Characteristics of the Western margins of the Corn Belt in Nebraska

John Knickman
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CHARACTERISTICS OF THE WESTERN MARGINS
OF THE CORN BELT IN NEBRASKA

A Thesis
Presented to the
Department of Geography
and the
Faculty of the Graduate College
University of Nebraska at Omaha

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

by
John Knickman
July, 1972
Accepted for the faculty of The Graduate College of the University of Nebraska at Omaha, in partial fulfillment of the requirements for the degree Master of Arts.

Graduate Committee

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3276/102
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INTRODUCTION

The designation of the most important agricultural crop in this nation would certainly and overwhelmingly find corn as the most vital to our agricultural economy. Corn is the leading crop in American agriculture both in terms of value and of the acreage grown each year. The peak acreage occurred in 1917, when 111 million acres were harvested for all purposes.¹ During the decade of the 1950's the acreage of corn declined to about 80 million acres a year. Corn acreage has continued this slow decline in the 1960's, but a consequent increase in per-acre production has kept total bushels at a very high level.

About 45 per cent of the total corn crop is grown in a region called the Corn Belt. A region can be described as a geographic area, that has some form of internal unity or similar quality which tends to provide a cohesive character. The regional concept differs from the concept of an area in that an area exists only in geographical extent, and does not have some internal factor that would give it a unified character.

The regional concept has been applied to a great variety of items on the landscape. Geographers have designated physical and industrial regions as well as agricultural.

The factor that lends unity to the United States Corn Belt is the intense cultivation of the crop corn; and a close association of land use and livestock production that is in harmony with the capability of the land. Throughout the Corn Belt region, corn is the major crop, and corn fed livestock the major source of income.

The "Corn Belt" has been called the richest agricultural region in the world by many authors, but few of them have ever set definite boundaries as to its extent. There have been many attempts to describe the Corn Belt in general terms. Higbee defines it in terms of "the wide humid plain which lies between the dairy region on the north and the Ohio River, Ozark hill country to the south is called the Corn Belt". The great majority of the literature of today that deals with the Corn Belt parallels. Higbee in the general nature of its coverage. Most of the description and analysis of this important region centers around the core of the Corn Belt, where Corn Belt agriculture is the most intense and easily recognized. In most studies of Corn Belt agriculture, this same core characteristic is presumed to extend to the periphery of the region where it terminates abruptly. Logical analysis would lead to the conclusion that every region has a core which exhibits the maximum intensity of the factor

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being used to designate that region. From this core, the intensity should decrease until a point is reached where a totally different factor predominates and a new region has been entered. In terms of the Corn Belt region, the core could be found by locating the area having the highest total harvested acres in corn. The core is easily recognized and lends itself well to geographic research. The problem arises in the placement of a boundary around a region and categorizing everything within this boundary as being homogenous and everything on the other side of the line as being typical of some other agricultural region. In reality, as the margin of a geographic region is approached, a transition zone is encountered rather than an abrupt change. This transition zone will exhibit characteristics symbolic of both regions. Although vast amounts of research have been completed on the characteristics of the core of this region, little effort has been extended toward an explanation of the margins. The observations made by Lyle Gibson concerning the corn-dairy margins reflect this problem.

Land use patterns appearing in the zones of contact between adjacent land use regions have rarely been the subject of geographic investigation.

It is commonly recognized however, that economic regions generally have "cores" of maximum specialization or intensity. These cores of maximum intensity decrease outward toward the periphery of the region. Centers are usually readily recognizable; but the margins, or peripheries are less easily defined.
If we observe the system of production within a region, it appears to lose its dominance of the scene with increasing distance from the core, until it is replaced by another system of production economy.

The line along which the two economies meet is defined as a regional margin, the place (zone) of contact between two types of economic occupancy.

The source of livelihood rarely changes abruptly, and the margin is more likely to appear as a gradual transition zone.3

Attempts have been made to delimit the western margin of the Corn Belt. An example of precise placing of boundaries comes from John Weaver, who decided "in order for a county to be included in the Corn Belt, it must have 20% or more of the total harvested cropland in corn".4 A boundary line defined in these terms would change every year, and is not very comparable to the intensity of corn production in the core with many counties averaging over 50% of harvested crops in corn.

Higbee chose the physical factor of the 20 inch isohyet to determine the western margin.5

O. E. Baker employed the use of total corn production in defining the location of the borders. Any area with more

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5Ibid., Page 463.
than three thousand bushels of production per square mile was considered Corn Belt. 6

The purpose of this paper is not to attempt to delimit the Corn Belt in terms of a line on a map that could be called the western margin. Others have previously tried this, and have produced only boundaries that reflect the single criteria employed, or a constantly fluctuating boundary that changes from year to year with varying local conditions. The purpose of this paper will be to examine the characteristics of the transitional zone along the western margin of the Corn Belt in direct contrast to the core. The complex factors that cause corn to diminish in importance from the core to the periphery of the region will be interpreted from statistical mapping.

METHODOLOGY

The central problem of this study revolves around the characteristics of a margin of a region in relation to the core of the same geographical region. An attempt will be made to contrast the agricultural pattern of the western margin of the Corn Belt with the generalized concepts of the core. The construction of a distinct line separating Corn Belt from Non-Corn Belt areas is not a goal of this study. There have been previous attempts by geographers to place such a line, and virtually all of these fall in the same general area. This points to the existence of a transitional zone along the western margin as opposed to a distinct terminating line. This study will focus on this transitional zone through a comparison with the core. A study area base map was prepared that included all of the different intensities of corn cropping in this region. Central Iowa represents the core of the Corn Belt, with the maximum intensity characteristic of the Corn Belt Agriculture. The transitional zone along the western margin of the Corn Belt lies in central Nebraska, where corn begins to lose its dominance of the agricultural landscape. Western Nebraska is predominantly a wheat and grazing region, and lies outside of the Corn Belt.

The statistical basis for the preparation of the topical study area maps is the 1964 United States Census of Agriculture.
There were several reasons for the selection of the agricultural census as the data source. The most important aspect was the wide range of statistical information available in the many subject areas pertinent to Corn Belt agriculture. The availability of information by county was helpful in constructing maps that are comparable in nature. The reliability of these reports was also a factor in applying them as the prime source. The last four agricultural census periods will be utilized (1954, 1959, 1964, 1969) to show recent changes in the agriculture of the study area. The preliminary 1969 census data was used to suggest current trends in the study area. Selected maps were constructed for comparative purposes. It is hoped that the material mapped here might some day be useful in comparing future changes or trends in the Corn Belt.

Since a majority of the data in the United States Census of Agriculture is given only in terms of total numbers or dollars per county, all figures had to be given a weighted value in order to validly compare counties of different sizes. For example, Custer County, Nebraska is over four times as large as the neighboring county of Valley. Mapping total dollars or numbers per county would have given an invalid picture of the actual intensity of agriculture within these counties. Therefore, all statistical data was converted into weighted values such as dollars per square mile or numbers per cultivated acre. These weighted values can then be compared.
A ranking of the first, second, and third most important crop of each county was also derived from the census data. By comparing the total acres of each of the six major crops to the total harvested acres in each county, the rank of a specific crop can be determined in the agriculture of each county.

The investigation will focus on answering the following questions:

1. What recent changes have occurred in the Nebraska Corn Belt?
2. How do the western margins in the Corn Belt differ from the core?
3. Why does Corn Belt agriculture lose its dominance of the landscape with increasing distance from the core?

Background material was gathered to explain the physical factors that effect the western margin of the Corn Belt. Factors such as soil, natural vegetation, physiography, and climate all exert forces on the agricultural pattern, and aid in the explanation of this pattern.
Approximate Western Corn Belt Margin

Source: U.S. Census of Agriculture - 1959

Figure 1
CLIMATE

The climate of Nebraska is typical of any area in the interior of a large continent in the middle latitudes. In general, Nebraska can be categorized as having rather light rainfall, low humidity, hot summers, cold winters, great variations in temperature and rainfall from year to year, and frequent day-to-day weather changes.

There are frequent changes in wind direction during all seasons of the year, but the prevailing direction is from the northwest to north from September to April, and from the south or southwest during the remainder of the year.

The Rocky Mountains have a profound influence on the climate of Nebraska. The air that crosses the mountains from the west loses much of its moisture on the windward slopes, and becomes warmer and drier as it descends on the eastern side. Therefore, no significant amount of moisture reaches Nebraska from the Pacific Ocean. The rainshadow effect accounts for the low average precipitation in Nebraska during the winter months when the prevailing winds are from the north or northwest.

The moisture supply for precipitation comes from the Gulf of Mexico. The remoteness of Nebraska from this source is one of the reasons for wide variations in rainfall from year to year. Moist air from the Gulf is often deflected eastward before it reaches Nebraska. Nebraska's precipita-
tion often results from the movement of a cyclone or a low pressure system, with its associated cold and warm fronts, across the state. Two or more of these systems may move from west to east across the state each week.

Average annual precipitation across Nebraska ranges from fourteen inches in the northwest to thirty-four inches in the southeast. The dual phenomena of the Rocky Mountain rainshadow, and increasing distance from the source, causes the amount of precipitation received in Nebraska to decrease rather uniformly from west to east.

If the state of Nebraska is divided into thirds, the average annual precipitation of the eastern third would be about twenty-seven inches; the central third, twenty-two inches; and the western third, eighteen inches. A very important factor of this precipitation pattern is that eighty per cent of the annual total falls in the warmer months of April to September. This allows more moisture to be available for plant use during the growing season.

During July and August, rainfall normally diminishes slowly in the eastern part of Nebraska. In the west, it

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1University of Nebraska College of Agriculture and Home Economics, the Agricultural Experiment Station, Nebraska's Precipitation; Its Patterns and Probabilities, Miscellaneous Publication 10, May, 1965, p. 7.

decreases more rapidly so that August averages are only a little over one-half of the June average. The June to August precipitation across the state decreases from 2.7 to 1.2 inches at Scottsbluff; 2.9 to 2.1 inches at North Platte; 3.6 to 2.3 inches at Grand Island; 4.4 to 3.7 inches at Lincoln; and 4.5 to 3.1 inches at Omaha. These precipitation depressions usually occur during the last week of July or the first week of August. This is the time when corn is usually in the critical silking and tasseling stage. If soil moisture is unavailable to the corn plant during a one week period just prior to or after silking and tasseling, corn yields may be reduced by as much as fifty per cent. Corn generally requires 267-400 pounds of water for each pound of dry matter produced. The factor of precipitation relating to corn yields that seem to favor the east over the west is that the heavier June precipitation, together with generally heavier soil type, permits greater storage of soil moisture in the areas to the east.

Although solar radiation to the Earth's atmosphere is steady and dependable, receipts of insolation vary from place to place due to local conditions. In Nebraska, there

3Ibid., Pages 6-7.

4G. E. Condra, The Relations of Drought to Water Use in Nebraska, Bulletin 6, Conservation and Service Division, University of Nebraska, Lincoln, Nebraska, 1934, p. 7.
is a slight increase in solar radiation from east to west, due apparently to lower atmospheric turbidity in the higher elevations of the west.\(^5\) A greater monthly average per cent of possible sunshine in eastern Nebraska offsets the higher solar radiation of western Nebraska, so that the average maximum temperatures during the growing season are about the same over the state.

The atmospheric effect on temperature is reversed during the night. Although hot nights in summer occur rather frequently in the east, they are almost unknown in the higher elevations of the western part of the state. Rapid cooling after sunset is much more evident in the western area. A comparison of minimum monthly temperatures during the corn growing season reveals a much greater range over the state than was found in maximum temperatures. The minimum temperatures show a very evident and orderly decrease from east to west. The minimum temperature of Omaha for June, July, and August average 65\(^0\) while Grand Island has 62.4\(^0\), North Platte has 59.6\(^0\), and Scottsbluff averages 56.2\(^0\). This is a decrease in average minimum temperature of almost nine degrees.
GROWING SEASON

Source: Climate and Man, Yearbook of Agriculture

Figure 2
from east to west during the critical months of corn growth. This has a very marked effect on the growth rate of the corn plant. The plant needs warm, humid nights in which to grow if the plant expects to reach maturity before the end of the growing season. The growing process of corn requires a continuity of temperature covering both day and night, and will not readily adapt to the cooler minimum temperature areas.

There are several climatic factors that help to delimit the margin of the Corn Belt in Nebraska. The diminishing precipitation from east to west with the associated precipitation depressions of western Nebraska make corn growing a risky project in this sector of the state. Unpredictable droughts can deplete soil moisture, reduce the area of surface water, and even lower the ground water table. Although average temperatures during the growing season are about equal over the state, the gradual decrease in night time temperatures from east to west causes a reduction in the growth rate of the corn plant.

In 1936, John Rose attempted to correlate corn yields and climate with the boundaries of the Corn Belt. His major conclusions were:

"On the southwest margin variations in as many as ten climate factors are shown to correlate significantly with variations in corn yield. The northwestern area has nearly

7Condra, op. cit., p. 23.
as many and part of the southern and eastern marginal areas show no paucity of factors giving significant correlations with yield. On the other hand, very few of the climatic factors studied correlate significantly with corn yields in the samples located near the core of the Corn Belt. This would seem to indicate that climatic conditions near the optimum for corn yield exist in the heart of the Corn Belt but act increasingly as limiting factors toward its margins. Near the margins, yield seems to depend on a very delicate balance of climatic factors which fluctuate widely from year to year and are seldom very favorable to high yields. His findings showed that early season temperature and precipitation were critical on the southwest margin of the Corn Belt in Nebraska. The factors most significant to corn yield on the northern margins of the Nebraska Corn Belt were early and mid-season temperature and precipitation. Significant correlations between corn yield and the factors of temperature and precipitation were found for all Corn Belt margins except for the one in west central Nebraska. The most probable reason for this is the occurrence of loess soils in this area. Loess soils provide greater water holding capabilities

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9 Ibid., p. 99.
and help to prevent precipitation damage to the crops on the western margin of the Corn Belt in Central Nebraska.
PHYSIOGRAPHY

The 77,000 square mile area of Nebraska exhibits a wide variety of physical features. The elevation increases gradually from eastern Nebraska toward the higher elevations of the west. The lowest elevation of 1,825 feet is found along the Missouri River in Richardson County. The highest areas of the state are found in Bonner and Kimball Counties with elevations reaching to 5,340 feet.¹ This results in a total difference of 4,515 feet and average elevation changes of 9.6 feet per square mile.

Going westward, the elevation change would be a gradient of 6 feet per mile for the first 100 miles, 7 feet for the second hundred, 8 for the third hundred miles, 10 for the fourth hundred miles and 18 to 20 for the last fifty.²

The oldest formations are in the eastern corner of the state, and younger formations appear to the west. Most of this geologic strata is covered by a deep layer of soil.

The rocks of Nebraska are all undisturbed sedimentary rock, such as common sandstone, limestone, and clay or shale. There are no native crystalline rocks such as granite or

²Erwin Barbour, Nebraska Geologic Survey, State Geologist; Volume 1, Lincoln, Nebraska, Jacob North and Company, 1903, p. 38.
marble in the state.\(^3\) There are also no rocks in the state that are older than the upper Carboniferous. These rocks appear in eastern Nebraska, then dip out of sight to reappear on the slopes of the Rockies. The trough thus formed is filled with layers of Cretaceous rock. The Carboniferous and Cretaceous constitute Nebraska's oldest rock and upon them lie the newer formations.

Two physiographic provinces are represented in Nebraska, with the Great Plains Province to the west and the Central Lowland Province on the east. The High Plains section of the Great Plains that exists in western Nebraska is part of a great fluvatile plain which formerly stretched from the Rockies on the west to the Central Lowland. The evidence for fluvatile origin of this area is found in the nature of the sediments and in the manner of their distribution. The materials found here are largely unconsolidated silt intermixed with quantities of sand and gravel.\(^4\) The more rapidly eroding silt often washes away, giving the surface layer the appearance of a solid gravel formation. Gravel and sand are found in long bands that exhibit a general east to west direction. This suggest deposition by overloaded streams in early geologic time. This material is often referred to as

\(^3\)Ibid., p. 116.

the Tertiary mantle, and is very porous in nature. Beneath this mantle, shale is the common rock.

The High Plains can be farther subdivided into four characteristic subregions; the Arikaree on the west and north, the Loess Plains on the east and south, the Sandhills in the central area and the Goshen Hole on the Wyoming - Nebraska border. 5

The Goshen Hole is a fifty mile widening of the Platte Valley. This area has sufficient gradient to result in excessive downcutting. The underlying Brule clays have been deeply eroded, forming mesas, buttes, and badland topography.

The river-laid Arikaree deposits of the northern High Plains are much older than other deposits to the south, and have been eroded deeply. The characteristic topography of this formation is one of broad and flat tabular uplands between streams. This older peneplain ends abruptly in northwest Nebraska at the Pine Ridge Escarpment.

The Sand Hills of Nebraska are found north of the Platte River in the central part of the state. This dune topography covers 24,000 square miles. 6 Several hundred feet of local relief exist here, with many small lakes occupying the basins between dunes. Most of these dunes are now fixed into position by grass vegetation, and only a few areas still have

5Ibid., p. 16.
6Ibid., p. 19.
drifting sand. The formation of these dunes took place
during the later stages of evolution. Much of the sand of
this hilly region is presumed to have originated in the
channels of braided streams that border this area.

East and south of the Sandhills is the area of the
Loess Plains. Here, the former topography has been recently
renewed by a thick covering of loess. The former topography
may have been like that farther west, but the wind deposited
loess leveled off the surface.

In Nebraska, the Central Lowlands merge imperceptibly
into the Great Plains. Loess is spread over the eroded sur-
face of the older glacial drift of the Central Lowlands and
the Tertiary mantle of the Great Plains, obscuring the
borders. With the lack of physical boundaries, other means
have often been employed to serve as the border between
these two provinces. The twenty inch isohyet, the hundredth
meridian, and the two thousand foot contour line all approx­
imate the division.

The topography of the Central Lowlands depends more on
glacial history than on the original strata. The eastern one­
fifth of Nebraska was covered by the drift of the Kansas
glacier. This was then covered by a thick blanket of loess.

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7A. K. Lobek, Physiographic Diagram of the United
The Great Plains, east of the High Plains, and the Central Lowland areas of Nebraska are well adapted to corn production due to the loess covering. The High Plains of western Nebraska are not well suited physically for a tillage type of agriculture. The porous nature of High Plains topography can cause soil water storage problems. The High Plains were once much more extensive, however, they are constantly losing ground to erosion.

A section known as the Plains Border\(^8\) exists on the eastern boundary of the High Plains in Nebraska where rougher topography suggests the erosion of the new cycle is incomplete.

\(^8\)Fenneman, op. cit., p. 25.
SOILS

Most of the Corn Belt soils of Iowa and eastern Nebraska have experienced one or more periods of glaciation. The major portion of Nebraska did not receive the beneficial effect of the glacial epoch. Only a small strip on the eastern border was covered by pre-Wisconsin Drifts, with the majority of the state being driftless. The lack of glaciation in the present western margins of the Corn Belt does not radically effect present agriculture in this region. A post glacial period of loess deposition covered glaciated and non-glaciated areas alike. As the ice cover retreated, much of the area was covered with loessal deposits exceeding four feet in thickness in much of southern Iowa and eastern Nebraska. The soils that have evolved in the Corn Belt today reflect this history.

The soil type occupying virtually all of Iowa and the far eastern section of Nebraska is a Brunizem soil. Brunizems have formed on poor to well drained sites under tall prairie grass vegetation. This natural vegetation was often of the Bluestem variety.

The upper or A horizon of a Brunizem soil is typically a very dark grayish brown in color and comparatively thick.

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1 Agricultural Experiment Station, University of Wisconsin Madison. Soils of the North Central Region of the United States, North Central Regional Publication No. 76, 1960, p.25.
SOILS

Source: Soils of the North Central Region

Figure 4
In many cases, the A horizon tends to be slightly acid in pH, but rather high in organic content. The B horizon is dark yellowish to brown in color and often of a clay or silt loam texture. The C horizon is often leached and of a yellowish to brown in color. The Brunizem soils are known to be excellent agriculturally, combining basically a fertile soil with adequate moisture for crops.

Soil Associations are naturally occurring combinations of soils and land units. A typical Soil Association of the Brunizem Great Soil Group is the Monona - Ida - Hamburg soils of Monona County, Iowa and Washington County, Nebraska. They are hilly, well drained areas with dark colored silty surfaces formed from loess deposits. With good management, excellent yields of corn can be derived from these soils. Nitrogen and phosphorus fertilizers are needed for grain crops. Although erosion is a serious problem, terraces and contour farming are effective soil conservation measures.

The Chernozem soils extend in a rather broad belt through Nebraska. These soils have developed under a tall grass vegetation in the absence of ground water influence.\(^2\) The typical Loess Plains landscape in Nebraska has a nearly level to rolling surface recently renewed by a covering of loess.

\(^2\)Ibid., p. 27.
The A horizon of a Chernozem soil may vary from a gray-brown to a dark black in color. The darkness of the surface layer is one of the most noticeable characteristics of this soil type. This dark coloration is due to the accumulation of organic matter through the decay of grass vegetation, and the lack of leaching.

The gray-brown to brown B horizon may have a moderately prismatic structure, and although there are no free carbonates in the A horizon, carbonates frequently accumulate in the lower B horizon. Chernozem soils are fertile and can be excellent for agricultural usage. In years of average to above average precipitation, Chernozem crop yields are excellent. Corn production in areas of Chernozem soils is limited only by the unreliability of precipitation. This unpredictable nature of the water supply often causes farmers to plant a more drought resistant grain such as wheat or sorghum.

A typical Soil Association of the Chernozem Group is the Moody-Crofton soils of Dixon and Rock Counties. These soils occupy a dissected till plain with a covering of loess. Corn can be profitably grown here, but moisture is a common limiting factor. Erosion control is a management problem.

Central Nebraska has the largest area of Regosol soils to be found in the midwest. This area of azonal soils is often referred to as the Sandhills. Coarse or resistent parent materials and insufficient time to develop a profile
are among the common causes of this soil type. Regosols have a notably weak profile development, having typically an A, AC, or C.\(^3\)

The A horizon is typically very thick, and the AC horizon is composed of slightly altered materials. The C horizon of this soil contains weathered and unconsolidated materials. Regosols have low water uptake and retention because of the large soil particle size and the falling topography. A low cation exchange capacity\(^A\) adds to the agricultural problems of this soil type. Although Regosols are generally unsuited for cultivated crops, they can maintain perennial grasses or tree vegetation. Wind erosion can be a problem if this protective cover is removed. The economic value of this soil type is in the area of livestock production. The nature of the Regosol soils will not permit extensive corn production, and therefore provides a definite limit to the Corn Belt in central Nebraska. The Valentine Soil Association of Blaine County is typical of the Regosols in Nebraska. This association consists of excessively drained soils of sand and fine sandy loam. The primary materials are deep eolian sands. These areas produce high

\(^3\)Ibid., p. 44.

\(^A\)The capacity of the soil colloids to exchange base ions for those in the soil solution is known as cation exchange capacity. It is defined as the amount of exchangeable cations expressed as Milliequivalents per 100 grams of clay determined at pH7, and is a measure of potential fertility.
yields of native grass pasture when properly managed, but wind erosion will result from overgrazing.

Panhandle and southwestern Nebraska have a Chestnut and Brown soil type. This soil has developed in semi-arid areas in the absence of ground water influence. The natural vegetation found over most Chestnut and Brown soil areas is a short grass. The A horizon is typically dark brown in color, and, in undisturbed areas, the surface is frequently mulch-like.

The brown colored B horizon is neutral to mildly alkaline in the upper areas, with free lime carbonates collecting in the lower section. The C horizon consists of only slightly altered primary materials. Wind erosion can be a hazard on this soil type. The flatness of the interstream divides is another striking feature of this landscape. Agriculture in areas of Chestnut and Brown soils is greatly limited by precipitation.

Corn is not planted widely due to the low total precipitation. The Keith-Colby Soil Association in Hitchcock County is representative of Chestnut and Brown Soil types. Wheat and sorghum are the main crops in a cash grain farming system. Water and wind erosion are chief problems of the wheat and summer-fallow cropping system.

\[4\] Ibid., p. 28.
Alluvial soils occur in the valleys of the Missouri, Platte, Republican, and other lesser streams of Nebraska. These Alluvial soils are stream-laid sediments and exhibit little in the way of a soil profile. The Azonal character of this soil type causes it to vary greatly in structure, fertility, and use. There is often a flood hazard involved with agriculture on Alluvial soils, as they occupy the lowest topographic position on the landscape. Fertility is not a problem with this soil, and some of the clay loams or gumbo lands produce very high yields.

The Brunizem and Chernozem soil groups offer no handicap to extensive corn production in Nebraska. Precipitation on the Chernozem belt is usually sufficient to produce an adequate crop. The Regosols and Chestnut and Brown soil types present an entirely different picture. The problems of wind erosion after tillage and insufficient moisture create high risk and usually a low average yield. The western margin of the Corn Belt in Nebraska has often been drawn along a line that separates these two groups of soils.

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5Ibid., p. 22.
The usage of the title "Natural Vegetation" presents problems in that definition of this term can vary from one source to another. A. W. Kuchler, defines natural vegetation as a plant community consisting of a given combination of life forms.¹ Most vegetation landscapes are composed of a single dominant species and various other minor species. Some authorities consider the vegetation of a region to be natural only when it is unaltered by man. If this definition is followed, the natural vegetation found over almost all of Nebraska and Iowa was grasslands. Grasslands are characteristic of areas in which trees have failed to develop, either because of unfavorable soil conditions, poor drainage, intense cold, insufficient moisture, or repeated fires.

Grasslands are best suited to withstand conditions of high moisture, drought, and fires which would destroy tree vegetation. The grasses are usually well supplied with water in the surface soil during the growing period and do not generally depend upon deeply stored soil moisture.² If soil moisture was available at depth, other plants could flourish.

and replace the grasses. Grasses are therefore characteristic of regions of summer rainfall.

The grasslands of this region are the tall grasses of the prairie, and the short grasses of the high plains. The tall grasses and short grasses are distinctive in growth, both in height of plant and depth of root. The difference is due mainly to moisture conditions in the soil. The line of demarcation between the short and tall grasses is not rigid, since the change in climatic conditions and topography is very gradual. A change in climate can cause this line of separation to swing back and forth somewhat. The permeability of the soil is highly influential in determining which type of grass will dominate. The tall grass pushes farther west on sandy soils, while harder lands favor short grass. This accounts for the westward bulge of tall grasses in the Sand Hill area. Almost all tall grasses are east of the 100th meridian except in this area where the division line between short and tall grasses is also correlated with the depth below the surface of the layers of carbonate accumulation. This layer is also the depth of the periodically moist surface layers of soil. Below the level of carbonate accumulation, the soil is dry except in occasional years of excess precipitation. Where the depth of moist soil is less than two feet, the short

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3Baker, op. cit., p. 15.
grass predominates. When the depth is thirty inches or over, the tall prairie grasses will be found.

The most important factors governing the existence of these two types of grasses are depth of soil moisture and total moisture supply. The dividing line between these two grasses is important to agriculture because it separates the highly productive farm lands of the prairie from the less productive ranch lands of the plains.

The tall prairie grasses are, therefore, found in a region where growth is not limited by moisture. The most extensive variety of all the tall grasses is the Bluestem. This type grew abundantly over most of what became the Corn Belt of today. Big Bluestem, Sand Bluestem, and Little Bluestem were representative of this variety in Nebraska.\(^4\) Bluestem bunch grass existed in central Nebraska, close to the boundary of the short grasses. In northern Nebraska, where both rainfall and evaporation were less, Needle grass was quite common.

The tremendous expanses of tall grasses that once flourished on this prairie landscape have now been almost entirely replaced by cultivated crops.

The short grasses characteristic of the high plains, develops in a region of early spring and summer precipita-

\(^4\)Kuchler, op. cit., p. 75.
tion averaging from 12 to 22 inches. The moisture during ordinary years does not penetrate more than two feet below the surface. This permits the grass to grow for only a short time following rains, and then pass into a drought resistant rest period. The most prevalent varieties of short grass were the Grama and Buffalo varieties. Wire grass and Sand Sage grass were commonly found on the border of the tall grass areas.

Forest vegetation was originally quite limited in Nebraska. Most of the trees found in Nebraska by the first settlers were located along the rivers and their tributaries. The Oak and Hickory timber, together with some Ash and Black Walnut, are the farthest extension of forest vegetation into the prairie region. The number of trees growing here was extended after settlement. The checking of prairie fires caused the extension of forested acres either by planting or natural seeding.

The natural vegetation does not have an exacting role in dictating the particular agricultural crop that will be planted upon its removal. The only significant factor lies in the precipitation association along the line dividing the tall and short grasses. Corn is very adaptive to the more moist land of the tall grasses, but does not produce sufficient yields on the drier land of the short grasses.

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5 Baker, op. cit., p. 9.
6 Ibid., p. 16.
INTRODUCTION TO STATISTICAL MAPPING

Figures 5 through 31 were constructed from data derived from the United States Census of Agriculture. The dates of census material used ranges from 1945 to the preliminary of 1969. The use of materials covering this extensive period of time is intended to provide a historical perspective, as well as recent trends. The topics selected to be mapped were chosen because they are representative of factors associated with Corn Belt agriculture. Any changes in the intensity of these factors from the core to the western margins can then be analyzed.

A written interpretation of each map examines the agricultural pattern and provides reasons for significant changes. In selected topical areas, maps were constructed for several census periods. These maps will then be used to determine if any long-range trends are developing in this region.
CORN ACRES PER SQUARE MILE
(Figures 5-9)

The four maps of acres of corn per square mile (1945, 1954, 1959, 1969) are designed to show possible changes in the importance of corn to this region. A comparison of these maps points out the continual changes and adjustments that have occurred here. The Corn Belt is not a stagnant entity, but fluctuates to meet changing conditions and situations. It is also evident that the western margins have experienced more numerous and drastic changes than has the core of the Corn Belt.

The changes in the acres of corn per square mile can be attributed to economic pressure. Professor R. H. Blossen of Ohio State University has determined that the cost of growing corn will average $61.00 per acre on a 160 acre farm.¹ The cost of growing an acre of corn is fairly stable, and should total approximately the same whether it be in the core or in the western margins. The same care and techniques of cultivation must be applied in both areas. Since the costs of production are stable and the market value of corn basically uniform, the only remaining variable is the yield per acre.

For example, a farmer in the core of the Corn Belt can expect an average yield of 100 bushels per acre and a production cost of 61¢ per harvested bushel. If a farmer in the western margins has the same production costs but only averages 75 bushels per acre, he has invested 81¢ to produce the same amount of corn. A farmer in the transitional zone of the Corn Belt must weigh the anticipated yield against the known cost of production. Since the precipitation is more variable from year to year in the western margins than in the core, farmers in the marginal area must expect more frequent drought. Many of these farm operators are turning to more drought resistant crops such as wheat or sorghum to assure income in years of below average precipitation.
In 1945, the core of the Corn Belt was well established. The peak county was Greene County, Iowa, with 271 acres per square mile. Nebraska also had a high intensity area, with nineteen counties averaging over 240 acres out of each 640.

The transitional zone along the western margin of the Corn Belt was rather expansive. Corn was being grown extensively as far west as Dundy, Chase, Perkins, and Lincoln Counties. In the northern sector of this transition zone, the production of corn diminished abruptly along the line separating Knox and Antelope Counties from Holt and Wheeler. The central and southern sectors of the western margin show a gradual decrease in the acres of corn per square mile in concentric arcs away from the core.
By 1954, corn production in what is now the core had decreased slightly. Low market value caused some changes in crops planted in this area. Wayne County, Nebraska was the leader with 247 acres per square mile in corn.

The transition zone counties show very little change for the period 1945 to 1954. The northern sector of the western margins remained exactly the same as it had been in 1945. There were slight changes in the southern sector, as Lincoln, Perkins, and Chase Counties fell into the lowest category.
Accelerated changes are evident in the Corn Belt by 1959. The core has gained in the intensity of corn acres, while the transition zone has contracted inward. Thirty-two Iowa Counties reached the top category of over 240 acres per square mile, with Sioux County ranking first at 310 acres. Eastern Nebraska also shows increased importance of corn acres, with sixteen counties in the highest bracket. The overall pattern in 1959 is much more similar to the pattern of 1945 than of 1954. The core of the Corn Belt is very evident visually from the map of 1959, with the large block of contiguous counties evidence of its existence.

The transition zone along the western margin of the Corn Belt shows a reduction in the importance of corn. This pattern of reduced importance was evident in 1954, and continues to 1959. The counties in the northern sector of this marginal area have remained remarkably stable over the three census periods. The line that divides Knox, Antelope, and Boone Counties from Holt and Wheeler has provided an abrupt change in agriculture patterns. The gradual decrease in the importance of corn that is evident in the rest of the transition zone is not prominent in this northern sector.

The counties in the central sector of the western margins also experienced several notable changes. Valley, Greeley, Sherman, and Howard Counties all experienced a
reduction in the acres of corn per square mile. This reduction can be attributed to economic pressures resulting in the planting of a more drought resistant crop such as wheat or sorghum. A notable increase in the acres of corn can be detected in the heavy irrigation region of Nebraska. The counties from Phelps to Hamilton base this increase on irrigated agriculture.

The trend of reduced importance of corn in the southern sector that was noticeable in 1954 continues in the period up to 1959. Hitchcock and Webster Counties were lowered into the bottom category for the first time. Reduction in this sector was a result of the search for a more drought resistant and reliable crop.

The census period of 1959 saw an expansion in the importance of corn in the core of the Corn Belt, and a general reduction along the western margins.
The numbers of corn acres were drastically reduced by 1964. This reduction was caused by a government program designed to eliminate the huge annual over production of corn and raise the value per bushel. Farmers of the Corn Belt had become too productive and were growing more corn than could be used each year. Most of this surplus found its way into the hands of the Federal Government under the provisions of the price support plan. Corn could be delivered to the government if the market value was below the stated government support price. With expanding production the market value of corn dropped below the level of the price supports and the government became the owner of vast quantities of corn. The new government program was aimed at elimination of surplus production. The Feed Grain Program allowed farmers to remove either twenty or fifty per cent of their corn base lands from production.\textsuperscript{1} The corn base of each farm was computed by averaging the total acres of corn each farmer produced in 1959 to 1960. A cash payment was then made to farm operators who signed up under the provisions of this plan. Payments were computed on the basis of average yield per farm, with higher payments assigned to the areas.

with the potential to produce the greatest yields. This provided more of an incentive to enter the program for farmers in the core of the Corn Belt than on the western margins because the yield and resulting payments were much higher. The government then removed the price support system for any farm operator who planted more acres to corn than his assigned corn base. This plan removed thousands of acres from corn production and eventually ended the surplus problem.

Farmers were required to maintain uncultivated acres in the number of acres for which they were being paid. They could plant the remaining 50 or 80 per cent of their corn base to corn if desired. This still left a vacancy in the agricultural picture, as some other crop was needed to utilize the rest of the farm lands that were not in this corn base. This void was quickly filled by application of two relatively new crops to the Corn Belt, grain sorghum and soybeans. Grain sorghum was finding increased acceptance in the western margins of the Corn Belt due to its hardy nature and resistance to drought. Grain sorghum produces about the same yield per acre as corn, has comparable nutrient value, and is worth approximately the same per harvested bushel.

The change from corn to grain sorghum was not temporary, and the western margins of the Corn Belt were adjusted to the east. Grain sorghum made striking inroads all along the southern sector of the transition zone. Lancaster County greatly altered its agricultural pattern and replaced many
acres of corn with sorghum. Although the northern and central sectors of the western margins remained about the same as the previous census periods, the southern sector greatly reduced its reliance on corn.

The core of the Corn Belt reflects the government program and its intended acreage reduction of up to fifty percent. Corn is still the most important crop of this region.
Very predictably, the highest proportion of cropland harvested in corn is found in the core of the Corn Belt. In this area, corn is harvested from half of the cropland. This becomes more significant when crop rotation is taken into account. Corn is not ideally suited to continued annual growth on the same plot of land. Corn Belt farmers usually rotate their plots in an effort to change the crop on each one in a maximum of three years. Continual cropping of corn on the same plot is considered unwise practice because of nutrient removal and lack of addition of sufficient humus to the soil. These factors then necessitate application of larger amounts of fertilizer and significantly raise production costs. In the core, corn dominates by occupying about half of the cropland in a rotation system composed mostly of corn, soybeans and hay or pasture.

In the transition zone of central Nebraska, the proportion of corn harvested is gradually reduced. A significant division line in the northern part of this zone is the county boundary line that divides Holt and Wheeler from Knox, Antelope, and Boone Counties. The proportion of corn harvested out of total cropland harvested drops rapidly from Knox and Boone with 37% and Antelope with 48%; down to a much lower figure of 11% in Holt and 9% in Wheeler. This extremely rapid drop in proportion of corn is predominantly
caused by physical factors. The climate and soil found in Holt and Wheeler Counties are better suited for use as hay or pasture producers than for corn production.

The central counties of the transitional zone lie farther to the west. Although several factors are involved in the extension of this marginal area, irrigation is the primary cause. The counties of Merrick, Hall, Phelps, and Dawson have as high a production of corn to cropland harvested as do most of the counties in the core of the Corn Belt. These counties are also located in the heaviest irrigation region of Nebraska. Since irrigation is a costly agricultural practice, farm owners in these areas are interested in a high yield of a high value crop. Under irrigation, corn will produce above average yields and an adequate return on the investment. Without irrigation, it is doubtful that corn would be found as the leading crop of this area.

The two southern tiers of counties in Nebraska along the transitional zone reflect a lack of dominance of corn. Certainly counties that have under 26% of cropland harvested being corn would not be considered typical of the Corn Belt. Corn is not grown in such great quantities due mainly to unreliable precipitation. Years with below average precipitation are numerous enough to make the more drought resistant crops of wheat and sorghum more reliable producers. Irrigation again accounts for the two more dominant counties of Phelps and Kearney.
The proportion of corn harvested out of the total cropland harvested declines from the core of the Corn Belt to the western margin.
The value of livestock sold can be used as an indication of the Corn Belt because of the close association between the two. Throughout the Corn Belt, the bulk of the individual farmers' income is derived from the sale of grain-fed livestock rather than the cash sale of grain. This situation exists because the farm operator can get a higher price for each bushel of grain if it is converted into meat rather than sold in its harvested form. The surplus of corn available for the cash market tends to keep the value per bushel at a low level, and, forces the farmer to seek a method of selling his crop in some form that has more demand.

The United States Government became the largest holder of this grain surplus by the use of the price support system. This governmental program guaranteed the farmer a minimum price for his grain through government purchase if the general market was not sufficient. The grain purchased under this program was fed back into the national market whenever the price of grain rose to a substantial level. Although the national government has reduced its one time vast supply of grain to an almost negligible level, their surplus and the additional high annual production has kept the cash price of corn at the same level for several decades. The growing demand for meat created by a rapidly expanding
population has proven to be a convenient outlet for surplus grain. The association between corn and livestock is interdependent to the extent that the Corn Belt is often referred to as the feed grain and livestock region.
The receipts from the sale of corn-fed beef constitutes the major source of income for Corn Belt farmers. The quality of their product is known both nationally and internationally, and is far superior to the grass-fed beef imported from other nations. This superiority stems from the internal change in the meat and the addition of fat throughout the product. Although some cattle are reared in the Corn Belt each year, the majority are purchased from the grassland regions which surround this region. The Sandhills to the west of the Corn Belt are ideally suited to the raising of large numbers of cattle.

Since corn is a bulky and low valued material, it is easier to import the cattle than it would be to transport the grain.

The core of the Corn Belt has many contiguous counties with over $16,000 worth of cattle sold per square mile. The peak counties are Douglas and Sarpy Counties, Nebraska and Sioux County, Iowa. Sarpy averages $86,468 for each square mile of land. The total dollars of cattle sold in these counties is influenced by the location of the market. Omaha and Sioux City both have extensive packing facilities and this influences the existence of the commercial feed lots in their immediate area. Commercial feed lots attempt to mass produce beef by feeding large numbers of cattle on a year-
around basis. Ease of marketing at these major meat packing centers has influenced the pattern of value of cattle sold.

The western margins of the Corn Belt reflect a decrease in the value of cattle sold per square mile. This is due to the necessity of reserving more acres per animal under a grazing system than is needed under a feeding system. The carrying capacity of the grasslands is the major determinant of cattle densities. The lower density on the short grasses in north central Nebraska causes this area to have the lowest value of cattle sold per square mile, even though the economy here revolves almost entirely around the sale of range livestock. Dawson and Phelps Counties occupy an advantageous position due to the presence of extensive grasslands, and an abundant supply of irrigated corn. Dawson County is one of the focal points for the sale of range livestock from the Sandhills region.

The increased value of a market weight beef over a grassland animal and the greater potential density of the more productive lands causes a decrease in the value of cattle sold away from the core of the Corn Belt.
VALUE OF CATTLE SOLD PER SQUARE MILE - 1964

Source: U.S. Census of Agriculture

16,000
12,000 - 15,999
8,000 - 11,999
4,000 - 7,999
UNDER 4,000

Figure 10
Pork production relies heavily on corn as the food source to the extent that numbers of hogs have often been used to suggest limits to the Corn Belt. Unlike cattle, the majority of hogs are born, raised, and marketed all within the Corn Belt region. Hogs are not pastured or allowed to mature before intense feeding and fattening begins. The intent is usually to bring them up to market weight in a rapid and continual program.

The value of hogs per square mile is not as great as the value of cattle in the core or the western margin of the Corn Belt. This lower total value of hogs is a reflection of the lower price per pound and smaller market weight. The advantage of swine over cattle lies in the smaller capital outlay necessary to begin operations and to achieve market weight. This makes swine production less risky and more appealing to the average Corn Belt farmer.

The peak value of hogs per square mile is in Sioux County, Iowa with $15,254 per square mile. The core of the Corn Belt has numerous counties that rank in the highest classification. The transition zone exhibits an abrupt drop in the value of hogs sold per square mile. As the supply of available feed corn diminishes, swine production ceases to be a major economic factor. The lower value per pound also places a limit on the transport distance to the
meat packing centers. The cost of transporting hogs from the western margins to Omaha or Sioux City makes it difficult for farmers in this area to compete with those in closer proximity. Swine production is therefore more characteristic of the Corn Belt core than of the western margins.
The value of sheep sold per square mile is much lower throughout the Corn Belt than either cattle or hogs. The peak value area is in Dickerson and Obrien Counties, Iowa with $1,881 and $1,566 per square mile respectively. The importance of sheep drops off very rapidly outside of the Corn Belt core, with only three Nebraska counties (Dodge, Sarpy, and Webster) having over a thousand dollars sold per square mile.

Sheep consume only small amounts of grain, and are therefore not as reliant upon corn as are the other meat animals. Mutton is not considered a staple meat in this nation and lower slaughter rates result.

Perkins, Chace and Dundy Counties show the application of sheep to areas not extensively suited for either hogs or cattle. This area, which lies outside of the transition zone in the non-Corn Belt area, bases its sheep enterprise on the use of grass vegetation.

Although a reduction in the value of sheep sold per square mile can be detected from the core to the western margin, sheep are not an integral part of the economy of this region.
In general, the value of poultry per square mile in the Corn Belt is greater than the value of sheep, but far less valuable than either cattle or hogs. Poultry actually consume only a small amount of corn, as the usual feed consists of a mixture of grains. They are important in some areas of the Corn Belt as a supplement to the family income.

The greatest value of poultry sold per square mile lies in the core of this region with Webster and Hamilton Counties at $15,819 and $8,250 respectively. These two counties are well located geographically to serve the larger urban centers of Iowa.

Poultry revenue experiences a rapid decrease along the western margins of the Corn Belt. This is especially true in the northern and central sectors. Where the Corn Belt gives way to the grazing region, the lack of a grain feed causes rapid reduction in the importance of poultry. The southern sector of the western margins is a much different situation. Counties such as Furnas, Harlan, and Kearney have an important poultry industry based not so much on corn as the basic feed, but on wheat and sorghum.
The importance of yield per acre to the Corn Belt farmer assumes critical proportions. Since production costs are stable, the profit margin is determined by the number of bushels harvested. For example, Greene County, Iowa had the highest average yield with 92 bushels an acre. Custer County, Nebraska averaged just half of this total or 46 bushels per acre. With the market value of corn being rather uniform, the marginal areas have difficulty competing with the core.

It is difficult to place exact limits on the feasibility of growing corn below a certain yield level. Certainly, all the counties in Nebraska that fall into the lowest two map categories (below 40 bushels per acre) are not economically suited for corn production. Those that average forty to sixty bushels an acre are definitely marginal, depending on which end of this category they are closest to.

The area of high average yields from Dawson to Kearney Counties can be attributed to irrigation. Larger yields are expected here to offset the higher costs of production.
The productive capability of the land itself determines the average size of farms over a region. The more productive land requires fewer acres to produce the same amount as can be derived from a poorer area. This makes it quite proper to find the smaller average size farms in the core of the Corn Belt. Farms under 250 acres are still adequate to provide the necessary income of a farm family in the core.

The average size of farm increases steadily from the core through the transition zone of the Corn Belt. There is a very small number of counties that averaged from 500 to 1,000 acres per farm. A vast majority were either below 500 acres or over 1,000 in size. Those that averaged over 1,000 acres reflect the presence of a grazing region. Cherry and Arthur Counties each average over 5,000 acres per farm. Single land holdings of this size are commonly associated with areas of low productivity and value. The counties that have between 500 and 1,000 acres in their average sized farms reflect the transition zone along the western margin of the Corn Belt.

In the northern sector of the Corn Belt margins, farm size changes rapidly. The boundary that divides Holt and Wheeler Counties from Knox and Antelope separates counties that are over 500 acres apart in their average sizes.
The central and southern sectors exhibit a more gradual transition in the average size of their farms.
AVERAGE SIZE OF FARM IN ACRES - 1964

Source: U.S. Census of Agriculture

Figure 15
The value of land per acre is directly related to its ability to produce. The more productive soils of the Corn Belt core have a higher value than those of the marginal area.

The highest value per acre land is found in the counties with the large urban centers. Douglas County at $504, Sarpy County at $426 and Polk at $390 per acre reflect the high cost of property on the edge of the urban area.

The value of land per acre generally decreases westward from the core of the Corn Belt. The only two exceptions to this are the urban area of eastern Nebraska and the irrigated region. These two show values above their surrounding areas.

The lands of the transitional zone were found to yield only about half as many bushels per acre as the core, and the average value per acre is approximately one half the core volume. The counties that have an average value of under $80.00 per acre are predominantly grazing lands.

The value of buildings would also be greater in the core. The typical farmstead of the Corn Belt core is larger and more complex than those of the western margins. The need to maintain a building for storage of machinery, grains, winter forage, and animals creates an expensive investment. The farmsteads tend to be less numerous and smaller in size in the transitional zone.
Tenancy is much more prevalent in the core of the Corn Belt than in the western margins. There are several reasons that account for this change in the type of management. A tenant normally receives his income in the form of one-half of the total farm revenue, with the other half going to the land owner. In this situation, the more productive land in the core will allow the tenant to succeed on a smaller amount of land.

A tenant usually acquires land when a farmer enters retirement or a landowner is employed in some other occupation. A farm owner will often become a tenant, if land becomes available, as a means of expanding his own enterprise without the expenditure of additional capital. The system of tenancy allows someone to enter the occupation without the extremely high cost of land purchase. The tenant still has a very substantial investment in equipment needed for farm operation.

The type of agricultural system in the transition zone is less suited to tenancy. Larger land areas would be needed to compensate for lower productivity. In many cases, an additional purchase of range livestock would be necessary.

The amount of tenancy drops abruptly along the line separating Boyd, Holt, Wheeler, and Greeley Counties from Knox, Antelope, Boone, and Nance Counties in the northern
sector of the transitional zone. This change in tenancy reflects a change in types of farming from feed grain to range livestock.

The heavy irrigation district has more tenancy due to higher productivity and a more typical Corn Belt type of agriculture.
Farms Operated by Tenant - 1964

Source: U.S. Census of Agriculture
IRRIGATED FARMS, PER CENT OF ALL FARMS
(Figure 18)

One of the important developments affecting crop production in Nebraska is the rapid growth of irrigation. Between 1945 and 1964, the number of irrigated acres increased from 631,762 to 2,169,317.¹ This annual growth rate of 6.7% per year is second highest among the states and places Nebraska fifth in the ranking of states by number of acres under irrigation.² Much of the increase in irrigation has been due to the development of groundwater wells. Nebraska is underlain by extensive supplies of underground water which is increasingly being tapped for agricultural use. The largest ground water and surface water sources coincide with the area on the map that exceeds forty per cent of all farms being irrigated.

Farm operators in this type of agriculture are most interested in planting a crop that will return a high volume and high value per acre. Irrigated farming is comparatively much more expensive than the conventional type. This extra cost is returned to the farm operator in the form of higher

¹Dr. Theodore Roesler, F. Charles Lamphear, and M. David Beveridge, The Economic Impact of Irrigated Agriculture on the Economy of Nebraska, Department of Economics, The University of Nebraska, Bureau of Business Research, 1969, p. 13.

²Ibid., p. 13.
yields and fewer crop failures. Corn is well suited to growth under a system of irrigated farming.

If the average yield per acre is multiplied by the normal market value, corn can easily compete economically with the other grains suited to this type of region.

The peak area of irrigation lies between Dawson and Phelps Counties on the west and Polk, York, and Fillmore Counties to the east. Irrigation has overcome one of the limiting factors to the growth of corn in this marginal area, and has effectively moved this margin farther to the west.

Iowa does not keep statistics on irrigation even though some does exist within its boundaries. Statistical data on irrigation in Iowa would be most difficult to use due to the fact that normally precipitation is adequate for agriculture in most years. The existing irrigation systems in Iowa may never be used for several years simply because there is no need. In other years, they might be utilized for only several weeks to get through a dryer period and remain unused the rest of the year. For these reasons, irrigation is not a factor in the core of the Corn Belt.
FERTILIZER, DOLLARS PER SQUARE MILE, 1964
(Figure 19)

Expenditures for fertilizer are higher in the core than along the western margins. The application of fertilizer is an expensive process, expected to return a profit through increased production. It is not well suited to areas with above average crop failures. If farm operators in the western margins experienced a drought, the added loss of fertilizer cost would make it a risky gamble.

The change in type of agriculture can also effect the pattern of fertilizer application. Corn and sorghum require large amounts of nitrogen if peak yields are desired. Wheat yields can be increased with application of fertilizer, but normally only small amounts are applied. This can be noted from the pattern of fertilizer dollars per square mile, as expenditures remain high in southern Nebraska corn and sorghum areas. The amount of money spent on fertilizer falls off much more rapidly in the marginal area between the corn and wheat regions.

The major irrigation region of Nebraska is also high in expenditures for fertilizers. The normal high cost of irrigated agriculture and removal of the drought factor makes fertilizer a safe investment.
The farm tractor is a familiar feature of the Corn Belt. The core of the region has twenty-one counties that average over six of these machines per square mile. Sioux and Winnebago Counties in Iowa are the leading areas with over seven per square mile. From this core, the number of tractors diminishes through the transition zone until the category of under 1.5 is reached in western Nebraska.

The need for tractors in the transition zone is lessened by a change in the type of agriculture. The grazing economy of Lincoln County, Nebraska would require far fewer of these machines than neighboring Dawson County. Wheeler and Greeley Counties show a sharp reduction in the need for tractors.
Source: U.S. Census of Agriculture
The decline in the number of cornpickers per square mile can be used as a valid indicator of the western margins of the Corn Belt. Where the need for cornpickers diminishes below 0.50 per square mile, corn cannot be the most important type of agricultural land use. The western border of Antelope and Boone Counties marks a significant drop in the number of cornpickers.

The irrigation region of Nebraska reflects the importance of corn in their agricultural system by having a larger number of cornpickers per square mile than the counties to the north or the south. The number of cornpickers in the southern tier of counties in Nebraska shows the presence of corn but not in dominant quantities. The counties from Jefferson to Franklin appear to use corn in conjunction with other crops, but only to a minor degree. The recent trend of combining and shelling corn instead of picking it will cause a future reduction in the number of cornpickers, especially in areas where combines are needed to harvest the wheat and sorghum.
NUMBER OF CORN PICKERS
PER SQUARE MILE - 1964

Source: U.S. Census of Agriculture

Figure 21
The area of heaviest density of combines is in southern and eastern Nebraska. Although combines can be used to harvest corn, this area of density reflects the presence of other crops in major proportions. Wheat and sorghum have gained wide acceptance in southern and western Nebraska over the last few years. In many cases, sorghum is replacing corn on marginal lands.

The number of combines per square mile diminishes more rapidly in the northern sector than in the central or southern. This is caused by the change from corn to predominantly grazing in the northern sector, while the change in the central and southern sectors is from corn to wheat or sorghum.

The core of the Corn Belt ranks below southern Nebraska in density of combines.
The ranking of crops for each county from first to third in order of importance was accomplished by comparing the total acres of each crop to the total harvested cropland. Corn dominates a large part of the study area, ranking first in all Iowa counties and a wedge shaped portion from eastern Nebraska to Lincoln County.

The line of importance is the one separating counties that rank first in corn from those with some other crop in the dominant role. In the northern part of the transition zone, corn loses dominance in the same area that showed a changing pattern on most of the topical maps. Holt and Wheeler Counties are again located on the edge of a changing agricultural situation. The transition from corn to hay and pasture is the result of a complex set of factors.

The irrigation region of Nebraska specializes in corn, and causes the wedge shaped extension of corn dominance into an area not ideally suited to extensive growth of this crop. Irrigation allows corn to be grown out as far as Keith and Perkins Counties, where the wheat region is encountered.

The southern boundary of predominant corn growth encounters a zone of wheat and sorghum from Pawnee to Hitchcock Counties.
FIRST RANKING CROP, PER CENT OF CROPLAND HARVESTED - 1964

Source: U.S. Census of Agriculture

Figure 23
SECOND RANKING CROP
PER CENT OF CROPLAND HARVESTED 1964
(Figure 24)

The map of second ranking crops shows the second most important crop of each county by comparing each crop's total to harvested cropland. The tremendous increase in soybean acreage over the past few years is most noticeable in the core of the Corn Belt. Most of the Iowa counties have soybeans as the second most important crop. Hay and pasture is found as the second ranking crop in southern Iowa.

A variety of crops ranking second are found in the area of Nebraska that had corn as the first place crop. All five of the other crops mapped are represented somewhere throughout this area. Oats are second in the northern area, from Thurston through Knox Counties. This crop is well suited to the cooler climate and shorter growing season found here. Hay and pasture occupies a broad zone from Custer to Burt Counties, reflecting the lower precipitation, and increasing importance of grazing. Wheat tends to be the second ranking crop in the area where sorghum was most important. This is a rather logical pattern, since both of these crops are well adapted to growth under dryer conditions.

There are very few counties that have corn as the second ranking crop, and all of them are directly adjacent to counties that had corn as the predominant crop. A sizeable area in northern Nebraska, from Keya Paha to Wheeler
Counties, shows the use of corn as a livestock feed in an area that is mainly hay and pasture. The other scattered counties of corn in second place lie on the fringe of the transition zone, and would fall into the category of marginal producers.
SECOND RANKING CROP, PER CENT OF CROPLAND HARVESTED - 1964

Source: U.S. Census of Agriculture

Figure 24
THIRD RANKING CROP
PER CENT OF CROPLAND HARVESTED 1964
(Figure 25)

Hay and pasture dominates the map of crops ranking third in each county. This bears out the importance of livestock in the Corn Belt and the associated need for winter forage and roughage.

The versatility of sorghum is demonstrated by the band of counties from Keya Paha and Boyd in the north to Dundy, Phelps, and Kearney in southern Nebraska. Sorghum can be grown in these areas in conjunction with corn as a hedge against drought.

Corn ranks third in the southern counties from Hitchcock through Gage Counties. The climate of this area provides more reliability in growing wheat or sorghum than in corn.
THIRD RANKING CROP, PER CENT OF CROPLAND HARVESTED -- 1964

Source: U. S. Census of Agriculture

Figure 25
FIRST RANKING CROP
PER CENT OF CROPLAND HARVESTED 1969
(Figure 26)

A few minor changes and adjustments occurred in the western margin of the Corn Belt during the 1969 census period. It is difficult to detect a pattern here, as the actual acreage shifts were small. Even small changes in acres planted can result in a county changing its first ranking crop along this western margin. The lack of one crop predominating the agriculture scene of marginal counties will cause this pattern to change from year to year. It can be noted that all of the counties of eastern-central Nebraska retained corn as the first ranking crop, while the changes in classification occurred along the margins.

Hay and pasture gained prominence along the western margins by ranking first in the large counties of Custer and Lincoln. The lack of precipitation in this area has caused a minor retreat of corn agriculture in this area.

The growing of wheat and sorghum in the southern counties of Nebraska remained fairly constant. Wheat gained first ranking in several counties at the expense of sorghum, while sorghum cropping in general was falling off. Thirteen counties have sorghum as the major crop in 1964, with only seven retaining this majority in 1969. The peak area of sorghum agriculture to the south of Lancaster County is still very significant.
The only notable advance of corn in the agricultural system is to be found in the counties from Gosper to Saline. The 1969 figures show corn replacing wheat and sorghum in five contiguous counties as the first ranking crop.
FIRST RANKING CROP, PER CENT
OF CROPLAND HARVESTED - 1969

Source: U.S. Census of Agriculture

Figure 26
SECOND RANKING CROP
PER CENT OF CROPLAND HARVESTED
(Figure 27)

The most notable change in second ranking crop from 1964 to 1969 is found in the increased utilization of corn to the west of the Corn Belt margins. A triangular group of counties from Holt on the east, to Lincoln on the south, and Cherry on the north show the importance of a feed grain in an area of predominant hay and pasture. The corn grown here can be readily used to supplement roughage feeds in a winter cattle ration. Although total yield and production in these counties is not representative of Corn Belt agriculture, it is significant to the livestock enterprise.

The broad belt of hay and pasture from Dawson County to Wayne County shows the need for a roughage feed in a feed grain and livestock situation. An extension of sorghum can also be noted in the area between Hamilton and Butler Counties.

Counties with a second ranking of soybeans in 1969 are identical to those of 1964. Although many counties showed an increased acreage of soybeans in 1969, it was not sufficient to alter the pattern.
SECOND RANKING CROP, PER CENT
OF CROPLAND HARVESTED - 1969

Source: U.S. Census of Agriculture

Figure 27
THIRD RANKING CROP
PER CENT OF CROPLAND HARVESTED
(Figure 28)

Only minor changes occurred in the pattern of third ranking crops. Again, the most notable changes are found in the block of northern counties. The 1969 census shows a belt of small grain production from Cherry to Dixon Counties that was not in evidence in 1964.

It also appears that there has been a general reduction in the use of grain sorghum in Nebraska. Earlier statistics gave the impression that sorghum was replacing corn in many of the dry margin areas. The 1969 figures show a reversal of this trend, with corn recording sizeable gains over sorghum in many areas.
THIRD RANKING CROP, PER CENT
OF CROPLAND HARVESTED - 1969

Source: U.S. Census

Figure 28
CORN YIELD
BUSHELS PER ACRE - 1969
(Figure 29)

The average yield per acre shows a dramatic rise in 1969 over the comparative yields for 1964. None of the study area counties in Nebraska show a decline in average yield for this census period. The most significant yield increase is found in a broad belt from Hitchcock and Keith Counties on the west to the Missouri River on the east. It is virtually impossible to even suggest the existence of a western marginal area on the basis of yield per acre. Counties such as Brown, Blaine, and Perkins are well outside the accepted Corn Belt transition area, but have average yields in the "over eighty bushels" category. All of these counties had averaged less than forty bushels an acre in 1964.

The peak corn yield county in 1969 is Hamilton County, with 123 bushels per acre. This compares to just 76 bushels an acre for the same county in 1964. The 1964 census found no county in Nebraska with an average yield in excess of one hundred bushels per acre, as Dawson led with 87. The 1969 census had twenty Nebraska counties averaging over 100 bushels per acre.

If a significant break in average yield per county is to be detected, it would have to be along an east-west line from Thurston to Arthur Counties. The average yield of almost all counties south of this line fall into the over eighty bushel category.
Several factors help account for this rapid increase. The climate of the agricultural year 1969 was much better than average. The almost ideal growing conditions provided during this year gave unexpected returns in the form of higher yields. This, coupled with increased knowledge in the area of productive farm practices, helped to create the new pattern. Increased fertilization, higher density planting, irrigation, and adapted seeds have given non-Corn Belt counties these high yields.
CORN YIELD, BUSHELS PER ACRE - 1969

Source: U.S. Census of Agriculture

Figure 29
The proportion of corn harvested as compared to the total harvested cropland changed very little between the census periods of 1964 and 1969. The only noticeable trend is a slight overall increase in the utilization of corn in Nebraska's agricultural system. The number of counties with over fifty-two per cent of harvested cropland in corn increased from ten counties in 1964 to 16 counties in 1969. The major irrigation region shows increased usage of corn, as the counties from Phelps to Seward represent.

There were almost no changes in proportion of corn harvested along the transition zone of the Corn Belt. The counties through this region of central Nebraska either remained the same or increased very slightly. This suggests a somewhat stable crop rotation pattern that has been determined mainly by physical factors. Corn diminishes in the less productive area, where the annual risk increases.
CORN, PROPORTION OF CROPLAND HARVESTED - 1969

Source: U.S. Census of Agriculture

Figure 30
CORN
ACRES PER SQUARE MILE - 1969
(Figure 31)

The acres of corn per square mile increased only slightly from 1964 to 1969. A general increase can be noted in most of the counties of eastern Nebraska. The most unchangeable pattern is the line separating counties with less than sixty acres per square mile from those with more than sixty acres per square mile. Valley County is the only exception, as it dropped from 62 acres in 1964 to 57 acres per square mile in 1969. All of the other counties that were under sixty in 1964 remained the same in 1969.

The heavy irrigation region from Phelps through Seward Counties shows increased usage of corn in the agricultural pattern.
CONCLUSIONS

The agricultural patterns of the core and of the western margins are similar in some respects, but yet quite different in others. Both areas utilize corn as a grain crop, and nurture it in the same manner. There is very little difference in the method of field preparation, planting, cleaning, and harvesting of corn in either of these two areas. Fields of corn undergo the same treatment in the western margins as they do in the core of the Corn Belt.

The great difference between agriculture in the core and in the western marginal region is in the intensity of the application of typical Corn Belt agriculture. Farmers in the core rely very heavily on harvested corn and corn-fed livestock for income. The only significant supplementary income that can not be directly traced to corn comes from the cash sale of soybeans, which are being increasingly used in the rotation. The landscape of the Corn Belt core is almost completely dominated by corn.

Corn is utilized in the western margins and can be found in further reduced quantities in counties to the west. The tremendous intensity of production and the dominance of corn is not the same however, as other crops and agricultural systems have replaced it.

Agriculture is more diverse in the margins than in the core. Farmers of the marginal lands usually rely on a
variety of crops or livestock to provide income. The entire agricultural pattern reflects the existence of a lesser quality land resource. Corn is still important to the farmer in the western margins, but not to the critical extent that it is in the core.

The gradual replacement of Corn Belt agriculture has been demonstrated through the use of census data mapping. The maps show the diminished effect of corn and associated agricultural factors, from the core toward the western margin. The gradual decline of corn acres, yield, livestock, and other factors proves the existence of a transitional zone along the western margins instead of a concise regional termination line.

Since it is evident that corn loses dominance from the core toward the western margin, and is eventually replaced by another agricultural system through this transitional area, certain factors must be responsible for causing this change. Physical changes in the landscape itself and in the climate seem to be the most limiting. As the physical factors of soil, precipitation, and growing season interact to gradually reduce corn productivity in the transitional zone, more resistent crops are able to compete economically. Corn ceases to be the dominant crop in the areas where another crop can be expected to yield a greater return. In the northern two-thirds of the transition zone, corn is gradually replaced by hay. This crop is better suited to the
cooler and dryer climate as well as the more porous, sandy soil.

Wheat gains dominance in the south central transition zone from Hayes through Webster Counties. Grain sorghum is making significant progress along the southern zone in an area centered about Lancaster County. A rapid increase in the acreage planted to soybeans is a trend more noticeable in the core of the Corn Belt than in the western margins. The cash value per bushel is especially attractive in areas where high yields are anticipated.

The agricultural pattern of the Corn Belt region has been constantly changing through time. This seems to be more true of the western margins than of the core. Whereas the core has remained fairly stable in its typical agriculture and has displayed only gradual change, the western margins tend to fluctuate much more rapidly. The changeable nature of the western margins is understandable in that most marginal areas are not truly stable agricultural producers.

Farmers of the western margins are dealing with an inferior area in comparison to the core. The transition zone has less fertile soil, lower and less predictable precipitation, and a shorter growing season. This causes much more experimentation and diversification in the western margins. Farmers here can not afford to gamble everything on the expectation of a good corn crop. As a hedge, they feel the necessity to plant other, drought-resistant and
rapid-maturing crops. If either production level or average price of corn shows a decline, these farmers may alter their choice of crops in hope of a larger return.

If the transitional zone experiences several years of adequate precipitation and above average prices, the acreage allotted to corn is expanded. In years where the reverse is true, corn acreage is decreased. The farmers in the transitional zone of the western margins of the Corn Belt are constantly seeking a new crop, or a new variety that will increase their productivity.

One of the most significant changes in the western margins has been the increased use of irrigation. The counties from Dawson and Phelps through Filmore and Polk represent the heaviest irrigation, with over forty per cent of all farms being irrigated. Surrounding counties such as Keith, Lincoln, Valley, Howard, and Gosper average about a third irrigated. This type of farming has increased greatly over the past few years.

The use of irrigated farming has had a marked effect on the amount of corn planted in these counties. By using only natural rainfall, counties such as Dawson, Phelps, and Lincoln would very likely be forced to plant other crops of more drought resistant character. The use of irrigation has effectively moved the transitional production zone farther west. Total corn production, yield, and acres planted, are as high through this irrigation zone as they are anywhere
in the state. The application of additional water has changed much of this area from marginal to Corn Belt.

Although the mapped statistical data reveals the existence of a gradually changing transitional zone as opposed to a definite termination line, the change in agricultural pattern appears to be more abrupt in the far northern area. The county boundary that divides Holt and Wheeler from Knox and Antelope Counties was often the dividing line between very different types of agriculture. The reduction of typical Corn Belt agriculture to the west of the boundary was detectable in many of the maps.

Changes will continue in the agriculture of the core as well as the western margins of the Corn Belt. These changes will reflect the continuing search for maximum economic production.
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