

12-31-1995

Dimensions of Farm Commodity Production: Horses, Strawberries, and Why

Ronald C. Wimberley
North Carolina State University

Robert M. Moxley
North Carolina State University

Follow this and additional works at: <https://egrove.olemiss.edu/jrss>



Part of the [Rural Sociology Commons](#)

Recommended Citation

Wimberley, Ronald, and Robert Moxley. 1995. "Dimensions of Farm Commodity Production: Horses, Strawberries, and Why." *Journal of Rural Social Sciences*, 11(1): Article 4. Available At: <https://egrove.olemiss.edu/jrss/vol11/iss1/4>

This Article is brought to you for free and open access by the Center for Population Studies at eGrove. It has been accepted for inclusion in *Journal of Rural Social Sciences* by an authorized editor of eGrove. For more information, please contact egrove@olemiss.edu.

**DIMENSIONS OF FARM
COMMODITY PRODUCTION:
HORSES, STRAWBERRIES AND WHY**

By Ronald C. Wimberly and Robert L. Moxley

ABSTRACT

To better understand the social context of food and fiber production, more and more researchers are beginning to study the production of agricultural commodities as independent, dependent and intervening variables. Typically, these commodity variables are measured in terms of separate crop or livestock products or by ad hoc indexes that summarize several commodities. To assess and better understand the spectrum of farm commodities examined in such research, this study uses North Carolina data from the U.S. Census of Agriculture to factor analyze various indicators of crop and livestock production and to determine any underlying, empirical dimensions. Explanations of the empirical combinations involve ecological relationships, biotechnical and geographic patterns, and agricultural coincidence. These dimensions offer a basis for improved measurement and indexing of commodity production as well as a basis for analyzing related variables such as siting agribusinesses and services, or studying impacts on social well-being in farm areas.

INTRODUCTION

To better understand the social context of food and fiber production, social and economic agricultural structure often has been measured by such single variables as farm acreage, gross sales by farms, or other farm characteristics. However, different studies using one or another of these single indicators of farm structure have produced contradictory outcomes for the same hypotheses (Moxley, 1986). These discrepant results led researchers to question the single-item

Ronald C. Wimberly and Robert L. Moxley are professors in the Department of Sociology and Anthropology at North Carolina State University.

measures and to construct multidimensional indexes of farm structure. As a result, new and more comprehensive patterns of farm structure were discovered through factor analyzing farm scale, ownership, operation, operator characteristics and labor resources.

One factor analysis of national data reveals three factors which are reliable over time (Wimberley, 1987). When these dimensions are used to test hypotheses relating farm structure and socioeconomic conditions (Reif, 1987; Lobao, 1990), the multidimensional approach adds a high degree of specification as compared to earlier, less precise measurements and helps to explain previously contradictory findings in the relationship of agristruure to socioeconomic quality of life. Going beyond earlier findings, for instance, large farm area structure was discovered to contribute to socioeconomic well being while corporate farm structure had little bearing on it.

As was the case for social and economic agricultural structure, farm commodity structure is still commonly measured one commodity at a time or by summing the presence of various commodities. It is less common to find commodity indexes that are systematically developed according to statistical criteria. Therefore, a more comprehensive multidimensional approach might also be useful for studying the structure of farm commodity production. This is important because the meaningful measurement of commodities is thought to be essential in the wider analysis of agricultural and rural conditions, and consequently useful in sociological research on agriculture.

Like social and economic variables, commodities — crops and livestock — may reflect important aspects of agricultural structure such as the dominance of a particular commodity or various diversifications of commodities. And like social and economic structural characteristics, commodities have been studied as independent variables (Fernandez, Luiz, and Tarrío-García, 1988), dependent variables (Lyson and Welsch, 1993), and intervening variables (Schulman, Garret, and Luginbuhl, 1985) in order to better understand social conditions. In some cases, the commodities themselves are the units of analysis (Friedland, Barton and Thomas, 1981; Friedland, 1984; Young, 1976).

Commodities as Independent Variables

In a study of 76 rural communities in central Tunisia, crops, along with other characteristics, were used to indicate major institutional complexes in the region (Young, Bertoli, and Bertoli, 1981). A factor analysis reveals several dimensions including one called "sedentary herding." Sedentary herding involves the presence and importance of olives, cactus and commercial alfa grass. This factor predicted the communities having ecological problems and poor housing.

Another example of commodities as independent variables is a study of Mexican ranching (Fernandez, Luis and Tarrío-García, 1988). This descriptive, historical study posits that the ranching system of cattle production contributes dramatically to Mexico's underdevelopment. It promotes land concentration, helps maintain the latifundium-minifundium agrarian structure¹, makes inefficient uses of land, and limits the production of basic foods and rural employment. In brief, cattle ranching is seen as a major cause of many of the problems of the countryside in which it predominates.

Commodities as Dependent Variables

In a study of social origins of three systems of farm production in the southern, the midwestern, and the western United States, one analyst uses an historical and descriptive approach. Pfeffer (1983) says that, "...the farm structure characteristic of a particular area is determined by the natural conditions of production with particular economic, social and political conditions." While this is stated at a high level of generality, Pfeffer (1983:543) becomes more specific with a case study of the completion of the transcontinental railroad in 1869. With the advent of icemaking machines in 1881 and refrigerated freight cars in 1888, California agriculture switched from wheat to fruit and vegetable production. Along with a large workforce, these technical changes impacted the type of commodity production. Pfeffer similarly describes the effects of the availability of slave labor on the types of crops grown in the South and changes caused by the subsequent loss of this cheap labor supply.

Arcury (1990) used agricultural diversity as a dependent variable in a study of ecological conditions related to the disappearance of

forest farming. Arcury studied a 31-county area of Appalachian Kentucky from 1880 to 1910. Since precollected data were used, forest farming — crop and mostly animal production using forested areas and natural forage — was indicated indirectly by counties with low population density, large farms having large amounts of unimproved forestland, farms having a large amount of unimproved agricultural land, farms that produce small amounts of grain and cash crops, and farms with large numbers of livestock. A cluster analysis of agricultural diversity was based on eight crops, seven animal commodities, total acres, unimproved acres, and percentage of farm owners in each county. Variation and change in agricultural production were effected by population density and growth, soil quality, the presence of railroads, and the development of commercial coal mining.

In a more recent analysis, Lyson and Welsch (1993) examine crop diversity as a dependent measure of sustainability. Both the coefficient of variation and Simpson's (1949) index reveal essentially the same outcomes in crop diversity. Results show that increases in expenditures for equipment and machinery, prevalence of corporate farms, higher rates of tenancy, and the prevalence of large farms are associated with lower levels of crop diversity or, in other words, with sustainability. Conversely, higher levels of diversity are found in counties with greater farm labor expenses, where there are more medium-sized farms, and where farmers are more likely to farm full time. They suggest that farming patterns reflecting conventional economic advantages are associated with lower levels of sustainability, while higher levels of crop diversity are related to higher levels of sustainability. How these outcomes may have differed had animal production been included in their measures of farm diversity remains an open question.

Commodities as Intervening Variables

In a study of internal stratification of small landholders in North Carolina, Schulman, Garrett and Luginbuhl (1985) find four factors: scale, off-farm labor, age and tenure. While these factors are similar to other studies of the stratification of small holders, tobacco allotment is introduced as a discriminating variable. A canonical discriminate

analysis indicates a significant difference between farmers who hold tobacco allotments and those who do not.

Farmers without allotments have less net annual income, total family income, total farm debt, and fewer acres farmed. Also, there is no significant difference in the amount of off-farm work, indicating that nonholders do not make up any differences through more off-farm work. The authors (Schulman, Garrett, and Luginbuhl, 1985:259) conclude, "...this study suggests that the type of commodity produced should also be studied." They also explain that, "Adequate or inadequate access to productive resources may be a dimension of stratification in regions that are ecologically suitable for a commodity," and that, "...more generally, inputs into the productive cycle ... have costs that vary by commodity."

Commodities as Units of Analysis

Some analysts only focus on a single commodity for reasons of convenience or because they have a specific interest in that commodity. Others see commodities as central to the study of agriculture because of their implications for social structure.

One of the earliest studies using commodities as comparative units of analysis was by Ruth Young (1976) in research on Caribbean Island agriculture. Young develops the notion of crops as culture areas. She says that crops produced on plantations are locked into the same economic, political and social institutions throughout an island. Therefore, commodities can be studied as organizational units although they occupy diverse land areas.

In Young's (1976) research, each of the island's crops is a separate unit of analysis. Seventy different island-crop topologies are studied in 18 Caribbean Islands. One example is Jamaican bananas; another is Cuban sugar. This commodity analysis discredits several plantation agriculture stereotypes. For example, the belief that plantation crops tend to be vertically integrated was not substantiated. This undermined the alleged role of plantation crops in dependency relation. A number of variables representing stereotypes of plantation agriculture were studied with the results typically showing either the reversal of a stereotype or an insignificant relationship.

One of the strongest advocates of commodities as units of analysis is Friedland (Friedland, Barton, and Thomas, 1981; Friedland, 1984). Like Ruth Young, Friedland and his colleagues argue that agricultural commodities are organized in complex systems with boundaries that can be used for social analysis.

The Friedland team suggests five analytic categories of the commodity system: production practices, grower organization, labor as a factor in production, scientific production and application, and marketing and distribution networks. This methodology is applied to studies of tomatoes; iceberg lettuce; and table, raisin, and wine grapes to gain sociological insights through the comparative analysis of commodities.

A Factor Analytic Approach

While several of the studies reviewed here have used factor analysis (Schulman, Garrett, and Luginbuhl, 1985; Young, Bertoli, and Bertoli, 1981; and R. Young, 1976), none factored an extensive array of both animal and crop commodities. An analysis which runs closest to the one proposed here was Leneo's (1975) classification of French farms.

Leneo's research appeals for a new and more objective classification of farm types as systems of production. The data are based on a sample of 6,000 farms and analyzed for factors. The analysis is based on types of labor — part-time, full-time, family, hired — and principal forms of animal or plant production. Fifteen farm production factors are distinguished and labeled by the crop or animal commodity: small cereal, great cereal or culture product producers, corn, grapes, fresh vegetables, market gardeners, mixed farming and mixed breeding, mixed breeding on natural fields, extensive breeding in poor zones, dairies, butcheries and breeding, cattle producers, sheep, pork, and poultry. Although types of labor would appear to serve as independent, dependent, or social structure variables that would relate to the commodity measures, labor variables were also included in the factoring.

Hypothesis and Research Questions

The present study is based on a factor analysis of commodity production apart from other social or economic indicators of agriculture. It is hypothesized that production of these commodities will not fit a single dimension. If not, the research questions are, how many dimensions are needed to account for the interrelationships in the production of these commodities, and how can they be explained?

Just as social and economic farm structure is not well defined by single variables nor by a single dimension comprised of all variables, this hypothesis and the research questions suggest that the diversity of commodities can be conceptualized into a few, more basic and meaningful dimensions. In turn, these dimensions should be useful in studies like those reviewed here, and will add greater precision to the measurement and analysis of physical and social agricultural structure.

RESEARCH TECHNIQUES

Data

This analysis uses data from the 1987 Census of Agriculture (U.S. Bureau of the Census, 1989) which is the most recent information at the time of this analysis. The area examined is the 100 counties of North Carolina. This state's agriculture is quite diverse and represents a broad spectrum of major animal, crop and horticultural commodities found in North Carolina's coastal plain, piedmont and mountain regions.

The agricultural census data provide several kinds of units of analysis that can be used to examine patterns of commodity production. The census reports sales, acreage and units produced for crop, horticulture and animal data. Of these, the units of production are reported for most census commodities and permit the most comprehensive picture of farm production. Unlike units of production, sales figures are subject to different interpretations due to inflation or deflation across time. Furthermore, acreage requirements for growing one type of commodity — for example, cotton — are not comparable to acreage requirements of another commodity, such as poultry.

Units of production, however, do not vary with inflation and are comparable across time, regardless of the acreage needed to produce them. A bushel of corn is a bushel of corn, and a head of livestock is a head of livestock regardless of the year they are counted and the acreage required to produce them. Therefore, because of to the thoroughness and interpretability of commodity units, production unit data are used as the operational variables for this analysis.

The animal commodities are the numbers of beef cattle, dairy cattle, hogs and pigs, sheep and lambs, horses and ponies, hens and pullets, broilers and other chickens, and turkeys. The crops are bushels of corn, wheat, soybeans, rye, and sweet potatoes; pounds of peanuts and of tobacco; tons of hay and of sorghum; and bales of cotton. Horticulture includes pounds of apples, grapes, peaches, blueberries, and strawberries. These total to 23 commodities to be analyzed.

Analysis Techniques

In order to determine the patterns of production for these commodities, their Pearson's r correlation matrix is factor analyzed by the principal axis factoring technique using the maximum absolute intercorrelation of each commodity variable as its initial communality estimate. The factors extracted are rotated for a simple structure interpretation by the oblique, promax rotation technique.

FINDINGS

Initial factoring gives evidence that at least six but no more than seven factors explain the common variance in the correlation matrix. Six factors accounted for 93 percent of the estimated common variance; seven factors accounted for 98 percent. To push the analysis to eight factors would have slightly exceeded 100 percent of the variance, and that would have been questionable since the eigenvalue for the eighth factor, .49, is low. Therefore, the choice comes to either six or seven factors.

Of these, the seven factor solution appears most adequate. It does not appear to overfactor the data. Neither does it appear to stop short

of extracting the total common variance that contains the dimensions underlying these 23 variables. The promax-rotated, factor-loading coefficients are presented in Table 1.

The first rotated dimension represents *grazing livestock and fodder*. It gets high factor loadings from dairy cattle, hay, sorghum, beef cattle, horses, and sheep. Other loadings are relatively marginal to this dimension.

The second dimension's definitive coefficients are for *major grains, turkeys, and hogs*. The major, field-crop grains in this dimension are soybeans, wheat, and corn. The agricultural ecology of these feed grains with turkey and hog production appears evident.

Dimension three contains other *field crops: potatoes, tobacco, and rye*. Here, a combination of sweet potatoes, tobacco, and rye are found in places where grapes are grown as well. Grapes, however, load somewhat better on another dimension.

The fourth dimension of commodity production has only two items. Both are field crops. It is the *field crops: cotton and corn* dimension.

Dimension five is defined primarily by broilers, but also includes hens and pullets and a notable secondary loading for turkeys which loaded somewhat better in the second dimension. Peach production also occurs in these localities. This dimension is dominated by poultry but is labeled as *poultry and peaches*.

The sixth rotated dimension is a combination of *strawberries and horses*. This seemingly unlikely combination of agricultural activities is an empirical phenomena. Note, however, that the loading for horses cross-loads with the first dimension for grazing livestock and fodder. Later, more will be noted regarding this particular combination.

Finally, the seventh dimension consists of *blueberries and grapes*. This pattern of horticultural commodities is more readily imaginable than those for some of the other dimensions.

With a few exceptions, commodities load highly in only one of these dimensions but not other dimensions. In each dimension there are distinctively high factor coefficients ranging from around .5 to .9 or greater for the commodities that define each pattern. This is evidence of good, although not perfect, simple structure for the rotated factors. In practical terms, this suggests that the counties in this analysis are fairly homogeneous in their presence or absence of each

dimension. The most noteworthy exceptions are horses in dimensions one and six, turkeys in dimensions two and five, and grapes in dimensions three and seven. Marginal loadings of .2 to .3 are shown in parentheses in Table 1 but do little to define their respective dimensions.

CONCLUSIONS

This study examines commodity patterns for the counties of one state. Although agriculture in North Carolina is quite diverse, it does not necessarily represent the pattern of the entire country or even for the Southern region. Citrus commodities, for example, are not covered in these data. Still, the analysis may be used as a starting point for work on regional or national crop patterns. Furthermore, this analysis expands the scope of commodities observed in earlier studies by systematically including a greater variety of both plants and animals.

Multidimensionality

The multidimensionality of agricultural production observed through the factor analysis of crop, animal and horticultural commodities in one state is strong evidence that a unidimensional hypothesis of commodity production does not fit the data. Furthermore, the systematic statistical approach of factor analysis shows actual, empirical configurations of commodity production. This moves understanding beyond casual observation and haphazard speculation about the interrelationships of commodity production.

With a multidimensional approach, studies such as the one reviewed earlier on sustainability (Lyson and Welsch, 1993) could be enhanced. First, adding dimensions that included animal production may affect conclusions. Second, examining which commodity dimensions are associated with large-scale farming — equipment and machinery, corporate organization, tenancy and farm size — could improve the specificity of findings.

Apple production appears to be an anomaly in this analysis. Although apples are grown commercially in a number of counties in western North Carolina, apple production is not associated particularly

Table 1. Dimensions of Commodity Production: Promax-Rotated, Principal-Axis Factors.

	Grazing, Livestock, and Fodder	Major Grains, Turkeys, and Hogs	Field Crops: Potatoes, Tobacco, and Rye	Field Crops: Cotton and Corn	Poultry and Peaches	Strawberries and Horses	Blueberries and Grapes
Diary Cattle	.96						
Hay	.88						
Sorghum	.84					(-.22)	
Beef Cattle	.73				(.24)	(.21)	
Sheep	.47				(-.26)	(.29)	
Soybeans		.92					
Wheat		.91					
Corn		.90					
Turkeys		.53			(.38)		
Hogs		.51	(.25)				

(Table 1 continued on next page.)

Wimberly and Moxley

Table 1. (continued)

Sweet Potatoes		.86		
Tobacco	(.26)	.62		
Rye		.56		
Cotton			.82	
Peanuts			.81	
Boilers			.74	
Peaches			.47	
Hens	(.26)		.41	(-.24) (-.21)
Strawberries			.70	
Horses	.54		.54	
Blueberries				.70
Grapes		.53		.57

Marginal loadings are shown in parentheses. Loadings less than plus or minus .2 are not shown. Data are from the 1987 Census of Agriculture (U.S. Bureau of the Census, 1987) for North Carolina in units of commodity production.

Wimberly and Moxley

with the presence or absence of other commodities in this factor analysis. Its highest correlations with other commodities are .16 with milk cattle and .15 with horses. Its highest loading on any rotated factor is merely .09 on the dimension defined by horses and strawberries. In other words, the small relationship between apple growing and the presence of other commodities is most evident in areas where there are horses or dairies.

Why Do Patterns Form?

This modest observation about apple production provides a clue to understanding other, more prominent dimensions of commodity production. It also helps answer questions like, why do strawberries and horses factor into the same dimension? The answer is basic to the ecology and geography of agriculture. Certain commodities are produced in certain places but not others. This may be due to coincidences; ecological and/or economic factors; or to other biological, geographical and climatic, or technological compatibilities of certain commodities.

A potential contribution of these empirical findings is to make explicit certain crop and/or animal combinations that are not commonly recognized. As such, the results offer heuristic patterns and a need to explain them. Several initial interpretations are suggested here.

Ecological patterns of production and consumption. In the case of the first dimension of grazing animals and fodder, and in the case of the second dimension for major feedgrains, turkeys, and hogs, the large factor loadings give empirical evidence of the ecology of feed production and consumption. An ecological efficiency for raising such livestock and feedstuffs in the same localities is apparent.

Biotechnical and geographical patterns. In still other instances, biological and geographic patterns link with technical agricultural practices to combine certain commodities into the same dimensions. The field crop dimensions of cotton and corn, and of sweet potatoes, tobacco, and rye, as well as the horticultural dimension of blueberries and grapes fit this explanation. The equipment and other technology for growing the field crops of cotton and corn — although not the

same — are similar. The same is the situation for horticultural production of blueberries and grapes. Growing conditions, tractors, cultivating equipment and harvesting techniques are generally more alike than different within each dimension of these field crops or horticultural specialties.

Coincidental production patterns. All farm animals are not produced in the same areas that grow their feed. Broilers and hens, for instance, are found with peach production rather than their feedgrains. Judging from the findings at hand, some commodities just happen to coincide in the same dimension. Another example is horses and strawberries. In this instance, places conducive to growing strawberries are most likely to be where people have horses as well. This does not mean that strawberry production generates the presence of horses, or vice versa. Nor does it mean that poultry production and growing peaches have any cause and effect connection. Rather, such activities coincide as a pattern of agricultural activity in given areas, and due to reasons other than the ecology of production and consumption or any geographic and biotechnical compatibility.

Why are broiler and egg-layer feed grains not produced in the same localities and the birds themselves? Perhaps this is also due to the emergence of highly concentrated, highly specialized and vertically integrated poultry production in places that are now almost exclusively involved with raising broilers and hens. Perhaps it has become more efficient to ship the feedgrains to these producers than for the farmers to divert their full-time attention from broiler or egg production, or perhaps an opportunity is being missed to produce the feedgrains on the same farms or locally. In either case, there is a social and economic structure of agriculture behind such arrangements. Further examination of commodity production's empirical dimensions may offer insights toward more efficient arrangements among commodities and the social structure of agriculture through which commodities are produced and consumed.

FURTHER RESEARCH

Extensions of this type of analysis can be made along both applied and conceptual lines. Applied considerations include the broader perspective the dimensions provide for developing agricultural

services to compliment existing agricultural patterns. In some cases, input and output services, such as supply and processing, may be located more efficiently with the goods upon which they depend. Agricultural extension and information services may find better ways to deploy personnel and useful agricultural or rural information for given commodity production areas.

Conceptually, a question for future analysis is, how do various dimensions of farm structure relate to the dimensions of commodity production? This is the type of question that rural and agricultural sociology can address. A number of sociological studies have already established the usefulness of the multidimensional approach to agriculture's social and economic structure (Wimberley, 1986, 1987; Reif, 1987; Lobao, 1990; Lobao and Schulman, 1991). Still, the relation of farm structure to commodity patterns — commodity structure — remains unknown, and models relating both farm and commodity structure with the well-being of agricultural and rural areas have not been developed.

Since sustenance production is a process that involves complex social interactions and organizational arrangements, knowledge of how these sociological interactions relate to the ecological; biological, geographic and technical; or coincidental patterns of commodity production could have scientific, policy and programmatic benefits.

Future applied and theoretical analyses should be accompanied by maps of the agristructural and commodity production patterns and should be extended to larger agricultural regions. They should also be traced over time in order to better understand how the social and physical circumstances for producing essential foods and fibers develops. Hopefully, basic principles can be established as to how these interrelationships work and how they may be enhanced to serve the growing human population and the shrinking environmental base. However, to fully develop the sociological explanations that are needed, a basic step is to conceptualize and systematically measure the dimensions of commodity production.

ENDNOTES

¹ Latifundium-minifundium agricultural structure refers to the pattern of land inequality characterized by large estates with primitive agriculture and labor that is typically in a state of servitude. This is found in conjunction with other farmers having small plots and who are capable of only subsistence production.

REFERENCES

- Arcury, Thomas A. "Ecological Dimensions of Appalachian Agricultural Diversity 1880-1910." *Human Ecology*, 18 (1):105-129.
- Fernandez, O., M. Luis, M. Tarrío-García. "Ganadería 1988 y Crisis Agroalimentaria (Ranching and the Farming-Food Crisis)." *Revista Mexicana de Sociología*, 50 (1):51-95.
- Friedland, William H. "Commodity Systems Analysis: An Approach to the Sociology of Agriculture." Pp. 221-235 in Harry K. Schwarzweller (ed.) *Research in Rural Sociology and Development*, Volume 1. Greenwich, Connecticut: JAI Press.
- Friedland, William H., Amy E. Barton, and Robert J. Thomas. 1981 *Manufacturing Green Gold: Capital, Labor and Technology in the Lettuce Industry*. New York: Cambridge University Press.
- Leneo, Michael. "A New Classification of French Farms." ("Une Nouvelle Classification Des Exploitations Agricoles Françaises.") *Estudes-Rurales*. 57:7-34.
- Lobao, Linda M. *Locality and Inequality: Farm, Structure and Socioeconomic Conditions*. Albany: The State University of New York Press.
- Lobao, Linda M., and Michael D. Schulman. "Farming Patterns, Rural Restructuring, and Poverty: A Comparative Regional Analysis." *Rural Sociology*, 56(4):565-602.
- Lyson, Thomas A., and Rick Welsch. "The Production Function, Crop Diversity, and The Debate Between Conventional and Sustainable Agriculture." *Rural Sociology*, 58 (3):424-439.

- Moxley, Robert L. "Agriculture, Communities, and Urban Areas." Pp. 322-1986 332 in *New Dimensions in Rural Policy*, Ronald C. Wimberley, Dale Jahr, and Jerry Johnson (eds.). Washington, D.C.: Joint Economic Committee, Congress of the United States.
- Pfeffer, Max J. "Social Origins of the Systems of Farm Production in the 1983 United States." *Rural Sociology*, 4:540-562.
- Reif, Linda L. "Farm Structure, Industry Structure, and Socioeconomic 1987 Conditions in the United States." *Rural Sociology*, 52 (4):462-482.
- Schulman, Michael D., Patricia Garrett, and Regina Luginbuhl. 1985 "Dimensions of the Internal Stratification of Smallholders: Insights From North Carolina Piedmont Counties." *Rural Sociology*, 50 (2):249-259.
- Simpson, E. H. "Measurement of Diversity." *Nature*, 113:688. 1949
- U.S. Bureau of the Census. *1987 Census of Agriculture: Part 33, North 1989 Carolina*. Washington, D.C.: U.S. Government Printing Office.
- Wimberley, Ronald C. "Dimensions of U. S. Agriculture: 1969-1982." 1987 *Rural Sociològy*, 52 (4):445-461.
- Wimberley, Ronald C. "America's Three Agricultures." Pp. 192-199 in *New 1986 Dimensions in Rural Policy*, by Ronald C. Wimberley, Dale Jahr, and Jerry Johnson (eds.). Washington, D.C.: Joint Economic Committee, Congress of the United States.
- Young, Frank W., Fernando Bertoli, and Sandra Bertoli. "Rural Poverty and 1981 Ecological Problems: Results of a New Type of Baseline Study." *Social Indicators Research*, 9:485-516.
- Young, Ruth. "The Structural Context of Caribbean Agriculture: A 1976 Comparative Study." *The Journal of Developing Areas*, 10 (July):425-444.