# A SPATIAL ANALYSIS OF GRAIN MARKETING COOPERATIVES IN SOUTHWESTERN KANSAS

By

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# CHAPTER I

# INTRODUCTION

Agricultural cooperatives have been organized in many places throughout the world. In regions as diverse as Northern Europe, Latin America, and the Middle East, agricultural producers have opted for various forms of cooperation as a means of increasing their economic welfare. Many examples of successful cooperative systems can be found and the outlook for the further development of cooperative organizations appears to be bright. Cooperation in the more developed countries continues to increase, even in places where cooperative organizations are already abundant. Partly because of the success of these systems, agricultural producers in the less developed countries increasingly utilize principles of cooperation when forming new marketing associations in an effort to boost their profits. The well-developed cooperative system of the agricultural heartland of the United States is an example of a successful and dynamic marketing alternative for that region's agricultural producers. The United States is often looked to for a model when structural change is desired by those who inhabit areas of the world where modernization is desired. The form of cooperation peculiar to agricultural regions in the United States may be such a model.

The agricultural cooperative system in the United States has evolved over the last century to the point that the earliest forms of cooperatives no longer exist. Local associations, originally with ties only to their member-patrons, have joined together and built a cooperative infrastructure, allowing them to become a powerful economic force in the rural environment. Still, the primary components of this system are the individual cooperatives. They may be defined as "businesses voluntary organized, operating at cost, which are owned, capitalized, and controlled by member-patrons as users, sharing risks and benefits proportional to their participation" (Roy, 1981). Local cooperatives are especially strong in the intensely farmed regions of the United States.

The productive agricultural region of southwestern Kansas is noted for the influence of agricultural cooperatives in its economy. Since the formation of the earliest association in 1902 (Cooperative Digest, 1951), this region has experienced phenomenal growth of its cooperative system. The presence of cooperatives in southwestern Kansas over several decades, in conjunction with the changes that have occurred in the system, creates a pattern of spatial responses that can be useful in a geographical analysis of cooperative development.

# Brief History of Agricultural Cooperatives in the United States

The cooperative movement in the United States began with the pioneer farmers' increasing desire to improve their marketing positions for the commodities they produced. Dissatisfaction with prices provided the impetus for the formation of the earliest modern era agricultural cooperatives beginning in the latter part of the nineteenth century. However, as the years passed, and cooperation among farmers began to be perceived as a viable organizational arrangement, two main objectives were sought in the development of new cooperatives. Participating farmers desired additional goods and services with realized cost savings, and they wished to stabilize food and agricultural systems (Sargent, 1982).

Two general farm organizations, the National Grange and the Farmers' Alliance, were among the first to use cooperative marketing, as well as cooperative wholesale buying, in attempts to improve the economic condition of farmer-members. Although the Grange's dominating influence in the establishment of local cooperatives throughout the nation was relatively short-lived, it was very instrumental in the introduction of the business cooperative system. As the Grange began to decline in the 1870s, the Farmers' Alliance became active in instituting cooperative business enterprises. It continued to foster cooperative endeavors for about twenty years, and the successful operations that it spawned provided the foundation for the initiation of new farm organizations that would work to establish cooperatives after the turn of the century (Abrahamsen and Scroggs, 1957).

The Farmers' Educational and Cooperative Union, an outgrowth of the Farmers' Alliance, became the next leading farm organization that began organizing local cooperative businesses. The first local union was formed in Texas in 1902 and the national organization was formed in 1905. In the Farmer's Union charter, its purpose was stated as follows:

> . . . it is formed to organize and charter subordinate Unions at various places in Texas and the United States to assist them in marketing and obtaining better prices for their products, for fraternal purposes, and to cooperate with them in the protection of their interests (Powell,1913).

By 1909, numerous state and local organizations had been founded in most agricultural areas, including Kansas. Membership in the local union was strictly confined to farmers, farm laborers, rural mechanics, rural school teachers, physicians, and ministers of the gospel. No one who was involved in banking, merchandising, law, or speculating was allowed to join. It was originally a secret organization with signs and passwords and, although members were elected by ballot, they were subject to "blackball" (Powell, 1913). In later years, the Farmers' Union became active in organizing federated and centralized regional associations. In 1914, the Kansas local unions formed a regional grain marketing association to sell their members' grain on the terminal market (Abrahamsen, 1976).

During the early years considerable uncertainty concerning the legality of cooperative associations existed. The Sherman Antitrust Act had been passed by Congress in 1890 making combinations that resulted in the restraint of trade illegal. Several states then followed this lead by enacting similar legislation. As a result, the young cooperatives' legal status became precarious, at best, because they were easily adjudged as combinations in restraint of trade. In this era associations began to be prosecuted under the new laws. Most, however, were allowed to continue their operations because they were considered fairly insignificant in terms of the industry as a whole. Meanwhile, cooperative leaders were lobbying for a definite statement in the law which would provide exemption from the provisions of the Sherman Act for this relatively new form of business organization. The Clayton Act of 1914 was the first step in this direction. It provided for exemption of non-stock, non-profit marketing cooperatives, but many of the early organizations had capital stock and others were interested in organizing with capital stock. A state of uncertainty remained regarding the status of most cooperatives. Finally, in 1922 the Capper-Volstead Act clarified the Clayton Act and made cooperative associations legal whether they were incorporated with or without capital stock. The Capper-Volstead Act has been frequently referred to as the "Magna Carta of farmers' cooperatives" (Roy, 1981). Following this landmark legislation a flurry of new associations began to dot the landscape in many areas (Bakken and Schaars, 1937).

The beginnings of the farmers' cooperative elevator associations were a result of perceived abuses in the grain distributing system as handled by the local grain dealers and line-elevator companies. The farmers who banded together were forced to meet the competition of the commercial grain handlers by forming organizations which were equal to or better than those already in existence. These early cooperatives were organized according to articles of incorporation and a set of by-laws. The earnings were generally distributed on the basis of capital invested, although each stockholder was allowed but one vote regardless of the number of shares that he owned (Powell, 1913). Most of the early members were primarily interested in the economic benefits that could be obtained through their patronage. They did not view cooperation among farmers as an aspect of reform. Rather, they looked forward to cheaper prices, rebates commensurate to their participation, or better services. In essence, these farmers felt that farming, as a way of life, "could be made more prosperous and satisfying through the organization and operation of cooperatives. Members viewed their cooperatives as a special type of business organization which would be more efficient and provide greater financial rewards than a non-cooperative business, and the cooperative that could not meet these standards seldom had a long history." (Fite, 1978)

Many failures occurred among the early farmers' elevator associations. Several factors were involved in the demise of some and in the success of others. One rather widespread problem was the mismanagement of cooperatives by men who could not handle the business successfully in competition with the more experienced line-elevator managers. Many were overly ambitious and branched out into speculative activities. Some failed when they ceased to pay large dividends at the end of the year, and some of the associations experienced a loss of cooperative spirit among the members (Powell, 1913). However, a number of them stood the test of time; many of the earliest cooperatives are still in existence today. In addition to purchasing grain from members and non-members, these cooperative elevators expanded their services by becoming purchasing agents for supplies, such as coal, lumber, and fertilizer. These supplies were sold at the prevailing prices and the profit was divided among the members at the end of the year. An early cooperative principle stated that "purchasing cooperatives should sell at regular retail prices so as not to pass out benefits to those who are not members of the cooperative. Otherwise, co-op members become disadvantaged relative to nonmembers." (Roy, 1981).

Probably the biggest reason for the early cooperatives' success, though, was their ability to band together into regional federations. In 1913, Powell recognized the necessity of this when he stated:

> Ultimately, the success of the farmers' cooperative elevators will depend on the federation of many of them into central organizations, that will act as a clearing house in handling the grain of each local elevator, as a part of a comprehensive distributing and marketing system. The central agencies will build terminal elevators at the primary markets . . . The larger form of organization is a matter of evolution as the necessity arises . . .

Largely as a result of federation, agricultural cooperatives began to expand their marketing and purchasing services through the years. Many of them, especially between the years of 1933 and 1945, started to handle a wider line of supplies, such as insecticides, veterinary supplies, and miscellaneous farm and home equipment. The newer regional farm supply cooperatives began to manufacture feed and fertilizer and to explore for crude oil as a source for their new refineries. Such services as seed cleaning, fertilizer spreading, and local beef processing plants were added. Through the economic hard times of the 1930s and early 1940s, cooperatives were increasingly "recognized as an effective type of business enterprise that could help members help themselves." (Abrahamsen, 1976)

From 1945 until the present, the trend towards integration has intensified. Cooperatives have gained economic power by the strength that has resulted from joining together. This "pooling of resources" into regional cooperatives has allowed the continued expansion of production supply facilities. Most of the feed, seed, petroleum, and fertilizer that the local cooperatives handle is processed by regional cooperative plants. Consolidations and mergers have increased as smaller cooperatives combine their resources. This is done in an effort to improve services and to take advantage of larger volumes that yield economies of scale, allowing them to hire more capable and efficient management. The continuing process of horizontal integration has created a strong foundation and made possible the handling of a wider variety of supplies and the marketing of more kinds of farm products. Some of the larger regional cooperatives have developed international markets and export programs that individual members may use as an alternative marketing strategy (Abrahamsen, 1976).

A sizeable difference exists in the small, local associations of yesteryear and the large-scale cooperative organizations of today. Present day cooperatives now handle a large variety of products and provide a wide range of services. They have achieved this tremendous growth "by effectively adjusting to change, responding to member needs, providing business leadership, integrating their operations, and adopting modern business methods and practice." (Abrahamsen, 1976)

# Literature Review

Agricultural cooperation is not an entirely American phenomenon. In fact, the cooperative movement began in Great Britain, although it is difficult to pinpoint exactly what initially constituted "cooperation." Many authors, both American and foreign, have written of the origins and subsequent development of agricultural cooperatives. The English have been especially prolific in their analysis and discussion of cooperatives. Potter (1930) stated that Robert Owen, the social reformer, was the father of cooperation and that his belief in the cooperative system of industry, beginning around 1770, was the genesis of agricultural cooperation. Potter continued by sketching the early British cooperative movement in an attempt to convince the readers that it was a new system with the potential to eliminate many social, administrative, and economic disorders. Ostergaard and Halsey (1965) studied the internal politics and structure of the British cooperative movement. They stressed the democratic nature of the cooperative society by expounding on the virtues of a voluntary association. The more voluntary an organization is, the less likely that exploitation of its membership will occur. The government of a cooperative organization, then, will be inclined to act in ways which further the interests of members. In another English work, Sargent (1982) limited his discussion only to agricultural cooperatives. He discussed the principles on which cooperation is based and reviewed the progress of the agricultural segment of the movement throughout several nations.

Probably the best known American authorities on agricultural cooperation are Knapp, Voorhis, and Abrahamsen. Knapp wrote several works on the subject, but his two-volume work (1969), where he covered the rise and advance of American cooperative enterprise, is especially noteworthy. A considerable portion of these texts deal with the history of agricultural cooperative activities, emphasizing the federal government's role in the promotion of this type of enterprise through legislative acts, and the institution of the centralized cooperative banking system which supplies funds to local and regional associations. Voorhis, ex-U.S. Congressman and a former executive director of The Cooperative League, said that cooperation is especially pertinent to the needs of our times (1961). He stated that he has seen how people can learn to live together in the small villages and farmlands of the world. Only if farmers join and act together can they possibly hope to gain a measure of economic bargaining power and some hope of escaping ultimate ruin. That is why farmers have formed cooperatives. No doubt the author that is most referred to on this subject is the agricultural economist, Abrahamsen. He thoroughly explained (1976) the cooperative's role in the American society and dissected each segment of the movement.

Then he proceeded to analyze, in detail, the characteristics of the agricultural cooperative as a business enterprise.

Another discipline that lends itself to the study of cooperatives is rural sociology. Several works identify the need for farm families to unite with one another in social organizations. Writing in the 1920's, Sanderson (1922) saw cooperation as a way to strengthen rural communities. He stated that "the very etymology of the two words, cooperate --to work together, and community--having in common, indicate that community activities are essentially a form of cooperation--of working together." Other authors developed this same theme. Burchfield (1947) listed a number of advantages that cooperatives provide the local communities, a few of which are:

> they save money for their members . . . Cooperatives offer educational benefits and spiritual satifaction. Through experience in cooperatives people come to appreciate the closer interrelation of producer and consumer. They gain an understanding of rural-urban interdependence. They learn democracy through participation . . .

Burchfield went on to say that cooperation must grow out of the needs, desires, interests, and active participation of the persons served since it is not imposed on anyone. Gee (1954) insisted that cooperation should not be expected to be a panacea for all the ills of agriculture. Cooperation is essentially a spiritual movement, and it is subject to human attitudes such as prejudices, passions, loyalty, and intelligent support. Cooperatives which operate according to fundamental economic principles will unite the membership and foster an improved community life.

No literature from the discipline of geography was found that specifically dealt with cooperatives. However, there are studies concerning the explanation of the spatial structure of agricultural activities, in general. Garrison and Marble (1957) presented a series of proofs for the basic theorem "that for every spatial location there is some jointly optimum intensity of land use, type of land use, and group of markets, the selection of which by the agricultural entrepreneur leads to spatially ordered patterns of land use." They also pointed out that there is a close relationship between industrial location theory and agricultural location theory. Garrison and Marble continued by stating that "essential to the rigorous development of any theory relating to the real world is the construction of a model or analogue of that portion of the real world under investigation. Through operations on this model the research worker is able to attempt investigations whose nature would render them extremely difficult without the aid of convenient abstraction."

Another study (Peet, 1969) concerns the spatial expansion of agricultural activities because of varying technical and economic inputs which results in changing spatial structures. Though Peet's study applies the von Thunen model to agricultural change in the last century, it highlights the system of forces that can be linked with evolving geographical patterns of agricultural production. In Chisholm's Rural Settlement and Land Use, the focus is on the development of "a partial approach to the general problem of the location of rural settlement and agricultural land use via an analysis of the significance of the distance factor." Chisholm discussed the bearing of technology on the distance factor both in terms of the effects on farm holdings and those external to the farmstead. In his conclusion, Chisholm explored "the technical and economic reasons for the decreasing relative importance of transport costs and thus of the distance factor, and notes some of the consequences for agriculture" (Birch, 1963).

Other literature deals with agricultural related phenomena as they occur in the Great Plains region of the United States. Hewes (1972) studied one causal factor of structural change in agriculture in western Kansas and eastern Colorado with in work on "suitcase" farming. He found that a substantial number of absentee landowners control farmland in western Kansas as a result of recurring drought and high crop failure rates. Non-residents, who buy land when local farmers are forced out, "move in with machines to extend wheat farming when conditions are favorable. In bad times, the non-residents can withdraw or cut back their operations more readily than local farmers." Hewes found that, while "suitcase" farming had generally declined, it still persisted in the area suggesting that this type of operation was well suited to the area owing to the variation in agricultural conditions from year to year.

Robinson, Lindberg, and Brinkman analyzed the areal variation in rural farm population in the Great Plains using multiple correlation and regression techniques. They concluded that correlation techniques are especially suited to a geographic study concerning areal variation of related phenomena since the variables always exist in complex interconnection. Another study concerning agricultural activity in the Great Plains is by Haining (1978), who outlined a methodology for developing spatial models to help explain the spatial pattern of corn and wheat yields in northwestern Kansas and southwestern Nebraska. Haining looked at two different scales of areal variation, at the regional and intercounty levels, using various forms of regression techniques.

Literary works from outside the discipline of geography were helpful in the formulation of the estimation and prediction models used in this study. A research paper by Burford (1966), outlines a cross sectional approach to create a set of regression equations for predicting migration, population, and various categories of employment for small area economies in time-series. Burford included lagged values of several endogenous variables as predetermined variables in his analysis. His work was experimental, as he focused on determining the feasibility of a particular approach. Still, reasonable forecasts were obtained for most of 680 counties. One of the early papers that dealt with the use of longitudinal data in developing an estimation model was by Bandeen (1957). He used regression analysis to estimate the income sensitivity of automobile consumption using variables that were derived from longitudinal data. Specifically, Bandeen's regression model was composed of compound variables, which consisted of combining variables such that values from one period were divided by values from another time period. Finally, a book by J. Scott Armstrong (1985) was very useful for reference, especially in the early stages of this study. In Long-Range Forecasting, Armstrong compared the most widely used methods for formulating estimation and prediction models in a fairly comprehensive format. After deciding to use regression analysis, frequent reference was made to the section of Armstrong's book dealing with regression.

# CHAPTER II

# THE RESEARCH PROBLEM

## Statement of the Problem

The primary objective of this study is to create a model that will help explain the spatial positioning of grain marketing cooperative plants within the specific counties of the study area for the years 1902 to 1986. The response variable is to be a function of several factors that have been identified as influencers of the incidence of cooperative plants on the landscape. Additionally, the following question is addressed: Is the model's solution for earlier years an accurate predictor of the density of cooperative plants per county in later years?

Additional questions explored in this study are: (1) How has the presence or absence of railroads in the study area influenced the spatial positioning of cooperative plants in different periods of time?, and (2) Has there been a significant change in the areal extent of the average servicing territory of marketing cooperative firms after the point in time in which each county was represented by at least one cooperative plant.

## The Study Area

The study area consists of seventeen counties in southwestern Kansas. It is bordered by Colorado on the west and Oklahoma on the south, and consists of the lower three tiers of counties by six counties wide. The individual counties that were surveyed are Clark, Comanche, Edwards, Finney, Ford, Grant, Gray, Hamilton, Haskell, Hodgeman, Kearny, Kiowa, Meade, Morton, Seward, Stanton, and Stevens (See Figure 1).

The cooperatives studied include every local grain marketing cooperative firm that has ever operated in the seventeen counties. The study also includes all cooperative plants located within the study area that are branches of cooperative firms outside the study area. However, cooperative plants that are located outside the study area, which are branches of cooperative firms within the study area, are not included in the analysis, although their existence is noted on maps.

## Hypotheses

Several hypotheses are offered concerning the existence of cooperatives, their growth or decline, and the spatial dynamics of the cooperative system in the study area over time. First, it is hypothesized that a model can be developed that will explain a significant proportion of the total variation in the spatial positioning of cooperatives

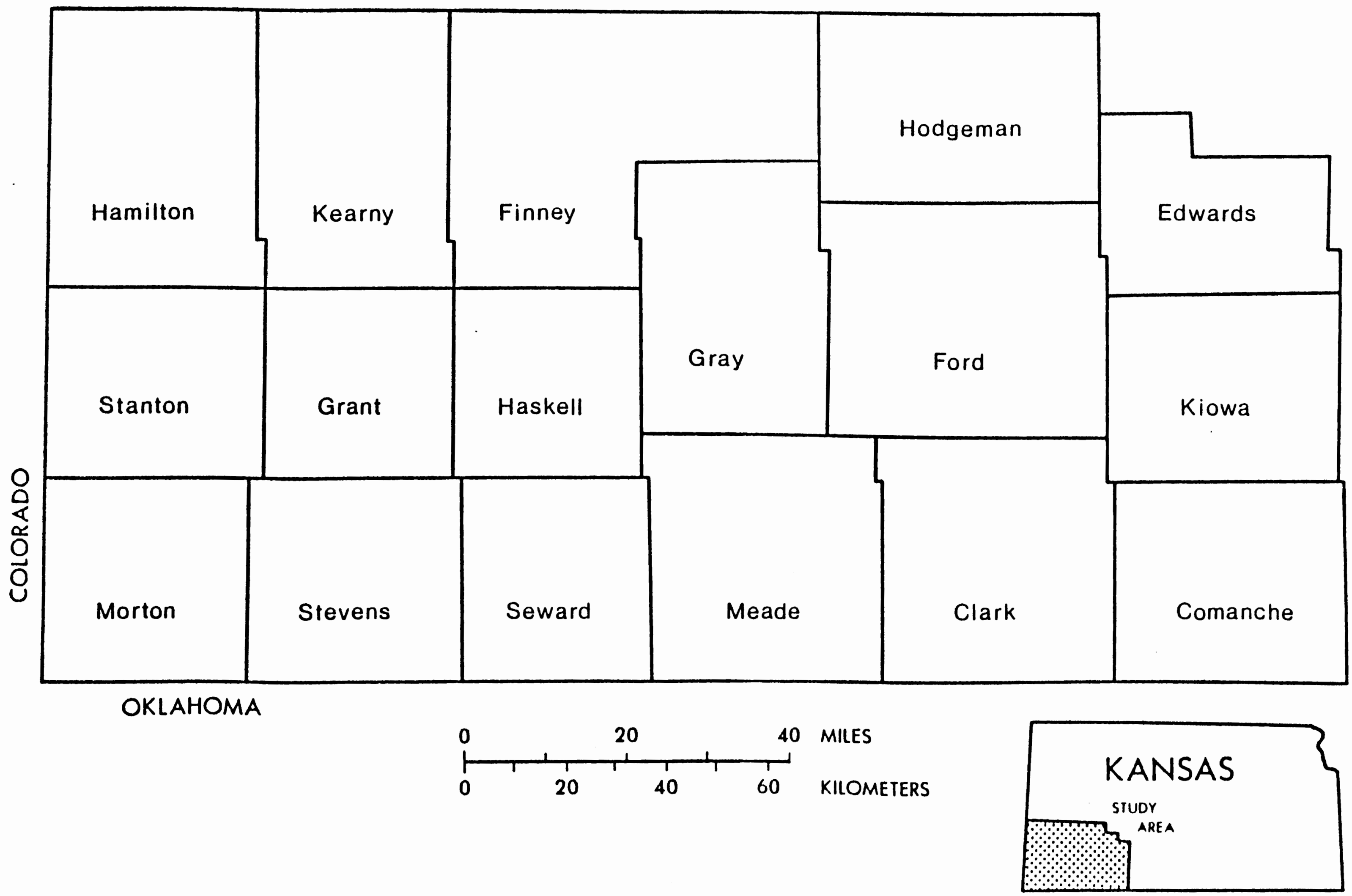



Figure 1. The Study Area

in the study area over time. Cooperators have tended to locate grain elevators in areas where current or potential grain production levels justify additional marketing facilities. The data to be included in the model reveal uneven grain production levels throughout the study area. It is probable that this unevenness is indicative of a disparate endowment over the landscape with respect to grain production potential at various points in time. The development of grain production technology through the years will cause disproportionate changes in the potential to produce grain in the different parts of the study area. The exogenous factors to be employed in the model will measure the effects of this potential changing into reality, prompting a spatial response in the form of a change in distribution of cooperative plants. It is thought that the model will account for a significant portion of the variation in observed cooperative density at the county level.

The second hypothesis is that the model's solution for a given time period can be utilized as a tool to predict the density of cooperative plants per county in a successive time period. This hypothesis rests on the assumption that a constant proportion of cooperators, or potential cooperators, in the population of grain producers exists throughout the study area at any point in time. Solving the model for a period in which a full complement of data is available will yield a value that can be used to predict the cooperative intensity of each county in the study area for a succeeding period. The rationale for this hypothesis follows, in part, from a much publicized goal of early cooperative organizers. Coulter (1914) stated that "the cooperative movement should extend into all parts of the country where grain-growing on a commercial basis warrants the building of a separate elevator." The supposition is that estimates of various county data over time will measure where, at the county level, and when the formation of new cooperative plants is warranted. As conditions change over time, it may be that fewer cooperative plants are warranted per square mile in some areas as the calculated density measure increases. The interplay of the exogenous factors to be employed in the model will yield a value that can be thought of as a demand determinant for the establishment of grain marketing cooperatives within each county at a specific point in time.

The third hypothesis is that, while railroads have had a major impact on the spatial positioning of grain marketing cooperative plants, the tendency to locate new cooperative plants on railroads is in decline. Rail transportation has traditionally been more cost effective than other transportation alternatives, in addition to having the ability to carry very heavy loads (Doerr, 1969). It is contended that cooperators have historically selected an elevator site on a railroad siding when faced with the infeasibility of locating elsewhere. However, it is further the case that there has been a decreasing reliance on rail transportation for grain shipment since the advent of large scale over-the-road trucking. Therefore, the percentage of cooperative plants locating on railroads will diminish over time as more and more plants are established in areas not proximate to railroads.

Finally, it is hypothesized that there has been a significant increase in the servicing territories of grain marketing cooperative firms since 1945, the first year that each county in the study area was represented by at least one cooperative. The on-going process of cooperative firm consolidations, in addition to the trend of locating plants at greater distances from their administrative centers, will result in an increase in the areal extent of servicing territories for most cooperative firms over time.

## Justification of the Study

The presence of agricultural cooperatives in southwestern Kansas impacts the lives of most residents of the region in one way or another. They are an integral part of the rural communities' economic structure and were developed in an effort to improve conditions within the rural environment. The scattered independent, local associations of yesteryear have banded together into a regional federation, transforming them into a united economic force as it relates to the purchasing and marketing of agricultural goods and services. The effects of this evolvement in southwestern Kansas can be observed in various ways. White, towering grain elevators with the CO-OP logo dominate the skylines of practically every community, whether large or small. Farmers in some areas depend wholly on the local cooperatives to supply the goods and services they need to keep their operations working. Merchants, in many cases, purchase their inventories of re-saleable goods from regional cooperative petroleum refineries, feed processing facilities, fertilizer plants, etc. Consumers from all walks of life frequent cooperatives in order to purchase commodities as varied as cat food, building materials, lawn care products and appliances. Agricultural cooperatives, both individually and as a federation of local associations, contribute to the fiber of life in southwestern Kansas.

The vitality of cooperatives may be thought of as a function of people and their activities. The more that people believe benefits can be gained through cooperation, the more likely they are to transact their business with the local association, and so the more vigorous it becomes. The extent of interaction of people with their cooperatives can be partially determined by observing the spatial positioning of the cooperatives. The density and ubiquity of cooperatives in a specific area may be viewed as being indicative of the degree to which they are warranted in the area. By reconstructing the locations of individual cooperatives over time, the spatial dynamics of the cooperative system can be observed and the changing distributions analyzed in terms of the cooperatives' spatial responses to the needs of people they serve.

The discipline of geography is especially suited for a study concerning the distribution and the resulting areal interrelations of the activities of people. Hartshorne (1958) maintained that

> the intrinsic characteristics of geography are the product of man's effort to know and understand the combination of phenomena as they exist in areal interrelation in his world. . . . geography has no one particular category of objects or phenomena as its specific subject of study but studies a multitude of heterogeneous things as integrated in areas.

Geography has been defined as "the science of the earth's surface . . . a systematic description and interpretation of the distribution of things on the face of the earth." (Doerr and Guernsey, 1959) Even though distributions are complex and uneven over space, it is assumed that there is an underlying orderliness that can be explained utilizing appropriate research strategies. The goal of geography is to make sense of spatial patterns as they are encountered. Usually a single factor can not explain the orderliness of spatial phenomena. On the other hand, explanations of distributions do not have to be approached by randomization and probability procedures. Somewhere in between these two extremes, by analyzing the interplay among a number of variables, can an understanding of a particular spatial orderliness be explained (Boyce, 1978). An analysis of the cooperative system in a specific area is an attempt to explain one facet of human economic behavior and its manifestation on the surface of the earth.

## Definition of Terms

Central Places: Cities and towns that tend to locate centrally to a rural market in order to provide the goods and services needed by the people in the surrounding area.

Cooperative Firm: A business enterprise that operates according to principles of cooperation. The firm may conduct business from a single location or it may include any number of outlying business locations, or plants.

Cooperative Plant: One part of a cooperative firm that operates at a single location and may or may not have its administrative center located elsewhere.

Marketing cooperative: Markets the farm products it assembles and purchases from producers.

Production supply cooperative: Provides farmer-members with the many inputs they need for their farm operations.

Local cooperative: Operates from a trading center and has individual farmers as its members. May have operations in surrounding towns and/or branch elevator locations.

Regional cooperative: Provides wholesaling, manufacturing services, marketing resources, etc. to its members - the local cooperative associations.

Horizontal integration: Adding or bringing together cooperatives of the same type. For the local cooperatives, this entails adding branches at different locations by purchasing existing facilities or building new ones. For the regional cooperatives, this entails adding member associations that provide essentially the same services.

Vertical integration: The taking of one or more products through more than one stage in the process of marketing or buying.

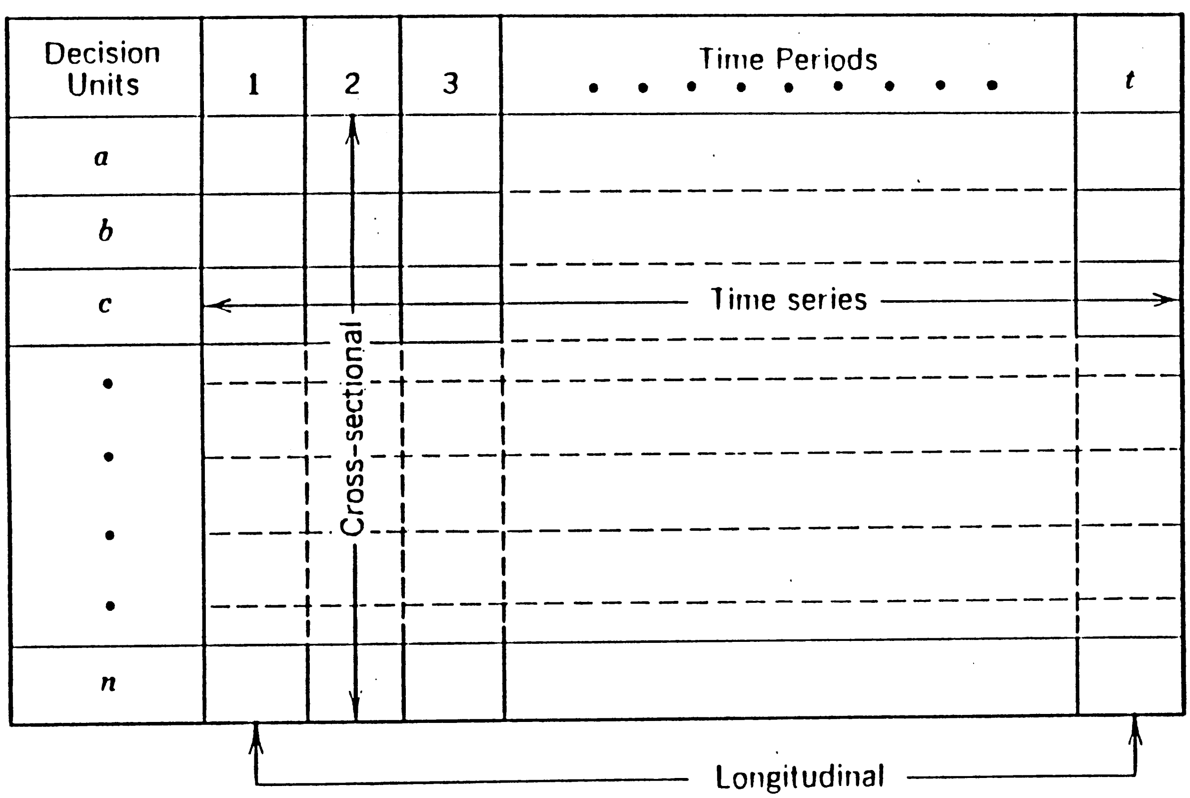
# CHAPTER III

## THE REGRESSION MODEL

Although various techniques may be used in an attempt to explain the spatial positioning of grain marketing cooperatives in the study area over time, it is thought that the best estimates, given the data that are available, can be derived through the utilization of multiple regression analysis. Once the decision was made to use regression, the first step was to determine the dependent variable. It was decided that a density index based on the number of square miles per cooperative per county would be a good measure of the spatial response of cooperatives on the landscape. The next step was to specify the variables expected to influence the density of cooperative plants as measured by the dependent variable. Several independent variables were determined for inclusion in the model. The data that were obtained for these predetermined variables consist of a combination of time-series and cross-sectional measures. The years that were selected for the time-series correspond, as closely as possible, to the years that data are available for the independent variables, beginning after the inception of cooperatives in the study area. These selected years are the following;

| | | | | | |
|---|---|---|---|---|---|
| 1904 | 1919 | 1934 | 1949 | 1964 | 1978 |
| 1909 | 1924 | 1939 | 1954 | 1969 | 1982 |
| 1914 | 1929 | 1944 | 1959 | 1974 | |

For every year listed above, data were gathered for each of the seventeen counties in the study area. Figure 2 shows the data matrix used in this study, with the decision units being individual counties. Hence, the data used in the model can be classified as longitudinal data.




Source: J. Scott Armstrong, Longe-Range Forecasting: From Crystal Ball to Computer (1985).

Figure 2. The Data Matrix

The independent variables included in the model are defined as follows;

F: Number of farms

A: Average size of farms

L: Number of acres of cropland harvested

W: Number of bushels of wheat harvested

C: Number of bushels of corn harvested

G: Number of bushels of grain sorghum harvested

R: Number of railroad miles converted to a density index

Data are available for the first six variables listed above only at the county level -- through the U.S. Census or the Kansas State Board of Agriculture. Because the seventeen counties included in the study are characterized by differing physical sizes (ranging from 568 to 1302 square miles), it was essential that the raw data be adjusted to account for this variation for each applicable variable, noting the following exceptions. The variable (A) does not lend itself to be adjusted for county size since it is an average of the areal extent of individual farms within a county. The variable (R) is adjusted in a different manner than the other variables as is described later in this chapter. However, the other independent variable values are divided by the respective county sizes to eliminate bias due to size differential. The rationale for this procedure follows using a case, for purposes of illustration, wherein a positive relationship exists between an independent variable being considered and the dependent variable. Counties which may be represented by large data values for a particular independent variable may, as well, be substantially larger in size than counties which are represented by smaller data values. It may be the case, though, that there is a higher propensity for the development of cooperatives within the smaller county than within the larger county. In the larger county the discrete units, which together constitute the value of the variable, may be sparsely distributed if they are located over a wide expanse. Whereas, fewer units located over space in a smaller county may, in fact, be more compact and therefore more likely to positively influence the existence of a cooperative plant.

The dependent variable is denoted as CDI -- a cooperative density index. It is assumed that the independent variables will interact in a linear relationship to determine the level of cooperative density. Therefore, the specification of the regression equation takes the form of

$$CDI = a + b\left(\frac{F}{S}\right) + cA + d\left(\frac{L}{S}\right) + e\left(\frac{W}{S}\right) + f\left(\frac{C}{S}\right) + g\left(\frac{G}{S}\right) + hR \qquad (1)$$

where: S = Respective County Size

## Clarification of the Dependent Variable

The task of identifying the dependent variable in a form that accurately measures the spatial response of cooperative plants on the landscape proved to be quite thought provoking. After giving serious consideration to various published techniques for specifying dependent variables, it was decided that an index based on the density of cooperative plants in each county for the selected years of the study would yield the best results. It is unlikely that any model can be developed that can explain the precise locations of the establishment of cooperative facilities within a specific county with much accuracy. However, it is feasible to develop a model than can be used to explain the spatial positioning of cooperative plants insomuch as the density of cooperatives within counties is concerned. Density levels can be gauged at various points in time and, with this information, projections for future time periods can be made. With this in mind, the derivation of the dependent variable used in this study was accomplished as follows.

The first step was to document the locations and dates of operation for individual cooperatives. The location of each grain marketing cooperative that has existed in the study area, since the founding of the first one in 1902, was ascertained by a combination of methods. Secondary sources such as the <u>Yearbook and Directory of Farmer Cooperatives</u>, the Farmers' Elevator Guide, and the American Cooperative Journal were of value by providing a starting point for actual field research. Although these publications contain some information about the individual cooperatives in disjointed time periods, additional information about the local associations' earliest history and their subsequent failure, consolidation, changing of names, etc. was gleaned by employing a combination of primary and secondary research methods (See Appendix A). This included:

1) Visiting each cooperative that is presently operating in the study area and interviewing appropriate personnel.

2) Searching real estate records on file at the Register of Deeds offices in county courthouses.

3) Searching property tax roll records on file at the County Clerk offices in county courthouses.

4) Interviewing current and/or former board members of cooperative associations or other individuals who may be knowledgeable about early-day cooperatives.

5) Inquiring by telephone about dates of incorporation from the Secretary of State's office in Topeka, KS.

6) Reviewing articles in county history books that give accounts of cooperative associations that have operated in the county.

Once the locational and temporal data were gathered they were transferred to a series of county based maps , portraying the spatial dynamics of cooperatives in southwestern Kansas from 1902 until the present. The maps (Figures 3 through 11) depict the cooperative system as if it was frozen in time at ten year intervals. The maps are then used as the basis for quantifying the dependent variable for the selected years of the study. The density of cooperative plants in each county was calculated by first counting the number of cooperatives in each county and then dividing the total into the number of square miles in the respective county. For every selected year this calculation yielded a set of cooperative density values, but only for those counties in which cooperatives were operating. For the remainder of the counties -- those in which no cooperatives were operating for the time periods considered -- no density value could be computed. It became necessary, at this point, to utilize an index so that values, based on cooperative density or the potential cooperative density in counties of uneven physical size, could be assigned to each county for each time period.

The configuration of the index as it was utilized in final form was not hastily or arbitrarily determined; rather, it was the result of an applied methodical search to find the best structural arrangement to address the specific problem. The final form of the index may be regarded as the merged entireties of two subindices. One subindex is predicated on actual cooperative density levels as found in the study area over time. The other subindex has its basis

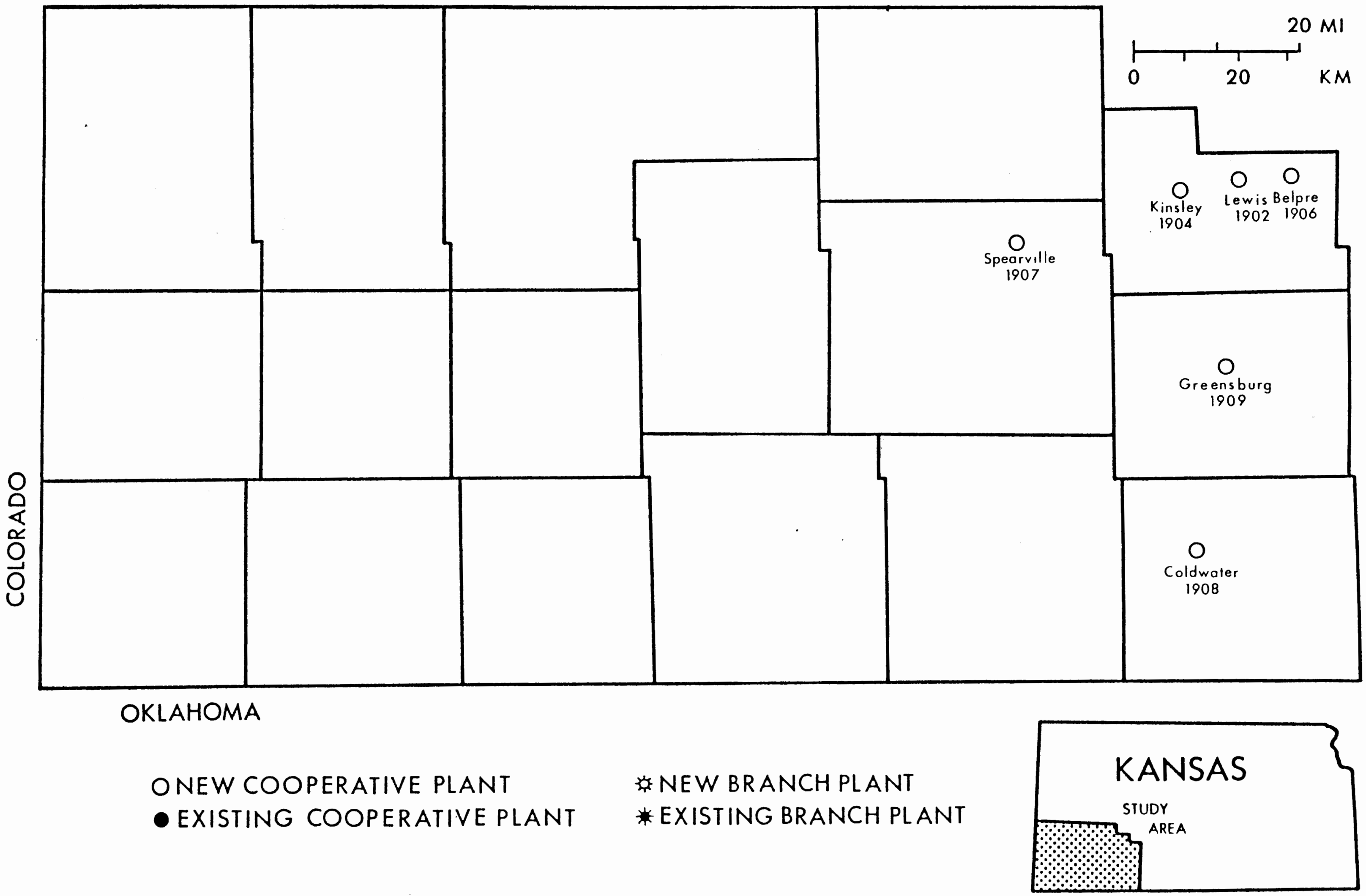



Figure 3. Spatial Distribution of Cooperatives 1902-1909

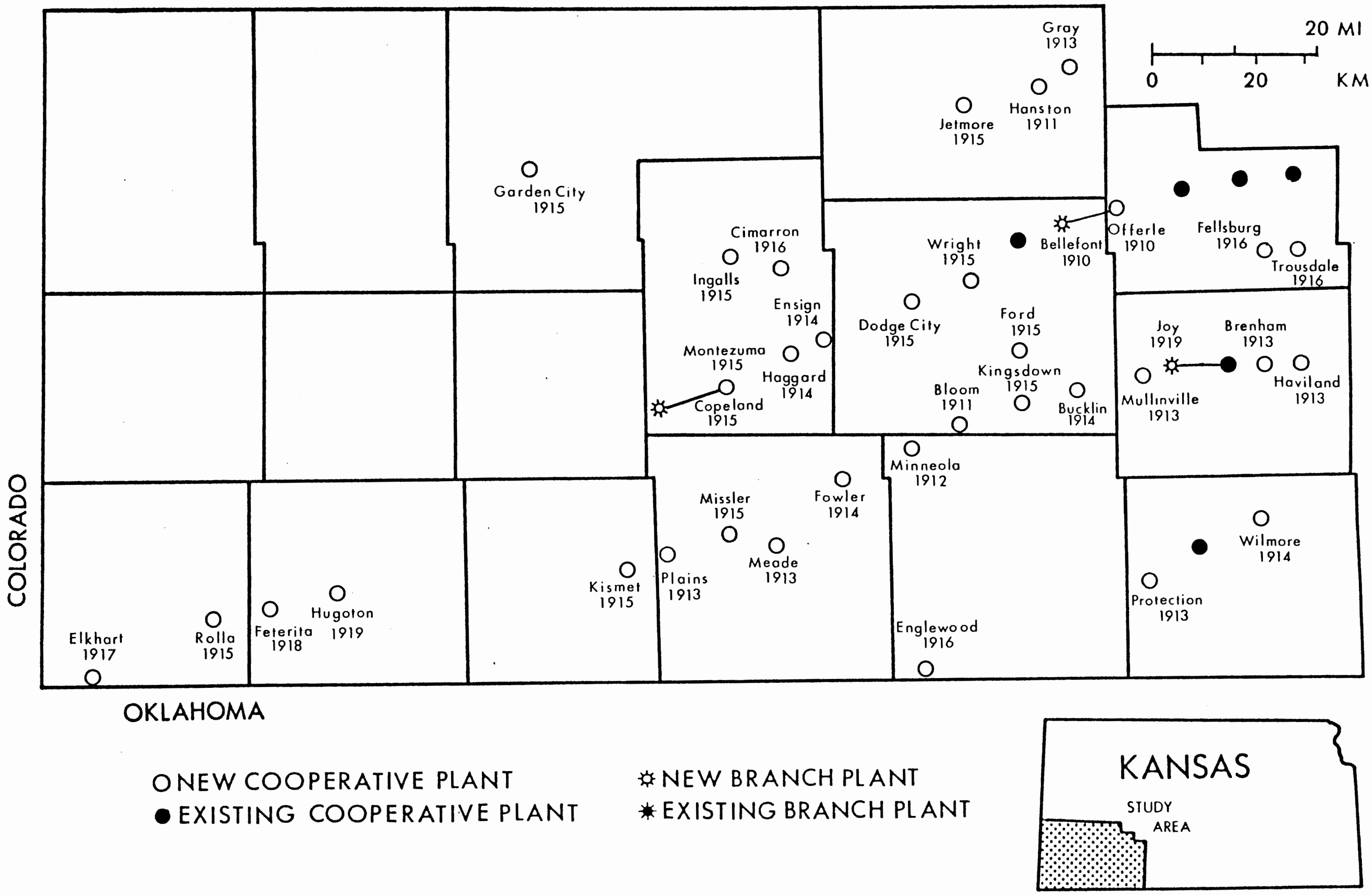



Figure 4. Spatial Distribution of Cooperatives 1910-1919

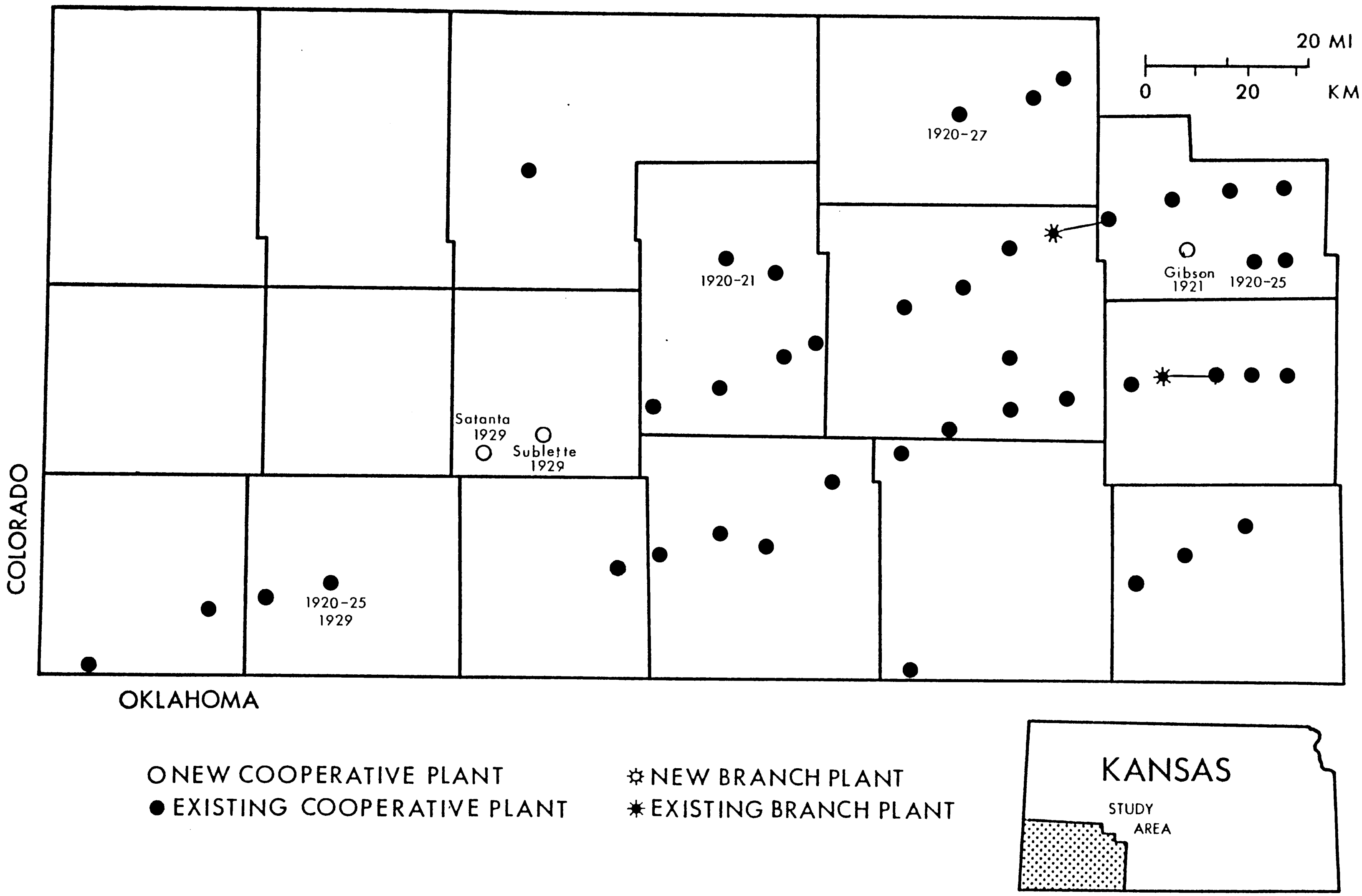



Figure 5. Spatial Distribution of Cooperatives 1920-1929

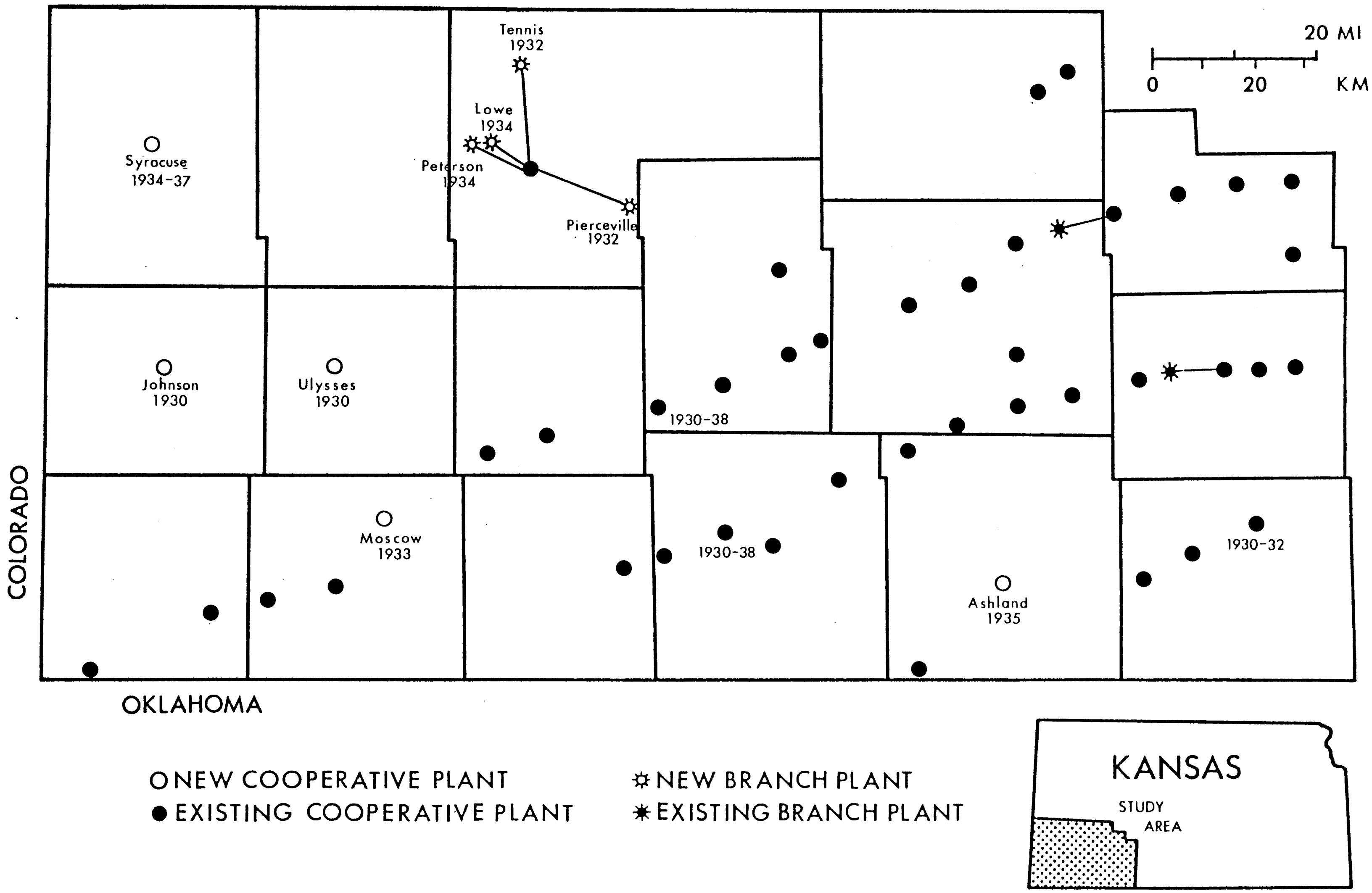



Figure 6. Spatial Distribution of Cooperatives 1930-1939

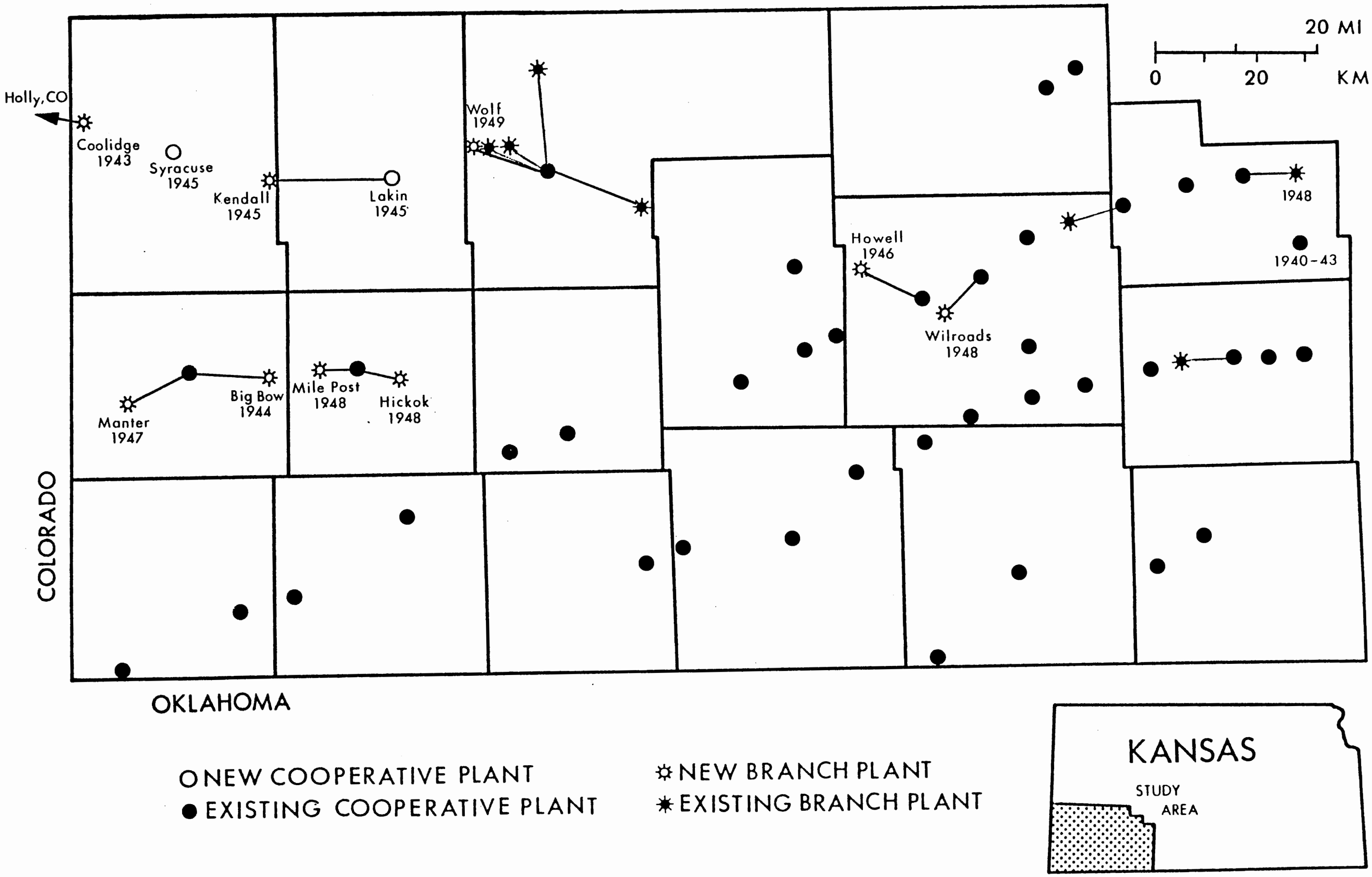



Figure 7. Spatial Distribution of Cooperatives 1940-1949

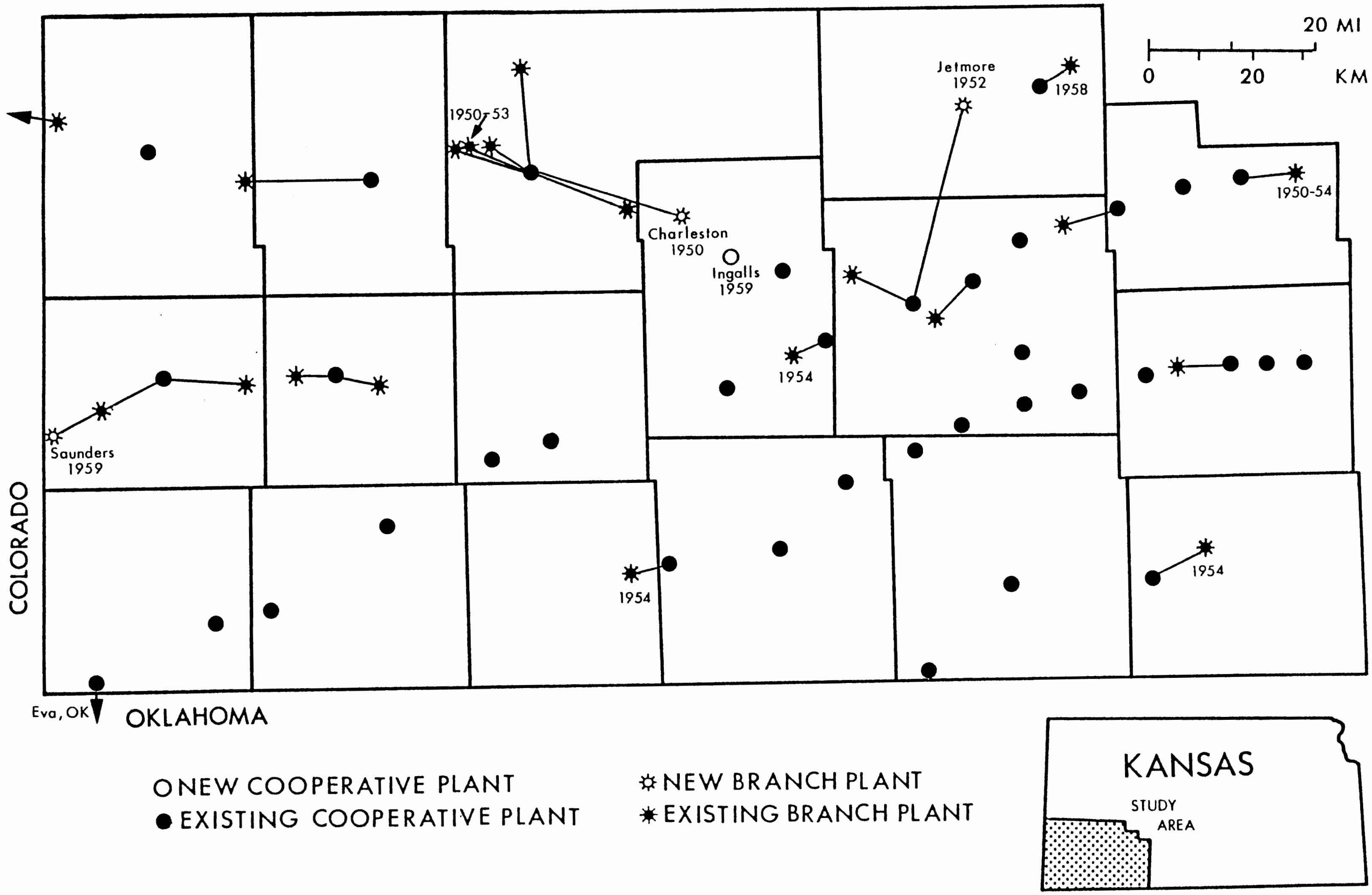



Figure 8. Spatial Distribution of Cooperatives 1950-1959

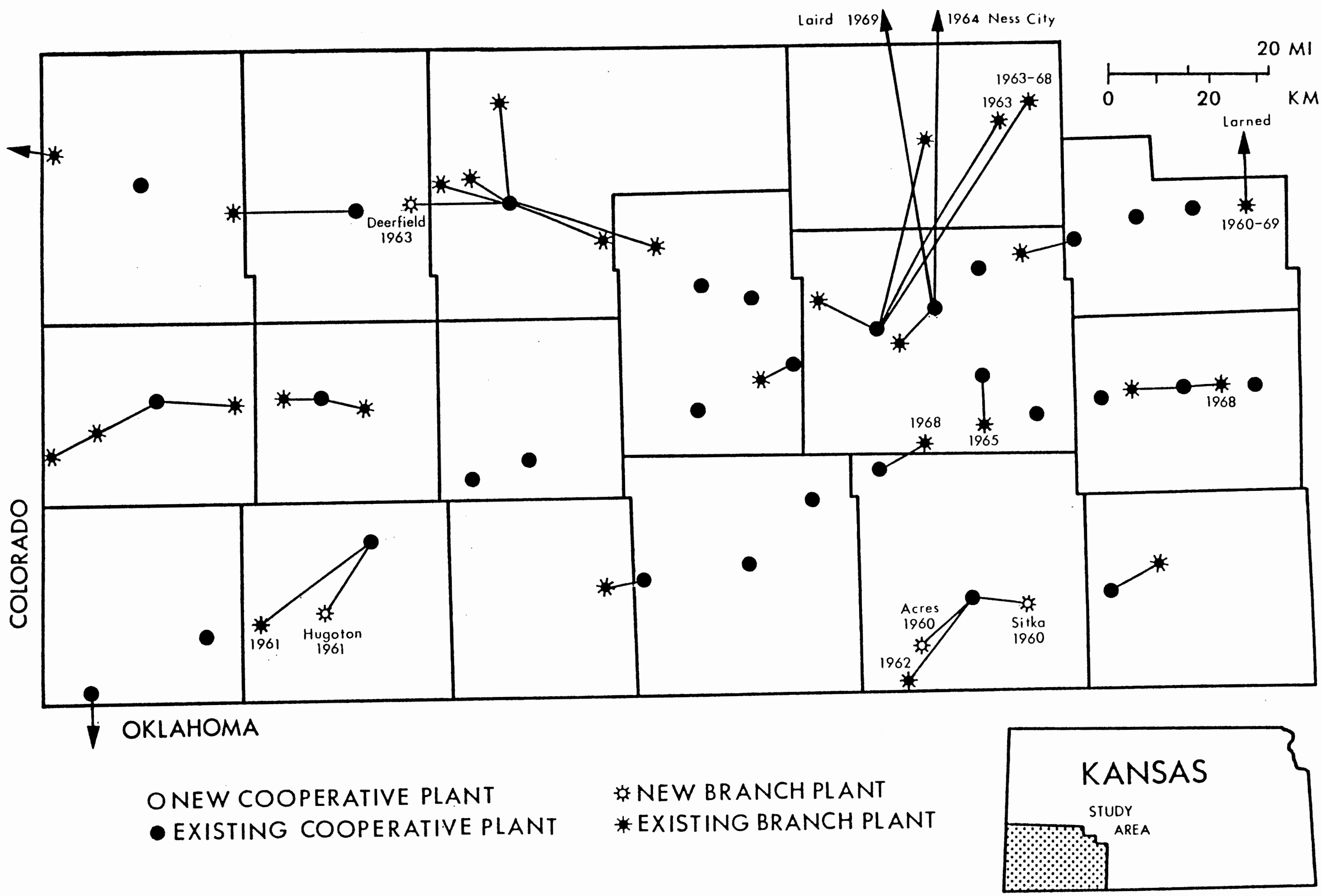



Figure 9. Spatial Distribution of Cooperatives 1960-1969

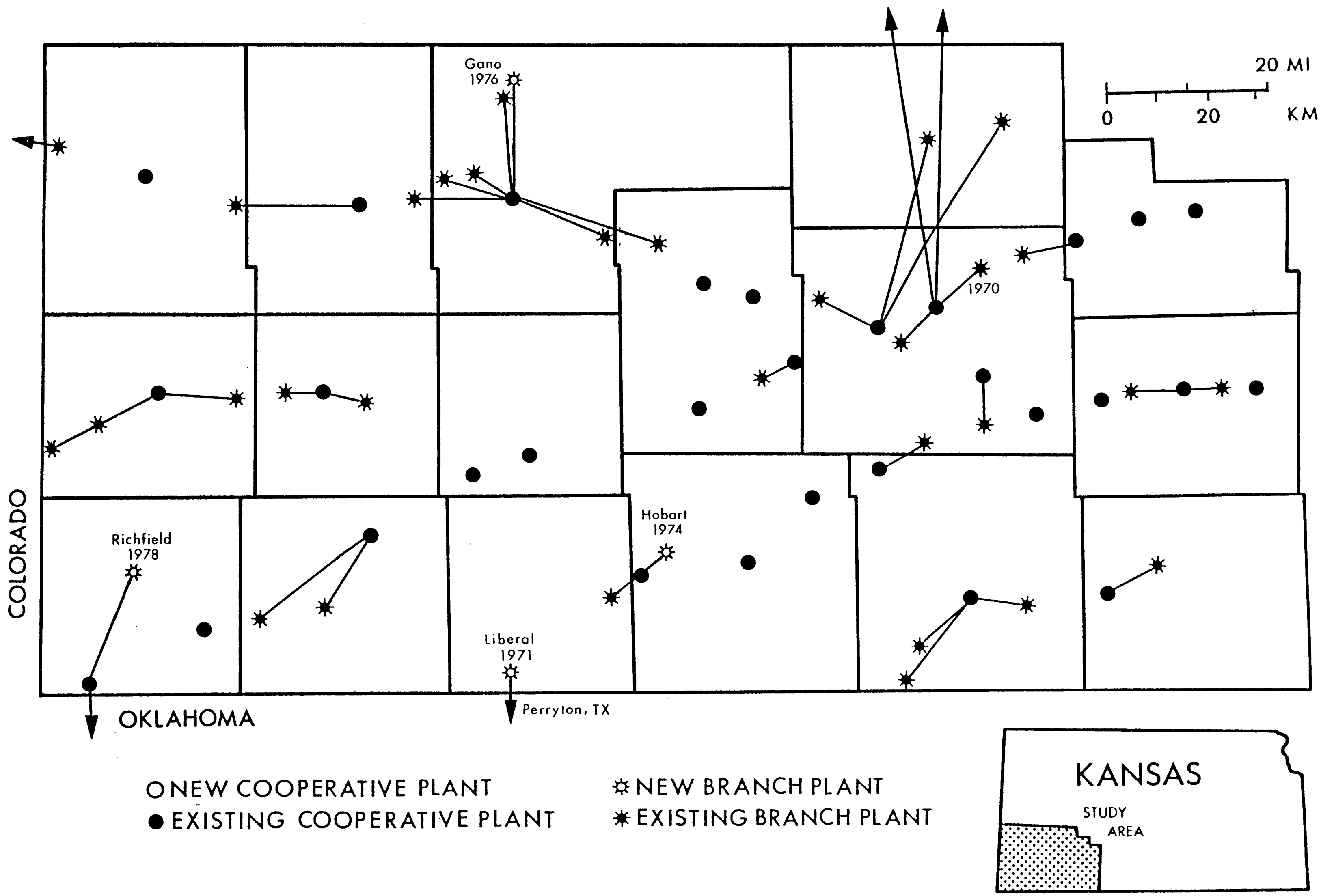



Figure 10. Spatial Distribution of Cooperatives 1970-1979

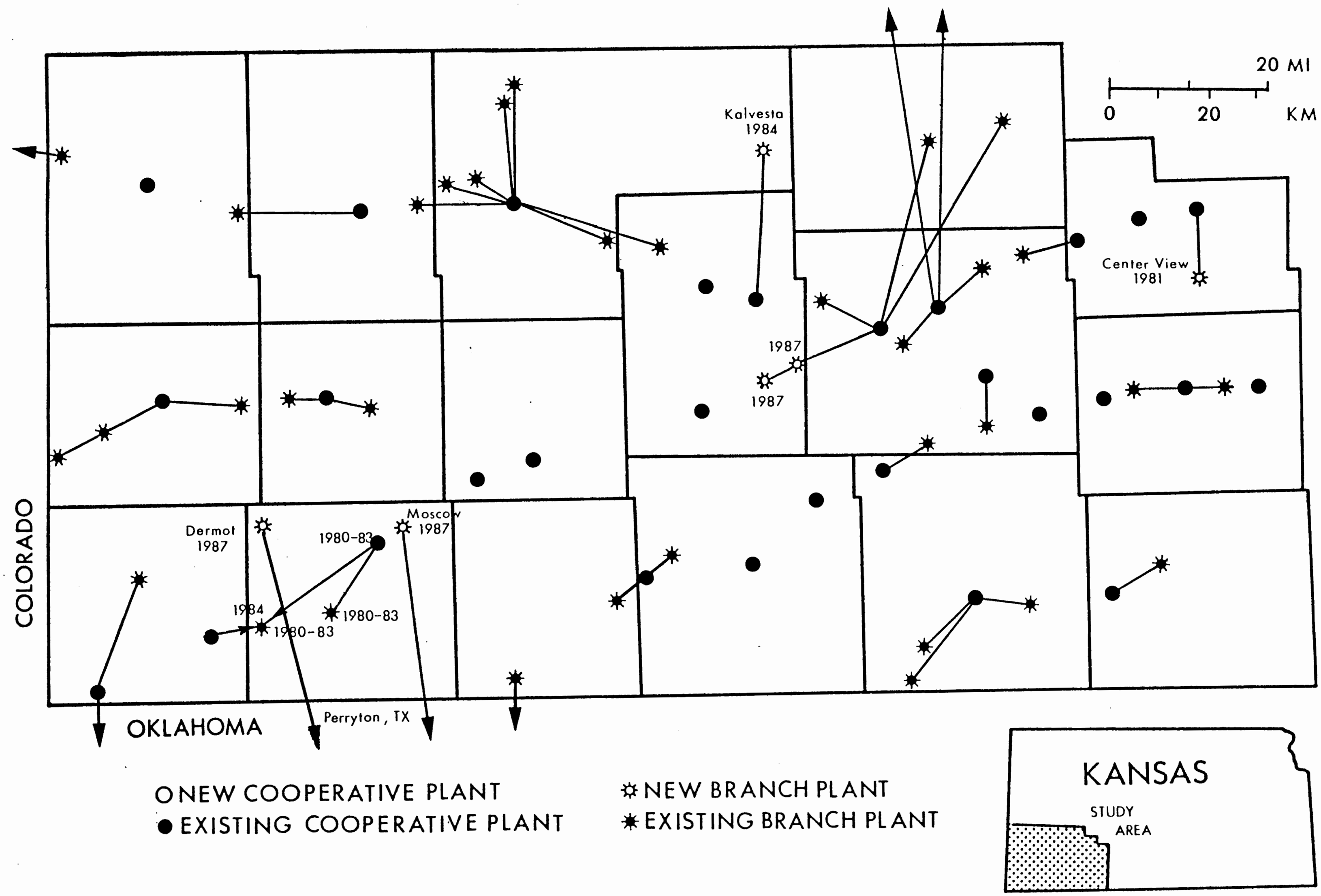



Figure 11. Spatial Distribution of Cooperatives 1980-1987

in the relative ordering of counties of unequal size with respect to the potential for cooperative density. An underlying assumption is that agricultural and structural conditions are constant throughout the study area for each time period.

The subindex (Subindex A) that is based on actual cooperative density levels (Table I) was created in the following manner. From the results of the preliminary density calculations described above, a search was made for the county value that corresponded to the most dense cooperative activity throughout all the time periods included in the study. It was determined that this value was represented by Edwards county in 1924 when there was a density level of 87.7 square miles per cooperative plant (614 square miles divided by 7 cooperative plants). Next, a search was made for the county value that corresponded to the least dense cooperative activity throughout all the time periods included in the study. This value was found to be represented by Finney county in 1919 when there was a density level of 1302 square miles per cooperative plant (1302 square miles divided by 1 cooperative plant). With these two extreme values forming the boundaries, the next step was to determine satisfactory increments of density values to be paired with sequentially arranged index values. After a period of manipulating both density and index values, it was deemed that density increments of twenty units (beginning with 80 square miles and ending with 1320

TABLE I

SUBINDEX A: BASED ON COOPERATIVE DENSITY INCREMENTS IN SQUARE MILES

| Index Value | Cooperative Density Range | Index Value | Cooperative Density Range |
|---|---|---|---|
| 1 | 80-100 | 32 | 701-720 |
| 2 | 101-120 | 33 | 721-740 |
| 3 | 121-140 | 34 | 741-760 |
| 4 | 141-160 | 35 | 761-780 |
| 5 | 161-180 | 36 | 781-800 |
| 6 | 181-200 | 37 | 801-820 |
| 7 | 201-220 | 38 | 821-840 |
| 8 | 221-240 | 39 | 841-860 |
| 9 | 241-260 | 40 | 861-880 |
| 10 | 261-280 | 41 | 881-900 |
| 11 | 281-300 | 42 | 901-920 |
| 12 | 301-320 | 43 | 921-940 |
| 13 | 321-340 | 44 | 941-960 |
| 14 | 341-360 | 45 | 961-980 |
| 15 | 361-380 | 46 | 981-1000 |
| 16 | 381-400 | 47 | 1001-1020 |
| 17 | 401-420 | 48 | 1021-1040 |
| 18 | 421-440 | 49 | 1041-1060 |
| 19 | 441-460 | 50 | 1061-1080 |
| 20 | 461-480 | 51 | 1081-1100 |
| 21 | 481-500 | 52 | 1101-1120 |
| 22 | 501-520 | 53 | 1121-1140 |
| 23 | 521-540 | 54 | 1141-1160 |
| 24 | 541-560 | 55 | 1161-1180 |
| 25 | 561-580 | 56 | 1881-1200 |
| 26 | 581-600 | 57 | 1201-1220 |
| 27 | 601-620 | 58 | 1221-1240 |
| 28 | 621-640 | 59 | 1241-1260 |
| 29 | 641-660 | 60 | 1261-1280 |
| 30 | 661-680 | 61 | 1281-1300 |
| 31 | 681-700 | 62 | 1301-1320 |

square miles) would provide a range that would allow for adequate density level differentiation when paired with index values beginning at one and ending at 62.

The subindex (Subindex B) that is based on the relative ordering of counties of unequal size with respect to the potential for cooperative density (Table II) was devised as follows. The counties were arrayed in tabular form such that the smallest county (Grant, with 568 square miles) was at the top and the largest county (Finney, with 1302 square miles) was at the bottom. Using much the same procedure as described above in the formulation of the other subindex, these two extreme county sizes formed the framework's boundaries. The numerical distance, or range, between the two boundaries was subdivided into twenty-unit increments beginning with 560 square miles and ending with 1320 square miles. Sequential index values, beginning with one and ending with 37, were paired with the twenty-unit increments. At this point, each of the seventeen counties of the study area was ordered in the appropriate incremental range in accordance with their county size. The outcome of this ordering system is that it provides a mechanism for assigning county index values while adjusting for the variation in the potential levels of cooperative density due to unequal county sizes. It will subsequently be shown that this subindex is applicable only for assigning values to counties for the time periods in which no cooperatives actually operated.

TABLE II

SUBINDEX B: BASED ON POTENTIAL COOPERATIVE DENSITY GIVEN COUNTY SIZE

| Index Value | Increments of County Size | County Index Assignments Based on Size (square miles) |
|---|---|---|
| 1 | 56Ø-58Ø | Grant (568), Haskell (579) |
| 2 | 58Ø-6ØØ | |
| 3 | 6Ø1-62Ø | Edwards (614) |
| 4 | 621-64Ø | Seward (639) |
| 5 | 641-66Ø | |
| 6 | 661-68Ø | Stanton (676) |
| 7 | 681-7ØØ | |
| 8 | 7Ø1-72Ø | Kiowa (72Ø) |
| 9 | 721-74Ø | Morton (725), Stevens (729) |
| 1Ø | 741-76Ø | |
| 11 | 761-78Ø | |
| 12 | 781-8ØØ | Comanche (8ØØ) |
| 13 | 8Ø1-82Ø | |
| 14 | 84Ø-86Ø | Kearny (853), Hodgeman (86Ø) |
| 15 | 861-88Ø | Gray (869) |
| 16 | 881-9ØØ | |
| 17 | 9Ø1-92Ø | |
| 18 | 921-94Ø | |
| 19 | 941-96Ø | |
| 2Ø | 961-98Ø | Meade (976), Clark (984) |
| 21 | 981-1ØØØ | Hamilton (992) |
| 22 | 1ØØ1-1Ø2Ø | |
| 23 | 1Ø21-1Ø4Ø | |
| 24 | 1Ø41-1Ø6Ø | |
| 25 | 1Ø61-1Ø8Ø | |
| 26 | 1Ø81-11ØØ | Ford (1Ø83) |
| 27 | 11Ø1-112Ø | |
| 28 | 1121-114Ø | |
| 29 | 1141-116Ø | |
| 3Ø | 1161-118Ø | |
| 31 | 1181-12ØØ | |
| 32 | 12Ø1-122Ø | |
| 33 | 1221-124Ø | |
| 34 | 1241-126Ø | |
| 35 | 1261-128Ø | |
| 36 | 1281-13ØØ | |
| 37 | 13Ø1-132Ø | Finney (13Ø2) |

After establishing the format in which index values could be assigned, both to counties in which cooperatives already existed as well as to counties characterized by no cooperative activity, the next step was to merge the two subindices into one master index (Table III). In the discussion that follows the procedure for merging the subindices will be outlined and then the rationale for doing so will be offered.

Subindex A, as it is found in final form within the master index, assumes the very same structural arrangement as it does independently. However, Subindex B is altered in the following way as it is merged with Subindex A. The sequential index values, that formerly began at one and ended at 37, were changed to begin with 63 and end with 100. In other words, the two indices are actually merged by physically placing Subindex B below Subindex A and then changing the starting point of the sequential index values for Subindex B to begin with the next integer after the ending point of the index values for Subindex A.

The rationale for merging the two subindices may best be understood by observing certain contingencies that relate to potential cooperative density levels. When the first cooperative is organized in the smallest county (Grant, with 568 square miles) the density level becomes 568 square miles per cooperative plant. While in the largest county, (Finney, with 1302 square miles) the founding of the first cooperative means a density level of 1302 square miles per

TABLE III

MASTER INDEX: CREATED BY MERGING SUBINDEX A AND SUBINDEX B

| Index Value | Cooperative Density Range | Index Value | Cooperative Density Range |
|---|---|---|---|
| 1 | 80-100 | 32 | 701-720 |
| 2 | 101-120 | 33 | 721-740 |
| 3 | 121-140 | 34 | 741-760 |
| 4 | 141-160 | 35 | 761-780 |
| 5 | 161-180 | 36 | 781-800 |
| 6 | 181-200 | 37 | 801-820 |
| 7 | 201-220 | 38 | 821-840 |
| 8 | 221-240 | 39 | 841-860 |
| 9 | 241-260 | 40 | 861-880 |
| 10 | 261-280 | 41 | 881-900 |
| 11 | 281-300 | 42 | 901-920 |
| 12 | 301-320 | 43 | 921-940 |
| 13 | 321-340 | 44 | 941-960 |
| 14 | 341-360 | 45 | 961-980 |
| 15 | 361-380 | 46 | 981-1000 |
| 16 | 381-400 | 47 | 1001-1020 |
| 17 | 401-420 | 48 | 1021-1040 |
| 18 | 421-440 | 49 | 1041-1060 |
| 19 | 441-460 | 50 | 1061-1080 |
| 20 | 461-480 | 51 | 1081-1100 |
| 21 | 481-500 | 52 | 1101-1120 |
| 22 | 501-520 | 53 | 1121-1140 |
| 23 | 521-540 | 54 | 1141-1160 |
| 24 | 541-560 | 55 | 1161-1180 |
| 25 | 561-580 | 56 | 1881-1200 |
| 26 | 581-600 | 57 | 1201-1220 |
| 27 | 601-620 | 58 | 1221-1240 |
| 28 | 621-640 | 59 | 1241-1260 |
| 29 | 641-660 | 60 | 1261-1280 |
| 30 | 661-680 | 61 | 1281-1300 |
| 31 | 681-700 | 62 | 1301-1320 |

TABLE III (Continued)

| Index Values | Increments of County Size | Revised County Index Assignments After Merger |
|---|---|---|
| 63 | 560-580 | Grant, Haskell |
| 64 | 581-600 | |
| 65 | 601-620 | Edwards |
| 66 | 621-640 | Seward |
| 67 | 641-660 | |
| 68 | 661-680 | Stanton |
| 69 | 681-700 | |
| 70 | 701-720 | Kiowa |
| 71 | 721-740 | Morton, Stevens |
| 72 | 741-760 | |
| 73 | 761-780 | |
| 74 | 781-800 | Comanche |
| 75 | 801-820 | |
| 76 | 821-840 | |
| 77 | 841-860 | Kearny, Hodgeman |
| 78 | 861-880 | Gray |
| 79 | 881-900 | |
| 80 | 901-920 | |
| 81 | 921-940 | |
| 82 | 941-960 | |
| 83 | 961-980 | Meade, Clark |
| 84 | 981-1000 | Hamilton |
| 85 | 1001-1020 | |
| 86 | 1021-1040 | |
| 87 | 1041-1060 | |
| 88 | 1061-1080 | |
| 89 | 1081-1100 | Ford |
| 90 | 1101-1120 | |
| 91 | 1121-1140 | |
| 92 | 1141-1160 | |
| 93 | 1161-1180 | |
| 94 | 1181-1200 | |
| 95 | 1201-1220 | |
| 96 | 1221-1240 | |
| 97 | 1241-1260 | |
| 98 | 1261-1280 | |
| 99 | 1281-1300 | |
| 100 | 1301-1320 | Finney |

cooperative plant. Taking this a step further, when Grant county has a second cooperative plant, the density level becomes 284 square miles per cooperative plant; on the other hand, a second cooperative plant in Finney county changes the density level to 651 square miles per cooperative plant. From this it can be observed that even when Finney county has two cooperatives, it has less cooperative density than Grant county does when it has one cooperative. Contingencies, such as the ones above, can be reiterated for each of the counties being considered for all possible numbers of cooperatives. The results of this will show that there is a wide variance in density levels between counties when they have the same number of cooperatives because they vary so much in physical size. Stated simply, the potential for cooperative density is a function of county size.

Subindex B is strictly a tool that was used for assigning values to counties for the time periods in which no cooperatives actually operated. The subindex's configuration is such that it initializes the starting points for each county without cooperative activity so that the numerical distance is equalized for every county's move up the index as cooperative density increases. For example, an index value of 63 was assigned to Grant county (568 square miles) before it had a cooperative. In the same way, an index value of 100 was assigned to Finney county (1302 square miles) before it had a cooperative. Now, for the first selected year of the study after one cooperative was organized in Grant county, an index value of 25 was assigned (Refer to Table III). For the first selected year after one cooperative was organized in Finney county, an index value of 62 was assigned. The numerical distance is equalized so that when each county has its first cooperative, Grant county moves up the index 38 units (from 63 to 25) and Finney county moves 38 units (from 100 to 62). The utilization of subindex B allows county values to be assigned based on the potential density level of cooperatives before they actually develop within the respective counties.

After formulating the index, it became apparent that there was some discrepancy concerning the shape of the index function with respect to the shape of the natural functions for increasing density levels. The graph in Figure 12 shows the resulting linear function of the master index in the form in which it is described above. However, the natural functions, as they are illustrated in Figure 13 for the smallest and largest counties, are not linear in form. In order to adapt the index function to the natural functions, a simple transformation using natural logarithms of the index values was implemented. Figure 14 illustrates the shape of the index function when the natural logarithm of each sequential index value is substituted for the value itself. After observing this relationship it became obvious that the logarithmic function fits the natural functions for increasing density levels. Consequently, the dependent

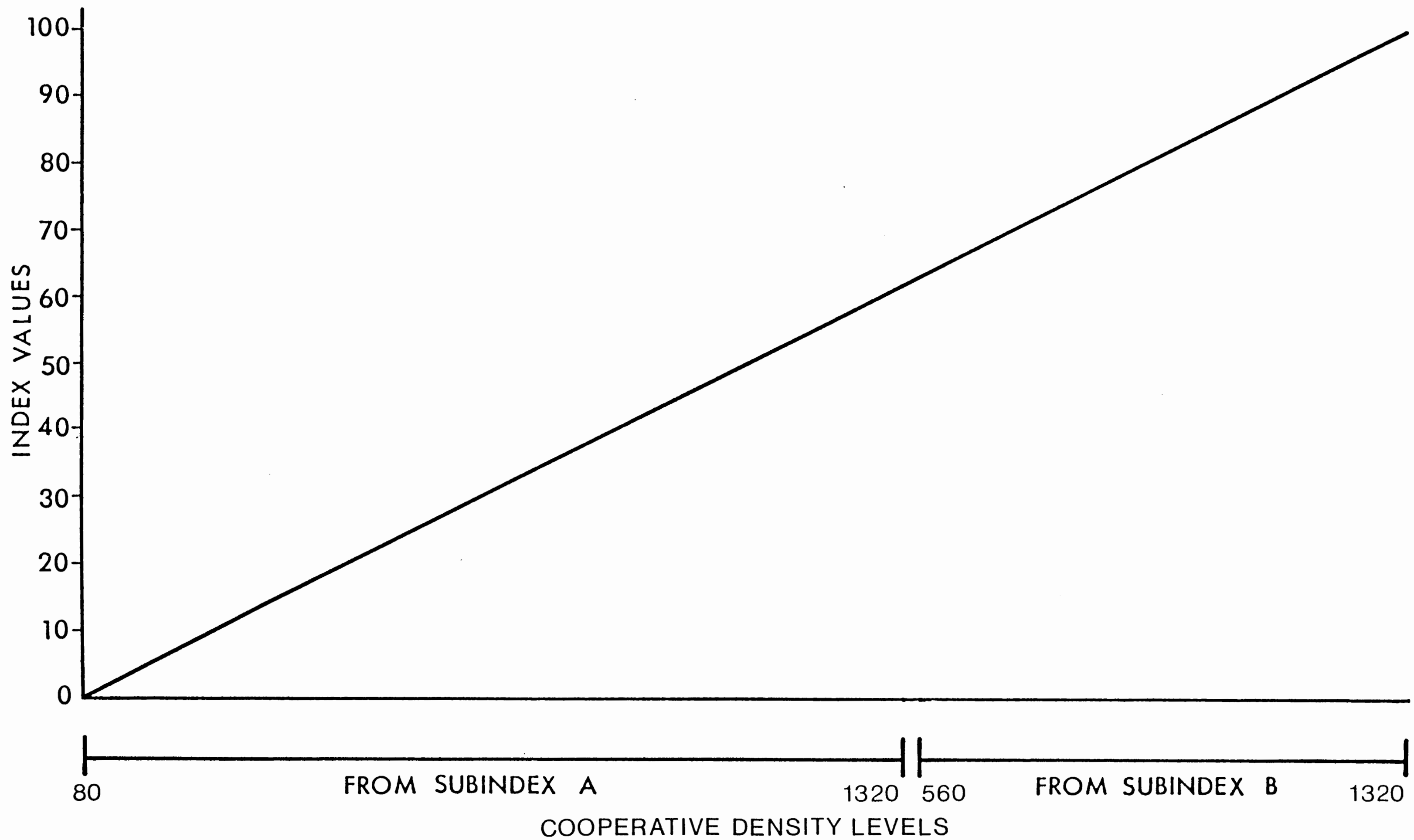



Figure 12. Linear Function of the Relationship Between Master Index Values and Cooperative Density Levels

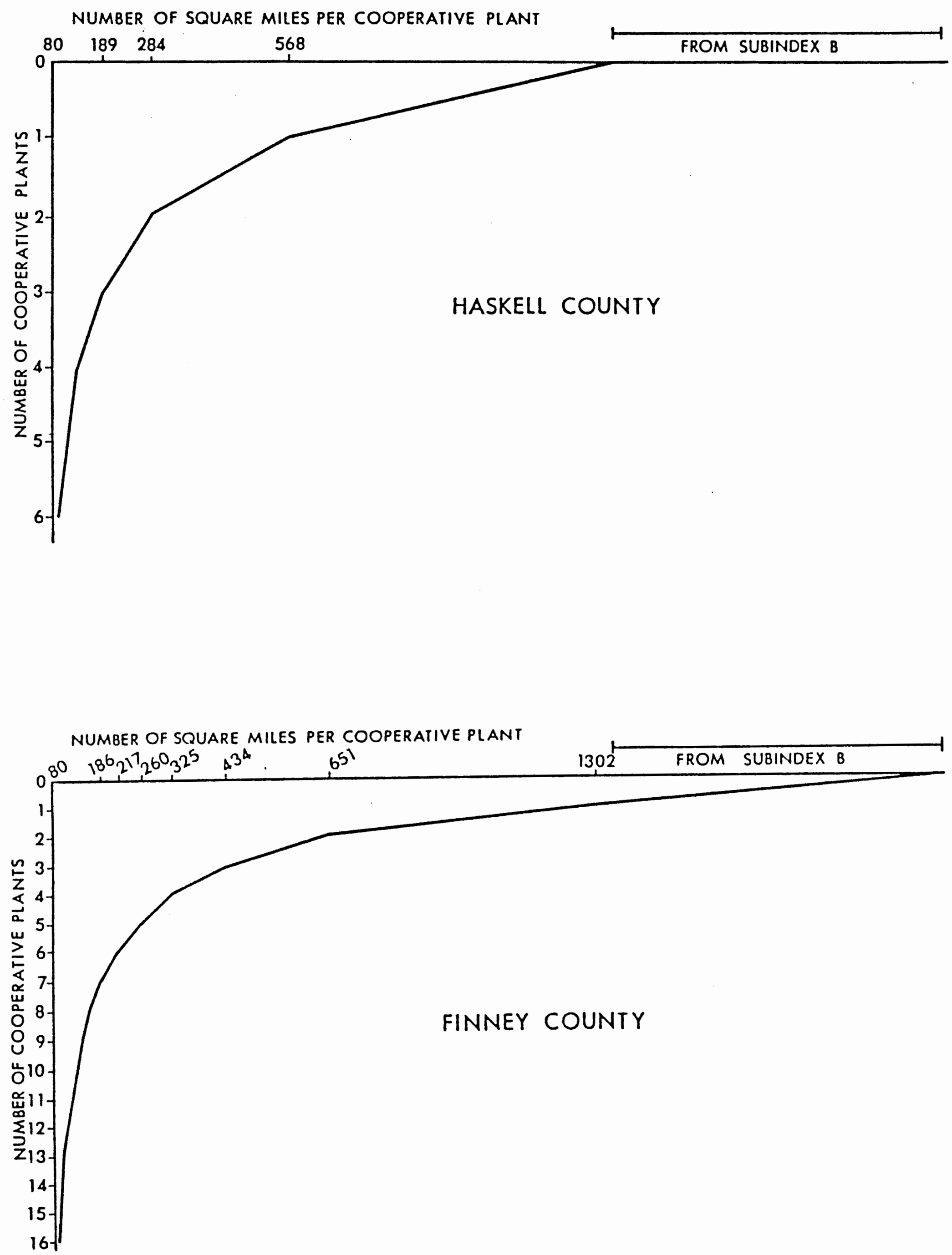



Figure 13. Natural Functions of the Relationship Between the Number of Cooperatives and Cooperative Density Levels in the Largest and Smallest Counties

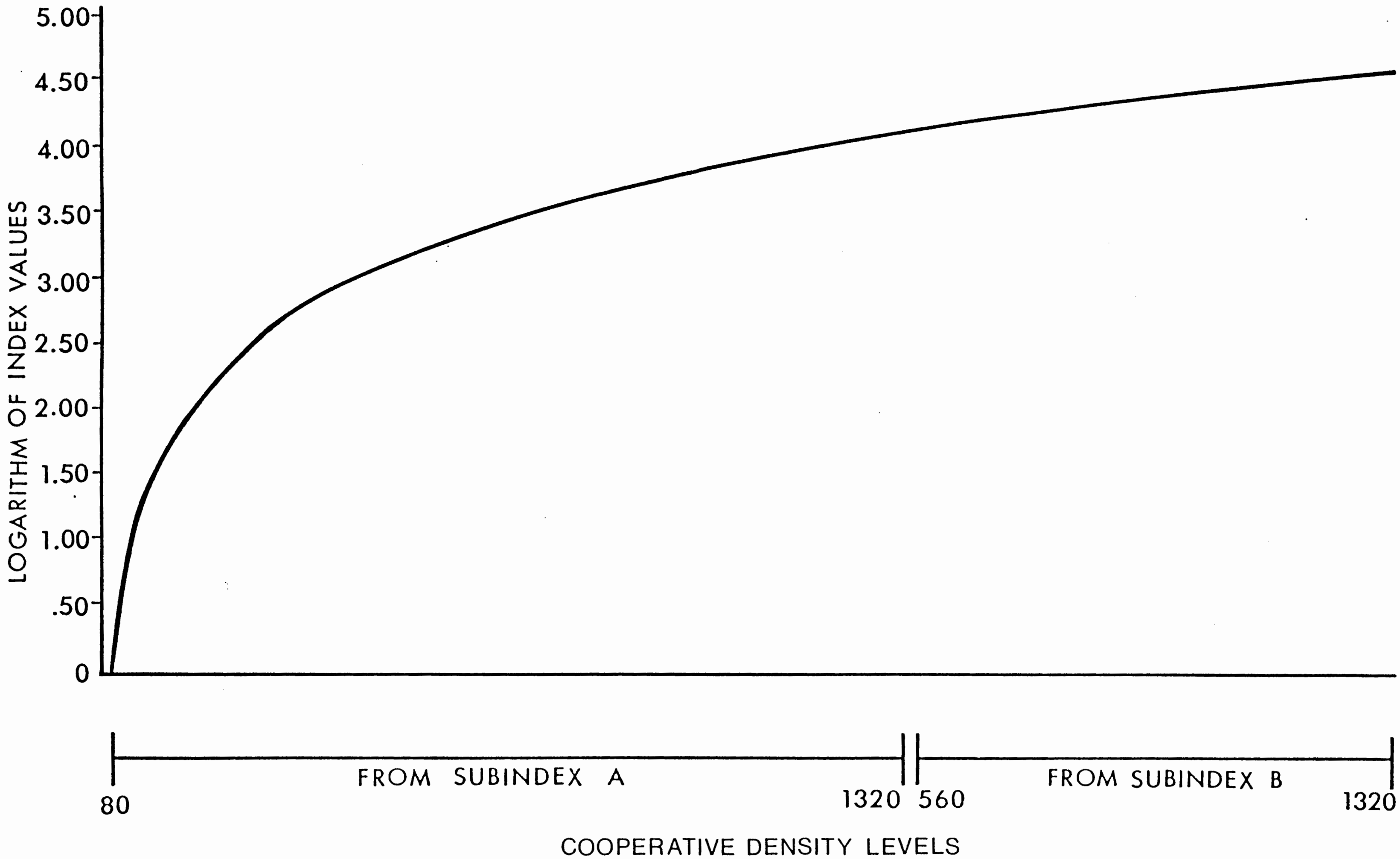



Figure 14. Natural Function of the Relationship Between Master Index Values Transformed to Logarithms and Cooperative Density Levels

variable for each county for each selected year is the natural logarithm of the sequential index value as determined from the master index.

## Clarification of the Independent Variables

### Number of Farms

The variable used here is the number of farms per county for each time period used in the analysis. Data were acquired from the decennial censuses of the United States from 1900-1950 in addition to the U.S. agricultural censuses, beginning in 1925 to the last year that census data are available, which was 1982. The number of farms were actually enumerated in the years that the censusus were conducted. However, the time-series used in this study does not exactly correlate with the seemingly arbitrary agricultural census years set by the federal government. So, in order to facilitate the data requirements for this study and to maintain data consistency for all variables, the values for each census year prior to 1954 were substituted in the following manner; the census year value for the number of farms was entered into the data set for the previous year. For example, the 1920 value was entered for the year 1919, the 1930 value was entered for the year 1929, etc. For 1954 and successive years the data values were entered for the years in which they were enumerated. Additionally, it was necessary to interpolate values for 1904 (by averaging values from the 1900 and 1910 censuses) and for 1914 (by averaging values from the 1910 and 1920 censuses).

It is thought that the number of farms in each county indirectly influences the cooperative activity in the respective county. Farms are operated by farmers and as farmers increase or decrease in number the propensity for cooperative development changes accordingly -- the result of a positive relationship between the number of farms and the density of cooperative plants.

Average Size of Farms

The data used for this variable is also taken from the U.S. decennial and agricultural censuses. As it is used in the model, the average size of farms refers to the total acreage in farms (including arable land, grassland, and woodland) per county for each time period divided by the number of farms in the respective county. The values for this variable were substituted in the time-series in precisely the same manner as described in the preceding discussion concerning the number of farms variable. Values for 1904 and 1914 were also determined exactly as stated above.

The average size of farms in an area is considered to influence cooperative density, primarily, for two reasons. First, smaller farm operators are more likely to benefit from the advantages accruing to cooperative members as a result of their collective bargaining power. Second, the large ranching operations (extensive grasslands) indigenous to certain locales in the study area increase the calculated average size of farms while these operations find little or no utility in grain marketing organizations. The average size of farms, then, is thought to be inversely related to the density of cooperatives in the study area.

Acres of Cropland Harvested

The data source for this variable is also the U.S. decennial and agricultural censuses. The number of acres of cropland harvested is the aggregate of all crops actually harvested in a county for each time period expressed in terms of total acreage. A variation in the data entry procedure (in comparison to the variables already described) for this variable must be noted. Each agricultural census form requires the producer to report the number of acres of cropland harvested for the year preceding the census year. Therefore, the harvested cropland data are for one year prior to the year in which the number of farms and the average size of farms are enumerated. So in this study, to maintain as much data consistency as possible, the values for acres of cropland harvested for each census year before 1954 were entered into the data set for the actual years in which they were reported by producers. However, for 1954 and successive years the data values were entered for the year corresponding to the census year (or one year after the acres were actually harvested). Data values for acres of cropland harvested were derived through interpolation for 1904 and 1914 as described for the aforementioned variables.

The amount of harvested cropland reported in a county is an indicator, not only of farming intensity, but also of the corresponding need for proximate grain marketing facilities to service that intensity level. It stands to reason that as crop production increases, the tendency to establish cooperatives also increases, under conditions of *ceteris paribus*. As stated above, the total harvested acreage of *all* crops is included in each of the census periods; this is important because only the most dominant crops in the study area are specifically accounted for in the model. The acres of cropland harvested variable allows the production of less dominant, or even minor, crops to be weighted into the regression equation -- crops such as soybeans, oats, barley, broomcorn, and alfalfa.

## Bushels of Wheat Production

After the Kansas wheat crop is harvested each year, wheat production for every county in Kansas is estimated by the State Board of Agriculture. Historical wheat production data by county, available through the Board's Division of Statistics office in Topeka, were gathered for individual years from 1900 through 1982. The reason for including wheat production figures for each year, as opposed to including only values for the study's selected years, is that wheat production levels are volatile throughout the time dimension of the study. This is due, for the most part, to the semi-arid farming conditions found in the study area and the variation over time in the economic climate as it relates to agriculture. It was determined that wheat production trends needed to be incorporated into the model rather than the production of single years that may, or may not, be indicative of the county production norm for a given period. As a result, the observations for each year were entered into a series of moving average equations. In this way a smoothed data value was derived for each county's wheat production for the selected years of the study. Each observation was weighted equally in calculating five-period moving averages. As an example, the 1904 data value was computed by summing the 1900, 1901, 1902, 1903, and 1904 observations and dividing by five. However, after the 1974 observation it was necessary to utilize four-period moving averages to compute values for 1978 and 1982.

The Great Plains region of the United States, which includes southwestern Kansas, is noted world-wide for its production of wheat (Boyce, 1978). Wheat has been the region's primary crop over time; it is, and has been, the mainstay of most farmers' cropping programs throughout the study area as well. It is not surprising, then, that wheat is the commodity most handled by the grain marketing organizations that have been established in the study area (Kansas Crop and Livestock Reporting Service). A positive relationship exists between the number of bushels of wheat produced and the number of cooperative plants, which were instituted, primarily, for the purpose of trading in wheat.

Bushels of Corn Production

The Kansas State Board of Agriculture also estimates the number of bushels of corn produced in each county just as it estimates the production of wheat. The methodology used in obtaining corn production data values for inclusion in the model is the same as described above for wheat production. It should be noted, however, that corn production in the study area has been irregular over time. In the earlier years under consideration in this study -- from 1900 until the Great Depression era -- producers planted considerably more corn in relation to other crops than they did after the drought years of the 1930's. Corn production in the study area remained very modest, subsequent to 1930, until the irrigation boom of the late 1960's and 1970's when production figures escalated rapidly. In recent years, corn production has even exceeded wheat production in many counties of the study area.

Corn, along with wheat and grain sorghum, is one of the three principal grain crops that has been produced in the study area over time. Usually corn is planted on superior ground or else it is fertilized very heavily. Corn responds very well to both irrigation and fertilizer. Grain marketing facilities normally handle a smaller percentage of a given corn crop than a given wheat crop due to corn's wide-spread use as a feed grain (Kansas Crop and Livestock Reporting Service). Still, a substantial amount of corn is marketed through grain marketing systems, which includes cooperative plants. As with wheat, a positive relationship exists between the number of bushels of corn produced and the number of cooperative plants established.

## Bushels of Grain Sorghum Production

Grain sorghum production figures are also estimated yearly by the Kansas State Board of Agriculture. The procedure used to collect grain sorghum data values for inclusion in the model is the same as described above for wheat and corn production with the following exception. Proxy data values were entered into the data set for 1904, 1909, and 1914 because the Board's Division of Statistics did not begin estimating grain sorghum production until 1915. It is important to realize, at this point, that the term "grain sorghum" is generic in the sense that all types of sorghums, of which there are several, are included under this umbrella term as long as the primary purpose of production is for grain. On the other hand, sorghum types which are produced primarily for forage are called forage sorghums. In the earliest years of the time dimension under consideration in this study, the common varieties of sorghum used chiefly for the production of grain were known by other names, such as kafir corn, milo, milo maize, or maize. In other words, these were the grain sorghums of that time.

This being the case, proxy data from the U.S. decennial censuses of 1900, 1910, and 1920 were utilized as follows. The 1900 census reported kafir corn production for each county in the study area. The 1910 census reported the combined production of kafir corn and milo maize. To obtain a grain sorghum data value for 1904, the 1900 census value for kafir corn was averaged with the 1910 census value for kafir corn and milo maize. As referred to above in describing the cropland harvested variable, grain producers report their production for the year previous to the year that the census is conducted. So, actually, it was the kafir corn production of 1899 and the kafir corn and milo maize production of 1909 that was averaged to determine a proxy grain sorghum value for 1904. The data value reported in the 1910 census as kafir corn and milo maize production was entered into the data set for the year 1909. Finally, the 1920 decennial census reported a value for kafir, milo, etc. This figure was averaged with the 1910 value for kafir corn and milo maize to determine a proxy grain sorghum value for 1914.

Most of the study area is characterized by semi-arid dry land farming interspersed with irrigation in areas where ground water is available. Grain sorghum has proven to be a profitable commodity because it is suited to both types of farming. It responds very well to irrigation, but it also is a hardy crop that will produce under harsh conditions. Grain sorghum complements wheat in many farmers' cropping programs; wheat is a very hardy winter crop while grain sorghum, a spring crop, can be counted on to yield even under adverse summer growing conditions. Grain sorghum, like corn, is used extensively as a feed grain. As a result, it is not uncommon for grain sorghum to be marketed through the producer's own cattle, or to be sold directly to commercial feeders. Even so, grain marketing facilities handle a sizeable proportion of a given grain sorghum crop. As with wheat and corn, a positive relationship exists between the number of bushels of grain sorghum produced and the density of cooperative plants in the study area.

## Railroad Density Index

This variable is the number of railroad miles per county per time period converted to a density index. The first step in obtaining values suitable for inclusion in the model was to reconstruct the study area's railroad network at each of the points in time corresponding to the selected years of the study. Data to accomplish this were obtained jointly from the Rail Planning Manager of the Kansas Department of Transportation and the Rate Section Supervisor of the Kansas State Corporation Commission. A report entitled _A History of Railroad Construction and Abandonment Within the State of Kansas_ was especially helpful in reconstructing the railroad network over time. The document is "a complete history of Kansas railroads, indicating the dates when railroad main lines and branches were placed into operation and the dates when abandonments took place." (Kansas State Corporation Commission, 1983)

The procedure used to quantify the railroad density of each county over time was as follows. The location of every rail line that ever existed in the study area was delineated on time-series maps. Next, the distance of each rail line as it appeared in each county was measured at the appropriate time intervals. The total rail miles in each county was calculated simply by summing these distances.

The next step was to make use of the total rail miles in each county per time period by computing line-to-area quotients. This was accomplished by dividing the total rail miles of each county by the size of the respective county expressed in square miles. A line-to-area quotient was calculated, then, for each county for every selected year under consideration. However, there were a substantial number of zero values owing to the fact that there were no railroads in several counties in the early years. Because zero values cannot be entered into regression, it was necessary to convert the line-to-area quotients to an index representing relative rail density among all counties at the various points in time. After reviewing the numerical values of all the quotients, the quotient representing the densest railroad network was assigned an index value of one and the quotients having a value of zero was assigned an index value of one hundred. Using this as a framework, a chart was devised in which the resulting range was divided into one hundred equal incremental units. Index values were assigned accordingly based on the relative position of the line-to-area quotients. For instance, the median quotient -- equidistant to the quotient representing the densest network and the quotient value of zero -- was assigned an index value of fifty, and so forth.

Railroads are considered to have been very important to the development of grain marketing facilities throughout the study area. Before the introduction of large trucks and the building of highway systems capable of supporting them, railroads were the only viable channel for shipping bulk grain from the hinterlands to terminal elevators located in cities. The data show that there is a positive correlation between the number of railroad miles in a county and the density of cooperative plants.

# CHAPTER IV

## REGRESSION ANALYSIS AND RESULTS

### Explanation of Variation in the Dependent Variable

One purpose of using multiple regression analysis in this study is to create an estimated model that helps explain the true model, which is the reality of the spatial positioning of cooperative plants in the study area at 17 points in time. Hanushek and Jackson (1977) refer to the true model as "the starting point in all of our developments and the frame of reference by which to judge results." When developing a regression model, there is a problem in specifying the exact and correct formulation so that it includes most of the variables that influence the true model. Undoubtedly, there are so many variables that influence cooperative activity that it would be impossible to specify and gather data on all of them. It is thought, however, that the model specified and described in Chapter III includes those variables that most heavily influence the spatial positioning of cooperatives being studied. It was hypothesized that the model would explain a significant proportion of the total variation in the dependent variable by yielding high coefficients of determination. In this application, then, the estimated model is a measurement tool that measures the goodness of fit between the variables expected to influence the incidence of cooperatives on the landscape and the true model.

The variables were analyzed with multiple regression using an IBM XT microcomputer equipped with the Statistical Analysis System (SAS). Regression routines were executed using variables in three different time period combinations. Data for variables representing one-year, two-year, and three-year time periods were analyzed independently using a SAS program written for this type of analysis.

The results for the one-year time period, shown in Table IV, include the calculated F values and the coefficients of determination for each selected year. In this application, the F value is used to test how well the model accounts for the dependent variable's behavior (SAS Institute, Inc., 1985). It can be observed, by comparing the calculated F values to the established tabular F value for 7 and 9 degrees of freedom, that there is evidence of systematic explanation of the dependent variable (for $p = .05$). The one-year model yields very high $R^2$ values.

After obtaining the regression results for the one-year time periods, it was obvious that the selected independent variables explain to a high degree the variation in the dependent variable. It was noted, however, that the explanation is derived from only seventeen observations for each year. It was decided that combining and entering data

TABLE IV

F VALUES AND COEFFICIENTS OF DETERMINATION FOR ONE-YEAR TIME PERIODS

| TIME PERIOD | F VALUE | $R^2$ |
|---|---|---|
| 1904 | 14.055 | .9162 |
| 1909 | 12.136 | .9042 |
| 1914 | 16.328 | .9270 |
| 1919 | 14.114 | .9165 |
| 1924 | 5.775 | .8179 |
| 1929 | 12.133 | .9042 |
| 1934 | 4.625 | .7825 |
| 1939 | 3.311 | .7203 |
| 1944 | 3.830 | .7487 |
| 1949 | 3.580 | .7358 |
| 1954 | 8.358 | .8667 |
| 1959 | 4.162 | .7640 |
| 1964 | 11.570 | .9000 |
| 1969 | 6.246 | .8293 |
| 1974 | 3.901 | .7521 |
| 1978 | 5.234 | .8028 |
| 1982 | 14.008 | .9159 |

from two selected years would double the number of observations to 34 and possibly increase the systematic explanation of the dependent variable. So, data from two consecutive selected years were analyzed in combination. In effect, the results of this approach are used to explain the dependent variable for tandem two-year time periods.

The results for the two-year time periods are shown in Table V. The F values increase substantially over those for the one-year time periods because there are twice as many observations than what was used previously. Systematic explanation for the density of cooperative plants is increased, as can be observed by comparing the calculated F values to the tabular F value for 7 and 26 degrees of freedom. There is, however, a marked decline in the values of the coefficients of determination when compared with those calculated for the one-year time period.

After observing and comparing the results of the one-year and two-year time periods, it was thought that an additional combination consisting of data from three-year time periods might further increase the reliability of the model without decreasing the calculated coefficients of determination to any great extent. In other words, it was deliberated whether or not the explanatory capacity of the model could be improved by increasing the number of observations by using data from an increased time span. Data from three consecutive selected years were then analyzed in combination.

TABLE V

F VALUES AND COEFFICIENTS OF DETERMINATION FOR TWO-YEAR TIME PERIODS

| TIME PERIOD | F VALUE | $R^2$ |
|---|---|---|
| 1904-1909 | 22.780 | .8598 |
| 1909-1914 | 21.957 | .8553 |
| 1914-1919 | 25.591 | .8733 |
| 1919-1924 | 8.112 | .6859 |
| 1924-1929 | 6.731 | .6444 |
| 1929-1934 | 11.013 | .7478 |
| 1934-1939 | 9.733 | .7238 |
| 1939-1944 | 9.337 | .7154 |
| 1944-1949 | 10.006 | .7293 |
| 1949-1954 | 10.320 | .7353 |
| 1954-1959 | 12.031 | .7641 |
| 1959-1964 | 7.856 | .6790 |
| 1964-1969 | 13.983 | .7901 |
| 1969-1974 | 11.163 | .7503 |
| 1974-1978 | 12.134 | .7656 |
| 1978-1982 | 19.594 | .8406 |

The results of the regression for three-year time periods are shown in Table VI. The F values for 7 and 43 degrees of freedom increase as expected, but there is a further erosion in the values for the coefficients of determination. Based on these results, it is thought that combining data from any additional time periods would be counterproductive.

A graphic summary of the calculated coefficients of determination from all three analyses was created by overlaying the resulting curves as shown in Figure 15. It is apparent that the explanation of variation in the dependent variable from one-year time periods is characterized by higher $R^2$ values, but is more erratic than the explanation from both two-year and three-year time periods. Conversely, the explanation from the three-year time period is consistently lower over time but more constant than the one-year and two-year time period explanations.

## Prediction of Cooperative Plant Density

Another application of multiple regression analysis employed in this study is the use of the estimated model as a forecasting tool, or predictor of the density of cooperative plants in the study area over time. The parameter estimates of the regression model for given time periods can be utilized in predicting the density of cooperative plants per county for successive time periods.

TABLE VI

F VALUES AND COEFFICIENTS OF DETERMINATION FOR THREE-YEAR TIME PERIODS

| TIME PERIOD | F VALUE | $R^2$ |
|---|---|---|
| 1904-1914 | 35.871 | .8538 |
| 1909-1919 | 30.224 | .8311 |
| 1914-1924 | 11.205 | .6459 |
| 1919-1929 | 10.007 | .6196 |
| 1924-1934 | 9.291 | .6020 |
| 1929-1939 | 14.298 | .6995 |
| 1934-1944 | 14.612 | .7040 |
| 1939-1949 | 14.948 | .7087 |
| 1944-1954 | 16.100 | .7238 |
| 1949-1959 | 13.950 | .6943 |
| 1954-1964 | 13.757 | .6913 |
| 1959-1969 | 11.971 | .6609 |
| 1964-1974 | 15.619 | .7177 |
| 1969-1978 | 18.654 | .7523 |
| 1974-1982 | 25.257 | .8044 |

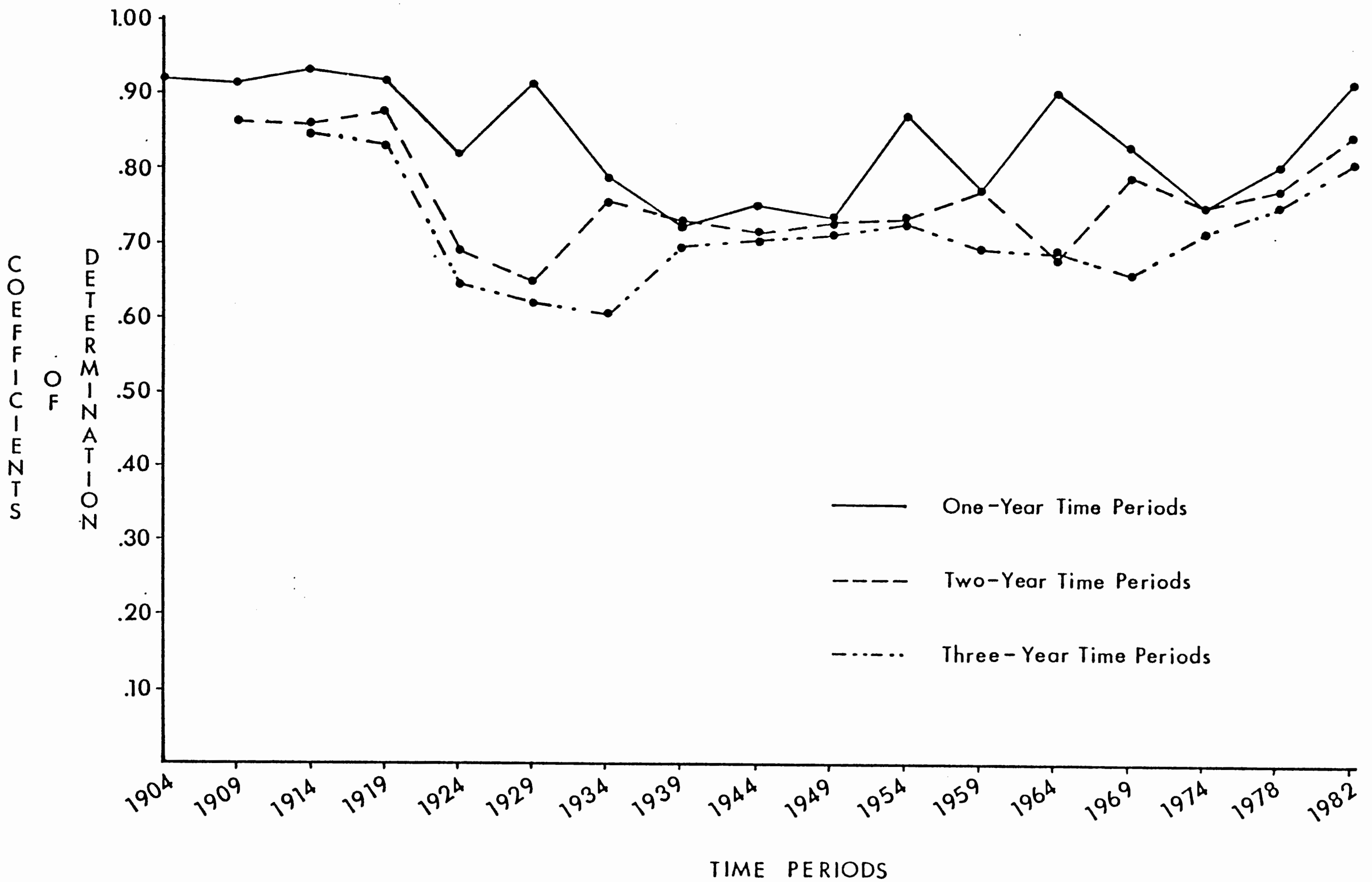



Figure 15. Graphic Summary of the Coefficients of Determination from Three Time Periods

Used in this way, the estimated model's function changes from a measurement tool to a forecasting tool.

For each time period included in the analysis, a set of beta coefficients was computed for the independent variables used in the model. The resulting variation in beta coefficients, together with the constant, or intercept, value that was calculated for each time period, yielded a series of regression solutions in accordance with the change in interaction of the independent variables. The solutions to the resultant equations were used to calculate predicted values of cooperative plant density for the next selected year succeeding the time period of the estimate. Because the dependent variable was entered into regression as logarithms of cooperative density index values when the estimated model was formulated, the predicted values were computed in logarithmic form. Each predicted logarithmic value was transformed back into cooperative density index values to facilitate the comparing of predicted density levels with actual density levels.

Predicted values were computed for each county for each of the time period combinations determined when formulating the estimated model, which resulted in three different predictions per county. The predicted density level was converted to the number of cooperative plants needed in each of the counties to attain the respective density level due to their unequal physical sizes.

As a result, three sets of predictions are reported in tabular form as the predicted number of cooperative plants in each county for every selected year of the study. Included is a fourth set of predictions, which is the average of the predictions per county, as well as the actual number of cooperative plants that were operating in each county over time (See Table VII).

After observing the above results, it became obvious that an objective measure needed to be implemented to determine a ranking of the prediction sets in terms of being closest to the actual number of cooperatives per county. It was decided that the utilization of chi-square analysis would yield a statistic measuring the relative accuracy of each prediction set. Using the Statistical Analysis System on Oklahoma State University's IBM mainframe computer, a series of chi-square tables was created by county, matching results from each of the four prediction sets with the actual number of cooperative plants for each selected year of the study. The county chi-square values were then summed for each set of predictions so that a comparison of the predictions could be made. The larger the summed value, the closer the predictions are to the actual cooperative levels. The chi-square results appear in Table VIII.

The prediction averages have the largest summed chi-square value; therefore, it can be said that the best, and most reliable, predictions can be made by averaging the predictions per county from all three time period estimates.

TABLE VII

NUMBER OF COOPERATIVE PLANTS PREDICTED PER COUNTY USING REGRESSION SOLUTIONS FOR ONE-YEAR, TWO-YEAR, AND THREE-YEAR TIME PERIODS

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| CLARK | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 2 | 1 | . | 1.50 | 1 |
| 1919 | 3 | 2 | 1 | 2.00 | 2 |
| 1924 | 2 | 3 | 4 | 3.00 | 2 |
| 1929 | 4 | 3 | 1 | 2.67 | 2 |
| 1934 | 5 | 1 | 2 | 2.67 | 2 |
| 1939 | 1 | 1 | 1 | 1.00 | 3 |
| 1944 | 1 | 2 | 2 | 1.67 | 3 |
| 1949 | 2 | 1 | 1 | 1.33 | 3 |
| 1954 | 2 | 2 | 2 | 2.00 | 3 |
| 1959 | 1 | 2 | 2 | 1.67 | 3 |
| 1964 | 4 | 3 | 3 | 3.33 | 5 |
| 1969 | 4 | 3 | 3 | 3.33 | 5 |
| 1974 | 4 | 3 | 3 | 3.33 | 5 |
| 1978 | 4 | 4 | 3 | 3.67 | 5 |
| 1982 | 4 | 4 | 4 | 4.00 | 5 |
| 1986 | 4 | 4 | 4 | 4.00 | 5 |
| COMANCHE | | | | | |
| 1909 | 0 | . | . | 0.00 | 1 |
| 1914 | 3 | 4 | . | 3.50 | 3 |
| 1919 | 3 | 2 | 2 | 2.33 | 3 |
| 1924 | 2 | 3 | 4 | 3.00 | 3 |
| 1929 | 5 | 4 | 1 | 3.33 | 3 |
| 1934 | 3 | 1 | 2 | 2.00 | 2 |
| 1939 | 2 | 1 | 1 | 1.33 | 2 |
| 1944 | 1 | 2 | 1 | 1.33 | 2 |
| 1949 | 1 | 1 | 1 | 1.00 | 2 |
| 1954 | 2 | 1 | 1 | 1.33 | 2 |
| 1959 | 1 | 1 | 1 | 1.00 | 2 |
| 1964 | 3 | 2 | 2 | 2.33 | 2 |
| 1969 | 2 | 2 | 2 | 2.00 | 2 |
| 1974 | 2 | 1 | 2 | 1.67 | 2 |
| 1978 | 2 | 2 | 2 | 2.00 | 2 |
| 1982 | 2 | 2 | 2 | 2.00 | 2 |
| 1986 | 2 | 2 | 2 | 2.00 | 2 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| EDWARDS | | | | | |
| 19Ø9 | 4 | . | . | 4.ØØ | 3 |
| 1914 | 4 | 5 | . | 4.5Ø | 4 |
| 1919 | 1 | 1 | 1 | 1.ØØ | 6 |
| 1924 | 6 | 6 | 6 | 6.ØØ | 7 |
| 1929 | 7 | 7 | 6 | 6.67 | 6 |
| 1934 | 5 | 7 | 7 | 6.33 | 5 |
| 1939 | 5 | 4 | 6 | 5.ØØ | 5 |
| 1944 | 5 | 6 | 4 | 5.ØØ | 4 |
| 1949 | 3 | 3 | 4 | 3.33 | 4 |
| 1954 | 3 | 3 | 3 | 3.ØØ | 4 |
| 1959 | 4 | 3 | 3 | 3.33 | 3 |
| 1964 | 7 | 6 | 4 | 5.67 | 4 |
| 1969 | 2 | 3 | 3 | 2.67 | 4 |
| 1974 | 3 | 2 | 3 | 2.67 | 3 |
| 1978 | 4 | 3 | 3 | 3.33 | 3 |
| 1982 | 3 | 3 | 3 | 3.ØØ | 4 |
| 1986 | 5 | 4 | 4 | 4.33 | 4 |
| FINNEY | | | | | |
| 19Ø9 | Ø | . | . | Ø.ØØ | Ø |
| 1914 | 1 | 1 | . | 1.ØØ | Ø |
| 1919 | Ø | Ø | Ø | Ø.ØØ | 1 |
| 1924 | 2 | 2 | 2 | 2.ØØ | 1 |
| 1929 | 2 | 2 | 4 | 2.67 | 1 |
| 1934 | 1Ø | 2 | 4 | 5.33 | 5 |
| 1939 | 2 | 1 | 2 | 1.67 | 5 |
| 1944 | 7 | 8 | 3 | 6.ØØ | 5 |
| 1949 | 3 | 3 | 3 | 3.ØØ | 6 |
| 1954 | 4 | 3 | 3 | 3.33 | 5 |
| 1959 | 7 | 6 | 6 | 6.33 | 5 |
| 1964 | Ø | Ø | 4 | 1.33 | 5 |
| 1969 | 4 | 2 | 2 | 2.67 | 5 |
| 1974 | 5 | 4 | 3 | 4.ØØ | 5 |
| 1978 | 4 | 4 | 4 | 4.ØØ | 6 |
| 1982 | 4 | 4 | 4 | 4.ØØ | 6 |
| 1986 | 4 | 4 | 4 | 4.ØØ | 7 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| FORD | | | | | |
| 1909 | 1 | . | . | 1.ØØ | 1 |
| 1914 | 6 | 7 | . | 6.5Ø | 4 |
| 1919 | 8 | 5 | 4 | 5.67 | 8 |
| 1924 | 8 | 8 | 8 | 8.ØØ | 8 |
| 1929 | 13 | 13 | 7 | 11.ØØ | 8 |
| 1934 | 13 | 8 | 1Ø | 1Ø.33 | 8 |
| 1939 | 8 | 6 | 1Ø | 8.ØØ | 8 |
| 1944 | 8 | 8 | 8 | 8.ØØ | 8 |
| 1949 | 7 | 7 | 7 | 7.ØØ | 1Ø |
| 1954 | 1Ø | 8 | 7 | 8.33 | 1Ø |
| 1959 | 8 | 8 | 8 | 8.ØØ | 1Ø |
| 1964 | 13 | 13 | 8 | 11.33 | 1Ø |
| 1969 | 7 | 7 | 7 | 7.ØØ | 1Ø |
| 1974 | 1Ø | 8 | 7 | 8.33 | 1Ø |
| 1978 | 8 | 8 | 8 | 8.ØØ | 1Ø |
| 1982 | 1Ø | 8 | 8 | 8.67 | 1Ø |
| 1986 | 1Ø | 1Ø | 1Ø | 1Ø.ØØ | 1Ø |
| GRANT | | | | | |
| 1909 | Ø | . | . | Ø.ØØ | Ø |
| 1914 | Ø | Ø | . | Ø.ØØ | Ø |
| 1919 | Ø | Ø | Ø | Ø.ØØ | Ø |
| 1924 | Ø | 1 | 1 | Ø.67 | Ø |
| 1929 | 1 | 3 | 5 | 3.ØØ | Ø |
| 1934 | 6 | 1 | 2 | 3.ØØ | 1 |
| 1939 | Ø | Ø | Ø | Ø.ØØ | 1 |
| 1944 | 2 | 3 | Ø | 1.67 | 1 |
| 1949 | 1 | 1 | 1 | 1.ØØ | 3 |
| 1954 | 1 | 1 | 1 | 1.ØØ | 3 |
| 1959 | 3 | 4 | 3 | 3.33 | 3 |
| 1964 | Ø | Ø | 1 | Ø.33 | 3 |
| 1969 | 5 | Ø | Ø | 1.67 | 3 |
| 1974 | 3 | 3 | 1 | 2.33 | 3 |
| 1978 | 2 | 2 | 3 | 2.33 | 3 |
| 1982 | 2 | 2 | 2 | 2.ØØ | 3 |
| 1986 | 4 | 3 | 3 | 3.33 | 3 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| GRAY | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 1 | 1 | . | 1.00 | 2 |
| 1919 | 2 | 1 | 1 | 1.33 | 6 |
| 1924 | 5 | 6 | 6 | 5.67 | 5 |
| 1929 | 10 | 10 | 6 | 8.67 | 5 |
| 1934 | 10 | 3 | 7 | 6.67 | 5 |
| 1939 | 3 | 2 | 4 | 3.00 | 4 |
| 1944 | 4 | 4 | 3 | 3.67 | 4 |
| 1949 | 2 | 3 | 3 | 2.67 | 4 |
| 1954 | 4 | 3 | 3 | 3.33 | 5 |
| 1959 | 5 | 5 | 4 | 4.67 | 6 |
| 1964 | 8 | 7 | 5 | 6.67 | 6 |
| 1969 | 4 | 4 | 4 | 4.00 | 6 |
| 1974 | 7 | 6 | 3 | 5.33 | 6 |
| 1978 | 5 | 5 | 6 | 5.33 | 6 |
| 1982 | 4 | 4 | 5 | 4.33 | 6 |
| 1986 | 7 | 6 | 6 | 6.33 | 6 |
| HAMILTON | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 0 | 0 | . | 0.00 | 0 |
| 1919 | 0 | 0 | 0 | 0.00 | 0 |
| 1924 | 1 | 0 | 0 | 0.33 | 0 |
| 1929 | 0 | 0 | 0 | 0.00 | 0 |
| 1934 | 4 | 0 | 1 | 1.67 | 1 |
| 1939 | 0 | 0 | 0 | 0.00 | 0 |
| 1944 | 2 | 3 | 1 | 2.00 | 1 |
| 1949 | 1 | 1 | 1 | 1.00 | 3 |
| 1954 | 2 | 1 | 1 | 1.33 | 3 |
| 1959 | 2 | 2 | 2 | 2.00 | 3 |
| 1964 | 4 | 3 | 2 | 3.00 | 3 |
| 1969 | 1 | 2 | 2 | 1.67 | 3 |
| 1974 | 1 | 1 | 2 | 1.33 | 3 |
| 1978 | 2 | 2 | 2 | 2.00 | 3 |
| 1982 | 3 | 2 | 3 | 2.67 | 3 |
| 1986 | 3 | 3 | 3 | 3.00 | 3 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| HASKELL | | | | | |
| 19Ø9 | Ø | . | . | Ø.ØØ | Ø |
| 1914 | Ø | Ø | . | Ø.ØØ | Ø |
| 1919 | Ø | Ø | Ø | Ø.ØØ | Ø |
| 1924 | 1 | 1 | 2 | 1.33 | Ø |
| 1929 | 4 | 4 | 2 | 3.33 | 2 |
| 1934 | 7 | Ø | 1 | 2.67 | 2 |
| 1939 | Ø | Ø | 1 | Ø.33 | 2 |
| 1944 | 2 | 1 | 1 | 1.33 | 2 |
| 1949 | 1 | 1 | 1 | 1.ØØ | 2 |
| 1954 | 2 | 1 | 1 | 1.33 | 2 |
| 1959 | 3 | 4 | 3 | 3.33 | 2 |
| 1964 | Ø | Ø | 2 | Ø.67 | 2 |
| 1969 | 2 | 1 | 1 | 1.33 | 2 |
| 1974 | 4 | 4 | 1 | 3.ØØ | 2 |
| 1978 | 3 | 4 | 4 | 3.67 | 2 |
| 1982 | 1 | 2 | 1 | 1.33 | 2 |
| 1986 | 2 | 2 | 2 | 2.ØØ | 2 |
| HODGEMAN | | | | | |
| 19Ø9 | Ø | . | . | Ø.ØØ | Ø |
| 1914 | 1 | 1 | . | 1.ØØ | 2 |
| 1919 | 4 | 1 | 1 | 2.ØØ | 3 |
| 1924 | 4 | 5 | 5 | 4.67 | 3 |
| 1929 | 2 | 4 | 3 | 3.ØØ | 2 |
| 1934 | 8 | 1 | 3 | 4.ØØ | 2 |
| 1939 | 3 | 2 | 2 | 2.33 | 2 |
| 1944 | 3 | 3 | 3 | 3.ØØ | 2 |
| 1949 | 1 | 2 | 2 | 1.67 | 2 |
| 1954 | 2 | 1 | 1 | 1.33 | 3 |
| 1959 | 3 | 2 | 2 | 2.67 | 3 |
| 1964 | 7 | 6 | 2 | 5.ØØ | 3 |
| 1969 | 3 | 2 | 2 | 2.33 | 2 |
| 1974 | 2 | 2 | 2 | 2.ØØ | 2 |
| 1978 | 2 | 2 | 2 | 2.ØØ | 2 |
| 1982 | 1 | 1 | 1 | 1.ØØ | 2 |
| 1986 | 2 | 2 | 2 | 2.ØØ | 2 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| KEARNY | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 0 | 0 | . | 0.00 | 0 |
| 1919 | 0 | 0 | 0 | 0.00 | 0 |
| 1924 | 1 | 1 | 0 | 0.67 | 0 |
| 1929 | 0 | 0 | 1 | 0.33 | 0 |
| 1934 | 4 | 0 | 1 | 1.67 | 0 |
| 1939 | 0 | 0 | 0 | 0.00 | 0 |
| 1944 | 2 | 3 | 1 | 2.00 | 0 |
| 1949 | 1 | 1 | 1 | 1.00 | 1 |
| 1954 | 1 | 1 | 1 | 1.00 | 1 |
| 1959 | 2 | 2 | 2 | 2.00 | 1 |
| 1964 | 4 | 3 | 2 | 3.00 | 2 |
| 1969 | 2 | 1 | 1 | 1.33 | 2 |
| 1974 | 1 | 1 | 1 | 1.00 | 2 |
| 1978 | 2 | 2 | 2 | 2.00 | 2 |
| 1982 | 2 | 2 | 2 | 2.00 | 2 |
| 1986 | 2 | 2 | 2 | 2.00 | 2 |
| KIOWA | | | | | |
| 1909 | 1 | . | . | 1.00 | 1 |
| 1914 | 7 | 9 | . | 8.00 | 4 |
| 1919 | 5 | 3 | 3 | 3.67 | 5 |
| 1924 | 5 | 5 | 5 | 5.00 | 5 |
| 1929 | 9 | 9 | 5 | 7.67 | 5 |
| 1934 | 5 | 4 | 5 | 4.67 | 5 |
| 1939 | 3 | 2 | 3 | 2.67 | 5 |
| 1944 | 3 | 3 | 2 | 2.67 | 5 |
| 1949 | 2 | 2 | 2 | 2.00 | 5 |
| 1954 | 3 | 3 | 2 | 2.67 | 5 |
| 1959 | 3 | 3 | 3 | 3.00 | 5 |
| 1964 | 7 | 5 | 3 | 5.00 | 5 |
| 1969 | 2 | 3 | 3 | 2.67 | 5 |
| 1974 | 3 | 2 | 3 | 2.67 | 5 |
| 1978 | 4 | 4 | 3 | 3.67 | 5 |
| 1982 | 4 | 4 | 4 | 4.00 | 5 |
| 1986 | 4 | 4 | 4 | 4.00 | 5 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| MEADE | | | | | |
| 1909 | Ø | . | . | Ø.ØØ | Ø |
| 1914 | 2 | 2 | . | 2.ØØ | 3 |
| 1919 | 4 | 2 | 2 | 2.67 | 4 |
| 1924 | 5 | 6 | 6 | 5.67 | 4 |
| 1929 | 9 | 9 | 3 | 7.ØØ | 4 |
| 1934 | 8 | 1 | 4 | 4.33 | 4 |
| 1939 | 1 | 1 | 2 | 1.33 | 3 |
| 1944 | 3 | 3 | 2 | 2.67 | 3 |
| 1949 | 2 | 2 | 2 | 2.ØØ | 3 |
| 1954 | 3 | 2 | 2 | 2.33 | 3 |
| 1959 | 2 | 2 | 2 | 2.ØØ | 3 |
| 1964 | 6 | 4 | 3 | 4.33 | 3 |
| 1969 | 4 | 2 | 2 | 2.67 | 3 |
| 1974 | 4 | 4 | 3 | 3.67 | 4 |
| 1978 | 3 | 3 | 3 | 3.ØØ | 4 |
| 1982 | 4 | 3 | 4 | 3.67 | 4 |
| 1986 | 4 | 4 | 4 | 4.ØØ | 4 |
| MORTON | | | | | |
| 1909 | Ø | . | . | Ø.ØØ | Ø |
| 1914 | 3 | 2 | . | 2.5Ø | Ø |
| 1919 | Ø | Ø | Ø | Ø.ØØ | 2 |
| 1924 | Ø | Ø | 1 | Ø.33 | 2 |
| 1929 | Ø | Ø | 1 | Ø.33 | 2 |
| 1934 | 6 | Ø | Ø | 2.ØØ | 2 |
| 1939 | Ø | Ø | Ø | Ø.ØØ | 2 |
| 1944 | 3 | 4 | Ø | 2.33 | 2 |
| 1949 | 1 | 1 | 1 | 1.ØØ | 2 |
| 1954 | 1 | 1 | 1 | 1.ØØ | 2 |
| 1959 | 2 | 1 | 1 | 1.33 | 2 |
| 1964 | 1 | 1 | 2 | 1.33 | 2 |
| 1969 | 4 | 3 | 2 | 3.ØØ | 2 |
| 1974 | 1 | 1 | 2 | 1.33 | 2 |
| 1978 | 2 | 2 | 2 | 2.ØØ | 3 |
| 1982 | 3 | 2 | 3 | 2.67 | 3 |
| 1986 | 3 | 3 | 3 | 3.ØØ | 3 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| SEWARD | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 5 | 4 | . | 4.50 | 0 |
| 1919 | 1 | 1 | 1 | 1.00 | 1 |
| 1924 | 1 | 2 | 3 | 2.00 | 1 |
| 1929 | 6 | 5 | 3 | 4.67 | 1 |
| 1934 | 4 | 3 | 3 | 3.33 | 1 |
| 1939 | 1 | 1 | 1 | 1.00 | 1 |
| 1944 | 3 | 3 | 1 | 2.33 | 1 |
| 1949 | 1 | 1 | 1 | 1.00 | 1 |
| 1954 | 2 | 1 | 1 | 1.33 | 1 |
| 1959 | 2 | 3 | 2 | 2.33 | 1 |
| 1964 | 0 | 0 | 2 | 0.67 | 1 |
| 1969 | 1 | 0 | 1 | 0.67 | 1 |
| 1974 | 2 | 2 | 2 | 2.00 | 2 |
| 1978 | 2 | 2 | 2 | 2.00 | 2 |
| 1982 | 3 | 2 | 2 | 2.33 | 2 |
| 1986 | 3 | 3 | 3 | 3.00 | 2 |
| STANTON | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 0 | 0 | . | 0.00 | 0 |
| 1919 | 0 | 0 | 0 | 0.00 | 0 |
| 1924 | 0 | 0 | 1 | 0.33 | 0 |
| 1929 | 0 | 0 | 0 | 0.00 | 0 |
| 1934 | 6 | 0 | 1 | 2.33 | 1 |
| 1939 | 0 | 0 | 0 | 0.00 | 1 |
| 1944 | 2 | 3 | 1 | 2.00 | 2 |
| 1949 | 0 | 1 | 1 | 0.67 | 3 |
| 1954 | 2 | 1 | 1 | 1.33 | 3 |
| 1959 | 4 | 3 | 3 | 3.33 | 4 |
| 1964 | 0 | 0 | 1 | 0.33 | 4 |
| 1969 | 4 | 0 | 0 | 1.33 | 4 |
| 1974 | 1 | 1 | 0 | 0.67 | 4 |
| 1978 | 3 | 3 | 3 | 3.00 | 4 |
| 1982 | 4 | 3 | 3 | 3.33 | 4 |
| 1986 | 4 | 4 | 4 | 4.00 | 4 |

TABLE VII (Continued)

| County & Year | One-Year Prediction | Two-Year Prediction | Three-Year Prediction | Prediction Average | Actual Number |
|---|---|---|---|---|---|
| STEVENS | | | | | |
| 1909 | 0 | . | . | 0.00 | 0 |
| 1914 | 9 | 7 | . | 8.00 | 0 |
| 1919 | 0 | 0 | 0 | 0.00 | 2 |
| 1924 | 3 | 3 | 3 | 3.00 | 2 |
| 1929 | 0 | 1 | 1 | 0.67 | 2 |
| 1934 | 3 | 1 | 2 | 2.00 | 3 |
| 1939 | 1 | 0 | 0 | 0.33 | 3 |
| 1944 | 7 | 9 | 0 | 5.33 | 2 |
| 1949 | 1 | 2 | 2 | 1.67 | 2 |
| 1954 | 2 | 1 | 1 | 1.33 | 2 |
| 1959 | 4 | 3 | 3 | 3.33 | 2 |
| 1964 | 0 | 0 | 2 | 0.67 | 3 |
| 1969 | 5 | 3 | 2 | 3.33 | 3 |
| 1974 | 2 | 2 | 2 | 2.00 | 3 |
| 1978 | 2 | 2 | 2 | 2.00 | 3 |
| 1982 | 3 | 3 | 3 | 3.00 | 3 |
| 1986 | 4 | 4 | 4 | 4.00 | 1 |

TABLE VIII

CHI-SQUARE VALUES FOR PREDICTIONS FROM THREE TIME PERIOD ESTIMATES AND THE AVERAGE OF THE PREDICTIONS

| County | From One-Year Prediction | From Two-Year Prediction | From Three-Year Prediction | From Prediction Averages |
|---|---|---|---|---|
| Clark | 42.591 | 16.400 | 14.021 | 64.175 |
| Comanche | 23.375 | 11.429 | 4.323 | 31.167 |
| Edwards | 42.500 | 29.222 | 29.286 | 55.250 |
| Finney | 28.994 | 21.500 | 9.427 | 37.010 |
| Ford | 41.556 | 9.593 | 3.333 | 45.333 |
| Grant | 14.607 | 3.244 | 11.333 | 18.889 |
| Gray | 50.292 | 23.889 | 10.573 | 64.812 |
| Hamilton | 17.472 | 16.148 | 20.833 | 21.880 |
| Haskell | 6.626 | 2.872 | 8.510 | 12.554 |
| Hodgeman | 26.335 | 6.425 | 5.250 | 30.291 |
| Kearny | 16.587 | 16.895 | 12.429 | 24.744 |
| Kiowa | 24.933 | 7.467 | 4.683 | 34.000 |
| Meade | 27.767 | 5.333 | 8.543 | 29.042 |
| Morton | 9.421 | 14.444 | 10.312 | 20.306 |
| Seward | 19.318 | 23.818 | 5.028 | 27.239 |
| Stanton | 31.875 | 20.000 | 10.726 | 44.637 |
| Stevens | 21.756 | 34.286 | 20.741 | 38.250 |
| Total | 446.005 | 262.965 | 189.324 | 599.579 |

The one-year estimates produce the next best predictions, followed by the two-year estimates and then the three-year estimates. An _a posteriori_ analysis of these results follows in an attempt to explain why there is variability in the estimates and their prediction averages with respect to predicting the number of cooperative plants within the study area at any one of 17 points in time.

The relationship between the three time period estimates, the prediction averages, and the resulting predictions are diagrammed in Figure 16. It follows from intuition that the prior time period nearest to the time period under consideration would provide better predictions than those prior time periods which are once or twice removed. In terms of the problem at hand, cooperators are more likely to make the decision of whether or not to establish grain marketing facilities on the strength of the most current conditions than they are on conditions that prevailed at much earlier points in time. On the other hand, the effect of the earlier conditions would probably not be discounted completely as a factor in the cooperators' decision. The problem, then, becomes one of determining the extent to which cooperators use knowledge of conditions in prior time periods as a basis for establishing cooperative plants. In effect, this problem was addressed by lagging the endogenous variables, which in this case are the predicted levels of cooperative density, by using four predetermined configurations.

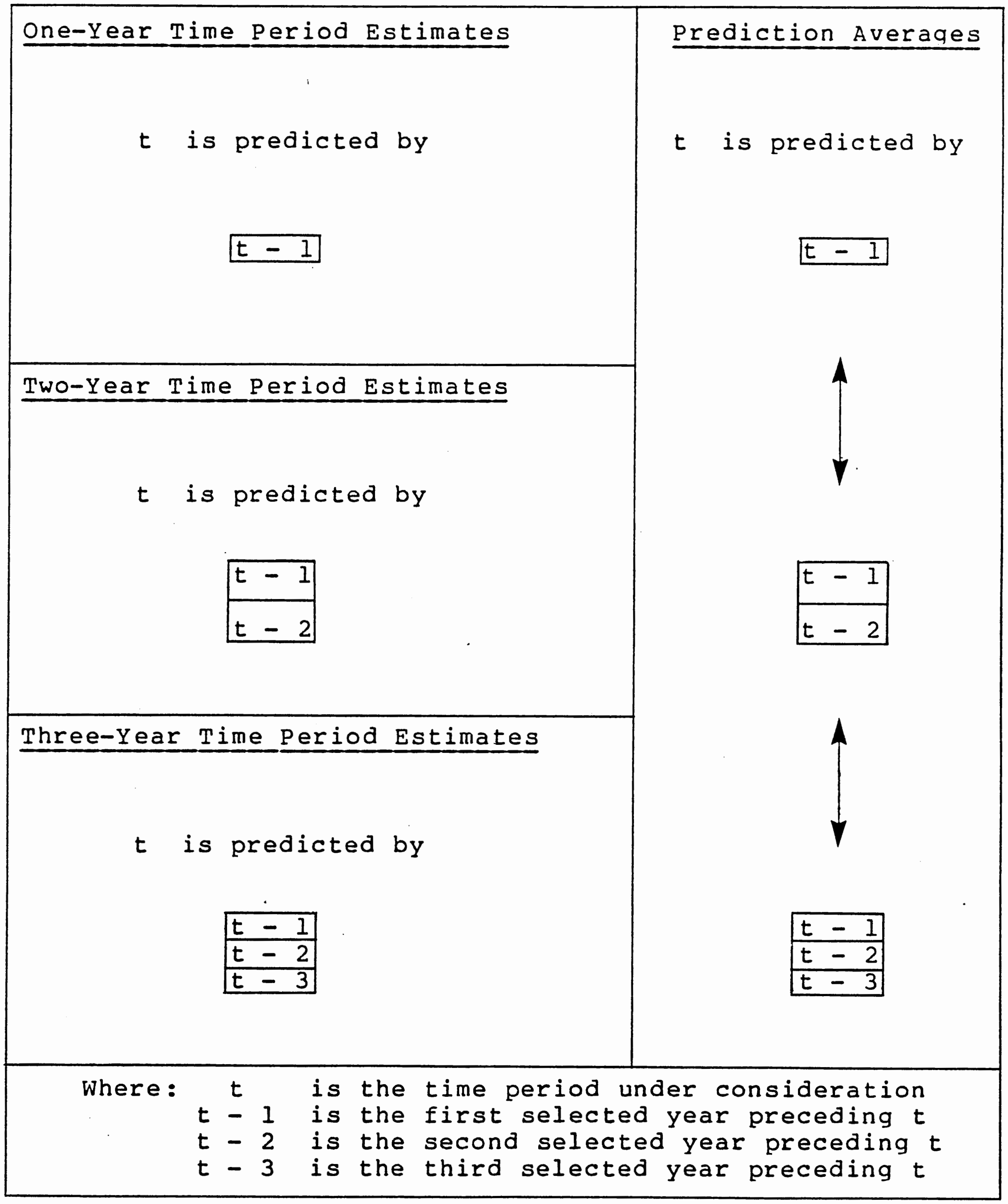



Figure 16. The Relationships Between the Three Time Period Estimates, the Prediction Averages, and the Resulting Predictions

With further dissection of the endogenous variables as they are used in the prediction model, it is possible to calculate the percentage weight exerted on resulting predictions by conditions of prior time periods for each configuration. From the chi-square results reported above, it is apparent that the three-year time period estimates yield the poorest predictions. By referring to Figure 16 once again, it can be observed that from the three-year estimates, cooperative levels are predicted equally by t-1, t-2, and t-3. Conditions that existed in the most distant time period are weighted equally with conditions from more current time periods. The two-year estimates provide the the third best estimates. In this case, conditions from t-1 and t-2 are weighted equally. The second best estimates are provided solely by the one-year, or most current, time period. From the above, it appears that a pattern exists -- the predictions improve as the most current time period is more heavily weighted. Stated another way, it appears that predictions worsen as conditions from the removed time periods, regardless of their chronological positions in relation to the time period under consideration, continue to be weighted equally with the most current conditions.

The best predictions, provided by the prediction averages, are also the result of weighted estimates from each time period. One important difference exists, however. Averaging the predictions has the effect of decreasing the percentage weight given to time periods in proportion to their chronological position. Using this procedure, conditions from the most current time periods are weighted at 61.11% -- considerably more than from the other time periods. Conditions from the second selected year preceding the time period for which a prediction is to be made are weighted at 27.78%. Conditions from the third preceding selected year are weighted at 11.11%. The technique of lagging the endogenous variables in this way seems to yield results that more nearly approximate the results of the cooperators' collective decisions as they relate to the building of cooperative elevators within specific counties at various points in time.

# CHAPTER V

# TREATMENT OF ADDITIONAL QUESTIONS EXPLORED IN THE STUDY

## The Impact of Railroads on the Spatial Positioning of Cooperatives

The presence or absence of railroads in the study area seems to be an especially important exogenous factor in the spatial positioning of grain marketing cooperatives over time. Determining the extent to which individual cooperatives have depended on the availability of rail for their "lifeline" to the terminal markets is a problem well suited to the discipline of geography. The marketing activity of each cooperative, when transporting its grain by rail, may be thought of as movement from single points to points located along lines. The marketing activity of each cooperator may be thought of as movements to a single point (historically, an elevator located on a rail line) from scattered points in an area. Different line-to-area systems are a result of the changing rail lines throughout the study area over time. These are some examples of movement geometry as it relates to cooperatives and their proximity to railroads. Geographers, such as Abler, Adams, and Gould (1971), treat movement geometry as an important consideration in describing the spatial distribution of some phenomena.

The rail system in southwestern Kansas has been of paramount importance in the area's agricultural development. Throughout most of the years under consideration in this study, railroads have provided a clearly superior means of grain transportation from country elevators over other available alternatives. In the early settlement years, in areas where railroads were nonexistent, grain could only be moved to terminal markets by horseback or wagon. This, in effect, precluded any commercial grain farming activity for pioneer farmers whose land was remotely located with respect to a railroad. The founding of early cooperative elevators was contingent upon the availability of rail within a reasonable transport distance to cooperating grain farmers. Even in later years after the development of trucks, the availability of railroads was vital to the cooperative marketing of grain. Trucks were small, and the highway system was inadequate for large-scale grain shipment. Railroads remained, by far, the most cost-effective mode of grain transportation.

For the first 60 years or so after their inception in the study area, cooperatives were always located on railroads as shown in Figure 17 (Kansas Department of Transportation, 1987). During these years, if railroads were abandoned, cooperatives on those lines were then disbanded (Kansas State Corporation Commission, ob. cit.).

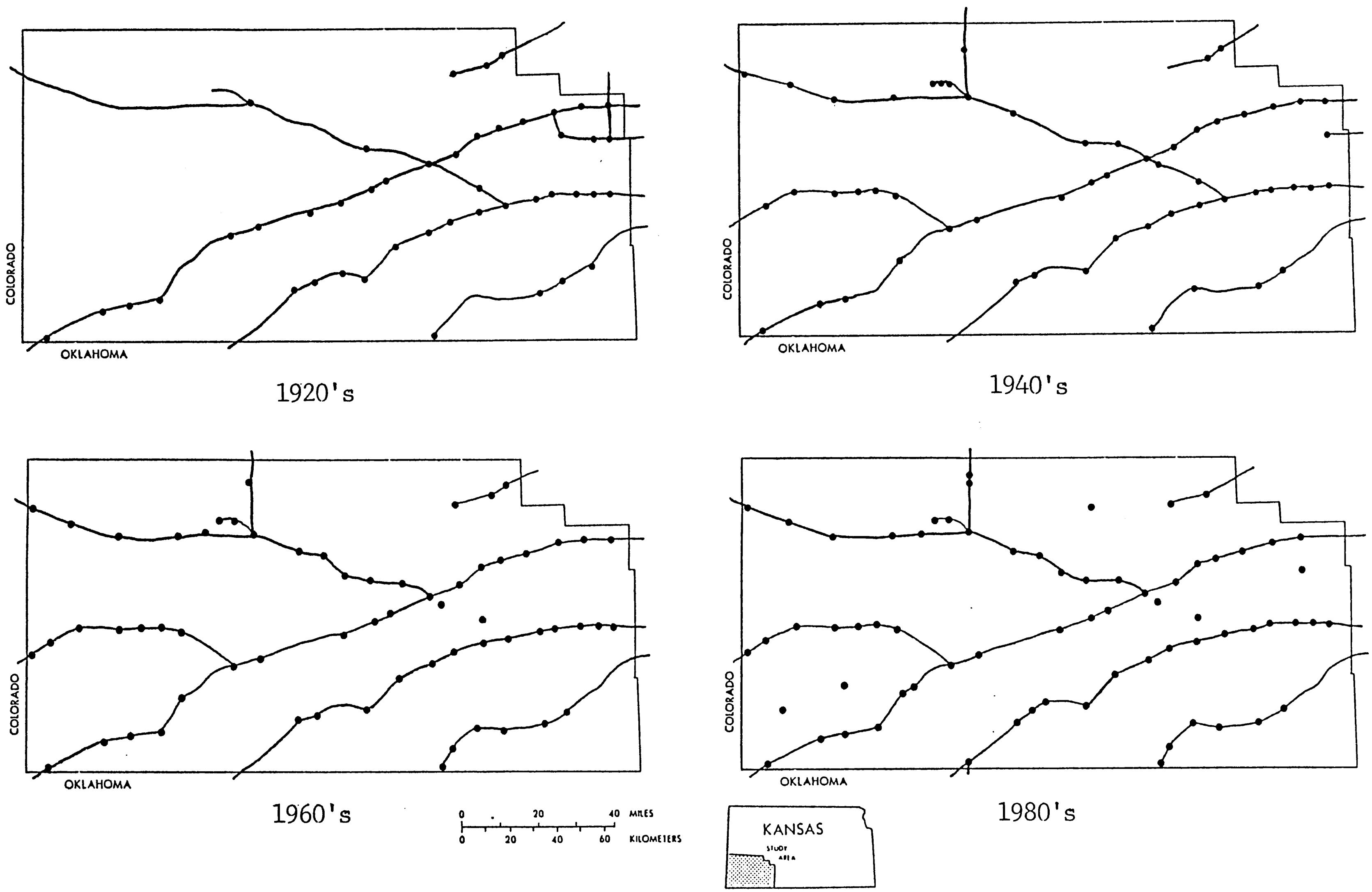



Figure 17. Cooperative Plants and Railroads as They Existed in Four Different Time Periods

In one instance a cooperative firm bought the 14 mile railroad spur that served two of its remote elevators when informed that the line was to be abandoned (Farmland News, 1975). Grain transportation began to change, though, with the advent of larger sized trucks and the improvement of the highway system approximately 15-20 years ago. Schoeff (1987) states that in the 1970's, many railroads were in poor financial condition and that there was a perennial problem of railcar shortages, especially in good crop years. He then refers to large trucks as "the 'white knights' for many Kansas elevators caught in the transportation crunch of the 1970's and for those located on abandoned branch rail lines." No cooperative elevators in the study area operated without direct access to a railroad before 1965. Since that year, when a railroad branch was abandoned, the two cooperative plants that were previously located on the line have continued their operations by transporting their grain by trucks.

In the last ten years, it appears that a new trend in locating branch cooperative plants has begun to develop in southwestern Kansas. For the first time, cooperative firms have built elevators in remote locations that are not served by railroads; at present there are four branch elevators operating as such. The fact that three of the elevators have been in operation for several years lends credence to the belief that this innovation has proven to be profitable for the firms involved. It seems probable that this trend will continue, which will allow "gaps" in the spatial landscape to be filled by cooperative elevators for the first time.

It was hypothesized that the percentage of cooperative plants with locations on railroads is now in a period of decline. To test this hypothesis, a count of the number of cooperatives located on rail and off rail was conducted. Next, the percentage of plants on rail was calculated for every selected year of the study. These results appear in Table IX. The data support the hypothesis, as the percentage of cooperative plants on rail has steadily declined since 1974.

## Measurement of the Areal Extent of Servicing Territories

Agriculture, in general, has undergone a myriad of structural changes in southwestern Kansas since the area was first settled. Many factors have been purported to be responsible for these changes as expressed in the wealth of literature dealing with the analyses of the agricultural economy throughout the years. Additional analysis of the causes of this phenomenon is not germane to this study; the effects, however, as they relate to the spatial positioning of the cooperative system in the study area, will be addressed. Certainly, one of the most obvious effects of changing agriculture is the continuing trend toward decentralization of almost all forms of agricultural

TABLE IX

NUMBER OF COOPERATIVE PLANTS PER YEAR, NUMBER AND PERCENTAGE OF PLANTS ON RAILROADS, AND NUMBER OF PLANTS OFF RAILROADS

| | Number of Cooperative Plants | | | |
|---|---|---|---|---|
| Year | Total | on Rail | off Rail | Percentage on Rail |
| 1904 | 2 | 2 | 0 | 100.00 |
| 1909 | 6 | 6 | 0 | 100.00 |
| 1914 | 23 | 23 | 0 | 100.00 |
| 1919 | 43 | 43 | 0 | 100.00 |
| 1924 | 43 | 43 | 0 | 100.00 |
| 1929 | 43 | 43 | 0 | 100.00 |
| 1934 | 49 | 49 | 0 | 100.00 |
| 1939 | 47 | 47 | 0 | 100.00 |
| 1944 | 47 | 47 | 0 | 100.00 |
| 1949 | 56 | 56 | 0 | 100.00 |
| 1954 | 57 | 57 | 0 | 100.00 |
| 1959 | 59 | 59 | 0 | 100.00 |
| 1964 | 63 | 63 | 0 | 100.00 |
| 1969 | 62 | 60 | 2 | 96.77 |
| 1974 | 63 | 61 | 2 | 96.83 |
| 1978 | 64 | 61 | 3 | 95.31 |
| 1982 | 66 | 62 | 4 | 93.94 |
| 1987 | 67 | 61 | 6 | 91.04 |

activity. As time progresses, arable acres are being farmed by fewer and fewer farmers. Agricultural lenders, implement dealers, and farm supply businesses continue to dwindle in number through various forms of integration and liquidation (Sjo, 1987). As conditions change, surviving farmers and agri-businesses alike must respond by periodically adjusting their operations, even when their goal is but to maintain current levels of profitability.

The grain marketing cooperative system of southwestern Kansas has responded in a dynamic way to this structural change. Individual cooperatives -- the primary components of the system -- have participated in numerous vertical integrations in efforts to increase their economies of scale. Horizontal integration is another response that has frequently been used. The effects of vertical integration would be very difficult, if not impossible, to measure in a spatial context. On the other hand, horizontal integration, whether through acquisition, consolidation, or merger, can be translated into measureable spatial responses. It is contended that one way to analyze the impact of structural change on the system is to reconstruct the individual cooperative firms' spatial responses by measuring change in the areal extent of their servicing territories over time.

The concept of the servicing territory for each cooperative firm is derived in part from the work of Christaller (1966) in the 1930's, which is referred to as central place theory. Based on a set of simplifying assumptions, Christaller proposed that a city tends to locate centrally to a surrounding area of sufficient size such that it is inhabited by enough people to form a viable market for the goods and services offered in the city. This results in cities locating in a hexagonal distribution across a landscape that is characterized by a developed urban hierarchy providing varying economic functions to the surrounding population. Christaller's landmark work is quite useful as a theoretical basis for studies involving the identification of trade areas associated with urban places.

In the application at hand, though, only the specific locations of the physical facilities of grain marketing cooperative firms are of concern in identifying their surrounding areas, or servicing territories, rather than in the towns or cities in which they may operate. In this sense, cooperatives located within towns are considered to be adjunct features of a central place. Additionally, this analysis focuses on only one economic function that grain marketing cooperatives provide; that is, the function of providing a marketing service through the assembling of grain for producers in the surrounding area. Finally, in this study, no hierarchy is perceived to exist, as all cooperative plants are assumed to be equal in every respect. Each plant's natural servicing territory is determined solely as a function of shortest transport distances for grain farmers in the surrounding area. Other factors such as price differentials, size of storage facilities, quality of service, etc. are not considered in calculating the areal extent of servicing territories.

It was hypothesized that there has been a significant increase in the areal extent of the servicing territories of cooperative firms in the study area since 1945. The methodology used in testing this hypothesis is described as follows. Using the locational data already gathered, as shown in Figures 7-11, the locations of cooperative plants in existence at various points in time, beginning in 1945, were manually digitized into X,Y coordinates. The coordinates were grouped together, representing the synoptic operations of individual plants, for the years 1945, 1949, 1959, 1969, 1979, and 1987. In addition, the coordinates from individual plants were placed in sub-groupings by their respective cooperative firms. An arbitrary Z value, from 1 to 5, was assigned to each cooperative firm sub-grouping, so that servicing boundaries would be differentiated. Coordinate groupings were analyzed using SYMAP, a computer cartography program designed for the analysis of spatial data, on Oklahoma State University's IBM mainframe computer system. A series of proximal maps was produced (Figures 18-23) based on searches of nearest-neighborhoods.

Using the proximal maps as a source, the areal extents of individual servicing territories were calculated by counting the number of symbols that comprise each area, and then multiplying the count totals by a factor. The factor

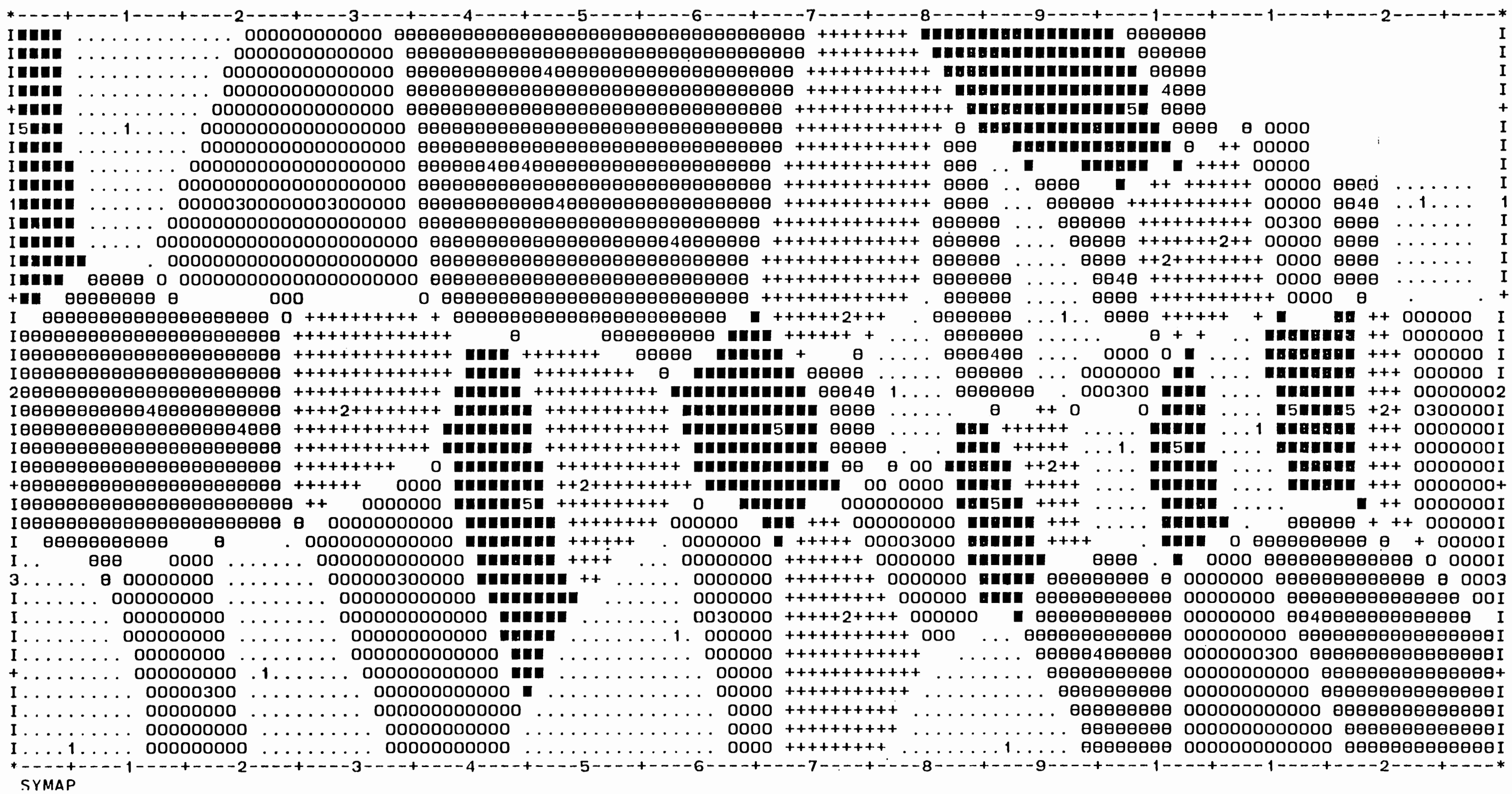



Figure 18. Servicing Territories of Cooperative Firms - 1945

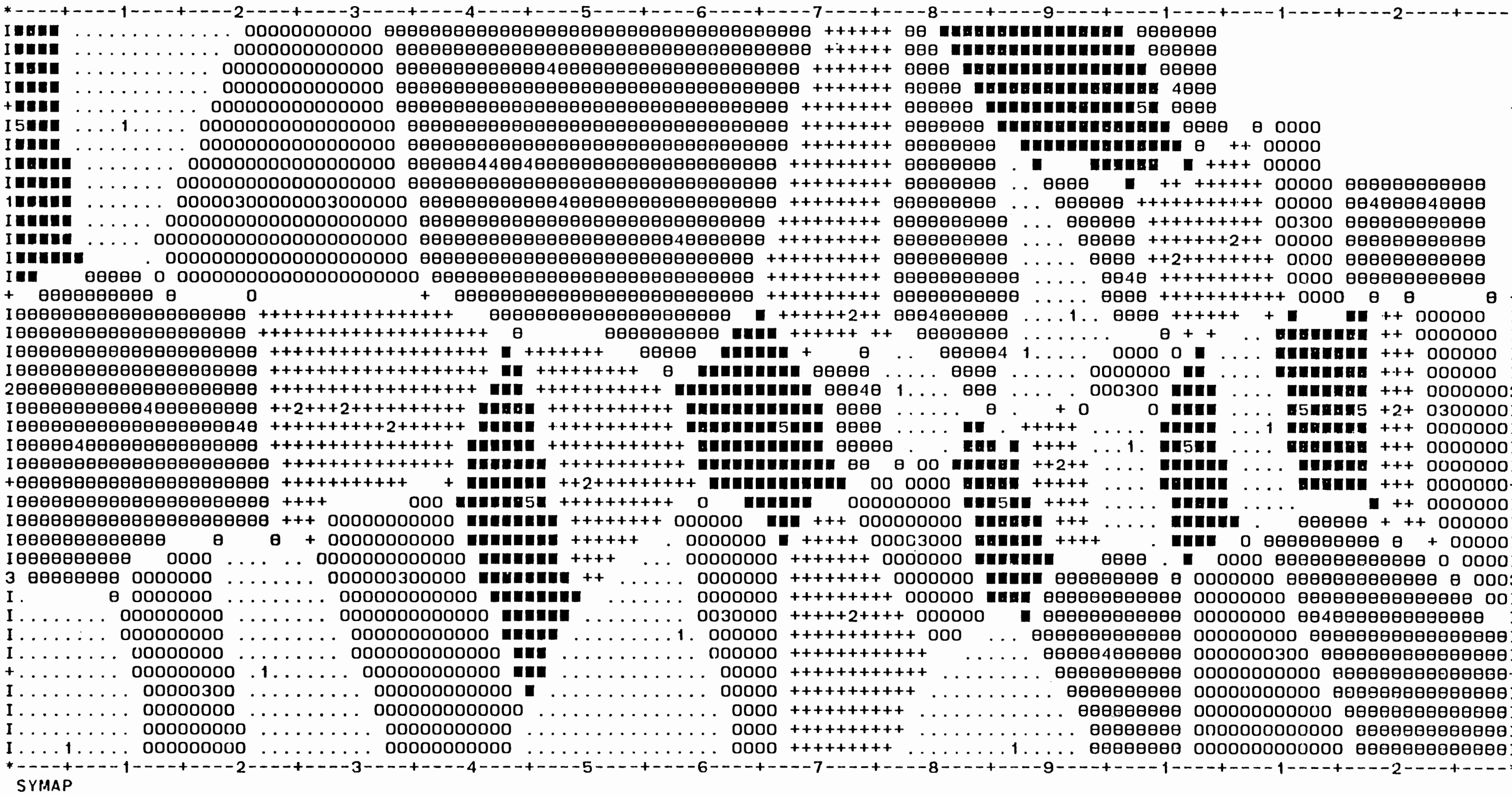



Figure 19. Servicing Territories of Cooperative Firms - 1949

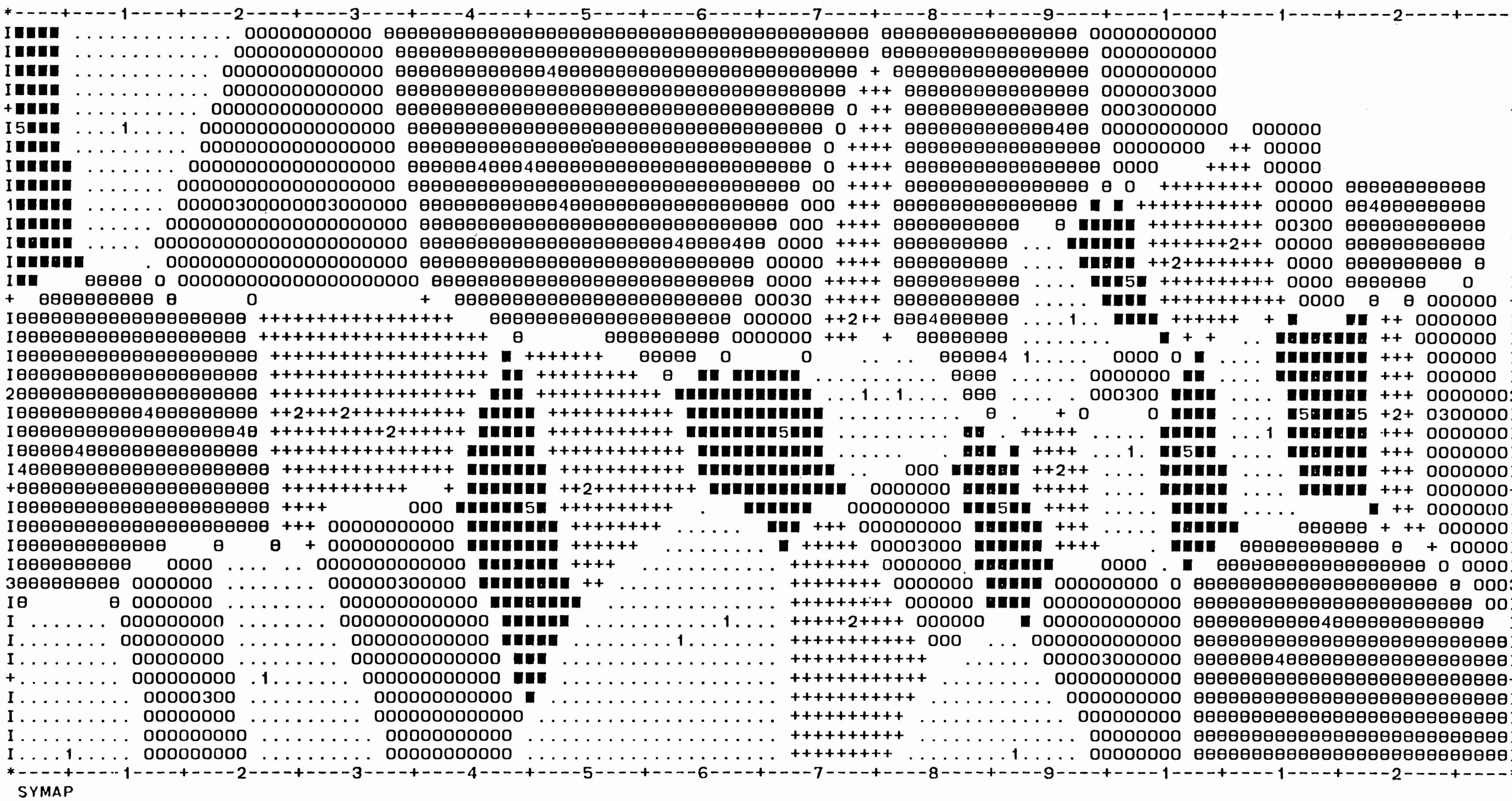



Figure 20. Servicing Territories of Cooperative Firms - 1959

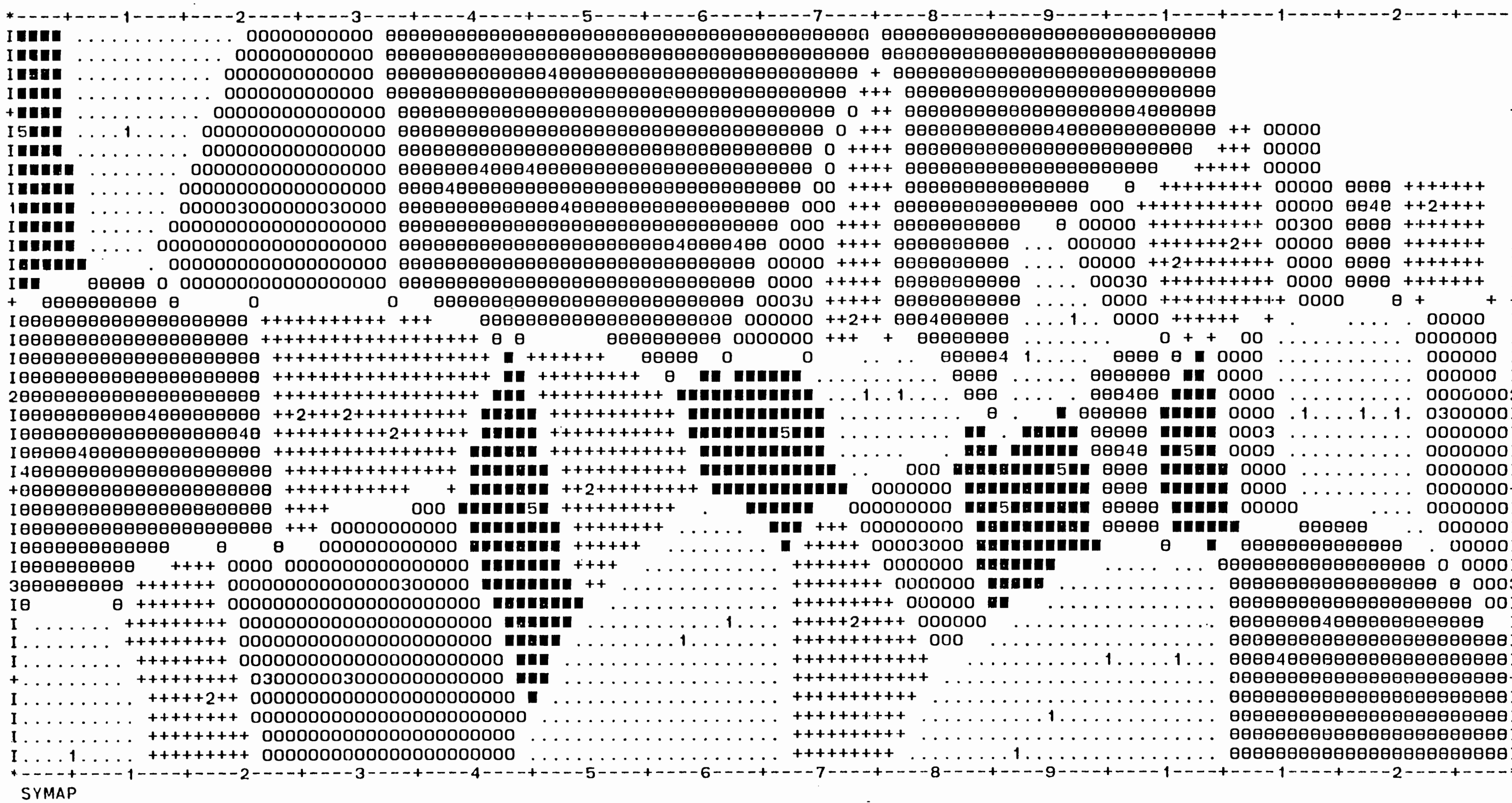



Figure 21. Servicing Territories of Cooperative Firms - 1969

Figure 22. Servicing Territories of Cooperative Firms - 1979

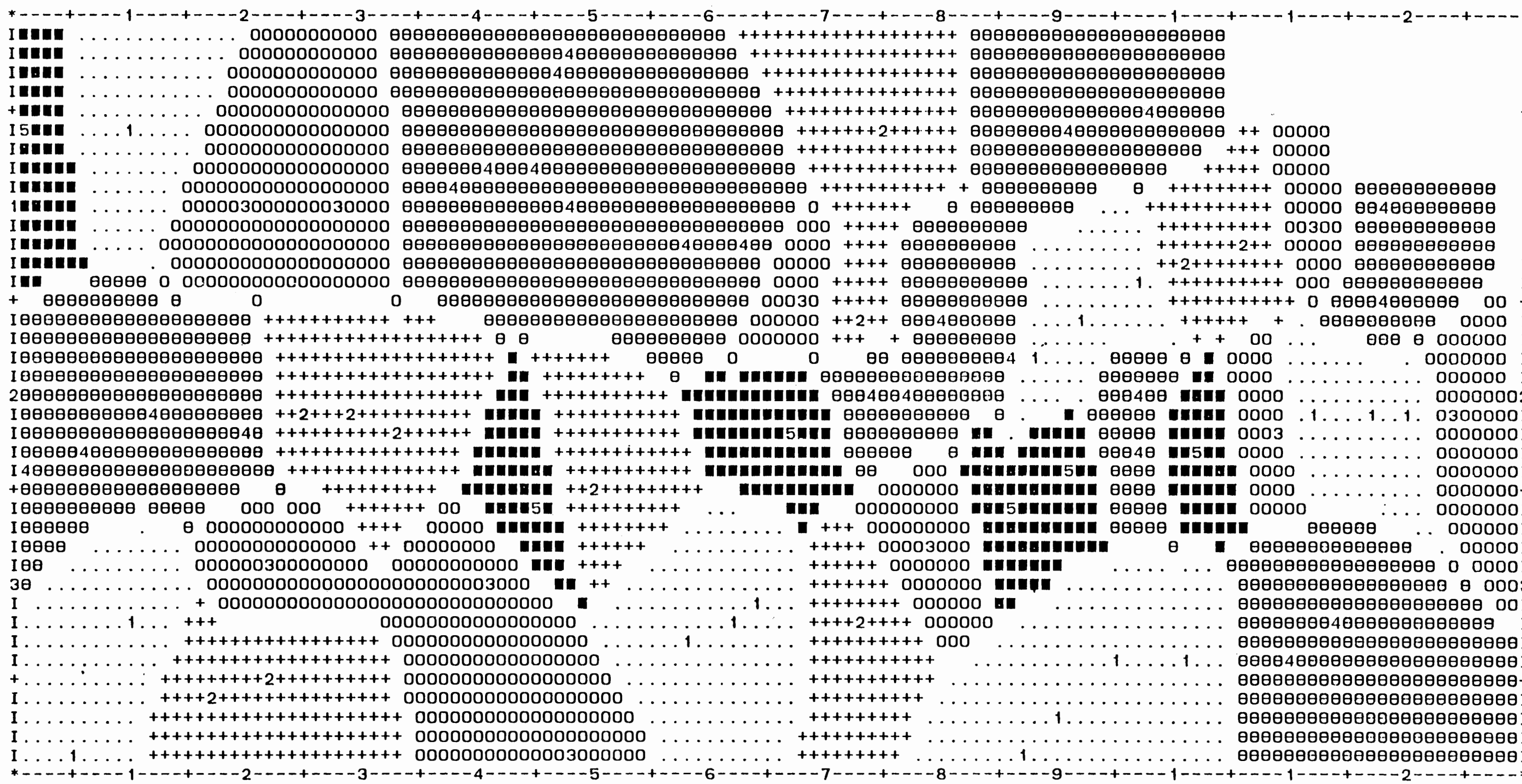



Figure 23. Servicing Territories of Cooperative Firms - 1987

was derived by dividing the maximum possible number of symbols (if the base map was completely filled by symbols without boundary lineations) into the number of total square miles in the study area. This procedure served as a way of measuring each Thiessen polygon in units of square miles. The inherent error in this approach, caused by the fact that symbol-free boundary spaces exist, was corrected in the following manner. For each map, a percentage error calculation was made for the observed discrepancy between the total of the counted symbols and the maximum possible number of symbols. The percentage error, translated into terms of square miles, was then added to the previously calculated areas to yield a corrected areal measurement for the servicing territories of each cooperative firm. Percentage error varied in a range from 9.8% in 1969 to 12.6% in 1945.

The corrected areal measurements of the servicing territories for every grain marketing cooperative firm that has conducted business in the study area between 1945 and 1987 are shown in Appendix B. Furthermore, a summary of cooperative activity is shown in Table X. As reported in the summary table, the average areal extent of servicing territories has increased substantially in the period from 1945 to 1987, which supports the research hypothesis. Also included in the summary table are the number of plants and the number of firms in the study area over time. It is apparent that since 1945 there is a trend of increasing

TABLE X

SUMMARY OF COOPERATIVE ACTIVITY WITHIN THE STUDY AREA 1945-1987

| Year | Number of Plants | Number of Firms | Average Areal Extent of Servicing Territory (square miles) |
|---|---|---|---|
| 1945 | 50 | 42 | 327.23 |
| 1949 | 56 | 41 | 335.67 |
| 1959 | 59 | 38 | 363.04 |
| 1969 | 62 | 33 | 419.40 |
| 1979 | 64 | 32 | 431.97 |
| 1987 | 67 | 30 | 460.02 |

centralization of cooperative activity within firms. However, there is evidence of a marked decentralization of cooperative activity overall, which parallels the ongoing trend of decentralization of agriculture in southwestern Kansas.

# CHAPTER VI

## SUMMARY, CONCLUSIONS, AND SUGGESTIONS FOR FURTHER RESEARCH

### Summary

An estimation model was formulated using multiple regression analysis that was used to help explain the spatial positioning of grain marketing cooperatives in southwestern Kansas for selected years from 1902 to 1986. Utilizing longitudinal data, a set of independent variables for each selected year was analyzed singly and in combination with two-year and three-year data, producing three estimates. The model yielded high coefficients of determination for each estimate which supported the hypothesis that the model would explain a significant proportion of variation in the dependent variable. It was shown that one-year time period estimates explained more variation than two-year and three-year estimates. However, results were more erratic from the one-year estimates than from two-year and three-year time period estimates.

The function of the estimation model was then changed from that of a measurement tool to a prediction tool. From the regression solutions of the various forms of the estimation model for prior time periods, the density of cooperative plants per county was predicted for succeeding time periods. This resulted in four different sets of predictions, derived from one-year, two-year, and three-year time period estimates, and an average of the three. It was shown that regression solutions from the estimation model could indeed be used to successfully predict the densities of cooperative plants in each county, which later were converted to the predicted number of cooperative plants, in successive time periods. Chi-square analysis was used to rank the four prediction sets with respect to how each one compared to the actual number of cooperative plants per county per selected year. It was found that the prediction averages most closely approximated actual cooperative levels, followed in order by the predictions from one-year, two-year, and three-year time period estimates.

A further objective of this study was to evaluate the impact of the presence or absence of railroads on the spatial positioning of cooperative plants. The railroad network, as it existed at various points in time throughout the study area, was reconstructed using time-series maps. Point to line relationships, representing the locations of cooperative plants to rail lines, were established on maps for the 1920's, 1940's, 1960's, and 1980's. Evidence was shown to support the hypothesis that the percentage of cooperative plants with locations on railroads is now in a period of decline.

Finally, changes in the areal extent of servicing territories were measured for each cooperative firm that operated in the study area between the years 1945 and 1987. It was shown that the average size of servicing territories has increased significantly since 1945, which supported the research hypothesis. Additionally, it was noted that, while there is increasing centralization of cooperative activity within firms, there is increasing decentralization of cooperative activity in general in southwestern Kansas.

## Conclusions

It is concluded that multiple regression analysis is an effective method for estimation and prediction in the application in which it was used in this study. The regression model, as it was formulated, produced estimates that were quite favorable in view of the fact that the phenomenon under consideration is a result of the interaction of many social and physical factors. Results emanating from the section of this study that dealt with the influence of railroads on the cooperative system further underscore the belief that the availability of rail has been a prime determinant in the establishment of individual cooperatives over time. The utilization of the SYMAP mapping program to analyze areal change in servicing territories provided useful insight into the spatial competition that appears to exist among cooperatives. It is believed that the various approaches implemented in this study, whether used separately or in tandem, contribute to spatial understanding which should be the goal of any spatial analysis.

Increased spatial understanding may lead to practical applications. For example, cooperative firms within the study area could use periodic areal measurements of servicing territories to evaluate their relative position among competitive firms. It is clear from reviewing the results of this study that firms which are characterized by increasing areal extents of servicing territory over time are most likely to be survivors of the recent revolution in agriculture. Another application might be for growth oriented cooperative firms, whether they are located in or out of the study area. Through close scrutiny of prediction tables, it is probable that areas can be identified that appear to be deficient in cooperative activity in relation to other areas. Firms within the study area could monitor cooperative density levels in hopes of finding an "opening" for locating a branch in a contiguous servicing area. Firms outside the study area may find this type of analysis helpful in determining optimum locations for remote branch elevators. It is also apparent from the results of this study that proximate railroad sidings are no longer prerequisites for the establishment of cooperative plants. A recognition of the relatively new trend of locating plants off rail may pay dividends for those firms who are willing to locate in grain-farming areas not served by rail.

Analyzing a complex system in a spatial context provides a valuable perspective for those involved with the inner workings of that system. Certainly, attention to the results of this analysis, by cooperatives' managers, directors, and member-patrons alike, would augment their spatial understanding of the system in which they participate. Increased understanding of the spatial responses and patterns of cooperatives in southwestern Kansas may translate into better decision-making in an economic environment that continues to become more competitive. In fact, proper recognition of the elements of spatial competition that exist among cooperatives may be as important to modern decision makers as pricing strategies, employee directives, capital expenditures, or other management responsibilities that often take precedence. As evidenced by the dearth of literature concerning the spatial qualities of cooperatives, it is probable that locational-type decisions by cooperators have been made without the help of geographers. This analysis is offered in response to the perception that a gap exists in the literature of geography with respect to the cooperative system.

## Suggestions for Further Research

This study was not designed to be comprehensive in the sense that all questions concerning the geography of agricultural cooperatives would be answered or even explored. Rather, it was designed to provide insight into a few questions for a limited number of specialized cooperatives operating over a small portion of the earth's surface. In other words, the focus of this study is really quite narrow. Numerous questions remain unanswered, even in this study of limited scope, and opportunities for further research abound. Three prominent questions, with regard to this particular study, are presented with suggestions for further research.

Is it possible to develop an approach using other types of models that produce similar, or better results? In this analysis, only one method was used to explain and predict the location of cooperative plants. It is conceivable that the development of other models or methodologies may be beneficial, if only for comparative purposes, when used in an analysis of the same, or another, cooperative system.

What are the effects of spatial interaction across study area boundaries, including internal county boundaries, in terms of the measurement and prediction of cooperative density levels? It is well known that county and state boundaries have little meaning with regard to the transporting of grain to be marketed at elevator stations.

Grain producers do not necessarily market their crops in the county in which they were grown. Yet, historic crop production and census data are available only at the county level. In this study, there is the implicit assumption that marketing volume balances out across county and study area boundaries. This assumption may, or may not be, valid. Further research into this phenomenon would be of value so that proper weighting measures could be incorporated into the model.

Is there a relationship between grossly under- or over-predicted county density levels with the capacities of existing cooperative grain elevators in the respective county? There are great disparities in the size and cost of individual grain marketing facilities. It can be observed from driving in southwestern Kansas that massive concrete grain elevators coexist with steel storage bins and out-dated, but still used, wooden storage structures. It is possible that under-predicted counties may be characterized by comparatively small facilities, while over-predicted counties may have fewer, but larger facilities. Nevertheless, additional investigation of this relationship is warranted, and the results could be used in a revision of this study.

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APPENDIX A

CHRONOLOGY OF COOPERATIVE ACTIVITY

IN STUDY AREA WITH SOURCES

The following is a list of the grain marketing cooperatives that have operated in the study area and which are included in the study. Every effort was made to find the complete name of each cooperative and the period of time it was in operation. The sources of each item of information are listed in parentheses.

<u>CLARK COUNTY</u>

Ashland - Ashland Cooperative Exchange
1935-present
(date of incorporation by current manager)

Acres - branch of Ashland Cooperative Exchange
1960-present
(interview with current manager)

Englewood - Englewood Cooperative Exchange
1916-1962
(date of incorporation by Secretary of State's office, merger date by interview with current manager)
branch of Ashland Cooperative Exchange
1962-present
(interview with current manager)

Minneola - Minneola Coop
1912-present
(interview with current manager)

Sitka - branch of Ashland Cooperative Exchange
1960-present
(interview with current manager)

COMANCHE COUNTY

Coldwater - Farmers' Grain, Livestock, and Cooperative
Mercantile Association
1908-1950
(American Cooperative Journal and Register of
Deeds real estate records)

Protection - Farmers' Grain and Fuel Company
1913-1925
(American Cooperative Journal)
Protection Cooperative Supply Company
1925-present
(date of incorporation by Secretary of
State's
office)

Wilmore - Farmers' Grain and Mercantile Company
1914-1932
(American Cooperative Journal and Register of
Deeds real estate records)

EDWARDS COUNTY

Belpre - Farmers' Elevator Company
1906-1948
(organization date by property tax roll records,
merger date by the Farmers' Elevator Guide)
branch of Lewis Cooperative Company
1948-1954
(Farmers' Elevator Guide and interview with
former Lewis Coop. board chairman, Dave Britton)
branch of Pawnee County Coop of Larned
1964-1969
(interview with former employee of Pawnee
County Coop and current manager of Davidson
Grain Co. in Belpre)

Center View - branch of Lewis Cooperative Company
1981-present
(interview with current manager)

Fellsburg - Fellsburg Equity Exchange
1916-1925
(American Cooperative Journal and property tax
roll records)

Gibson - Gibson Cooperative
1921-1930
(property tax roll records)

Kinsley - Kinsley Cooperative Exchange
1940-present
(interview with current manager)
Kinsley Cooperative Grain and Supply Co.
1934-1940
(interview with manager of Kinsley Cooperative Exchange)
Edwards County Cooperative Association
1904-1934
(interview with manager of Kinsley Cooperative Exchange)

Lewis - Lewis Cooperative Company
1902-present
(interview with current manager)

Offerle - Offerle Cooperative Grain and Supply
1910-present
(interview with current manager)

Trousdale - Trousdale Cooperative Exchange
1916-1943
(date of incorporation by Secretary of State's office, closing date by American Cooperative Journal)

FINNEY COUNTY

Gano - branch of Garden City Cooperative Equity Exchange
1976-present
(interview with current manager)

Garden City - Garden City Cooperative Equity Exchange
1919-present
(interview with current manager)
Farmers' Cooperative Equity Exchange
1915-1917
(organization date by American Cooperative Journal, closing date by article in county history book in Finney County Museum)

Lowe - branch of Garden City Cooperative Equity Exchange
1934-present
(data provided by Jerry Jones, office manager for Garden City Cooperative Exchange)

Peterson - branch of Garden City Cooperative Equity Exchange
1934-1953
(data provided by Jerry Jones, office manager for Garden City Cooperative Exchange)

Pierceville - branch of Garden City Cooperative Equity Exchange
1932-present
(interview with current manager)

Tennis - branch of Garden City Cooperative Exchange
1932-present
(data provided by Jerry Jones, office manager for Garden City Cooperative Exchange)

Wolf - branch of Garden City Cooperative Exchange
1949-present
(data provided by Jerry Jones, office manager for Garden City Cooperative Exchange)

FORD COUNTY

Bellefont - branch of Offerle Cooperative Grain and Supply
1910-present
(interview with current manager)

Bloom - branch of Minneola Coop
1968-present
(interview with current manager)
Bloom Coop Exchange
1911-1968
(interview with current manager)

Bucklin - Bucklin Cooperative Exchange
1930-present
(date of incorporation by Secretary of State's office)
Bucklin Cooperative Elevator and Supply Co.
1914-1930
(organization date by American Cooperative Journal)

Dodge City - Dodge City Cooperative Exchange
1915-present
(interview with current manager)

Ford - Ford-Kingsdown Cooperative
1965-present
(interview with current manager)
Ford Cooperative Equity Exchange
1915-1965
(interview with manager of Ford-Kingsdown Cooperative)

Howell - branch of Dodge City Cooperative Exchange
1946-present
(interview with current branch manager)

Kingsdown - branch of Ford-Kingsdown Cooperative
1965-present
(interview with current manager)
Kingsdown Cooperative Equity Exchange
1915-1965
(opening date by American Cooperative Journal, merger date by manager of Ford-Kingsdown Cooperative)

Spearville - branch of Right Cooperative Association
1970-present
(interview with current manager)
Farmers' Cooperative Grain and Supply Co.
1907-1970
(organization date by Farmers' Elevator Guide, merger date by interview with manager of Right Cooperative Association)

Wilroads - branch of Right Cooperative Association
1948-present
(interview with current manager)

Wright - Right Cooperative Association
1915-present
(interview with current manager)

GRANT COUNTY

Hickok - branch of Ulysses Cooperative Oil and Supply Co.
1948-present
(interview with current manager)

Mile Post - branch of Ulysses Cooperative Oil and Supply Co.
1948-present
(interview with current manager)

Ulysses - Ulysses Cooperative Oil and Supply Co.
1930-present
(interview with current manager)

GRAY COUNTY

Charleston - branch of Garden City Cooperative Equity Exchange
1950-present
(data provided by Jerry Jones, office manager of Garden City Cooperative Equity Exchange)

Cimarron - Cimarron Cooperative Equity Exchange
1916-present
(date of incorporation by Secretary of State's office)

Copeland - branch of Equity Exchange Mercantile Association of Montezuma
1915-1920
(Register of Deeds real estate records)
Copeland Cooperative Equity Exchange
1920-1938
(date of incorporation by Secretary of State's office, closing date by Farmers' Elevator Guide)

Ensign - branch of Dodge City Cooperative Exchange
1987-present
(interview with current manager)
Farmers' Cooperative Grain and Supply Co.
1914-1987
(interview with manager of Dodge City Cooperative Exchange)

Haggard - branch of Dodge City Cooperative Exchange
1987-present
(interview with current manager)
branch of Farmers' Cooperative Grain and Supply Co. of Ensign
1954-1987
(interview with manager of Dodge City Cooperative Exchange)
Farmers' Grain and Supply Co. of Haggard
1914-1954
(interview with manager of Dodge City Cooperative Exchange)

Ingalls - Ingalls Cooperative
1959-present
(interview with office manager)
Ingalls Cooperative Exchange
1915-1921
(organization date by American Cooperative Journal, closing date by Register of Deeds real estate records)

Montezuma - Montezuma Cooperative Exchange
1930-present
(date of incorporation by Secretary of State's office)
Equity Exchange Mercantile Association
1915-1930
(Register of Deeds real estate records)

HAMILTON COUNTY

Coolidge - branch of Southeastern Colorado Coop of Holly, CO
1943-present
(interview with current branch manager)

Kendall - branch of Farmers' Cooperative of Lakin
1945-present
(interview with current manager)

Syracuse - Syracuse Cooperative Exchange
1945-present
(interview with current manager)
Farmers' Cooperative Elevator
1934-1937
(interview with Harold Bray, purchaser of elevator property in 1939, and Register of Deeds real estate records)

HASKELL COUNTY

Satanta - Satanta Coop Grain Co.
1929-present
(interview with current manager)

Sublette - Sublette Cooperative
1929-present
(interview with current manager)

HODGEMAN COUNTY

Gray - branch of Dodge City Cooperative Exchange
1963-1968
(Register of Deeds real estate records)
branch of Farmers' Cooperative Grain and Supply Co. of Hanston
1958-1963
(Register of Deeds real estate records)
Farmers' Grain and Supply Co. of Gray
1913-1958
(date of incorporation by Secretary of State's office, merger date by Register of Deeds real estate records)

Hanston - branch of Dodge City Cooperative Exchange
1963-present
(interview with current manager)
Farmers' Cooperative Grain and Supply Co.
1911-1963
(interview with manager of Dodge City Cooperative Exchange)

Jetmore - branch of Dodge City Cooperative Exchange
1952-present
(interview with current manager)
Jetmore Cooperative Elevator Co.
1915-1927
(organization date by American Cooperative Journal, closing date by Register of Deeds real estate records)

KEARNY COUNTY

Deerfield - branch of Garden City Cooperative Equity Exchange
1963-present
(interview with current manager)

Lakin - Farmers' Cooperative
1945-present
(interview with current manager)

KIOWA COUNTY

Brenham - branch of Farmers' Grain and Supply Co. of Greensburg
1968-present
(interview with current manager)
Brenham Mercantile Co.
1913-1968
(interview with manager of Farmers' Grain and Supply Co. of Greensburg)

Greensburg - Farmers' Grain and Supply Co.
1909-present
(interview with current manager)

Haviland - Farmers' Cooperative Company
1913-present
(article in the Kiowa County centennial history book)

Joy - branch of Farmers' Grain and Supply Co. of Greensburg
1919-present
(interview with current manager)

Mullinville - Equity Grain and General Merchandise Exchange
1913-present
(article in the Kiowa County centennial history book)

MEADE COUNTY

Fowler - Fowler Equity Exchange
1914-present
(interview with current manager)

Hobart - branch of Plains Equity Exchange and Cooperative Union
1974-present
(interview with current manager)

Meade - Cooperative Elevator and Supply Co.
1913-present
(interview with current manager)

Missler - Cooperative Equity Exchange
1915-1938
(organization date by American Cooperative Journal, closing date by Register of Deeds real estate records)

Plains - Plains Equity Exchange and Cooperative Union
1913-present
(interview with current manager)

MORTON COUNTY

Elkhart - Elkhart Cooperative Equity Exchange
1917-present
(interview with current manager)

Richfield - branch of Elkhart Cooperative Equity Exchange
1978-present
(interview with current manager)

Rolla - Rolla Cooperative Equity Exchange
1915-present
(organization date by American Cooperative Journal)

SEWARD COUNTY

Kismet - branch of Plains Equity Exchange and Cooperative Union
1954-present
(interview with current manager)
Kismet Equity Exchange
1915-1954
(interview with manager of Plains Equity Exchange and Cooperative Union)

Liberal - branch of Perryton Equity Exchange of Perryton, TX
1971-present
(interview with current branch manager)

STANTON COUNTY

Big Bow - branch of Johnson Cooperative Grain Co.
1944-present
(interview with current manager)

Johnson - Johnson Cooperative Grain Co.
1930-present
(interview with current manager)

Manter - branch of Johnson Cooperative Grain Co.
1947-present
(interview with current manager)

Saunders - branch of Johnson Cooperative Grain Co.
1959-present
(interview with current manager)

STEVENS COUNTY

Dermot - branch of Perryton Equity Exchange of Perryton, TX
1987-present
(interview with manager of Plains Equity Exchange and Cooperative Union)

Feterita - branch of Rolla Cooperative Equity Exchange
1984-present
(interview with office manager at Rolla)
branch of Farmers' Grain and Supply Co. of Moscow
1961-1983
(Register of Deeds real estate records)
Stevens County Cooperative Exchange
1928-1961
(date of incorporation by Secretary of State's office, merger date by Farmers' Elevator Guide)
Farmers' Equity Exchange
1918-1928
(article in The History of Stevens County and its People)

Hugoton - branch of Farmers' Grain and Supply Co. of Moscow
1961-1983
(Register of Deeds real estate records)
Farmers' Grain and Supply Co.
1929-1940
(organization date by Register of Deeds real estate records, closing date by Farmers' Elevator Guide)
Hugoton Cooperative Equity Exchange
1919-1925
(Register of Deeds real estate records)

Moscow - Farmers' Coop Grain and Supply Co.
1933-1983
(organization date by Register of Deeds real estate records, closing date by interview with office manager of Rolla Cooperative Equity Exchange)

Moscow (4 miles northeast) - branch of Perryton Equity Exchange of Perryton, TX
1987-present
(interview with branch manager of Perryton Equity Exchange of Liberal)

# APPENDIX B

## AREAL MEASUREMENTS OF THE SERVICING TERRITORIES OF EACH COOPERATIVE FIRM THAT HAS OPERATED IN THE STUDY AREA SINCE 1945

TABLE XI

SERVICING TERRITORIES OF COOPERATIVE FIRMS
WITHIN THE STUDY AREA IN SQUARE MILES

| NAME OF TOWN AND COOPERATIVE FIRM | 1945 | 1949 | 1959 | 1969 | 1979 | 1987 |
|---|---|---|---|---|---|---|
| Ashland<br>Ashland Cooperative Exchange | 357.40 | 356.13 | 352.64 | 712.87 | 715.47 | 721.96 |
| Belpre<br>Farmers' Elevator Co. | 142.96 | | | | | |
| Bloom<br>Bloom Coop Exchange | 110.47 | 100.36 | 99.37 | | | |
| Brenham<br>Brenham Mercantile Co. | 113.71 | 113.31 | 112.19 | | | |
| Bucklin<br>Bucklin Cooperative Exchange | 159.21 | 158.63 | 157.08 | 145.74 | 146.27 | 147.60 |
| Cimarron<br>Cimarron Cooperative Equity Exchange | 659.58 | 459.73 | 176.32 | 174.26 | 174.89 | 567.94 |
| Coldwater<br>Farmers' Grain, Livestock, and Cooperative Mercantile Ass'n | 584.84 | 582.76 | | | | |
| Dodge City<br>Dodge City Cooperative Exchange | 263.18 | 466.21 | 811.08 | 1048.72 | 1052.54 | 1074.92 |
| Elkhart<br>Elkhart Cooperative Equity Exchange | 289.17 | 242.82 | 234.03 | 231.29 | 438.82 | 433.17 |

TABLE XI (Continued)

| NAME OF TOWN AND COOPERATIVE FIRM | 1945 | 1949 | 1959 | 1969 | 1979 | 1987 |
|---|---|---|---|---|---|---|
| Englewood<br>Englewood Cooperative Exchange | 230.68 | 229.86 | 227.61 | | | |
| Ensign<br>Farmers' Cooperative Grain and Supply Co. | 113.71 | 80.94 | 179.52 | 177.42 | 178.07 | |
| Feterita<br>Stevens County Cooperative Exchange | 331.42 | 320.52 | 317.37 | | | |
| Ford<br>Ford Cooperative Equity Exchange and Ford-Kingsdown Cooperative | 68.24 | 67.99 | 67.32 | 171.09 | 171.71 | 173.27 |
| Fowler<br>Fowler Equity Exchange | 214.45 | 213.68 | 208.37 | 205.94 | 206.69 | 208.56 |
| Garden City<br>Garden City Cooperative Equity Exchange | 1663.56 | 1680.31 | 1776.04 | 1824.96 | 1831.61 | 1658.91 |
| Gray<br>Farmers' Grain and Supply Co. | 103.97 | 142.44 | | | | |
| Greensburg<br>Farmers' Grain and Supply Co. | 220.94 | 220.15 | 218.00 | 354.85 | 356.14 | 304.83 |
| Haggard<br>Farmers' Grain and Supply Co. | 87.73 | 87.41 | | | | |

TABLE XI (Continued)

| NAME OF TOWN AND COOPERATIVE FIRM | 1945 | 1949 | 1959 | 1969 | 1979 | 1987 |
|---|---|---|---|---|---|---|
| Hanston<br>Farmers' Cooperative Grain and Supply Co. | 399.64 | 398.22 | 240.44 | | | |
| Haviland<br>Farmers' Cooperative Co. | 308.67 | 307.57 | 330.20 | 300.99 | 327.52 | 304.83 |
| Ingalls<br>Ingalls Cooperative | | | 296.02 | 292.56 | 293.62 | 118.72 |
| Johnson<br>Johnson Cooperative Grain Co. | 968.25 | 987.47 | 980.99 | 969.51 | 858.56 | 811.81 |
| Kingsdown<br>Kingsdown Cooperative Equity Exchange | 97.48 | 97.13 | 96.17 | | | |
| Kinsley<br>Kinsley Cooperative Exchange | 149.47 | 148.93 | 147.47 | 145.74 | 146.27 | 137.97 |
| Kismet<br>Kismet Equity Exchange | 409.39 | 407.93 | | | | |
| Lakin<br>Farmers' Cooperative | 851.28 | 796.45 | 788.64 | 722.38 | 725.01 | 731.59 |
| Lewis<br>Lewis Cooperative Co. | 87.73 | 242.82 | 218.00 | 85.54 | 216.23 | 311.24 |
| Meade<br>Cooperative Elevator and Supply Co. | 380.15 | 378.79 | 375.08 | 370.69 | 343.42 | 346.54 |

TABLE XI (Continued)

| NAME OF TOWN AND COOPERATIVE FIRM | 1945 | 1949 | 1959 | 1969 | 1979 | 1987 |
|---|---|---|---|---|---|---|
| Minneola<br>Minneola Coop | 172.20 | 171.58 | 169.90 | 272.47 | 273.47 | 275.95 |
| Montezuma<br>Montezuma Cooperative Exchange | 328.16 | 326.99 | 285.31 | 256.63 | 257.57 | 259.90 |
| Moscow<br>Farmers' Coop Grain and Supply Co. | 552.36 | 514.77 | 509.72 | 852.28 | 759.99 | |
| Mullinville<br>Equity Grain and General Merchandise Exchange | 129.96 | 129.50 | 128.53 | 126.73 | 127.19 | 128.34 |
| Offerle<br>Offerle Cooperative Grain and Supply Co. | 282.67 | 281.66 | 278.90 | 288.32 | 289.37 | 292.00 |
| Plains<br>Plains Equity Exchange and Cooperative Union | 250.19 | 249.29 | 689.26 | 681.19 | 578.73 | 583.98 |
| Protection<br>Protection Cooperative Supply Co. | 347.37 | 346.41 | 952.13 | 940.99 | 852.20 | 859.94 |
| Rolla<br>Rolla Cooperative Equity Exchange | 292.42 | 281.66 | 278.90 | 275.64 | 181.25 | 468.47 |
| Satanta<br>Satanta Coop Grain Co. | 386.65 | 326.99 | 323.78 | 320.00 | 267.11 | 189.30 |

TABLE XI (Continued)

| NAME OF TOWN AND COOPERATIVE FIRM | 1945 | 1949 | 1959 | 1969 | 1979 | 1987 |
|---|---|---|---|---|---|---|
| Spearville<br>Farmers' Cooperative Grain and Supply Co. | 123.47 | 123.02 | 102.58 | 104.55 | | |
| Sublette<br>Sublette Cooperative | 370.40 | 369.08 | 365.46 | 361.18 | 362.50 | 365.79 |
| Syracuse<br>Syracuse Cooperative Exchange | 376.89 | 375.55 | 371.87 | 367.52 | 368.86 | 372.20 |
| Ulysses<br>Ulysses Cooperative Oil and Supply Co. | 393.14 | 579.53 | 573.85 | 567.13 | 569.20 | 567.94 |
| Wright<br>Right Cooperative Association | 159.21 | 200.72 | 160.29 | 158.41 | 279.83 | 282.37 |
| Cooperative Firms Administrated Outside the Study Area with Branches in the Study Area: | | | | | | |
| Pawnee County Coop of Larned - branch at Belpre | | | | 139.40 | | |
| Perryton Equity Exchange of Perryton, TX - branches at Dermot, Liberal, and Moscow | | | | | 273.47 | 892.03 |
| Southeastern Colorado Coop of Holly, CO - branch at Coolidge | 211.19 | 197.49 | 195.55 | 193.26 | 193.97 | 208.56 |

# VITA 2

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Master of Science

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