THE DEMOGRAPHIC IMPLICATIONS OF IRRIGATION IN WESTERN KANSAS

by

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A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Geography

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1973

Approved by:

Major Professor

ACKNOWLEDGEMENTS

The author wishes to express his thanks to his major professor, Dr. David Kromm, for his personal devotion, advice and assistance in the preparation of this thesis.

Special thanks is also extended to Dr. Charles Bussing, who introduced me into the social problems of the Great Plains region, and from whom I derived background knowledge for this research.

The author appreciates the time given by Professor Huber Self, who apart from serving in the supervisory committee, also made available his personal library for my use.

Lastly, I would like to acknowledge the assistance of Dr. H. L. "Sy" Seyler, in helping to analyze the data, and to the Head of the Department, Dr. William R. Siddall, whose encouragement and drive facilitated my study in this Department.

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Chapter I

INTRODUCTION

Kansas is one of the ten states which constitute the Great Plains States geographical region of the United States. Western Kansas forms part of the eastern portion of the Great Plains Proper as distinguished by both Kraezel[1] and Pearson.[2]

Climate has a profound influence upon the region's agriculture. The climate of the Great Plains is characterized by variability and semi-aridity. Its variability is very unpredictable. Years of drought may be succeeded by periods of excessive precipitation. The climatic extremes have been noted to be the most distinctive physical characteristic of the Great Plains.

> They are not arid land; they are not a humid or sub-humid land; instead the Plains are a semi-arid land, but not semi-arid in that the climate is not half-way between humid and arid. They are not half-way between dry and wet. Rather, some years they are dry and even arid; other years they are very wet; and still other years they are wet or dry at wrong times from the stand-point of agricultural production and yields. It is this undefinable aspect of aridity that gives the Great Plains their distinctiveness.[3]

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[1]Carl Frederick Kraezel, The Great Plains in Transition. (University of Oklahoma, 1955), p. 5.

[2]James Pearson, "The Great Plains Today: Depopulation Poses Its Problems," Journal of the West, Vol. 6, No. 1, 1967, pp. 6-8.

[3]Kraezel, op. cit., p. 12.

In such an unpredictable climatic environment, irrigation practices become very important to supplement the inadequate moisture precipitation, and to serve as an insurance against the uncertainties and prolonged drought years. The dependence of irrigation where agriculture is the main economic activity, has become of increasing significance in many portions of the semi-arid Great Plains.

Low population density and slow growth rate characterize the human aspects of the Great Plains. Anderson has described the Great Plains as:

> . . . known for its wide fluctuations in many parameters of economic activity, climate and social structures. It is an area whose economy is highly dependent upon agricultural production and related activities. It is an area which has experienced relatively low growth rates in population and levels of employment during the past three decades. It is an area in which its natural resources exist in relatively abundant amounts. . . . It is an area which is spar ely populated, and as such, its location relative to large markets for non-agricultural products places the area at a comparatively great disadvantage.[5]

Regarded as "The Great American Desert"[6] it was last settled in the history of Europeanization of the continent, and served as a transit region[7] throughout the frontier movement of the west. Settlement in this region was a struggle between fortune seekers

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[5]Dale Anderson, "Dimensions of Future Water Resource Problems in the Northern Great Plains," Proceedings of the Seminar, Agricultural Council of the Great Plains, Publication No. 54, 1971, p. 1.

[6]Carroll D. Clark, People of Kansas: A Demographic and Sociological Study. (Topeka, Kansas: Kansas State Planning Board, 1936), p. 8.

[7]Cotton E. Mather, "The Great American Plains," AAG, Vol. 62, No. 2, 1972, p. 245.

of the late nineteenth century and the inhospitable nature. It was a struggle through which adaptations to the environment were evolved, the most important of which was irrigation.

Whereas the Great Plains proper constituted about 16% of United States land area, it had only 2.7% of the people by the 1960 census, with a density of only 5 persons per square mile.[8] One of the greatest contemporary human problems include rural migration and depopulation, a phenomena started since the 1930's.

1930 was the population growth peak in all the Great Plains States. 1870-1920 marked the period of the most rapid growth. Since 1930, there has been a steady or slow decline in the population growth rate of most states in this region. This decline is most marked in the rural areas. Table 1 gives the trend of rural population growth and decline between 1920 and 1950. The economic depression of the 1930's affected all sectors of the economy, but regions depending on agriculture were most affected. Yet, to the Great Plains farmers, it was the combined tragedies of the world-wide economic depression, the prolonged drought and dust bowl, and the depopulation of the rural community.

But while other areas have long recovered from the demographic disruptions of the period, in the Great Plains States rural depopulation and low density persist. For example, the 1970 census shows that many of the counties with population decrease during the past few decades were located within the

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[8]Homer E. Socolofsky, "Introduction to the Great Plains," Journal of the West, Vol. 6, No. 1, 1967, p. 3.

Table 1

Rural Population of the Great Plains States 1920-1950

State	1920	1930	1940	1950
North Dakota	376,500	387,200	338,900	302,500
South Dakota	266,400	293,900	247,100	217,800
Nebraska	367,600	375,400	332,900	289,800
Kansas	284,200	302,500	258,400	235,000
Oklahoma	388,300	388,600	302,000	237,800
Texas	831,300	1,118,500	1,121,800	1,018,100
New Mexico	54,600	62,700	67,900	69,800
Colorado	168,400	178,700	153,900	153,200
Wyoming	65,500	72,600	74,200	64,800
Montana	252,500	235,600	212,300	198,500
TOTAL	3,005,300	3,415,700	3,109,400	2,787,300

Source: U.S. Bureau of Census, Population Census of 1930, 1940 and 1950.

Great Plains.[8] Measures of economic parameters have indicated that the Great Plains region also lags behind the nation in economic growth as is shown in Table 2.

Table 2

Growth Rate: Income and Employment in U.S. and Great Plains

	Period	U.S. Growth Rate %	Great Plains Growth Rate %
Population [a]	1940 - 1950	14.5	11.0
	1950 - 1960	18.5	9.5
	1960 - 1970	13.3	6.0
Income [b]	1950 - 1960	76.25	58.70
	1960 - 1969	86.35	77.42
Employment [c]	1940 - 1950	26.7	19.2
	1950 - 1960	15.5	5.7
	1965 - 1970	19.9	18.5

Sources: a. U.S. Bureau of Census, U.S. Census of Population, 1940-1970.

b. U.S. Department of Commerce, Office of Business Economics, 1970.

c. Growth pattern in employment, Vol. 4, Great Plains, 1950-1970, Washington, D.C.

Statement of the Problem

Kansas shares a relatively stable or declining population with the rest of the Great Plains states, particularly the Western half which falls within the Great Plains Proper. Within this broad region of marked depopulation, Southwestern Kansas

stands out as an exception. The Southwestern group of counties have had a steady population since the 1940's while the counties in the Northwest Central have had a persistent decline in population typical of the Great Plains Proper. Fig. 1 shows the study regions. The Southwest region consists of fifteen counties which are: Finney, Grant, Gray, Greeley, Hamilton, Haskell, Kearney, Lane, Meade, Morton, Scott, Seward, Stanton, Stevens and Wichita. This region has a combined area of 7,589,090 acres, which is about 14.5% of the total land area of Kansas. The Northwest Central also consists of fifteen counties, which are: Cloud, Ellis, Gove, Graham, Jewell, Lincoln, Mitchell, Norton, Osborne, Ottawa, Phillips, Rooks, Russell, Smith and Trego. It has a combined area of 8,259,480 acres, or about 15.7% of the total land area of Kansas.

Both groups of counties have the same average climatic parameters.[9] They all depend upon agriculture as the main economic activity for the welfare of the people. It is the principal source of income and employment. Pallesen has remarked of the significant role of agriculture in the economy of Kansas:

> The state's overall economy is dependent upon its agricultural resources. Agriculture is the largest industry and creates the most business of any industry in the state. Farmers are burying many things and creating numerous jobs for other people. Agriculture during the recent years has become a highly inter-dependent industry. As agriculture becomes commercialized and specialized it is more difficult to distinguish between farming and related industries.

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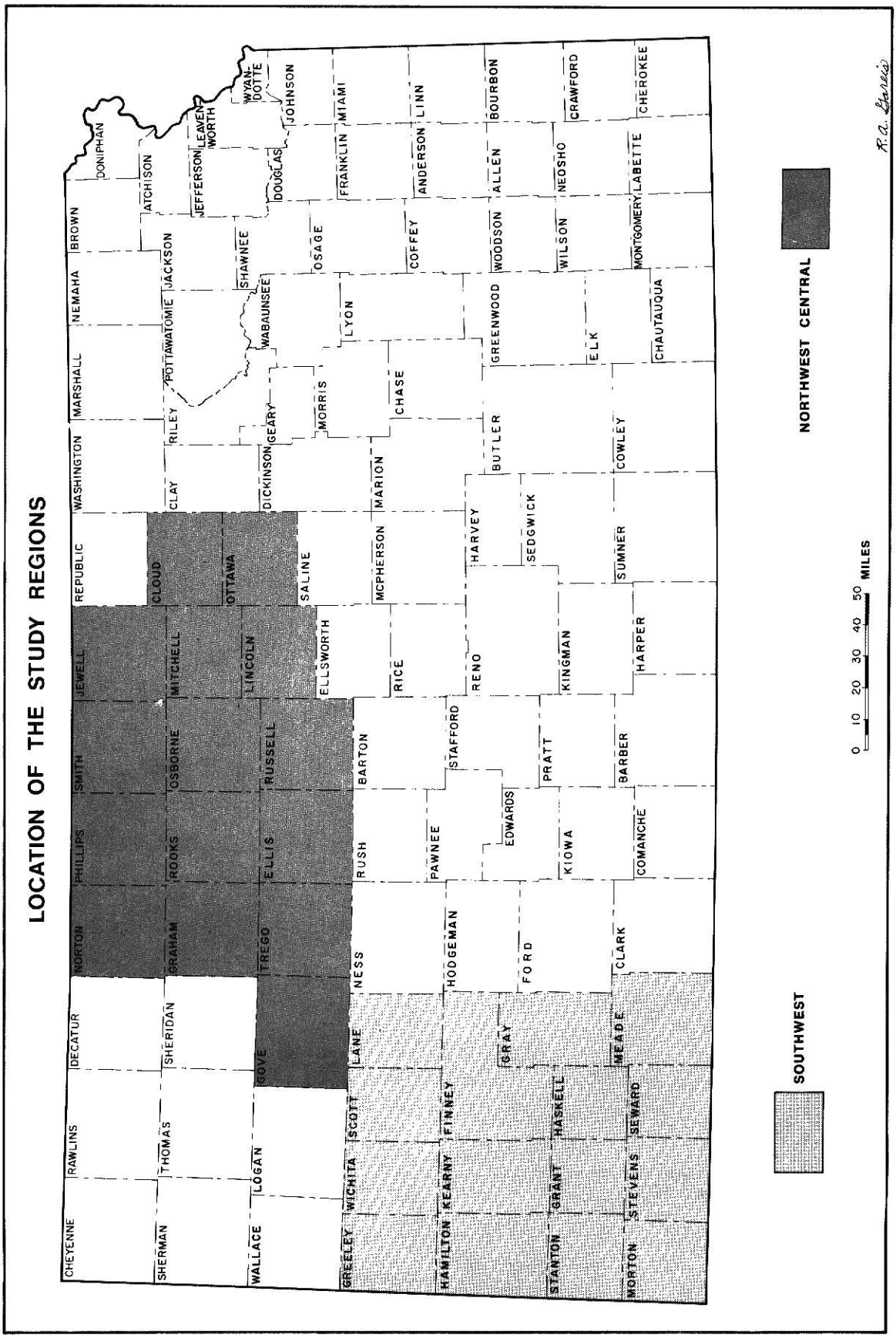
[8]Norman Landgren, "The Role of Water in the Economic Development of the Great Plains," Proceedings of the Seminar, Great Plains Agricultural Counsel, Publication No. 54, 1971, p.iv.

[9]Kansas Planning for Development, Regional Review (09 and 07) for Planning in Kansas, Report Nos. 14-09 and 14-07.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.

Fig. 1


LOCATION OF THE STUDY REGIONS
CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
REPUBLIC
WASHINGTON
MARSHALL
NEMAHA
BROWN
DONIPHAN
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
CLOUD
CLAY
RILEY
POTTAWATOMIE
JACKSON
ATCHISON
JEFFERSON
LEAVEN-WORTH
WYAN-DOTTE
JOHNSON
WALLACE
LOGAN
GOVE
TREGO
ELLIS
RUSSELL
LINCOLN
OTTAWA
DICKINSON
GEARY
WABAUNSEE
SHAWNEE
DOUGLAS
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
ELLSWORTH
SALINE
MCPHERSON
MARION
MORRIS
LYON
OSAGE
FRANKLIN
MIAMI
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
STAFFORD
RICE
HARVEY
BUTLER
CHASE
COFFEY
ANDERSON
LINN
GRAY
FORD
EDWARDS
RENO
SEDGWICK
GREENWOOD
WOODSON
ALLEN
BOURBON
STANTON
GRANT
HASKELL
KIOWA
PRATT
KINGMAN
ELK
WILSON
NEOSHO
CRAWFORD
MEADE
CLARK
COMANCHE
BARBER
HARPER
SUMNER
COWLEY
CHAUTAUQUA
MONTGOMERY
LABETTE
CHEROKEE
MORTON
STEVENS
SEWARD
0 10 20 30 40 50 MILES
SOUTHWEST
NORTHWEST CENTRAL

> Today agriculture includes production, processing, manufacturing, marketing, utilization and consumption. Also included are the purchased inputs used in commercial farming.[10]

This remark is even more potent for Western Kansas where the industries are agriculturally based. Table 3 shows the proportion of persons employed in the various industries of occupational employment in 1970. It should be observed that the

Table 3

Industry of Occupational Employment for Persons of 16 Years and Above 1970

INDUSTRY	SOUTHWEST	NORTHWEST CENTRAL	STATE
TOTAL	32,313	46,704	852,313
Agriculture	8,685 (26.7%)	11,189 (24.0%)	90,714 (10.7%)
Manufacturing	2,312 (7.2%)	2,721 (5.8%)	147,933 (17.4%)
Mining	1,221 (3.8%)	1,487 (3.2%)	10,228 (1.2%)
Construction	1,826 (5.7%)	2,976 (6.4%)	51,423 (6.0%)
Others	18,079 (56.6%)	28,328 (60.6%)	552,015 (64.8%)

Source: U.S. Department of Commerce, Bureau of Census, 1970, Section C, Social and Economic Characteristics.

percentages employed directly by agriculture in both the Southwest and the Northwest Central were over two and a half times the percentage for the state. On the other hand, while manufac-

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[10] J.E. Pallesen, Kansas Board of Agriculture, 54th Annual Report, 1970-71, p. 132.

turing accounted for 17.4% of employment for the state, the proportions for the Southwest and the Northwest Central were 7.2% and 5.8% respectively.

In 1970, farm income accounted for 6.4% of personal income in the state of Kansas, but in Western Kansas it was 26.9% for the Southwest and 22.1% for the Northwest Central. However, one major variable factor is the extent to which irrigation practices have been developed. For instance, in Southwestern Kansas, development of irrigation has been accelerated since 1940, in an attempt to adapt to the natural environment. Development of irrigation in the Northwest Central has been very slow. The Southwest has the highest density of irrigation in the state, with 40.6% of harvested cropland under irrigation. The Northwest Central has only 3.5% and the state 9.9%. The Southwest possesses 64.8% of the irrigated lands in Kansas while the Northwest Central has only 4.6%.

In 1970 ten out of the fifteen counties in the Southwest had an overall farm value of over $10 million dollars from field crops, and the remaining five counties between $7-9 million. For the same period the Northwest Central had no county with crop value above $10 million dollars, and the only six counties had between $7-9 million while the rest fell below $7 million. Per acre and per farm value in the Southwest exceeds the state's levels while in the Northwest Central they are below the state's levels. For the period of 1940-1970, the population of the Southwest increased by 55.7% while the Northwest showed a decline of -21.5%.

This thesis measures various demographic, social and economic parameters in these two regions (the Southwest and the Northwest Central) in correlating irrigation practices and demographic trends in Western Kansas from 1940 to 1970. The postulation of the researcher is that there is a strong areal association between irrigation density and steady population growth in Western Kansas.

Although this thesis is not mathematically accounting for causal relationship, it is supported by developing a strong correlation between the highly irrigated areas and steady population growth in both time and space. Other factors may be contributive, but in these two regions various human and economic measures only show a stronger correlation between irrigation and population growth.

Economic development in the region depends upon agriculture. Water and land are the two most important natural resources, and serve as the foundation for agriculture. The combination of fertile soils and adequate moisture are necessary for agricultural viability in a moisture deficit region like the Great Plains. Since natural precipitation is inadequate, intensive agriculture is not possible without the application of irrigation for supplement. Field crops produce significant revenues throughout the Plains States, and supplemental irrigation adds materially to the levels of output. Where irrigation has been developed, the localities have been able to derive higher income and the agricultural economic base has been stabilized. It is here also that population has continued to grow

similarly with the other parts of the nation. There is less rate of out-migration, which leaves the population with a sizeable proportion of the reproductive age group, preventing decline.

The persistent population decline in the Northwest Central reflects the absence of intensive irrigation practices in the region's agriculture. Thus if irrigation were developed as in the Southwest, it is suggested that the socio-economic well-being would compare favorably vis-a-vis the other counties, and that the persistent population decline might also be arrested to an extent.

Method of Analysis and Preview of the Thesis

In 1963 the state of Kansas was divided into eleven multi-county regions, based on the variability of selected physical, social, economic and politic l factors , for the purpose of regional planning and economic development. The regions created were desgnated as "State Economic Regions for Planning." These economic regions were delineated on the assumption that they form "homogeneous units with commonality of character, problems and opportunities."[11] Two regions which coincide partially with the state economic regions have been chosen for the purpose of this study. These are the Southwestern Kansas Region, 07 and the Northwest Central Region, 09. However, the units of each region have been modified by the inclusion of other adjacent counties for reasons for comparative study based

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[11]Kansas Planning for Development, op. cit., p. 1.

on an equal number of county units.

Each of the regions consist of fifteen contiguous counties selected on the basis of their homogenuity in physical and human attributes to determine the spatial association between the levels of irrigation practices and steady population growth. Other human, economic and social elements were statistically tested by using correlation analysis. The net-increase in farm income, attributable to irrigation, was computed from which the productive capacity ratios of crops under irrigation and dry farming were determined. Assuming greater labor input in the irrigated regions, the percentage increase of employment, was also examined. Demographic and economic statistics for each of the regions and the state as a whole are included for comparison.

Chapter II of the thesis describes the physical setting for irrigation agriculture, with special emphasis on the precipitation variability. Chapter III examines the water resources available for irrigation expansion in both regions. Chapter IV discusses the development of irrigation and its economic impact on income and employment opportunities in the regions. Chapter V outlines the trends in population change since the earliest time of settlement in Western Kansas. Chapter VI is the crux of the thesis. It analyzes the various socio-economic and socio-demographic parameters which are considered to be the direct and indirect influences of irrigation. These analyses lead to the summary and conclusions.

Review of Literature

Several studies dealing with irrigation[12] or population trends[13] have been undertaken by economists, demographers and statisticians for the state of Kansas and the Great Plains[14] in general. However, these studies limit their scope or extent to specific aspects of irrigation, agriculture or population. Most economic and demographic studies content themselves with statistical analyses, without adequate emphasis on the spatial relationship between irrigation and population. But it is not sufficient to generalize, for example, that in the Great Plains or in Kansas, "there is a continued outward migration from the rural areas to the urban; and migrants tend to be young adults or teens."[15] Although studies relating to population and irrigation are not difficult to find, to the best knowledge of the researcher, no study comparable to this one of spatial association between irrigation and specific demographic patterns of growth or decline has been done in any part of this region.

Data used in this were collected chiefly from the U.S. Bureau of Census, Census of Population and Agriculture of the U.S.,

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[12]Richard Pfister, Water Resources and Irrigation in Southwestern Kansas. (Lawrence, Ks.: U. of Kansas, 1955).

[13]James H. Hop, Population Trends in Kansas from 1940-1950. (Kansas Agricultural Experiment Station, Report No. 71, 1956).

[14]Paul J. Schwind, "Migration and Regional Development in the United States, 1950-1960," Research Paper No. 133. (Chicago: University of Chicago, Department of Geography, 1971).

[15]Dorothy Thomas, Research Memorandum on Migration Differentials, Social Science Bulletin 43, 1938.

the Kansas State Board of Agriculture, Publications of the Kansas Agricultural Experiment Station, the Extension Service of the University of Kansas, the Center for Research in Business, University of Kansas, the Water Resources Board, Kansas Planning for Development, and the Proceedings of Seminars of the Great Plains Agricultural Council.

Sources of data vary greatly, with the degree of accuracy. In certain instances required valuable data for investigation are withheld from publication for individual interests. Besides, state and national publications may possess conflicting data. Where such conflicts arise, national figures have been used in this study. It is doubtful that these anomalies in any way reduce the strength of the argument presented in this thesis.

Chapter II

THE PHYSICAL SETTING FOR IRRIGATION

In all agricultural communities, the constituents of the physical factors of the environment and their interplays with man's cultural adaptations and innovations determine, to a great extent, the types of products, the systems and methods of production, and the level of successful and productive capacity. Although these may be modified by technology, social and economic factors, all living organisms require certain optimum natural conditions from their environments in order to successfully reproduce. Climate and soil are the most important aspects among the physical factors affecting agricultural production. Climatic factors considerably influence the agricultural settlements of the arid and semi-arid regions, as in the Great Plains. Of the climatic factors, precipitation is the most important element. The total amount, distribution and reliability of precipitation, exerts great influence upon agricultural communities of the Great Plains region. Writing during the prolonged drought of the 1930's, Clark remarked:

> Droughts often combined with hot winds have been responsible for the major economic disasters of natural origins in Kansas. . . . Of the numerous geographic variables affecting the economic organization and community patterns in Kansas, rainfall variably is the most striking, pervasive and compelling in its effect.[1]

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[1]Carroll D. Clark, People of Kansas: A Demographic and Sociological Study. (Topeka, Kansas: Kansas State Planning Board, 1936), p. 7.

Recognizing the importance of climate in agriculture, this chapter considers the environmental factors necessitating the application of irrigation practices in Western Kansas as in other parts of this broad semi-arid region. Climatic variability and inadequate and unreliable precipitation are mostly emphasized.

Climate

Western Kansas marks the eastern most portion of the Great Plains Proper, which extends westward to the foothills of the Rocky Mountains. It occupies the high plains physiographic region of Kansas, with an approximate maximum elevation of 4,000 feet along the Colorado border, and slopes gradually eastward to the Missouri valley. As in the Great Plains in general, the inland location gives the region a continental mid-latitude climate of an exceptional variability.[2] The scarcity of water and the low annual average precipitation of 16-22 inches places the region in a semi-arid climatic category, and is regarded as part of the legendary "Great American Desert"[3] and "The Short Grass Country."[4]

Factors which affect the climate of Western Kansas and the Great Plains in general include relief, continental loca-

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[2]Andrew D. Robb, "Supplementary Climatic Notes for Kansas," Climate and Man: Year Book of Agriculture. (Washington, D.C.: U.S. Dept. of Agriculture, 1941), p. 882.

[3]Clark, op. cit., p. 8.

[4]Flora D. Snowden, Climate of Kansas, Report of the Kansas State Board of Agriculture, Vol. LXVII, No. 285, 1948, p. 1.

tion and the alternate procession of different air masses which sweep over the region.

Most of the rainfall in this region results from the interaction of two major air masses; namely, the Tropical Maritime (mt) from the Gulf of Mexico and the Polar Continental (cp) which advances from the Arctic Pole. The mt is weak, warm, light and unstable. The cp is dry, cold, heavy and unstable. When the mt is drawn inland to meet the advancing cp, the former is displaced and frontal rains occur. This is the chief source of rain in the region. However, the region is too far west to be constantly under the mt from the Gulf of Mexico. The mt, which reaches the Plains through the Mexican Plateau, has too little moisture to spill when it comes into contact with the cp. This situation accounts for the meager rainfall in the region. However, the region is too far west to be constantly under the mt from the Gulf of Mexico. The mt, which reaches the Plains through the Mexican Plateau, has too little moisture to spill when it comes into contact with the cp. This situation accounts for the meager rainfall in the region and is the cause of its semi-aridity.

Occasionally the moist laiden mt air masses may be drawn far west when powerful low pressure cells develop inland. It is during occasions like this that the region receives above normal rainfall. Variability of rainfall therefore depends on the frequencies of contact between these air masses. But these occasions, although they may come in a series, are hardly predictable.

In Kansas, the amount of annual precipitation decreases from the east to the west. (See Fig. 2). The annual average rainfall ranges from 26 inches in Ottawa county to 15.7 inches in Stanton county along the Colorado line. Mean annual rainfall for the Southwest is 17.6 inches while the Northwest Central is 22 inches. Most of this is received between April and September. Fortunately for an agricultural region, the modest precipitation is offset by the fact that over 75% of the rain, "whenever it comes," is received during the growing season. Rainfall efficiency for the region is high.

Table 4

Climatic Conditions of Western Kansas

	SOUTHWEST	NORTHWEST CENTRAL	STATE
Mean Annual Rainfall[a]	17.6 inches	22.0 inches	26.8 inches
% Precipitation during growing season[b]	77.0	77.0	73.0
Mean Temperature[a]	55.5° F.	53.7° F.	55.0° F.

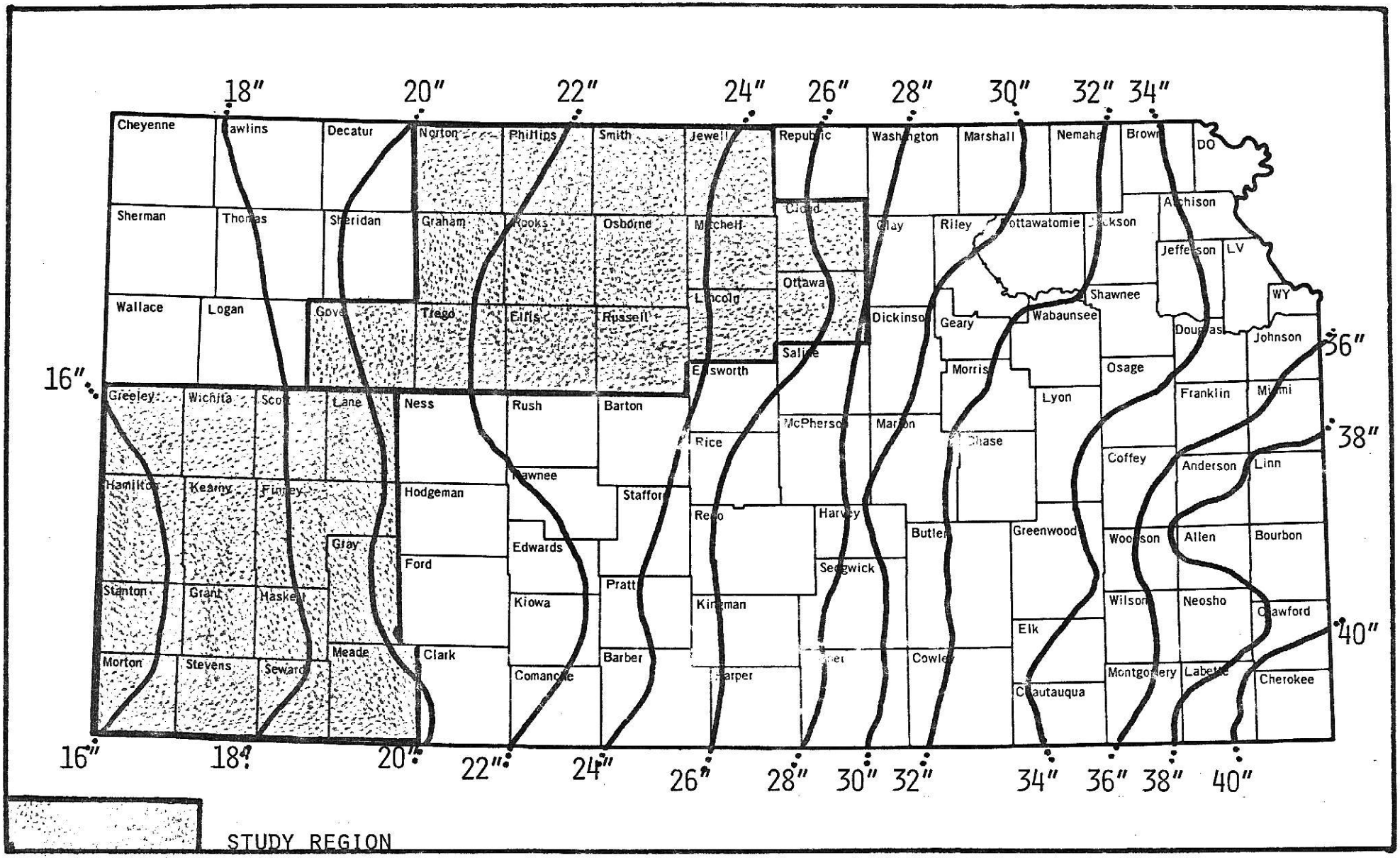
Sources: (a) Climate of Kansas, State Board of Agriculture, Vol. XXXVII, 1939-1940, p. 137.

(b) Regional Review for Planning in Kansas, Report Nos. 14-07 and 14-09.

Precipitation in the form of snow varies from 14.8 inches in the Northwest Central to 22.7 inches in the Southwest.[5] In some years, snow cover may be present as long as 30 days in the

[5] Farm Facts, Annual Report of the Kansas Board of Agriculture, Topeka, Kansas, 1970.

THE DISTRIBUTION OF MEAN ANNUAL RAINFALL IN KANSAS (ISOHYETS IN INCHES)



SOURCE: Changes for Precipitation in Kansas, K.S.U. Agric. Exp. Station, Manhattan, Kansas. 1963.

northern part of the region, but on the average this may not be more than a total of 15 days.[6]

Mean temperature decreases from the south to the north. Mean annual temperature in Morton County (Southwest) is 59.9° F. while the same for Jewell County (Northwest) is 52.7° F. Variation in temperature is considerably less than variation in precipitation. The average temperature ranges from above 80° F. in the summer to below 25° F. in winter in the Northwest. The corresponding figures for the Southwest are 78° F. and 30° F. respectively.

Prevailing winds are from the south for most of the year, except during the winter when the northerly cold wind may be more pronounced. In general, the Southwest has the highest wind velocity in Kansas. Wind speed in the Southwest averages about 15 miles per hour, approximately 5 miles faster than in the east.[7] The wind contributes to the moisture deficiencies. It increases the rate of evapotranspiration, and in prolonged drought periods, dust storm incidents may be more severe as in the 1930 and 1953 dust storms.

Temperature and winds directly affect the supply of moisture available for plant use. The higher the temperature and greater the wind velocity, the greater will be the loss of moisture by evaporation and transpiration (generally grouped as evapotranspiration). Western Kansas receives its rain at the

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[6]Robb, loc. cit.

[7]Kansas Water Atlas, Kansas Water Resources Board, Report No. 16a, "701" Project No. P-43, 1967, p. 9.

period of maximum temperature. This, coupled with high winds lead to a high proportion of water loss, which intensifies the effects of low precipitation in these agricultural regions. In Kansas as a whole evapotranspiration consumes 95% of all precipitation in the year. In Western Kansas it consumes 99%.[8] Thus, it has been estimated that moisture loss resulting from evapotranspiration in these regions is 105.3 Million Acre Feet (MAF) from the total available supply of 115 MAF.

Rainfall variability has the profoundest impact on an agricultural region. Fig. 3 on the following page illustrates the aspect of rainfall variability in these regions. About half of the years are below average. But most serious, is that the years of above average or below average lack definite patterns to allow predictability. Periods of drought alternate with periods of above normal. Variations from one year to the other are so great that it is better to define the climate in terms of periods rather than seasons. Variability is sometimes more than 50% in the extreme Southwest.[9] In Johnson City the average annual precipitation is 15.47 inches, but in the drought year of 1956, total precipitation was only 4.77 inches. Table 5 gives the totals from the mean rainiest and driest years for both Western and the Northwest Central. The wettest years may be as much as three times the driest. Judging from these figures, it is difficult to place Western Kansas under a specific climate. Desert climate may prevail many years. At other times its so-called semi-aridity might be more apparent than real.

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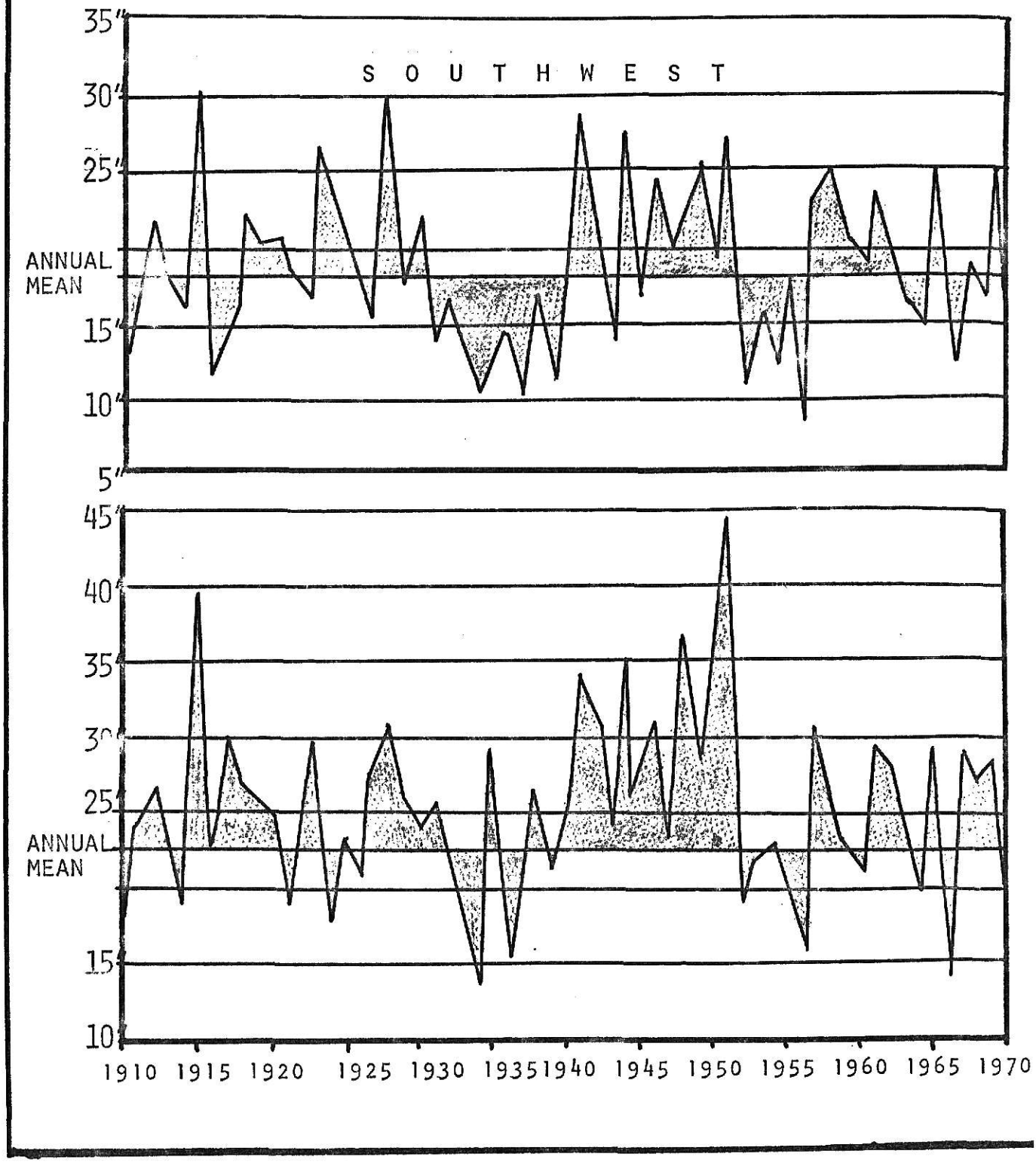
[8]Kansas Water Atlas, op. cit., p. 24.

[9]Ibid., p. 12.

RAINFALL VARIABILITY IN WESTERN KANSAS, 1910 - 1970



SOURCE: Climate of Kansas, Report of the Kansas State Board of Agticulture, 1948; Farm Facts, Kansas State Board of Agric. 1953- 1970.

Table 5

Precipitation Variability 1887-1945

County	Normal Annual Average	Wettest Year on Record 1915	Driest Year on Record 1936
SOUTHWEST	INCHES	INCHES	INCHES
Finney	19.0	28.1	14.1
Grant	17.2	26.2	15.3
Gray	20.0	30.3	13 1
Greeley	16.4	33.4	10.1
Hamilton	17.0	23.1	9.9
Haskell	18.0	22.4	12.8
Kerney	16.9	18.7	11.5
Lane	18.8	29.5	15.0
Meade	20.0	31.6	17.9
Morton	16.9	26.1	9.7
Scott	18.6	36.2	18.2
Seward	18.9	32.4	19.5
Stanton	15.9	*	10.7
Stevens	17.9	28.1	12.3
Wichita	17.3	28.9	16.5
NORTHWEST CENTRAL			
Cloud	25.2	37.5	16.0
Ellis	23.1	34.1	15.9
Gove	19.8	30.1	16 9
Graham	20.6	36.0	14.4
Jewell	24.6	40.1	12.4
Lincoln	24.2	35.0	16.4
Mitchell	24.1	37.1	17.7
Norton	20.8	33.0	12.7
Osborne	21.6	32.7	18.8
Ottawa	25.8	38.7	18.2
Phillips	22.4	33.5	15.3
Rooks	22.4	38.5	15.5
Russell	24.5	39.0	15.1
Smith	22.7	34.1	10.1
Trego	21.5	31.8	14.3
Southwest Region	17.9	28.2	12.9
Northwest Central Region	21.9	35.5	15.3
State	26.8	40.8	18.3

Source: Climate of Kansas, Report of the Kansas State Board of Agriculture, 1948.

* Not Available.

From 1930 to 1940, all the years were below average. From 1940 to 1951 all the years were above average. In the Southwest, 26.50 inches in 1951 was succeeded by 11.12 inches in 1952. 8.44 inches in 1956 was replaced by 23.58 inches in 1957. Drought periods may persist for years with an occasional interval wet year as in 1935, which was a wet year between a ten-year drought.

From the foregoing discussion on the rainfall variability, it is clear that successful agricultural activity in Western Kansas cannot depend upon "when and if the rain comes." With an average of 17 inches in the Southwest and 22 inches in the Northwest Central, and with over 75% of the rainfall in the growing season, normal agricultural activity without reliance on irrigation may be possible. But the problem is variability and unpredictability. Irrigation practices in regions of indeterminate climate is a means of coping with the hazards of the physical environment. It is a measure against the uncertainties of the weather. Thornthwait states:

> In a desert you know what to expect of the climate and plan accordingly. The same is true of the humid regions. Man has been badly fooled by the semi-arid regions because they are sometimes humid; sometimes desert, and sometimes a cross between the two.[10]

Geology and Soil

Western Kansas is geographically part of the northeastward trending series of plains, and marks the western portion

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[10]G.W. Thornthwait, "Climate and Settlement in the Great Plains," Climate and Man: Year Book of Agriculture. (Washington, D.C.: U.S. Dept. of Agriculture, 1941), p. 177.

of the central Kansas uplift. The rocks which underly the surface soils in these western portions are of the sedimentary formations. This great mantle of outwashed materials was laid down by ancient streams and pedimentation processes from the Rocky Mountains. Of these rocks the most important are the cretaceous chalk and shale, and the tertiary which are relatively young geological formations. In addition to these, are deposits of fine silty materials known as loess, which now constitutes surface soil of most parts of the region.

The tertiary rock covers the entire area of the Southwest except the Finney-Scott depression, which is of the quarternary formations, and there is a narrow band of alluvium along the main streams. In the Northwest Central the cretaceous sedimentary rocks cover most parts of the east. Tertiary rocks are restricted to the western counties of Norton, Phillips, Graham, Gove and Trego. The tertiary rocks, which cover the Southwest, are made of different kinds of rocks and are porous. Underlain by impervious rock strata, they therefore allow the accumulation of ground water, the main source of water for irrigation in the region.

The soils of Western Kansas fall into two main groups: (1) the cretaceous chalk and shale soil province, and (2) the tertiary soil province. The cretaceous is characterized by chernozem which consists mainly of silty loam and sand. They

contain a high quantity of organic matter and nitrogen. The tertiary soil province is characterized by chestnut formed of a thick loess deposit of sand and silty loams. Both soils are among the most fertile if properly supplied with moisture. The chestnut is more extensive in the Southwest while the chernozem covers most of the Northwest Central region. Both soils are well suited for irrigation because of their nutrient content and permiability.

In this brief review of the physical setting, the following points are summarized for emphasis. First, several measures of climatic elements show that an agriculturally based region such as Western Kansas cannot depend on the natural moisture supply of rainfall for successful agricultural activities. Reliance on irrigation is necessary in order to ensure successful harvest. Second, there is no significant difference in the climatic variation between the Southwest and Northwest Central. They both fall into the same climatic regime. And third, both regions have almost the same type of soils. Although higher crops yields have been obtained through the application of fertilizers and drought resistant seeds, the much higher yields in the Southwest region compared with the Northwest Central may be attributable to the application of irrigation as a supplement to the exceptionally variable climate.

Chapter III

WATER RESOURCES

Water and Agriculture

Water is a prerequisite need by all living organisms for the existence of life. Water and land are the most important resources in an agricultural economy. Availability of fertile and suitable land for cultivation and access to adequate and reliable supplies of water are therefore the major natural factors which influence the economic prosperity of agricultural societies and their patterns of settlement. From the earliest times of settlement in these semi-arid regions no other physical factor has had a greater influence in the establishment of the present agricultural pattern and production.[1]

Of the rival claimants for the use of water agriculture, in the state of Kansas, is by far the largest single consumer. Most of this is for irrigation. Between June 1970 and July 1971, there were a total of 942 applications for the appropriation of water in Kansas, requiring 494,000 acre feet of water. Applications for irrigation

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[1]U.S. Dept. of Agriculture, Irrigation Agriculture in the West, Misc. Pub. No. 670, 1948, p. 22.

purposes were 865 (91.8%) and accounted for 423,800 acre feet (85.7%).[2]

The principal sources of water are precipitation, running streams and rivers, springs, lakes, ponds and wells. In Western Kansas agricultural needs for water far exceed total precipitation. Rainfall, the most important form of precipitation, ranges from below an annual average of 15 inches in the extreme Southwest to a little above 22 inches in the eastern margin of the region. Average water needs for the principal crops in Western Kansas are shown in the following table.

Table 6

Water Requirements of Crops	Annual Rainfall and Irrigation
Alfalfa	48 Inches
Sugar Beets	46 "
Pastures	43 "
Corn	36 "
Sorghum	33 "
Wheat	28 "

Source: 38th Biennial Report, Kansas Board of Agriculture, 1952, p. 28.

From the above table it is observable that successful agriculture and variability of precipitation apart, cannot be possible without the application of irrigation to supplement the inadequate precipitation. For irrigation, the chief sources of water are the surface and ground water.

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[2] Kansas Agriculture, Annual Report of the Kansas State Board of Agriculture, 1970-71, p. 197

Surface Water

Western Kansas is not well endowed with surface water supplies. In the Southwest region the Arkansas and the Cimarron are the main rivers, with both receiving their sources from western mountains. There are very few tributaries and drainage areas are confined to main stream valleys. The only significant tributary of the Arkansas river is the Pawnee River, which flows eastward across Greeley, Wichita and Scott counties, and j o i n s the Arkansas river in Barton county. Consumption of Arkansas River water in Colorado leads to shortages for the western Kansas users. Thus, in most cases, portions of the streams are entirely dry at the time of greatest need for irrigation. Nevertheless, both rivers were the chief sources of water supply for irrigation purposes during the early settlement and until ground water resources were explored in the 1930's.

The Northwest Central seems to be relatively better endowed with a surface water supply. Located in the Missouri drainage basin, its various tributaries, including the Smoky Hill, Saline, Solomon and Republican Rivers, drain the area. Rainfall is comparatively higher in the Northwest Central and streams flow relatively more even than in the Southwest.

Throughout the study area, surface water resources are meager. Insufficient rainfall, lack of suitable reservoirs sites,[4] and the high evaporation rate are the major problems

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[4]Kansas Planning for Development, Regional Review for Planning in Kansas, Report No. 14-07, 1967, p. 11.

limiting greater use of the land. In the West, evaporation accounts for 99% of precipitation loss[5] and a total water loss of 70 inches in the year. Water loss due to evaporation in the Northwest Central is estimated at 60 inches annually.[6]

Ground Water

The most important source of water supply in Western Kansas is ground water. Clark states:

> In a region of deficient rainfall such as the Great Plains, the underground water supply is of the utmost importance. It is from this source that the flow of streams is maintained in time of drought, and it not only supplies moisture for crops and natural vegetation, but also furnishes practically all of the supply for livestock and domestic consumption.[7]

Western Kansas and especially the Southwest is underlain with rich acquifers, a large proportion of which supplies over 500 gallons per minute in individual wells.

The major water bearing rocks of Western Kansas are those of the unconsolidated and permeable type, ranging from the lower cretaceous to the present pleistocene, tertiary and quarternary formations. Of these, the Ogallale are most important and high yielding. The thickness of these rocks ranges from less than 100 feet in Greeley and Hamilton counties to 400 feet in Haskell, Grant and Finney counties, and to over 700

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[5] Kansas Water Atlas, Kansas Water Resources Board, Report No. 16a, Project No. P-43, 1967, p. 24.

[6] Kansas Planning for Development, op. cit., Report No. 14-09, 1968.

[7] Carroll D. Clark, People of Kansas: A Demographic and Sociological Study. (Topeka, Kansas: Kansas State Planning Board, 1936), pp. 9-10.

feet in Stevens county.[7] These are the regions with the greatest potentials for irrigation. Other water bearing rocks are the Cheyenne formation, Dakotan sandstones in the Northwest, the cretaceous shales and sandstones, the permian "red beds," and the quarternary alluviums along the present and former stream valleys.[8] The permian "red beds" are more widespread in the Northwest; they yield lesser amounts than the Ogallale in the Southwest. Moreover, they are deeper and construction costs are higher.

Ground water has been the premier source for irrigation, particularly since the 1940's, when irrigation spiraled up in Kansas. As has been noted, the largest aquifers and those with high yielding capacity, are concentrated in the Southwest. These are the major sources of supply for the irrigation wells.

In the state of Kansas, total irrigable area overlying aquifers with yielding capacity of over 100 gallons per minute is estimated at 15,600,000 acres. 10,900,000 acres lie over well yields of 500 gallons per minute and above.[9] The Southwest has roughly over 70% of these, thus combining suitable land and adequate water supply for irrigation purposes. The supply of ground water is

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[7]Irrigation in Kansas, Water Resources Board, Report No. 16e, 1967, p. 12.

[8]Richard Pfister, "Water Resources and Irrigation," Economic Development in Southwestern Kansas, IV. (Lawrence, Kansas: University of Kansas, Bureau of Business Research, 1955), pp. 93-95.

[9]Irrigation in Kansas, op. cit., p. 4.

meager in the Northwest Central. Ground water in storage is estimated by the Kansas Water Resources Board at 500 million acre feet (MAF).[10] Of this, the Southwest has 238 MAF (47.6% of the state), where the Northwest Central has only 13.234 MAF (2.6% of the state). Table 7 shows the distribution of ground water in storage in the study regions of Western Kansas. Seven counties (Stevens, Meade, Haskell, Seward, Gray, Grant and Finney) have 200 MAF accounting for 40% of the total ground water in storage in Kansas.

Watershed Districts, Reservoirs and Water Resource Management

Apart from ground water, which is only available in plentiful supply in the Southwest, water as a resource is scarce. Effective conservation and management would make the quantity more available to serve larger demands than at present. The need for this can hardly be overstressed in an undefinable climatic regime, where drought occurrences and below average precipitation are common.

Although water is scarce and the variability of streams flow is high, much water is wasted during floods because of inadequate reservoir capacity. However, watershed districts have been created for the efficient management and appropriation of water use in many regions of Kansas, as shown in Table 8.

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[10] Kansas Water Atlas, op. cit., p. 40.

Table 7

Estimated Ground Water in Storage

Rank	County	Ground Water MAF	Rank	County	Ground Water MAF
1	Stevens	44.6	12	Norton	5.0
2	Seward	30.8	14	Graham	3.4
3	Finney	26.1	18	Gove	1.3
4	Haskell	25.6	19	Trego	0.7
5	Grant	25.1	20	Cloud	0.6
6	Meade	20.4	21	Jewell	0.6
7	Gray	15.0	22	Ottawa	0.4
8	Kerney	13.6	23	Phillips	0.4
9	Stanton	12.6	24	Rooks	0.2
10	Morton	9.8	25	Russell	0.2
11	Wichita	5.1	26	Lincoln	0.1
13	Scott	3.5	27	Ellis	0.1
15	Greeley	2.8	28	Smith	0.08
16	Hamilton	2.1	29	Osborne	0.06
17	Lane	1.5	30	Mitchell	0.04
	REGION	238.5		REGION	13.2

Source: Irrigation in Kansas, Water Resources Board, Project No. P-43, Report No. 16e, 1967.

Table 8

Watershed Districts

SOUTHWEST District	Acres	NORTHWEST District	Acres
Bear Creek	400,000	Salt Creek	300,310
Pawnee River	368,640	Buffalo Creek	243,560
Wet Walnut	200,000	Spellman Creek	101,460
James Creek	162,000	Fisher/Criss Creek	25,189
N.E. Greeley County	30,000	Lost Creek	12,150
Lakin	10,000	Spellman	17,000
		Five Creeks	4,500
REGION	1,170,640	REGION	704,169

Source: Kansas Planning for Development, Regional Review for Planning in Kansas, Report No. 14-07, 14-09, 14-10 and 14-06.

Besides the state's watersheds, the U.S. Federal Government, under the agencies of the Bureau of Reclamation and the U.S. Corps of Engineers, have constructed 19 major reservoirs with a capacity for 10 MAF. Seven of these are in the Northwest Central. Although only 20% is allocated for irrigation and conservation and 70% for flood control,[12] it does hold a future promise for the Northwest Central that has a very negligible supply of ground water resources. Presently there is no significant reservoir in the Southwest, and both the Arkansas

[12] Kansas Agriculture, op. cit., 1968-1969, p. 8.

and Cimarron Rivers still lose a great deal of valuable water during flood periods.

This brief review of water resources available for irrigation in Western Kansas indicates the problems of shortages and hopes. Rainfall is meager and stream flows are variable. Ground water is available only in limited quantities and is almost always concentrated in the Southwest. If the future of irrigation is going to depend upon ground water, the Northwest Central will have a very low rate of irrigation development. However, the availability of numerous streams and the efficient management of water by the watershed districts, including the expansion of the existing reservoirs, holds some promise for irrigation expansion in the Northwest. In the Southwest, reservoirs to store flood waters now being lost in the Cimarron and Arkansas Rivers would augment the existing ground waters.

The great expansion in agriculture impels far better management of scarce water resources. In 1965, irrigation alone consumed 2.4 MAF in Kansas. Most of these were no doubt, in the moisture deficit regions of Western Kansas with the highest irrigation density in the state. By 2,000 AD irrigation needs are estimated to reach 8.8 MAF, which is almost 3½ times the rate consumed in 1965.[13] Water, according to Governor Robert Docking, is the most important resource in Kansas.[14] This is true in the

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[13] Kansas Agriculture, op. cit., 1970-71, p. 20.

[14] Ibid.

light of the phenomenal rate of growth in demand for water for irrigation purposes in these regions. A Kansas Board of Agriculture report states:

> Nothing is more important in Kansas than water. Nothing in recent years has done much to stabilize the agriculture of Kansas, particularly for production of meat animals, than irrigation in Western Kansas. We have some of the most challenging problems that relate to the future. Certainly we would urge, for the preservation of agriculture, . . . the formation of ground water districts. We would hope the Federal Government would place, in cooperation with Kansas State University, a multimillion dollar laboratory to be used by all of the Great Plains area for agriculture . . . to develop techniques that would promote efficient water utilization through the next century.[15]

Certainly the development of water resources would place a premium on the future expansion of irrigation in Western Kansas. Apart from cost, the individual construction and withdrawal from wells and streams lead to inefficient management of water. With organized and efficient management, irrigation potentialities in this region may be better realized than at present.

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[15] Ibid.

Chapter IV

THE DEVELOPMENT OF IRRIGATION

Unfavorable climatic factors of necessitate the application of irrigation for intensive agriculture in the semi-arid and desert regions of the Great Plains. In Western Kansas, with the annual average rainfall of 17.6 - 22 inches farmers may not have needed any form of supplementary irrigation if the rainfall were regular. Various methods of adaptations to the unpredictable weather in these regions include dry farming and irrigation. The use of fallow to conserve moisture will not prevent crop failures in Western Kansas during excessive and prolonged years of rainfall deficiency. Dry farming is practiceable where the rainfall, although inadequate, is reliable. But in drought periods when the land is parched, seeding is almost impossible and crop failures are more common than successful harvests.

Economic fluctuations attendant upon crop failures have led to widespread irrigation practices in order to ensure safety of crop harvests and stable income, all other factors being well with the marketing of products. Irrigation is now the most important form of reducing agricultural economic hazards, as is noted by Steinel:

> It is well known to all familiar with the country and its climate, that more than one-half of the total area of the United States cannot produce crops of grain or vegetables with certainty except by irrigation. There are localities, small in extent, where the rule does not apply, and there are occasional seasons at long and irregular intervals, when irrigation is unnecessary. Yet it is idle to depend upon the rains to nourish crops. The only dependence must be upon artificial irrigation. This necessity applies to the states of California, Oregon, Nevada, the western half of Kansas, and to the territories of Colorado, New Mexico, . . . Montana and the western half of Nebraska and South Dakota.[1]

The above was the assessment of the potential role of irrigation in the agricultural economy of the nation as early as 1864. This is more pertinent today in Western Kansas.

Early Settlers and Irrigation Before 1930

Early settlers were more dependent upon raising livestock because of the inadequate water to cultivate land. As the population grew, crop raising became a necessity to meet the growing demand for food crops. The first application of irrigation was probably to raise garden crops by diverting water from the streams on a limited scale.[2]

The history of irrigation development in Western Kansas is the history of Kansas irrigation. Erhart[3] and Schoewe[4] have

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[1]Alvin T. Steinel, "Mythical, Great American Desert Vanishes When Irrigation Begins," History of Agriculture in Colorado, 1858 to 1926. Colorado State Board of Agriculture, 1926, pp. 190-191.

[2]Irrigation in Kansas, Water Resource Board, Planning for Development, Report No. 16e, 1967.

[3]Andrew B. Erhart, How Far Irrigation in Kansas, 39th Biennial Report, Kansas State Board of Agriculture, 1952, p. 25.

[4]W.H. Schoewe, Geography of Kansas, Part III Concluded, Transactions of the Academy of Science, Vol. 56, No. 2, 1953, p. 174.

shown that irrigation in Kansas dates back to about 1660 when a band of Tao Indians settled and practiced irrigation in their pueblo's along Beaver Creek in Scott county. However, the Indians' irrigation practices ceased during the Europeanization of America, and they were either forced out of their pueblos[5] or exterminated. Modern irrigation methods did not start until the 1880's when Western Kansas became attractive to the people from Eastern Kansas and the state of Missouri.

The development of irrigation in the 1880's was mainly along the Arkansas River where canals and ditches were constructed by irrigation canal companies. During the decade 1880-1890, Kansas witnessed the first phase of growth. Most important of these early companies included Eureka Irrigation Company in Gray and Ford counties in 1883. The Ingel Canal in Gray county was 96 miles long and was estimated to irrigate 400,000 acres. Others included the Amazon Canal (Kerney), South Side Ditch, Alamo Ditch, Frontier Ditch, Western Kansas Flood Ditch (Hamilton), Kansas, Sherlock, and Garden City (Finney).[6]

The first difficulty encountered in these early irrigation practices was water shortages at the time of most need. They depended solely on the Arkansas, which was also used by Colorado farmers for irrigation purposes.

Severe droughts, which started in the late 1880's, further added impetus to the development of irrigation, particularly by exploring underground water sources. In 1895 the

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[5]Erhart, op. cit., p. 25.

[6]Richard Pfister, Economic Development in Southwestern Kansas: Water Resources and Irrigation, (Lawrence, Ks.: U. of Kansas, 1955), pp. 50-55.

Kansas State Legislature passed an Irrigation Law and created the Irrigation Commission to construct wells. Of the 20 wells designated, 10 were in the Southwest region and 3 in the Northwest Central.[7] Development continued at a modest pace until the 1930's when another severe drought period gave a new fillip for expansion.

The Growth of Irrigation Since the 1930's

The decade beginning with 1930 is a remarkable period in the history of the people of the Great Plains. 1930 to 1940 witnessed the greatest prolonged drought in the region. In Western Kansas rainfall remained below annual mean throughout the decade. The effect of the drought was immediately passed on to agriculture by crop failures. To sustain agricultural production, the Western Kansas farmer realized that the fallow system and dry farming, the only traditional conservation methods, would not suffice in a severe drought as prevailed in the 1930's. This led to widespread irrigation, more so as successful reports were received from fellow irrigators. A combination of good weather by the 1940's and the post World War II increased demand for grain products led to a rapid expansion of irrigation in Kansas.

The period also witnessed the introduction of hybrid wheat, corn and sorghum. For maximum yields of these plants there needs to be sufficient water and fertilizers. Commercial fertilizers became more available after the war, but what was needed was water.

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[7]Schoewe, op. cit., p. 178.

This was answered by the development of lightweight, alluminum irrigation pipelines, which makes transportation and distribution of water relatively inexpensive and efficient to permit economy of scale in application.

Precipitation in the 1940's was within normal range, but in the 1950's another set of droughts occurred, especially from 1953. Many farmers turned to a wider scale application of irrigation in order to sustain profitable economic returns from the farm investments of the previous decade.

Water had always been a limiting factor in irrigation. Although wells were topping the Western Kansas acquifers since the 1880's,[8] the ability to draw water from deep wells was improved by the introduction of turbines and machines powered by natural gas and electricity. Southwestern Kansas had an Ideal set of conditions for irrigation farming. The land is fertile, it has large ground water reserves, and has plentiful natural gas bearing wells. It is no surprise that irrigation has developed at a faster pace than elsewhere in Kansas. In 1909, only 5% of irrigated land was watered from well supply.[9] By 1949, this proportion increased to 60% and in 1970, 94%.[10]

The period from 1940 to 1960 witnessed the most rapid

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[8]Pfister, op. cit., p. 67.

[9]Schoewe, op. cit., p. 185.

[10]Humber Self, Irrigation Farming in Kansas, Transactions of the Kansas Academy of Science, Vol. 74, Nos. 3 and 4, 1971, p. 316.

rate of growth in irrigation development in Kansas. It rose from 122,000 acres in 1940 to 1,008,624 acres in 1960. In fact, the rate of development has far exceeded many estimates and projects. In 1936, the National Resource Board's report on potential irrigation expansion in the seventeen Western states estimated a total of 1,333,000 acres for Kansas.[11] By 1963, this figure had been exceeded and by 1970 irrigated acreages in Kansas as a whole reached 1,588,377.[12]

Phenomenal as this increase was, the greatest development was most impressive in the Southwest region of Kansas. Table 9 shows the percentages of total irrigated acreages in the Southwest and Northwest Central. It will be observed that the Southwest had always been in the lead for the whole state. The table shows that in 1929, Southwestern Kansas had 89.1% of the irrigated acreage. The Northwest Central had none. By 1970, the Southwest had 64.8% of the irrigated acreages while the Northwest Central had only 4.6%. Although the percentage proportion for the Southwest has been reduced, it has had the greatest number of increases in acreages for every period. The following table illustrates this fact.

Table 10

Increases in Irrigated Acreages

Period	State	Southwest Region	Northwest Central	Other
1919-1929	23,978	19,797	--	4,181
1929-1940	50,697	24,818	2,923	22,955
1940-1960	866,637	587,222	47,436	251,979
1960-1970	872,613	542,453	36,833	293,327

Source: U.S. Census of Agriculture, 1955, 1959, 1964, 1970.

[11] Irrigation Agriculture in the West, U.S.D.A. Misc. Pub. No. 670, p. 9.

[12] Russell L. Herpic, Statistical report on Irrigated Acres—Selected Years by County, 1968.

Table 9

The Development of Irrigation in Western Kansas 1929-1970

	SOUTHWEST		NORTHWEST CENTRAL		STATE
Year	Acres Irrigated	% state[c]	Acres Irrigated	% state[c]	Total
1929[a]	63,504	89.1	-	0.0	71,290
1940[a]	88,322	72.4	2,923	2.4	121,987
1948[a]	186,740	84.4	2,900	1.3	221,199
1955[a]	390,465	76.6	17,935	3.3	537,566
1960[a]	675,544	67.0	50,359	5.0	1,008,624
1961[a]	683,128	67.9	50,884	5.1	1,006,813
1962[a]	714,248	67.8	59,090	5.6	1,054,304
1963[a]	732,866	67.0	56,943	5.2	1,094,641
1964[a]	772,344	66.6	67,067	5.8	1,159,931
1966[a]	925,226	67.1	64,806	4.7	1,379,054
1968[a]	1,036,889	65.2	70,331	4.4	1,588,379
1970[b]	1,217,997	64.8	87,192	4.6	1,881,237

Sources: a. Herpich Russell, "Irrigated Acres-Selected Years by County" Agricultural Extension Service, Kansas State University, Manhattan, 1968
b. Herpich Russell. "County Irrigation Summary 1970" Agricultural Extension Service, Kansas State University, Manhattan, 1970
c. Computed by the author.

In 1970 all five counties with over 100,000 irrigated acres in Kansas were in the Southwest. (See Fig. 4). Six of the seven counties with between 50,000 and 100,000 acres were also located in the Southwest.[13] The county with the highest irrigated acreage in the Northwest Central was Cloud, with 13,270 acres, which was less than the 17,000 acres of Lane county, the least in the Southwest.

Table 11 shows the irrigation rank of the counties. There were seven counties in the Southwest each of which had higher irrigated acreages than the whole of the Northwest Central combined in 1970. These seven counties, Finney, Grant, Haskell, Wichita, Scott, Stanton and Gray accounted for 46% of all irrigated acres in Kansas and 71% in the Southwest.

The Kansas Water Resources Board in 1967 published survey reports of acreages suitable for irrigation and projected estimated acres irrigated in 2,000 A.D.[14] Although both the Southwest and Northwest Central have potential irrigable acreages, the prospect for development appears limited in the Northwest Central, but the Southwest is expected to expand irrigable acreages to 2,400,000 by 2,000 A.D. The Northwest Central has only 182,000 irrigable acres, even though suitable land for irrigation totals 5,947,160 acres.

There is hope here in the future, if the water resources could be developed, for irrigation to significantly expand.

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[13] Humber Self, op. cit., p. 314.

[14] Irrigation in Kansas, op. cit., p. 23f.

Fig. 4

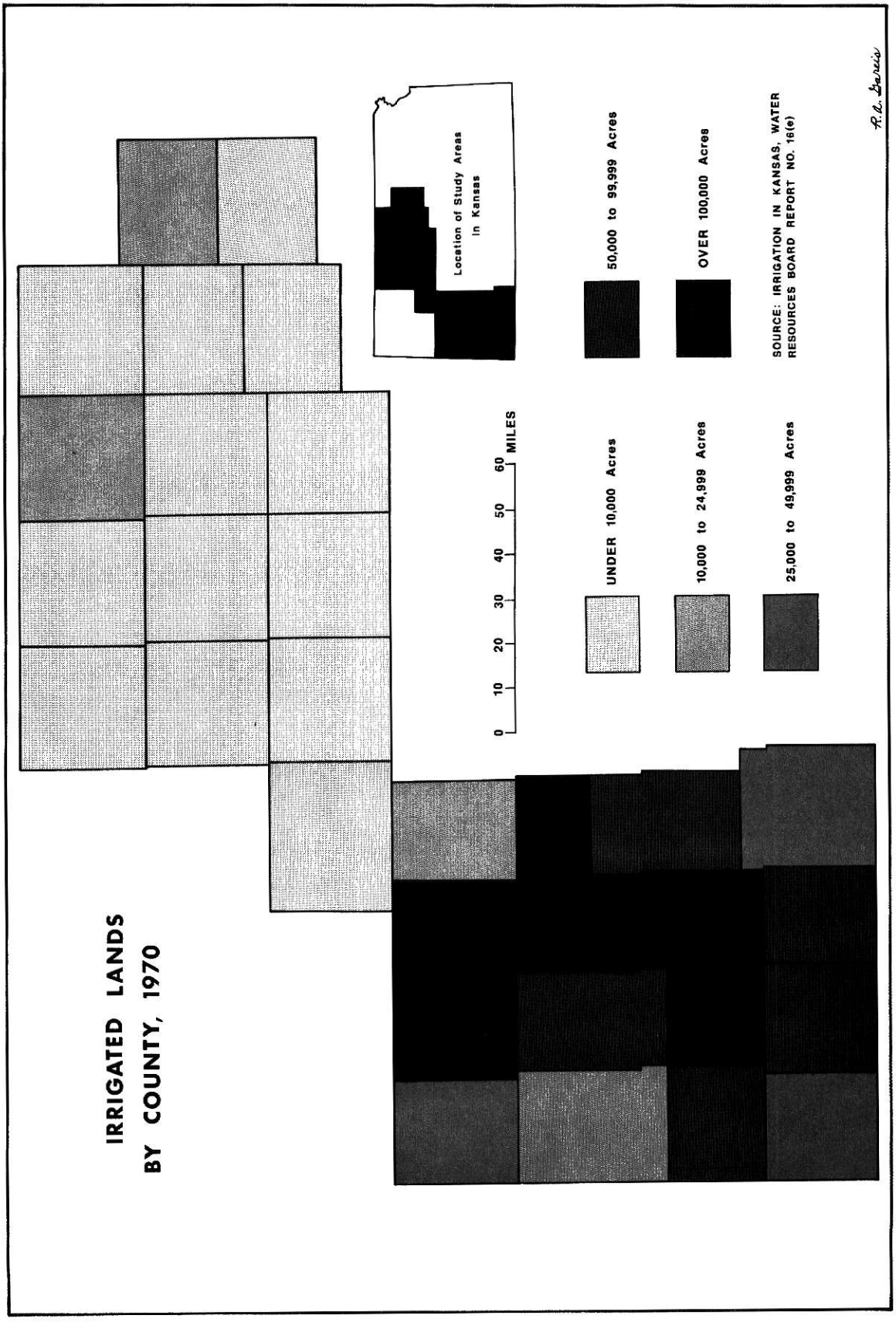
IRRIGATED LANDS
BY COUNTY, 1970
Location of Study Areas in Kansas
0 10 20 30 40 50 60 MILES
UNDER 10,000 Acres
10,000 to 24,999 Acres
25,000 to 49,999 Acres
50,000 to 99,999 Acres
OVER 100,000 Acres
SOURCE: IRRIGATION IN KANSAS, WATER RESOURCES BOARD REPORT NO. 16(e)
R.L. Harris

Table 11

Irrigated Acreages in 1970

Rank	Southwest	Irrigated Acreage	Rank	Northwest Central	Irrigated Acreage
1	Finney	162,820	16	Cloud	13,270
2	Grant	135,500	17	Smith	10,250
3	Haskell	130,260	18	Gove	9,860
4	Wichita	129,998	19	Mitchell	8,010
5	Scott	111,610	20	Osborn	7,711
6	Stanton	97,910	21	Jewell	6,750
7	Gray	96,200	22	Ottawa	6,300
8	Kearney	83,800	23	Lincoln	6,000
9	Stevens	65,000	24	Elliss	5,216
10	Seward	51,000	25	Rooks	5,000
11	Greeley	41,494	26	Norton	4,282
12	Meade	41,150	27	Phillips	3,700
13	Morton	30,300	28	Graham	3,000
14	Hamilton	23,795	29	Trego	2,083
15	Lane	17,000	30	Russell	1,160
Region		1,217,997	Region		87,192
State		1,881,237	State		1,881,237

Source: U.S. Bureau of Census, Census of Agriculture, 1970.

Economic Benefits of Irrigation

Economic gains of irrigation can be classified as direct and indirect returns. Direct gains include: (a) increased yield per acre; (b) reduction of crop failures; and (c) stability of income. Indirect gains include: (a) expansion of livestock industry; and (b) increased purchasing power; hence, expansion of secondary and tertiary sectors of the economy by creating more employment opportunities.

The best obtainable yields from crops are had when the critical minimum optimum requirements of land and water are available. The deficiency and variability of rainfall make water the most important of these requirements in Western Kansas. This has necessitated the application of artificial water in the form of irrigation to ensure stability of production and avoid crop failures. Irrigation makes it possible to serve the water needs of plants at the right time and in sufficient quantity. This leads to higher yields. Increased yields per acre resulting from the application of irrigation ranges from 100% on some lands to an increase of 15% or 20% in more humid sections.[5]

Table 12

Average Yield of Major Grain Crops in Irrigated and Non-Irrigated Lands

CROPS	IRRIGATED (Yield in Bushels Per Acre)	NON-IRRIGATED (Yield in Bushels Per Acre)
Wheat	48	24
Sorghum	84	28
Corn	108	41

Source: 54th. Annual Report, Kansas Board of Agriculture, 1970-71

As early as 1955 it was reported 1/8 of the nation's (U.S.) harvested crops came from irrigation which occupied only

[15] Elco Greenshild, Water for Irrigation-U.S.Agriculture Year Book, 1955, pp. 249-250

1/16 of the croplands. Thus the productive capacity of an irrigated acre was estimated to be twice the non-irrigated equivalent.[16]

Certainly there have been increases in crop yields per acre since 1935 in both the Southwest and the Northwest Central. Reasons given for the increases include the introduction of hybrid seeds, the application of artificial fertilizers, and the development of irrigation. However, the following table shows that there are higher rates of increase in the Southwest than in the Northwest Central and this may be attributed to the effects of irrigation. Haskell and Jewell counties have been taken for illustration. Haskell is in the Southwest and Jewell is in the Northwest Central.

Table 13

Increase in Yield of Crops

YEAR	WHEAT (Bushels Per Acre)		CORN (GRAIN) (Bushels Per Acre)		SORGHUM (GRAIN) (Bushels Per Acre)	
	Haskell	Jewell	Haskell	Jewell	Haskell	Jewell
1935	4.0	8.0	1.0	4.0	2.2	4.0
1953	6.1	9.3	11.4	8.5	8.7	14.9
1970	36.1	33.3	105.0	78.0	90.0	32.6

Source: Computed from data in Biennial Report of the Board of Agriculture, Kansas, 1935-1936, Kansas Farm Facts, 1953, 1970 and 1971.

[16] Greenshild, op. cit. p. 251.

The yields of the major crops for the year 1970 were examined by computing the means for both regions. Mean yield of sorghum grain for the Northwest Central is 30 bushels per acre which was less than half the mean for the Southwest. The ratio of corn yield per acre was 1:1.5 for the Northwest Central and the Southwest respectively.[17] There was little or no difference in wheat yield per acre for both regions. This is attributable to the vast wheat producing capacity under dry farming, so that in years of normal rainfall the effect of irrigation may be entirely negated. This will be seen from Table 14 which shows that wheat croplands are not widely irrigated in the Northwest Central where the rainfall is a little higher than in the Southwest.

However, this table also demonstrates that for a given irrigated crop in both regions, there are no significant differences in the yield per acre. It could therefore be generalized that if irrigation was expanded in the Northwest Central, yields per acre would compare favorably with those in the Southwest.

Of the 7,464 farms which applied irrigation in the state of Kansas in 1970, 2,900 (38.9%) were in the Southwest. These farms irrigated 1,217,997 acres representing 64.8% of all irrigated acreages in Kansas. The Northwest Central had only 755 (10.9%) irrigating farms and 87,192 irrigated acres representing 4.6% of Kansas.[18]

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[17]Computed by the author.

[18]Computed by the author based on County Irrigation Summary, 1970, (Manhattan, Ks.: Agr. Ext. Service, KSU).

Table 14

Comparable Yields of Sorghum and Wheat
Under Irrigation and Dry Farming 1970

	SORGHUM (GRAIN) (Bushels Per Acre)		WHEAT (Bushels Per Acre)	
	Irrigated	Non-Irrigated	Irrigated	Non-Irrigated
SOUTHWEST				
Finney	90	33	37	25
Grant	93	33	48	21
Gray	97	34	43	26
Greeley	83	25	38	18
Hamilton	82	34	27	13
Haskell	93	33	48	32
Kearney	89	40	37	23
Lane	84	32	25	24
Meade	93	31	33	16
Morton	97	35	26	11
Scott	89	31	40	21
Seward	90	30	35	19
Stanton	95	24	37	13
Stevens	81	29	40	23
Wichita	86	31	45	24
NORTHWEST CENTRAL				
Cloud	76	42		31
Ellis	78	22	36	21
Gove	75	31	19	16
Graham	78	34	48	20
Jewell	73	32	-	28
Lincoln	72	25	-	28
Mitchell	72	27	-	28
Osborne	80	21	-	28
Norton	80	25	-	
Ottawa	67	41	-	27
Phillips	74	24	-	28
Rooks	69	24	-	27
Russell	75	24	-	24
Smith	75	24	-	35
Trego	79	23	-	20
SOUTHWEST	90	31	37	21
NORTHWEST CENTRAL	75	28	34	26
STATE	87.2	33.4	40	29

Source: Farm Facts, Kansas Board of Agriculture, 1970/71.

Irrigation and Farm Income

The direct impact of irrigation is often expressed in the net increased income of the farmer, irrigator. To obtain this, the number of irrigated acreages for given crops was taken by the author as a basis of measuring the values of non-irrigated crops. This was multiplied by the average yields of crops in non-irrigated lands to obtain the total yields. These were again equated with the yields from irrigated crops given the same market value. Tables 15 and 16 show the values obtained from the equivalent acres of land subjected to irrigation and non-irrigation for both the Southwest and the Northwest Central in 1970.

In the Southwest irrigated sorghum and wheat in 1970 yielded $34,645,050 and $9,678,080 respectively. The equivalent non-irrigated acreage for sorghum and wheat yielded only $10,677,150 and $5,372,160 respectively. The net increases of income attributable to irrigation gain for sorghum and wheat are therefore calculated at $23,967,900 and $4,305,920 respectively. The net increases attributable to irrigation for the given crops in the Northwest Central are $1,483,020 and $128,000 respectively.

The productive capacity ratio of irrigated and non-irrigated acreages was further computed for purposes of comparing the effectiveness of irrigation in both regions. In the Southwest, sorghum production ratio under irrigation was 2.94:1. Dry farming in the Northwest Central was 2.76:1. Wheat ratio

Table 15

Net Increase in Value of SORGHUM Production
Attributable to Irrigation

	Irrigated	Non-Irrigated Equivalent	Net Increase In Production	Productive Ratio
SOUTHWEST				
Finney	$ 4,257,000	$ 1,560,900	$ 2,696,100	2.72
Grant	2,680,260	951,060	1,729,200	2.81
Gray	4,481,400	1,570,800	2,910,600	2.85
Greeley	611,710	184,250	427,460	3.32
Hamilton	829,840	344,080	484,760	2.41
Haskell	4,634,190	1,644,390	2,989,800	2.81
Kearney	655,930	294,800	361,130	2.22
Lane	351,120	133,760	217,360	2.62
Meade	1,872,090	624,030	1,248,060	3.0
Morton	1,973,950	712,250	1,261,700	2.77
Scott	1,801,360	627,440	1,117,392	2.87
Seward	1,346,400	448,800	897,600	3.0
Stanton	2,800,600	707,520	2,093,080	3.95
Stevens	4,419,360	1,582,240	2,837,120	2.79
Wichita	1,929,840	695,640	1,234,200	2.77
NORTHWEST CENTRAL				
Cloud	154,440	67,320	87,120	2.29
Ellis	77,220	21,780	55,440	3.54
Gove	552,750	228,470	324,280	2.41
Graham	75,240	41,580	33,660	1.80
Jewell	72,270	31,680	40,590	2.28
Lincoln	77,000	26,400	50,600	2.91
Mitchell	71,280	26,730	98,010	2.66
Norton	501,600	156,750	344,850	3.20
Osborne	176,000	46,200	129,800	3.80
Ottawa	44,220	27,060	17,160	1.63
Phillips	65,120	23,760	41,360	2.74
Rooks	68,310	23,760	44,550	2.87
Russell	77,000	26,400	50,600	2.91
Smith	49,500	15,840	33,660	3.12
Trego	260,700	75,900	184,800	3.43
SOUTHWEST	34,645,050	10,677,150	23,967,900	2.94
NORTHWEST CENTRAL	2,322,650	839,630	1,483,020	2.76

Source: Data computed from Farm Facts, Board of Agriculture, 1970/71.

Values for non-irrigated equivalent was computed by multiplying yields per acre in non-irrigated land by the equivalent acres irrigated for the same period.

Table 16

Net Increase in Value of WHEAT Production
Attributable to Irrigation

	Irrigated	Non-Irrigated Equivalent	Net Increase In Production	Productive Ratio
SOUTHWEST				
Finney	$ 1,280,000	$ 864,000	$ 416,000	1.48
Grant	1,240,320	537,600	702,720	2.28
Gray	824,320	499,200	325,120	1.65
Greeley	48,640	230,400	256,000	2.11
Hamilton	104,960	88,320	16,640	2.07
Haskell	1,408,000	924,080	465,920	1.50
Kearney	330,240	206,080	124,160	1.60
Lane	64,000	61,440	2,560	1.04
Meade	385,280	184,320	200,960	2.06
Morton	199,680	84,480	115,200	2.36
Scott	614,400	322,560	291,840	1.90
Seward	399,360	218,880	180,480	1.84
Stanton	1,075,200	382,720	692,480	2.84
Stevens	1,013,760	588,800	424,960	1.73
Wichita	689,920	368,640	321,280	1.87
NORTHWEST CENTRAL				
Cloud	431,520	39,680	3,840	1.09
Ellis	46,080	26,880	19,200	1.71
Gove	48,640	40,960	89,600	1.18
Graham	61,440	25,600	35,840	2.4
Jewell	43,520	35,840	7,680	1.21
Lincoln	43,520	35,840	7,680	1.21
Mitchell	43,520	35,840	7,680	1.21
Norton	43,520	24,320	19,200	1.78
Osborne	43,520	35,840	7,680	1.21
Ottawa	43,520	34,560	8,960	1.25
Phillips	43,520	35,840	7,680	1.21
Rooks	43,520	34,560	8,960	1.25
Russell	43,520	30,720	12,800	1.41
Smith	43,520	44,800	1,280	1.41
Trego	43,520	25,600	17,920	1.70
SOUTHWEST	9,678,080	5,372,160	4,305,920	1.80
NORTHWEST CENTRAL	634,880	506,880	128,000	1.25

Source: Data computed from Farm Facts, Board of Agriculture, 1970/71.

Values for non-irrigated equivalent was computed by multiplying yields per acre in non-irrigated land by the equivalent acres irrigated for the same period.

was 1.8:1 in the Southwest and 1.25:1 in the Northwest Central. This again illustrates the emphasis that irrigation offers equal gains for both regions. The assumption here is that irrigated lands have higher productive capacities over non-irrigated lands. For the Southwest, with higher density of irrigation, there would also be higher income derivable from farm. This would be reflected in the general income pattern and economic parameters.

Because of the advantages of irrigation, both per farm and total farm income have risen tremendously in the Southwest, particularly since 1940 following the rapid development of irrigation in this region. Table 17 gives per farm and total income from 1940 to 1970.

Table 17

Per Farm Income & Total Farm Income 1940-1970

	SOUTHWEST		NORTHWEST CENTRAL	
	Total Farm Income	Per Farm Income	Total Farm Income	Per Farm Income
1940	$ 17,744,034	$ 2,467	$ 38,358,879	$ 1,776
1950	$ 85,465,520	$14,362	$161,774,160	$ 9,525
1960	$188,491,838	$32,696	$183,198,150	$13,496
1970	$285,339,917	$53,817	$244,943,710	$20,346
% Increase 1940-70		2,801.5%		1,045.6%

Source: Kansas Board of Agriculture Reports.

Not only has the Southwest per farm and total farm income increased faster than the Northwest Central, it has also exceeded in aggregate income. Until 1950 the Northwest Central aggretate farm income was almost twice that of the Southwest; but since 1960 this ratio has been changed in favor of the Southwest. Fig. 5 is an illustration of county value of field crops in 1970. Of the ten leading counties in the state of Kansas, five were in the Southwest; there were none in the Northwest Central. All counties in the Northwest Central earned below $10,000, whereas ten counties were above $10,000 in the Southwest.

A break down of farm income into field crops and livestock shows the direct economic gains of irrigation in the Southwest.

Table 18

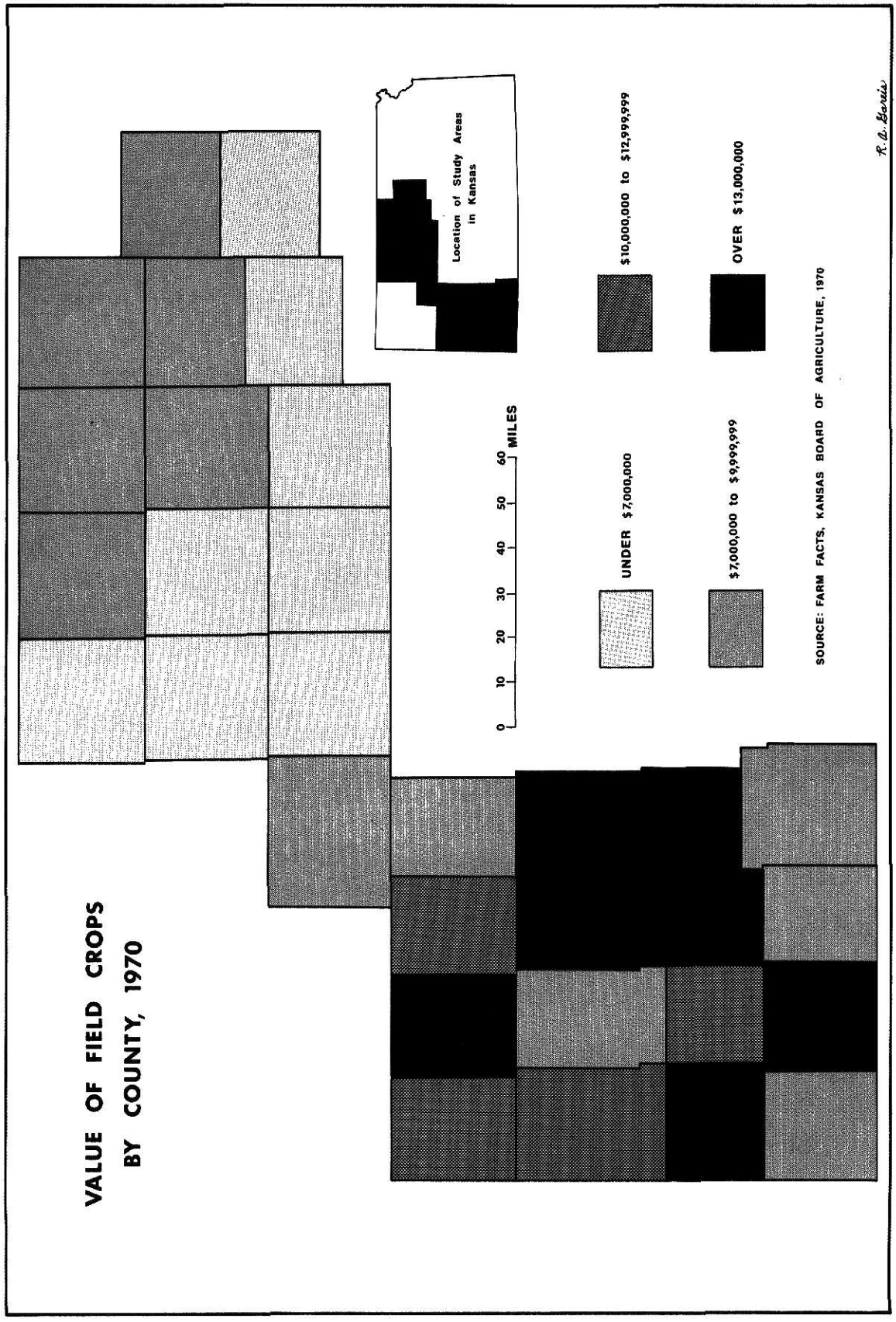
Trends in Field Crops 1940-1970

	Field Crop Value	
	SOUTHWEST	NORTHWEST CENTRAL
1940	$ 11,787,386	$ 16,635,234
1950	$ 54,191,850	$ 91,395,220
1960	$158,397,640	$123,062,930
1970	$184,647,520	$108,332,160
% Increase 1940-1970	1,4.66.5%	560.3%

Source: Kansas Board of Agriculture Annual Reports.

The value of field crops in the Southwest rose from $11.8 million in 1940 to $184.6 million in 1970, an increase of 1,446%

Fig. 5


VALUE OF FIELD CROPS
BY COUNTY, 1970
Location of Study Areas in Kansas
0 10 20 30 40 50 60 MILES
UNDER $7,000,000
$7,000,000 to $9,999,999
$10,000,000 to $12,999,999
OVER $13,000,000
SOURCE: FARM FACTS, KANSAS BOARD OF AGRICULTURE, 1970
R. A. Harris

in forty years. The Northwest Central field crops increased only by 560.3% for the same period.

Between 1940 and 1970 the Southwest livestock income increased 3 times as much as the Northwest Central. Table 19 shows a very high correlation between irrigation and livestock in the Southwest. The Southwest increases rapidly in both field crops and livestock. This is one of the indirect impacts of irrigation.

Table 19

Trends in Livestock 1940-1970

	Livestock Value	
	SOUTHWEST	NORTHWEST CENTRAL
1940	$ 5,956,648	$ 21,723,645
1950	$ 31,273,670	$ 70,378,940
1960	$ 30,094,198	$ 60,135,220
1970	$100,951,650	$136,611,550
% Increase 1940-1970	1,594.8%	528.9%

Source: Kansas Board of Agriculture Annual Reports.

Corn and sorghum form important parts of the cattle feed. Irrigation of these crops in the Southwest, therefore, provides availability of feeds needed to raise livestock. This makes livestock enterprise a good industrial mix with irrigation agriculture. Irrigation of hay pasture and feed crops have

become more important in recent times to ensure stability in livestock enterprise. Of the 239,502 acres under irrigation for Alfalfa, pasture grass, corn and sorghum forage in Kansas in 1970, (Table 20) there were 46.6% acres in the Southwest. The Northwest Central has 6.2%. This shows a great potential for the growth of the livestock industry peri pasu with irrigated agriculture in the Southwest.

Rio emphasized the significant role of irrigation providing assurance of feed crops in Kansas agriculture. Thus irrigation has not only increased field crops, but also livestock.[19] The future of the livestock industry, particularly in the semi-arid region like Western Kansas, would depend greatly upon feed crops, roughages and irrigated pasture as remarked by the U.S. Department of Agriculture:

> Irrigated feed crops and pasture play a significant part in stabilizing the western livestock industry by providing a dependable feed base that permits more effective use of the extensive pasture areas. Irrigation also aids the growth of large scale livestock, farming operations near western population centers.[20]

Irrigation and Socio-Economic Parameters

It has been demonstrated earlier in this thesis that agriculture is the economic base for Western Kansas. Successful and gainful agriculture is influenced by the application of irrigation in the Southwest. Farm income and other socio-economic parameters are further investigated to determine the net

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[19]Jerry Minshall Rio, Kansas Agricultural Report, 1970-1971, p. 97.

[20]U.S. Dept. of Agriculture, Major Uses of Water and Land, No. 149, 1964, p. 37.

Table 20

Application of Irrigation in 1970

	Southwest	Northwest Central	State
Number of Farms [a]	5,657	11,921	92,439
% State [c]	6.1	12.9	
Number of Farms using Irrigation [b]	2,900	755	7,464
% State [c]	38.9	10.9	
Farm Acres Harvested [a]	3,000,210	2,477,181	18,966,000
% State [c]	15.8	13.1	
Farm Acres Irrigated [b]	1,217,997	87,192	1,881,237
% State [c]	64.8	4.6	
Irrigated Acreage under Wheat, Corn & Sorghum (Grain) [b]	1,058,356	67,047	1,559,544
% State [c]	67.9	4.3	
Irrigated Acreage under Corn and Sorghum (Forage), Alfalfa and pasture grass [b]	111,658	14,767	239,502
% State [c]	46.6	6.2	
Irrigation Density per 1,000 Acres of Harvested Cropland [c]	406.0	35.2	99.1

Sources: a. Kansas Farm Facts, Kansas State Board of Agriculture, 1970-71.
b. County Irrigation Summary, 1970, Compiled from reports by Agric. Ext. Service, KSU, Manhattan, Ks.
c. Computed by the researcher.

influence of irrigation on the economic well being of these study regions. Per capita farm income and per capita personal income were computed. Both incomes were much higher in the Southwest than in the Northwest Central. The mean of per capita farm income in the Southwest was $3,434 while the comparative figure for the Northwest Central was only $2,015. The mean per capita personal incomes were $4,637 and $3,434 for the Southwest and the Northwest Central respectively. There is no doubt the per capita personal income was equally influenced by the farm income in the study regions. When compared with the state of Kansas, per capita personal incomes in the Southwest exceeded both the state and the Northwest Central between 1950 and 1970. These comparative figures are shown in Table 21 .

Table 21

Per Capita Personal Income 1950-1970

	SOUTHWEST	NORTHWEST CENTRAL	STATE
1950	$1,552	$1,309	$1,443
1960	$2,355	$1,813	$2,161
1970	$4,637	$3,434	$3,823

Source: Computed by author based on data from Kansas county income 1950-1964 by Darwin Daricoff, State of Kansas, Office of Economic Analysis, 1966; and Ninth Annual Economic Report of the Governor, State of Kansas, January, 1972.

The rate of increase between 1950 and 1970 illustrates the comparative influence of farm income in the Southwest and the Northwest Central. Per Capita personal income increased by 198.8% for the Southwest whereas the Northwest Central and

the state increased by 162.3% and 164.9% respectively.

Median family income, mean family income and the net effective buying income are other measures of economic parameters. Table 22 shows that the Southwest median and mean family incomes were higher than those for the Northwest Central even though both regions lage behind the state level.

Table 22

Median and Mean Family Income, 1970

	SOUTHWEST	NORTHWEST CENTRAL	STATE
Median Family Income	$8,396	$7,069	$8,693
Mean Family Income	$9,777	$8,271	$10,063
Net Effective Buying Income 1966-1969:			
1966	$2,043	$1,752	$2,165
1967	$2,859	$2,324	$2,653
1968	$2,995	$2,455	$2,820
1969	$3,146	$2,624	$3,069

Sources : U.S.Dept. of Commerce, Social and Economic Characteristics, Bureaur of Census, Part 21, 1970; Kansas Statistical Abstract, 1970

When income rises, the purchasing power increases, not only by volume of purchases, but also by the velocity of monetary exhanges and transactions. Thus the incomes generated from the economic base to to influence the net effective buying income. The comparative net effective buying income for the two regions and the state from 1966 to 1969 shows that, except for 1966, the Southwest region has always been above the state's level. This demonstrates that the region's favorably comparative economic well being is a direct influence of the major economic base, which is agriculture, influenced in turn by irrigation practices.

In order to firmly establish the influence of irrigation in the region's economy, income from minerals was examined. The

data shown below shows that the Southwest with the higher irrigation density and higher incomes also had the higher income from minerals. However, in both regions, total incomes from agriculture far exceeded that from minerals. In 1969-70 the Southwest income from minerals was only $183,048,000 compared with $285,339,917 from agriculture. In the Northwest, the corresponding amounts were $102,100,000 and $244,943,710 respectively.

There is no doubt that minerals contribute substantially to the economy of the region, but its influence is minimal, as is shown. Even those counties with comparatively high mineral income in the Northwest Central suffered population losses between 1940 and 1970. Besides incomes, minerals are generally less widely distributed than in agriculture.

In conclusion, it will be recalled that irrigation forms the principal foundation for agricultural growth in Western Kansas. The major direct impacts are to serve as insurance against crop failures in drought years, the net increase in yields per acre and hence overall income. The farmer who has access to water for irrigation in this semi-arid region would ensure successful harvests even in bad years. Irrigation also has an indirect impact on the secondary and tertiary sectors of the economy, and most especially the mix between irrigation agriculture and the livestock industry:

The 'spill-off' from increased irrigation in the past several years in the Western Part of the state (Kansas) has been the construction of a number of large commercial slaughtering facilities, processing plants, numerous industries involved in the manufacture and distribution of irrigation equipment, and many other agri-business firms.[21]

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[21] J.E. Palleson, op. cit., p. 137.

Chapter V

DEMOGRAPHIC TRENDS IN WESTERN KANSAS

Like the rest of the portions of the Great Plains Proper, Western Kansas was among the last region to be settled by the white man during the great westward frontier movement in the nineteenth century. Until the end of the Civil War, only the nomadic Indians and wild roving herds of buffalo[1] occupied this vast stretch of land. The late settlement of the region resulted from the environmental perception of the frontier vanguards. Much of this semi-arid region was considered unfit for agricultural settlement for want of adequate rainfall and prevelant scarcity of water.[2] For many years before the 1880's, despite the Homestead Act of 1862 and Morrill Act of 1863, which encouraged agricultural settlements, the westward frontier line of settlement remained almost stationary along the 98th meridian.[3]

By 1860 the eastern one-third of Kansas counties had been organized, but the western two-thirds remained unsettled with only a few trading posts and forts developed along trail

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[1]G.W. Thorntwaite, "Climate and Settlement in the Great Plains," Climate and Man: Year Book of Agriculture. (Washington, D.C.: U.S. Dept. of Agriculture, 1941), p. 183.

[2]W.H. Schoewe, Geography of Kansas, Part III, Concluded. Transactions of the Academy of Science, Vol. 56, No. 2, 1953, p. 175.

[3]Carl Frederick Kraezel, The Great Plains in Transition. (University of Oklahoma, 1955), pp. 125-126.

routes to the west.[4] Hoover mentions that:

> . . . for some time after the geography of the west was well known, much of Kansas was supposed to be unfit for human habitation, at least by civilized people. Even after the settlement of Eastern Kansas had begun, it was thought that the western part could never become agricultural. Most maps of the 1830's and 1840's showed an area called 'The Great American Desert' which was frequently compared with the Sahara.[5]

Settlement did not become attractive until the 1880's when a combination of factors, including development of effective transportation, farming equipment and most important, good years of above mean average rainfall which led to successful crop harvests and gradually removed the desert image. The realization that the so-called desert soil is fertile if only water was available lured pioneer cultivators to Western Kansas. Since then, like the rest of the Great Plains, various means of adaptations have evolved to utilize the once neglected region and establish permanent settlement. This chapter outlines the trends of population movement in Western Kansas since the 1880's, with emphasis on the correlation between fluctuations in climate and population growth or decrease.

Trends Before 1930

The white pioneers in Western Kansas were the cattle range men; permanent agricultural settlers emerged only from the 1880's. Although Kansas territory was opened for settlement in 1854,[6] the earliest organized counties in these study regions

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[4] Thorntwait, op. cit., p. 186.

[5] Leo M. Hoover, Kansas Agriculture After 100 Years. Agric. Exp. Station, KSU, Bulletin No. 392, 1957, p. 9.

[6] Hoover, op. cit., p. 10.

were in 1866 and included: Cloud, Ottawa and Ellis in the Northwest Central. No county was organized in the Southwest until 1884, the first being Finney. Settlement of this region although late when it started, was very rapid, for by 1888 all counties in the Southwest had been organized.

The decade from 1880-1890 witnessed the most rapid population growth in Western Kansas, especially in the Southwest region which increased from 1,315 people in 1880 to 26,260 in 1890. The accompanying table shows the comparative population increase in the Southwest, Northwest Central and Kansas.

Table 23

Population Change 1880-1890

	SOUTHWEST	NORTHWEST CENTRAL	STATE
Population 1880	1,315	141,662	996,096
Population 1890	26,260	162,612	1,428,108
Population Change 1880-1890	24,945	14,131	432,012
% Change 1880-1890	1,897%	10%	43.4%

Source: Kansas Statistical Abstract, 1970.

Several factors accounted for this rapid growth of population during the period. The development of transportation was one of the reasons for the late settlement of the Great Plains Proper. Rapid expansion of railroads offered cheap transportation for farm products, thus reducing marketing costs to the

pioneer cultivators. This was an impetus to further expand farm acreages. Besides, the railroad promoters contributed to rapid settlement of this region in other indirect ways. They offered cheap land to farmers along the railroads already constructed, for in this region the rails preceded settlements. In addition, free transportation was offered to willing settlers. But perhaps most important was the promoters propaganda. The drought of the 1870's was succeeded by years of above average rainfall in the 1880's. The moderately wet soil further amplified belief in the success of dry farming practices. To attract agricultural settlers, railroad promoters propagated the theory of major climatic change in this semi-arid region, and that the region would be blessed with increased precipitation.[7] Early irrigation schemes were abandoned as one year of wetness was succeeded by another.

The 1880's also witnessed the widespread adoption of mechanized farming. Land was offered cheaply. Climate was favorable. Demands for wheat and corn and general field crops were high. The bid to produce more crops in order to meet market demand further gave incentive to expansion of farm acreages, and application of agricultural machinery.

Western Kansas' chief problem was water. The demand for water was partially met by the introduction of wind mills and the appearance of specialized well drillers.[8] The region has

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[7]Schoewe, op. cit., p. 176.

[8]Kraezel, op. cit., p. 131.

expansive fertile soils underlain by rich acquifers. The drilled wells serves for both domestic consumption of water and for early irrigation application.

The increased farm yields resulting from years of plentiful rainfall, cheap land offers, the rapid expansion of railway transportation, improvement in agricultural machinery, high prices and stable economic returns from farming investments, and the exploitation of ground water were the combination of factors that made Western Kansas attractive to settlers coming from the eastern states, already pressed by competition to seek new opportunities on the frontier.[9] By 1890, all tracts of land in Western Kansas had been claimed.

Villages and towns grew rapidly until 1889. In Meade County, the first building was registered on May 20, 1885. By August of the same year there were already 139 buildings with 500 people. Garden City in Finney County rose from 600 people in 1885 to 5,000 in 1886 and 8,000 in 1888.[10]

Climatic change was not alone in the trail of calamities. Railway mania and the consequent over-investment of capital led to a fall in market prices, and when projected railroads failed the impact was first received by the farmers. The combined tragedies of drought and falling market prices for agricultural products led to a massive exodus of people from Western Kansas. Clark relates:

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[9]Carroll D. Clark, People of Kansas: A Demographic and Sociological Study. (Topeka, Kansas: Kansas State Planning Board, 1936), p. 7.

[10]Paul W. Ziekefoose, Population and the Labor Force: Economic Development in Southwestern Kansas. (Lawrence, Kansas: University of Kansas, 1953), p. 8.

> To erect crude shelters and begin cultivation was relatively easy. But to establish agriculture on a basis sufficiently secured to withstand drought and market slumps, required decades of dogged endeavor. . . . The invasion of the territory (Western Kansas) was marked by many tragic failures, and following certain disastrous years, wholesale retreats.[11]

Between 1889 and 1900, counties which grew a hundred fold in the previous decade were left with less than half their population at the turn. Grant county with a population of 1,308 in 1890, was left with only 422 in 1900 while the population of Stanton county was reduced from 1,031 to 327 for the same period. The Southwestern counties as a whole decreased from 26,260 people in 1890 to 16,150 in 1900, a percentage loss of 38.5%. On the other hand, the Northwest Central registered a 4.4% increase in population for the same period.

Population became stable again with the return of rain in the late 1890's. World War I created a demand for agricultural goods and this again, coupled with favorable wet weather, revived settlements which grew steadily until the 1930's when more severe drought years struck the land and people.

Population Change 1930-1940

The post-world war agricultural boom and good years of rain came to an abrupt end in 1930. The 1930's saw one of the most prolonged droughts since cultivation began in the Great Plains. All years during this period registered below mean average rainfall. Drought periods are difficult years as

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[11]Clark, op. cit., pp. 24-26.

Brannan notes:

> Nowhere in the United States has climate influenced the patterns of settlement and agriculture more definitely than in this broad region. It has determined the location of settlement, restricted the number of people that the region as a whole can support, and has been primarily responsible for the introduction of irrigation into the nation's agriculture.[12]

In Western Kansas drought periods are almost invariably followed by depopulation. But the depopulation which resulted from the drought of the 1930's had no parallel in this century. 1930 marked the peak of population growth for most of the Great Plains states. Since then there have been persistent population declines, particularly in the regions depending mainly upon agriculture.

Not only was there scarcity of rainfall between 1930 and 1940, The world wide economic depression which followed the devaluation of the gold standard in 1929, sent the prices of goods to a record low. In the immediate post-war booms, farmers had mortgaged their farms for expansion in investment. The financial collapse of the period was most felt by the farmers, who were unable to obtain high prices for their products when they attempted to increase their income by further increased production; a "self-generating depression."[13]

The economic situation of the time has been described by Clark as follows:

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[12]U.S. Dept. of Agriculture, Irrigation Agriculture in the West, U.S. Dept. of Agriculture Publication No. 670, 1948, p. 12.

[13]Kraezel, op. cit., p. 149.

> Today the problems which tax the understanding and try the patience of the Kansas farmer or small business proprietor are: the intransient land on the half-arid fringe of settlement, the baffling problems of destructively low market prices and ruinously high cost of credit, freight haul, and other instrumentalities of production. The small proprietor whose business represents a life-time of painstaking effort and drift, finds his whole investment threatened by new competitive forces, depopulation of his trade territory and rising overhead costs such as taxation. Neither the wage earner nor the white collar worker, descendents of pioneers who sought Kansas as the land of opportunity, are able to escape these problems of changing social and economic environment.[14]

Prolonged droughts are generally attended by dust bowls in the Western part of Kansas. Beginning in 1934, the dust bowl continued until 1937, and farmers became helpless. People migrated in search of means for sustenance. Table 24 shows the magnitude of population change in the regions and the state between 1900 and 1940.

Table 24

Population Change Between 1900 and 1940

	SOUTHWEST	NORTHWEST CENTRAL	STATE
1900	1,650	162,612	1,470,495
1930	67,117	170,112	1,880,999
1940	53,370	154,956	1,801,028
Percentage Change			
1900-1930	3967.7%	4.6%	27.9%
1930-1940	- 20.5%	- 8.9%	- 4.3%

Source: Kansas Statistical Abstract, 1970.

[14] Clark, op. cit., p. 2.

In some counties less than half of the 1930 population remained when the 1940 census was taken. In the Southwest all the counties suffered substantial population losses, ranging from -4.3% in Greeley County to 46.6% in Morton County, while the region registered a total loss of -20.5%. But the Northwest Central lost only 8.9%, with only two counties recording losses above 20% for the period.

Population Change in 1940-1970

The 1940's were good years of normal or above average rainfall. Farmers reaped successful harvests until 1951 when floods destroyed crops. Between 1952 and 1956 there was another drought which created a dust storm. In addition to favorable weather, other factors also led to the prosperity of the 1940's. The post World War II period created large demands for farm products. Following the cessation of the war, and the restoration of the gold standard, prices of commodities soared high. Farmers reaped good harvests and were able to recuperate from the losses of the past decade.

The introduction of hybrid grains, especially corn, wheat and sorghum also led to higher yields per acre return for these crops. They in turn require proper application and adequate water to obtain maximum yields, which were provided especially in the Southwest by the development of irrigation which ensured adequate water supply. Following the wide scale application of irrigation in the Southwest, there arose a marked difference in farming systems between the two regions since the 1940's. Irrigation farming rapidly developed in the Southwest

region whereas in the Northwest Central development of irrigation has been negligible.

Another factor which contributed to agricultural prospertity was the development and expansion of motor transportation since the end of the second world war. The short distance services, geographical wide and intensive coverage, and small units of operation by trucks are advantages over the railway transportation system. For perishable farming products, short distances are better served by motor transportation.

From Table 25 presenting the population change in Western Kansas, the following points could be observed. While both regions suffered heavy population losses from 1930 to 1940, since the 1940's, the Southwest has had steady population increases in each census decade. The Northwest Central had a persistent population decline since 1930.

Table 25

Population Change 1930-1970

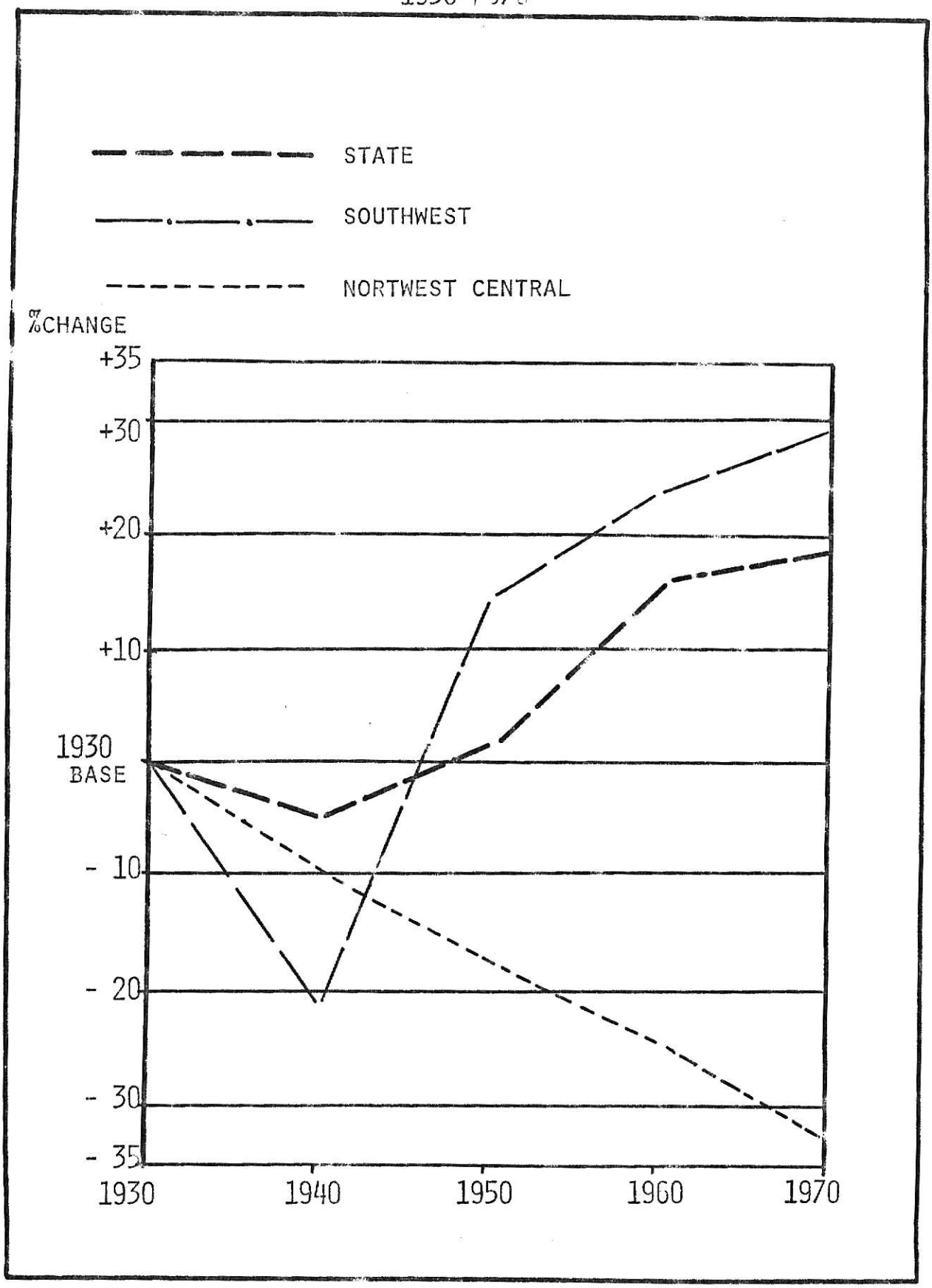
	SOUTHWEST	NORTHWEST CENTRAL	STATE
Total 1930	67,117	170,112	1,880,999
Total 1940	53,370	154,956	1,801,028
Total 1970	83,095	121,593	2,249,071
% Change 1930-1940	- 20.5	- 8.9	4.3
% Change 1940-1950	+ 34.7	- 8.2	+ 14.5
% Change 1950-1960	+ 9.5	- 6.2	+ 14.3
% Change 1960-1970	+ 4.6	- 8.5	+ 3.2
% Change 1930-1970	+ 23.8	- 28.5	+ 19.6
% Change 1940-1970	+ 55.7	- 21.5	+ 24.9

Source: Data compiled from National Census, U.S. Dept. of Commerce, Bureau of the Census, 1940-1970.

The Southwest region has not only regained the losses of 1930-1940, but has also risen substantially above the 1930 base. On the other hand the Northwest Central has not only had a persistent decline in each census decade, but the 1970 population was also much less than the 1930 base. Figure 6 illustrates the comparative population between 1930 and 1970 in the Southwest, the Northwest Central and the state. It will be seen that the Southwest population has increased even faster than the state.

Fig. 6

THE MAGNITUDE OF POPULATION CHANGE IN WESTERN KANSAS AND STATE 1930-1970



SOURCE: Compiled by the author based on data from U.S. Bureau of Census, U.S. Census of Population 1940-1970

Chapter VI

SOCIO-DEMOGRAPHIC ANALYSIS

Regions depending upon agriculture for their economic base have had unemployment problems since the beginning of this century. In many places this has resulted in a rural exodus and depopulation. Farm income has grown less rapidly than incomes from manufacturing and other tertiary activities. Reasons for inadequate rural employment include mechanization and increasing cost of farm operations, and the comparative low return from farm investments. In a semi-arid region with climatic hazards as in Western Kansas, irrigation practices have become the only sure means of successful harvests, intensive farming with economics of scale from investment, and above all, the stability of income. Irrigation facilitates higher yields per acre and per farm income. Where these possibilities exist, the rate of out-migration and depopulation have been stemmed to an extent. Where the potentials have not been developed to ensure stable income from agriculture, out-migration and depopulation persist on a large scale.

The depopulation in the Great Plains since the 1930's has posed problems to rural communities. Manpower needs to develop the natural resources of the communities have

declined:

> Many rural towns and villages that once flourished with small business or railroad centers or trade centers are now merely aggregations of low marginal operations—grocery stores, filling stations, eating places and garages. Poverty and unemployment are now ingrained.[1]

The adverse socio-economic effects of declining population are well discussed in social and economic literature. Population, per se, may not indicate a viable economy. Its growth or decline, however, reflects the employment opportunities which are available in the community. People tend to locate where employment opportunities are easily attainable[2] and tenure ensured.

This chapter discusses the spatial or an areal association between the steady population growth and irrigated agricultural counties in Western Kansas.

Demographic Variables and the Magnitude of Population Change Since 1930

Components of population change. Births, deaths and migration are the three most important demographic variables, with birth and migration being the more influential. Excess of births over deaths in time, measures the natural increase, while actual growth is determined by the addition of excess births

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[1]Art Mauc and George E. Brandow, "The Rural Problem Identified," People and Income in Rural America: What are the Choices?, No. 1, p. 1.

[2]Edgar Hoover, The Location of Economic Activity. (New York: McGraw-Hill, 1948), pp. 4-5.

over deaths to net migration: $P_{t_2} = P_{t_1} + (B - D)+(I - E)$. Population decline may be characterized by the excess of deaths over births, excess emigration over immigration, or the combination of both processes. The opposite is the case for population growth.

Table 26 shows the situation of the demographic variables in the study region from 1960 to 1970. Crude birth rate and natural increase were higher in the Southwest than in the Northwest Central. Crude death rate and net-migration were lower in the Southwest than in the Northwest Central. The interplay of these components of demographic variables were reflected in the net population change for the period measured. The Southwest population increased by a total of 3,674 persons while the Northwest Central lost a total of 11,228 (8.5%). The following points could be observed from the table. First, the higher crude birth rate in the Southwest reflects a population with youthful reproduction age, a potential source for further population growth. Second, the higher death rate for the Northwest Central reflects the preponderence of post reproductive age, symptomatic of a static or declining population. Third, the higher percentage of migration reflects the declining economic base, rural unemployment and the exodus of people to other centers of economic activity. These parameters are discussed more fully in the subsequent portions of this chapter.

Irrigation and migration. Both regions show losses of population through out-migration, but it could be observed that the rate for the Southwest is comparatively lower. One reason for this is farm income.

Table 26

Demographic Variables 1960-1970[a]

	SOUTHWEST	NORTHWEST CENTRAL
Population 1960	79,421	132,821
Population 1970	83,095	121,593
Total Births	19,181	23,142
Crude Birth Rate	230.8	190.3
Total Deaths	7,049	16,392
Crude Death Rate	85	135
Natural Increase	12,132	6,750
% Natural Increase	15.3	5.1
Net In-Migration[b]	- 8,458	- 17,978
%	- 10.6	- 13.5
Net Population Change	+ 3,674	- 11,228
% Population Change	+ 4.6	- 8.5

Sources: (a) Compiled by author from Annual Summary of Vital Statistics, Kansas State Department of Health, Division of Registration and Health Statistics, 1960-1970.

(b) Kansas State Statistical Abstract, 1970-71.

52.4% of the farms in the Northwest Central earned less than $10,000 in 1970, while only 7.1% earned above $40,000. The corresponding figures for the Southwest were 36.6% and 24.7% respectively.

Table 27

Farm Income Distribution and Per Capita Farm Income in 1970

	SOUTHWEST	NORTHWEST CENTRAL
Farm Income over $40,000	24.7%	7.1%
$20,000-$39,999	19.1%	16.1%
$10,000-$19,999	19.1%	24.4%
Less than $10,000	36.6%	52.4%
Per Capita Farm Income	$3,434	$2,015

Source: Computed from Data of the U.S. Dept. of Commerce, U.S. Bureau of Census, Census of Kansas Agriculture, 1970.

Successful farming in the U.S. rural economy has been categorized as those with farm income above $10,000.[3] Judging by this criteria, over 52% of the Northwest Central farmers were below the poverty level, a situation which encourages out-migration. This helps to understand the higher out-migration from the counties in the Northwest Central. People tend to shift from agriculture to other more gainful employments elsewhere in response to the push and pull effects of the agricultural

[3] Mauc, loc. cit.

economy, where farm incomes are not only low but also unstable. A large proportion of the youth population, with little hope of future entrance into gainful employment within the agricultural sector, are therefore pushed to migrate. In the Southwest the high level application of irrigation agriculture has enabled the counties to obtain a comparatively higher farm income and thus are able to sustain steady population growth, whereas in the Northwest Central the counties suffer persistent population decline.

The net increase in farm income attributable to irrigation in 1970 has been considered in Chapter IV. The irrigation of wheat and sorghum in the Southwest yielded a net increase of $28,273,820 over the equivalent of non-irrigated acreage. The net increase for the Northwest Central was $1,611,020. Assuming these gains and the overall multiplier effects in the irrigation interrelated services, there would be more employment opportunities and higher incomes in the irrigated counties. The correlation between irrigation and these variables are shown by the results from Spearman's Rank Correlation Test in Table 28 .

On the county ranking we can observe the strong correlation between irrigation and the various income parameters. The weak correlation in the regions is explainable in terms of a high level of homogenuity which exists among the counties within each region. The Southwest counties are highly irrigated. The Northwest Central counties are minutely irrigated. The interpretation of this is that the Southwest counties have

Table 28

Irrigation and Income Variables

	COUNTIES	SOUTHWEST	NORTHWEST CENTRAL
Per Farm Income	.8239	.7250	- .2642
Per Capita Farm Income	.6582	.4358	- .1321
Per Acre Value	.9473	.8643	.6340
Field Crops Income	.8699	.6840	.3072
Livestock Income	.5751	.7804	- .2283
Per Capita Income	.6497	.0697	.2742
Median Family Income	.7707	.2429	- .2839
Mean Family Income	.7460	.2768	.1143
Assessed Valuation of Property	.5601	.0732	- .4107
Net Effective Buying Income	.5844	.0822	- .3446

Source: Computed from data in Kansas Statistical Abstract, 1971, U.S. Bureau of Census, Census of Agriculture, 1940, 1945, 1950, 1955, 1959, 1964, 1969.

higher incomes in comparison to the Northwest Central with almost uniformly low incomes.

The argument is that the higher incomes in the Southwest region are largely attributable to irrigation. These incomes in turn influence the employment opportunities in the tertiary sectors, which explains the relatively lower rate of out-migration. This is shown in the following table by the percentage change in employment between the Southwest and the Northwest Central.

Table 29

Percentage Change in Employment 1965-1970*

	SOUTHWEST	NORTHWEST CENTRAL
Persons Employed 1965	14,204	18,565
Persons Employed 1970	16,766	20,168
% Increase 1965-1970	18.03%	8.63%

* Figures exclude Government employees and self-employed persons.

Source: U.S. Dept. of Commerce, County Business Patterns, 1965, 1970.

The effects of these higher incomes in the Southwest are further expressed in the percentage change in wholesale and retail transactions, and units of occupied dwellings. Wholesale establishments increased by 24.3% between 1954 and 1963 in the Southwest, but in the Northwest Central there was a decrease of -9.1% for the same period. The Southwest registered an increase of 7.2% in retail establishments between 1954 and 1967,

whereas the Northwest Central experienced a decrease of -10.3%. Similarly, the units of occupied dwellings increased by 37.4% between 1950 and 1970 in the Southwest; in the Northwest Central there was only an increase of 5.4%.

Table 30

Changes in Wholesale and Retail Establishments

YEARS	SOUTHWEST	NORTHWEST CENTRAL
Wholesale Establishment 1954	251	499
Wholesale Establishment 1963	312	454
% Change 1954-1963	+ 24.3%	- 9.1%
Retail Establishment 1954	1,080	2,147
Retail Establishment 1967	1,158	1,925
% Change 1954-1967	+ 7.2%	-10.3%
Occupied Dwellings 1950	20,643	43,583
Occupied Dwellings 1970	28,422	45,949
% Change 1950-1970	+ 37.4%	+ 5.4%

Source: Kansas Statistical Abstract, 1965-1971.

The effects of gainful employment and guaranteed income are to lessen the rate of out-migration. This would further ensure a much higher proportion of youth for the population. This is so because migration is selective of age. Persons between the ages of 15 and 49 years are more prone to migration than persons over 50 years. Demographically and economically the potential migrants are also the most reproductive age. The migration of this age group would mean the removal of population

replacement sources for the future. Recent trends in the demographic movement of the Northwest Central shows that certain counties are experiencing negative natural population increase.[4] The counties included Smith, Jewell, Ottawa and Lincoln. No county in the Southwest experienced negative increase.

Age Distribution

The long term effects of migration upon the population structure is revealed in Table 31, which gives the age distribution in the study regions, from 1950-1970. The proportions of persons under 18 years in the Southwest were higher than both the Northwest Central and the state for the period. Thus, apart from the relatively lower rate of out-migration in the Southwest, the above national average of persons under 18 years reflects potential population momentum[5] for future replacement and sustenance of steady population growth.

At the other end of the age continuum is the preponderence of aged in the Northwest Central. The demographic implications are further elaborated by computing the dependency ratio.

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[4] Negative natural population increase is a situation where there is excess death over birth for a given period. The population may still register growth for the same period by excess in-migration over out-migration. However, negative natural population increase in a region of heavy out-migration is a very critical situation, and symptomatic of persistent future decline.

[5] Population momentum is used to express the reservoir of youth that would enter into the reproductive age group in the immediate or distant future. A high proportion of the population in the ages 1-18 years provides population momentum for the next 35 years. Thus even if birth rate is reduced in a population, the fact that a sizeable proportion enters into the reproductive group would keep the population to register high growth rates.

Table 31

Age Distribution 1950-1970

		Southwest	Northwest Central	State
	Under 18 years	36.5%	32.2%	30.4%
1950	18 - 64 years	57.6%	56.5%	59.4%
	Over 65 years	5.9%	11.3%	10.2%
	Under 18 years	40.8%	34.9%	35.4%
1960	18 - 64 years	51.6%	50.6%	54.6%
	Over 65 years	7.7%	14.4%	11.0%
	Under 18 years	37.7%	31.9%	32.2%
1970	18 - 64 years	52.7%	50.5%	54.9%
	Over 65 years	9.6%	17.6%	11.8%
Dependency Ratio 1970				
	General	89.5%	98.5%	82.1%
	Aged	18.2%	35.6%	21.6%

Source: Data for states compiled from the National Census, U.S. Department of Commerce, Bureau of Census, 1950, 1960, and 1970.

The age dependency ratio for the Northwest Central is almost two times that of the Southwest, which is also lower than the national average. The general dependency ratio is higher for both of the study regions than in the state as a whole. The relatively high ratio in the Southwest reflects not the age, but the larger proportion of youth under 18 years.

Another way to consider the structure of population and to estimate future decline of growth, is to measure the median age.

Table 32

Median Years 1950-1970

YEARS	SOUTHWEST	NORTHWEST CENTRAL	STATE
1950	26.1	31.7	31.1
1960	26.7	33.7	29.9
1970	28.7	36.5	28.7

Source: U.S. Bureau of Census Population 1950, 1960, 1970.

The median year is the age point below which represents one half of the population and above which represents the other half. Thus in the Southwest, about 50% of the population is below 29 years. In the Northwest Central the equivalent is 36.5. This implies that over 50% of the population are approaching or past their reproductive age, which also indicates a static population now and in the future. To test the validity of these assumptions, correlation tests were made between irrigation and the various demographic parameters. The results given on Table 33

Table 33a

Irrigation and Socio-Demographic Variables

	COUNTIES	SOUTHWEST	NORTHWEST CENTRAL
Median Age	.7564	.7465	- .0312
Mean Age of Farmers	.8276	.7617	. 475
% Migrant	.7589	.7322	.1965
Migration Ratio	.7640	.7340	.0911
Fertility Ratio	.7170	.6923	.1277
Dependency Ratio	.7646	.6474	.2142

Table 33b

Farm Incomes and Socio-Demographic Variables

	COUNTIES	SOUTHWEST	NORTHWEST CENTRAL
Population Change 1940-1970	.7652	.5021	.1648
Median Years	.7213	.5161	- .1169
Mean Age of Farmers	.7449	.4262	.0221
% Migrant	.7066	.4375	- .3535
Migration Ratio	.7384	.4965	.1715
Fertility Ratio	.7276	.6518	- .0508

Table 33c

Migration, Median Years and Fertility Ratio

	COUNTIES	SOUTHWEST	NORTHWEST CENTRAL
Migration Ratio/ Fertility Ratio	.7806	.7099	- .0929
Median Years/ Fertility Ratio	.7697	.8456	.5590

show high correlations between irrigation and steady population growth. A lower rate of migration sustains a higher proportion of the reproductive age group, as shown by the youth under 18 years and median year in the Southwest. Of importance is the correlation between median year and fertility ratio.[6] Table 35 shows the lower median age for the Southwest corresponding with a higher fertility ratio. The lower the median age the higher the proportion of reproductive persons in the population set, and for the Southwest this ensures a long term steady population growth, as long as irrigation will continue to maintain stable and sizeable farm income.

Fig. 7 is a graphic illustration of the association between irrigation development and population movements in time and space, in these study regions. Before 1940, there were very few irrigated lands in these regions. Although the Southwest had a little development before 1940, its effect was little felt until large areas were brought under irrigation. Since the 1940's, steady population growth has gone along the same trend with rapid irrigation development in the Southwest. It is generalized that the link here is the net incremented economic returns of higher farm income and the employment opportunities which are attendant upon irrigation. The persistent population decline through out-migration in the Northwest Central reflects the lower farm incomes and inadequate employment, which

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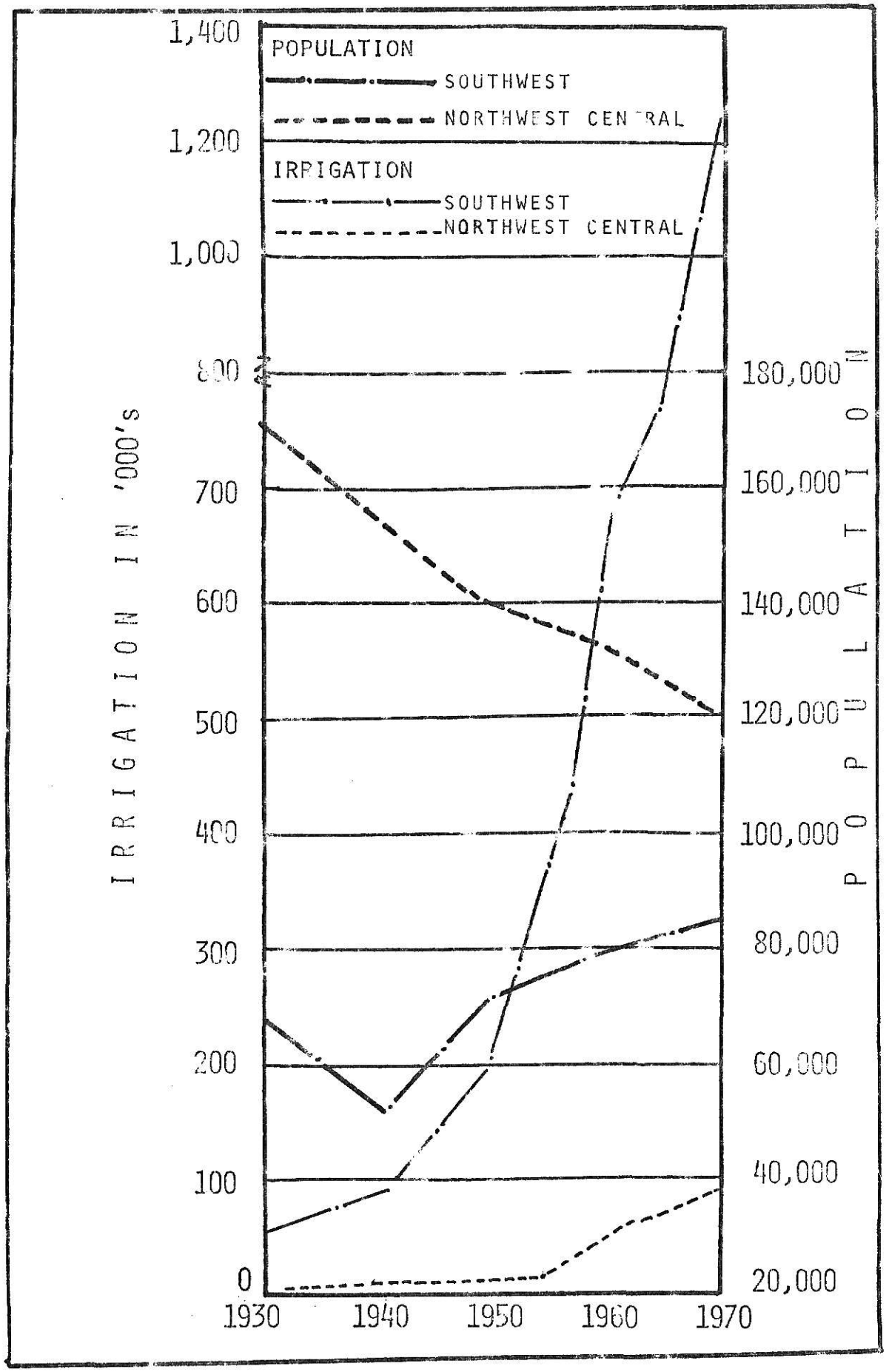
[6] Fertility ratio is the number of births that occur in a year per 1,000 women of childbearing age. The difference with the ordinary crude birth rate is that only women exposed to childbearing are used as the denominator for computation.

Fig 7

IRRIGATION AND POPULATION TRENDS IN WESTERN KANSAS, 1930 - 1970



SOURCE: Compiled by the author based on data from the Bureau of Census, U.S. Census of Population, 1940-70

encourages disillusionment in persons to migrate. Table 34 shows these correlations.

Table 34

Irrigation and Population Changes 1930-1970

	COUNTIES	SOUTHWEST	NORTHWEST CENTRAL
1930-1940	.0317	.1992	.1429
1940-1950	.8066	.7715	.1089
1950-1960	.7843	.7322	-.1285
1960-1970	.8625	.8170	.6170
1940-1970	.9045	.5677	.2134

Source: Computed from data based on U.S. Census of Population and Agriculture, and Kansas Statistical Abstract 1970-71.

The spatial association between population change and irrigation was very weak between 1930 and 1940. But from thence, the association became stronger. This is evidenced in the Southwest where the population growth has gone along with irrigation development since the 1940's. From Table 35 presenting the county population change in 1930 to 1970, four patterns can be identified: (a) counties which have never had population decline since 1930; (b) counties which had population losses between 1930 and 1940, but have since then gained during each census decade; (c) counties with population losses from 1930-1940 and have had steady growth since 1940, but have not increased their 1930 base; and (d) counties with persistent population decline for each decade since 1930.

Table 35

County Population Change 1930-1970

	1930-1940	1940-1970	1930-1970
	%	%	%
SOUTHWEST			
Finney	- 8.4	+88.6	+72.7
Grant	-37.1	+206.3	+97.7
Gray	-23.2	- 8.2	-27.2
Greeley	- 4.3	+ 11.1	+ 6.2
Hamilton	-20.5	+ 3.9	-17.4
Haskell	-25.6	+ 75.9	+30.9
Kearney	-21.0	+ 20.7	- 4.6
Lane	-16.3	- 4.1	-19.7
Meade	-19.5	- 11.1	-28.3
Morton	-46.6	+ 63.6	-12.6
Scott	- 5.1	+ 48.6	+40.9
Seward	-19.0	+140.7	+94.9
Stanton	-33.0	+ 58.5	+ 6.2
Stevens	-31.4	+ 68.5	- 9.8
Wichita	-15.3	+ 50.0	+26.9
NORTHWEST CENTRAL			
Cloud	- 4.2	- 21.9	-25.2
Ellis	+10.1	+ 41.3	+55.4
Gove	-15.1	- 17.8	-30.1
Graham	-21.9	- 31.6	-38.8
Jewell	-17.2	- 49.7	-57.8
Lincoln	-14.1	- 45.1	-52.7
Mitchell	-11.2	- 29.4	-37.8
Norton	-16.0	- 26.0	-37.7
Osborne	-15.0	- 34.8	-44.5
Ottawa	- 6.1	- 33.0	-37.7
Phillips	-14.2	- 24.4	-35.1
Rooks	-10.9	- 10.2	-19.9
Russell	-21.9	- 30.0	-14.6
Smith	-21.9	- 36.2	-50.1
Trego	-10.0	- 23.8	-31.4
SOUTHWEST	-20.5	+ 55.9	+23.8
NORTHWEST CENTRAL	- 8.9	- 21.5	-28.5
STATE	- 4.3	+ 24.9	+19.6
UNITED STATES	+ 7.3	+ 54.9	+66.2

Source: Data compiled from National Census, U.S. Dept. of Commerce, Bureau of the Census, 1940-1970.

In the Northwest Central where irrigation development is negligible, all the counties, with the exception of Ellis county, have had persistent decline in population since the period under review. In the Southwest, only three counties, Meade, Gray and Lane, declined between 1940 and 1970. Meade and Lane were among the four least irrigated in the Southwest by 1970. For the same 1970, five counties which irrigated over 100,000 acres each in Kansas state, had a combined population increase of 15.8% between 1960 and 1970, as against state population of only 3.2%.[7] These five counties are in the Southwest and include Finney, Grant, Haskell, Wichita and Scott. These spatial correlations between irrigation and population growth are further illustrated in Figure 8.

Of all the demographic variables accountable for population increase or decline, migration is the most important in Western Kansas. It influences the population directly by reducing the aggregate number of people. It reduces the proportion of the reproductive age group, thereby indirectly influencing the fertility and birth rate and the preponderence of the non-reproductive age groups. These factors have led to the persistent population decline in the Northwest Central, which is likely to continue until gainful employment opportunities are obtained. An agricultural economy in a semi-arid region that suffers both rainfall deficiency and variability cannot hope

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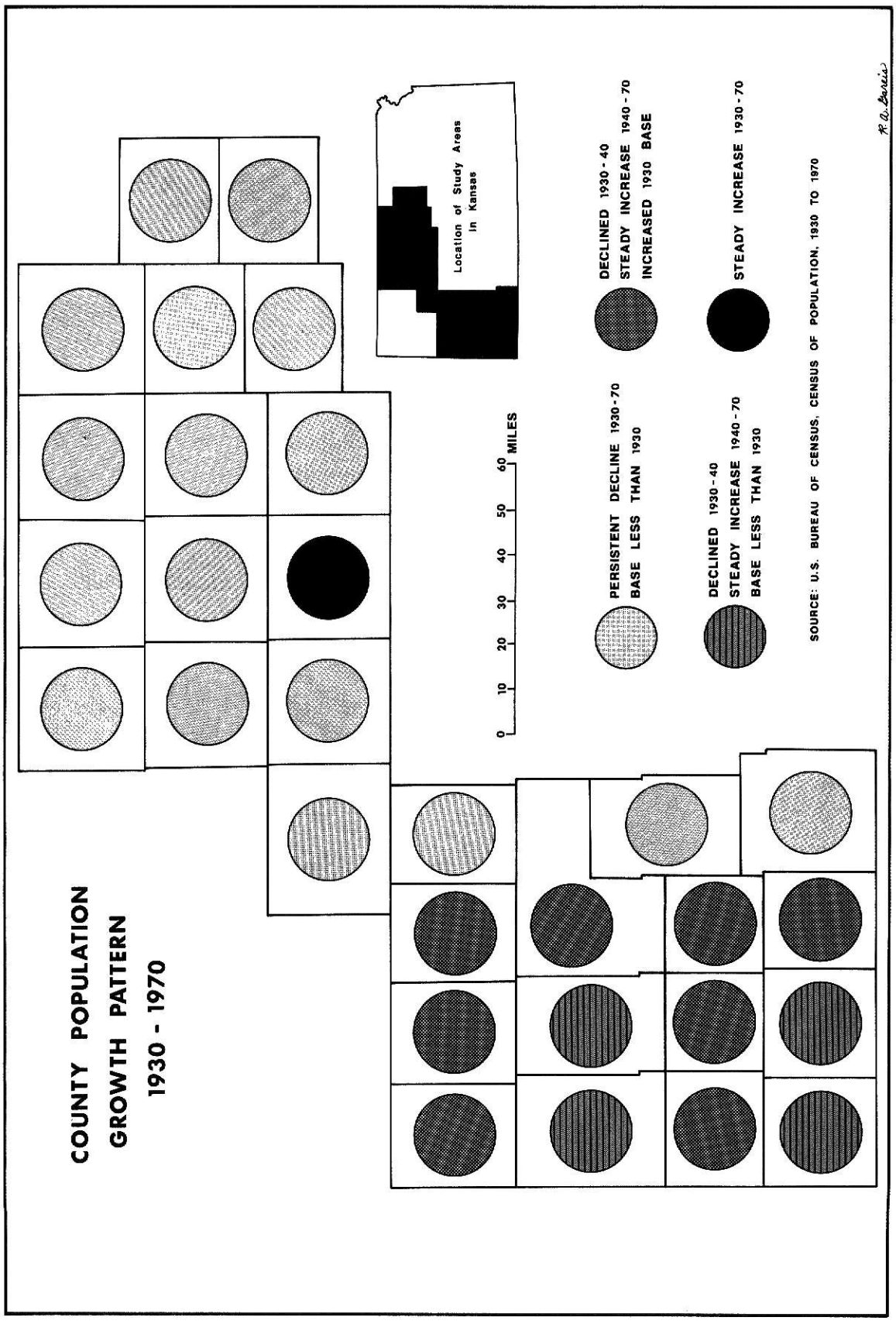
[7]Huber Self, Irrigation Farming in Kansas, Vol. 74, Nos. 3 and 4. (Transactions of the Kansas Academy of Science, 1971), p. 317.

Fig. 8


COUNTY POPULATION
GROWTH PATTERN
1930 - 1970
Location of Study Areas
in Kansas
0 10 20 30 40 50 60 MILES
PERSISTENT DECLINE 1930-70
BASE LESS THAN 1930
DECLINED 1930-40
STEADY INCREASE 1940-70
BASE LESS THAN 1930
DECLINED 1930-40
STEADY INCREASE 1940-70
INCREASED 1930 BASE
STEADY INCREASE 1930-70
SOURCE: U.S. BUREAU OF CENSUS, CENSUS OF POPULATION, 1930 TO 1970

to stabilize the farm income and steady population growth without irrigation. If the farm income and the related impacts of irrigation are provided in the Northwest Central, the present higher rate of out-migration may be reversed. As has been noted by Self:

> Where irrigation is practiced, more farm workers are required to attend the land; thus, irrigation is helping to stabilize the farm population. Where irrigation is practiced productivity increases, farm income increases, the economy expands and the risk of crop failure due to droughts is lessened.[8]

In the Southwest the advantages and economic gains of irrigation have stabilized the farm income and hence the relatively low out-migration, leaving the population with a sizeable reproductive age group to sustain a steady growth. But to hold on to this position, irrigation will have to be maintained while development would be required to provide job opportunities for the new entrants.

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[8]Huber Self, Irrigation Farming in Kansas, op. cit., p. 317

Chapter VII

SUMMARY AND CONCLUSIONS

This thesis has considered the major implications of irrigation practices on the demographic trends of Western Kansas since the 1940's. Western Kansas depends upon agriculture for a substantial source of income and employment.

Located in the center of the continent, the study region forms part of the eastern portion of the Great Plains, which is climatically characterized by rainfall variability and semi-aridity. This region was not settled until the 1880's because of the unfavorable natural conditions for the agricultural settlers. The unpredictable climatic variability, often in the form of prolonged drought years, has resulted in agricultural crop failures and fluctuation in farm incomes and employment. The demunition of the income base and the consequent disillusionment of the agricultural rural community have found expressions in migration and depopulation of many towns and villages.

The review of demographic trends in Western Kansas revealed that the population of the regions had always fluctuated with good years of rainfall marking rapid growth and drought years initiating an exodus from the agricultural settlements. It was shown that the 1880's were favorable rainy years, which witnessed the most rapid population growth. The

succeeding years of the 1890's were periods of intermitent droughts which equally witnesses the highest record of depopulation within the shortest time record. The droughts of the 1930's initiated migration and depopulation in the Great Plains, a trend which persists in most counties into contemporary times.

It was on this background that this thesis distinguishes counties in Southwestern Kansas as exceptionally different from other counties in this region. While the other counties in the Northwest Central are still experiencing rapid depopulation, these counties in the Southwest have steady population growth for each census decade.

Investigations revealed that irrigation practices which are most intensive in the Southwest, have led to increased crop yields and farm incomes, particularly since the 1940's. Until this period, when irrigation was less developed in Western Kansas, both regions fluctuated in demographic trends in times of good years and drought years respectively. This observation can be strengthened if we recall that between 1930 and 1940 the Southwest counties suffered population losses of 20.5% while the Northwest Central lost only 8.2%.

Since the 1940's the application of irrigation has received added impetus both from the economic depression of the 1930's and the realization of the direct and indirect gains from irrigated agriculture. The limiting factors in the development are availability of water and capital. The Southwest is well endowed with rich acquifers in larger reserve quantities than the Northwest Central. Between 1940 and 1970 the rapid development and expansion of irrigation agriculture,

which took place in Kansas, were concentrated in the Southwest counties. With only 14.5% and 3.9% of Kansas land area and population respectively, the Southwest possessed 64.8% of all irrigated cropland in Kansas in 1970. The Northwest with 15.7% of the land and 5.4% of the population of Kansas had only 4.6% of the irrigated crop lands.

The impacts of irrigation find expression in the socio- economic well-being and socio-demographic behaviors of the agricultural community. Irrigation is the most important factor which influences the yields and income from farms in Western Kansas. Observed differences in economic, social and demographic parameters between the Southwest, characterized by irrigated agriculture, and the Northwest Central, characterized by dry farming, were subjected to statistical tests. All measurements show strong spatial correlations between intensity of irrigated agriculture and specific socio-demographic trends. The steady population growth in the Southwest counties correlates with the region's high density of irrigation. It has the higher concentration of youth under 18 years, the lower median age, lower death rate, higher birth rate and fertility ratio, and lower general dependency ratio.

In both regions this study shows that there were out-migrations exceeding in-migrations. This is one of the problems facing the Great Plains counties, and may be attributed to frustration from the declining economic base and enemployment situation. However, on a comparative basis, out-migration losses were lower in the Southwest than in the Northwest Central. Between 1950 and 1960, the Northwest Central suffered a net

migration loss of 21.2%. The Southwest lost only 10.4%. Between 1960 and 1970, the Northwest Central lost 19.5% by net migration. The Southwest lost only 8.9%.

Between 1950 and 1960 and 1960 and 1970, the Southwest had the natural population increase of 21.3% and 15.3% respectively. For the same period the Northwest Central had only 12.2% and 5.5% respectively. The higher rate of natural increase in the Southwest is a direct influence of lower out-migration rate. It had already been stated that migration is selective of age, the highest migrants being the reproductive age group. For the Southwest, the lower migration rate, the larger proportion of youth, and the low median age and fertility ratio would mean a brighter future for population replacement. The higher natural increase would create a population momentum to sustain a long term growth in the Southwest. In the Northwest Central, population would continue to decrease through migration, and likely there would be a negative natural increase.

As already indicated, these demographic implications of irrigation are indirect. Direct effects are on yields and stable farm incomes. Tests of irrigation and farm incomes show strong correlations, as would be expected. Farm income and other socio-economic and socio-demographic parameters were equally tested. These include per capita personal income, net effective buying income, assessed valuation of property, wholesale and retail establishments, all of which showed positive high correlation with the region's population trend since 1940, particularly when all counties were ranked, irrespective of the

regions.

Conclusion

The review of physical factors in both regions revealed that there were no significant differences in climate and soil, the principle components of agriculture. Measurement of crop yields under irrigation in both regions equally revealed that there were no significant differences. It is thereby assumed that if irrigation potentials were equally developed in the Northwest Central as in the Southwest, crop yields and farm income would compare favorably. Increased income would lessen the push and pull factors of out-migration. A reduced out-migration will ensure the concentration of a large proportion of migrants who, by the selective nature of migration, are generally in the reproductive age group. Rates of natural increase resulting from the high birth rate and fertility ratio would create a large population momentum age group of persons under 18 years, serving as future reservoirs of growth, and the reverse of the persistent population decline.

While this thesis does not account for causal relationships between irrigation and population growth, this is inferred from the long term direct effects of irrigation through the direct economic and social well-being derivable from irrigated agriculture. Besides, the thesis demonstrates the spatial correlation and association between irrigated agricultural practices and steady population growth in a broader region characterized by unabated migration and depopulation since the 1930's. The Southwest and the Northwest Central are

in the same geographical region, and all depend upon agriculture. The rapid development of irrigation in the Southwest since the 1940's and the absence of it in the Northwest Central constitutes the major variable which influences their demographic trends.

Irrigation agriculture may not be the single panacea for the economic and socio-demographic problems of depopulation in Western Kansas, but there is a great influence, by irrigated agriculture, on a sustained, viable and assured economic well-being of an agricultural community in this semi-arid region. Agriculture remains the economic base for income and employment, which determines the healthy, social atmosphere to sustain population growth. To see the influences of irrigation on demographic trends, one might hypothesize the adverse social and economic effects which would attend the reversion of the irrigated land in the Southwest to dry farming. Yields would be lowered, farm income reduced, harvests unassured, social and economic frustration would encourage out-migration. Perception of a possible area where job opportunities exist at comparable stable measures would add the pull for the already disillusioned migrant. Sooner or later depopulation would be equally initiated. This has been noted by Brannen:

> Gambling on the weather is possible in semi-arid country, but intensive agriculture must be supported by irrigation or must perish. . . . Farms that are created as a result of irrigation must be looked upon not merely as a source of security for the repayment of the costs, but as the foundation for sound agricultural operations and for prosperous and contented rural communities. The general public has a major stake in the future health and expansion of the nation's irrigation agriculture.[1]

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[1]Charles Brannen, Irrigation Agriculture in the West, pp. 12, 39.

Irrigation is already an indispensable factor in the entire social system in Western Kansas. The developed areas would continue to reap both direct and indirect gains. The underdeveloped Northwest Central may be equally prosperous if agriculture, the principal income base, is supplemented by irrigation. It was on these considerations that Harold May congratulated the role of irrigation in Kansas agriculture.

> Irrigated agriculture in Kansas has made increasing significant contributions to the state's economy. I viewed this with interest and gratification. If full use is to be made of natural resources available for agricultural development, . . . much more development of irrigation must be made. An irrigated district has not been made in the fertile areas where periodic droughts continue to take their tolls in less than maximum crops; therefore, less than maximum economic development of the area has been realized.[2]

The Northwest Central has much agricultural potentials which are yet to be fully realized if irrigation could be developed. This has been true of the Southwest. As long as the region depends upon agriculture, irrigated agriculture would be the most important factor in stabilizing the economy and population.

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[2]Harold May, Irrigated Agriculture in Kansas, (48th Biennial Report: Kansas State Board of Agriculture, 1964-1965).

BIBLIOGRAPHY

Anderson, Dale. Dimension of Future Water Resource Problems in the Northern Great Plains. Proceedings of the Agricultural Council of the Great Plains Seminar, Publication No. 54, 1971.

Bayne, Charles K. Geology and Ground Water Resources of Cloud County, Kansas. University of Kansas Publication No. 139, 1959.

Beal, Calvin. Trends in the U.S. Rural Population Development. Kansas State University Agricultural Experiment Station, 1973.

Bowden, Leonard W. Diffusion of the Decision to Irrigate. Research Paper No. 97. Chicago, Illinois: Chicago Press, 1965.

Brannen, Charles. Irrigation Agriculture In the West.

Cantor, Leonard M. A World Geography of Irrigation. New York: Praeger Publishers, 1970.

Center for Regional Studies. Kansas in the 1970's. Lawrence, Kansas: University of Kansas, 1967.

_____. Kansas Statistical Abstracts. Lawrence, Kansas: University of Kansas, 1965-1971.

Changes for Precipitation in Kansas. Kansas State University Agricultural Experiment Station, Bulletin 461, May, 1963.

Clark, Carroll. People of Kansas: A Demographic Sociological Study. Topeka, Kansas: Kansas State Planning Board, 1936.

Clark, Colin. The Economics of Irrigation. Oxford: Pergamon Press, 1970.

Copley, Josiah. Kansas and the Country Beyond. Philadelphia, 1867.

Copp, James H. Population Trends in Kansas 1940-1950. Kansas State University Agricultural Experiment Station Report No. 71, 1956.

County Irrigation Summary, 1970. A two page statistical report compiled from reports by Kansas County Agents of the Agricultural Extension Service, Kansas State University, Manhattan, Kansas.

Daicoff, Darwin. Kansas County Income 1950-1964. State of Kansas, Office of Economic Analysis, 1966.

Demonds, Leland R. Delineation of Development of Regions in Kansas. Great Plains Agricultural Council Report No. 4, 1968.

Determining Water Quality for Irrigation. Circular No. 396. Manhattan, Kansas: Kansas Cooperative Extension Service, Kansas State University, August, 1968.

Disanto, Joseph E. Some Considerations for a Population Information System in Kansas. Kansas Planning for Development Report No. 29b.

Emerson, M. Jarven. Inter-industry Structure of the Kansas Economy. Kansas Department of Economic Development, Office of Economic Analysis and Planning Division, January, 1969.

Erickson, Donald. Kansas Programs for Area Economic Development. Publication No. 48. Proceedings of Great Plains Resource Economics Committee Seminar, Denver, Colorado, October, 1968.

Farm Facts. Annual Report of the Kansas State Board of Agriculture, Topeka, Kansas, 1953-1970.

Fishel, V.C. Ground Water Levels in Observation Wells in Kansas. Lawrence, Kansas: University of Kansas Publication No. 146, 1960.

Flora, Cornelia B. Reference Tables: Population Change of Counties and Incorporated Places in Kansas, 1940-1960.

_____. Reference Tables: Population Change of Counties and Incorporated Places in Kansas, 1950-1970.

_____, Kirsten Rusholt and William Curtis. Migration in Kansas: Out Migration and Population Trends.

Flora, S.D. Climate of Kansas. Report of the Kansas State Board of Agriculture, Vol. LXVIII, No. 285, June, 1948.

Great Plains Agricultural Council. Attaining Economic Development: How the Great Plains Can Contribute to the U.S. Economy. Proceedings of the Great Plains Economic Committee Seminar, Misc. Publication No. 48, Sept. 30, 1968.

_____. Area Planning and Development in the Great Plains. Proceedings of the Great Plains Economic Committee Seminar, Misc. Publication No. 49, April 22, 1970.

Ground Water Study: A Hydrolic Study. State of Kansas Water Resources Board, Project P-43, Report No. 16c, 1967.

Hamburg, J. A Study of Factors Affecting Population Trends in Northwestern Kansas. M.A. Thesis, Kansas State University, Department of Geography, 1964.

Herpich, Russel L. Irrigated Acres Selected Years by County. Manhattan, Kansas: Kansas State University, Agricultural Extension Service, 1960.

_____. "Kansas Irrigation Spirals Upward," Kansas Farmer. Vol. 108, No. 8, April 17, 1971.

Hinton, Richard. A report on Irrigation in the U.S. for 1892. 52d Congress, 1st Session, Senate Document 41, Washington, D.C., 1892.

Hoover, Edgar. The Location of Economic Activity. New York: McGraw-Hill, 1948.

Hoover, Leo M. Kansas Agriculture After 100 Years. Agricultural Experiment Station, K.S.U. Bulletin No. 392, August, 1957.

Irrigation in Kansas. Water Resources Board, Report No. 16e, Topeka, Kansas, 1967.

Issues in Farm Policy, Great Plains Publication No. 8, 1953.

Jewett, J.M. Pleistocene Geology in Kansas. Vol. 66, No. 3. Transactions of the Kansas Academy of Science, 1963.

Kansas Agriculture. Annual Report of the Kansas State Board of Agriculture, Topeka, Kansas, 1953-1970.

Kansas Basin—Pilot Study of a Watershed, The. Lawrence, Kansas: University of Kansas Press, 1956.

Kansas Industrial Development Commission. Directory of Kansas Manufacturers and Products, 1963.

Kansas Planning for Development. Regional Review for Planning in Kansas: Region's 07 and 09, 1967.

Kansas Statistical Abstract. Lawrence, Kansas: University of Kansas, Institute for Social and Environmental Studies, 1965-1971.

Kansas Water Atlas. Project No. P-43, Report No. 16a. Topeka, Kansas: Kansas Water Resources Board, 1967.

Kansas Water Law. Project No. P-43, Report No. 16f. Topeka, Kansas: Water Resources Board.

Kansas Water Resources Research Institute. Annual Report submitted to U.S. Department of the Interior, Office of Water Resource Research, August 1, 1971.

Kraezel, Carl F. The Great Plains in Transition. University of Oklahoma, 1955.

_____. Area Development Exemplified by a 16-County Cooperation in Sparsely Populated Mountain. Proceedings of the Great Plains Seminar, Publication No. 48, 1968.

_____, and Frances H. McDonald. Some Health Care Needs in Sparsely Populated Regions. Project No. PH 108-66-33, Montanta State University, 1966.

_____. Sound Research in North American Moisture Deficit Regions. American Association for the Advance of Science, 1966.

Kneese, Allen V. Water Resources Development and Use. Federal Reserve Bank of Kansas City, 1959.

Landgren, Norman. The Role of Water in the Economic Development of the Great Plains. Proceedings of the Great Plains Agricultural Seminar, Publication No. 54, Pt. IV, 1971.

Lewis, G. Malcom. "Williams Gilpin Concept of the Great Plains Region," AAG, 66, 1966.

Major Soils of Kansas. Agricultural Experiment Station, Kansas State University, Circular 336, July, 1967.

Management Strategies in Great Plains Farming. Proceedings of a workshop held by the Great Plains Research Technical Committee, Gp. 2, Publication No. 19, 1959.

Mather, Cotton E. "The American Great Plains," AAG, Vol. 62, No. 2, 1972.

Mauc, Art and George E. Brandow. People and Income in Rural America: What Are the Choices, No. 1.

May, Harold. Irrigated Agriculture in Kansas. 48th Bienniel Report, Kansas State Board of Agriculture, 1964-1965.

McCullick, Jack. "The Economic Impact of Irrigation on Selected Southwestern Counties: An Input-Output Approach." Unpublished Doctor's dissertation, Kansas State University, Department of Economics, 1970.

McKinney, R. D. and Paul W. Barkley. Some Economic Impacts of Water Reservoir Development. Kansas Agricultural Experiment Station Report No. 106, 1965.

Moley, Raymond. "What Price Federal Reclamation," in the series of National Economic Problems. New York: American Enterprise Association, 1955.

Moore, Raymond. The Nature and Origin of Kansas Soil. Biennial Report, No. XXXII, Kansas State Board of Agriculture, 1929/1930 to 1951/1952.

Ninth Economic Report of the Governor of Kansas, 1972. Eighth, 1971; Seventh, 1970; Sixth, 1969; Fifth, 1968.

Niobrara, Lower Platte, and Kansas River Basins. Annual Operating Plan, 1970 Operations and 1971 Outlook, U.S. Department of Interior, Bureau of Reclamation.

North America Water and Power Alliance. Water: Our Number One Problem. Nawapa Water for the Next One Hundred Years.

Osborn, Ben and Phoebe Harrison. Water and the Land: Facts About Our Water Problem. U.S.D.A., SCS-TP-147, 1965.

Pallesen, J.E. Kansas Board of Agriculture 54th Annual Report, 1970-71.

Pearson, James. "The Great Plains Today: Depopulation Poses Its Problems," Journal of the West, Vol. 6, No. 1, 1967.

Pfister, Richard. "Water Resources and Irrigation," Economic Development in Southwestern Kansas, Part IX, Bureau of Business Research, University of Kansas, 1955.

Robb, Andrew D. Supplementary Climatic Notes for Kansas, Climate and Man: Year Book of Agriculture. Washington, D.C.: U.S. Department of Agriculture, 1941.

Rohner, Wayne. A Century of Migration of the Kansas Population. Kansas Agriculture Experiment Station, Report No. 1, 1961.

Role of Water Resources in the Great Plains Economic Development, The. Proceedings of the Water Resource Committee and Resource Economics Committee Seminar, Great Plains Agricultural Council Publication No. 54, 1971.

Rubey, Harry. Supplemental Irrigation for Eastern United States. Danville, Illinois: The Interstate Printers and Publishers, 1954.

Salute to Kansas Where Irrigation is Subject of Conversation and Conservation, A, Irrigation Age, Vol. 1, No. 6, January, 1967.

Schoewe, Walter H. The Geography of Kansas, Part III, Concluded. Transactions of the Kansas Academy of Science, Vol. 56, No. 2, 1953.

_____. Mineral Industry in Kansas. Bulletin No. 127. Lawrence, Kansas: State Geological Survey of Kansas, 1957.

Schwind, Paul J. Migration and Regional Development in the United States, 1950-1960. Research Paper No. 133. University of Chicago, Department of Geography, 1971.

Self, Humber. Atlas of Kansas. Oklahoma City, 1960.

_____. Irrigation Farming in Kansas, Vol. 74, Nos. 3 & 4. Transactions of the Kansas Academy of Science, 1971.

Snowden, Flora D. Climate of Kansas. Report of the Kansas State Board of Agriculture, Vol. LXVII, No. 285, 1948.

Socolofsky, Homer E. "Introduction to the Great Plains," Journal of the West, Vol. 6 No. 1, 1967.

Soil and Water Research in the Great Plains 1970-2000. Research Committee of the Great Plains, Agricultural Council Publication No. 35, Vol. I & II, March 17-19, 1969.

Steinel, Alcin T. History of Agriculture in Colorado 1858-1926. The State Agricultural College, Fort Collins, 1926.

Talbot, Murrell. Range Watering Places in the Southwest. U.S. Department of Agriculture Bulletin No. 1358, 1926.

Thomas, Dorothy. Research Memorandum on Migration Differentials. Social Science Bulletin 43, 1938.

Thorntwait, G.W. "Climate and Settlement in the Great Plains," Climate and Man: Year Book of Agriculture. Washington, D.C.: U.S. Department of Agriculture, 1941.

U.S. Army Corps of Engineers. Water Resources Development in Kansas, 1969.

U.S. Department of Agriculture. Irrigation Agriculture in the West. U.S.D.A. Misc. Publication No. 670, 1948.

U.S. Department of Agriculture. Population Characteristics of Farm Operator Households. U.S.D.A. Economic Research Service, Agric. Econ. Report No. 141, 1968.

U.S. Department of Agriculture. Water Conservation in Irrigation Agriculture. July, 1961.

U.S. Department of Commerce. Bureau of the Census, Official Census 1940, 1950, 1960, and 1970.

U.S. Department of Interior. Bureau of Reclamation Water and Land Resource Accomplishments, 1971.

U.S. Department of Interior. Bureau of Reclamation Water and Land Resource Accomplishments, 1971. (A Statistical Appendix.

"U.S. Irrigated Acreage," World Irrigation, Vol. XIX, No. 5, August, 1970.

Wise, Harold F. Kansas Planning for Development: State Comprehensive Development Planning and Programming for the State of Kansas, Report No. 18.

Ziekfoose, Paul W. Population and the Labor Force: Economic Development in Southwestern Kansas, Part III. Lawrence, Kansas: University of Kansas, 1953.

APPENDIX I

Suitable Irrigable Acres and
Projected Acres Irrigated by 2,000 AD

Counties	Acres Suitable for Irrigation (000's)	Projected Acres Irrigated by 2,000 A.D. (000's)
NORTHWEST CENTRAL		
Cloud	3[illegible]1	16
Ellis	384	11
Gove	496	10
Graham	431	35
Jewell	453	9
Lincoln	284	2
Mitchell	339	20
Norton	463	10
Osborne	366	11
Ottawa	311	24
Phillips	450	10
Rooks	384	4
Russell	347	4
Smith	457	11
Trego	431	6
SOUTHWEST		
Finney	735	270
Grant	341	190
Gray	511	230
Greeley	477	82
Hamilton	586	31
Haskell	354	330
Kearney	502	130
Lane	401	41
Meade	444	128
Morton	437	163
Scott	420	192
Seward	356	140
Stanton	414	190
Stevens	439	178
Wichita	429	205
NORTHWEST CENTRAL	5,947	182.4
SOUTHWEST	6,846	2,400

Source: Irrigation in Kansas, Water Resources Board, Project No. P-43, Report No. 16e, 1967.

APPENDIX 2

Comparable Yields of Major Crops in Per Acre Bushels—1970

SOUTHWEST				NORTHWEST CENTRAL			
Counties	Wheat	Corn Grain	Sorghum Grain	Counties	Wheat	Corn Grain	Sorghum Grain
Scott	40	106	55	Gove	36	91	42
Haskell	40	105	90	Cloud	33	70	43
Stanton	32	109	84	Graham	31	88	37
Wichita	34	111	67	Jewell	33	78	33
Grant	36	96	64	Lincoln	31	30	25
Finney	33	103	69	Mitchell	34	60	28
Gray	37	107	86	Norton	34	88	35
Greeley	38	109	54	Osborne	34	84	20
Stevens	32	104	49	Ottawa	29	39	42
Kearney	33	90	49	Phillips	36	78	28
Lane	38	116	46	Rooks	33	65	28
Morton	30	100	51	Russell	38	40	23
Meade	32	86	73	Smith	39	71	25
Seward	29	94	48	Trego	32	80	8
Hamilton	36	97	49	Ellis	29	63	43
REGION	34	102	62	REGION	33	70	30

Source: Compiled from Farm Facts, Kansas Board of Agriculture, 1970-1971.

APPENDIX 3

Family and Personal Income 1970

	Median Family Income	Mean Family Income
SOUTHWEST		
Finney	$8,982	$10,310
Grant	9,025	10,890
Gray	8,227	9,604
Greeley	7,986	8,752
Hamilton	8,088	8,457
Haskell	8,454	9,733
Kearney	7,894	8,936
Lane	7,875	10,215
Meade	8,304	10,030
Morton	9,091	10,615
Scott	8,440	9,715
Seward	9,025	10,110
Stanton	7,565	9,013
Stevens	8,869	11,038
Wichita	8,113	9,205
NORTHWEST CENTRAL		
Cloud	7,185	8,252
Ellis	8,150	9,400
Gove	6,571	8,784
Graham	7,505	8,691
Jewell	7,268	8,013
Lincoln	6,289	7,081
Mitchell	6,939	8,091
Norton	7,281	8,402
Osborne	6,414	8,435
Ottawa	6,780	8,056
Phillips	6,939	8,143
Rooks	7,407	8,047
Russell	7,801	8,830
Smith	6,458	8,020
Trego	7,004	7,815
SOUTHWEST	$8,396	$ 9,775
NORTHWEST CENTRAL	$7,069	$ 8,271
STATE	$8,693	$10,063

Source: U.S. Department of Commerce, Bureau of Census, Kansas Social and Economic Characteristics, 1970.

APPENDIX 4

Rank in Population Changes 1940-1970

County	Region	% Change	Rank	County	Region	% Change	Rank
Grant	S.W.	206.3	1	Rooks	N.W.C.	-10.2	16
Seward	S.W.	140.7	2	Mead	S.W.	-11.1	17
Finney	S.W.	88.6	3	Gove	N.W.C.	-17.8	18
Haskell	S.W.	75.9	4	Cloud	N.W.C.	-21.9	19
Stevens	S.W.	68.5	5	Trego	N.W.C.	-23.8	20
Stanton	S.W.	58.5	6	Phillips	N.W.C.	-24.4	21
Morton	S.W.	63.6	7	Norton	N.W.C.	-26.0	22
Wichita	S.W.	50.0	8	Mitchell	N.W.C.	-29.4	23
Scott	S.W.	48.6	9	Russell	N.W.C.	-30.0	24
Ellis	N.W.C.	41.3	10	Graham	N.W.C.	-31.6	25
Kearney	S.W.	20.7	11	Ottawa	N.W.C.	-33.0	26
Greeley	S.W.	11.1	12	Osborne	N.W.C.	-34.8	27
Hamilton	S.W.	3.9	13	Smith	N.W.C.	-36.2	28
Lane	S.W.	-4.1	14	Lincoln	N.W.C.	-45.1	29
Gray	S.W.	-8.2	15	Jewell	N.W.C.	-49.7	30

Source: Compiled from U.S. Bureau of Census Population, 1940-70.

THE DEMOGRAPHIC IMPLICATIONS OF IRRIGATION IN WESTERN KANSAS

by

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AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF ARTS

Department of Geography

KANSAS STATE UNIVERSITY
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1973

ABSTRACT

Western Kansas forms part of the easternmost portion of the Great Plains geographical region. Its climate is characterized by rainfall variability and semi-aridity. It is an agricultural area of marked low population density, and since the 1930's, rural migration and depopulation.

Within this broad semi-arid region, although it has the same physical factors and depends upon agriculture for its economic base and employment, certain differences in human, cultural and socio-demographic phenomena could be identified.

To reduce the uncertainties of the natural rainfall and its deficiency and to increase the value of agricultural incomes, irrigation practices have been introduced. The development of irrigation in Kansas is concentrated mainly in the counties of Southwestern Kansas. Southwestern Kansas thus has the highest density of irrigation in the state. The Northwest Central portion has a very negligible proportion of irrigated acres.

The Northwest Central with a negligible proportion of farmlands under irrigation has lower agricultural yields, lower farm incomes, and is marked by persistent migration and population decline since the 1930's, typical of the Great Plains region. The Southwest region has higher agricultural yields, higher farm incomes and is exemplified by a steady population.

This thesis measures various demographic, social and economic parameters in these two regions in correlating irrigation practices and demographic trends in Western Kansas from 1930 to 1970. Two regions, the Southwest and the Northwest Central have been chosen for the purpose of this study. Each of these regions consists of fifteen groups of contiguous counties selected on the basis of their homogenuity in physical and human attributes. The Southwest region includes Finney, Grant, Gray, Greeley, Hamilton, Haskell, Kearney, Lane, Meade, Morton, Scott, Stanton, Seward, Stevens and Wichita. This region has a total land area of 7,589,090 acres, which represents 14.5% of Kansas and 3.9% of the population in 1970. The Northwest Central consists of Cloud, Ellis, Graham, Gove, Jewell, Lincoln, Mitchell, Norton, Osborne, Ottawa, Phillips, Rooks, Russell, Smith and Trego. The Northwest Central has a total of 8,259,480 acres or about 15.7% of Kansas land area and 5.4% of the population in 1970.

Both regions suffered heavy depopulation between 1930 and 1940 following the prolonged drought, dust bowls and economic depression of the 1930's development.

The development of irrigation agriculture in the Southwest has been very rapid since 1940. Irrigation grew from 88,322 acres in 1940 to 1,217,997 acres in 1970, representing 64.8% of all irrigated lands in Kansas. The Northwest Central's irrigation grew from 2,923 acres to 87,192 acres, representing 4.6% of irrigated lands in Kansas for the same period.

Increased yield has led to higher earnings in farm income in the Southwest than in the Northwest Central where dry farming prevails, yields are lower, and income is unstable. Direct economic effects of irrigation in the agriculture of the Southwest region is reflected in higher per capita personal income, assessed valuation of property, net effective buying income, employment, increases in retail and wholesale transactions, including occupied dwellings. In all these economic parameters, the Northwest Central ranks below the Southwest and the state.

The direct economic gains in turn influenced social and demographic parameters. Lower income and unemployment in the Northwest Central has resulted in a higher rate of migration and depopulation, low fertility ratio and birth rate, low median age and smaller proportion of youth under 18 years of age. The reverse is the case in the Southwest. The population of the Southwest increased from 53,370 in 1940 to 83,095 in 1970 which was about 55.7%. For the same period, the Northwest Central was depopulated from 154,956 to 121,593 or about 21.5%.

The generalization reached by the researcher is that there is a strong areal association between irrigation density and steady population growth in Western Kansas, a broad region characterized by depopulation since the 1930's.