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Agricultural Economic Report No. 196

Effect of Urban Expansion on Dairying in the Lake States, 1949-69

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ABSTRACT

Census of Agriculture data for selected years during 1949-64 indicate that longrun changes in Lake States dairying are related importantly to economic forces whose geographic impacts vary considerably. In the economic setting typified by large, expanding metropolitan areas, dairying is now declining in importance. In contrast, dairying is becoming more important beyond the sphere of urban-industrial expansion--over 30 miles from metropolitan areas. The net consequences over time of these changes are shifts from the metropolitan areas in the geographic distributions of the number of milk producers, milk cow numbers, and aggregate milk production.

Key Words: Urban-industrial expansion, dairy farm decline, land values, milk production, and off-farm labor earnings.

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SUMMARY

A major shift of dairy production in the Lake States since World War II has been from farms near metropolitan centers to larger farms 30 miles or more from the centers. More visible changes in dairy farming during this period include increased milk production (although output is now down from its peak in 1964); a downtrend in numbers of cows and dairy farmers; and a rapid increase in milk output per cow. Milk prices at the farm level, except during the Korean war and since 1965, generally have been low.

Until recently, milk for fluid use was largely produced within 30 miles of metropolitan centers, because of transportation and perishability problems of shipping it from farther out. The close-in areas have assumed the following important characteristics: (1) High land values and substantial land speculation; (2) high nonfarm labor incomes; (3) rapid increases in population; (4) improved transportation facilities, especially highways; (5) a relatively rapid withdrawal of land resources from the agricultural sector and their incorporation in nonfarm uses; and (6) many alternative occupational-cultural opportunities for farm youth.

With the shift, dairying is taking on new importance in areas 30 miles or more from metropolitan centers. Key characteristics of this environment include: (1) Lower land values and larger farm size than the close-in areas; (2) low labor incomes and few jobs; (3) steady to slightly declining population; (4) improved farm-to-market highways (especially important for bulk milk transport); (5) a stable or slightly expanding agricultural land base; and (6) relatively few alternative job opportunities for farm youth. It is within this environment that Lake States dairying is recording its greatest gains. The number of farms reporting 30 or more milk cows is increasing rapidly in these areas. An expansion in farm acreage often accompanies herd enlargement.

In areas close to cities, dairying is being driven out, but some of the land is being used for other types of agriculture while being held for future sale. Smaller herds are quickly disappearing from the entire Lake States region, because these operations cannot generate adequate income for a family. The decline in numbers of close-in producers with medium-size herds has also been substantial.

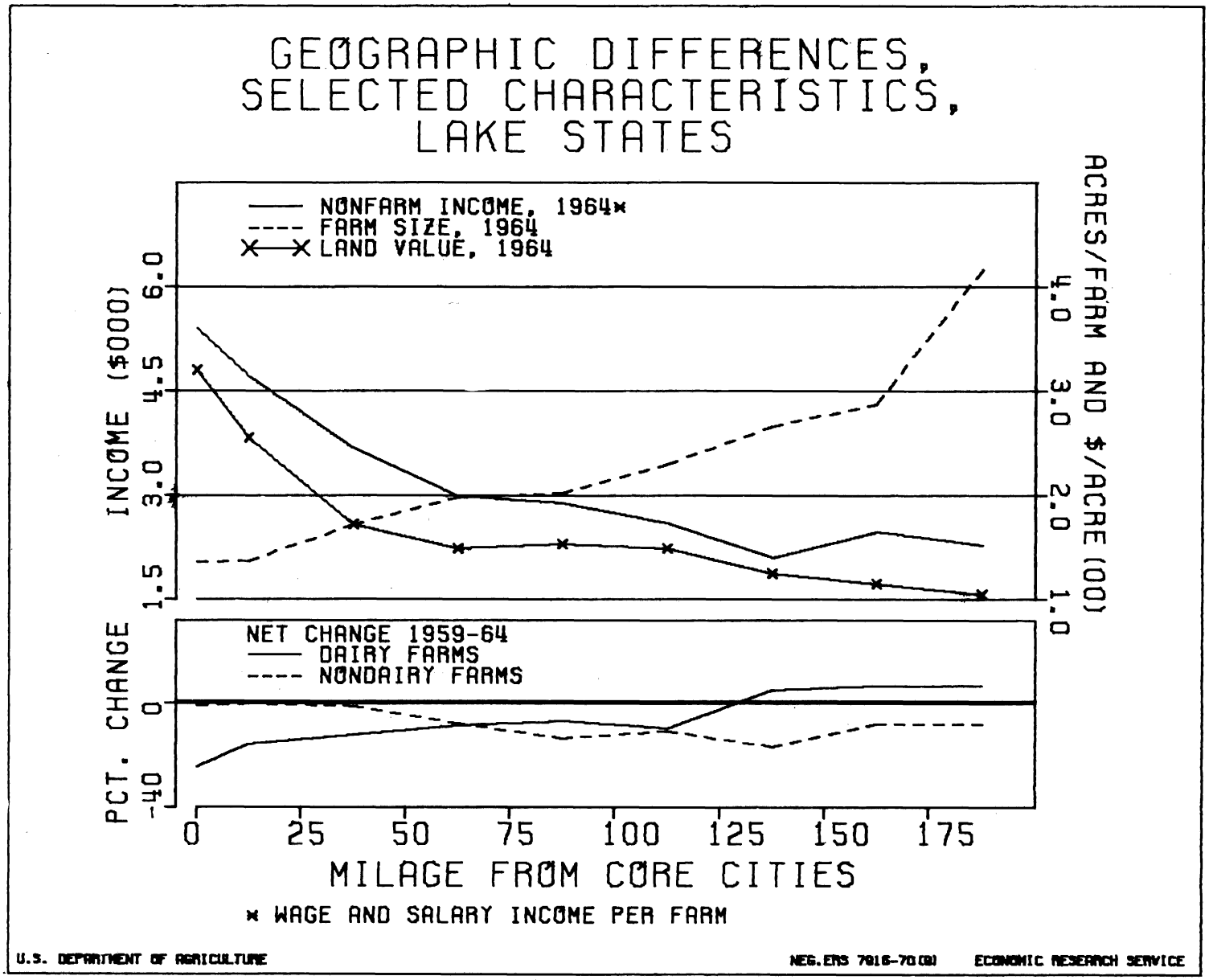
GEOGRAPHIC DIFFERENCES,
SELECTED CHARACTERISTICS,
LAKE STATES
NONFARM INCOME, 1964*
FARM SIZE, 1964
LAND VALUE, 1964
INCOME ($000)
6.0
4.5
3.0
1.5
ACRES/FARM AND $/ACRE (00)
4.0
3.0
2.0
1.0
NET CHANGE 1959-64
DAIRY FARMS
NONDAIRY FARMS
PCT. CHANGE
0
-40
0
25
50
75
100
125
150
175
MILAGE FROM CORE CITIES
* WAGE AND SALARY INCOME PER FARM
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Figure 1

EFFECT OF URBAN EXPANSION ON DAIRYING IN THE LAKE STATES, 1949-69

by

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INTRODUCTION

The Lake States is the most important U.S. milk-producing region. After World War II and until the midsixties, annual increases in milk production and decreases in cow numbers and dairy herds typified dairying in the region and nationally. Total milk production increased because of steady gains per cow stemming from improved animal nutrition, breeding, and housing.

These historical trends altered in 1965. The downturn in cows and herds intensified that year, and milk production dropped sharply and has continued to fall. National milk production declined substantially, but not as severely as the 5.5-billion-pound decline from 1952-53. However, the significant declines in the Lake States during 1964-66 abruptly reversed the region's production trend, and concerned the dairy industry more than the change in national output. Milk prices across the Nation rose sharply in 1966 and 1967, following 13 years of relatively stable and low prices, and have continued to gain. The sharpest hike came in 1966, when dairy price support levels were raised twice. After the drop in the milk supply from 1964 to 1966 and the price improvements in 1966-67, the downtrend in Lake States cow numbers, dairy herds, and production moderated (table 1).

Since World War II, the number of dairy farmers producing milk for both fluid and product markets has been declining at a rapid rate nationally but at a noticeably slower rate in the Lake States. Initially, losses largely were of non-dairy farms on which only a few milk cows were kept, mainly for milk for home consumption. Today, however, increased economic pressures and gains in technology encourage enterprise specialization, and the trend toward fewer but larger producing units is accelerating. Even operators of specialized dairy farms now account for a substantial proportion of the producer decline.

Production of fluid milk in the Lake States is concentrated in southeastern Wisconsin and southern Michigan. The outflow of manufacturing grade milk from western Wisconsin and Minnesota is fading. Producers of grade B milk there are converting to the lucrative fluid market in response to the expansion of urban markets. Proximity to efficient manufacturing milk plants still provides a price advantage for grade B producers in some areas of the Lake States. Also, particularly in the more remote areas of the Lake States milksheds, some farmers prefer the manufacturing grade milk market because whey and skim milk--byproducts of cheese and butter--are used as supplementary feed for swine and poultry.

Table 1.--Contribution of the Lake States to U.S. dairy farming, 1945-69

Item	Unit	1945-54 average	1955-64 average	1965	1966	1967	1968	1969
Milk production 1/.....	Mil. lb.	28,886	33,282	35,100	33,212	33,165	33,029	32,381
Proportion of U.S. total....	Pct.	24.7	26.8	28.3	27.7	28.0	28.2	27.9
Milk cows 2/.....	Thous.	4,567	4,186	3,892	3,655	3,523	3,424	3,326
Proportion of U.S. total....	Pct.	20.3	23.0	26.1	26.0	26.1	26.3	26.2
Production per cow.....	Lb.	6,324	7,950	9,018	9,087	9,414	9,644	9,736
Relative to U.S. average....	Pct.	121.4	116.1	108.6	106.8	107.0	107.3	106.3

1/ Excludes milk sucked by calves.
2/ Average number on farms during year, excluding heifers not yet fresh.

Source: Economic Research Service. Milk Production, Disposition and Income, annual and summary reports.

Before the days of adequate refrigeration techniques, vastly improved transportation methods, and classified pricing in the well-organized State and Federal marketing orders, most milk for the fluid market had to be located close to market. Bulky and highly perishable milk for fluid use could be transported safely only over relatively short distances, so producers located near rapidly expanding urban-industrial growth centers within the region--Detroit, Madison-Milwaukee, Green Bay, Minneapolis-St. Paul, and Duluth-Superior--or nearby, particularly Chicago. As new transportation and refrigeration technology was adopted, producer location close to these major consumption markets became relatively less important.

Geographic expansion of milksheds today is least prevalent in the Detroit milkshed because of the historical development of the well-established dispersion and interspersion of many urban markets--Battle Creek, Detroit, Flint, Grand Rapids, Jackson, Kalamazoo, and Lansing. The Detroit milkshed is virtually self-sufficient, as nearly all fluid milk consumed within it is produced in the Lower Peninsula of Michigan.

In the remaining Lake States, the milksheds are not as well defined in either production or marketing. To ensure adequate supplies of fluid milk, geographic expansion is widespread. Expansion northward, particularly in Wisconsin, continues as grade B producers are financially able and willing to convert to grade A markets and as milk handlers are willing to accept new suppliers for the fluid market. The Twin Cities milkshed, which developed initially in east-central and southeastern Minnesota, continues to spread into western Wisconsin and deeper into southern Minnesota. It is approaching the theoretical circular supply area. In 1961, half the fluid milk consumed in the Twin Cities was produced in northwestern Wisconsin.

Recent advances in the bulk transport of milk and our interstate highway network, coupled with expansion of heavily populated, highly industrialized areas within the Lake States, are reshaping the traditional agricultural-industrial balance in the region. This applies particularly to dairying.

OBJECTIVE AND HYPOTHESIS

This study investigates the longrun dynamic forces underlying the recent abrupt changes in Lake States dairying. It also assesses the future structure of dairying in that region and the implications for aggregate milk supplies. Primary emphasis is placed on longrun structural adjustments--number and size of producing units--related to geographic factors, both economic and noneconomic.

The central hypothesis is that recent reductions in aggregate regional milk supplies and the accelerated rates of decline for both cow numbers and producing units have been occurring where the local economy is influenced more by nonfarm developments than by the agricultural environment.

Within the Lake States, the nature of milk--its perishability, inelastic demand, and bulkiness--led initially to the establishment of dairy farms close

to developing population centers. This pattern conforms closely to Von Thunen's location theory.1/ In essence, Von Thunen envisioned a land use pattern under which: (1) Lands near consumption markets would be used intensively to produce milk, truck crops, poultry, and other perishables, which are difficult and costly to transport; (2) the tendency for transportation costs to increase with distance from the product markets would lead to production of commodities requiring lower product transportation costs per unit, such as feed grains, other field crops, and hogs and beef.

But the hypothesis advanced here is that rapid urban-industrial growth in the Lake States, coupled with increasing bulk milk handling and improved highways and methods of refrigeration are canceling, at least in part, the nearness-to-market advantages theorized by Von Thunen. Rapid economic development in the Lake States--particularly in southern Michigan, eastern Wisconsin, and eastern Minnesota--is exerting increasing pressure for use of land resources for nonagricultural purposes--space competition--and is giving rise to an unprecedented level of off-farm employment opportunities. Consequently, local land values are high and rising, and nonfarm jobs are becoming increasingly attractive as alternatives for farm operators and potential hired labor.2/

Farmers near urban centers can realize economic gains in several ways--land value appreciation, fractional land sale with retention of the residence, and land rental. The operator of a dairy farm cannot take off-farm employment full- or even part-time, because of the time required to tend the herd. In contrast, the cash grain farmer can buy or hold agricultural land for speculation, raise grain for sale, participate in Government programs, and work at least part-time off the farm.

Off-farm employment attracts many farmers located near urban centers, because it does not require physical relocation or social adjustment to a new work environment. Once exposed to urban life, the farm operator and his family adjust readily to its ways.

All these urban factors interact and become integrated into a package--a way of life. My proposition is that where these factors prevail together, declines in milk production, cow numbers, and producing units are substantially greater than where the setting is predominately rural.

PROCEDURE AND DATA

The procedure selected consists of delineating the Lake States region on the basis of a location theory criterion and adapting data to this model to investigate and test the hypothesis.

1/ For a more detailed discussion of this theory, see: Barlowe, Raleigh, Land Resource Economics, Prentice-Hall, 1958, pp. 33-35, 249-260.

2/ Von Thunen's theory was based on explicit transportation cost differentials, and did not entertain land and labor costs in an opportunity returns sense.

The geographic model developed for this study is fundamentally Von Thunen's location model in its simplest form (fig. 2, center spread, pp. 24-25).3/ It entails the construction of a series of equidistant, modified concentric circles radiating from the core (identifiable as a principal city, or cities) of each SMSA (Standard Metropolitan Statistical Area) as defined for 1960 by the U.S. Bureau of the Census.4/ Depicting geographic isolines, spaced uniformly at 25-mile intervals, helps relate the farm's physical location to the SMSA's on a linear distance basis. This avoids having to reduce the number of variables that are free to interrelate over time as would have been the case if a set of isoprice, isocost, or other measurement lines had been the basis of selection.5/ Nine geographic zones are delineated, and the smallest geographic unit aggregated is the county:

Z_0 = SMSA, 0 miles from core	Z_3 = 50-74 miles from core
Z_1 = less than 25 miles from core	Z_4 = 75-99 miles from core
Z_2 = 25-49 miles from core	Z_5-Z_8 = 4 zones, 100-200 miles from core

The resulting pattern of expanding equal-interval zones defines the following subareas: (1) Southern Michigan, (2) the eastern two-thirds of Wisconsin (Madison-Milwaukee-Green Bay based), (3) southern Minnesota and west-central Wisconsin (Twin Cities based), and (4) northern Minnesota and northwest Wisconsin (Duluth-Superior based). The remaining portion of the region--the Upper Peninsula of Michigan--was eliminated for reasons cited in appendix A.

By happenstance, these four areas conform closely to the existing major Lake States milksheds--Detroit, Chicago-Milwaukee, Minneapolis-St. Paul, and Duluth-Superior. The model constructed should be sufficiently analogous to the presently defined milksheds for the results of the analyses to be applicable without extensive modification.

The basic set of data incorporated into the geographic model are primary Census of Agriculture county population data, which are based on a 20-percent sample. Confining the data considered to this source reduces the problem of obtaining comparability over time, which cannot be avoided even when using published census data only. Comparisons are made using data for the census years 1949, 1954, 1959, and 1964, depending on both the specific objective and the particular characteristic considered. Data on milk cow numbers, for example, are available as a continuous, comparable series, whereas data on the number of commercial dairy farms are not, because of a 1959 change in definition. Data on

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3/ No single method of delineating a region has been found that meets perfectly the criteria of Von Thunen's location theory. Implicit in this study is the testing of the hypothesis that Von Thunen's theory is no longer wholly applicable.

4/ By census definition, each SMSA must include at least: (1) A city with 50,000 inhabitants or more, or (2) two cities having contiguous boundaries and consisting, for general economic and social purposes, of a single community with a combined population of at least 50,000, the smaller of which must have a population of at least 15,000. If two or more adjacent counties each has a city of 50,000 inhabitants or more, and the cities are within 20 miles of each other (city-to-city limits), they will be included in the same area unless there is definite evidence that the two cities are not functionally integrated.

5/ A complete description of the model--its physical characteristics and underlying rationale, and its limitations and consequences--can be found in appendix A.

off-farm income are available only for 1964. Further, population census data for 1950 and 1960 are used to establish the urban element in the region. Census data also are used for two Markov chain analyses of distributions of farms by number of milk cows and by acreage.

CHANGES IN DAIRYING OVER TIME

Location of Farms

Commercial dairy farms in the Lake States outnumber all other commercial farms combined, and since 1950 has remained a stable proportion of all types of commercial farms, about 51 percent.

Among the other major types of farms, cash grain farms have increased relative to all farms and their number has remained about constant since 1954. This situation probably can be attributed to Federal Government support programs (principally feed grains and wheat), the introduction and rapid growth of soybean production in the southern portion of the Lake States, the northward movement of hybrid corn production, and the rapid advances in grain farming mechanization. The region's "other livestock" farm population--representing specialized hog or beef production, or both--also has been relatively stable compared with all other commercial farms.

Because of the inherent flexibility in the organization of farms other than true dairy operations, changes in numbers and rates and the direction of change probably reflect shifts over time among the farms engaged principally in cash crop or livestock production. The net result has been that losses in the number of dairy farms have been proportionally greater than losses among all other types combined, a relationship which was more pronounced during 1959-64 than during 1950-54. During 1959-64, commercial dairy farm disappearance of over 11 percent was nearly double the rate for all other commercial farms combined, and accounted for two-thirds of the net loss of commercial farms. Reinforcing the implications of these changes was a 40-percent increase between 1950-54 and 1959-64 in the rate of decline in dairy farms.

Census data for 1959 and 1964 showed substantial variations in changes in the geographic distribution of dairy farms. Their rate of disappearance in the Lake States was related significantly to their geographic distance from major urban-industrial complexes (fig. 3 and table 2). The differential rates of change varied from a decline of nearly 25 percent for the aggregate of 27 SMSA counties to an increase of 7 percent for the most distant zone (Z_8).

The proportional rate of disappearance for each of the nearest three zones (less than 50 miles from core cities) accelerated between 1950 and 1964. The area within 50 radial miles contained 55.5 percent of the farms in 1959, but had 73 percent of the loss in number of farms during 1959-64. Comparable earlier figures were 58.6 percent for 1950 and 85.7 percent for 1950-54. The rate of shift of dairy farming from areas adjacent to the core cities between the two periods suggests that the influence of urban-industrial expansion on dairying is intensifying. Rates of decline for the two nearest zones (Z_0 and Z_1) were

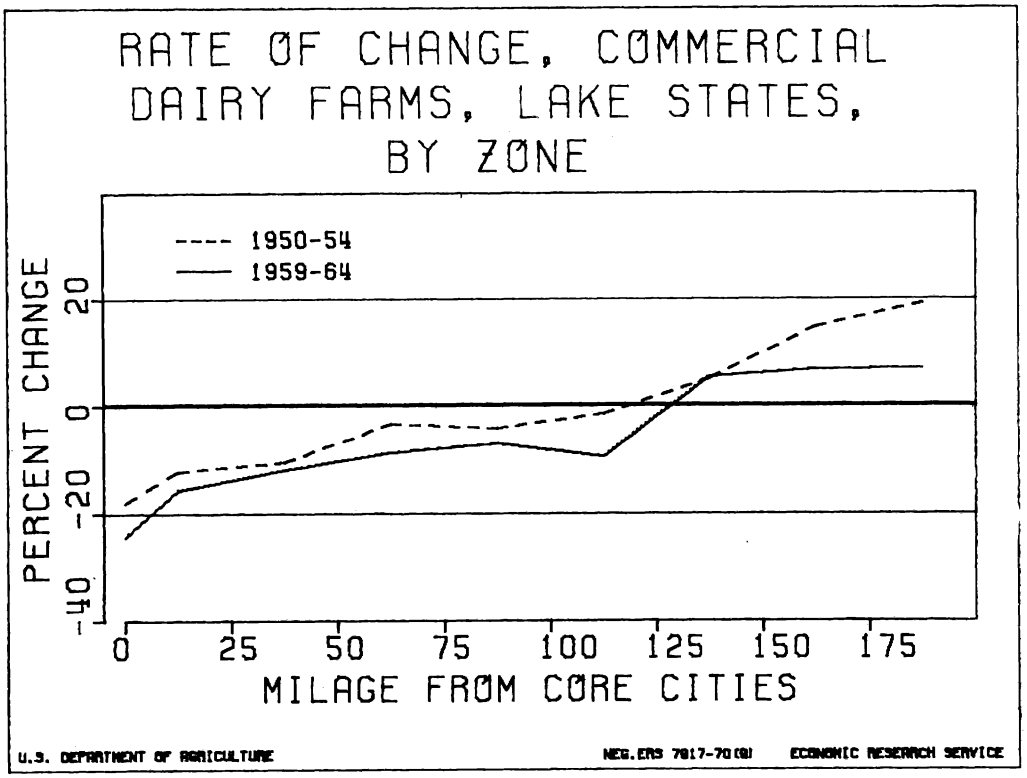

Figure 3

considerably greater for 1959-64 than in 1950-54, and represented 47.7 and 56.0 percent, respectively, of gross dairy farm losses. A distribution of individual counties within each zone on the basis of the 1959-64 change in dairy farms provides additional evidence of the sharp differential geographic effect (see appendix table A).

The pattern of changes in dairying shown in table 2 dates back at least to 1950. Agreeing with Von Thunen's location theory, table 2 data show the early establishment of dairy farm concentrations in relatively close proximity to the major consumption markets. The data also reveal that these areas (zones) currently are where the dairy farms are disappearing most rapidly. This is not true of all types of farms found interspersed with dairy farms in the close-in zones, where the number of cash grain farms increased sharply during both periods cited. Also, the rate of decline of dairy farms in the 250,000 or more total population SMSA counties (zone Z_0^*) is significantly greater than the rate for the less dense SMSA counties (zone Z_0'). This reinforces the thesis that the swelling urban areas have a substantial effect on dairying. The net effect of these rates of change is a declining proportion of dairy farms within a radius of about 50 miles from urban-industrial complexes, and, as the following paragraphs will indicate, the converse beyond this range.

Changes occurring in the numbers of other types of commercial farms are given in figure 4. The most obvious pattern is represented by cash grain farms. In general, they have been increasing since at least 1950, both in numbers and relative to all other types of commercial farms where dairy farm losses have been greatest, and have been decreasing in the more distant zones. The first three zones (0-50 miles) included nearly all of the net increase in numbers of cash grain

Table 2.--Selected changes in the dairy farm population in the Lake States, by geographic zone, 1950-64

Item	Time period	Geographic zone								
		Z_0 1/ 0 mi.	Z_1 2/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 3/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 4/ region	Z_0^* 5/	Z_0' 6/
		Percent								
Dairy proportion of all commercial farms	1950	52.4	60.5	58.8	54.8	50.9	30.7	51.5	53.0	51.8
	1964	41.4	55.3	58.5	58.1	55.1	35.2	51.2	38.6	44.2
Frequency distribution of dairy farms	1950	12.5	21.5	24.6	16.6	14.0	10.8	100.0	7.1	5.4
	1964	8.4	19.6	24.9	18.1	16.2	12.8	100.0	3.9	4.5
Rate of change in number of dairy farms (μ_j) 7/	1950-54	-18.0	-12.1	-10.5	-3.4	-4.2	+3.9	-8.2	-20.0	-15.2
	1959-64	-24.3	-15.5	-11.8	-8.5	-6.9	-2.4	-11.4	-27.7	-21.2
Distribution of dairy farm losses	1950-54	25.9	30.1	29.7	6.4	6.8	1.1	100.0	16.3	9.6
	1959-64	20.5	27.2	25.3	12.7	9.1	5.2	100.0	11.4	9.1

1/ Aggregate of all SMSA counties.
2/ Aggregate of all counties not designated as SMSA counties located within 25 radial miles from the SMSA counties' core cities.
3/ Aggregate of the four zones falling between 100 and 200 miles from the SMSA core cities. Data for these four zones have been aggregated because each zone treated separately contributes little additional information.
4/ Total of all zones.
5/ Aggregate of all 250,000 or more total population counties.
6/ Aggregate of all 100,000-250,000 total population counties.
7/ Zonal differences for 1959-64 are significant at the 5-percent level for: 0 and 1, 1 and 2, 2 and 3, and for the Z_0^* and Z_0' county aggregates.

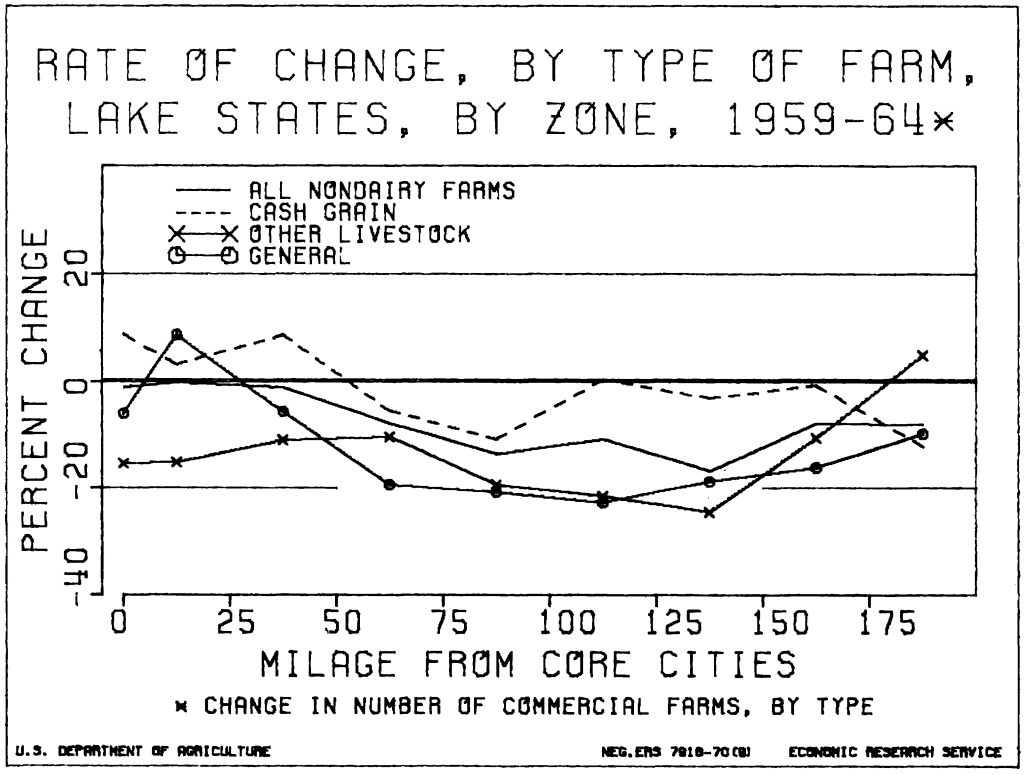

Figure 4

farms. This same pattern was exhibited by the aggregate of "other" commercial farms, but the increases were considerably smaller and the decreases larger. Changes in the number of the "other livestock" and "general" farms have been more erratic over time, but their respective distributions by geographic zone have been relatively stable.

Changes in numbers of a type of farm do not always accurately indicate shifts in principal products produced, as represented by either physical sales or income. Major shifts in numbers of a type of farm should result in corresponding shifts in income distributions (provided that type-of-farm definitions remain unchanged). The correspondence would not be exact, however, because product prices vary greatly within an area as large as the Lake States, and so do costs of production.

Relative Importance of Dairy Products

Dairy products provide the most important source of farm income in the Lake States, 35 percent in 1964, followed by other livestock products (28 percent) and field crops (25 percent). Despite substantial increases in the value of dairy product sales since 1949, they gained only slightly in importance relative to all other major sources of farm income. In contrast, total value of crops, primarily field crops, increased steadily during this period in absolute terms and relative to income from all other sources. Total value of dairy product sales in 1964 was 54 percent higher than in 1949, primarily because the total milk equivalent--whole milk plus milk equivalent of cream--sold was 36 percent greater. Total returns from field crop sales increased 91 percent.

Geographically, the relative contribution of dairy product receipts to the value of total farm product sales varies less than the differential rates of change in dairy farm numbers. Even substantial losses in producer numbers, particularly among low-volume producers, can be offset by increases in herd size and production per cow among remaining farms and by increases in milk prices received. Dairy product income in 1964 as a proportion of the total value of farm product sales varied from 42 percent for zones Z_1 and Z_2 to 19 percent for aggregate zones at least 100 radial miles from the core cities (table 3). Except for the aggregate of SMSA counties, increases over time in this statistic have varied directly with distance from the core cities, as increases in dairy product sales generally have occurred at more rapid rates in zones at least 50 miles out.

Dairy product receipts relative to all other sources have been declining in the SMSA county aggregate since 1949. The pattern of change in the value of field crop sales for the same period (table 3) is related inversely to the geographic pattern of change for total dairy receipts.

Location of Production

Lake States sales of total milk equivalent increased substantially between 1949 and 1964, a period typified by steady-to-slightly-rising prices to farmers and sharp declines in producer numbers. Meanwhile, sales of whole milk rose 60 percent, despite a reduction of more than one-third in the number of producers. Although accounting for nearly 17 percent of total milk equivalent sold in 1949, sales of cream and the number of cream producers are practically nonexistent today.

Underlying these trends are intraregional changes of considerable interest and importance. A decided shift away from the core cities in the distribution of whole milk sales has been occurring since 1949. In 1964, 58 of every 100 pounds of whole milk sold on farms in the region originated on farms located within 50 miles of the core cities, compared with 68 pounds in 1949 (table 4). Corresponding figures for the number of farms selling whole milk were about 52 of every 100 farms in 1964 and 64 in 1949. In fact, 85 of every 100 producers lost during these 15 years were within this 50-mile radius.

Whole milk sales increased in all zones between 1949 and 1964, with the increases ranging from 14 percent in the SMSA county aggregate (Z_0) to 160 percent for aggregate zones 100 or more miles from the core cities (fig. 5).

Historically, whole milk production and producing units have been concentrated heavily in the closer zones, with commercial dairy farms representing a high proportion of both. In contrast, cream production has been concentrated in the more distant zones. Only slightly over 11 percent of total cream sales in 1964 were made by farms within 50 miles of core cities, compared with 19 percent in 1949. Nearly half of the reduction in cream sales occurred 50-99 miles (zones Z_3 and Z_4) from the core cities, reflecting in part the geographic expansion of supply areas for the major fluid milk consumption markets.

Farms associated with cream production typically are nondairy types, even though a substantial proportion of the product originates on dairy farms. In 1964, for example, commercial dairy farms represented less than one-third of all

Table 3.--Value of dairy product and field crop sales as a proportion of the total value of farm product sales, by geographic zone, Lake States, 1949 and 1964

Commodity and year	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
Dairy products:									
1949	37.6	41.7	39.3	33.4	30.0	16.8	33.0	36.9	38.4
1964	33.1	42.0	42.0	36.3	34.1	19.0	34.6	30.7	35.3
Field crops:									
1949	16.2	12.9	14.7	16.7	17.1	36.5	19.4	13.4	19.5
1964	26.7	18.7	22.1	24.4	22.2	37.1	25.2	22.1	31.2

1/ See matching boxheads and footnotes, table 2.

Table 4.--Sales distribution of whole milk and cream, and the number of producers of each, by geographic zone, Lake States, 1949 and 1964

Item	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
Distribution of whole milk sales:									
1949	14.7	26.3	26.5	14.1	12.0	6.4	100.0	7.4	7.3
1964	10.5	22.4	25.4	16.3	15.0	10.4	100.0	4.6	5.9
Distribution of all farms selling whole milk:									
1949	13.7	22.8	27.9	15.6	12.3	7.7	100.0	7.5	6.2
1964	8.2	18.3	25.0	18.5	16.6	13.4	100.0	3.9	4.3
Change in milk sales, 1949-64	+14.1	+36.2	+52.8	+85.7	+100.6	+159.8	+59.9	+0.1	+28.2
Change in farms sold, 1949-64	-60.7	-47.2	-41.3	-22.2	-11.5	+14.0	-34.4	-65.9	-54.6
Distribution of cream sales:									
1949	3.3	4.1	11.2	24.6	21.8	35.0	100.0	2.2	1.1
1964	2.4	3.0	5.7	15.2	14.6	59.1	100.0	1.7	0.7
Distribution of farms selling cream:									
1949	5.5	6.0	10.6	19.0	20.0	38.9	100.0	3.5	2.0
1964	4.0	3.6	5.9	13.1	13.1	60.3	100.0	2.9	1.1

1/ See matching boxheads and footnotes, table 2.

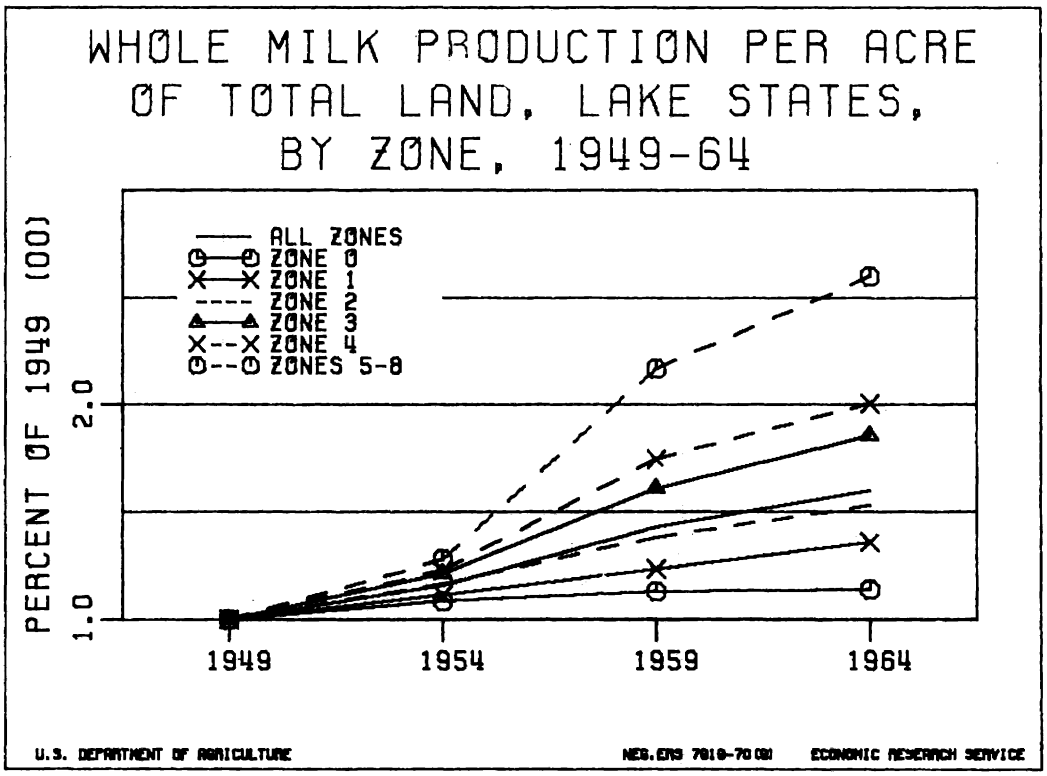

Figure 5

farms producing cream for sale, but accounted for 59 percent of total cream sales.

DAIRY FARM SIZE

Herd Size and Projections

Average dairy herd size in the Lake States nearly doubled between 1949 and 1964, from 11 to 21 milk cows. The milk cow population was only about 7 percent smaller than in 1949, but the number of farms reporting milk cows had declined over 50 percent.

Between 1949 and 1964, the shift from the core cities in the distribution of cow numbers was less pronounced than the shift in the number of farms with milk cows. During this period, 71.6 percent of the regional decline in cow numbers occurred within 50 miles of the core cities, and 41.3 percent in the SMSA county aggregate (Z_0). Changes in cow numbers ranged from a decrease of about 26 percent in zone Z_0 to a slight increase in zone Z_4, and, except for the aggregate of zones Z_5 through Z_8, varied inversely with distance from urban-industrial centers. The rates of decline in the number of all farms with milk cows also tended to vary inversely with distance from the core cities, again except for zones Z_5 through Z_8.

Even more revealing is an analysis of shifts in the number of farms reporting milk cows by herd size. County data are available only for 1959 and 1964,

but the pattern established for those years is assumed to reflect that for the entire 15-year period. As shown in table 5, the largest loss of farms occurred among those reporting fewer than 10 cows, followed closely by farms with 10-19 cows. Three-fourths of the increases from 1959 were movements into the 30-49 herd size interval.

Commercial dairy farms have been increasing as a proportion of all farms having milk cows. In 1964, only one-fifth of all farms with one to nine cows were commercial dairy farms, whereas nearly 96 percent of the farms with at least 30 cows were commercial dairy farms. Thus, farms with a large number of dairy cows--e.g., 30-49--are nearly always commercial farms; farms with fewer cows will comprise proportionately fewer dairy farms.

The geographic distribution of losses in farms with fewer than 10 milk cows in 1959 was proportional to the geographic distribution of such farms, reflecting comparatively uniform rates of decrease throughout the region. Losses of farms with 10-19 cows in 1959 were at rates related inversely to their distance from core cities. Rates of decline ranged from 47 percent in zone Z_0 to about 28 in zones Z_5 through Z_8 (table 6). The proportion of all farms with herd sizes in either of the above intervals increases as distance from the core cities increases, and in 1964 varied from 41 of every 100 farms in Z_1 to 68 for zones 100 or more miles away. Comparable figures for 1959 were 55 and 82 of every 100 farms. In general, the substantial and rapid losses in the number of farms having fewer than 20 milk cows suggests that most farms with smaller herds are not organized competitively as dairy farms.

Substantial declines also occurred among farms reporting 20-29 milk cows, particularly within 50 miles of the core cities, whereas their numbers increased 16 percent 100 and more miles away. The net rates of change for this herd size interval varied inversely and significantly with geographic location.

Table 5.--Number of, and changes in, all farms reporting milk cows and their proportion represented by commercial dairy farms, by herd size interval, Lake States, 1959 and 1964

Item and unit	Time period	Herd size interval					
		50-plus	30-49	20-29	10-19	Less than 10	Total
Number of farms..	1959	3,432	24,956	53,780	83,371	78,709	244,248
	1964	7,119	36,300	48,913	53,030	43,524	188,886
Percentage change	1959-64	+107.4	+45.5	-9.0	-36.4	-44.7	-22.7
Proportion dairy:							
In 1959.....	1959	94.4	95.4	92.6	74.1	18.5	62.7
In 1964.....	1964	95.8	95.6	91.0	76.1	20.2	71.5

Table 6.--Geographic distribution of, and rate of change in, farms reporting milk cows, by herd size interval and for all farms, Lake States, 1964

Herd size interval	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
30 or more milk cows:									
1964	11.2	24.8	25.6	15.1	15.0	8.3	100.0	4.6	6.6
1959-64 2/	+23.1	+38.4	+55.1	+77.2	+68.5	+85.6	+52.9	+21.3	+24.3
20-29:									
1964	7.1	18.3	24.5	19.6	17.6	12.9	100.0	3.3	3.8
1959-64	-28.4	-21.6	-11.5	-0.7	-2.9	+16.2	-9.0	-30.5	-25.8
10-19:									
1964	6.0	13.5	22.6	19.8	17.4	20.7	100.0	3.2	2.8
1959-64	-47.1	-43.0	-37.9	-35.5	-33.7	-27.6	-36.3	-47.4	-46.9
Less than 10 cows:									
1964	11.3	14.8	20.4	16.1	13.5	23.9	100.0	7.1	4.2
1959-64	-47.1	-44.2	-42.9	-43.4	-45.7	-45.7	-44.7	-48.1	-46.5
All farms with cows:									
1964	8.7	17.6	23.3	17.8	16.0	16.6	100.0	4.4	4.3
1959-64	-31.7	-22.9	-20.7	-19.8	-19.2	-24.7	-22.5	-34.3	-28.8

1/ See matching boxheads and footnotes, table 2.
2/ Zonal differences for 1959-64 are significant at the 5-percent level for 0 and 1, 1 and 2, 2 and 3, and 4 and the Z_5-Z_8 aggregate.

The number of farms reporting 30 or more milk cows increased rapidly between 1959 and 1964, and this group's proportion of all farms with milk cows nearly doubled (12 to 23 percent). The increase varied from 1.8 times in zones Z_0 and Z_1 to 2-1/2 times for zones Z_5 through Z_8, despite relatively small losses of smaller herds among farms in the latter area. Numerical increases for farms with 30 or more cows varied from 23 percent in zone Z_0 to 86 percent in zones Z_5-Z_8. In 1959, two-fifths of the farms with at least 30 milk cows were located within 25 miles of the core cities (Z_0 and Z_1). Five years later, however, about one-fourth of the numerical increases in this herd size interval had occurred in this two-zone area. The most substantial increases occurred in zones Z_3 and Z_4 (50-99 miles).

Average herd size tended to decrease as distance from the core cities increased. It varied in 1964 from 24 to 16 cows for all farms reporting milk cows. The range in 1959 was 7 cows, and in 1950, 4 cows. The widening spread over time is explained by observing rates of change among farms within each herd size interval during 1959-64. Losses among the farms with smaller herds, and even medium-sized ones, occurred at more rapid rates in the closer zones than farther out. A higher proportion of the remaining farms had larger herds in the closer zones compared with those farther out.

A 1964 distribution of counties by mean herd size per county clearly reveals the substantial geographic variation described (appendix table B). Of the 32 counties in zone Z_1, three-fourths had a mean herd size of at least 20 milk cows, whereas 91 percent of the 47 counties 100 miles or more out had a mean herd size of fewer than 20 cows. The highest geographic concentration of counties having mean herd sizes of 15 to 24 cows was within a 25-74-mile radius from the core cities. This interval contains the population mean and includes 60 percent of the counties.

Projecting to 1974

What does further shrinkage and expansion among geographic zones and herd size intervals hold for dairying in the Lake States? Assume that the dynamic forces operative during 1959-64 both in and outside agriculture will continue into the near future. By incorporating herd size data for this period in a Markov chain model6/ and determining distributions of farms by herd size interval for the census years 1969 and 1974, we obtain extensions of the trends established during 1959-64. The results do not lend themselves to any test of statistical significance. Their credibility rests solely on the assumption that recent history will continue to repeat itself.

6/ A Markov chain model is basically a mechanical process of tracing movements of firms or industries between classifications, or "states," over time. Given data for a set of states for any two time periods, a set of probabilities can be constructed that reflects movements over time between the states. This set of "transitional" probabilities then is applied to an initial distribution of firms or individuals to generate projections.

As shown in figure 6, the number of farms with 30 or more milk cows will increase rapidly to the point where these farms will comprise half of all farms with milk cows. The comparable figure for 1964 was 23 of every 100 farms reporting milk cows. Farms reporting 20-29 cows are expected to decline 30 percent by 1974, and to represent one-fourth of the population, about the same proportion as in 1964. Farms with fewer than 20 cows are expected to decline over 60 percent by 1974 and to comprise the remaining one-fourth of the 1974 population. This segment of the population, which in 1964 accounted for 51 of every 100 farms, is expected to account for about 80 of every 100 farms quitting dairying, for a total projected loss of nearly 75,000 farms among those with fewer than 30 cows.

Farms with all sizes of dairy herds are expected to continue the shift away from the expanding urban-industrial centers (table 7). The rate of this movement is most rapid for herd sizes which are increasing--in general, 30 or more milk cows. For example, in 1964, about 40 percent of the farms with 30-49 cows were located at least 50 miles from the core cities; by 1974, the proportion is expected to increase to 48 percent. The corresponding shift in farms with over 50 cows is expected to be from 29 percent in 1964 to over 35 percent in 1974.

The relative and increasing importance of farms with over 30 cows can be observed in the regional data presented in table 8. Only 23 of every 100 farms reporting milk cows in 1964 had 30 or more cows. But this segment of the dairy farm population accounted for 45 percent of the milk cow population and half of the total milk sold. All three items increased substantially during 1954-64. Projections to 1974 of all three statistics are included in table 8. In 1974, approximately

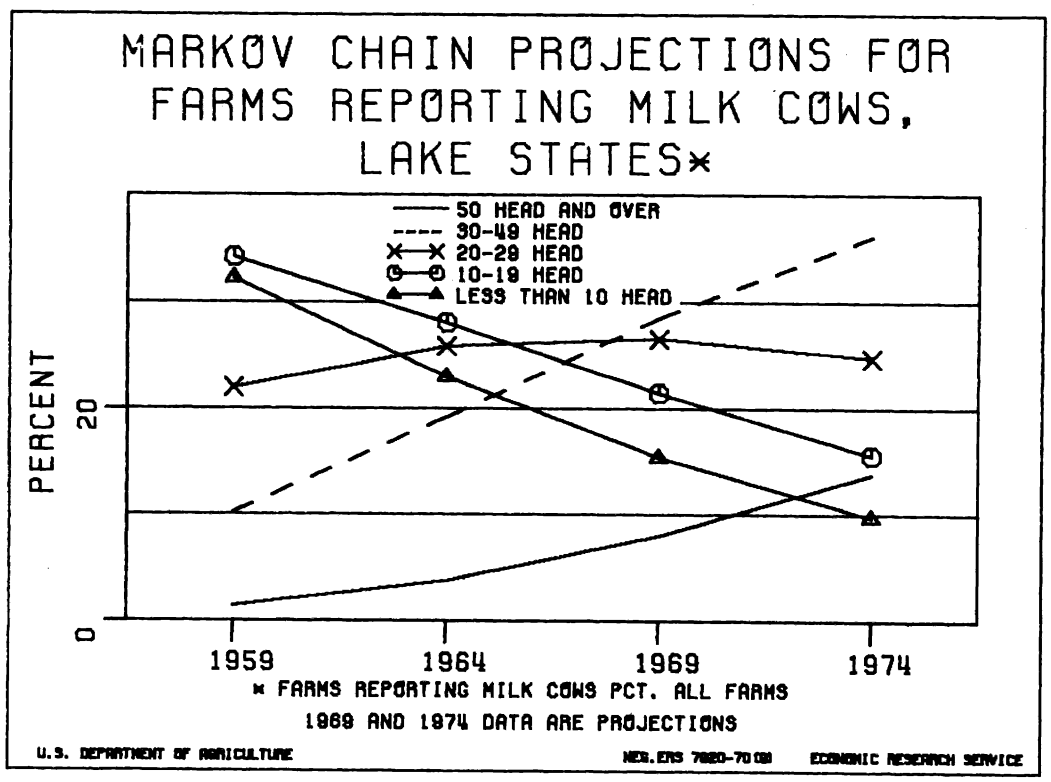

Figure 6

Table 7.--Changes in the geographic distribution of farms having milk cows by herd size interval, Lake States, 1964-74

Herd size interval	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
30 or more milk cows:									
1964	11.2	24.8	25.6	15.1	15.0	8.3	100.0	4.6	6.6
1974	8.7	21.5	25.3	17.2	16.4	10.9	100.0	3.5	5.2
Increases:									
1964-74	4.4	16.1	24.8	20.8	18.8	15.1	100.0	1.8	2.6
20-29:									
1964	7.1	18.3	24.5	19.6	17.6	12.9	100.0	3.3	3.8
1974	5.2	15.4	23.3	21.0	18.7	16.4	100.0	2.6	2.6
Decreases:									
1964-74	11.6	25.0	27.3	16.4	15.1	4.6	100.0	5.0	6.6
Less than 20 cows:									
1964	8.4	14.1	21.6	18.1	15.6	22.2	100.0	5.0	3.4
1974	6.4	12.2	21.2	18.7	16.4	25.1	100.0	3.9	2.5
Decreases:									
1964-74	9.5	15.2	21.8	17.8	15.3	20.4	100.0	5.6	3.9
All farms with cows:									
1964	8.7	17.7	23.3	17.8	16.0	16.5	100.0	4.4	4.3
1974	7.2	17.7	23.8	18.5	17.0	15.8	100.0	3.4	3.8
Decreases:									
1964-74	12.8	17.6	21.9	15.9	13.3	18.5	100.0	7.4	5.4

1/ See matching boxheads and footnotes, table 2.

Statistics for 1964 derived from published U.S. Census of Agriculture data. 1974 data derived from 1964 U.S. Census of Agriculture data by applying Markov chains.

Table 8.--Farms in the Lake States reporting 30 or more milk cows: Relative importance in regional milk production, 1954, 1964, and projected 1974

Item	Time period				
	1954 1/	1964 2/	1974 3/	Increase in--	
				1954-64	1964-74
	Percent				
Farms with 30-plus milk cows	5.9	4/23.0	49.9	140.8	59.3
Share of 30-plus milk cow herds of total population:					
Milk cows	15.8	45.3	71.2	160.0	75.9
Milk sold	17.4	49.6	75.1	245.9	121.5

1/ Related to all commercial farms reporting milk cows.
2/ Related to all farms reporting milk cows.
3/ Farms projections are based on Markov chain analyses; total cow projections are based on trending forward and upward mean herd sizes and then applying these estimates to the projected farm numbers; total milk sold projections are based on trending forward and upward mean production per cow data and then applying these estimates to the projected total cow numbers. The above steps were performed for each herd size interval and then aggregated for the region.
4/ The 1964 statistic for all commercial farms that corresponds to the 1954 figure of 5.9 is 25.6. Statistics for milk cows and milk sold corresponding to those for 1954 probably also are slightly higher.

half of all farms with milk cows are expected to have at least 30 cows--70 percent of the milk cows--and account for 75 percent of milk sold. Total milk sales in 1974 for this group of farms alone are projected to exceed, by roughly 3 billion pounds, total 1964 milk sales by all farms in the region. Virtually all farms with over 30 milk cows in 1974 are expected to be commercial dairy farms, as now defined by the Bureau of the Census.

Uses of Land Resources

Land Base

The agricultural land base in the Lake States comprised 570 of every 1,000 acres of total land area in 1964, a decline from 640 per 1,000 acres in 1950. This retirement of farmland varied considerably among the geographic zones delineated, but was most prevalent in the closer zones (table 9).

Table 9.--Agricultural land base relative to total land area and changes in the agricultural land base, by geographic zone, Lake States, 1950-64

Item	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
Zonal distribution of total land area.....	12.4	10.5	17.8	18.4	15.0	25.9	100.0	8.9	3.5
Proportion agricultural, 1964.....	40.8	75.3	63.3	50.0	57.9	57.4	57.0	30.5	67.2
Zonal distribution, 1964.....	8.9	13.9	19.8	16.1	15.2	26.1	100.0	4.8	4.1
Reduction in agricultural land base 1950-64:									
Rate of loss.....	-23.0	-11.3	-10.6	-12.6	-9.0	-6.9	-11.2	-28.2	-15.7
Zonal distribution.	21.1	14.2	18.7	18.6	11.9	15.5	100.0	15.0	6.1

1/ See matching boxheads and footnotes, table 2.

Farmland reductions for all zones were substantially greater during 1954-59 than during either of the other two 5-year periods considered. Most of this loss reflects farmland retired under the Federal Soil Bank program.7/ Over half of the more than 8 million acres retired from agricultural uses between 1950 and 1964 occurred during 1954-59.

The greatest shifts in land retirement from agricultural uses came in the close-in zones. Absolute reductions in 1950-54 and 1959-64 were approximately the same--1.84 million for 1959-64 and 1.98 million for 1950-54. During the earlier period, 49 percent of the acreage withdrawn lay within 50 miles of the core cities; during 1959-64, two-thirds of the net reduction occurred within this area. Most of this increase occurred in zones Z_1 and Z_2. The rate of decrease in the land base of zone Z_1 during 1959-64, for example, was double the 1950-54 rate.

There was considerable shifting of agricultural land among types of farms during 1959-64. Even though the land in dairy farms remained a nearly constant proportion--43 percent--of total agricultural land, its 3-percent rate of loss amounted to nearly 870,000 acres. In contrast, the land base for cash grain farms increased over 660,000 acres. The "other livestock" type of farm--primarily beef and hog production--lost more than a million acres of its land base.

Land and Population

In general, the most substantial decreases in the agricultural land base have occurred where population growth rates have been most rapid (Z_0 and Z_1) (table 10). And this trend is expected to continue. The rapid retirement of agricultural land within 50 miles of cities can be partly accounted for by land acquisition for the construction of highways, beltways, and the accompanying radial access routes and intercity connecting links. Meanwhile, there has been a leapfrogging of urban development. Speculation over this pattern of future development has been sufficient to swell land values, since returns to land resources are generally highest when land is employed in intensive nonfarm uses.

Farm Size

Shrinkage in both farm numbers and the agricultural land base led to fairly uniform rates of increase in farm size in all zones. Absolute increases in average farm size, however, varied substantially, and tended to vary inversely with proximity to the core cities (fig. 7). In 1964, farm size averaged 136 acres in zone Z_0 and 416 acres in zone Z_8, the outermost one.

7/ The 1959 census redefinition of farms probably accounted for a small portion of the reduction of about 4.2 million acres in the agricultural land base between 1954 and 1959.

Table 10.--Relating land base and population changes over time, by geographic zone, Lake States, selected years, 1950-64

Item	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
Zonal distribution:									
Total land area, 1964	12.4	10.5	17.4	18.4	15.0	25.9	100.0	8.9	3.5
Total population, 1960	62.2	13.3	7.5	5.8	6.2	5.0	100.0	52.1	10.1
Population:									
Change, 1950-60	+25.8	+21.5	+7.0	+5.4	+5.4	-2.1	+19.2	+25.4	+27.5
Distribution of increase	78.7	14.5	3.0	1.8	2.0	---	100.0	65.1	13.6
Density, 1960 2/	426	107	36	27	35	16	85	495	249
Proportion urban, 1960	88.1	46.2	26.4	32.2	43.1	26.2	68.8	91.5	70.3

1/ See matching boxheads and footnotes, table 2.
2/ Total persons per square mile.

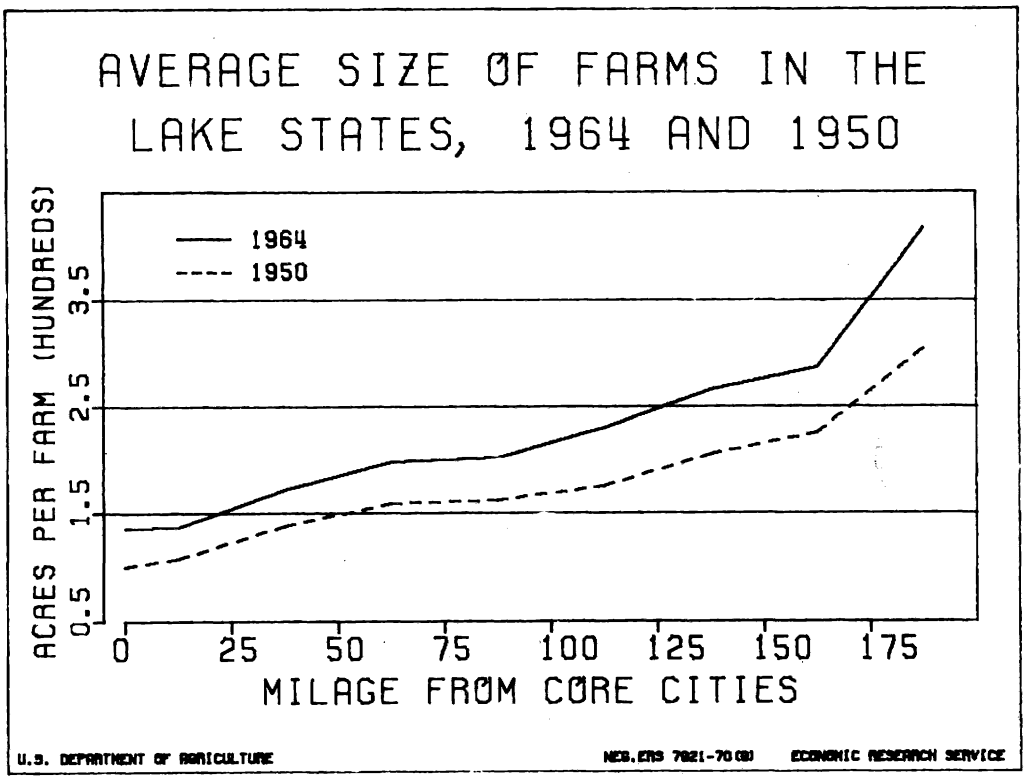

Figure 7

The substantial variation in mean farm size is shown by the geographic distribution of farms by total acreage per farm. Data in table 11 indicate that in 1964 about 73 percent of all farms with fewer than 70 total acres were located within 50 miles of the core cities, whereas 47 percent with 500 or more acres were at least 100 miles out.

In 1964, farms reporting fewer than 70 total acres accounted for nearly one-third of all farms in zone Z_0, but for a decreasing proportion as distance from the core cities increases (table 12). This pattern also hold for the next larger size interval of 70-139 acres. The proportion of all farms represented by farms with 260 or more acres increases markedly as distance from the core cities increases, varying from nearly 12 percent in Z_0 to over 41 percent for the zonal aggregate Z_5-Z_8.

Shifts in the farm distribution between 1959 and 1964 were gradual (tables 11 and 12), but two general trends appeared. Among larger farms, the highest rates of increase in farm numbers were in the distant and middle zones. For the smallest farms, the highest rates of decline occurred in the closer zones. The net effect was a shift away from the core cities in the geographic distribution of all farms, particularly for the smallest and largest groups. Markov chain transitional probabilities, 8/ computed for the farm size intervals in which farm numbers increased, increased directly with the distance from core cities.

8/ Here thought of as coefficients of expansion of farm numbers.

Table 11.--Geographic distribution of all farms in the Lake States, by total acreage per farm, 1964

Total farm acres	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
500 plus	6.4	7.0	13.7	13.3	12.5	47.1	100.0	3.6	2.8
260-499	6.9	10.3	18.5	17.1	16.8	30.4	100.0	3.9	3.0
140-259	8.7	15.2	22.3	18.3	17.3	18.2	100.0	4.4	4.3
70-139	14.2	24.6	25.1	14.3	12.4	9.4	100.0	7.4	6.8
Under 70	23.1	29.7	20.3	9.8	8.7	8.4	100.0	14.2	8.9
All farms	12.3	19.1	21.7	15.3	14.2	17.4	100.0	6.8	5.5

1/ See matching boxheads and footnotes, table 2.

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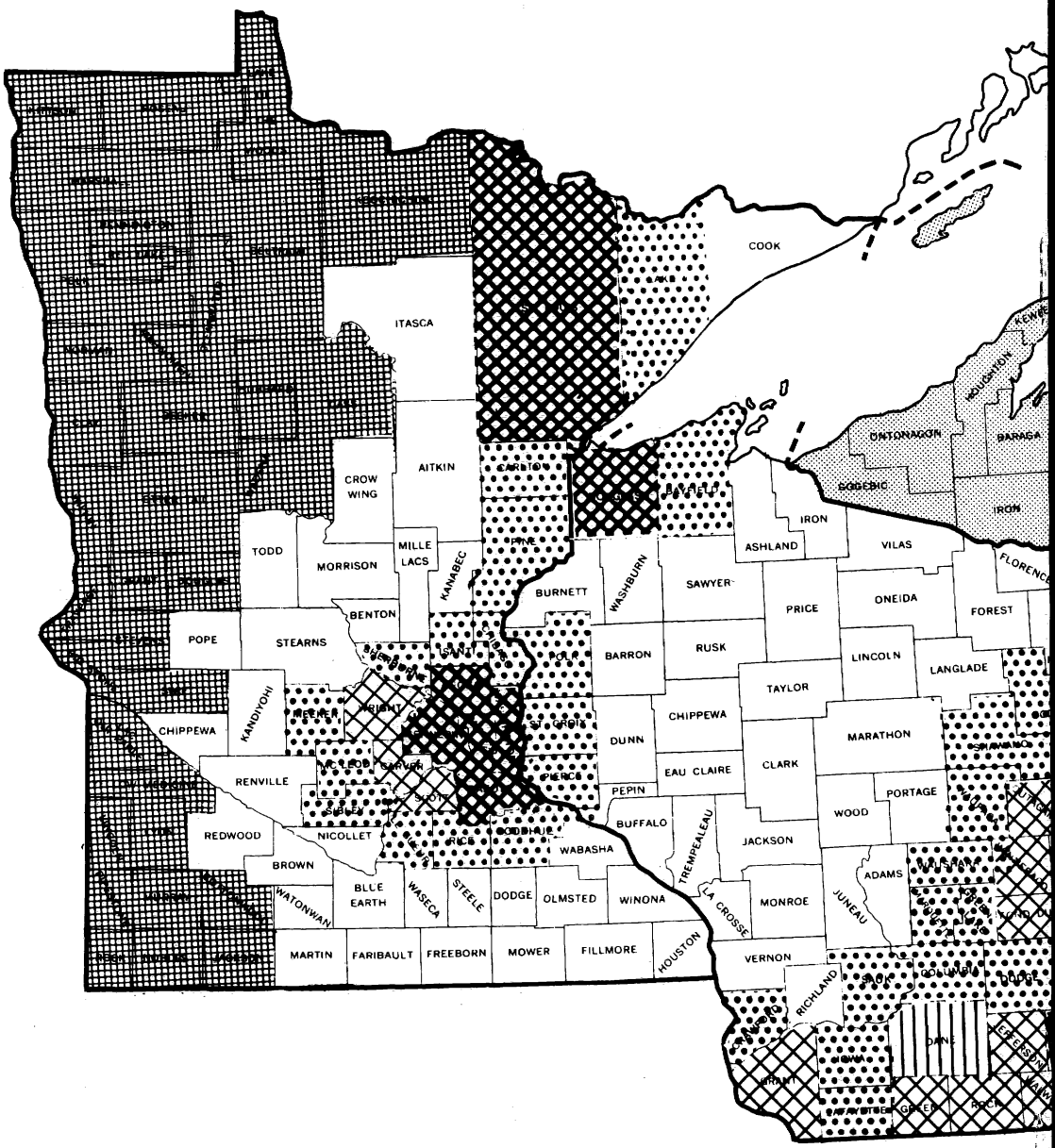

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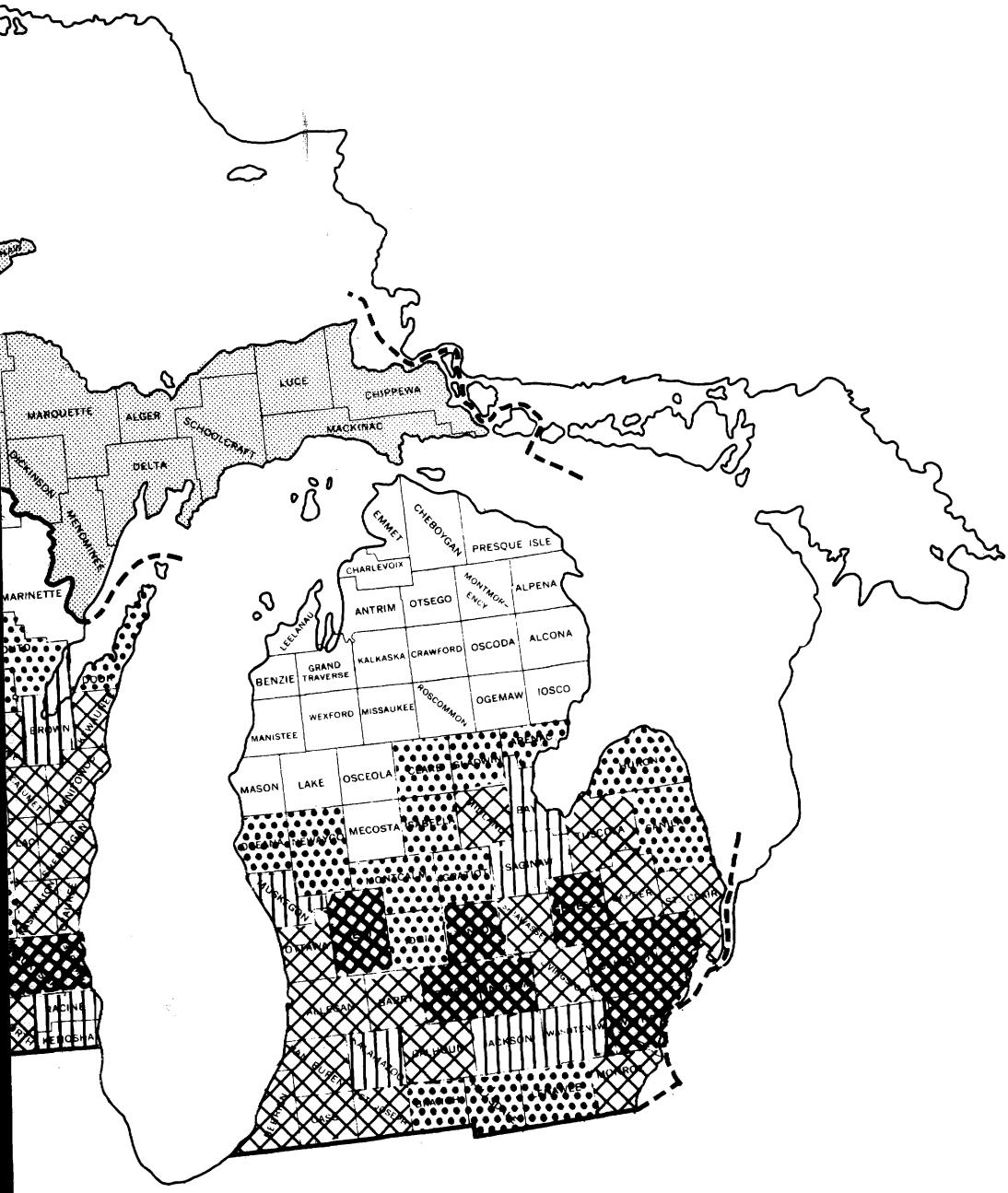

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Table 12.--Farm size frequency distribution of all farms in the Lake States, by geographic zone, 1964

Total farm acres	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
500 plus	2.2	1.5	2.6	3.6	3.6	11.2	4.1	2.2	2.1
260-499	9.6	9.3	14.6	19.1	20.4	30.0	17.2	9.8	9.4
140-259	24.4	27.2	35.1	40.8	41.6	35.7	34.2	22.4	26.8
70-139	31.8	35.4	31.7	25.5	23.9	14.8	27.4	29.8	34.1
Under 70	32.0	26.6	16.0	11.0	10.5	8.3	17.1	25.8	27.6
All farms	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1/ See matching boxheads and footnotes, table 2.

Changes in the distribution of farm numbers and agricultural land can be related on a farm size interval basis only at the regional level. Net declines during 1959-64 in both farm numbers and agricultural land were recorded for all farm sizes below 260 total acres, while all net increases in both were limited to the farm size strata beginning with 260 acres. Farms reporting 260 or more acres in 1964 comprised a fifth of all farms, but represented nearly half the agricultural land area in the Lake States. In contrast, farms reporting fewer than 70 acres comprised 17 percent of all farms, but accounted for only 3 percent of total farmland. During 1959-64, farms with 260 acres or more increased by 8.4 percent, and their agricultural land base expanded by nearly 4 million acres.

Land Use and Dairying

Commercial dairy farms, in aggregate, comprised about 40 percent of the region's farms in both 1959 and 1964. But in the interim they increased as a proportion of all farms with 260 or more acres. Few of these farms total more than 500 acres--3 percent--or fewer than 50 acres (table 13). However, about 29 percent of all farms with at least 500 acres in 1964 were dairy farms.

Losses in number of dairy farms clearly were largest among the smaller farms. Three-fourths of the net loss of commercial dairy farms was from the 50-139-acre group, while net increases occurred among farms having at least 260 acres. Around 23 percent of all dairy farms in 1964 reported at least 260 acres, compared with 18 percent in 1959.

A more informative analysis of shifts among farm size groups was revealed by computing Markov chain transitional probabilities for 1959-64. Assuming that all dairy farms that were in the 1,000-and-over group in 1959 remained in this stratum, that no farm skipped a size stratum, and that no formerly nondairy farm types became reclassified as dairy farms, observe the number of dairy farms falling in this stratum in 1964. The change was an increase, with the net addition obtained solely from the next smaller size stratum of dairy farms (500-999 acres). This chain process continues downward through the size strata until the net change for the population has been accounted for. The coefficients of expansion for 1959-64 are summarized below:

1959 size, acres	1964 size, acres	Coefficient of expansion	Number of farms
140-179	180-219	0.0455	1,521
180-219	220-259	.1672	3,542
220-259	260-499	.2551	3,855
260-499	500-999	.0469	1,172
500-999	1,000 or more	.0228	63

The fastest increase in dairy farm numbers occurred among farms reporting 220-259 acres in 1959. Five years later, slightly more than one-fourth of this group had increased farm size to 260-499 acres. The second most dynamic size stratum was 180-219 acres. Nearly 17 percent of its 1959 population expanded in farm size and moved into the 220-259-acre stratum. These two shifts comprised 73 percent of the gross increase when considering all of the relevant size strata.

Table 13.--Relative incidence of commercial dairy farms and their frequency distribution by farm size interval, Lake States, 1964

Item	Farm size interval with acreage--										
	Under 10	10-49	50-99	100-139	140-179	180-219	220-259	260-499	500-999	1,000 and over	All sizes
	Percent										
Proportion dairy of all farms, 1964	2.3	6.2	28.2	47.9	50.8	56.9	52.1	46.8	31.2	12.3	39.7
Distribution of dairy farms, 1964	0.1	1.6	12.6	16.9	20.6	14.0	10.9	20.3	2.8	0.2	100.0
Percentage change in numbers, 1959-64	+58.2	-18.6	-27.3	-23.4	-16.0	-9.5	-2.1	+10.7	+40.1	+38.6	-11.5

Commercial dairy farms of 220 or more acres are increasing rapidly, and represent the most important expanding segment of the dairy farm population in the Lake States. These farms represented over 340 of every 1,000 dairy farms in 1964, compared with 280 in 1959. Commercial dairy farm Markov chain projections for 1974, based on 1959-64 changes, reveal the following distribution by total acres:

Year	Total farm acres: Under 140	140-259	260 or more
	Percent		
1974.....	21.7	43.4	34.9
1964.....	31.2	45.5	23.3

The corresponding distribution for 1964 also is included for comparison. For greater detail, see appendix table C.

Several size strata showed substantial losses. Farms reporting 50-139 total acres in 1959 accounted for 76 percent of the net decline. Below is a summary of the coefficients of contraction, which represent the net losses in the declining dairy farm segment of population:

Farm acreage	Coefficient of contraction	Number of farms
10-49	0.1625	447
50-99	.2728	6,443
100-139	.2338	7,037
140-179	.1142	3,823

All coefficients of change considered together strongly indicate that smaller dairy farms are inefficient and that their scale of operation generates net resource returns lower than alternative uses. On the other hand, the existence of economies of scale is reflected strongly by the rapid movement over time of farms into the 220-259 and 260-499 acre strata.

One now can relate the farm numbers associated with the coefficients of change for the aggregate of commercial dairy farms and for other farm types in the region to changes in the number of all farms for each geographic zone by farm size. A direct comparison of the coefficients of change is not as meaningful for the present purpose because of the extreme variation among farm types in farm numbers within the given farm size strata.

Of all farm increases from one size stratum to the next, dairy farm proportions were:

1959 size, acres	1964 size, acres	Dairy percentage of all farm shifts
140-179	180-219	58.9
180-219	220-259	71.8
220-259	260-499	62.7
260-499	500-999	33.6
500-999	1,000 or more	12.4

With these additional data, one can now estimate in which zones commercial dairy farms most likely increased in farm size. For example, about one-third of the farms reporting 260-499 total acres in 1959 that had 500-999 acres in 1964 were commercial dairy farms. A geographic distribution of all farms in this group reveals that only about 12 percent were located within 25 miles of the core cities (table 14). Even among farms which shifted from the 180-to-219-acre to the 220-to-259-acre stratum (of which 72 percent were dairy farms), only one-fourth were within 25 miles of the core cities, and less than half within 50 miles.

Of the losses in all farm numbers, the proportion represented by commercial dairy farms was substantial for the smaller acreage strata: 50-99 acres, 56.5 percent; 100-139 acres, 67.5 percent; and 140-179 acres, 42.7 percent. Losses for smaller and larger strata were neglible or nonexistent.

The gross losses in all farm numbers, particularly among smaller farms, are weighted heavily toward the core cities (table 15). The proportion of the gross declines in farm numbers represented by the smaller farm strata declines rapidly as distance from the core cities increases. The converse holds true for the farms falling in the larger size strata. These data strongly suggest that, where dairy farm numbers declined rapidly and are highly concentrated, a substantial proportion had a small land base. This reflects a general situation in dairying of operating with too few land resources to be competitive, and to generate adequate income, particularly when located close to major consumption markets.

So far, some association has been established between changes in dairy farm numbers, total farm acreage, and in the number of farms reporting milk cows by herd size. Now several additional and significant distributions on the basis of farm size intervals can be made to strengthen earlier observations about changes in dairying for dairy farms. These distributions for 1959 and 1964 are included in table 16.

Each distribution was more highly concentrated toward the larger farm sizes in 1964 than in 1959. This trend likely will continue in the Lake States. Even though farm size was treated as an independent variable, the association between milk production and the land base is very evident. Milk sales from farms with 180 or more acres (47 percent of the farms selling milk) accounted for over 61 percent of total milk sales in 1964, compared with 53 percent 5 years earlier.

Data for 1964 also reveal a strong association between herd size and land base. In table 17, total farm acreage is the independent variable and farms within each stratum reporting milk cows were distributed by herd size. Larger herd sizes are associated with larger land bases. In contrast, nearly all farms reporting fewer than 50 acres had fewer than 20 milk cows.

In table 18, farms falling in selected herd size strata are distributed by total farm acreage. In the farm acreage strata in which dairy farms are increasing in importance, three-fourths of the dairy farms with 30 or more milk cows also had at least 180 acres in 1964. In general, as herd size increases, the

Table 14.--Geographic frequency distribution of gross increases in farms by total farm acreage intervals, Lake States, 1959-64

Total farm acres	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
500-999 to 1,000-plus....	2.8	5.8	11.2	6.3	11.9	62.0	100.0	1.0	1.8
260-499 to 500-999.....	5.2	6.5	15.2	11.9	15.6	45.6	100.0	2.5	2.7
220-259 to 260-499.....	3.9	13.3	20.8	17.3	22.0	22.7	100.0	1.1	2.8
180-219 to 220-259.....	3.8	21.6	23.0	18.1	24.3	9.2	100.0	---	3.8
All sizes.....	4.0	15.4	18.8	15.0	20.7	26.1	100.0	1.1	2.9

1/ See matching boxheads and footnotes, table 2.

Table 15.--Frequency distributions of gross losses in farm numbers, by geographic zone and by farm acreage sizes, Lake States, 1959-64

Acreage interval for farm losses	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percentage distribution by zone								
Under 10	31.2	30.0	16.8	13.3	7.0	1.7	100.0	21.2	10.0
10-49	28.0	30.4	17.4	9.8	7.7	6.7	100.0	17.5	10.5
50-69	23.6	38.7	15.2	7.7	9.2	5.6	100.0	13.6	10.0
70-99	16.2	24.5	21.9	13.6	11.6	12.2	100.0	8.4	7.8
100-139	13.6	21.3	24.4	15.4	13.5	11.8	100.0	7.3	6.3
140-179	9.0	6.3	19.8	17.9	18.4	28.6	100.0	5.8	3.2
All sizes	17.1	20.4	19.9	14.3	12.1	16.2	100.0	10.3	6.8
	Size distribution within zones								
Under 10	6.5	5.2	3.0	3.3	2.1	0.4	3.3	7.3	5.2
10-49	30.9	28.2	16.5	12.9	11.9	7.8	19.1	32.1	29.2
50-69	7.1	9.8	3.9	2.8	3.9	1.8	5.1	6.8	7.6
70-99	19.7	25.0	22.9	19.7	19.8	15.5	20.8	17.0	23.6
100-139	18.5	24.4	28.5	25.1	25.9	16.9	23.3	16.5	21.7
140-179	12.6	7.4	23.9	29.9	36.4	42.4	25.1	13.5	11.3
180-plus	4.7	---	1.3	6.3	---	15.2	3.3	6.8	1.4

1/ See matching boxheads and footnotes, table 2.

Table 16.--Frequency distributions of selected characteristics of Lake States dairying, by farm acreage intervals, 1959 and 1964

Item	Total farm acreage									
	Under 10	10-49	50-99	100-139	140-179	180-219	220-259	260-499	500-999	1,000-plus
	Percent									
Commercial dairy farms:										
1959	0.1	1.8	15.3	19.5	21.7	13.7	9.8	16.2	1.8	0.1
1964	0.1	1.6	12.6	16.9	20.6	14.0	10.9	20.3	2.8	0.2
Farms with milk cows:										
1959	0.5	5.4	16.5	16.9	19.7	12.1	9.5	16.9	2.3	0.2
1964	0.4	4.3	14.0	15.5	19.0	12.5	10.2	20.3	3.5	0.3
Milk cows:										
1959	0.1	1.5	10.4	15.6	20.4	14.2	11.2	22.5	3.6	0.5
1964	0.1	1.0	7.8	12.9	18.6	14.0	12.1	27.0	5.7	0.8
Milk sales:										
1959	0.1	1.0	9.7	15.5	20.4	14.6	11.3	23.0	3.8	0.6
1964	0.1	0.7	7.0	12.5	18.3	14.3	12.3	27.9	6.0	0.9

Table 17.--Frequency distribution of all farms reporting milk cows by farm acreage interval and by herd size, Lake States, 1964

Herd size interval	Total farm acreage										
	Under 10	10-49	50-99	100-139	140-179	180-219	220-259	260-499	500-999	1,000-plus	All
	Percent										
30 or more	1.2	0.2	1.7	10.4	20.2	29.2	33.7	41.0	48.9	49.7	23.0
20-29	1.6	0.9	14.7	30.8	31.7	32.4	29.2	25.9	18.6	12.6	25.9
10-19	12.6	13.3	39.6	35.8	30.7	25.8	24.3	20.7	16.1	12.1	28.1
Under 10	84.6	85.6	44.0	23.0	17.4	12.6	12.8	12.4	16.4	25.6	23.0

Table 18.--Frequency distribution of all farms reporting milk cows by herd size interval and by total farm acreage, Lake States, 1964

Herd size interval	Total farm acreage									
	Under 10	10-49	50-99	100-139	140-179	180-219	220-259	260-499	500-999	1,000 plus
	Percent									
30 or more	1/	1/	1.0	7.0	16.7	15.9	15.0	36.3	7.4	0.7
20-29	1/	0.1	8.0	18.4	23.3	15.7	11.6	20.3	2.5	0.1
10-19	0.1	2.0	19.8	19.8	20.8	11.5	8.9	15.0	2.0	0.1
Under 10	1.3	15.8	26.8	15.5	14.4	6.8	5.7	10.9	2.5	0.3
All sizes	0.4	4.3	14.0	15.5	19.0	12.5	10.2	20.3	3.5	0.3

1/ Less than 0.1 percent.

proportion of farms reporting a larger land base also rises. Since the number of farms with 30 or more milk cows is increasing rapidly, indications are that most of the increases in herd size are accompanied by an expansion of land base or are occurring on larger land base farms. A location shift of these farms can be observed, in general, as away from the core cities in terms of herd size and farm size.

OFF-FARM INCOME AND EMPLOYMENT

A large majority of farm households in the Lake States reported some off-farm income in 1964. They averaged $3,700 per farm reporting. The most important source of nonfarm income was wages from off-farm work, which comprised about two-thirds of all nonfarm income that year. Nonfarm income was closely related to type and size of farm and to location.

Type of Farm

There were nearly 52,000 part-time farms 9/ in the Lake States in 1964. They represented 15 percent of all farms, less than 2 percent of total farm product sales, and one-third of aggregate nonfarm income. Off-farm earnings accounted for $87 of every $100 accruing to these farm households in 1964. This compared with less than $17 per $100 for all commercial farms.

A proposition stated earlier was that the dairy farm is probably least suited to the addition of an off-farm job. Data for 1964 reveal that, for every 100 commercial dairy farms, there were fewer than 4 part-time dairy farms, compared with at least 30 per 100 for all other major farm types (table 19). Also, less than one-tenth of the part-time farms in 1964 were dairy farms. This contrasts with over half of all commercial farms. Wage and salary income earned by dairy farm operators in 1964 averaged only $5,600, compared with over $8,300 for all other part-time farmers.

The importance of nonfarm income is not limited to part-time farms, but its relative contribution to total income from all farm and nonfarm sources is less for commercial farms than for all farms. Relating nonfarm income, principally from wages and salaries, to type of farm among commercial farms reveals a pattern similar to the one established for part-time farms (table 20).

Geographic Area

Part-time farming and attractive off-farm employment incomes are most prevalent in zones nearest the core cities. Nearly 65 percent of these part-time farm operators who worked off the farm 100 or more days in 1964 were located within 50 miles of the core cities. Nonfarm income per farm averaged $5,335 for SMSA counties, but declined to $2,676 in zones 5 through 8 (table 21 and fig. 8).

9/ The 1964 Census of Agriculture defines a part-time farm as those with $50 to $2,499 in farm product sales reported by an operator under 65 years of age who worked off the farm 100 or more days.

Table 19.--Selected nonfarm income data for all part-time farms in the Lake States, by type of farm, 1964

Item	Unit	Type of part-time farm								
		Other livestock	Cash grain	General	Miscellaneous	Dairy	Specialty crop 1/	Poultry	Other 2/	Total
Farm distribution	Percent	28.7	26.4	15.5	12.2	9.5	5.1	1.9	0.7	100.0
Ratio per 100 commercial farms	Percent	36.6	31.4	33.8	104.7	3.6	35.9	20.4	12.2	19.5
Total nonfarm income per farm	Dollar	6,302	7,167	6,473	---	4,623	6,911	6,090	---	6,449
Proportion from farm operator wages and salary	Percent	72.4	72.4	71.1	---	74.4	70.6	73.2	---	71.8
Wages and salary income per farm	Dollar	7,993	8,899	7,970	---	5,582	9,182	7,146	---	8,027

1/ Includes fruit and nut, and vegetable farms.
2/ Includes other field crop and tobacco farms.

Table 20.--Selected nonfarm income data for all commercial farms in the Lake States, by type of farm, 1964

Item	Unit	Other livestock	Cash grain	General	Miscellaneous	Dairy	Specialty crop 1/	Poultry	Other 2/	Total
Farm distribution	Percent	15.3	16.4	9.0	2.2	51.3	2.8	1.9	1.1	100.0
Proportion had any nonfarm income	do.	80.4	82.1	81.3	64.1	70.7	77.2	82.8	73.0	75.3
Proportion had $3,000-plus nonfarm income	do.	34.6	37.5	31.9	32.9	22.2	42.3	38.9	31.4	28.9
Total nonfarm income per farm	Dollar	3,559	3,797	3,326	4,393	2,565	4,556	3,795	3,543	3,149
Proportion from farm operator wage and salary	Percent	35.4	38.8	34.9	33.4	31.5	48.8	41.4	38.2	35.3
Income per farm reporting	Dollar	4,417	4,709	4,372	5,026	3,144	7,184	4,840	5,360	4,021
Proportion farm operators worked off-farm 100-plus days	Percent	20.0	22.1	18.5	18.8	13.1	30.0	26.1	18.1	17.0
Proportion nonfarm income of total income:										
All commercial farms	do.	17.3	24.1	21.4	14.3	14.7	18.0	8.9	6.2	16.6
Commercial farms with less than $5,000 sales	do.	54.1	53.7	53.7	---	37.3	55.4	54.0	---	47.9
Proportion of farms with nonfarm income exceeding farm income	do.	20.2	20.2	19.0	29.7	7.6	24.2	14.7	9.9	13.7

1/ Includes fruit and nut, and vegetable farms.
2/ Includes other field crop and tobacco farms.

Table 21.--Selected nonfarm income and employment data for all farms in the Lake States, by geographic zone, 1964

Item	Unit	Geographic zone								
		Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\Sigma_{j=0}^{8}$ 1/ Z_j region	Z_0^* 1/	Z_0' 1/
Farm distribution	Percent	12.3	19.1	21.7	15.3	14.2	17.4	100.0	6.8	5.5
Proportion part-time farms	do.	24.7	18.3	14.6	12.3	11.4	9.9	14.9	29.1	19.2
Distribution of	do.	20.3	23.4	21.2	12.6	10.9	11.6	100.0	13.2	7.1
Proportion had any nonfarm income	do.	84.4	80.8	79.8	78.7	78.7	81.1	80.5	85.9	82.5
Proportion had $3,000-plus nonfarm income	do.	54.0	46.5	38.5	30.6	29.7	26.5	37.4	56.1	51.5
Total nonfarm income per farm reporting	Dollar	5,335	4,622	3,677	3,069	2,981	2,676	3,708	5,542	5,069
Proportion from operator wage and salary income	Percent	75.1	74.6	70.4	63.2	62.3	54.5	68.4	74.9	75.4
Income per farm reporting 2/	Dollar	5,394	4,717	3,676	2,978	2,883	2,409	3,730	5,661	5,062
Proportion of farm operators worked off-farm 100-plus days	Percent	42.6	35.5	30.1	23.5	22.8	18.9	28.7	45.2	39.3
Distribution of	do.	18.2	23.6	22.8	12.6	11.3	11.5	100.0	10.7	7.5

1/ See matching boxheads and footnotes, table 2.

2/ Zonal differences for 1964 are significant at the 5-percent level for 0 and 1, 1 and 2, 2 and 3, and 4 and 5-8, and for the Z_0^* and Z_0' county aggregates.

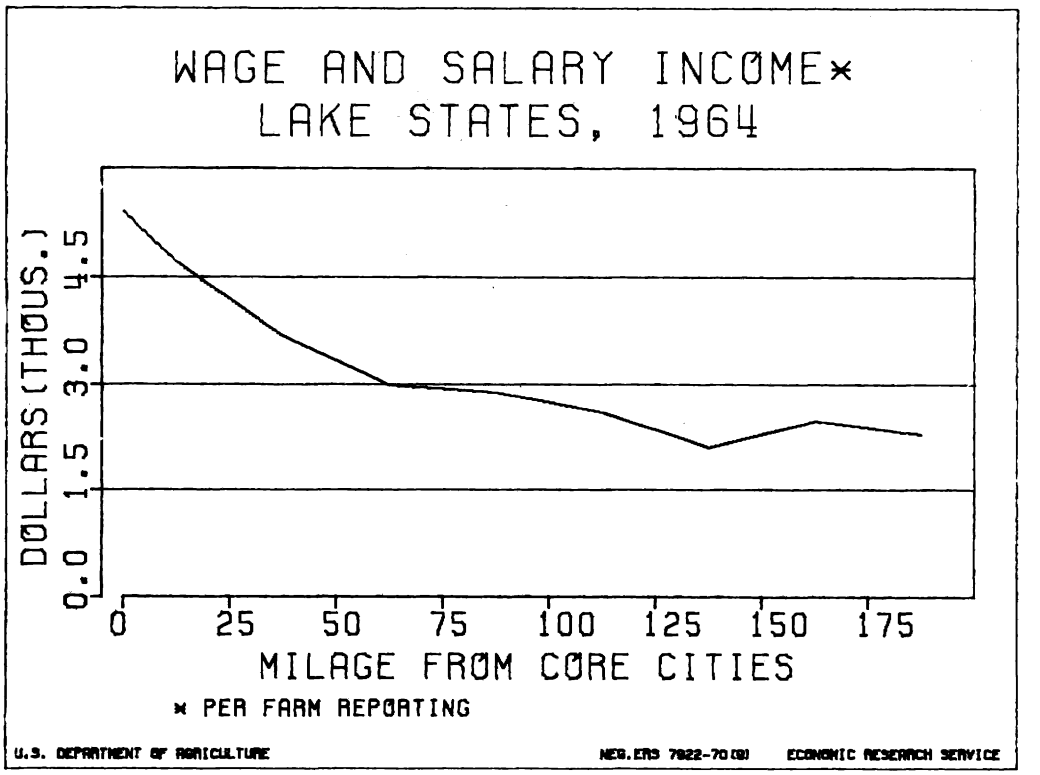

Figure 8

For operators and other members of the farm household, off-farm earnings was by far the most important source of outside income throughout the region. Yet their relative contribution ranged from three-fourths of nonfarm income in zone 0 to about 55 percent in the distant zone. Nearly 70 percent of regional labor earnings accrued to farm households within 50 miles of the core cities.

Possibly the best indicator of the importance of nonfarm income is the relative geographic incidence of the part-time farm. In 1964, nearly a fourth of all farms in zone 0 were part-time farms, compared with one-tenth of the units 100 or more miles out. Over 40 percent of all farm operators in zone 0 also worked off the farm at least 100 days in 1964, compared with less than 20 percent in the outermost zones.

The substantial geographic variation in the availability and level of nonfarm income are also shown by the two county distributions included in table 22. The distribution of counties comprising each geographic zone on the basis of mean nonfarm income shows clearly that farm operator's labor opportunity returns are highest near the core cities.

The alternative of off-farm employment--for farm operators, other family members, and potential hired help--affects the agricultural sector's balance where nonfarm labor returns are high and exerts the greatest effect where such returns in agriculture are low, as they are generally in dairying in the Lake States. This situation is largely attributable to the relatively slow rate of dairying mechanization, and is also reflected by the numerous remaining small dairy farms with inadequate resource bases.

Table 22.--Frequency distributions of counties by level of nonfarm income and by geographic zone, Lake States, 1964

Nonfarm income	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0 1/
	Percent								
County distribution within zone:									
Under $2,000	---	---	2.3	2.4	17.1	29.8	9.7	---	---
$2,000-$2,999	---	6.2	27.3	47.6	34.3	46.8	29.9	---	---
$3,000-$3,999	3.7	25.0	34.1	38.1	34.3	8.5	24.7	---	10.0
$4,000-$4,999	18.5	21.9	31.8	11.9	14.3	12.8	18.5	17.7	20.0
$5,000-$5,999	63.0	43.8	4.5	---	---	2.1	15.0	58.8	70.0
$6,000 or more	14.8	3.1	---	---	---	---	2.2	23.5	---
County distribution by zone:									
Under $2,000	---	---	4.5	4.5	27.3	63.7	100.0	---	---
$2,000-$2,999	---	2.9	17.7	29.4	17.6	32.4	100.0	---	---
$3,000-$3,999	1.8	14.3	26.8	28.6	21.4	7.1	100.0	---	1.8
$4,000-$4,999	11.9	16.7	33.3	11.9	11.9	14.3	100.0	7.1	4.8
$5,000-$5,999	50.0	41.2	5.9	---	---	2.9	100.0	29.4	20.6
$6,000 or more	80.0	20.0	---	---	---	---	100.0	80.0	---
Total counties	11.9	14.1	19.4	18.5	15.4	20.7	100.0	7.5	4.4

1/ See matching boxheads and footnotes, table 2.

LAND VALUES

Land prices also influence resource allocation in the Lake States. Land, as a physical input, has been discussed already by farm type, size, and geographic distribution. What remains to be discussed are the varied market values for land.

The most relevant proposition--one posed early in this study--is that farmland values near urban-industrial growth centers reflect strongly high-valued alternative nonagricultural uses. High resource values from nonagricultural activities are not uncommon where urbanization processes are occurring.

In 1964, market values of all agricultural land in the Lake States averaged $178 per acre, contrasted with $158 in 1959 and $90 in 1950. Longrun increases in land values, particularly in absolute terms, have been substantially larger nearest the core cities, where land values are significantly higher than in the predominantly agricultural zones (table 23).

Average land values in 1964 ranged from $320 per acre for zone 0 to slightly over $100 for the farthest zone. The corresponding figures for 1950 were $140 and about $50, a considerably narrower range than in 1964.

Land values not only increased fastest in the closer zones, but also displayed considerably more variation among the closer zones in 1964 than in 1950. This might indicate a widening geographic dispersion over time of the effects of expanding metropolitan areas. Underlying the widely varying zonal land values observed for 1964 are distributions of their respective counties by mean value per acre. A summary of these distributions is included in table 24. Over half of the 27 counties in zone 0 had a mean land value of at least $300 per acre in 1964, compared with none for aggregate zones Z_5 through Z_8.

One would also expect differences in intensity of land use to be reflected in land values. The best land use intensity criterion available is the variation in farmland values by type of farm location. This assumes, of course, that particular type-of-farming areas can be isolated reasonably well as homogeneous aggregations of concentrated specialized farm units. The most representative general type of farm that one would expect to meet this criterion best is the specialty type farm--for example, fruit and nut, vegetable, tobacco. In contrast, the geographic dispersion of cash grain and hog and beef farms is wide (table 25).

Several general conclusions can be drawn from these and additional supporting data. First, the considerably higher mean land values in the closer zones are attributed primarily to demands for land for nonfarm uses, and should be viewed as opportunity returns by farm operators. If zonal land values were determined primarily by their respective predominant types of farming, then the distribution of farm types in the high land value zones might be weighted heavily by farm types characterized by high mean values per acre. The evidence available, however, reveals that the types of farms concentrated in the closer zones--those associated with high land values--represent too small a proportion of all commercial (or all) farms to influence significantly zonal land values (table 26). Commercial dairy, cash grain, other livestock, and general farms make up more than 85 percent of all commercial farms within the two closest zones, and close to 95 percent in all other zones.

Table 23.--Land values per acre by geographic zone, Lake States, 1950 and 1964

Item	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Dollars								
Land values per acre: 2/									
1950	140	129	87	75	82	67	90	140	139
1964	320	255	172	149	153	127	178	332	307
Increase in land values per acre, 1950-64	180	126	85	74	71	60	88	192	168

1/ See matching boxheads and footnotes, table 2.
2/ Zonal differences for 1950 and 1964 are significant at the 5-percent level for 0 and 1, 1 and 2, and 2 and 3.

Table 24.--Frequency distribution of counties by mean land value per acre, Lake States, 1964

Land values per acre	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} \bar{Z}_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
Under $100	7.4	---	18.2	38.1	42.9	46.8	27.7	11.7	---
$100-$149	---	3.1	29.6	35.7	28.6	25.5	22.5	---	---
$150-$199	---	6.2	31.8	7.2	8.6	19.2	13.7	---	---
$200-$249	18.5	46.9	9.1	9.5	8.6	6.4	15.0	17.6	20.0
$250-$299	18.5	18.7	6.8	9.5	8.5	2.1	9.7	11.8	30.0
$300 or more	55.6	25.1	4.5	---	2.8	---	11.4	58.9	50.0

1/ See matching boxheads and footnotes, table 2.

Table 25.--Average land value per acre, average farm size, and geographic distribution, selected types of commercial farms, Lake States, 1964

Item	Unit	Type of commercial farm							
		Specialty crop 1/	Miscel-laneous	Poultry	Cash grain	Other field crops	General	Other live-stock	Dairy
Value per acre	Dollar	312	257	257	212	205	178	176	154
Mean farm size	Acre	141	103	133	255	408	240	239	205
Proportion of farms in zone:									
Z_0 (0 miles)	Percent	18.6	27.1	12.5	12.9	20.8	10.8	9.1	8.4
Z_1 (less than 25 miles)	do.	44.1	20.2	23.6	14.3	9.1	15.1	14.2	19.6
Z_2 (25-49 miles)	do.	16.6	13.7	18.5	19.3	10.4	20.4	18.3	24.9
Z_3 (50-74 miles)	do.	4.7	13.0	15.4	12.6	13.5	16.3	14.6	18.1
Z_4 (75-99 miles)	do.	9.5	11.7	13.9	12.9	7.2	13.4	16.8	16.2
Z_5-Z_8 (100-200 miles)	do.	6.5	14.3	16.1	28.0	39.0	24.0	27.0	12.8

1/ Includes fruit and nut, and vegetable farms.

Table 26.--Frequency distribution of commercial farm numbers for each geographic zone, by type of farm, Lake States, 1964

Type of farm 1/	Geographic zone								
	Z_0 2/ 0 mi.	Z_1 2/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 2/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 2/ region	Z_0^* 2/	Z_0' 2/
	Percent								
Specialty crop 3/	5.0	6.8	2.1	0.9	1.8	1.0	2.8	6.7	3.4
Miscellaneous	5.8	2.5	1.4	1.8	1.7	1.7	2.2	8.1	3.5
Poultry	2.2	2.4	1.6	1.8	1.7	1.6	1.8	2.7	1.8
Cash grain	20.6	13.0	14.6	13.1	14.2	24.8	16.6	18.3	22.8
Other field crops	2.0	0.5	0.5	0.8	0.4	2.0	1.0	0.9	3.0
General	9.4	7.5	8.4	9.2	8.0	11.5	9.0	9.5	9.3
Other livestock	13.4	12.0	12.9	14.1	17.1	22.2	15.3	15.2	11.6
Dairy	41.6	55.3	58.5	58.3	55.1	35.2	51.3	38.6	44.6

1/ Farms are arrayed by declining mean value per acre, ranging from $312 for specialty crop farms to $154 for dairy farms.
2/ See matching boxheads and footnotes, table 2.
3/ Includes fruit and nut, and vegetable farms.

A second conclusion, based on data in table 25, is that farm size, as well as type of farm, is affected importantly by land values, measured here as total farm acres. The observation that the highest mean land values, by type of farm, are associated with the smallest farms probably is no coincidence. These units are farmed intensively--high ratio of capital and labor to land--suggesting that the land-to-capital price ratios for the closest zones are high, and probably have been trending upward.

Dairying in these closer zones probably is not experiencing a rapid rate of substitution of capital for land (and labor). One explanation for this, and for the declining importance of dairying here, is that a substantial portion of the capital investment in dairying largely represents a long-term investment in fixed plant and equipment. Longrun returns expected from this investment frequently are overestimated by the farm operator because of the rapid change in the number and nature of alternative nonfarm employment opportunities for resources. In this case, farm operators must be willing to discount more rapidly net returns to dairying to avoid incurring losses on longrun capital investments. One can point out that many studies related to dairying have shown that high land values deter dairy farm expansion. And land values are highest and rising fastest where the effects of urban-industrial expansion are greatest, which also is where dairying has been the most important agricultural activity.

CONCLUSIONS AND IMPLICATIONS

Competition for resource use in Lake States areas typified by established and booming urban-industrial complexes is causing radical changes in the surrounding agriculture--especially dairying. Results of the analyses in this study support the hypothesis that rapid urban-industrial growth in the Lake States, coupled with efficient bulk milk handling and improved highways and refrigeration are diminishing the nearness-to-market advantages for dairying theorized by Von Thunen. Industrial and urban expansion in this area continue to siphon off land and labor resources from the agricultural sector, a general trend that will likely continue. This drainage will continue as long as farm returns remain below the level of returns in other sectors of the regional economy. And as long as regulatory factors and imperfect markets act as impediments, current resource adjustments among the agricultural and other sectors will not result in an optimal resource use pattern. Assuming the Lake States nonfarm economy continues to prosper (rising incomes and low unemployment), expansion in industrial and urban development can be expected to continue. The dairy industry probably will continue to bear the brunt of displacement because of that industry's historical concentration relatively close to major consumption markets.

Numerical losses in dairy farms are greatest in areas where the local economy benefits from an interaction of agricultural and other sectors. The net effect of this interaction has been a geographic shift away from the principal consumption markets and resulting decreases in the number of dairy farms, the milk cow population, and aggregate milk production. Under the current geographic pattern of resource allocation and factor prices--especially of land and labor--these changes in dairying in the Lake States will continue.

Losses in the number of milk-producing farms vary by size of operation and location. The number of larger, highly specialized dairy farms will continue to increase away from urbanization. Overall, the steepest declines will continue within about 30 miles of the metropolitan centers in the Lake States, especially near those displaying high population density and rapid growth. Farm types which prosper in this environment will be largely those on which the operator can readily integrate his agricultural operations with part-time employment off the farm.

Present indications do not suggest the emergence in the Lake States of the large specialized dairy farm organization associated commonly with the Southwest, California, and Florida. Traditional beliefs and values held today by most milk producers, as well as the general farm populace, will serve as a strong deterrent to such a structural change. Strong economic forces encouraging the formation of 100-200 cow herds clearly are operative in some portions of the region. But other economic forces in these areas reduce the survival ability of dairying as a competitive user of available resources. The incidence of larger dairy operations, in general, probably will be concentrated well beyond the expanding sphere of urban growth centers. Small dairy herds--fewer than 20 cows--will continue to disappear rapidly.

Probably the most important and critical direct implication derived from this study relates to milk market order pricing. The situation and arguments follow.

Population centers in the Lake States are supplied with fluid milk in an orderly fashion under the rules set forth in Federal milk marketing orders. Most milk marketed for bottling is priced and regulated by Federal and State marketing orders according to market supply-demand conditions and production costs. These regulations indirectly establish prices for the unregulated markets for bottled milk. The national price support for manufacturing milk is established by law at 75-90 percent of parity and reviewed at least annually. This price influences all class I and II milk prices across the Nation. For each major consumption market is a well-defined supply area that can be adjusted to changing demand-supply conditions.

Two recent market order developments are of considerable significance for Lake States dairying: (1) Supply areas have been enlarged to compensate for the rapid exodus of milk producers from fringe rural-urban areas and to accommodate rising urban population and widening marketing areas; and (2) national dairy support levels were raised one-third during 1966-69 and again in 1970 to improve income of dairy farmers, thus encouraging milk production to assure adequate supplies of fluid milk.

Market order pricing policy for Lake States dairying can adopt one of at least two general courses of action: (1) Continue to raise minimum levels of milk prices, largely in response to signals received from close-in areas where dairying is declining, or (2) allow dairying to freely undergo regional production adjustments in response to prevailing prices, demand levels, and alternative demands for resource use. A full discussion of these and other policy alternatives is beyond the scope of the present study. However, implications of this study shed some light on these policy choices.

Land and labor opportunity returns prevailing in the expanding metropolitan areas are signaling a reallocation of land and labor to employment in the nonagricultural sector of the Lake States economy. 10/ Milk price increases in this situation may impede resource adjustments expected from the natural behavior of competitive forces. The net result, largely temporary, is a "locking-in" to dairying of substantial quantities of resources that otherwise would be employed to realize higher returns outside the agricultural sector. Also, higher milk prices strengthen the competitive bidding for resources, and fuel already rising resource prices. This causes still higher unit costs of producing milk and spiraling milk price increases.

Legislating higher milk prices could also aggravate the problem of surplus milk production in the Lake States. This study shows that milk production in the outlying zones increased considerably during 1954-64, a period of relatively low milk prices. Apparently, these zones have a much higher survival potential for dairying than the region as a whole. This suggests that production in the outer zones is expanding rapidly in response to the currently high milk prices.

The regional competitive advantage is shifting from relatively high-cost production areas near cities to distant rural areas where land, labor, and production costs are lower. Current signs indicate a continuation of this trend. Further, enlargement of the geographic supply areas and additional increases in milk prices would facilitate a continued improvement in the competitive position of dairying farther out, with respect both to dairying near metropolitan areas and to agricultural alternatives within the outer areas. Uniform pricing of milk and regional consolidation of State and Federal marketing orders, a possibility for adoption in the near future, also would enhance the competitive position of dairy farmers farther out.

Perhaps milk marketing order policy in the Lake States should be geared to encourage production in areas where dairying is the most profitable alternative--thereby simultaneously improving dairy farm incomes and lowering milk production costs. The transfer of close-in resources presently used for producing milk to other uses will continue despite higher milk prices. Producing milk competitively in this situation may require fluid milk prices considerably above present levels--thereby raising retail milk prices unnecessarily. Consumers likely would react to higher milk prices by drinking less milk--at least per capita. Thus, production of milk at the lowest unit cost regionally might become necessary for dairying to be competitive with acceptable substitute products.

In summary, the raising of minimum order prices without carefully weighing intraregional variations may trigger increased supplies of milk, especially from producers located in a primarily agricultural environment. Overemployment of local resources in the production of milk also might occur, particularly of resources near population concentrations where resource prices and unit production costs are substantially higher. But increasing the output of milk would make the

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10/ Examples of labor "opportunity returns" in the Lake States are reflected in official blue-collar factory worker earnings. According to reports of U.S. Dept. of Labor and U.S. Dept. of Commerce for July 1969, annual rates for selected cities were as follows: Michigan-Detroit, $9,309; Grand Rapids, $7,422; Minnesota-Duluth, $6,562; Minneapolis-St. Paul, $7,396; and Wisconsin-Milwaukee, $7,679.

existing milk surplus situation worse. And increasing the resources used in milk production, particularly in areas where in the absence of administered prices, returns in the nonfarm sector probably would be higher than in dairying, would interfere with the competitive processes which allocate resources efficiently.

We turn now to some more specific conclusions relevant to Lake States dairying in the near future. The commercial dairy farm--the most important producing unit--will continue to increase in herd size and land base. The incidence of farms having 30 or more milk cows will increase considerably. Within this interval lies the size of dairy operation whose basic organization depends heavily on farm operator labor and the most efficient laborsaving technology, and includes a land base of about 300 acres. On many of these farms, a hog enterprise or cash grains will supplement the dairy operation.

The most important factor contributing to increased total output of milk is improved production per cow. More and more dairy farm operators are accepting and using this usually least-cost means of increasing net returns. Improvements in milk cow quality and feed efficiencies are likely to continue having a very important role in increasing milk production. The geographic trends in dairying shown by census data will continue and adjustments will become even more important in the belt 30-50 miles from the expanding metropolitan areas, where land and labor resources are more readily available and have lower opportunity costs (returns) than close to metropolitan areas. Surviving dairy farms located closer in will tend to be organized intensively--combining substantial quantities of capital with a relatively small land base and limited labor requirements. This type of resource organization in dairying likely will concentrate where land and labor opportunity returns are high. However, these operations will continue to represent only a small proportion of the population of dairy farms.

APPENDIX

The geographic model developed for the Lake States entails the construction of a series of equidistant, modified concentric circles radiating from the core of each SMSA (Standard Metropolitan Statistical Area), as defined for 1960 by the U.S. Bureau of the Census. Describing strictly geographic isolines helps to relate the farm's physical location to the SMSA's on a linear distance basis.

Most studies that include a location theory model, not designed to test hypotheses related to urban versus rural influences, implicitly accept Von Thunen's location theory propositions. Traditional geographic models using such isoline criteria as milk price, milk price-transport cost ratio, milk hauling cost, or milk-feed price ratio were not selected for this study because of the wide dispersion of producers and processing plants, the regional variation in marketing orders, and the overlapping supply areas for the marketing areas. These criteria are more amenable to an analysis based on specific marketing orders and supply areas. Other complicating factors include the production location flexibility associated with the bulk transport of milk and the coexistence of fluid and manufacturing milk producers. No single method of delineating a region has been found that perfectly meets the criteria of Von Thunen's location theory. Inherent in the model selected to delineate the Lake States in this study is the implicit testing of the hypothesis that Von Thunen's theory is no longer wholly applicable.

For this investigation, the construction of strictly concentric circles for each SMSA and based solely on SMSA's is not possible or totally satisfactory. Certain modifications were made to portray a more realistic picture of the region, based on personal familiarity with the region studied and supported by suitable additional assumptions. Departures from the strictly concentric circle pattern are explained where they occur. It is not anticipated that such exceptions will invalidate the testing of the hypotheses advanced for the region in aggregate.

The traditional and theoretical binocular-shaped pattern can be constructed only if the SMSA's are represented by single, widely spaced counties, with each containing only one major city. This is not typical of the SMSA's defined and the resultant pattern described for the Lake States. Several SMSA's encompass at least two counties and include at least two principal cities. In these situations, the equidistant isolines were based on each city containing at least 25,000 people in 1960, and resulted in an overlapping of the concentric isolines. The overlapping segments were then removed to improve accuracy. Otherwise, a farm could be located 50 miles from a city of 100,000 population within a three-county SMSA and be only 5 miles from a city of 50,000 included in the same SMSA, but yet be confronted with similar circumstances. (The Detroit and Twin Cities SMSA's provide good examples of this possibility.)

Two assumptions should be made explicit at this point. The equidistant spacing of the isolines would be 25 miles, and all family units located on the same isoline have equal access to the core city. A commuting distance of 25 miles from a core city appears to be a reasonable average maximum in this age of rapid superhighway driving and improved public commuter systems. Further, a radius of 25 miles from the core city typically encompasses the entire county. However, equal access to the core city does not imply that each has equal opportunity to become gainfully employed in the core city, since differences must be recognized among individuals' skills, health, age, education, and attitudes.

Each county containing a city of 50,000 or more people in 1960 fell automatically in an SMSA, but those with 25,000-50,000 did not. These latter cities, when

located close to an SMSA, were considered to be a core city, because of the rapid rate at which many of the SMSA's are growing in population and industry. A good example of this situation is eastern Wisconsin, where cities of this size form a corridor from the Madison-Milwaukee belt to Green Bay. This approach seems appropriate particularly because changes over time in this corridor can occur only westward. This limitation facilitates identifying readily such areas.

Where cities of 25,000-50,000 population were isolated, they were not treated as core cities, and quite possibly will appear as exceptions to the general pattern. An example of such localized situations is the city of Wausau, Marathon County, Wis.

The influence of the large urban centers situated in the northern Illinois, Indiana, and Ohio counties and in northeastern Iowa, bordering the Lake States, also were included in the model. A large city located in Illinois 5 miles south of the Wisconsin border should have economic effects similar to one 5 miles north of the Wisconsin line.

An exception to the model is the two-county SMSA comprised of Clay County in Minnesota and Cass County in North Dakota--the Fargo-Moorhead based SMSA. This SMSA was not considered as such for this study. Prior knowledge reveals that its economic and social effects are highly localized because of its geographic location. Additionally, its present population characteristics (density and proportion urban) and its population and industrial potential differ substantially from the other SMSA's in the region.

To improve further the usefulness and reality of the location framework, I made three additional modifications. First, recognizing fully that basic land characteristics vary considerably within the region, I adjusted the pattern to define five general subareas: (1) The southern two-thirds of Minnesota, which represents most of the State's agriculture; (2) the northern third of Minnesota, which includes all of the State's "unorganized territory";11/ (3) the eastern two-thirds of Wisconsin; (4) southern Michigan; and (5) the Northern Peninsula of Michigan.

Second, the Northern Peninsula subsequently was excluded from the analytical framework, and data for this area are included primarily to balance regional totals. The basic reason for this decision is that there is no effective or meaningful way of relating these counties to any one of the SMSA's, since none is located close to this area. It is suspected and assumed here that, because of its geographic containment, life in the Peninsula is relatively self-contained and self-sustaining, and that the major factors influencing the agriculture in much of the Lake States are relatively unimportant in this area.12/

The third adjustment was necessitated by a lack of precision when assigning some counties to the various 25-mile bands. If at least half the land area in a county fell within a zone, the county was assigned there automatically. When portions of a county were included in three or more bands, consignment was determined by the geographic center of the county, unless the county was located in the "unorganized territory" in northern Minnesota. In the latter situation, assignment was based on the section of the county that is inhabited.

11/ By definition, as it relates to northern Minnesota, "unorganized territory" represents the uninhabited lands that predominate in forests, rivers, lakes, and rocky terrain.

12/ For example, land uses, transportation system, proximity to consumption markets.

Appendix table A.--Distribution of counties by direction and rate of change in the number of commercial dairy farms, by geographic zone, 1959-64

Item	Unit	Geographic zone								
		Z_0 1/ 0 mi.	Z_1 2/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 3/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 4/ region	Z_0^* 5/	Z_0' 6/
Total counties	Number	27	32	44	42	35	47	227	17	10
With decreases	do.	27	29	39	35	24	22	176	17	10
Under 10	Percent	3.7	10.3	35.9	22.8	20.8	31.8	21.6	5.9	---
10-19	do.	14.8	51.7	53.9	48.6	54.2	31.8	43.8	5.9	30.0
20-29	do.	29.6	34.5	5.1	20.0	8.3	22.7	19.3	29.4	30.0
30 or more	do.	51.9	3.5	5.1	8.6	16.7	13.7	15.3	58.8	40.0
Mean rate of decrease	do.	-24.3	-16.2	-13.0	-13.1	-11.0	-13.3	-14.7	-27.7	-21.2
Distribution of--										
Farms lost	do.	18.3	24.7	23.4	14.1	11.3	8.2	100.0	10.2	8.1
1959 population	do.	11.0	22.4	26.6	15.9	15.0	9.1	100.0	5.4	5.6
With increases	Number	0	3	4	6	10	25	48	0	0
Under 10	Percent	---	33.4	75.0	33.3	30.0	32.0	35.4	---	---
10-19	do.	---	33.3	25.0	16.7	10.0	8.0	12.5	---	---
20-29	do.	---	33.3	---	33.3	20.0	16.0	18.8	---	---
30 or more	do.	---	---	---	16.7	40.0	44.0	33.3	---	---
Mean rate of increase	do.	---	+8.4	+9.0	+10.7	+20.4	+22.5	+16.0	---	---
Distribution of--										
Farms gained	do.	---	3.0	6.7	20.8	23.7	45.8	100.0	---	---
1959 population	do.	---	5.6	12.0	31.3	18.6	32.5	100.0	---	---
Net rates of change:										
Mean (μ_j)	do.	-24.3	-15.5	-11.8	-8.5	-6.9	-2.4	-11.4	-27.7	-21.2
Mean ($\bar{X}_j$)	do.	-28.7	-16.3	-10.2	-9.8	+6.1	+12.0	-9.4	-30.8	-25.1
Median	do.	-30.0	-16.5	-12.3	-11.6	-11.1	+1.0	-12.9	-30.0	-26.0

1/ Aggregate of all SMSA counties.
2/ Aggregate of all counties not designated as SMSA counties located within 25 radial miles from the SMSA counties' core cities.
3/ Aggregate of the four zones falling between 100 and 200 miles from the SMSA core cities. Data for these four zones have been aggregated because each zone treated separately contributes little additional information.
4/ Total of all zones.
5/ Aggregate of all 250,000 or more total population counties.
6/ Aggregate of all 100,000-250,000 total population counties.

Appendix table B.--Frequency distributions of counties by average herd size and geographic zone, Lake States, 1964

Herd size interval	Geographic zone								
	Z_0 1/ 0 mi.	Z_1 1/ less than 25 mi.	Z_2 25-49 mi.	Z_3 50-74 mi.	Z_4 75-99 mi.	Z_5-Z_8 1/ 100-200 mi.	$\sum_{j=0}^{8} Z_j$ 1/ region	Z_0^* 1/	Z_0' 1/
	Percent								
Distribution by herd size:									
Under 15 milk cows	3.7	6.2	2.3	11.9	20.0	53.2	18.1	5.9	---
15-19	25.9	18.8	31.8	45.2	40.0	38.3	34.3	29.4	20.0
20-24	26.0	25.0	43.2	33.4	22.9	6.4	26.0	29.4	20.0
25-29	33.3	40.6	18.2	9.5	17.1	2.1	18.1	29.4	40.0
30 or more	11.1	9.4	4.5	---	---	---	3.5	5.9	20.0
Distribution by zone:									
Under 15 milk cows	2.4	4.9	2.4	12.2	17.1	61.0	100.0	2.4	---
15-19	9.0	7.7	17.9	24.4	17.9	23.1	100.0	6.4	2.6
20-24	11.9	13.6	32.2	23.7	13.5	5.1	100.0	8.5	3.4
25-29	22.0	31.7	19.5	9.8	14.6	2.4	100.0	12.2	9.8
30 or more	37.5	37.5	25.0	---	---	---	100.0	12.5	25.0
All intervals	11.9	14.1	19.4	18.5	15.4	20.7	100.0	7.5	4.4

1/ See matching boxheads and footnotes, appendix table A.

Appendix table C.--Frequency distributions of all farms and commercial dairy farms, by total farm acreage, Lake States, 1964 and 1974 projections 1/

Item and year	Total farm acreage									
	Under 50	50-99	100-139	140-179	180-219	220-259	260-499	500-999	1,000 plus	All intervals
	Percent									
All farms:										
1964	12.8	17.7	14.0	16.1	9.8	8.3	17.2	3.6	0.5	100.0
1974	10.6	15.6	11.8	13.9	9.5	8.5	22.3	6.6	1.2	100.0
Commercial dairy:										
1964	1.8	12.6	16.9	20.6	14.0	10.8	20.3	2.8	0.2	100.0
1974	1.6	8.1	12.0	17.7	13.7	12.0	28.8	5.7	0.4	100.0
Dairy percentage of all farms:										
1964	5.6	28.5	48.6	51.4	57.7	52.7	47.5	31.7	12.5	40.2
1974	6.1	21.3	42.2	52.4	59.9	58.1	53.1	35.5	13.0	41.2

1/ 1974 projections were determined by using Markov chains and the base period 1959-64.