50	200.61	227.74	273.71	141.88	106.45	134.22	89.85	0.00	91.20	192.71	172.40	239.95	226.38	169.38	90.10	105.20	174.00
12	Memphis, Tenn.	329.60	294.30	280.76	327.20	169.60	234.94	110.80	234.79	122.60	93.20	0.00	151.51	81.20	198.11	135.18	77.18	77.50	83.40	82.80
13	Jackson, Miss.	313.93	255.19	197.10	233.81	233.81	124.00	212.31	308.21	224.11	192.71	151.51	0.00	98.11	119.86	260.69	215.68	169.71	190.51	151.25
14	New Orleans, La.																			
(Domestic)		410.80	351.74	361.96	299.50	79.00	154.65	171.00	229.66	182.80	172.40	81.20	98.11	0.00	146.47	295.45	179.59	98.30	108.40	82.24
15	Shreveport, La.	478.35	419.29	429.51	405.97	225.67	194.23	259.55	355.45	271.35	239.95	198.11	119.86	146.67	0.00	307.93	267.92	216.95	237.11	198.49
16	Springdale, Ark.	464.78	405.72	415.94	441.47	441.47	293.24	246.60	341.88	257.78	226.38	135.18	260.69	295.45	307.93	0.00	105.81	212.68	262.45	302.12
17	Little Rock, Ark.	406.78	360.71	357.94	396.46	259.77	176.78	200.97	296.87	171.37	169.38	77.18	215.08	232.57	262.92	105.81	0.00	154.68	160.58	159.98
18	Henderson, Ky.	398.80	365.10	274.28	320.20	203.30	207.24	83.10	177.50	93.40	90.10	77.50	169.71	98.30	216.95	212.68	154.68	0.00	203.00	57.60
20	Ashland, Ky.	189.76	158.16	259.34	269.88	326.70	233.17	193.60	317.59	205.40	174.60	83.80	151.25	82.24	198.49	302.12	159.98	57.60	55.00	0.00
21	Harrisonburg, Va.	129.43	129.43	257.75	264.45	313.61	267.32	216.57	192.63	197.42	224.23	293.18	320.31	352.23	384.15	375.85	326.06	229.34	190.72	142.52
22	Baltimore, Md.	140.59	177.63	263.15	180.00	289.18	314.25	269.24	232.53	250.73	277.22	348.08	376.17	410.33	446.40	407.45	392.45	274.03	238.60	183.37
23	Salisbury, Md.	146.59	185.61	269.15	186.00	295.18	322.23	290.63	245.94	275.30	301.80	372.66	395.00	429.16	465.23	440.97	417.03	307.54	272.11	213.70
24	Norfolk, Va.	110.59	145.07	223.15	140.00	249.18	281.69	251.68	198.38	240.19	267.64	338.51	354.47	388.62	424.69	433.95	382.87	300.84	262.22	196.78
40A	New Orleans, La.																			
(Export)		410.80	322.64	361.96	299.50	95.00	154.65	171.00	229.69	182.80	172.40	81.20	98.11	0.00	146.47	225.63	171.37	158.50	108.40	82.24
40B	Pascagoula, Miss.																			
(Export)		423.10	364.04	374.26	288.40	85.00	169.65	186.00	122.09	216.10	184.70	93.50	113.11	39.00	161.47	237.93	183.67	110.60	120.76	97.26
40C	Mobile, Ala.																			
(Export)		366.03	244.02	317.19	288.40	85.00	85.23	98.30	122.09	159.03	184.70	93.50	113.11	39.00	161.47	237.93	183.67	110.60	120.70	97.26
44	Charleston, S. C.																			
(Export)		127.80	111.87	132.62	129.75	189.76	179.54	170.29	125.08	172.84	216.89	295.44	257.75	279.45	493.55	439.87	385.61	266.24	315.28	222.32

TABLE XLVII

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING THE LEAST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	Plant	Origin											
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)
		Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.
1	Wilson, N. C.	0.00	156.15	181.92	153.64	183.60	245.76	330.84	203.12	363.40	390.59	368.32	345.92
2	Charlotte, N. C.	104.85	120.88	145.00	138.52	155.04	217.20	217.20	174.56	237.30	263.10	315.40	269.00
3	Valdosta, Ga.	158.70	0.00	157.00	163.44	158.96	241.36	233.16	174.84	253.36	279.06	331.46	284.96
4	Jacksonville, Fla.	162.52	84.42	178.56	178.28	173.52	217.56	264.28	191.08	274.08	294.78	352.18	305.68
5	Tampa, Fla.	198.92	120.17	203.30	224.90	203.30	302.73	109.70	169.60	183.20	216.10	261.30	214.80
7	Montgomery, Ala.	190.80	112.20	128.44	142.44	123.12	174.96	230.64	135.08	250.84	276.54	300.28	277.88
8	Guntersville, Ala.	161.68	109.08	83.10	109.70	83.10	182.53	108.00	90.90	128.20	153.90	206.30	160.80
9	Gainesville, Ga.	148.52	106.60	134.04	133.76	129.00	206.36	201.20	150.76	221.40	247.10	299.50	253.00
10	Chattanooga, Tenn.	139.36	109.40	93.40	98.20	93.40	179.40	118.40	101.30	138.50	164.30	216.30	170.20
11	Nashville, Tenn.	164.56	152.80	90.10	105.20	90.10	139.64	108.00	90.90	128.20	153.90	163.90	118.90
12	Memphis, Tenn.	189.48	140.76	68.20	87.80	69.20	168.13	87.30	68.20	98.50	128.20	171.80	125.40
13	Jackson, Miss.	219.16	163.64	158.60	192.08	137.12	218.32	194.91	138.72	212.01	240.81	282.01	235.51
14	New Orleans, La. (Domestic)	236.84	148.88	98.30	117.90	98.30	197.13	115.40	98.30	135.50	161.30	203.00	156.50
15	Shreveport, La.	287.48	256.40	216.94	246.61	225.01	289.99	241.51	225.01	258.61	287.41	282.33	223.59
16	Springdale, Ark.	363.92	324.78	202.53	261.26	204.76	225.83	203.48	153.69	214.98	265.78	187.20	122.73

TABLE XLVII (continued)

Plant	Origin												
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
17 Little Rock, Ark.	290.28	241.66	167.67	203.97	176.35	225.19	203.65	158.48	217.50	244.37	240.51	176.03	
18 Henderson, Ky.	181.92	164.00	0.00	84.00	49.63	98.15	101.55	76.90	109.40	136.95	149.00	116.50	
19 Louisville, Ky.	164.56	159.80	82.51	66.74	67.70	82.19	120.30	76.90	125.00	152.20	159.00	126.50	
20 Ashland, Ky.	189.76	258.64	57.60	46.60	57.04	122.73	146.60	115.80	151.10	176.80	203.20	156.70	
40A New Orleans, La. (Export)	345.85	193.59	98.30	117.70	98.30	197.73	115.40	98.30	135.50	147.30	203.00	156.50	
40B Pascagoula, Miss. (Export)	317.44	159.12	110.60	130.20	110.60	210.03	127.70	110.60	147.80	159.60	215.30	168.80	
40C Mobile, Ala. (Export)	302.76	146.35	110.60	130.20	110.60	210.03	127.70	110.60	147.80	159.60	215.30	168.80	
44 Charleston, S. C. (Export)	115.64	115.64	214.52	178.52	187.20	227.80	239.52	222.28	259.62	285.42	323.72	291.32	

TABLE XLVIII

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING THE LEAST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
	Plant																			
	Wilson, N. C.	Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La. (Domestic)	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	104.85	0.00	120.88	130.96	157.04	152.72	98.80	100.06	114.79	114.79	161.83	183.36	161.83	256.40	335.36	263.44	145.00	136.00	138.52
4	Jacksonville, Fla.	162.52	130.96	85.32	0.00	109.00	122.00	112.52	142.64	112.24	141.48	144.72	172.96	176.04	263.40	358.88	264.52	178.56	174.36	269.88
5	Tampa, Fla.	198.92	164.83	120.17	109.00	0.00	157.20	157.20	156.20	173.60	202.16	169.60	191.48	79.00	225.67	393.09	314.64	203.30	215.40	316.40
7	Montgomery, Ala.	190.80	152.72	112.20	122.00	84.84	0.00	93.20	112.20	52.82	103.26	93.20	124.00	120.64	194.23	252.64	196.78	128.44	130.16	161.00
8	Guntersville, Ala.	161.48	121.15	109.08	112.52	169.08	93.20	0.00	86.98	71.02	86.20	86.20	120.63	138.04	210.02	223.59	168.69	83.10	103.80	192.95
9	Gainesville, Ga.	148.52	99.74	106.60	142.64	156.20	112.20	86.98	0.00	84.10	112.20	112.24	143.04	138.04	251.02	283.28	229.02	117.50	129.84	173.16
10	Chattanooga, Tenn.	139.36	110.79	109.40	112.24	171.60	52.82	71.02	84.10	0.00	89.85	81.20	130.16	152.60	231.55	244.02	189.76	93.40	98.20	129.64
11	Nashville, Tenn.	164.56	114.79	152.80	177.72	200.16	106.64	93.20	107.20	89.85	0.00	91.20	133.50	151.40	215.66	212.10	161.03	90.10	103.26	143.48
12	Memphis, Tenn.	189.48	157.84	140.76	144.72	91.20	93.20	109.20	126.24	109.20	91.20	0.00	113.79	81.20	150.82	135.18	90.17	68.20	83.40	82.80
13	Jackson, Miss.	219.16	181.36	163.64	172.96	191.48	124.00	122.64	143.04	132.16	133.50	93.20	0.00	98.11	116.66	187.52	127.51	144.12	137.12	151.25
14	New Orleans, La. (Domestic)	236.84	196.48	148.88	176.04	79.00	120.64	138.04	158.72	152.60	151.40	81.20	98.11	0.00	146.47	238.60	178.59	98.30	108.40	82.24
15	Shreveport, La.	287.48	256.40	256.40	263.40	225.67	194.23	210.02	251.02	231.55	215.66	150.82	116.66	146.67	0.00	148.26	112.51	216.95	237.11	198.49
16	Springdale, Ark.	363.92	335.36	324.78	358.88	393.09	252.64	222.96	283.28	244.02	187.52	135.18	144.43	212.10	148.26	0.00	0.00	202.53	234.45	302.12
17	Little Rock, Ark.	290.28	258.64	241.56	264.52	259.77	176.78	172.84	226.15	171.37	161.03	90.17	127.51	178.59	112.51	103.81	0.00	167.67	199.57	227.84
19	Louisville, Ky.	164.56	136.00	159.80	181.36	215.40	130.16	103.80	129.84	98.20	105.20	83.40	137.12	108.40	237.11	234.45	207.95	82.51	0.00	55.00
20	Ashland, Ky.	189.76	158.16	258.64	269.88	316.40	161.00	186.57	181.46	129.64	143.48	82.80	151.25	82.24	198.49	302.12	228.40	57.60	55.00	0.00
21	Harrisonburg, Va.	129.43	137.09	210.96	228.40	259.52	251.40	152.80	141.68	164.60	224.23	231.00	297.04	320.49	346.12	299.47	299.47	229.34	177.64	142.52
22	Baltimore, Md.	136.45	177.63	250.32	114.00	249.64	287.24	253.85	224.37	238.98	260.26	317.16	339.71	367.13	396.10	352.78	352.78	274.03	238.60	183.37
23	Salisbury, Md.	129.75	185.61	269.15	124.00	259.64	283.60	271.02	235.14	258.72	279.99	336.89	334.38	382.26	411.22	372.08	372.08	307.54	272.11	213.70
24	Norfolk, Va.	88.89	107.48	171.08	69.00	204.64	188.40	192.88	155.92	177.52	206.64	237.44	244.96	237.47	378.67	345.09	344.04	234.76	234.48	196.78
40A	New Orleans, La. (Export)	345.85	289.35	193.59	227.74	79.00	154.65	171.00	229.66	182.80	151.40	81.20	98.11	0.00	146.67	181.06	178.59	98.30	108.40	82.24
40B	Pascagoula, Miss. (Export)	317.44	259.66	159.12	193.27	69.00	121.45	151.40	122.09	103.06	131.80	93.50	113.11	39.00	161.47	186.19	184.97	110.60	120.70	97.24
40C	Mobile, Ala. (Export)	302.76	244.02	146.35	180.50	69.00	107.40	144.75	122.09	169.01	131.80	93.50	104.85	39.00	161.47	186.19	183.67	110.60	120.70	97.24
44	Charleston, S. C. (Export)	115.64	111.87	115.64	115.64	135.48	131.88	170.29	120.64	121.12	121.12	170.43	244.62	233.72	301.01	279.99	297.04	214.52	175.72	222.32

TABLE XLIX

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING THE LEAST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Plant	Origin														(34)
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)		
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.		
1 Wilson, N. C.	0.00	156.15	162.52	171.56	153.64	183.60	245.76	330.84	203.12	363.40	390.59	368.32	345.92		
2 Charlotte, N. C.	104.85	120.88	130.96	136.00	98.31	108.22	145.52	211.38	118.34	224.18	224.82	217.46	204.02		
3 Valdosta, Ga.	158.70	0.00	84.42	159.80	163.44	158.96	241.36	233.16	174.84	279.06	279.06	331.46	284.96		
4 Jacksonville, Fla.	162.52	84.42	0.00	174.36	178.28	173.52	217.56	264.28	191.08	294.78	294.78	352.18	305.68		
5 Tampa, Fla.	198.92	120.17	109.00	215.40	224.90	203.30	294.70	109.70	169.60	183.20	216.10	261.30	214.80		
6 Montgomery, Ala.	190.80	112.20	132.00	128.16	142.44	123.12	174.96	230.64	135.08	252.34	276.54	328.00	277.88		
7 Guntersville, Ala.	161.48	109.08	112.52	103.80	80.39	73.17	124.74	108.00	83.78	128.20	153.90	182.90	160.80		
8 Gainesville, Ga.	148.52	106.60	142.64	129.84	95.46	92.60	141.82	197.10	104.06	209.90	244.14	287.76	189.74		
9 Chattanooga, Tenn.	139.36	109.40	112.24	98.20	98.20	93.40	179.40	118.40	101.30	138.50	164.30	216.30	170.20		
10 Nashville, Tenn.	164.56	152.80	177.72	103.26	105.20	90.10	139.64	108.00	90.90	128.20	153.90	163.90	118.90		
11 Memphis, Tenn.	189.48	140.76	260.62	83.40	87.80	69.20	168.13	87.30	68.20	98.50	128.20	171.80	125.40		
12 Jackson, Miss.	219.16	163.64	172.96	137.12	134.85	97.47	146.19	189.87	128.25	202.67	236.91	195.95	182.51		
13 New Orleans, La. (Domestic)	236.84	148.88	176.04	108.40	117.90	98.30	197.13	115.40	98.30	135.50	161.30	203.00	156.50		
14 Shreveport, La.	287.48	256.40	263.40	237.11	246.61	225.01	289.99	241.51	209.24	258.61	287.41	279.80	209.24		
15 Springdale, Ark.	363.92	324.78	358.88	234.45	223.38	172.40	221.29	203.48	14.540	214.98	207.00	173.96	122.73		
16 Little Rock, Ark.	290.28	241.56	264.52	160.58	164.98	146.38	225.19	164.48	145.38	175.68	205.38	240.51	176.03		
17 Henderson, Ky.	181.92	157.00	274.67	82.51	84.00	49.63	98.15	101.55	76.90	109.40	136.95	149.00	116.50		
18 Louisville, Ky.	164.56	159.80	181.36	0.00	66.74	67.70	82.19	120.30	76.90	125.00	152.20	159.00	126.50		
19 Ashland, Ky.	189.76	258.64	269.88	55.00	46.60	57.04	122.72	146.60	115.80	151.10	176.80	203.20	156.70		
20 New Orleans, La. (Export)	345.85	193.59	227.74	108.40	113.04	98.30	161.76	115.40	98.30	135.50	147.30	148.96	137.20		
40A Pascagoula, Miss. (Export)	317.44	159.12	193.27	120.70	130.20	110.60	210.03	127.70	110.60	147.80	159.60	215.30	168.80		
40B Mobile, Ala. (Export)	302.76	146.35	180.50	110.70	115.20	100.60	200.03	117.70	100.60	137.80	140.60	195.30	153.80		
40C Charleston, S. C. (Export)	115.64	115.64	115.64	175.72	178.52	187.20	227.80	239.52	222.28	285.42	285.42	323.72	291.32		

TABLE I

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING THE LEAST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1975

	Market	Plant																		
		(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
2	Charlotte, N. C.	104.85	0.00	120.88	130.96	157.04	152.72	98.80	100.06	114.79	114.79	161.83	183.36	161.83	256.40	335.36	263.44	145.00	136.00	138.52
5	Tampa, Fla.	198.92	164.83	120.17	109.00	0.00	157.20	157.20	156.20	173.60	202.16	169.60	191.48	79.00	225.67	393.09	259.77	203.30	215.40	316.40
7	Montgomery, Ala.	190.80	152.72	112.20	122.00	84.84	0.00	93.20	93.20	52.82	106.64	93.20	124.00	120.64	194.23	252.64	176.78	128.44	130.16	161.00
8	Guntersville, Ala.	161.68	121.15	109.00	112.52	169.08	93.20	0.00	0.00	71.02	86.20	86.20	120.63	138.04	210.02	223.59	168.69	83.10	103.80	192.95
9	Gainesville, Ga.	148.52	99.74	106.60	142.64	156.20	112.20	86.98	0.00	84.10	112.20	112.24	143.04	138.04	251.02	283.28	229.02	134.04	129.84	173.16
10	Chattanooga, Tenn.	139.36	110.79	109.40	112.24	171.60	52.82	71.02	84.10	0.00	89.85	81.20	130.16	152.60	231.55	268.60	171.37	93.40	98.20	129.64
11	Nashville, Tenn.	164.56	136.00	152.80	177.72	200.16	106.64	93.20	107.20	89.85	0.00	91.20	133.50	151.40	250.66	212.10	161.03	90.10	103.26	143.48
12	Memphis, Tenn.	189.48	157.84	140.76	144.72	91.20	93.20	109.20	110.80	109.20	91.20	0.00	113.79	81.20	150.82	134.18	77.18	68.20	83.40	82.80
13	Jackson, Miss.	219.16	181.36	197.10	172.96	191.48	124.00	122.64	122.64	132.16	133.50	93.20	0.00	98.11	116.66	187.52	127.51	144.12	137.12	151.25
14	New Orleans, La.																			
	(Domestic)	236.14	196.48	148.88	176.04	79.00	120.64	138.04	158.72	152.60	151.40	81.20	98.11	0.00	146.47	238.60	178.59	98.30	108.40	82.24
15	Shreveport, La.	287.48	256.40	256.40	263.40	225.67	194.23	210.02	251.02	231.55	215.66	150.82	116.66	146.67	0.00	148.26	112.51	216.95	237.11	198.49
16	Springdale, Ark.	363.92	335.36	324.78	358.88	393.09	252.64	222.96	283.28	244.02	187.52	135.18	144.43	212.10	148.26	0.00	105.81	202.53	234.45	302.12
17	Little Rock, Ark.	290.28	258.64	241.56	264.52	259.77	176.78	172.84	226.15	171.37	161.03	77.18	127.51	178.59	112.51	105.81	0.00	145.38	160.58	159.98
18	Henderson, Ky.	181.92	153.36	157.00	178.56	203.30	140.24	83.10	129.04	93.40	90.10	77.50	139.12	98.30	141.88	202.53	145.38	0.00	82.51	57.60
20	Ashland, Ky.	189.76	158.16	258.64	269.88	316.40	161.00	186.57	181.46	129.64	143.48	82.80	151.25	82.24	198.49	302.12	159.98	57.60	55.00	0.00
21	Harrisonburg, Va.	129.43	129.43	210.96	228.40	259.52	251.40	152.80	141.68	164.60	224.23	231.00	297.04	320.49	346.12	299.47	308.18	229.34	177.64	142.52
22	Baltimore, Md.	136.45	177.63	250.32	114.00	249.64	287.24	253.85	224.37	238.98	260.26	317.16	339.71	367.13	396.10	352.78	392.45	274.03	238.60	183.37
23	Salisbury, Md.	129.75	185.61	269.15	124.00	271.36	283.60	271.02	235.14	258.72	279.99	336.89	334.38	382.26	411.22	372.08	414.07	307.54	272.11	213.70
24	Norfolk, Va.	88.89	107.48	171.08	69.00	204.64	188.40	192.88	155.92	177.52	206.64	237.44	244.96	237.47	378.67	345.09	314.62	234.76	234.48	196.78
40A	New Orleans, La.																			
	(Export)	345.85	289.35	193.59	227.74	79.00	154.65	171.00	171.00	182.80	151.40	81.20	98.11	0.00	146.67	181.06	171.37	98.30	108.40	84.24
40B	Pascagoula, Miss.																			
	(Export)	317.44	259.66	159.12	193.27	69.00	121.45	151.40	122.09	183.06	131.80	93.50	113.11	39.00	161.47	186.19	183.67	110.60	120.70	97.24
40C	Mobile, Ala.																			
	(Export)	302.76	244.02	146.35	180.50	69.00	85.73	98.30	122.09	159.03	131.80	93.50	113.11	39.00	161.47	186.19	183.67	110.60	120.70	97.24
44	Charlotte, S. C.																			
	(Export)	115.64	111.87	115.64	115.64	135.48	131.88	170.29	120.64	121.12	121.12	170.43	244.62	233.72	301.01	279.99	247.67	214.52	175.72	222.32

TABLE LI

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING THE HIGHEST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1964

	Plant	Origin											
		(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)
1	Wilson, N. C.	0.00	208.59	398.80	428.00	401.40	592.60	426.40	409.30	446.50	416.80	524.60	478.20
2	Charlotte, N. C.	122.20	164.22	265.10	291.70	265.10	399.40	365.96	273.00	397.96	412.56	407.77	364.36
3	Valdosta, Ga.	208.59	0.00	274.28	300.88	274.28	409.46	339.64	297.01	398.52	467.14	436.50	372.02
4	Jacksonville, Fla.	210.19	135.64	320.20	326.10	299.50	420.18	385.84	324.14	417.84	494.28	469.06	404.58
5	Tampa, Fla.	268.92	135.64	320.63	342.02	324.46	394.50	409.08	370.11	441.08	540.24	506.40	441.93
7	Montgomery, Ala.	238.92	135.64	207.24	233.84	207.24	396.94	331.80	228.62	353.16	407.36	364.36	319.56
8	Guntersville, Ala.	216.57	154.01	144.75	176.03	148.26	274.30	292.16	187.84	322.48	322.48	328.29	294.48
9	Gainesville, Ga.	152.73	135.81	192.86	231.29	204.69	384.06	337.40	266.00	369.40	423.80	369.47	335.80
10	Chattanooga, Tenn.	207.00	158.16	138.38	155.28	311.37	284.60	347.12	355.74	318.56	372.96	331.16	284.96
11	Nashville, Tenn.	232.45	200.61	137.60	138.37	129.64	281.30	278.04	142.20	310.04	364.44	298.84	276.44
12	Memphis, Tenn.	329.60	280.76	134.08	198.70	132.94	260.40	274.80	148.32	314.64	349.44	340.40	261.72
13	Jackson, Miss.	313.93	197.10	215.84	260.62	215.84	407.04	306.32	215.84	338.32	394.96	329.36	306.40
14	New Orleans, La. (Domestic)	410.80	361.96	246.58	307.54	250.73	302.76	328.56	265.41	360.56	441.61	491.08	326.96
15	Shreveport, La.	481.22	455.38	330.64	352.24	330.64	521.80	368.20	330.64	403.00	457.40	434.24	387.74
16	Springdale, Ark.	464.78	537.72	354.04	368.24	377.64	538.84	366.74	347.64	386.20	407.64	254.60	179.00

TABLE LI (continued)

Plant	Origin												
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
17 Little Rock, Ark.	429.82	403.88	239.24	334.40	233.24	405.00	320.60	213.80	355.40	407.00	303.40	271.00	
18 Henderson, Ky.	398.80	274.28	0.00	166.60	107.80	251.04	259.00	133.92	363.24	417.64	352.04	329.64	
19 Louisville, Ky.	240.51	246.26	203.00	116.20	136.96	248.40	239.40	133.92	363.24	417.64	352.04	325.63	
20 Ashland, Ky.	231.48	260.64	200.60	144.20	189.00	248.24	368.76	224.36	476.00	437.80	395.16	372.76	
40A New Orleans, La. (Export)	420.80	361.96	246.37	307.54	250.73	302.76	313.29	265.41	338.51	441.61	491.08	308.82	
40B Pascagoula, Miss. (Export)	423.10	374.26	241.79	302.44	245.62	301.80	304.99	259.66	333.72	438.42	378.41	312.33	
40C Mobile, Ala. (Export)	423.10	374.26	226.15	274.03	229.34	301.80	292.22	248.81	317.76	424.05	373.30	308.82	
44 Charleston, S. C. (Export)	127.80	132.62	266.24	321.18	294.58	465.10	384.60	313.09	416.60	464.91	458.21	394.68	
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.	

TABLE LIII

ASSEMBLY COSTS FOR TRANSPORTING CORN UTILIZING THE HIGHEST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Plant	Origin												
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.
1 Wilson, N. C.	0.00	208.59	211.14	422.20	428.00	401.40	592.60	426.40	409.30	446.50	486.80	524.60	478.20
2 Charlotte, N. C.	122.20	164.22	170.93	285.90	291.70	265.10	399.40	365.96	273.00	397.96	412.56	407.77	364.36
3 Valdosta, Ga.	208.59	0.00	135.64	294.98	300.88	274.28	409.46	339.64	297.01	398.52	467.14	436.50	372.02
4 Jacksonville, Fla.	210.19	135.64	0.00	320.20	326.10	299.50	420.18	385.84	324.14	417.84	494.28	469.06	404.58
5 Tampa, Fla.	268.19	135.64	135.64	320.63	342.02	324.46	394.50	409.08	370.11	441.08	540.24	506.40	441.93
7 Montgomery, Ala.	238.92	135.64	156.88	271.79	233.84	207.24	396.94	331.80	228.62	353.16	407.56	364.36	319.56
8 Guntersville, Ala.	216.57	154.01	187.84	147.30	176.03	148.26	274.30	292.16	187.84	322.48	382.48	328.29	294.48
9 Gainesville, Ga.	152.73	135.81	152.73	225.47	231.29	204.69	384.06	337.40	243.38	369.40	423.80	369.47	335.80
10 Chattanooga, Tenn.	207.00	158.16	183.69	133.90	155.28	311.37	284.60	347.12	355.74	318.56	372.96	331.16	284.96
11 Nashville, Tenn.	190.92	200.61	227.74	139.72	138.37	129.64	281.30	278.04	142.20	310.04	364.44	298.84	276.44
12 Memphis, Tenn.	329.60	280.76	327.20	163.58	198.70	132.94	260.40	274.80	148.32	314.64	349.44	340.40	261.72
13 Jackson, Miss.	313.93	197.10	233.81	225.51	260.62	215.84	207.04	306.32	215.84	338.32	394.96	329.36	306.40
14 New Orleans, La.													
(Domestic)	410.80	361.96	299.50	272.43	307.54	250.73	302.76	328.56	265.41	360.56	441.61	491.08	326.96
15 Shreveport, La.	481.22	455.38	405.97	342.74	352.24	330.64	521.84	368.20	330.64	403.00	457.40	434.24	387.74
16 Springdale, Ark.	464.78	537.72	514.32	362.84	368.24	347.64	538.84	366.74	347.64	407.64	407.64	254.60	179.00
17 Little Rock, Ark.	406.78	357.94	396.46	238.84	259.84	233.24	337.58	320.60	176.20	355.40	407.00	293.80	215.40
18 Henderson, Ky.	398.00	274.28	320.20	203.00	166.60	107.80	251.04	259.00	133.92	363.24	417.64	352.04	329.64
19 Louisville, Ky.	240.51	246.26	294.28	0.00	116.20	136.91	248.40	239.40	133.91	363.23	417.63	352.03	325.63
20 Ashland, Ky.	231.48	260.64	293.28	161.00	144.20	189.00	248.24	368.76	224.36	400.76	437.80	437.80	372.76
40A New Orleans, La.													
(Export)	420.80	361.96	304.20	272.43	307.54	250.73	302.76	313.29	265.41	338.51	441.61	491.08	308.82
40B Pascagoula, Miss.													
(Export)	423.10	374.26	288.40	249.77	302.44	245.62	301.80	304.99	259.66	333.72	438.42	407.20	312.33
40C Mobile, Ala.													
(Export)	378.80	317.19	288.40	239.55	274.03	229.34	285.80	292.22	248.81	317.76	424.05	407.20	308.82
44 Charleston, S. C.													
(Export)	127.80	132.62	129.75	315.38	321.18	294.58	465.10	384.60	313.29	416.60	471.00	471.00	394.68

TABLE LIV

DISTRIBUTION COSTS FOR TRANSPORTING CORN UTILIZING THE HIGHEST-COST MODE OF TRANSPORTATION,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Plant																			
	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	
Wilson, N. C.		Charlotte, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Tampa, Fla.	Montgomery, Ala.	Guntersville, Ala.	Gainesville, Ga.	Chattanooga, Tenn.	Nashville, Tenn.	Memphis, Tenn.	Jackson, Miss.	New Orleans, La. (Domestic)	Shreveport, La.	Springdale, Ark.	Little Rock, Ark.	Henderson, Ky.	Louisville, Ky.	Ashland, Ky.	
2	Charlotte, N. C.	122.20	0.00	164.22	170.93	228.70	182.42	151.14	120.64	147.94	180.50	294.30	391.05	351.74	447.05	529.39	360.71	265.10	285.90	158.16
5	Tampa, Fla.	268.92	228.70	135.64	135.64	0.00	187.84	212.42	193.59	252.53	273.71	294.46	260.30	251.04	464.00	593.84	336.91	320.63	320.63	326.70
7	Montgomery, Ala.	238.92	182.42	135.64	156.88	187.84	0.00	193.36	135.64	122.64	141.18	234.94	135.64	165.64	235.44	320.56	221.44	207.24	227.94	277.30
8	Guntersville, Ala.	216.57	151.74	154.01	187.84	229.98	113.92	0.00	120.64	107.64	107.64	124.00	212.31	178.59	308.90	524.68	256.40	144.75	147.30	222.04
9	Gainesville, Ga.	152.73	135.64	135.81	152.73	206.04	135.64	135.64	0.00	122.64	135.64	234.79	418.74	305.44	442.34	524.68	390.84	192.86	225.47	317.59
10	Chattanooga, Tenn.	207.00	147.94	158.16	183.67	232.53	122.64	122.64	0.00	122.64	145.39	311.54	205.40	319.70	402.04	268.20	138.37	133.90	216.44	
11	Nashville, Tenn.	232.45	180.50	200.61	227.74	273.71	141.88	122.64	135.18	122.64	0.00	122.64	192.71	214.98	394.94	372.64	229.24	137.60	139.72	216.44
12	Memphis, Tenn.	329.60	294.30	280.76	327.20	294.46	234.94	124.96	234.79	145.39	122.64	0.00	188.94	171.56	303.74	279.44	148.60	134.08	163.58	240.24
13	Jackson, Miss.	313.93	391.05	163.64	233.81	260.30	135.64	212.31	308.21	311.54	192.71	188.94	0.00	221.64	235.44	468.38	334.54	215.84	225.51	282.01
14	New Orleans, La.																			
(Domestic)		410.80	351.74	361.96	299.50	251.04	165.64	181.46	365.44	205.40	214.98	171.56	221.64	0.00	212.80	406.00	262.00	246.58	272.43	322.55
15	Shreveport, La.	481.22	447.05	445.38	405.97	400.64	235.44	308.90	442.34	319.70	394.94	303.74	235.44	212.80	0.00	583.31	449.34	330.64	342.74	395.92
16	Springdale, Ark.	464.78	529.39	537.72	514.32	593.84	320.56	524.68	524.68	402.04	372.64	279.44	468.38	406.00	583.31	0.00	243.80	355.04	362.84	379.12
17	Little Rock, Ark.	406.78	360.71	357.72	396.46	441.80	271.44	256.40	297.74	229.24	229.24	145.60	266.12	299.60	449.34	243.80	0.00	239.24	238.84	341.04
18	Henderson, Ky.	398.80	265.10	274.28	320.20	305.31	207.24	216.04	216.04	137.41	120.64	129.75	215.84	246.90	330.64	354.04	239.24	0.00	203.00	194.60
20	Ashland, Ky.	231.48	213.04	260.64	293.28	326.70	239.64	222.04	317.59	205.40	174.60	233.23	282.01	322.55	395.92	379.12	339.84	200.60	161.00	0.00
21	Harrisonburg, Va.	188.84	216.28	257.75	264.45	313.61	267.32	243.84	209.96	208.32	268.80	293.18	320.31	352.23	384.15	275.85	375.40	279.00	190.72	186.20
22	Baltimore, Md.	238.84	238.84	296.05	298.92	358.93	314.25	271.31	253.85	256.15	277.76	348.08	376.17	410.33	446.40	407.45	440.92	309.80	279.00	228.20
23	Salisbury, Md.	230.84	230.84	295.09	313.72	352.87	322.23	288.84	271.02	276.29	301.80	372.56	395.00	429.16	465.23	440.97	451.28	346.20	309.80	259.00
24	Norfolk, Va.	115.64	145.07	254.56	304.20	312.33	281.69	251.68	198.38	240.19	267.64	338.51	354.47	388.62	424.69	433.95	382.87	300.84	262.22	233.80
40A	New Orleans, La.																			
(Export)		420.80	362.00	361.96	304.20	345.20	161.60	228.40	305.44	242.40	205.40	171.56	154.79	0.00	193.70	406.00	226.80	246.58	272.43	348.60
40B	Pascagoula, Miss.																			
(Export)		423.10	364.04	374.26	288.40	317.20	167.65	186.00	320.00	295.80	242.40	163.90	154.79	76.44	286.40	426.00	238.80	241.79	249.77	328.60
40C	Mobile, Ala.																			
(Export)		378.80	322.80	317.19	288.20	306.00	161.60	173.30	278.64	276.03	242.40	161.35	154.79	93.04	286.40	426.00	214.80	226.15	239.55	328.60
44	Charleston, S. C.																			
(Export)		127.80	115.64	132.62	129.75	189.76	179.54	195.32	195.32	172.84	220.80	295.44	384.82	394.92	504.73	449.87	385.61	266.20	315.38	282.12

TABLE LV

ESTIMATED CORN PRODUCTION FOR THE SM-29 SOUTHERN SUB-REGIONAL AREAS,
UNITED STATES 1964 AND 1975

Area	Corn Production ^a	
	1964	1975
	-----1,000 Bushels-----	
1	68,744	69,414
2	18,635	18,763
3	68,441	77,612
4	7,408	16,520
5 ^b	243	560
7	24,431	27,837
8	18,949	10,368
9	4,057	5,344
10	10,438	7,204
11	14,099	9,366
12	39,518	29,096
13	10,074	1,824
14	4,188	3,836
15	1,458	967
16	461	192
17	736	342
18	27,320	28,034
19	32,989	29,945
20	7,226	5,734
Total	359,415	342,958

^aProduction for corn was calculated by adding 2/3 of the 1963 crop to 1/3 of the 1964 crop. This was done to make the marketing year coincide with the calendar year.

^bArea 6 was absorbed into other areas.

TABLE LVI

ESTIMATED CORN UTILIZATION FOR THE SM-29 SOUTHERN SUB-REGIONAL
AREAS, UNITED STATES 1964 AND 1975

Area	Corn Utilization	
	1964	1975
	-----1,000 Bushels-----	
1	36,337	48,377
2	53,501	68,346
3	59,624	62,012
4	10,287	15,937
5 ^a	15,101	24,721
7	32,221	41,875
8	37,980	65,294
9	45,039	77,327
10	17,305	13,315
11	20,367	14,623
12	40,896	39,821
13	41,568	60,690
14	6,973	10,366
15	12,701	21,909
16	22,090	43,330
17	4,647	7,607
18	19,434	30,270
19	49,913	57,061
20	10,344	7,232
Total	536,328	710,113

^aArea 6 was absorbed into other areas.

TABLE LVII

VALUES OF THE CONSTANT TERM IN PSEUDO DEMAND FUNCTIONS FOR CORN BY MODE OF TRANSPORTATION,
SM-29 DEFICIT AREAS 1964 AND 1975

SM-29 Area	Market Point	Mode of Transportation			
		Least-Cost Mode 1964	Least-Cost Mode 1975	Rent-A-Train Rate 1975	Gainesville Rate 1975
		-----Dollars Per Unit-----			
2	Charlotte, N. C.	45,124.97	51,789.03	50,807.82	50,901.22
4	Jacksonville, Fla.	13,101.51	a	a	a
5	Tampa, Fla.	25,046.63	26,352.72	25,550.65	25,608.66
7	Montgomery, Ala.	18,011.77	16,100.00	15,353.68	15,388.42
8	Guntersville, Ala.	29,217.93	57,118.90	56,159.86	56,356.30
9	Gainesville, Ga.	51,214.93	74,185.33	73,227.14	73,350.20
10	Chattanooga, Tenn.	17,064.33	8,111.00	7,393.64	7,432.22
11	Nashville, Tenn.	16,423.23	7,420.90	6,546.64	6,579.54
12	Memphis, Tenn.	11,535.33	12,885.43	12,032.76	12,057.28
13	Jackson, Miss.	41,726.03	54,105.95	53,146.97	53,246.37
14	New Orleans, La.				
	(Domestic)	12,979.33	8,527.00	7,891.90	7,935.50
15	Shreveport, La.	21,516.66	23,202.47	22,247.00	22,266.84
16	Springdale, Ark.	31,801.80	45,311.96	44,345.00	44,420.00
17	Little Rock, Ark.	14,137.10	9,492.26	8,558.80	8,596.00
18	Henderson, Ky.	a	4,185.00	3,494.92	3,549.63
19	Louisville, Ky.	27,053.00	a	a	a
20	Ashland, Ky.	13,278.97	4,154.32	3,278.32	3,319.64
21	Harrisonburg, Va.	12,906.55	4,102.00	3,398.82	3,402.74
22	Baltimore, Md.	10,388.57	1,000.00	1,553.50	1,645.84
23	Salisbury, Md.	10,784.87	1,000.00	1,931.70	2,019.22
24	Norfolk, Va.	23,757.01	15,762.68	14,846.30	14,933.82

TABLE LVII (continued)

SM-29 Area	Market Point	Mode of Transportation			
		Least-Cost Mode 1964	Least-Cost Mode 1975	Rent-A-Train Rate 1975	Gainesville Rate 1975
		-----Dollars Per Unit-----			
40A	New Orleans, La. (Export)	238,125.33	430,777.42	429,955.60	429,985.50
40B	Pascagoula, Miss. (Export)	62,100.33	98,766.42	97,821.70	97,874.50
40C	Mobile, Ala. (Export)	21,308.33	66,523.42	65,578.70	65,731.50
44	Charleston, S. C. (Export)	13,529.73	5,541.00	4,745.14	4,832.66

^aThis market was surplus.

TABLE LVIII

TOTAL COSTS OF THE OPTIMUM SHIPPING PATTERNS FOR CORN WITH ADJUSTED AND UNADJUSTED DEMAND,
UNITED STATES BY SM-29 SUB-REGIONAL AREAS, 1964 AND 1975

Transportation Mode	1964		1975	
	Unadjusted Demand	Adjusted Demand ^a	Unadjusted Demand	Adjusted Demand ^a
	-----Dollars-----			
Least-cost mode	60,456,300	92,592,600	109,079,000	184,914,000
Barge, least-cost rail	65,608,400	104,637,000	124,691,000	218,043,000
Barge-truck	67,997,800	104,842,000	124,958,000	214,139,000
Barge, weighted-average rail	72,628,400	113,304,000	131,627,000	226,566,000
Least-cost rail	115,051,000	179,898,000	--	--
Rent-A-Train rate	--	--	186,599,000	328,863,000
Gainesville rate	--	--	205,495,000	364,545,000
Weighted-average rail	117,760,000	185,449,000	213,287,000	381,649,000
Truck	127,332,000	194,648,000	239,869,000	406,584,000
Highest cost mode	135,940,000	205,588,000	254,245,000	428,671,000

^aAll market demands were proportionately adjusted upward to force all allocations to real markets.

TABLE LIX

OPTIMUM SHIPMENTS OF CORN WITH THE LEAST-COST MODE OF TRANSPORTATION
AND ADJUSTED^a DEMAND,, UNITED STATES BY SM-29 MARKET AREAS 1964

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
1	2	10,626
1	21	2,719
1	22	132
1	23	676
1	24	18,254
3	2	330
3	4	3,888
3	44	4,599
18	2	7,886
25	2	15,847
26	2	12,407
26	9	55,357
26	10	2,837
26	20	4,211
27	7	7,971
27	19	22,860
29	5	20,069
29	40A	101,695
29	40B	70,113
29	40C	15,012
30	8	25,442
30	10	6,438
30	13	15,710
30	14	3,761
30	40A	108,569
31	12	1,861
31	40A	7,195
32	8	264
32	40A	85,378
33	7	2,551
33	11	8,466
33	13	26,831
33	15	1,238
33	40A	5,049

TABLE LIX (continued)

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
33	Slack ^b	16
34	15	13,948
34	16	29,216
34	17	5,282

^aDemand was proportionately adjusted to force allocations to real markets. The adjustment factor was 1.35078703.

^bSince values were rounded to whole numbers, this is the result of accumulated rounding errors.

TABLE LX

OPTIMUM SHIPMENTS OF CORN WITH THE HIGHEST-COST MODE OF TRANSPORTATION
AND ADJUSTED^a DEMAND, UNITED STATES BY SM-29 MARKET AREAS 1964

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
1	2	6,027
1	21	2,719
1	22	132
1	23	676
1	24	18,254
1	44	4,599
3	4	3,888
3	5	4,929
18	40C	7,886
25	2	2,361
25	10	9,275
25	20	4,211
26	5	15,140
26	8	4,315
26	9	55,357
27	40A	30,831
29	14	3,761
29	40A	203,128
30	7	10,522
30	8	21,391
30	11	8,466
30	12	1,861
30	13	3,672
30	15	15,186
30	19	22,860
30	40B	68,836
30	40C	7,126
31	40A	9,056
32	2	38,708
32	40A	45,641
32	40B	1,277
32	Slack ^b	16
33	13	38,869

TABLE LX (continued),

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
33	17	5,282
34	16	29,216
34	40A	19,230

^aDemand was proportionately adjusted to force allocations to real markets. The adjustment factor was 1.35078703.

^bSince values were rounded to whole numbers, this is the result of accumulated rounding errors.

TABLE LXI

ESTIMATED COSTS OF TRANSPORTING CORN OVER SUB-OPTIMUM ROUTES AMONG DESIGNATED MARKETS WITH THE LEAST-COST MODE
OF TRANSPORTATION, UNITED STATES BY SM-29 MARKET AREAS, 1964

Market	Origin												
	(1)	(3)	(18)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Henderson, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
2 Charlotte, N. C.	53.48	125.44	70.20	34.56	55.84	57.76	63.00	55.00	55.00	0.00	55.00	108.20	
4 Jacksonville, Fla.	0.00	72.96	59.96	30.52	30.52	14.32	34.72	27.72	27.72	27.72	27.72	80.92	
5 Tampa, Fla.	0.00	0.00	28.16	1.40	0.00	22.36	4.92	4.92	4.92	4.92	4.92	58.12	
7 Montgomery, Ala.	116.56	101.24	38.12	22.96	8.40	0.00	8.00	0.00	0.00	0.00	0.00	53.20	
8 Guntersville, Ala.	101.88	112.16	29.44	7.28	0.00	25.72	8.00	0.00	0.00	0.00	0.00	53.20	
9 Gainesville, Ga.	60.00	81.36	29.44	0.00	0.00	21.80	9.40	1.40	1.40	1.40	1.40	54.60	
10 Chattanooga, Tenn.	86.40	119.72	36.16	0.00	4.76	25.72	8.00	0.00	0.00	0.00	0.00	53.20	
11 Nashville, Tenn.	124.20	175.72	55.76	19.60	24.36	43.32	8.00	0.00	0.00	0.00	0.00	53.20	
12 Memphis, Tenn.	142.68	157.24	57.76	31.28	27.36	53.92	11.00	11.00	11.00	11.00	0.00	64.20	
13 Jackson, Miss.	141.28	149.04	50.16	68.96	18.76	39.72	8.00	0.00	0.00	0.00	0.00	53.20	
14 New Orleans, La.													
(Domestic)	112.82	68.84	43.24	33.52	14.40	45.24	0.00	0.00	0.00	0.00	0.00	53.20	
15 Shreveport, La.	211.32	243.52	166.68	191.92	160.00	156.24	86.80	89.20	85.60	89.60	2.80	0.00	
16 Springdale, Ark.	335.36	370.36	235.56	265.84	192.96	214.20	117.60	117.60	120.40	86.80	0.00	0.00	
17 Little Rock, Ark.	225.32	239.88	158.20	149.64	127.80	154.36	50.40	50.40	53.20	50.40	2.80	0.00	
19 Louisville, Ky.	146.09	204.28	70.65	52.49	46.24	0.00	15.69	41.16	41.16	41.16	41.16	79.36	
20 Ashland, Ky.	198.44	269.28	151.48	65.92	115.48	38.24	108.00	100.00	0.00	113.12	119.00	153.20	
21 Harrisonburg, Va.	0.00	108.84	79.32	52.16	56.92	30.71	46.40	52.16	52.16	52.16	52.16	105.36	
22 Baltimore, Md.	0.00	74.08	54.88	53.10	57.86	58.63	58.10	53.10	22.40	50.56	53.10	106.30	
23 Salisbury, Md.	0.00	143.36	123.92	94.76	110.24	117.96	113.48	105.48	85.84	60.20	105.48	158.68	
24 Norfolk, Va.	0.00	126.56	110.88	92.96	114.24	116.16	121.40	113.40	113.40	58.40	113.40	116.60	
40A New Orleans, La.													
(Export)	113.52	88.84	39.00	33.52	114.32	45.24	0.00	0.00	0.00	0.00	0.00	53.20	
40B Pascagoula, Miss.													
(Export)	113.52	87.76	0.00	29.44	14.40	28.55	0.00	0.00	0.00	0.00	0.00	52.43	
40C Mobile, Ala.													
(Export)	113.52	65.36	0.00	29.44	14.40	28.55	0.00	0.00	0.00	0.00	0.00	52.43	
44 Charleston, S. C.													
(Export)	0.00	63.28	94.60	58.44	63.20	78.55	66.44	58.44	58.44	58.44	58.44	111.64	

TABLE IXII

OPTIMUM SHIPMENTS OF CORN WITH THE LEAST-COST MODE OF TRANSPORTATION
AND ADJUSTED^a DEMAND, UNITED STATES BY SM-29 MARKET AREAS 1975

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
1	21	656
1	23	744
1	24	19,637
3	7	10,542
3	44	5,058
4	22	146
4	24	437
19	40B	14,896
19	40C	21,411
25	2	29,436
25	20	2,971
26	7	10,310
26	8	52,322
26	9	90,359
27	2	44,216
27	9	16,499
27	21	2,334
29	5	35,889
29	40A	362,501
29	40B	24,698
30	10	9,077
30	13	34,138
30	14	9,700
30	40A	274,121
31	12	15,931
31	40C	2,589
32	40B	103,645
32	40C	71,493
33	8	29,281
33	11	7,809
33	13	42,970
33	11	6,906
33	18	3,321

TABLE LXII (continued)

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
33	Slack ^b	2
34	15	31,108
34	16	57,172
34	17	10,792

^aDemand was proportionately adjusted to force allocations to real markets. The adjustment factor was 1.48542259.

^bSince values were rounded to whole numbers, this is the result of accumulated rounding errors.

TABLE LXIII

OPTIMUM SHIPMENTS OF CORN WITH THE HIGHEST-COST MODE OF TRANSPORTATION
AND ADJUSTED^a DEMAND, UNITED STATES BY SM-29 MARKET AREAS 1975

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
1	24	20,074
1	44	963
3	5	15,600
4	5	583
19	21	2,990
19	22	146
19	23	744
19	40C	32,427
25	2	20,359
25	10	9,077
25	20	2,971
26	8	46,133
26	9	106,858
27	5	19,706
27	40C	43,343
29	40A	418,993
29	44	4,095
30	7	20,852
30	8	35,470
30	11	7,809
30	12	15,931
30	13	17,927
30	18	3,321
30	40A	184,607
30	40B	41,119
31	14	9,700
31	40A	8,820
32	2	53,293
32	40B	102,120
32	40C	19,723
32	Slack ^b	2
33	13	59,181
33	15	31,108
34	16	64,078

TABLE LXIII (continued)

Origin SM-29 Area	Destination SM-29 Area	Volume of Corn Shipped 1,000 Bushels
34	17	10,792
34	40A	24,202

^aDemand was proportionately adjusted to force allocations to real markets. The adjustment factor was 1.48542259.

^bSince values were rounded to whole numbers, this is the result of accumulated rounding errors.

TABLE LXIV

ESTIMATED COSTS OF TRANSPORTING CORN OVER SUB-OPTIMUM ROUTES AMONG DESIGNATED MARKETS WITH THE GAINESVILLE RAIL RATE,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.	
2 Charlotte, N. C.	106.00	114.68	123.72	89.88	33.27	52.42	42.09	56.78	63.62	50.40	0.00	50.40	86.40	
5 Tampa, Fla.	63.28	0.00	0.00	65.24	1.26	0.00	8.07	2.35	17.19	3.97	3.97	3.97	49.97	
7 Montgomery, Ala.	152.40	73.80	97.04	49.84	15.04	0.00	19.97	14.00	6.00	10.42	15.46	9.30	43.06	
8 Guntersville, Ala.	153.40	101.40	117.68	57.84	7.81	11.25	12.35	6.38	13.22	0.00	0.00	0.00	36.00	
9 Gainesville, Ga.	113.34	71.42	110.26	53.06	0.00	0.00	7.57	6.38	9.22	0.00	0.00	0.00	36.00	
10 Chattanooga, Tenn.	130.16	100.20	116.48	49.08	0.00	4.28	19.21	21.92	13.92	18.34	23.38	17.22	50.98	
11 Nashville, Tenn.	154.04	101.68	134.92	54.76	5.68	9.96	24.89	8.00	0.00	4.42	9.46	3.30	37.06	
12 Memphis, Tenn.	169.22	120.50	137.90	60.06	14.06	9.66	30.19	7.70	7.70	12.12	17.16	0.00	44.76	
13 Jackson, Miss.	194.81	139.29	162.05	72.85	64.42	18.14	24.95	6.38	13.22	0.00	0.00	0.00	36.00	
14 New Orleans, La.														
(Domestic)	142.66	55.40	96.00	54.68	19.60	0.00	24.81	0.00	0.00	4.42	9.46	3.30	37.06	
15 Shreveport, La.	274.66	243.58	264.02	199.18	185.07	156.34	139.80	88.38	105.74	92.52	92.52	14.40	0.00	
16 Springdale, Ark.	393.94	365.38	402.34	252.38	251.60	184.90	191.96	116.10	130.94	120.24	0.00	11.88	0.00	
17 Little Rock, Ark.	271.30	222.58	258.98	179.94	151.86	129.54	150.07	66.54	66.54	74.76	76.00	22.24	0.00	
18 Henderson, Ky.	180.31	162.39	190.39	63.67	75.99	21.47	0.00	22.31	8.91	13.33	18.37	12.21	45.97	
20 Ashland, Ky.	223.86	231.42	247.70	113.46	47.58	96.66	13.39	103.58	95.58	0.00	118.16	117.88	132.64	
21 Harrisonburg, Va.	87.68	133.24	164.12	60.00	96.08	99.14	0.00	85.20	110.00	99.14	99.14	99.14	130.74	
22 Baltimore, Md.	3.02	14.50	37.10	3.26	12.36	16.64	3.26	28.46	26.28	0.00	1.06	23.73	59.73	
23 Salisbury, Md.	0.00	80.08	64.20	63.68	40.95	60.10	49.77	64.46	71.30	58.08	7.68	58.08	94.08	
24 Norfolk, Va.	0.00	63.28	67.40	95.76	39.15	58.30	47.97	62.66	69.50	56.28	5.88	56.28	92.28	
40A New Orleans, La.														
(Export)	143.36	55.40	96.00	39.00	19.60	0.00	24.81	0.00	0.00	4.42	9.46	3.30	23.69	
40B Pascagoula, Miss.														
(Export)	143.36	54.32	96.00	0.00	15.52	0.00	0.00	0.00	0.00	4.42	9.46	3.30	23.69	
40C Mobile, Ala.														
(Export)	143.36	31.92	96.00	0.00	15.52	0.00	0.00	0.00	0.00	4.42	9.46	3.30	23.69	
44 Charleston, S. C.														
(Export)	0.00	0.00	13.44	20.16	14.68	18.96	20.16	36.60	28.60	33.02	6.20	31.90	65.66	

TABLE LXV

ESTIMATED COSTS OF TRANSPORTING CORN OVER SUB-OPTIMUM ROUTES AMONG DESIGNATED MARKETS WITH THE RENT-A-TRAIN RAIL RATE,
UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan./Mo.	
2 Charlotte, N. C.	111.88	150.07	173.59	130.48	57.93	80.80	27.02	33.60	84.96	33.60	0.00	33.60	57.60	
5 Tampa, Fla.	33.77	0.00	0.00	70.45	40.35	47.15	12.49	5.29	56.65	5.29	0.00	5.29	29.29	
7 Montgomery, Ala.	99.62	50.53	73.77	31.87	11.20	4.84	0.00	1.39	10.84	1.38	1.38	1.38	25.38	
8 Guntersville, Ala.	162.32	139.83	156.11	101.48	40.97	46.71	7.20	0.00	51.36	0.00	0.00	0.00	24.00	
9 Gainesville, Ga.	128.88	116.47	155.31	103.32	35.76	45.86	4.00	0.00	51.36	0.00	0.00	0.00	24.00	
10 Chattanooga, Tenn.	81.22	80.77	97.05	34.86	0.00	12.96	3.08	30.60	22.60	41.80	50.42	37.32	52.36	
11 Nashville, Tenn.	99.42	76.57	109.81	34.86	0.00	12.96	3.08	11.00	3.00	22.20	27.42	17.72	32.76	
12 Memphis, Tenn.	106.22	87.01	104.41	31.78	0.00	4.28	0.00	2.32	2.32	21.52	25.30	6.04	32.08	
13 Jackson, Miss.	206.75	180.74	203.50	119.51	82.38	57.96	15.60	0.00	51.36	0.00	0.00	0.00	24.00	
14 New Orleans, La.														
(Domestic)	98.74	40.99	81.59	45.48	24.62	13.70	7.20	0.00	13.70	0.00	0.00	0.00	24.00	
15 Shreveport, La.	206.98	205.41	225.85	166.22	169.82	169.04	134.44	110.24	112.74	128.24	58.71	40.96	0.00	
16 Springdale, Ark.	381.42	382.37	419.33	274.58	200.82	162.80	120.61	70.48	129.84	80.16	0.00	7.92	0.00	
17 Little Rock, Ark.	221.25	201.77	238.17	164.34	150.48	136.84	132.56	73.84	73.84	95.84	113.20	40.96	0.00	
18 Henderson, Ky.	147.50	159.09	187.09	65.58	92.12	46.28	0.00	47.12	33.72	52.92	73.08	48.44	63.48	
20 Ashland, Ky.	177.66	214.73	231.01	101.98	50.32	108.08	0.00	115.00	107.00	26.20	159.48	140.72	136.76	
21 Harrisonburg, Va.	4.08	79.15	110.03	11.12	35.76	45.86	4.00	0.00	51.36	0.00	0.00	0.00	24.00	
22 Baltimore, Md.	7.84	48.83	71.43	42.80	48.77	58.87	17.01	13.01	64.37	13.01	0.00	13.01	37.01	
23 Salisbury, Md.	0.00	109.59	93.71	98.40	59.73	82.60	28.82	35.40	86.76	35.40	1.80	35.40	59.40	
24 Norfolk, Va.	0.00	92.79	96.91	130.48	57.93	80.80	27.02	33.60	84.96	33.60	0.00	33.60	57.60	
40A New Orleans, La.														
(Export)	85.74	27.29	67.89	16.10	10.92	0.00	0.00	0.00	0.00	16.10	12.46	14.72	12.46	
40B Pascagoula, Miss.														
(Export)	108.64	49.11	90.79	0.00	29.74	22.90	6.21	0.00	22.90	0.00	0.00	0.00	1.49	
40C Mobile, Ala.														
(Export)	108.64	26.71	90.79	0.00	29.74	22.90	6.21	0.00	22.90	0.00	0.00	0.00	1.49	
44 Charleston, S. C.														
(Export)	0.00	29.51	42.95	54.88	58.25	70.50	27.34	24.64	76.00	24.64	0.32	24.64	48.64	

TABLE LXVI
ESTIMATED COSTS OF TRANSPORTING CORN OVER SUB-OPTIMUM ROUTES AMONG DESIGNATED MARKETS WITH THE LEAST-COST MODE OF
TRANSPORTATION, UNITED STATES BY SM-29 MARKET AREAS, 1975

Market	Origin													
	(1)	(3)	(4)	(19)	(25)	(26)	(27)	(29)	(30)	(31)	(32)	(33)	(34)	
	Wilson, N. C.	Valdosta, Ga.	Jacksonville, Fla.	Louisville, Ky.	Cincinnati, Ohio	Evansville, Ind.	Indianapolis, Ind.	Peoria, Ill.	St. Louis, Mo.	Davenport, Iowa	Minneapolis, Minn.	Omaha, Neb.	Kansas City, Kan. Mo.	
2 Charlotte, N. C.	58.61	35.50	104.61	45.69	0.00	11.92	0.00	87.37	11.43	80.07	54.91	11.16	49.22	
5 Tampa, Fla.	169.99	49.10	87.96	111.40	112.90	95.31	144.92	0.00	77.00	53.40	60.50	69.58	74.31	
7 Montgomery, Ala.	117.74	0.00	68.83	11.03	17.31	0.00	2.62	20.39	1.35	20.29	203.90	36.57	41.40	
8 Guntersville, Ala.	138.37	46.83	109.30	36.62	52.10	0.00	2.35	7.12	0.00	7.22	7.12	0.00	29.13	
9 Gainesville, Ga.	105.98	24.92	109.35	41.55	0.85	0.00	0.00	74.67	0.85	69.49	74.67	0.85	38.64	
10 Chattanooga, Tenn.	98.73	29.63	91.50	13.50	5.50	2.71	39.49	0.00	0.00	0.00	0.00	15.88	21.01	
11 Nashville, Tenn.	160.45	68.95	147.78	55.08	49.02	35.96	36.25	26.12	26.12	26.20	26.12	0.00	5.63	
12 Memphis, Tenn.	188.85	100.99	163.98	38.70	35.10	18.51	68.22	8.90	6.90	0.00	3.90	11.38	16.21	
13 Jackson, Miss.	183.00	88.34	156.64	56.89	46.62	11.25	10.75	75.94	0.00	68.64	77.08	0.00	37.79	
14 New Orleans, La.														
(Domestic)	198.51	72.11	158.30	26.70	28.20	10.61	60.22	0.00	0.00	0.00	0.00	5.58	10.41	
15 Shreveport, La.	6.80	6.58	2.61	2.36	2.34	4.27	9.12	3.06	7.89	0.06	3.06	9.33	0.00	
16 Springdale, Ark.	349.75	271.47	364.60	160.34	156.74	108.17	107.84	111.54	70.56	102.94	69.16	0.00	0.00	
17 Little Rock, Ark.	222.81	134.95	216.94	49.04	45.44	28.85	58.44	19.24	17.24	10.34	14.24	13.25	0.00	
18 Henderson, Ky.	192.71	128.65	209.24	49.23	42.72	10.36	9.66	34.57	27.02	22.32	23.87	0.00	18.73	
20 Ashland, Ky.	195.23	204.71	267.24	1.64	0.00	12.45	28.92	74.30	60.60	58.70	58.60	48.88	53.61	
21 Harrisonburg, Va.	0.00	42.39	118.86	177.92	7.62	20.07	0.00	53.60	53.60	53.70	53.60	47.42	61.23	
22 Baltimore, Md.	2.56	76.61	0.00	60.41	44.01	56.46	72.93	118.31	104.61	102.71	102.61	92.89	97.62	
23 Salisbury, Md.	0.00	93.75	17.14	97.88	81.48	93.93	110.40	155.78	138.63	140.18	140.08	130.36	135.09	
24 Norfolk, Va.	0.00	43.05	0.00	101.52	64.83	76.75	64.83	129.26	76.26	129.26	119.74	76.26	114.05	
40A New Orleans, La. (Export)	199.21	72.11	107.04	26.70	28.20	10.61	60.22	0.00	0.00	0.00	0.00	5.58	9.81	
40B Pascagoula, Miss. (Export)	191.29	43.35	134.46	0.00	15.14	10.61	60.22	0.00	0.00	0.00	0.00	5.58	10.31	
40C Mobile, Ala. (Export)	191.29	30.58	134.46	0.00	15.14	10.61	60.22	0.00	0.00	0.00	0.00	5.58	10.31	
44 Charleston, S. C. (Export)	39.14	0.00	59.03	55.15	85.38	84.60	85.38	74.85	74.85	74.95	74.85	48.73	54.36	

VITA

Harry Boger Strawn, son of Mr. and Mrs. Homer Strawn, was born February 7, 1940 in Monroe, North Carolina. His childhood years were spent on a poultry and livestock farm in the central part of the State. He received his elementary and high school education at Unionville High School where he received his diploma in 1958.

From high school he entered North Carolina State University and obtained his Bachelor of Science degree in Agricultural Economics in June 1962. During the summer of that year he accepted a research assistantship at The University of Tennessee where he was awarded his Master of Science degree in Agricultural Economics in December 1964.

Upon receipt of an additional research assistantship, he continued his post-graduate education at the same institution. His doctorate was awarded in December 1969.

He is an associate member of Farmhouse Fraternity, Tennessee Chapter.