Journal of Rural Social Sciences

Volume 14
Issue 1 *Southern Rural Sociology Volume 14, Issue 1 (1998)*

Article 2

12-31-1998

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Southern Rural Sociology **Vol. 14**

AGRICULTURAL CONCENTRATION: AN ANALYSIS BY COMMODITY

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ABSTRACT

One of the most striking consequences of the industrialization of agriculture in the United States is the extent to which production is becoming increasingly concentrated on a relatively few farms. In this study, a human ecological perspective and nationwide census data at the county level from 1982, 1987, and 1992 were used to explore concentration in the dairy, hog, and beef cattle industries. Wide differences were found in the extent of concentration from commodity to commodity and from county to county. It was found that in counties where the production of one commodity is highly concentrated, the production of other commodities may not necessarily be similarly concentrated. Also, factors related to high levels of concentration for one commodity are not generally related to high levels of concentration for other commodities.

INTRODUCTION

With the re-emergence of the sociology of agriculture during the 1970s, increased attention has been paid to structural issues in US agriculture (Albrecht & Murdock, 1990; Buttel et al., 1990). Perhaps the structural issue causing the greatest concern to producers, researchers, and policy-makers is the extent to which the production of food and fiber in the United States is becoming increasingly concentrated on a relatively few very large and highly capitalized farms (e.g. Stockdale, 1982). Although there have been major exceptions (Pfeffer, 1983), the United States has historically been a nation of family farmers, with national policy stressing the Jeffersonian ideal of production coming from a large

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number of small and medium-sized farms (Paarlberg, 1980). Indications that agricultural production is following the same trends toward concentration that have occurred in other industries is very troubling to some. Researchers have explored reasons for this concern, such as fears of the emergence of a landed aristocracy (Gilbert & Harris, 1984). Further, researchers have sought to understand if concentration will disrupt our present diverse, relatively safe, nutritious, and inexpensive diet (Rodefeld et al., 1978), or if the emergence of large-scale farming will have negative implications for farm communities (Goldschmidt, 1978). Also, researchers have discussed questions about the role of government and policy decisions in encouraging trends toward greater concentration (Busch & Lacy, 1983).

Historically, agricultural production has had two major characteristics that have inhibited trends toward the large-scale, concentrated production that has occurred in other industrial sectors (Friedland, 1984; Mooney, 1983). First, the production of many agricultural commodities is seasonal. This makes it difficult for producers to efficiently utilize a labor force throughout the year. For many agricultural commodities, there are periods of extensive labor, such as planting and harvest, followed by periods where labor requirements are minimal as biological processes unfold (Mann & Dickinson, 1978). Second, many agricultural products require large amounts of land. Heavy investments in land rather than capital inhibits the establishment of capitalistic forms of production. Recent trends toward increased concentration in agriculture can be traced to developments that have allowed these two obstacles to be overcome (Berardi & Geisler, 1984; Friedland, 1984). The extent of concentration is likely to vary from commodity to commodity, as some commodities are more amenable to overcoming these labor, land, and capital problems than are others. Concentration is most likely to occur in those products where seasonality can be reduced, allowing the efficient and steady use of labor (Green & Heffernan, 1984), and where the ratio of capital to land inputs are the greatest.

Farm concentration research has taken several distinct avenues. Perhaps most common are studies that examine trends toward concentration for individual commodities. Examples include explorations of the poultry industry (Heffernan, 1984) and studies of the production of several types of fresh fruits and vegetables (Friedland & Barton, 1975; Friedland et al., 1981; Wells, 1996). While these studies provide insights

into why some commodities are more concentrated than others, they fail to help us understand variations from one area to another. Approaches to understand area-to-area variations in concentration include historical analyses (Pfeffer, 1983) and analyses of the factors correlated with various levels of farm concentration (Albrecht, 1992). In a study that combined both types of analysis, Gilbert and Akor (1988) examined trends in the concentration of a single commodity (the dairy industry). They also sought to understand the reasons for the vastly different structures in the dairy industry in California (characterized by capitalized, large-scale farms) and Wisconsin (characterized by traditional family farms).

While making important strides, the research to date has several major gaps. First, with the exception of the Gilbert and Akor (1988) work, commodity-specific studies have yet to account for the major variations in the extent of concentration within a single commodity from area to area. Further, analyses comparing levels of concentration in different parts of the country have largely ignored the fact that much of the reason for these variations are that different commodities are being produced and some of these commodities are more amenable to concentration than others. This study attempts to further improve our understanding of agricultural concentration by using theoretically generated insights and then examining commodity-specific data at the county level from the 1982, 1987, and 1992 Censuses of Agriculture for the dairy, hog, and beef industries in the United States.

The analysis of commodity-specific data at the national level over time provides an opportunity to examine three important questions relative to agricultural concentration. First, using data from three different censuses allows an exploration of the direction and extent of change in farm concentration over time. Second, using this data allows an exploration of the extent to which areas that are concentrated in the production of one commodity are also concentrated in the production of other commodities. For example, do areas that have a concentrated dairy industry also have a concentrated hog or beef industry? Third, it allows an exploration of the extent to which the factors related to high levels of concentration are the same across commodities. For example, are the factors related to high levels of concentration in the dairy industry the same factors that are related to high levels of concentration in the hog industry?

Sociological Theory and Agricultural Concentration

The re-emergence of the sociology of agriculture has largely been driven by the utilization of neo-Marxist and neo-Weberian perspectives, and much of the research conducted has been attempts to answer questions derived from these perspectives (Buttel et al., 1990). Specifically, these perspectives raise questions about how and under which circumstances the family farm can continue to survive in our industrialized society (Buttel et al., 1990; Mooney, 1983). These perspectives provide a strong rationale for technological developments and other aspects of industrialization that are making possible the trend toward capitalized, large-scale (concentrated) agriculture (e.g. de Janvry, 1980). Researchers utilizing these perspectives have also provided reasons why some commodities have become more concentrated than others (Friedland, 1984; Mann & Dickinson, 1978). However, when attempting to explain variations in trends toward capitalized agriculture from area to area, these perspectives also encounter problems. These problems may largely be a result of the fact that environmental factors are generally ignored.

Further insights about conditions and trends in agriculture can be obtained from a human ecological perspective. In recent years, the human ecological perspective has been suggested as a framework appropriate for studies in the sociology of agriculture (Albrecht & Murdock, 1984, 1986, 1990; Dunlap & Martin, 1983). Proponents of this perspective maintain that it emphasizes important environmental, technological, organizational, and population factors that are critical in gaining an understanding of agriculture but have largely been neglected by other perspectives. The fundamental goal of the human ecology framework is to understand how human populations adapt to constantly changing yet ever-restricted environments (Hawley, 1950; Micklin & Choldin, 1984). The nature of this adaptation to one's environment is primarily determined by the interaction of several key factors, including the physical environment, the social environment (which includes markets, finance, and policy), technology, and the size and composition of the population (Duncan, 1964; Duncan & Schnore, 1959).

When applied to agriculture, the human ecological perspective maintains that the structure of agriculture that emerges in an area is a result of efforts by producers to adapt to environments that are constantly changing, ever-restricted, and greatly varying from place to place

(Albrecht & Murdock, 1990). A major factor influencing operator decisions about farm structures are the commodities produced. Different commodities have different labor requirements, vary in the extent to which technology can be applied, and have distinct seasonal patterns, all of which impact decisions about the farm structure. Physical environmental factors such as climate, soil type and water availability place important constraints on which commodities can be produced, since some crops require longer growing seasons or more water than others. Similarly, water availability and the types and extent of plants available for grazing influence livestock decisions.

Obviously, other factors in addition to the physical environment influence decisions about farm structure. For example, markets, land prices, technology, the cost and availability of farm labor, and government regulations and policies all impact the decisions made by farm operators. Within the constraints imposed by these and other factors, producers make decisions about the farm structural configuration that are achievable and will allow them to best accomplish their objectives. The decisions made are not necessarily rational or based on complete and accurate information. Even for persons producing the same commodity, variations in any of a number of ecological factors can greatly impact choices about farm structural configuration. Thus, ecological variations result in varying farm structures from area to area. For example, while technological developments have allowed the production of some commodities to become very capitalized, environmental differences often have a major influence on the extent to which a given technology can be utilized. Thus, after a study of technology adoption, Perrin and Winkelman (1976) concluded,

> The most pervasive explanation of why some farmers do not adopt new varieties and fertilizers while others do is that the expected increase in yield for some farmers is small or nil, while for others it is significant, due to differences (sometimes subtle) in soils, climate, water availability, or other biological factors. (p.893)

Thus, from a human ecological perspective, one would expect the production of some commodities to be more concentrated than other commodities because of variations in the way that technology and labor can be applied. Similar conclusions could be drawn from other perspectives. However, from an ecological perspective one would also expect variations in the extent of concentration for a single commodity

from area to area because of environmental differences, the extent to which technological developments can be applied, population variations, markets and other economic differences, policy constraints, and other factors.

To explore the potential utility of the human ecological perspective in understanding agricultural concentration, this paper provides an examination of the dairy, beef and hog, industries in the United States. Any number of commodities could be selected for analysis, but these three represent a variety of agricultural endeavors and should provide some indication of the power of the theory. From a human ecological perspective, one would expect that the amount of farm concentration would vary from one of these commodities to another. However, because of differences in the environment, population, technology application, or other factors, variations in the extent of concentration within the same commodity would also be expected from area to area. Thus, from an ecological perspective, one would expect that areas highly concentrated in the production of one commodity would not necessarily be concentrated in the production of other commodities. Likewise, one would expect that those characteristics related to high levels of concentration for one commodity would not necessarily be related to high levels of concentration for other commodities.

The Dairy Industry

At one time, most dairy cows in the United States were on family farms. Typically, these farms were diversified, in that they had a variety of livestock in addition to dairy cows and also had land available to produce the necessary feed. In that era, many farms had only 1 or 2 dairy cows to provide milk, butter, and cheese for the farm family. Thousands of farms had 5 to 10 dairy cows and would sell the milk not needed for family consumption to a nearby cheese factory. The 1950 Census of Agriculture reported that there were over 3.6 million farms with dairy cows, but these farms had an average of only 5.8 cows.

In recent decades, the dairy industry has gone through dramatic transformations as a result of technological developments, policy decisions, and numerous other factors (Lyson & Gillespie, 1995). The amount of milk produced per cow has increased dramatically. Economies of scale associated with new technologies such as milking machines and bulk tanks virtually eliminated the very small dairy operation.

Breakthroughs in veterinary medicine helped control infectious diseases when large numbers of animals were confined in tight quarters. Computers greatly enhanced record keeping and performance evaluations. All of these changes made the large, capitalized dairy farm feasible and allowed such farms to compete effectively with existing smaller family operations. By 1992, there were just 155,879 farms in the United States with dairy cows (a 96 percent decline from 1950), and these farms had an inventory of 9.5 million animals (Table 1). Thus, the number of cows on the average dairy farm had increased from 5.8 to 61.

Many American dairy farms are still basically family farms that not only have dairy cows, but also produce the feed for these cows, and family members provide most or all of the farm labor (Gilbert & Akor, 1988). However, on these family farms, new technologies have made it possible for family workers to handle a much larger number of cows and to produce a great deal more feed. In 1992, over one-half of the dairy farms were of the typical family farm size, having between 20 and 99 cows, and about 50 percent of the dairy cows were on farms of this size (Table 1).

Within the dairy industry, however, a much different type of operation is emerging: the large-scale, capitalized dairy farm that typically has 500 or more cows (Lyson & Gillespie, 1995). These dairy farms usually specialize in dairy production and purchase most or all of their feed. Therefore, large amounts of land are not needed, and the ratio of capital to land inputs increases. In many respects, this type of operation more closely resembles a factory than a farm. The product of those operations is milk, which is steadily produced each day throughout the year. For this continual milk production, a steady supply of labor is needed. These large dairy farms rely heavily on a hired labor force that can be continually employed throughout the year. In 1992, 1.1 percent of all dairy farms had 500 or more cows, but about 17 percent of the dairy cows were on such farms. An additional 12 percent of the farms had between 100 and 499 cows, and these farms had almost one-third of our nation's dairy cows.

The Hog Industry

Hog production has also changed dramatically in recent decades. At one time, most hogs were part of diversified family farms, where they were fed the crops that were produced on the farm. Many farms had only

Table 1. Extent of concentration in the dairy, beef, and hog industries for the U.S., 1982, 1987, and 1992.

Commodity and Size Categories	1982		1987		1992	
	Percent of Farms	Percent of Production	Percent of Farms	Percent of Production	Percent of Farms	Percent of Production
Dairy (Number of cows in inventory)						
1-19	41.8	5.0	32.6	3.6	28.1	2.1
20-99	51.1	61.6	57.4	59.3	58.7	50.0
100-499	6.7	26.5	9.4	26.5	12.1	31.2
500 or more	0.4	6.9	0.6	10.6	1.1	16.7
Total	277,762	9,855,464	202,068	8,636,789	155,539	8,719,933
Hogs (Number sold)						
1-49	38.2	2.3	33.3	1.5	30.1	0.8
50-199	27.6	9.6	26.3	6.8	23.0	4.2
200-999	27.3	40.2	30.3	33.6	32.2	26.0
1,000 or more	6.9	47.9	10.1	58.1	14.7	69.0
Total	315,095	89,998,294	238,819	90,833,453	188,167	106,368,840

Table 1. Extent of concentration in the dairy, beef, and hog industries for the U.S., 1982, 1987, and 1992 (cont.).

Commodity and Size Categories	1982		1987		1992	
	Percent of Farms	Percent of Production	Percent of Farms	Percent of Production	Percent of Farms	Percent of Production
Beef (Number of cows in inventory)						
1-19	57.1	14.3	55.2	13.9	51.9	9.9
20-99	25.8	22.4	26.8	23.6	28.2	22.3
100-499	16.6	49.7	17.4	48.9	19.3	54.7
500 or more	0.5	13.6	0.6	13.6	0.6	13.1
Total	957,698	31,141,826	841,778	28,440,768	803,241	30,540,647

one or two sows, and the pigs raised were used to meet the family's food needs, with those remaining sold in the marketplace. The 1950 Census of Agriculture reported that there were nearly 2.1 million farms that sold hogs. These farms sold a total of 65.5 million hogs, an average of 31 per farm.

Table 1 shows that the number of farms producing hogs had declined to 188,167 by 1992, a reduction of 91 percent. Nonetheless, hog farms sold over 106 million animals in 1992, an average of 565 per farm. Some of these hog producing farms are still family farms that produce crops and, in effect, market their crops by feeding hogs and selling them. However, technological developments related to feeding, waste management, and disease and climate control have made it possible for extremely large hog operations to emerge. Like the large dairy operation, these large hog plants are specialized, use purchased feed and hired labor, and are operationally similar to the nonfarm factory. Labor can be continually applied and the final product (fattened hogs) can be marketed throughout the year. With purchased feed, land requirements are minimal. Between the 1978 and 1992 Censuses of Agriculture, there was a tremendous movement toward greater concentration in the hog industry as the number and size of "hog factories" increased. In 1978, 34 percent of the hogs sold were from farms that sold 1,000 or more animals. However, by 1992, 15 percent of the nation's hog farms sold 1,000 or more hogs and these farms had 69 percent of the total hog sales (Table 1).

The Beef Cattle Industry

The beef cattle industry can be divided into two almost totally distinct operations: the maintenance of beef cows for the purpose of breeding and then marketing their calves (which operations are analyzed here), and the feeding and sale of fattened cattle for slaughter. The cattle feeding industry, much like the hog industry, has become dominated by capitalized, large-scale operations. Such is not the case with the beef cow industry, in which several aspects of the industry have deterred the emergence of large-scale operations.

The first deterrent is that the marketable product of the beef cattle industry is the one calf that the cow produces per year, rather than a continual product like milk. The production of this calf requires long periods of time, during which biological processes transpire and needed

labor inputs are erratic (Mann & Dickinson, 1978). Further, the beef cattle industry continues to be dependent on large amounts of land. Most of the beef cows in the U.S. graze on vast stretches of land that are incapable of efficient crop production. Also, there are no major technological needs for the production of beef cows and thus there are no economies of scale. This makes the beef cattle industry very amenable to small operations, and there are large numbers of hobby and part-time farms that consist of a few beef cows and some grazing land. In many respects, beef cattle production has changed little from 1950. At that time there were about 3.9 million farms with beef cows and these farms averaged 9.5 cows each. Since 1950, the total number of farms with beef cows has decreased and the size of the average farm has increased, but the transition has not been as extensive as with the dairy and hog industries. Table 1 shows that the number of farms with beef cattle was down to 803,241 in 1992 and that the average farm had 38 cows. Still, over one-half of the beef cattle operators had 19 or fewer cows, and over 80 percent had 49 or fewer cows.

Ecological Factors and Concentration

From a human ecological perspective, there are several population, environmental, and technological factors that could be used to explain the differences in farm concentration from area to area. Although numerous factors could be related to the degree of concentration, ecological theory suggests some that are likely to be important. These factors are described and utilized here. From an ecological perspective, population is a critical factor influencing the form of adaptation taken by individuals. For this study the total population of the county is used as the indicator of population. As the total population increases, the relative degree of urbanization also increases. A greater degree of urbanization means greater competition for land, water and other resources, closer and larger markets, and a larger potential labor force, all of which could greatly affect farm structure. For some commodities, being near large population centers may be advantageous for the large, capitalized farms, and thus enhance their emergence. On the other hand, for other commodities, being near large population centers may be a competitive disadvantage for large operations and thus suppress their emergence. Within the dairy industry, for example, a larger population may result in greater levels of concentration. To begin

with, the higher land prices common in more densely populated areas may necessitate capitalized forms of production that result in high sales per acre. Further, being near major markets may be advantageous to the very large bulk milk producers, because the product has a limited shelf life and is rather difficult and expensive to transport long distances. Similarly, the capitalized hog farms may have advantages over smaller hog farms in urbanized areas. Being near the markets may be much less of an advantage for other agricultural commodities which are often marketed nationally and even internationally. These same factors associated with urbanization may preclude large beef operations, because they require so much land.

Variations in the environment from area to area is another factor expected to have an impact on the extent of farm concentration. Differences in the availability of natural resources or variations in slope, climate or other factors could effect the extent to which machines or technologies can be utilized. Sometimes even minor variations can influence the relative advantage of farms with various structures (i.e. capitalized vs. family farms). In macro-level national studies, such as this, effective environmental indicators are difficult to obtain. Thus, this study uses two indirect indicators of the agricultural environment: the percent of the total acreage in the county in harvested cropland and the number of acres irrigated. The percent of the total acreage in harvested cropland, a measure which has been used effectively in other studies (Albrecht & Murdock, 1984), provides some indication of the relative presence or absence of essential natural resources for agriculture, including soil, water and climate. Where such resources are available, a large proportion of the land will be devoted to harvested cropland. The number of acres irrigated is an indication of aridity, an important element of the agricultural environment. Where rainfall is sufficient, the cost and labor associated with irrigation will be unnecessary, and thus the extent of irrigation will be small.

It is expected that the extent of concentration for dairy and hogs is greater where the environment is conducive to agricultural production as indicated by the percent of the total acreage in harvested cropland. In such areas, the increased availability of feeds may enhance the emergence of large-scale dairy and hog operations. In contrast, large-scale beef cattle operations need large amounts of range land, which is not likely to be available in counties with a more advantageous agricultural environment where most land is transformed to crop

production. It is also expected that greater levels of irrigation are related to higher levels of hog concentration, as irrigation increases crop production and makes more feed available for the large-scale operations, increases the amount of labor needed, and requires large capital investments, all of which should be related to large-scale agriculture. Further, in arid areas where irrigation is utilized, extensive portions of land cannot be irrigated. This unirrigated land is generally too dry for cropland and thus may provide the large land tracts necessary for large-scale beef production.

Finally, the relative use of technology and hired labor are obviously critical factors in determining the extent to which agriculture becomes concentrated. Where circumstances allow technology to be effectively utilized, large-scale, capitalized farms seem much more likely to appear. This is more likely true of dairy and hog operations than beef production, since beef production is much less technologically dependent. Similarly, where a hired farm labor force can be used continuously and efficiently throughout the year, as is the case in the dairy and hog industries, the emergence of capitalized farms is more likely. This paper uses the value of machinery and equipment per farm as a measure of technology and hired farm labor expenditures per farm as a measure of farm labor.

METHODS

This study utilized county-level data from the 1982, 1987, and 1992 Censuses of Agriculture for all counties in the United States. The Census of Agriculture data were supplemented with total county population data from the STF3C files of the 1980 and 1990 Censuses of Population and Housing. The dependent variables for this analysis are concentration ratios generated for each of the three commodities.[2] The

[2] Other measures were considered to determine the extent of concentration for each commodity, including the proportion of production from the largest farm size category and the Gini concentration coefficient. The concentration ratio was selected because it has several advantages over other measures. When using the proportion of production from the largest farm size category, there are a large number of counties that have a score of zero. This results in analysis problems because of a lack of variation in the dependent variable. Also, it is misleading because a score of zero could mean very little production of that particular commodity or it could mean that there is extensive production with all of it coming from medium- and small-sized farms. For the Gini concentration coefficient, there are different combinations of farm sizes and farm numbers that could result in the same score.

concentration ratios were computed by determining the proportion of agricultural production (defined as the inventory of adult female cows for dairy and beef, and the number of animals sold for hogs) coming from each farm size category. Then, since this study is concerned with the concentration of production in the large size categories, the proportions in each size category were multiplied by incrementally larger numbers as the size category increased. For example, for the dairy industry, the concentration ratio was computed on the inventory of dairy cows and seven farm size categories were used, ranging from (1) 9 or fewer cows to (7) 500 or more cows. If all of the dairy cows in the county were on farms with 9 or fewer cows, the concentration ratio for that county would be one. However, if all of the dairy cows were on farms with 500 or more cows, the concentration ratio would equal seven. Computations for the other concentration ratios were similar. For the hog industry, seven farm size categories were used, ranging from 24 or fewer hogs sold to 1,000 or more hogs sold. For the beef cattle industry, seven farm size categories were used, ranging from 9 or fewer cows to 500 or more cows. For each commodity, some counties were eliminated from the analysis because there was no production of that particular commodity within the county.

The independent variables for this analysis are factors that represent the population, environmental, and technological conditions in the county as described earlier. The population variable is the total population in the county as reported by the 1980 and 1990 Census of Population and Housing. To avoid problems of heteroskedasticity, a log transformation of the population variable was used in the regression models. The percent of the total acreage in the county in harvested cropland and the number of acres irrigated are used as indicators of the environment. Both measures were taken from each of the three Censuses of Agriculture. Because the number of acres irrigated was extremely skewed (most counties have 0, whereas a few counties have several hundred thousand), a log transformation of this variable was used in the regression models. Technology usage is determined by the total market value of machinery and equipment used in agriculture in the county

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The measure utilized was developed after carefully reviewing a variety of measures of dissimilarity and concentration (Massey & Denton, 1988) and combining elements appropriate for studies of agriculture.

divided by the number of farms. A similar measure was constructed for farm labor (labor expenditures divided by the number of farms).

The first question of this study regards the changes in the extent of concentration over time. This question was answered by comparing concentration ratios over time. The second question is the extent to which counties highly concentrated in the production of one commodity are also highly concentrated in the production of other commodities. This was accomplished by computing and comparing correlation coefficients between the concentration measures for each commodity for each year of the study. Regression analysis was used to explore the extent to which the various ecological factors are related to concentration levels for each of the three commodities, which is the third research question for this study. Three separate regression models were run for each of the three census years, with the concentration coefficient for each of the commodities being the dependent variables, and the population, environment, and technology factors for that same year being the independent variables. To give greater emphasis to the more important agricultural counties, the regression analysis was weighted by gross farm sales in the county. The total county population in 1980 was used in conjunction with the 1982 analysis, while the 1990 measure of total county population was used with the 1987 and the 1992 analyses.

RESULTS

The first major concern of this paper is to explore the direction and extent of changes in farm concentration from 1982 to 1992. It is evident that concentration levels for the dairy and hog industries are increasing rapidly. Between 1982 and 1992, the number of dairy farms in this country declined by 44 percent (from 277,762 to 155,539) and the amount of production from very large farms increased greatly. Similarly, during this decade the number of hog farms declined by 40 percent (from 315,095 to 188,167). The decline in the number of beef farms was not nearly as extensive. Table 2 presents average concentration ratios for the three commodities for counties in the United States for 1982, 1987 and 1992. With a potential range of one to seven, the average U.S. county had a dairy concentration ratio score of 3.43 in 1982. This score increased to 3.63 in 1987, and to 3.91 in 1992. With the same potential range of one to seven, the average U.S. county had a hog concentration ratio score of 4.13 in 1982. This score increased to 4.27 in 1987, and to

4.60 in 1992. Again with a potential range of one to seven, the average U.S. county had a beef concentration ratio score of 3.39 in 1982. The score remained almost unchanged in 1987, and then increased to 3.66 in 1992. Thus, as expected, in the decade from 1982 to 1992, increases in the amount of concentration were most extensive for the dairy and hog industries, and much less pronounced for beef production.

Table 2. Average concentration rates for U.S. counties, 1982, 1987, and 1992 (number of counties in parentheses).

	Commodity		
Year	**Dairy**	**Hog**	**Beef**
1982	3.43 (2,104)	4.13 (2,637)	3.39 (2,996)
1987	3.63 (1,883)	4.27 (2,561)	3.38 (2,999)
1992	3.91 (1,819)	4.60 (2,399)	3.66 (2,998)

Table 3 presents a set of correlation coefficients between the concentration measures for the three commodities used in this study. As expected from ecological theory, this table shows that those counties that are highly concentrated in the production of one commodity are not necessarily highly concentrated in the production of other commodities. All of the correlation coefficients for all of the years analyzed are weak.

Table 4 presents the results of regression analyses exploring the relationships between the ecologically generated independent variables and the concentration ratios for each commodity for each of the three census years. In general, these regression results strongly support the ecological perspective, as the independent variables related to high levels of concentration for one commodity were not necessarily related to high levels of concentration for other commodities. Also, the independent variables were able to explain a relatively high proportion of the variation in concentration. The first independent variable in Table 4 is the total population in the county. This study found that the more urbanized counties were more likely to have a concentrated dairy industry, as expected, while such counties were likely to have the least concentrated beef industry, again as expected. Urban counties are well known for having large numbers of part-time farms that often consist of a few acres near the city with a few beef cattle grazing on these acres. In contrast,

large-scale beef operations require large tracts of unpopulated grazing land. Total population was only weakly related to levels of concentration in hog production.

Table 3. Correlation coefficients between measures of concentration for different commodities for 1982, 1987, and 1992.

Commodity and Year	Commodity	
	Hogs	Beef
Dairy		
1982	-.05	-.05
1987	-.07*	-.01
1992	-.15*	.07*
Hogs		
1982		-.03
1987		-.09*
1992		-.09*

* Statistically significant at the .01 level.

The percent of the total acreage in the county in harvested cropland had a strong positive relationship with hog concentration. Most likely, the large hog farms have emerged where there is plentiful feed nearby. There was, however, a negative relationship between beef concentration and the percent of the county in harvested cropland. As noted earlier, large-scale beef production generally requires vast amounts of grazing land not suitable for crop production. Dairy concentration was only weakly related to this variable.

The number of acres irrigated was positively related to the level of concentration for both dairy and beef production. Irrigation, used as a measure of aridity, is far more prevalent in the arid regions of the west. These arid areas also have vast tracts of grazing land that are unsuitable for crop production but provide an environment for large-scale beef

Table 4. Regression analysis of independent variables on measures of concentration for various commodities for 1982, 1987, and 1992.

Independent Variables	Dairy			Hogs			Beef		
	1982 (N=1,739)	1987 (N=1,692)	1992 (N=1,655)	1982 (N=2,183)	1987 (N=2,289)	1992 (N=2,198)	1982 (N=2,461)	1987 (N=2,637)	1992 (N=2,713)
	Unstandardized Regression Coefficients (b's)								
Intercept	-.33	-1.48*	-.08	4.05*	2.96*	3.25*	4.48*	4.25*	4.89*
Total Population (log)	.32*	.42*	.31*	-.02	.07	.07	-.24*	-.23*	-.25*
Percent Harvested	-.39*	-1.53*	-.81*	3.49*	4.75*	4.21*	-1.34*	-1.60*	-1.36*
Acres Irrigated (log)	.12	.13*	.14*	.01	.03	.03	.22*	.26*	.24*
Technology	-.01*	.01*	.00	-.01*	-.01*	-.01*	.00	-.00	-.00
Farm Labor	.03*	-.01*	.01*	-.01*	-.01*	-.01*	.02*	.01*	.01*

* Statistically significant at the .01 level.

Table 4. Regression analysis of independent variables on measures of concentration for various commodities for 1982, 1987, and 1992 (cont.).

Independent Variables	Dairy			Hogs			Beef		
	1982 (N=1,739)	1987 (N=1,692)	1992 (N=1,655)	1982 (N=2,183)	1987 (N=2,289)	1992 (N=2,198)	1982 (N=2,461)	1987 (N=2,637)	1992 (N=2,713)
	Standardized Regression Coefficients (betas)								
Total Population (log)	.32*	.44*	.32*	-.02	.05	.05	-.27*	-.28*	-.32*
Percent Harvested	-.07*	-.23*	-.14*	.48*	.54*	.52*	-.25*	-.26*	-.27*
Acres Irrigated (log)	.25*	.27*	.29*	.01	.05	.04	.51*	.55*	.58*
Technology	-.09*	.16*	.06	-.10*	-.13*	-.10*	.04	-.00	-.04
Farm Labor	.29*	-.15*	.17*	-.13*	-.09*	-.25*	.22*	.27*	.18*
F-Value	279.3*	211.9*	291.1*	156.5	158.5*	216.3*	514.1*	642.3*	549.6
R-Square	.45	.39	.47	.26	.26	.33	.51	.55	.51

* Statistically significant at the .01 level.

operations. Irrigation was also positively related to the concentration of the dairy industry, but was not significantly related to the concentration of hog production.

Technology was relatively weakly related to all of the dependent variables. Finally, farm labor was a rather weak and inconsistent variable. Generally, farm labor was positively related to dairy and beef concentration, with higher levels of labor expenditures occurring in counties with more concentration in these industries, and was weakly inversely related to hog concentration.

The five independent variables used in this analysis were able to explain between 26 percent (hog concentration in 1982 and 1987) and 55 percent (beef concentration in 1987) of the variance in the dependent variables. The regression results for each commodity were very consistent for each of the three census years.

CONCLUSIONS

This study provides several important insights about farm concentration in the United States. First, the extent of concentration is increasing rapidly in some commodities, especially in the dairy and hog industries. Further, the level of concentration of one commodity in a county is not necessarily related to the level of concentration of other commodities. This finding supports the contentions of the ecological perspective that the farm structural configuration that emerges in an area is largely a consequence of farmers' attempts to adapt to varying ecological conditions. Thus, when ecological conditions vary, farm structures also vary. Also, since the ecological requirements vary from commodity to commodity, factors related to large-scale concentrated agriculture for one commodity may not be related to high levels of concentration for another commodity.

In this regard, the analysis revealed that more extensive urbanization was related to greater levels of concentration in the dairy industry. At the same time, this variable had a strong inverse relationship with the concentration of the beef cattle industry, since a large beef cattle operation requires extensive tracts of grazing land, which are more likely to be present in more remote, unpopulated counties. Also, having high proportions of the total acreage in the county in harvested acreage tends to result in a more concentrated hog industry, since more feeds are

available for the large hog plants. However, high proportions of land in harvested cropland means fewer acres available for grazing, and thus this variable is inversely related to the concentration of the beef cattle industry. Counties with large amounts of irrigated acreage had more concentrated beef and dairy industries.

The variables utilized in this study left much of the variation in the extent of concentration unexplained. Obviously, other variables that were not used in this study account for much of these differences. In particular, the data set used in this study did not have variables to measure the organization component of the ecological model. Specifically, an exploration in variations from state to state in policies toward corporate or other forms of large-scale agriculture, variations in prices received, or variations in land values could all be insightful. However, obtaining measures of these variables is difficult when using national data sets. Another problem with using national data is that some of the relationships may be diffused. That is, a particular variable may be related to high levels of concentration of a commodity in one way in one part of the country, but because of the interactive effects of other variables, the relationship is different in other parts of the country. Given this problem, important understandings may be obtained from more in-depth studies of smaller geographic areas. Further, this study focused on three livestock commodities. It is likely that additional insights could be gained from studies of other commodities, specifically studies of some crop commodities. Regardless, an improved understanding of farm concentration in the United States is critical, and additional research is obviously needed. Other perspectives, the use of different variables, and the use of different research methods may all provide important insights.

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