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SOCIAL ORGANIZATION AND CHANGE IN AGRICULTURAL TECHNOLOGY IN BRAZIL: A SOCIOLOGICAL ANALYSIS OF MINAS GERAIS MUNICIPIOS, 1950-1970.

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SOCIAL ORGANIZATION AND CHANGE IN AGRICULTURAL TECHNOLOGY IN BRAZIL: A SOCIOLOGICAL ANALYSIS OF MINAS GERAIS MUNICIPIOS, 1950-1970

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Department of Agricultural Economics and Rural Sociology

By

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* * * * * *

The Ohio State University

1978

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CHAPTER I

INTRODUCTION

THE PROBLEM

This study is concerned with patterns of rural social organization and the processes of social change at the municipal level in the state of Minas Gerais, Brazil. The research covers the period of 1950 to 1970, with particular emphasis on the interrelations between agricultural technology and dimensions of social organization.

The underlying rationale for this study is that it is important to understand local variations in patterns of structural changes in rural areas. In particular, we are concerned with how the processes of technological change are both causes and consequences of these structural changes.

Three major research questions have guided us throughout the study:

1) What are the major patterns of structural change in local rural social organization in Minas Gerais between 1950 and 1970?
2) What patterns of social organization can be viewed as conditions for (or antecedent of) local technological change?

3) What are the consequences of technological change for observed changes in local patterns of rural social organization?

The objectives of this study are to provide some tentative and preliminary answers to these questions. In this introductory chapter, we present the overall context for the research problems and strategies through which these research questions will be addressed.

THEORETICAL CONTEXT

The nature and properties of the processes of historical transformation of the Western socities over recent centuries have generated the intellectual debates that lie at the heart of the major social science paradigms (Giddens, 1971). Since World War II, the focus of attention has shifted to the peripheral areas of the globe, which are loosely called traditional, developing, dependent, underdeveloped, or Third World societies. The theoretical and empirical puzzles involved in discovering why these latter societies lagged behind the Western states in their development and how their rates of change could be increased have given rise to the so-called "development" specialties in most social sciences and the articulation of different development ideologies in the intellectual and political scenes (Bodenheimer, 1971). It is beyond our scope here to fully detail the various schools of thought that have advanced competing theories of or approaches to the explanation of developmental changes (or lack of changes). It is sufficient to point out at the outset that social scientists have recently become much more aware of the shortcomings, naiveté, and ideological bias behind many of their positivistic assumptions about development issues (Frank, 1972; Bodenheimer, 1971; de Janvry, 1976-77). From the late 1960's to the present, we witness widespread efforts to critically reevaluate these social science perspectives, starting with the meaning of the concept of development itself, as well as its broader societal implications (Seers, 1970; Havens, 1972; Bodenheimer, 1972; Wilber, 1973).

There is a growing consensus today that development--even economic development--means more than economic growth, and that the latter is not merely a technical matter. We are reaching a fuller understanding of the notion that economic development is highly dependent on the social organization of each country and its historical linkages with a worldwide political-economic system (Frank, 1969; Johnson, 1973; Wallerstein, 1974; de Janvry, 1975); that economic and social policies of governments are severely limited by these two sets of constraints (Griffin, 1974; Malan, 1977); that the broad, overarching processes of social change (specialization of roles and differentiation of social systems, urbanization, industrialization, technological and productivity increases, and changes in class structures and political organization) have to be qualified and understood within specific socio-historical contexts, making sweeping generalizations problematic; and that the consequences of such processes are not easily predicted, and many of them are neither anticipated nor umabiguously desirable (Goss, 1977). It is also well acknowledged that there are striking differences between early industrialized and "modern" Third World nations (Johnston, 1970; Johnston and Kilby, 1975) in terms of their social structures and development experiences. Further, within the Third World, differences are again sufficiently large to make it tenuous to convey a very concrete meaning to such umbrella concepts as "traditional society" or "traditional agriculture." In fact, the transformation of traditional forms of rural social organization may lead, rather, to simplification of some of its components, e.g., land tenure and labor arrangements (Griffin, 1974; Forman, 1975) and cultural patterns (Pearse, 1971). To stress the heterogeneity of the traditional societies does not, however, mean that they have no common characteristics.

There is a broad cluster of evidence to show that the less developed countries have predominantly agrarian economies with low productivity and technological levels, limited economic surpluses and markets, and localistic social structures and cultural traits (Johnston and Kilby, 1975). However, traditional agrarian societies do not typically have isolated, subsistence economies. Most of them, especially those with a colonial past, have a long history of linkage between their traditional peripheries and their metropolises, and as well as with the economic centers of the world in their role as exporters of raw materials. The distinctions between the export and non-export sectors of these societies have even struck earlier analysts, and these differences have become a basis for the various versions of the dualism or dual societies construct which popularized the dichotomy of "traditional" versus "modern."[1] The traditional pole of the dichotomy is mainly represented by the non-export agricultural sector of the political economy and is usually characterized by its low level equilibrium reached over a long period of unchanging conditions (Schultz, 1964). The modern pole, mainly represented by the agricultural export and urban-industrial sectors, is postulated to be a locus of dynamism, change and growth. The power of this typology can be gauged by the fact that even the most radical interpretations of the processes of development and underdevelopment do not discard the distinction, but reinterpret it within a new perspective (de Janvry, 1975, 1976-77).

The earlier uses of the construct, however, provided a raionale for the diffusionist approach to modernization, which in essence, argues that people, communities or a whole sector of society (e.g., agriculture) can escape from the "trap of tradition" by adopting modern values and organizational forms.[2] The main criticism directed at the approach is rather than being isolated from each other, traditional agriculture is connected to modern agriculture and the rest of the political economy, and they tend to have "functional"--albeit asymmetrical--relationships (Stavenhagen, 1968; Figueroa, 1977; de Janvry, 1975). It seems patently obvious that these linkages are increasing in most Third World nations. In fact, we can say that the driving force of change in rural social organization is the expansion of the modes of production and market relations of the urban-industrial complex as it reaches each developing country (Pearse, 1971; Paige, 1975). This "incorporative drive" implies an itensification of interaction between local communities and the urban centers of the larger society--"a direct attachment of local production, exchange and consumption to the national market system and the establishment...of standard national institutions" (Pearse, 1971, p. 71). The emphasis here is on the concept of interaction, since the traditional sector can "adjust" itself to new demands through new "modes of articulation" with the modern sectors without experiencing radical changes (Long, 1977).

Given the frequent equation of development with economic growth--that is, maximization of output per worker--in the strategies of most underdeveloped countries, agricultural development has been conceived mainly as growth of agricultural output. A crucial element for this growth objective is to increase the efficiency of the production system which, in turn, directs attention toward the "need" for technological improvements. Therefore, agricultural development became almost synonymous with diffusion of agricultural technologies. As with economic growth, diffusion of technology became imbued with a highly positive connotation. Technology adoption has emerged as a--perhaps the--major variable in the micro-level production and diffusion studies of agricultural economists and rural sociologists, as well as a policy to be pursued to governments in their efforts to foster agricultural growth.

Evidence from recent years, however, shows that technological improvements in agriculture in most underdeveloped nations have been less pervasive than originally anticipated. Further, when widespread technological change has occurred, the consequences have not always been beneficial for the majority of the population (Griffin, 1974; Perelman, 1977; Johnston and Kilby, 1975). It was this awareness that prompted the present wave of social scientific re-evaluation of prevailing perspectives on rural development issues (Griffin, 1974; Havens, 1972; Johnston and Kilby, 1975; de Janvry, 1975; Perelman, 1976, 1977; Lipton, 1976).

It is in the context of this re-evaluation that the distributional aspects of economic growth and technological innovation came into focus as a significant dimension in their own right, to be evaluated with at least co-equal weight with output/growth levels (Goss, 1977). One of the most important corollaries of the equity-output debate is the shifting of attention toward the examination of the relationships between social structures and economic development (Aldeman and Morris, 1967) which have remained in limbo in prevailing development studies for quite some time. Such relationships include the linkages between agricultural technology and rural social organization (Gotsch, 1972; Griffin, 1974); others include the connections between agricultural and non-agricultural sectors of the economy (Johnston, 1970; Johnston and Kilby, 1975; Long, 1977; Schuh, 1975) and the relation of national socio-economic structures with the worldwide capitalist system (Frank, 1969, 1969a; Galtung, 1971; Wallerstein, 1974; de Janvry, 1975).

In Latin America, this perspective has gained increasing support among social scientists in the last decade, and is being articulated under the labels of dependency and center-periphery (internal colonialism) theories (Frank, 1969; dos Santos, 1970; Stavenhagen, 1975; Cardoso, 1973; de Janvry, 1975; Kahl, 1976; Furtado, 1976). Whatever the flaws of such theories--and they have been constructively criticized recently (O'Brien, 1975; Walton, 1975; Long, 1977)--they have performed an important role in raising new issues for debate in the field of development and contributing to the wave of re-evaluation now witnessed in the social sciences.

THE BRAZILIAN CONTEXT

The formation and transformation of the Brazilian society are intimately tied with the coloniel history of the nation. Colonialism left its mark in an agrarian structure characterized by large-scale farm holdings together with a minifundio-system for food production, an emphasis on export crops and a resulting series of boom-bust economic cycles, an extremely hierarchical class system with high levels of inequality, a system of labor relations that fit the patron-client syndrome (Forman, 1975), and an extensive pattern of land use that allowed output expansion without structural change (i.e., growth without development). "Agrarian dependent take-offs" (Fandino, 1975, p. 17) took place since the second half of the last century in the form of export booms and some spilled-over industrialization. But major structural changes are more recent--dating from the 1930's on and especially in the post-war period. There has been, then, significant <u>economic growth</u> in the country, even conceding periodic short-run stagnation (The Ohio State University Team Report, 1975, Chapter II); substantial industrialization has occurred, and agricultural production has seemingly kept pace with population increases. The overall economy and society have experienced a discernible process of differentiation and urbanization. However, the most striking characteristic of the recent Brazilian experience is the <u>unevenness</u> of the development process, i.e., the exaggeration of the regional and social inequalities in the country (Redwood, 1975; Fishlow, 1972). For the rural sector, Schuh (1975) summarizes the problem in terms of "puzzles": Why in the aggregate there has been so little modernization? Why has this modernization been so concentrated in the state of São Paulo? And why, even in São Paulo, has modernization not occurred in the food or subsistence crop sector?

There certainly are other noteworthy "puzzles" with respect to Brazilian agriculture, as well as with the non-agricultural patterns of social organization and social change in the country. But the ones noted previously are sufficient to illustrate the intellectual context of this study. To wit, we will focus on the uneven course of change in the lower-level, intermediate aggregates--the municipio--to gain some insight into this process of polarized development.

METHODOLOGICAL CONSIDERATIONS

The choice of the municipio as the unit of analysis is justified on the following grounds: This unit--a political-physical entity approximately similar to a U.S. county--permits a macro-level approach for research which is essential is structural dimensions of the social organization are to be considered. At the same time, the municipal unit is small enough to be considered a tangible and socially meaningful aggregate for which social statistics can be collected. Data on larger units such as regions, states and macro-regions, generally used for aggregate analyses, cannot reveal (or rather, underestimate) local differences, which, given the regional inequalities in Brazil, are here assumed to be very important. This is even more critical when we consider the wide areal dispersion of agricultural activities and the differential patterns of social organization they generate.

There are presently more than 4,000 municipios in Brazil. The large number of these population units may be a pragmatic reason why municipal-level data have not been widely used in aggregate analyses. Considering this problem, the present study reduces the universe of municipios to those belonging only to the state of Minas Gerais.

This state, located in the east-central section of Brazil, has characteristics particularly suited for this research. It covers an area of 587,172 square kilometers (approximately the size of France) and is the fifth largest Brazilian state. Minas Gerais has the second largest number of municipios and an important and diversified agricultural sector. It is also heterogeneous--ecologically and socially (IBGE, 1968a). In fact, Minas Gerais is, so to speak, at the crossroads and a microcosm of Brazilian society. It borders and overlaps socio-economically with the typically underdeveloped and poverty-stricken Northeast, the urban-industrial dynamic centers of the Southeast, as well as the new frontier territory of the Center-West (which has experienced rapid transformation in the last decade or so, under the influence of Brasilia, the new capital). Historically, Minas Gerais has participated in the major economic phases and political processes in the country, and its history has left pronounced regional disparities within the state that effectively capture the predominant internal differentiations of Brazil (Leloup, 1970; Rios, 1969).

The data to be used in this research come from the Brazilian censuses of 1950 and 1970. The period chosen is one assumed to correspond to the era during which the most important structural changes have occurred in Brazil, and for which we have comparable data. As Juan Linz has argued, ecological data are especially pertinent for the study of rural society, since they allow the kind of information about social structures in large territorial areas that no survey approach can reveal (Linz, 1974). However, they suffer from both the limitations of secondary data sources--which do not always ideally fit specific research questions and objectives--and the technical pitfalls involved in establishing inferences from aggregate areal data (Duncan, Cuzzort and Duncan, 1961; Valkonen, 1974; Alker Jr., 1974; Langbein and Lichtman, 1978).

The research utilized herin includes aspects of both inductive and exploratory research, and deductive and hypothesis-testing research. The initial empirical chapter, for example, does not pursue the test of any formal model of social change, but rather attempts to probe the available data to gain preliminary insight concerning the nature of rural social organization and change at the local level in Minas Gerais. More specifically, we will examine the directions and magnitudes of change in the selected indicators that represent dimensions of social organization at the municipal level. The formal hypothesis-testing portion of the study is devoted to the analysis of the associations of one sphere of rural change--agricultural technology changes--with other dimensions of rural social organization, with the latter being viewed as both as an antecedent and consequence of the first. We are not claiming that local social organization variables can fully explain why technological change does or does not occur; the generation, diffusion, and adoption of technology is, of course, multifaceted, including both "local" and "national" (and increasingly "international") components. The variables represented herein deal largely with "local causes." Nevertheless, the local antecedents of technological changes and the local consequenees of these changes have remained virtually unexplored, and this study's principal goal is to fill this voie.

PLAN OF THE STUDY

The study is divided into seven chapters, in addition to this introduction. In the next chapter we offer a general overview of the processes of social change in Brazil and Minas Gerais. Chapter III introduces the dimensions of social organization to be considered herein in terms of their relevance to existing competing theoretical and empirical approaches. Chapter III also details the hypotheses that pertain to the research questions specified at the outset of this chapter. Chapter IV is devoted to the development of the methodologies used in the study. The next three Chapters--V, VI, and VII--present the results and analyses pertaining to each of the major research questions. The final Chapter summarizes the findings and conclusions, and offers suggestions for further research.

FOOTNOTES

1. Major examples of the dual economy approach include Boeke (1953), Hirschman (1958), Fei and Ranis (1964), Rostow (1960), and Jorgenson (1967). For useful critiques of the dual economy conceptualization and its rationale for "dualistic development," see Griffin (1969), Stavenhagen (1968), and Frank (1969, 1969a).

2. The more visible representatives of the modernization perspective are Hoselitz (1960), Hagen (1962), McClelland (1961), Levy (1966, 1972), Pye (1963), and Rogers with Svenning (1969).

CHAPTER II

SOCIO-ECONOMIC CHANGE IN BRAZIL AND MINAS GERAIS--AN OVERVIEW

The purpose of this chapter is to present a brief overview of some of the key historical elements of the Brazilian development experience. Emphasis is placed on those aspects of the socio-economic structures that relate most directly to the concepts and variables this study will deal with in greater detail in subsequent chapters. This chapter is divided into six major sections. The first three present a brief account of historical materials and the recent development experience. The fourth section illustrates some major changes that have occurred during the 1950-1970 time frame--using national and macro-regional data comparable to those employed later in this study to serve as benchmarks for the municipal level findings (especially for Chapter 5). The final sections will present a summary of current contrasting views on the performance, strategies and perspectives of development in Brazil.

THE COLONIAL LEGACY (1500-1822)

The discovery of Brazil was intimately tied to European maritime expansion of the 15th and 16th centuries, and the productive structure which resulted from colonial penetration was conditioned by the European market to which it was oriented (Furtado, 1963; dos Santos, 1974; Paiva, Shattan and Freitas, 1973). The highly specialized nature of export agriculture (i.e., sugar cane) was the driving force behind Brazilian colonization in the 16th and 17th centuries. This in turn made the large estate a "functional" production unit and the basic element of colonial social organization (Furtado, 1976). The sugar complex located primarily in the coastal areas of the Northeast consisted of isolated units directly linked to the exterior--while at the same time cut off from all the other areas of the interior, with the exception of the pastoral interior with which weak linkages were developed (Furtado, 1976). The basis of the agrarian structure characterized by the latifundio-minifundio pattern was laid down in the first century of colonization in connection with the export sector and pastoral activites (Furtado, 1963). The "family farm" system emerged later, "in regions which remained relatively isolated and were characterized by the prevalence of recent settlement of European origin" (Furtado, 1976, p. 68). Manpower linked with the sugar section basically consisted of slave labor. Nevertheless, from the beginning of colonization, a diversified labor force organized in a variety of tenure arrangements was present, forming the peasant sector of the agrarian system (Forman, 1975).

The area where the state of Minas Gerais is presently located was not integrated into the colonial society until the beginning of the 18th century with the discovery of gold in its central region. The Gold Cycle--as it is commonly called--foreshadowed a new dimention in the evolution of the colony, besides marking the beginning of Minas Gerais history. Before that, the only population groups in the area consisted of scattered cattle estates on the margins of the Sao Francisco River developed out of the expansion of pastoral activities linked with the sugar economy. As Furtado (1976) argues, the growth pole formed by the gold and diamon-producing areas was to have considerable significance in the development of the Brazilian economy.

> In contrast to sugar production, only feasible for those in a position to mobilize substantial financial resources, alluvial gold could be exploited by lone prospectors and large-scale operators alike. The mining region thus attracted immigration on a far greater scale than that of the preceding two centuries (and provided new opportunities for the underemployed labor force of the sugar economy). The rapid development of urban life created an expanding market for food, which was added to the even more important market for draught and pack animal used in the extensive transport network linking the vast gold region to the port of Rio de Janeiro. The market for cattle and mules was supplied mainly by the southern regions whose pastoral potential was soon recognized. The growth pole created by the mining industry made it possible to establish economic links between Northeast, Central and Southern Brazil already in the 18th century, i.e., in the period immediately preceding independence (Furtado, 1976, p. 31).

However, the gold boom did not generate self-sustaining growth. The high returns of the gold activities, coupled with low quality soil, did not encourage the development of significant permanent agricultural activities. The stringent controls imposed by the Portuguese crown also blocked the emergence of any manufacturing activity. With the eventual decline of mining production in the last decade of the 18th century, the collapse of the gold economy took only a few decades. The wealth generated over almost a century of expansion eventually found its way to England due to the demise of the Portuguese empire. For the mining region, the Gold Cycle ended with little in the way of institutions or infrastructure for sustained economic growth; rather the end of the Gold Cycle was to portend a centrifugal movement of the population toward the southern, eastern and western edges of the state and an involution along the lines of a subsistence economy (Governo do Estado de Minas Gerais, 1967, Vol. 1). As Furtado (1963, p. 94) has observed, "in no other part of the Western Hemisphere was there an instance of so rapid and so complete a process of involution from an economic system chiefly composed of population of European stock." During the first decades of the 19th century, Minas Gerais economy was connected with the exterior only through its cotton and livestock production. The whole social and economic fabric of the colony suffered from this breakdown. The economy entered a period of sustained depression which minor spurts in cotton and sugar cane exports were unable to dislodge. At the same time, the political sphere witnessed critical changes in the linkages between colony and metropolis, triggered by the European consequences of the Napoleonic wars, which would ultimately lead to political independence in 1822.

As noted, the colonial era in Brazil served to bring about a form of social and economic organization typified by the dominance of the large, monocultural, and export estate. This estate or plantation system was characterized by use of slave or semi-servile labor; coexistence with a peasant-like, subsistence economy; and a rigid, hierarchical system of social stratification. The emerging system of Brazilian society was cast in the mold of this dominant mode of agricultural production (Iutaka, 1971). Towns and cities were dependent on the countryside economically and were politically dominated by the dominant agrarian class. It is in this context that the coffee boom ushered in a new cycle as the country's dominant export commodity.

THE COFFEE ERA (1822-1930)

"The expansion of coffee cultivation took place when Brazil, as an exporter of primary products, mainly cotton and sugar, was encountering serious market difficulties due to competition from other producing areas" (Paiva, Schattan and Freitas, 1973, p. 11). The coffee era emerged under much different internal and external conditions than those prevalent in the previous cycles. From the outset, the men responsible for organizing the coffee economy in the Paraiba valley (from which it spread to the São Paulo highlands) were individuals with a mercantile outlook and business experience. These persons were involved in both the production of and trade in coffee--contrary to the landlords of the sugar economy whose trading involvement was minimal (Furtado, 1963, 1976). Coffee thus developed outside the latifundian structures established earlier. Nonetheless, "since the new export agriculture was also modelled on the large unit, it achieved a basic solidarity with the latifundios. The latter were thus able to retain control of local power in their respective regions while leaving hegemonic control of national power to the new interests" (Furtado, 1976, p. 41). In the first stages of the coffee era, involving the occupation of lands in the present states of Rio de Janeiro and Minas Gerais, expansion was based on the abundance of slave manpower available in the latter state as a result of the earlier boom period. This permitted the coffee economy to proceed

> within the framework of the traditional plantation, in which the monetary flow was minimal and the level of real wages extremely low. In the second phase, during which coffee planting spread to São Paulo, the shortage of labor played a key role. The govenment sponsored and financed a large influx of European immigrants, stipulating from the outset that wages were to be paid in money, and that living conditions should be sufficiently attractive to appeal to prospective immigrants from southern Europe. These social changes account for the more rapid pace of urbanization in the São Paulo highlands, the formation of a domestic market nucleus in this region, and its subsequent development (Furtado, 1976, p. 59).

By the end of the 19th century, coffee production was well established as the dynamic center of the economy. High returns from coffee export activity were maintained by constant incorporation of new and fertile lands into production. With the abolition of the slavery in 1889, the agrarian labor force became more diversified. The backbone of the labor force was peasants in semi-servile conditions, although through a wide variety of labor arrangements, wage workers and a large number of small property owners (minifundistas) served as temporary laborers (dos Santos, 1974). The system of large estates for agricultural production was eventually consolidated by land appropriation and law enactments (Furtado, 1976; Hoffman and Silva, 1975). Industrialization, which might have begun earlier (Suzigan, 1976), finally began by the end of the century. Industrialization ultimately was based on the favorable conditions created in the coffee region. The extensive farming methods of this export crop provided a crucial transportation network. The labor shortage hastened immigration and internal migration, and resulted in rapid urban population growth, higher wage rates, and entrepreneurial talent. Profits from coffee and commercial activities provided the capital for industrial financing, and, finally, very favorable conditions for the installation of hydro-electric power plants allowed cheap electrical energy for the onset of industrialization (Suzigan, 1976; Furtado, 1976; Paiva, Schattan and Freitas, 1973). However, this initial surge of industrialization--which was largely substitution for food, beverage, textile and clothing imports--did not imply that the ideology of industrialism had the allegiance of the elites responsible for the affairs of the state. As Suzigan argues, "the agricultural interests that wielded the political power kept national opinion from rallying to the support of industry"

(Suzigan, 1976, p. 10). Such support would not crystallize until much later, in the post World War II period. However, even though industrialism and industrialization did become increasingly recognizable as national priorities in the eyes of ruling groups, these ideologies did not become clearly articulated until the "desenvolvimentismo" program of President Kubitscheck (1956-1961) (Suzigan, 1976).

During the period from the mid-19th century to the 1930's, the main elements influencing the urbanization process in the country were overall population growth and the industrialization process. However, it was not until the 1930's that the Brazilian urban system began to grow rapidly, move inland, and become more hierarchical (Lodder, 1977). The urbanization process and the urban system were decisively altered by changes in the political and economic structures of the country deriving from the "coffee crack" os 1929. The Brazilian political system that remained since the fall of the Monarchy--the "Old Republic" which lasted until 1930--was based on the large rural estate (coffee, sugar and cattle), the urban export sectors, and the political control of the rural oligarchy (Lodder, 1977; dos Santos, 1974). Efforts to protect the interests of the dominant agrarian class during a period of declining world demand for Brazilian export products (especially coffee) led to a situation of increased internal demand for goods and services. This made it profitable to invest in activities oriented toward the domestic markets--permitting the emergence of an urban industrial/commercial bourgeoisie together with a proletariat and the urban middle classes (Lodder, 1977; Furtado, 1963; dos Santos, 1974). The so-called Revolution of 1930 set in motion a long process of socio-economic and political changes that would culminate in the transfer of the main locus of political power from the rural oligarchy (from then on only a secondary partner in political power) to the new urban-industrial bourgeoisie (Lodder, 1977; dos Santos, 1974).

The rapid growth of the coffee economy between 1880 and 1930 provided the conditions for increased articulation among the various regions of the country, but also exacerbated regional economic disparities. Resources and income remained concentrated in São Paulo and the southern regions which benefitted most from the expansion of the coffee market (Furtado, 1963). The state of Minas Gerais lost its leadership in the coffee economy after the first phase of the boom. Its plantations were based on slave labor, and after abolition, mainly on sharecroppers and other traditional labor arrangements. Minas Gerais never experienced the inflow of immigrants or wage labor as did São Paulo. In addition, hilly terrain coupled with rudimentary cultivation techniques soon led to declines in productivity. Further, Minas Gerais' locational disadvantage was accentuaged by a poor transportation system. However, despite Minas Gerais' secondary role in the coffee economy, coffee has remained the main economic basis of the state throughout the period, even though livestock activities continued to expand in the western and northern areas, as well as in the old coffee region of Mata Zone. Minas

Gerais shared in the first industrialization spurt of the late 19th century, and its main city at the time, Juiz de Fora, continues to have a sizable textile sector. But without a truly dynamic pole within its boundaried (with coffee in a secondary role and livestock remaining a traditional productive activity), market and infrqstructural problems mounted to constrain the expansion of industrialization. By the late 1920's, the state of Minas Gerais was basically a peripheral area to the Rio de Janeiro and São Paulo poles (Governo do Estado de Minas Gerais, 1967, Vol. 1).

THE RECENT BRAZILIAN MODERNIZATION EXPERIENCE

Economic and Political Transformation

The period spanning from the early 1930's to the late 1940's can be broadly viewed as an "intermezzo" in Brazilian history that marked the gradual criculation of ruling elites. The rural oligarchy lost its dominant position to the emergent urban-industrial bourgeoisie. The Vargas era--represented first by the Revolution of 1930 and later by the dictatorship institutionalized in the "New State" (Estado Novo)--was the political vehicle of such transition (dos Santos, 1974). The political authoritarianism of this era disciplined the cleavages among the social groups formed during the evolution of the coffee economy.[1] Vargas' strategies can be generally interpreted as an attempt to compromise different interests; industrialization was supported, but at the same time "agriculture contined to be upheld, this time by a federal coffee-support program" (Suzigan, 1976, p. 11). The strategy also included "a program of controlled worker participation, of rules for work conditions and social security" (dos Santos, 1974, p. 440), a program for modernizing public administration and expanding the public sector, and a strengthening of the participation of the army and civil servants in the affairs of the state. This attempt at conflict management, coupled with the war mobilization, helped the regime to last until the immediate post-war period. However, these competing strains proved to be too difficult to forge into a lasting compromise.

The end of the Vargar Era and the rise of bourgeois hegemony signalled the emergence of dramatic new directions in Brazilian development policy. These new policies arrived in two stages.

> The post-war era can be divided roughly into two historical periods. The first (from 1947 to 1963) can be called the inward looking import-substitution period. This period marked the first deliberate strategy to industrialize through stimulation of domestic production of previously imported finished manufactured goods and later capital goods . . . The second period (1964 to the present) can be characterized as an outward looking export expansion and diversification phase of economic growth (The Ohio State University Research Team Report, 1975, pp. 2-1 and 2-2).[2]

Industrialization in Brazil from the late 19th century up to World War II had "consisted essentially of the establishment of a nucleus of industries producing non-durable consumer goods which had become a feasible proposition as a result of the increased income made available for consumption with the expansion of exports" (Furtado, 1976, p. 108). A second phase of industrialization that began in the post-war period and gained momentum during the 1950's was characterized by specific government policies (e.g., "erection of high protective tariff walls, various methods of foreign exchange controls, government spending on infrastructure projects, direct investment in a number of industrial enterprises, special inducements to foreign capital, and the establishment of a governmental development bank"; Baer, 1976, p. 42), aimed at increasing industrial production geared to domestic demands. As a result of such efforts, the Brazilian economy experienced relatively high rates of growth in the period of 1950-1961--with GDP expanding at about 6 percent per annum (Baer, 1976; The Ohio State Univeristy Team Report, 1975). However, the imbalances and distortions associated with this stage of the industrialization process are by now well documented. This industrialization was very capital intensive and resulted in low labor absorption due to heavy state subsidization of capital, discouragement of manpower utilization by social security charges, and "to imported techniques, demand patterns, and corresponding production profiles characteristic of advanced capitalist economies" (Suzigan, 1976, p. 28). Other features of Brazilian industrialization included increased participation of foreign capital, with its correlates of lagged technological and capital-goods development; sectoral and regional concentration of industrial activity, accentuating regional and social income distribution; and increased government participation in the economy (Suzigan, 1976; Furtado, 1976; Baer, 1976; The Ohio State University Team Report, 1975).

By the early sixties the industrial boom began to fade, ushering in seven years (1961-67) of relative stagnation. At the same time, experiences with political democracy, nationalism and populism were developing during this period. These led to a process of social mobilization of different social groups, and increasingly to an ideological radicalization. The combined climate of social and political instability and economic stagnation, together with rampant inflation (exacerbated by the fiscal and monetary policies of previous governments; The Ohio State University Research Team, 1975), prompted the military take over of 1964.

The new ruling group in the country, protected by an authoritarian political establishment (Stepan, 1973), set out to correct the perceived distortions of the economy as well as to eliminate social and political unrest.[3] A comprehensive set of economic actions were taken to minimize inflation and balance of payments disequilibria forming what is now known as the stabilization and institutional reform policies (The Ohio State University Research Team, 1975; Baer, 1976). After 1968, the second and third governments of the military regime pursued strategies that would lead to the short-term maximization of the rate of growth of Gross Domestic Product (GDP). The achievements concerning this limited objective during the boom years of 1968 to 1974 (when the economy grew at yearly rates ranging from 9 to 11 percent) have become known as the Brazilian "miracle."[4] The upturn of the economy was used as a major weapon for legitimizing a leadership which put into effect "political repression and rich men's economic policy" (Bacha, 1977, p. 62).

Most of the features of the so-called import-substitution period were carried over in the military regime's economic program. In particular, there was continuity in industrial growth, the intensification of foreign capital participation, an expanded role of the state in the economy, and the high capital intensity of the dynamic industrial sectors (The Ohio State University Reserach Team, 1975). A largely new feature, however, has been the opening up of the economy through measures such as a reduction of the protection enjoyed by the domestic industries and a deliberate effort to promote and diversity exports (especially of manufactured products; Furtado, 1976).

Urbanization and Internal Migration

In the last 40 years or so, Brazil has experienced remarkable growth of its urban population. In 1940, the urban proportion of the total population was 31.2 percent, while by 1970, the proportion had reached 55.9 percent (Anuario Estatistico do Brasil, 1975). The last decades, then, have been critical in the urbanization process and the major structural changes that accompany it (Fandino, 1975; Johnston, 1970). The rapid growth of urban population is basically due to high urban rates of natural increase and out-migration from rural areas (Davis, 1965). As we will see later in this chapter and in the one that follows, much of this rural outmigration can be traced to the combined forces of agricultural modernization and stagnation which have been contradictory, but integrally related, aspects of agricultural change in Brazil.

The major characteristics of the process of urban development in Brazil during recent decades (in addition to the high overall rates of growth of cities) show seemingly paradoxical tendencies, according to Lodder (1977). On one hand, there is a tendency toward interiorization of urban growth, with medium-size and larger cities developing away from the coastal areas. Along with the interiorization there has been the formation of regional subsystems of cities. On the other hand, a concentration process has occurred both in the consolidation of metropolitan areas and in the faster growth of cities in the industrial region (polarized by the "metropolitan triangle" of Rio de Janeiro, São Paulo, and Belo Horizonte, Lodder, 1977). The main factor in the context of the recent urban development in Brazil is industrialization, with its tendency toward concentration in geographic space. The patterns observed in the last decade do not, on the whole, warrant an optimistic view of industrial decentralization brought about by market forces (Tolosa, 1977). A second important factor is the internal migration movements which have accelerated in the last decades. More important than the mere quatitative aspect of migration are the characteristics of these recent population movements: the predominance of short distance flows (which tell us why medium size and interior cities have grown), the prevalence of intraregional movements, and the predominance of urban over rural flows (i.e., population movements between cities, generally in a hierarchical trajetory toward the metropolitan centers; Tolosa, 1977; Lodder, 1977). According to Tolosa, rural "push" factors tend to be more important than cities' attraction or "pull" forces (Tolosa, 1977). Rapid urban growth has resulted in the formation and accentuation of a labor surplus in the urban areas. Coupled with the strategies noted above to foster industrialization and economic growth, migration has exacerbated urban problems--mainly those of unemployment, underemployment, urban poverty, and income inequality (Tolosa, 1977; Lodder, 1977).

Regional polarization under the dominance of the southeastern region (mainly São Paulo) developed during the coffee era has been intensified during the last decades (Babarovic, 1971; Redwood, 1975). This polarization has persisted even though regional inequalities were explicitly recognized in the early 1960's as a problem to be tackled by national development plans. Despite an arsenal of strategies and policies designed to deal with regional inequality and uneven development, recent analyses are critical both of limited achievements and inappropriate strategies (Redwood, 1975; Goodman, 1975; Suzigan, 1976).

The Agricultural Sector

With the gradual hegemony of urban and industrial groups in the political and economical life of the country since the early 1930's, agricultural interests lost their dominance. The survival of the old agrarian structures became dependent on their ability to adjust and respond to the needs of an urban economy (Goodman, 1976). In the post-war period,

> Brazilian agriculture has gone through two distinct phases (paralleling those discussed in connection with the industrialization process and the critical political changes that occurred): the first characterized by general neglect and occasional discrimination, especially during the 1947-1961 period of intense import substitution industrialization, resulting in growth largely along the extensive margin, and the second, beginning in the mid-1960's and continuing to the present in which policies have aimed at agricultural modernization and expanded exports (The Ohio State University Research Team Report, 1975, p. 3-2 and 3-3).

During the 1950's and 1960's, agricultural output expanded mainly by extension of the agricultural frontier and the further incorporation of the traditional factors of production--land and labor--into the agricultural sector (Barros and Graham, 1977; Schuh, 1970; Paiva, Schattan and Freitas, 1973; Nicholls, 1975). Nevertheless, the performance of the agricultural sector is generally considered adequate in terms of being able to grow at rates commensurate with growth in internal demand and its capacity to produce an export surplus to finance industrialization (Barros and Graham, 1977; Schuh, 1970). This performance has actually concealed many of the distortions and problems within agriculture. It is useful to note that it was only by the early

1960's, when occasional urban food deficits appeared, that the thesis of structural bottlenecks within the agricultural sector received recognition within government circles. However, the effects of this recognition were meager because the ruling groups who assumed control of the country in 1964 were not primarily interested in either defending the interests of rural elites or emphasizing the agricultural sector in their development strategies.

The new regime did acknowledge the relative backwardness of agriculture, and legel instruments to guide an agrarian reform were promulgated in the first months of the present regime. However, the path eventually chosen for agricultural development was that of modernization through market incentives and institutional reforms, rather than through explicit structural changes. Resultant policies thus were largely aimed "at increasing agricultural production and productivity through higher profitability and reduced risk, while at the same time holding consumer prices" (The Ohio State University Research Team Report, 1975, p. 3-25). It can be said that in comparison with the previous post-War period lasting through the mid-1960's, the major change brought about by the present Brazilian regime was a recognition of the importance of the agricultural sector for achieving overall objectives of economic growth, especially industrial growth. Agricultural development thus was conceived not so much as a strategy for improving the livelihood of the rural population as it was for financing and otherwise dovetailing with the needs for an expanding industrial sector.

In this respect the military governments have formulated and implemented a wide variety of policy instruments. These include: 1) programs oriented toward specific commodities to influence output and product prices; b) factor pricing programs to affect the farm-level supply of modern inputs (such as seeds, fertilizers, insecticides, tractors, and other farm equipment), providing for expanded low cost agricultural credit, and increasing labor costs through social security and minimum wage legislation; c) commercial policies oriented toward modernization of the supply system for agricultural products, and recently, to remove disincentives to export; d) national and regional programs to improve the infrastructure of production (e.g., rural electrification, irrigation, recent changes in the organization of agricultural research and extension services) and encourage investments in aforementioned export crop and cattle-raising activities; and e) programs for continuing the expansion of the agricultural frontier through occupation and colonization projects (Paiva, Schattan and Freitas, 1973; Barros and Graham, 1977; The Ohio State University Research Team Report, 1975). As Barros and Graham (1977, p. 9) have noted, the agricultural policies implemented in Brazil have tended to primarily benefit specific regions (South and Center-West) and specific groups of farmers (large, commercial farmers). These policies, then, have contributed to the exacerbation of intra-sector and inter-regional inequalities--both in terms of income levels and rates of growth (Barros and Graham, 1977, p. 9). In fact, the unevenness of growth has been a major characteristic of and issue surrounding the strategies for development employed in Brazil. These and other aspects of the recent agricultural transition and development experience of Brazil will be dealt with later in this chapter.

Social Change in Minas Gerais

The development of the state of Minas Gerais in the recent period has been conditioned by its secondary position relative to the growth poles of Rio de Janeiro and São Paulo. The period of 1930 to 1947 reveals a mixed picture: it is during this period that the significant rural exodus and out-of-state migration begin. There is also a decline of coffee exports, with substantial voluntary erradication of coffee trees and the expansion of food crops (corn, rice, sugar cane, manioc, beans) and livestock activities (for beef and dairy products). The region of the extreme west (known as the Triangulo zone) emerges as a dynamic locus of livestock production, even though the meat packing industries continued to locate mainly in the Rio-São Paulo area. However, the region from this time forward became a pole for diffusion of technological improvements for an agricultural system characterized by traditional production methods, high land concentration, a large subsistence sector and low dynamism. In terms of industry, the development of Minas Gerais was historically consolidated along three main lines: the textile, food (mainly dairy and sugar processing), and metallurgical and steel industries (already characterized, at this time, by large projects involving state and foreign capital). The urbanization process was still slow in the period; by 1950, only about 30 percent of the population was classified as urban, the majority of which resided in small towns (Governo do Estado de Minas Gerais, 1967, Vol. 1).

The post-war period, in general, reveals a much slower pace of change for Minas Gerais when compared with São Paulo and other southern states. The pace quickened, however, after the late 1960's. Minas Gerais did not participate in the import-substitution industrialization of the 1950's at the levels of Rio de Janeiro, São Paulo and Rio Grande do Sul. Nevertheless, during the post-war period, the industrial share of state gross real product increased from 13 percent in 1949, to 18 percent in 1960 (Governo do Estado de Minas Gerais, 1967, Vole 1). Until the 1960's, the economy was geared mainly to supplying raw materials and components to the center-south. Since the 1950's, the state governments have been responsible for the expansion of transport and communications networks and electricity generation facilities. Considerable progress had been made toward the establishment of a more diversified heavy industrial base in Minas Gerais by the late 1960's (Bank of London & South America Review, July, 1976). Most of the industrialization efforts of recent years have been concentrated in the area around the state capital, Belo Horizonte, which became a major metropolis of the country only in the last twenty years. From a population less than 400,000 in 1950, Belo Horizonte grew to more than 1.2 million inhabitants by 1970. This phenomenal population increase has certainly contributed to the state crossing the 50 percent urban threshold in 1970. However, there was substantial growth of smaller cities in the state, and by 1970, ten cities in Minas Gerais had a population in excess of 50,000 inhabitants. As was the case for the country as a whole, Minas' cities were integrated into a more complex and hierarchical urban system during the last two decades. This urban system is characterized by several tiers of regional centers with different levels of development and influence (Leloup, 1970; Ferreira, 1972). In Minas Gerais, rural push factors also have performed a crucial role in the urbanization process with industrialization generally being the minor factor in the attractiveness of cities (Leloup, 1970).

Throughout the period agriculture remained the primary economic activity of the state. However, in this sector, more than in others, Minas Gerais' performance has been below that of other states in the South and Center-West regions. Output has increased for crops, livestock and extractive activities, but at relatively low rates. There are several reasons why Minas Gerais' productivity in these sectors has lagged. Livestock, a principal component of the Minas Gerais agricultural economy, has remained traditional in most of Brazil. Other characteristics of Minas Gerais agriculture include land-extensive methods and low technological and productivity levels (Governo do Estado de Minas Gerais, 1967, Vol. 1; Paiva, Shatan and Freitas, 1973; Contador, 1975); the predominance of food crops which have generally been ignored in agricultural modernization efforts (Schuh, 1975); an agrarian system characterized by the minifundio-latifundio complex (Furtado, 1976); and low occupational mobility opportunities for the majority of the labor force. In addition, Minas Gerais has a large proportion of infertile soils which demand improved cultivation methods and modern inputs for higher productivity (Schuh, 1970; Governo do Estado de Minas Gerais, 1967, Vol. 1). However, studies conducted over the last decade indicate that there is wide regional differentiation in Minas Gerais agriculture as well as in other sectors of the economy and society (Leloup, 1970; Clements, 1969; I.B.G.E., 1968a). In fact, as a recent review article emphasizes, Minas Gerais "represents a microcosm of Brazil, in that its chief economic problem is the great disparity in levels of development between the richest and poorest areas" (Bank of London & South American Review, July 1976, p. 376).

RECENT CHANGE TRENDS: BENCHMARKS FOR THE STUDY

In this section we wish to illustrate some master social changes observed in the Brazilian agrarian structure and social organization from 1950 to 1970, as revealed by census data. The indicators reported in the following tables were constructed with the same procedures used for the variables employed in empirical analysis in subsequent chapters. The reader is referred to chapter 4 for details on the sources, procedures, and problems and limitations of these data. Figure 1 shows the map of Brazil with its state boundaries and the macro-regional breakdowns formulated in the late 1960's by the national statistics agency (Fundação Instituto Brasileiro de Geografia e Estatistica - F.I.B.G.E.) and adopted in the 1970 census. The following tables present aggregate data for Brazil, the macro-regions, and selected states. As we shall see below, the data consistently reveal pronounced regional disparities in the course of social change in Brazil.

Land Inequality and Farm Size

Brazil has an extremely unequal pattern of land distribution, as the Gini coefficients of Table 1 indicate. Hoffman and Silva (1975), who have calculated these coefficients, observe that these coefficients (and those for Latin American countries generally) tend to be higher than for most other countries, including the United States, Canada and Britain. Land concentration tends to be higher in the scarecely populated regions of North and Center-West, and in the densely-populated Northeast, where the latifundio-minifundio syndrome is prevalent. The South, where the "family farm" has become widespread through European immigration and colonization, shows the least land concentration. The Southeast--particularly Minas Gerais--exhibits Gini coefficients lower than those for Brazil as a whole, but higher than those of the South. The land concentration values tend to be quite stable between 1950 and 1970--reflecting the inertia and structural centrality of patterns of land appropriation developed in the colonial past. On the other hand, average farm size experiences sharp declines during the 1950-1970 period in all regions and the selected states. Such development is basically explained by phenomenal growth in the number of farms. The number of farms more than doubled from 1950 to 1970--from around 2 million to about 4.9 million for Brazil as a whole. Total farm land increased much less rapidly than the number of farms--from 233 million hectares to 294 million. Evidence exists that the majority of new farms consists of small farms, and the data on percentages of farms less than two and more than 200 hectares, also presented in Table 1, corroborate other findings (Schuh, 1970). While the proportion of minifundios increased substantially in the country and most of the selected states, the proportion of larger farms has consequently decreased. However, the proportion of land in units 200 hectares or larger decreased only slightly.[5] A process of fragmentation of farm holdings

Brazil's Macro-Regions:

1 - North
2 - Northeast
3 - Southeast
4 - South
5 - Center-West

Figure 1. Map of Brazil showing the states and Macro-Regions.

Table 1. Indicators of Land Inequality and Farm Size, Brazil, Macro-Regions, and Selected States, 1950 and 1970

Brazil, Macro-Regions and Selected States	Land Inequality (Gini)[2/]		Average Farm Size (Ha.)		% Farms Less 2 Ha.		% Farms More 200 Ha.	
	1960	1970	1950[3/]	1970[4/]	1950[3/]	1970[5/]	1950[3/]	1970[5/]
Brazil	.836	.837	113.2	59.7	7.9	18.0	8.2	4.8
North[1/]	.942	.829	298.5	88.7	12.4	-	7.9	-
Para	.824	.874	109.9	76.0	14.1	18.9	4.3	2.6
Northeast	.841	.849	70.1	33.6	15.9	-	6.1	-
Ceara	.744	.783	120.1	49.3	4.1	11.4	11.9	4.4
Pernambuco	.839	.833	30.3	19.2	22.1	37.6	2.6	1.7
Southeast	.763	.753	106.4	74.8	2.3	-	8.8	-
Minas Gerais	.754	.743	138.0	92.5	2.3	4.3	13.0	9.1
Sao Paulo	.788	.772	86.0	62.4	1.2	5.4	7.4	5.6
South	.715	.716	73.8	35.6	1.2	-	5.1	-
Parana	.687	.691	89.7	26.3	.6	3.4	6.2	1.5
Rio Grande do Sul	.746	.746	77.0	46.4	1.0	4.3	5.6	3.6
Center-West	.839	.850	674.3	322.7	1.2	-	37.7	-
Goias	.759	.729	387.6	246.5	1.3	1.0	33.8	25.4

1/ Macro-Regions in this and the following tables are established according to the 1970 census. The states located in each Macro-Region are presented in Figure 1.

Sources: 2/ Hoffman and Silva (1975), Tables VIII. 5 and VIII.6. Only the 1960 and 1970 coefficients were available.

3/ I.B.G.E. Anuario Estatistico do Brasil, 1954, pg. 76, and 83-86 (Computed)

4/ F.I.B.G.E. Anuario Estatistico do Brasil, 1975, pg. 146 (Computed)

5/ I.B.G.E. Sinopse Preliminar do Censo Agro-Pecuario, 1970. Brasil e Unidades da Federação. Rio de Janeiro, 1973. Table 3 (Computed).

is clearly indicated by these data. This process is encouraged by the pattern of land inequality which creates the paradox of land scarcity in a country with abundant land resources (Governo do Estado de Minas Gerais, 1967, Vol. 1). Farm units with two hectares or less form production units too small to provide subsistence for a family. Minifundio-operators thus are often forced to sell their labor elsewhere on a part-time or seasonal basis. This situation, not surprisingly, is "functional" for meeting the labor needs of larger farms, be they involved in capitalist or pre-capitalist modes of production (Goodman, 1976; Furtado, 1976).

Land Use

In 1960, only about 30 percent of the total land area of Brazil was utilized as farm land (Schuh, 1970). The data reported in Table 2 indicate that farm land is used rather extensively as well. By 1950, only about 55 percent of farm land was devoted to crops or pastures, and this proportion only reached about 53 percent in 1970. The bulk of farmland in both years was used for pastures in the entire country as well as in all regions and selected states (with the single exception of Parana, in 1970). While the proportion of farmland in crops and pastures has tended to increase between 1950 and 1970, the percentage of land in forests has shown a corresponding decrease during the period.

The data in Table 2 also reveal regional variations in patterns of land use. The North is the region with the largest proportion of land in forests, and the major trend during the period was an increase in its proportion of pastureland. The South, however, experienced much more rapid growth in the proportion of cropland--reflecting the expansion into Parana state's fertile frontier lands with coffee, soybeans and other high valued crops, and the expansion of rice, wheat, soybeans and other crops in Rio Grande do Sul. Nevertheless, the prevalence of farmland devoted to crops remained high (over 20 percent) in São Paulo and Pernambuco states and increased significantly in Ceará. By contrast, Minas Gerais continued to exhibit a very small proportion of its farmland devoted to crops over the period--ranking only higher than the sparsely populated regions of the North and Center-West. The only significant change in the pattern of land use in Minas Gerais was the continuation of the secular trend of an increasing prevalence of pastureland. By 1970, the state shows the highest proportion of land devoted to pastures. This explains why Minas Gerais continued to show the highest average farm size in all of Brazil outside of the Center-West region. As Hoffman and Silva demonstrate, livestock production is typically carried out on relatively large farm units in Brazil generally, and in Minas Gerais in particular (Hoffman and Silva, 1975; Governo do Estado de Minas Gerais, 1967, Vol. 1).

Table 2. Indicators of Land Use, Brazil, Macro-Regions and Selected States, 1950 and 1970.

Brazil, Macro-Regions, and Selected States	% Farmland in Crops		% Farmland in Pastures		% Farmland in Forests	
	1950 1/	1970 2/	1950 1/	1970 2/	1950 1/	1970 2/
<u>Brazil</u>	8.6	11.5	46.0	52.4	24.1	19.6
<u>North</u>	1.7	2.6	10.5	19.1	76.2	60.0
Para	5.2	3.4	24.2	23.6	48.5	45.8
<u>Northeast</u>	9.7	13.8	28.6	37.5	26.0	2.2
Ceara	10.1	19.4	23.4	33.4	28.8	26.8
Pernambuco	20.2	23.0	19.5	37.3	21.3	14.4
<u>Southeast</u>	13.7	13.8	54.4	64.3	12.5	10.8
Minas Gerais	8.1	8.4	62.5	70.7	9.4	9.4
Sao Paulo	22.3	23.2	45.3	56.1	14.7	11.8
<u>South</u>	12.9	24.2	52.5	47.5	16.2	13.8
Parana	16.9	32.2	27.9	30.8	23.4	17.5
Rio Grande do Sul	11.5	20.9	65.9	61.4	10.2	8.2
<u>Center-West</u>	1.4	2.9	66.7	67.9	17.5	16.6
Goias	2.2	4.5	62.6	66.4	13.8	13.7

Sources: 1/ I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1954, pg. 76 (Computed).

2/ F.I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1975, pg. 148 (Computed)

Land Tenure

Census data on land tenure arrangements in Brazil are quite circumscribed and cannot reveal the complexities of the situation (Forman, 1975; Goodman, 1976). The problem is even more severe when inter-censal comparisons are attempted. Nevertheless, Table 3 provides some illustrative data on patterns and changes relative to some major land tenure categories.[6] It can be observed that the majority of farm operators is owners, but that the proportion of farms operated by owners has progressively decreased in all regions and selected states during the period. On the other hand, the relative numbers of operators with less secure tenure such as tenants (sharecroppers and renters) and squatters[7] have generally tended to increase from 1950 to 1970. The proportion of farm units operated by managers or administrators is not large, and comparisons between 1950 and 1970 are hampered by the fact that managers and administrators were not considered separate tenure category in the last census; their numbers are concealed within the other categories--particularly that of owners. This underscores the profound decrease of the owner group discussed above. The proportion of squatters has decreased only in the South (where agriculture is substantially commercialized) and in the Center-West (where extensive cattle-raising activities on large estates are dominant). Similar general tendencies were detected by other studies using census materials (Hoffman and Silva, 1975; Goodman, 1976). The state of Minas Gerais, while conforming to national tendencies in changes of land tenure

Table 3. Indicators of Land Tenure, Brazil, Macro-Regions, and Selected States, 1950 and 1970.

Brazil, Macro-Regions and Selected States	% Owners		% Tenants		% Squatters		% Administrators 1/	
	1950 2/	1970 3/	1950 2/	1970 3/	1950 2/	1970 3/	1950 2/	1970 4/
Brazil	75.1	62.8	9.0	20.6	10.0	16.4	5.7	-
North	64.4	38.8	5.8	14.5	25.1	46.5	4.5	-
Para	63.3	45.6	4.6	7.5	27.8	46.7	4.2	-
Northeast	72.0	56.7	9.9	22.0	11.3	21.1	6.6	-
Ceara	80.3	64.6	4.8	20.0	3.2	15.3	11.4	-
Pernambuco	69.8	61.2	20.5	20.8	6.0	17.8	3.5	-
Southeast	77.9	76.7	11.8	16.3	3.0	6.8	7.0	-
Minas Gerais	88.4	85.3	3.3	7.8	2.4	6.8	5.7	4.9
Sao Paulo	64.5	63.6	23.9	30.6	3.4	5.7	7.9	-
South	81.5	67.7	5.1	23.6	10.6	8.6	2.6	-
Parana	76.7	56.4	4.9	34.5	13.4	9.0	4.8	3.2
Rio Grande do Sul	79.9	73.8	5.5	17.2	11.9	8.8	2.5	3.0
Center-West	62.1	65.2	6.4	15.2	25.0	19.4	6.2	-
Goias	59.5	76.5	6.6	5.1	27.9	18.3	5.7	7.7

1/ This category was not considered separately, in the 1970 census and is inflating the other 1970 tenure categories mainly the % of owners. The percentages referred in this column were computed from information available only for regional (State) series of the agricultural census, reporting the number of farms operated by administrators.

Sources: 2/ I.B.G.E. Anuario Estatistico do Brasil, 1954, pg. 77 (Computed).
3/ F.I.B.G.E. Anuario Estatistico do Brasil, 1975, pg. 146 (Computed).
4/ F.I.B.G.E. Censo Agro-Pecuario- 1970, Serie Regional: Minas Gerais, Parana, Rio Grande do Sul, and Goias, the ones available in the O.S.U. libraries.

patterns reveals less dramatic trends.

Rural Labor Force

Table 4 presents the distribution of rural labor force into four major categories detailed in the agricultural censuses. Three of these categories refer to landless laborers--permanent and temporary workers and sharecroppers, i.e., the hired labor paid either with wages or a share of crops. The fourth category refers to the labor performed by farm operators themselves and members of their families. The outstanding feature of these data is the general predominance and increase in the proportions of rural family labor throughout the country. This finding is clearly associated with sharp increases in the number of farm units--primarily of minifundios and small farms--and tenancy and squatter groups as noted above. The sharpest increases in the proportion of family labor in the rural labor force, for example, are found in the Northeast region which has experienced the most acute process of fragmentation of farm holdings. The South, which has been historically identified with prevalence of family farm units, exhibited the largest relative proportion of family labor in both 1950 and 1970. The North, which experienced the largest increase in the proportion of squatters, also showed large increases in the percentage of rural family labor. It is in the Southeast region--especially São Paulo where export and commercial agriculture has been traditionally carried in

Table 4. Indicators of Rural Labor Force, Brazil, Macro-Regions and Selected States 1950 and 1970.

Brazil, Macro-Regions and Selected States	% Rural Family Labor		% Sharecroppers		% Permanent Rural Workers		% Temporary Rural Workers	
	1950	1970	1950	1970	1950	1970	1950	1970
Brazil	54.5	80.2	11.4	3.4	12.3	6.5	20.9	8.4
North	68.7	92.6	3.1	0.9	9.6	2.0	18.4	3.7
Para	75.3	90.0	2.6	1.4	5.4	2.4	16.6	5.1
Northeast	48.8	83.5	7.9	2.1	8.7	3.9	26.8	8.4
Ceara	44.8	72.6	13.6	4.7	5.2	2.2	36.2	13.2
Pernambuco	56.7	81.9	2.4	0.2	12.3	7.2	26.6	10.2
Southeast	40.0	63.0	19.8	8.6	20.4	13.8	19.6	13.1
Minas Gerais	39.8	63.7	19.5	10.1	12.2	9.6	28.3	14.7
Sao Paulo	39.6	61.4	15.3	4.6	33.9	20.3	11.1	12.8
South	75.5	88.7	4.0	0.9	8.5	5.0	11.8	4.7
Parana	54.8	85.6	5.1	1.2	21.0	6.6	18.9	6.0
Rio Grande do Sul	81.0	90.8	4.1	0.8	4.7	4.3	10.1	3.4
Center-West	66.4	75.8	9.1	5.3	8.2	8.2	16.0	9.8
Goias	67.1	70.8	10.6	8.7	6.8	7.6	15.2	11.7

Sources: 1/ I.B.G.E. Anuario Estatistico do Brasil, 1954, pgs. 80-82 (Computed).
2/ F.I.B.G.E. Anuario Estatistico do Brasil, 1975, pgs. 149-150 (Computed).

relatively large farm units relying on hired labor--that the proportions of family labor were relatively small in 1950 and in 1970 (despite exhibiting a secular increase, as noted above). Another tendency revealed in Table 4 is a progressive decrease in the prevalence of sharecropping as a form of organizing hired labor throughout Brazil. Further, due to increases in family labor, the proportions of both permanent and temporary workers have tended to diminish, but less so in the state of São Paulo than in other regions. These patterns and trends thus provide further support for previously cited interpretations of the "functionality" of minifundios for meeting fhr labor requirements of larger farms (Furtado, 1976; Goodman, 1976).

Agricultural Technology and Productivity

The data presented in Tables 5 and 6 illustrate the well-acknowledged, low overall levels of agricultural modernization in Brazil (Schuh, 1970, 1975; Paiva, Shatan and Freitas, 1975; Contador, 1975; Furtado, 1976; The Ohio State University Research Team Report, 1975). The use of modern bio-chemical inputs--in this case, fertilizers, seeds, and insecticides--is low throughout the country, with only exceptions of São Paulo state and in the South region, particularly in Rio Grande do Sul. The same can be noted with respect to levels of mechanization--represented here by the number of tractors. Agricultural modernization is not only highly concentrated in certain states and regions, but rates of increase are also highly skewed during the period under consideration in favor of the initially favored areas. The result is that regional disparities in agricultural modernization were larger in 1970 than in 1950--with the state of São Paulo far ahead of any other unit in the nation. Different types of data presented in the empirical studies referred to above reveal the same picture. The state of Minas Gerais occupies an intermediate position with respect to technological change; it lags behind its neighbor, São Paulo, and the South region, but is generally better off in comparison with the North, Northeast, and Center-West.

Despite improvements in the technological levels of Brazilian agriculture (keeping in mind its spatially uneven character, however), the impact of technology on aggregate physical productivities seems quite modest, judging from the data in Table 6. For the five selected crops, only coffee and sugar cane--which are non-staple, export commodities--have experienced sizeable productivity gains at the national level from 1950 to 1970. The typical staple food crops--rice, corn and beans--have shown no significant yield increases, with beans even experiencing productivity declines. These results are consistent with a variety of recent studies of Brazilian agriculture (Schuh, 1970, 1975; Paiva, Schatan and Freitas, 1973; Nicholls, 1975; The Ohio State University Research Team Report, 1975; Patrick, 1975; Barros, Pastore and Rizzieri, 1977). These studies also point toward other conclusions which can be inferred from the data in Table 6. These authors report substantial regional

Table 5. Indicators of Agricultural Technology, Brazil, Macro-Regions and Selected States, 1950 and 1970.

Brazil, Macro-Regions and Selected States	CR$ Modern Biochemical Inputs per Farm 1/		CR$ Modern Biochemical Inputs per Ha. of Cropland 1/		Number of Tractors		Tractors per 1000 Ha. of Cropland	
	1950 2/	1970 3/	1950 2/	1970 3/	1950 4/	1970 4/	1950 5/	1970 6/
<u>Brazil</u>	CR$ 176	CR$ 374	CR$ 15	CR$ 52	8,372	157,346	0.4	4.6
<u>North</u>	9	59	2	23	61	1,035	0.1	1.7
Para	10	93	1	33	33	855	0.1	2.4
<u>Northeast</u>	61	76	7	15	451	6,177	0.1	0.6
Ceara	22	32	2	3	32	580	0.0	0.2
Pernambuco	136	133	18	29	142	1,387	0.1	0.9
<u>Southeast</u>	363	915	23	88	5,155	79,852	0.6	8.3
Minas Gerais	94	310	9	39	763	9,332	0.3	2.6
Sao Paulo	756	2,048	37	140	3,819	65,801	0.9	13.9
<u>South</u>	162	557	16	63	2,566	60,684	0.6	5.5
Parana	139	484	8	56	280	17,258	0.2	3.7
Rio Grande do Sol	215	785	23	80	2,245	38,358	0.9	7.7
<u>Center-West</u>	16	243	1	25	139	9,598	0.2	4.0
Goias	12	487	1	21	89	5,294	0.2	3.3

Sources: 1/ In Constant Cruzeiros of 1970.
2/ I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1954, pgs. 76 and 79 (Computed).
3/ F.I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1975, pgs. 148 and 154 (Computed).
4/ F.I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1975, pgs. 164 and 165.
5/ Sources 2/ and 3/ above (Computed).
6/ Sources 1/ and 3/ above (Computed.

Table 6. Average Yields in kg. per Ha., of Selected Crops, Brazil, Macro-Regions and Selected States 1953 and 1973.

Brazil, Macro-Regions and Selected States	Coffee		Sugar Cane		Rice		Corn		Beans	
	1953 1/	1973 2/	1953 1/	1973 2/	1953 1/	1973 2/	1953 1/	1973 2/	1953 1/	1973 2/
<u>Brazil</u>	380	839	38,690	46,904	1,483	1,495	1,169	1,436	695	584
<u>North</u>	-	-	25,325	26,045	1,254	1,241	903	947	778	904
Para	333	785	22,692	22,987	953	1,117	775	860	602	721
<u>Northeast</u>	-	-	37,787	45,788	1,114	1,300	596	687	481	517
Ceara	305	568	35,168	41,853	550	1,427	481	601	367	360
Pernambuco	428	714	35,822	47,410	1,837	1,821	571	742	517	531
<u>Southeast</u>	-	-	41,921	49,276	1,246	1,148	1,203	1,583	683	572
Minas Gerais	382	759	34,896	35,295	1,249	1,060	1,254	1,307	688	591
Sao Paulo	322	1.337	45,899	55,657	1,252	1,138	1,068	2,020	685	545
<u>South</u>	-	-	28,207	37,780	2,421	2,328	1,372	1,697	926	694
Parana	542	568	52,588	49,643	1,292	1,400	1,306	1,854	954	650
Rio Grande do Sul	-	-	17,840	24,058	2,878	3,447	1,291	1,394	820	800
<u>Center-West</u>	-	-	36,330	44,033	1,545	1,397	1,673	1,564	998	594
Goias	634	687	33,610	36,683	1,553	1,263	1,689	1,569	1,077	481

Sources: 1/ I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1956, pgs. 110, 107, 115 and 112 (Computed).

2/ F.I.B.G.E. <u>Anuario Estatistico do Brasil</u>, 1974, pgs. 190, 188, 194 and 192 (Computed for the Macro-Regions).

variations in yields of comparable crops due to differences in input use, relative regional importance of crops, and natural quality of soils, among others. Further, they note the relatively small contribution that productivity gains have made to the observed growth of agricultural output in the last decades (the bulk of overall growth being accounted for by increased area under cultivation). In Minas Gerais, only coffee among the selected crops in Table 6 has shown any sizeable yield increase--reflecting both the relative backwardness of the state's agriculture and the still dominant position occupied by that commodity.[8]

Rural and Urban Wages

One of the key aspects of Brazil's recent trajectory of economic growth and social change has been the exacerbation of inter-regional, inter-sectoral, and overall social inequalities in income distribution, as noted above. Whatever the interpretations for the causes of these phenomena--which have been major issues in the recent debates on Brazil--the fact remains that a number of studies leave no doubt as to the heightening of income inequality during recent decades (Fishlow, 1972; Langoni, 1973; Costa, 1975). Data presented by Langoni (1973, p. 81) clearly demonstrate the widening gap between the primary versus the secondary and tertiary sectors in Brazil during the 1960's. While the primary sector (agriculture) had an average monthly income (in constant 1970 cruzeiros) of 121 cruzeiros in 1960, the urban sectors (secondary and tertiary) averaged 273 cruzeiros in the same year. In 1970, these values became 138 and 378 cruzeiros, respectively (Langoni, 1973, p. 81). Intra-sectoral income inequality coefficients reported in the same study indicate that agriculture, which exhibited Gini coefficients similar to the industrial sector in 1960, experienced less income concentration in the decade than the urban (secondary plus tertiary) sectors.[9] Two qualifications, however, must be made to this conclusion. Firstly, income concentration within agriculture was found by the same researcher to be lower in the less developed regions where traditional technologies are employed and inequality is largely a function of distribution of land than in the developed regions. However, income inequality was increasing most rapidly in regions with the most rapid rates of economic growth (Langoni, 1973, pp. 166-168). The second caveat is that inequality of income distribution in agriculture--even though no higher than in other sectors in an absolute sense--has "the most serious consequences due to the low level of income in this sector" (Paiva, Shatan and Freitas, 1973, p. 95). It is recognized that even with the growing income disparities in urban areas, the problem of poverty in Brazil is very much a problem of rural poverty (Schuh, 1975, 1977; Fishlow, 1972; Paiva, 1975).

Unfortunately, we lack data on income levels and income inequality within the agricultural sector for 1950. In this study we rely on average annual wages of hired rural workers (those classified as permanent and temporary workers) which were calculated by dividing total wage receipts by the number of hired workers. A similar approach was utilized to estimate average wages of industrial workers.[10] The data for the units considered in this section are presented in Table 7. Three general observations can be made from the table. Firstly, there are distinct regional and state variations in the average wage levels of both farm and industrial workers in both 1950 and 1970. Such variations follow the general expected pattern--with the South and São Paulo state having significantly higher wages and the Northeast with lower averages than the nation as a whole. Secondly, there is a wide gap between rural and industrial wages in the entire country as well as in all regions and selected states. Despite sizeable increases in rural wages during the period, these increases were too small to diminish the rural-urban gap in wages. Thirdly, the low absolute levels of rural wages are stiking. Considering an exchange rate of about six cruzeiros per dollar for 1970, the average rural worker's wages were about $174 dollars in that year, and $78 in 1950. Although these data are more meaningful in a relative than an absolute sense, given the margin of error involved in the census figures and the ratio procedure used for their derivation, they are, nevertheless, illustrative of the poverty levels in rural areas. Data presented by Paiva (1975), Bacha (1977) and Schuh (1977) on the average wage levels of rural workers for selected regions, although based on different sources and computed somewhat differently, point toward the same

Table 7. Annual Average Wages of Farm and Industrial Workers, in Constant Cruzeiros of 1970, Brazil, Macro-Regions, and Selected States, 1950 and 1970.

Brazil, Macro-Regions and Selected States	Average Wages of Hired Farm Workers		Average Wages of Industrial Workers	
	1950	1970	1950	1970
Brazil	CR$ 469	CR$ 1,046	CR$ 2,309	CR$ 4,288
North	557	1,110	1,384	2,345
Para	291	1,062	1,276	2,108
Northeast	294	722	1,188	2,313
Ceara	153	450	985	1,788
Pernambuco	328	932	1,422	2,702
Southeast	648	1,254	2,661	4,835
Minas Gerais	327	839	1,703	3,618
Sao Paulo	983	1,662	2,792	5,061
South	596	1,210	2,131	3,107
Parana	640	1,114	1,954	2,864
Rio Grande do Sul	597	1,551	2,291	3,241
Center-West	459	1,125	1,594	2,560
Goias	348	960	1,711	2,330

Sources: 1/ I.B.G.E. Anuario Estatistico do Brasil, 1954, pgs. 79, 81, 111 (Computed).

2/ F.I.B.G.E. Anuario Estatistico do Brasil, 1975, pgs. 149, 150, 154, 194 (Computed).

relatively low levels of rural income.[11] By 1970, only in São Paulo and a few other southern states were rural wages moving closer to the minimum wages prevailing in particular regions (Paiva, 1975; Bacha, 1977; Schuh, 1977). As to the percentage of the total rural labor force dependent on wages or receiving similarly low incomes estimates are difficult to obtain. The data in Table 7 pertain only to that small percentage classified as temporary or permanent workers. However, Paiva (1975), when including sharecroppers and renters in his estimates and using data derived from a survey conducted by the National Institute for Colonization and Agrarian Reform (INCRA) in 1972, concluded that about 69 percent of the country's rural labor force is basically dependent on wages (Paiva, 1975).

Literacy and Education

Table 8 presents data on literacy and education for 1950 and 1970. Here again, wide rural-urban differentials can be observed for literacy levels in both 1950 and 1970, despite considerable improvements in rural literacy levels in most regions and states (except those of the Northeast). Regional variations follow the same observed pattern. The Southeast and South regions are privileged relative to other areas of the country. However, with respect to the urban literacy rates, these variations are minimal in 1970 (again, excepting the Northeast).

Table 8. Indicators of Literacy and Educational Levels, Brazil, Macro-Regions and Selected States, 1950 and 1970.

Brazil, Macro-Regions and Selected States	Rural Literacy Rate (%) 1/		Urban Literacy Rates(%) 2/			% Population with Completed Elementary Education3/		% Population with Completed Secondary Education3/		% Population with Completed College Education3/	
			19505/		19705/						
	1950	1970	Urban	Suburban		1950	1970	1950	1970	1950	1970
Brazil	27.7	41.4	73.1	55.7	74.7	14.7	22.4	2.7	7.0	0.4	0.8
North	-	37.6	-	-	73.9	7.9	13.1	1.4	3.1	0.2	0.4
Para	28.4	41.3	85.4	60.5	75.5	8.9	12.9	1.5	4.4	0.2	0.4
Northeast	-	24.5	-	-	59.0	5.3	9.3	1.0	3.5	0.1	0.3
Ceara	18.9	24.1	57.1	42.2	57.7	3.8	7.9	1.0	3.8	0.1	0.3
Pernambuco	24.7	23.8	56.4	47.4	58.6	7.4	12.7	1.5	4.9	0.2	0.5
Southeast	-	50.2	-	-	79.2	21.8	31.3	4.3	9.9	0.7	1.2
Minas Gerais	26.3	42.9	69.3	58.1	72.7	12.6	23.0	1.9	5.9	0.3	0.5
Sao Paulo	39.2	61.9	79.7	65.8	81.2	26.8	37.6	4.6	10.6	0.6	1.3
South	-	61.2	-	-	80.8	16.3	24.9	2.1	6.2	0.3	0.6
Parana	36.8	52.7	76.0	65.1	78.4	13.7	19.8	2.0	4.7	0.3	0.5
Rio Grande do Sul	49.8	68.5	78.1	64.2	82.4	17.6	27.1	2.5	8.0	0.8	0.9
Center-West	-	42.6	-	-	71.9	7.5	16.9	1.2	5.0	0.2	0.6
Goias	21.1	41.5	61.7	38.3	69.6	4.9	15.0	0.9	3.6	0.1	0.4

1/ Literacy rates refer to population 5 years old and above.

2/ For 1950, the urban literacy rates maintain an administrative distinction between urban (cities, townships) and suburban (villages) units.

3/ Percentages refer to population 10 years old and above, with degrees at each educational level.

Sources: 4/ I.B.G.E. Anuario Estatistico do Brasil, 1954, pgs. 390-41 and 391 (Computed)

5/ F.I.B.G.E. Censo Demografico do Brasil, VIII Recenseamento Geral - 1970, Serie Nacional, Vol. 1, Rio de Janeiro, 1973, Tables 47 and 49 (Computed)

The second set of data presented in Table 8 deal with the proportion of population 10 years of age and older which has completed primary, secondary and college levels of schooling. The most striking characteristic of these data is the extreme skewness of the educational hierarchy in Brazil. In Brazil, the basic educational distinction is between those with no educational training (illiterates) and those with an elementary educational level. As Costa (1975) observed for 1970, 84.2 percent of the economically active population (PEA) had five or less years of schooling. If only the rural PEA is considered, this proportion increases to 98.4 percent. Regional disparities in education and literacy exhibited during the period reveal the same trends noted for previous indicators. Minas Gerais again o-cupies an intermediate position between the most developed and underdeveloped regions and states.

Urbanization and Industrialization

The data in Table 9 convincingly depict the large strides Brazil has taken towards urbanization and industrialization during the 1950 to 1970 period. The proportion of urban population has increased about 20 percent--reaching the 56 percent level by 1970. Industrial product per capita has more than doubled. Most of this industrial growth has been concentrated in the Southeast region--particularly São Paulo--where the percentage of urban population increased by about 27 percent

Table 9 . Indicators of Urbanization and Industrialization, Brazil, Macro-Regions, and Selected States, 1950 and 1970.

Brazil, Macro-Regions and Selected States	% Urban Population		Values of Industrial Production per capita 1/	
	1950 2/	1970 2/	1950 3/	1970 2/
Brazil	36.1	55.9	CR$ 526	CR$ 1,250
North	31.4	45.1	97	286
Para	34.6	47.1	109	220
Northeast	26.4	41.8	137	259
Ceara	25.2	40.8	080	239
Pernambuco	34.3	54.4	316	500
Southeast	47.5	72.7	920	2,297
Minas Gerais	29.8	52.7	252	758
Sao Paulo	52.5	80.3	1,399	3,651
South	29.5	44.2	478	892
Parana	24.9	36.1	396	599
Rio Grande do Sul	34.1	53.3	568	1,159
Center-West	24.3	48.0	104	232
Goias	20.2	42.1	98	245

Sources: 1/ In Constant Cruzeiros of 1970.

2/ F.I.B.G.E. Anuario Estatistico do Brasil, 1975, pgs. 56, 60 and 204 (Computed)

3/ I.B.G.E. Anuario Estatistico do Brasil, 1954, pg. 113, and source 1/above, pg. 56 (Computed).

and the value of industrial product per capita increased nearly 300 percent. Detailed regional data presented and discussed by Redwood (1975) in a recent paper more fully document the dynamics of the regionally uneven pattern of urban and industrial growth in Brazil from 1940 to 1970. Using a less inclusive criterion for urbanization than ours--the proportion of population living in cities of 20,000 or more inhabitants--the conclusions are the same as those suggested by Table 9. The Southeast region (mainly São Paulo) has the largest concentration of urban population and the most rapid rate of urban growth. Redwood's data pertaining to changes in the Brazilian urban system lead to conclusions similar to those pointed out in section three of this chapter (Redwood, 1975; see also Tolosa, 1977; Lodder, 1977). With respect to the regional distribution of economic activity as reflected by sectoral product and employment patterns, the conclusions are identical. In 1950, the Southeast accounted for 52 percent of the agricultural product, 76 percent of the industrial product, and 69 percent of services (i.e., the tertiary sector). In 1970, these proportions were, respectively: 40 percent, 81 percent, and 66 percent. In 1940, 80 percent of the industrial employment was located in the Southeast, of which 44 percent alone was in the city of São Paulo. By 1970, these percentages were 80 percent and 59 percent, respectively (Redwood, 1975, pp. 23, 29). The state of Minas Gerais exhibited discernible dynamism in its rates of urban and industrial growth during 1950 to 1970, with a 23 percent increase in the proportion of urban population and a 300 percent increase in the value of industrial production per capita. This performance, however, did not appreciably alter the relative position of Minas Gerais in 1970. Further, most of this growth has been concentrated in the metropolitan area of the capital city, Belo Horizonte (Bank of London & South America Review, July, 1976).

Rural Net Migration

Changes in the distribution of the Brazilian population during recent decades are basically due to internal migration. Estimates of net migration rates for the last three decades made by Graham and Hollanda, and Quoted by Redwood (1975), indicate the South and Center-West regions as net recipients of population in all three decades. The North was a net recipient during the last two decades, while all other regions were net losers (Redwood, 1975, p. 15). These f-ows can be explained largely in terms of the expansion of the agricultural frontiers of North and West Parana, the Center-West states (and in the last decade, the influence of Brasilia), and the colonization in the Amazon area, combined with the growth rates of metropolitan areas. Internal migration has intensified during the last decade. Calculations of inter-municipal and inter-state flows made on the basis of the 1970 population census indicate a predominance of urban-urban and rural-rural migrations over rural-urban and urban-rural flows for Brazil as a whole and all regions (Redwood, 1975). The data in Table 10 report estimates of rural net migration during the

Table 10. Rural Net Migration between 1950 and 1970, Brazil, Macro-Regions and Selected States

Brazil, Macro-Regions and Selected States	Rural Net Migration 1950-1970 1/
Brazil	-30.3
North	-12.0
Para	-12.2
Northeast	-30.4
Ceara	-27.9
Pernambuco	-40.6
Southeast	-48.2
Minas Gerais	-44.0
Sao Paulo	-54.6
South	-6.4
Parana	56.8
Rio Grande do Sul	-36.1
Center-West	12.8
Goias	-1.2

1/ Expressed as percentage deviation of 1970 observed rural population from the expected one, according to a projection for 1970, made on the basis of the national population growth rate of 2.92% per annum, from 1950 to 1970. The specific formula used in the calculations is presented in Chapter IV.

Source: F.I.B.G.E. Anuario Estatistico do Brasil, 1975, pg. 60 (Computed).

1950 to 1970 period on the basis of percentage difference between observed and projected rural population for 1970, under the hypothesis of no net rural migration.[12] The results show a pattern that is consistent with our expectations. The Northeast and Southeast regions, which were both net population losers and experienced high rates of urbanization, also exhibit the higher percentages of rural out-migration. The other regions show lower rates of net rural out-migration, with the Center-West and the state of Parana appearing as net receivers of rural population. The state of Minas Gerais, which is characterized by significant out-migration in recent decades,shows the second highest level of rural out-migration during the 1950 to 1970 period. Likewise, the state of São Paulo--which experienced not only a relative, but also an absolute, loss of rural population in the last decade, and had the highest proportion of urban population in the country in 1970--exhibits the highest rate of rural-outmigration in Table 10.

The data presented in this section have illustrated some of the key characteristics of the recent Brazilian development experience. The main feature that pervades throughout this section is regional, sectoral, and social unevenness of the process of socio-economic growth and change in the country. This feature, as we shall see, has become the most central critical issue in evaluating the development process in Brazil and kindred Third World Nations.

SOME CONTEMPORARY ISSUES AND PERSPECTIVES

In previous sections we attempted to highlight some of the issues and perspectives pertaining to Brazil's patterns of economic growth and social change. This debate has persisted "through the last twenty-five years, and usually sharpens in times of crisis" (Baer, 1976, p. 41). It is not our purpose to go through the many facets of the overall debate, but rather to emphasize certain elements which have generated particularly disparate interpretations. These competing interpretations illustrate the complexities of the development questions and perspectives which often preclude a strictly scientific and objective method of resolving the controversies between them. As Packenham argues, "the weights assigned to the various factors (emphasized by different analysts) reflect values, general theoretical perspectives, and views of the world, as well as reflecting social science considerations more narrowly defined" (Packenham, 1976, p. 112).

General interpretations of Brazil's recent evolution and its corresponding social, political, and economic distortions or problems have increased dramatically in the last decade. These interpretations were largely triggered by the controversial national development model in effect since 1964. The main features of this model are well known: "very high rates of growth in aggregate terms; a reliance on the market and on material incentives with substantial governmental intervention in key areas; increasing class, regional, and urban-rural social economic inequalities; political authoritarianism and repression" (Packenham, 1976, p. 104).

Two broad themes pervade the major controversies focused on the Brazilian development experience. These can be labelled the critiques of dependency and inequality. The first theme runs through the issues related to foreign economic penetration and the relative degree of autonomy the country (or its elites) has had to chose its own development path. The second critique, although highly interconnected with the first, is addressed most clearly to the problems of internal dulaistic structures and how they affect and are affected by economic growth and social change.

The notion of dependency has often been formulated in a very vague fashion despite its crucial role in most recent theorizing about Latin American development.[13] Dependency is here viewed in terms of power; the greater the degree of dependency on the part of a party, the weaker and less autonomous it is in a series of relationships for which dependency is defined (Packenham, 1976). Two groups of issues or relationships underline the dependency theme. The first group stresses the characteristics and problems associated with foreign--especially U.S. multinational--penetration of the Brazilian economy and society, while the second group primarily addresses the questions of the relative ability of national elites (and the state apparatus) to deal with social and economic problems in an autonomous fashion.

The controversies linked with foreign penetration go back to the first stages of Brazilian attempts toward modernization and industrialization and have continued to generate various types of nationalist and radical thought (dos Santos, 1974). Recently, the issues have been focused on aspects such as increases in foreign debt, foreign trade (i.e., more import and export volume as part of the outward looking strategy for economic growth), direct foreign investments, and the influence of multinational corporations in the economy. The influence of transnational firms is viewed to be particularly important in the most dynamic industrial sectors such as trucks and automobiles, tractors, industrial machinery, pharmaceuticals, tobacco, rubber, perfume and plastic products. This control may range from the prerogatives associated with direct investment and ownership to the relatively "loose" control that derives from massive dependency on foreign technology (particularly in the more sophisticated industries; dos Santos, 1974; Furtado, 1976; Suzigan, 1976; Schuh, 1975; Malan, 1977; Baer, 1976; Bacha, 1977, The Ohio State University Team Research Report, 1975; Packenham, 1976). The main questions with respect to these issues are: Does foreign penetration significantly affect the structure of political power? Does this penetration result in increased state power and an extension of its role in the political economy through control of key infra-structural sectors (energy, communications and transportation, financial institutions) as well as a wider arsenal of political and economical policy instruments? Or has increased state power been illusory--confined narrowly to enhancing the interests of foreign multinationals?

The controversies underlines by the second aspect of the dependency theme are represented in issues such as the following: Do the development strategies of the present regime reflect a significant change in previous paths? How much of the growth boom of the 1968-1974 period was due to specific governmental actions and how much to internal structural conditions associated with a temporary favorable international environment? Once the power of the state has increased, to what extent has the state been free to act for national interests, or been constrained by dualistic internal structures? Do these factors, now as in the past, "bound the narrow limits of the possible in terms of economic (and social) choices?" (Malan, 1977, p. 36).

The inequality theme has been central in recent controversies over Brazilian growth and development. The issue is multifaceted, and a complete summary is beyond the scope of this study.[14] We will merely highlight aspects of the debate that are most relevant to the data and approach used below. A caveat is necessary at this point; this chapter has clearly demonstrated that inequality is not a recent phenomenon in Brazilian society. On the contrary, socio-economic (class, income, education), political, inter-sectoral, and inter-regional inequalities have long accompanied the country's historical processes of national formation and transformation. There is also little disagreement that such inequalities were induced by both internal (e.g., the colonial legacy) and external (e.g., multinational penetration) forces, and that economic growth in Brazil has generally--and particularly so in recent decades--exacerbated these inequalities. The main question underlined by the inequality theme is: Does economic growth require increasing inequalities (Hirschman, 1958)? The question has been posed in alternative ways: To what extent does economic growth produce socio-economic development (Furtado, 1976; Baer, 1976)? To what extent would a reduction of inequality hinder economic growth and development (Schuh, 1975; Paiva, 1975)? Is the basic dilemma a clear-cut choice between a capitalist or socialist model or socio-economic organization and development, or does the answer lie in a reformed capitalism (dos Santos, 1974; de Janvry, 1976)? In Brazil, these questions revolve around a number of specific issues. They include the issues of concentration versus stagnation, or technological dualism in industry and agriculture which conditions demand and production profiles that in turn affect and are affected by income concentration. Also of concern is the high capital intensity and low labor absorption in industry, which combined with massive rates of rural-outmigration, aggravates urban poverty and inequality. The income concentrating policies of recent governments (e.g., the wage squeeze, and tax and credit incentives) and their effects on ths savings propensity of the higher income groups have been hotly debated. Further aspects of the inequality controversies deal with the problems of the relative importance of increasing the size of the domestic market through fundamental changes in agrarian and industrial structures; and the most effective ways to diminish inter-regional and inter-sectoral disparities (Baer, 1976, 1977; Furtado, 1976; dos Santos, 1974; Bacha, 1977; Malan, 1977; Suzigan, 1976, Schuh, 1976, 1977; Babarovic, 1971; Redwood, 1975; Tolosa, 1977; Goodman, 1975; Paiva, 1975; The Ohio State University Research Team Report, 1975). In the following chapters we will return to some of the features of and controversies on the recent Brazilian experience of economic growth and social change as they bear upon the specific research problems of this study.

SUMMARY

The overview of growth, stagnation, and change in Brazil's socio-economic history clearly documents the decisive role of its colonial legacy. Two features of this legacy are particularly crucial. The colonization and plunder of the Northeast has left a lasting imprint; the Northeast remains a very underdeveloped, backward, stagnant region that has failed to share in the recent Brazilian "economic miracle." Secondly, the monocultural, export-oriented, estate system in conjunction with an economically insecure, marginalized labor force established in the colonial era remains remarkably intact today. Further, the latifundia/ minifundia complex corresponds with the uneven spatial course of development set in motion by colonial exploitation, with land concentration remaining at extremely high levels in the Northeast.

Subsequent post-colonial eras--the coffee era; Vargas era; the import-substitution phase; and the export expansion, rapid economic growth period--have modified the rate and focus of Brazil's economic development, but have not fundamentally altered the patterns of regional and agricultural organization laid down during colonialism. But despite the pervasiveness of the colonial legacy, the emphasis placed on industrial growth since World War II unleashed new forces for social change. This attention paid to industrialization would eventually lead to the Brazilian "economic miracle" of 1968-1974--a period of extremely rapid aggregate economic growth. This rapid economic growth set Brazil apart from the vast bulk of Third World nations which have experienced continued economic stagnation (see, for example, Lipton, 1976). Despite the obvious tendency for social scientists and other Third World peoples to see much to admire in Brazil's accomplishments, the conditions surrounding the "miracle"--authoritarianism, exaggeration of inequalities, rising debt dependency, among others--have generated as much criticism as praise. Highlights of this heated controversy were summarized above, and they certainly will continue to be matters of debate for many years.

It is noteworthy that the lion's share of the issues addressed by believers and disbelievers of the economic miracle are <u>urban</u> or <u>industrial</u> issues. Despite the fact that Brazil remains a largely <u>rural, agrarian</u> nation, these spheres are typically underemphasized or ignored. This is particularly ironic in that the Brazilian rural social classes have tended to suffer most from poverty, land concentration, and forced exodus from the countryside. This study seeks to bring the rural, agrarian sector into sharper focus. Again, while the data of this study pertaining to Minas Gerais' rural sector can provide substantial insight into the debate over the "conomic miracle," many of the issues involved remain beyond the scope of our inquiry. Nevertheless, the -road issues surrounding Brazil's recent patterns of social and economic transformation have influenced the research questions to which we apply our data.

As noted in Chapter I, we see agricultural technology--mechanization and the use of modern biochemical inputs--to be a useful organizing framework for an analysis of Brazilian rural society. We assume that technological change has grave import for the Brazilian rural sector in several ways. Firstly, it may be the case that improved living standards and quality of life require technological change. Technological improvements may be seen to enable farmers to increase their productivity to the point where their returns or incomes may allow a favorable standard of living. In addition to enhancing the livelihood of individual farmers, this increased productivity is imperative in a milieu of rapid population growth. Thus, insight into the factors that facilitate technological change can help encourage such change and the benefits associated with it.

The scenario depicted above is a decidedly beneficient one. However, for this scenario to be feasible, one must make the assumption that the process of technological change is spatially even and socially equal. If not, certain regions or rural classes may receive the vast bulk of the benefits of technological change, while other regions and social classes may actually be exploited, marginalized, and immiserated through these changes. It is clear from the overview of the Brazilian and Minas Gerais socioeconomic context that for technological change to occur, it must be superimposed on a system of exaggerated regional and class inequalities. Our enthusiasm concerning the efficiency of technological change in yielding the beneficient consequences that are theoretically conceivable must therefore be tempered. Evidence from other Third World nations in connection with the Green Revolution (Griffin, 1974; Perelman, 1977) must make one even more cautious.

Before concluding we wish to make clear the fact that even if technological change in agriculture is carried out under ideal conditions (i.e., regional and social equality), continuing "doses" or "modern" technology *ad infinitum* are not necessarily socially or ecologically desirable. These technologies may be seen to be largely dependent on scarce fossil fuels (Perelman, 1976, 1977). Mechanization requires fuel to manufacture and power implements. Fertilizers and pesticides likewise require substantial amounts of petroleum, natural gas, electricity, and cosl. Thus, there appear to be limits to the extent to which ostensibly modern agricultural technologies can be adopted, presuming that fossil fuel resources are themselves limited.

The implication is that a highly-mechanized, fossil fuel-dependent agriculture is no more the answer for Brazil and kindred nations than the unproductive, traditional agriculture that has been characteristic of most of Brazil's history.

With this background, we move to Chapter III where the implications of competing development theories for the process of technological change in agriculture are considered.

FOOTNOTES

1. More detailed accounts of this period can be found in dos Santos (1974) and Skidmore (1967).

2. This research report in Chapters II and III contains detailed analyses of the strategies, performance, and problems and associated with Brazilian economic development for the period of concern. The Brazilian development experience of the last three decades has generated a vast literature, some of which is referred to in this and subsequent sections of the chapter. An overview of such literature is beyond our scope and purposes here, and the interested reader is advised to consult the bibliographic material contained in the literature cited in this chapter.

3. There are different interpretations of the causes of economic stagnation and social unrest in Brazil in the early 1960's. Some of the issues and contrasting views on these issues, plus the objectives and inadequacies of the development strategies put forward by the military regime since 1964, will be commented on in the last section of this chapter.

4. It is exactly this single-mindedness with which economic (especially industrial) growth was pursued that prompted much of the interest of the international academic community in the recent Brazilian development experience.

5. The percentage of farm land occupied by farms with more than 200 hectares was 68 percent in 1960 and 65 percent in 1970, for Brazil. Comparable figures for Minas Gerais were 69 percent and 63 percent, respectively.

6. Details on specific census definitions for these groups, as well as the problems involved in inter-censal comparisons, are given in Chapter 4.

7. Squatters are operators who occupy land without title or explicit permission of land owners.

8. Before leaving this topic, we must emphasize that these data are merely illustrations of the general productivity trend for Brazil. A more objective view would require time-series data for a broader selection of crops. The interested reader is referred to the literature cited above for more complete analyses.

9. The values of Gini coefficients for income distributions by sector reported by Langoni are: 1960: primary, .43; secondary, .42; tertiary, .50; 1970: primary, .44; secondary, .50; tertiary, .57 (Langoni, 1973, p. 81).

10. More detailed discussions of the construction of these indicators are given in Chapter 4 below.

11. Data presented in Table VII.4 of Paiva's (1975, p. 203) paper indicate the following average wages for 1970: Pernambuco, 912 cruzeiros, Ceará, 876; Minas Gerais, 1,212; São Paulo, 1,848; Parana, 1,500; and Rio Grande do Sul, 1,720. In reporting these estimates we have multiplied Paiva's monthly data by 12 to place them on an annual basis.

12. Details on the calculations of this measure are given in Chapter 4. The projected rural population for 1970 was calculated using the national rate of population growth during the 1950-1970 period (2.92%) in conjunction with the observed 1950 rural population.

13. For criticisms of the uses and definitions of this concept, as well as on the merits and problems of the dependency perspective for analyzing development issues in Lating America, see Oxaal, Barnett and Booth (1975), O'Brien (1975), Long (1977), and Backenham (1976).

14. For further analyses on the inequality problem in Brazil, in recent decades, see: Fishlow (1972), Langoni (1973), Morley and Williamson (1974), Wells (1974), Costa (1975, 1975a), Furtado (1974, 1976), Baer (1976), Bacha (1977), where the interested reader can find also, other references on the topic.

CHAPTER III

SOCIAL ORGANIZATION AND AGRICULTURAL CHANGE: THEORETICAL ORIENTATIONS AND WORKING HYPOTHESES

In this chapter we present and discuss the major conceptual notions and working hypotheses that will serve as an analytical framework for the study. In this respect some general caveats must be made at the outset. Given the scope and complexity of the problems this research is concerned with, both an inductive and exploratory strategy, as well as a more conventional deductive one, are used herein. We will attempt to inform our analysis of the available data with insights from prevailing theoretical perspectives on substantive issues such as inequality and regional economic disparities (Long, 1977). These theoretical orientations will be utilized to derive hypotheses concerning the relationships between social organization and change in agricultural technology. We refer to these theoretical ideas as "orientations" or "perspectives" because they offer us general guides with which to select, conceptualize, and categorize teh available data into an analytical framework. However, they do not necessarily tend to form a consistent system of interrelated propositions leading to direct empirical test--which more properly constitutes a formal theory. It is in this context that we refer to the hypotheses generated in this chapter as working hypotheses--hypotheses derived from both theoretical and empirical analyses of the Brazilian experience, rather than being directly deduced from a formal theory. In this way, the hypotheses are working guides for answering the research questions proposed in chapter 1. Logically, our results could be viewed as hypotheses themselves, calling for further study in Brazilian and other Third World contexts.

This chapter is divided into five major sections. The first section deals with the concept of social organization--a major organizing construct in this study. In the second, we focus more specifically on relevant aspects of regional inequality and spatial patterns of rural social change. The third section addresses the general topic of social organization and agricultural technology. The last two sections are devoted to the discussion of the working hypotheses concerning the associations between agricultural technology change and patterns of rural social organization, with selected components of the latter viewed as both antecedents and consequences of the former.

THE CONCEPT OF SOCIAL ORGANIZATION

Social organization has often been an ambiguous and elusive concept, despite its obvious centrality in the social sciences. However, an effort to carefully specify its meaning is warranted here since social organization is a central, organizing construct in this study. Social organization refers both to processes and structures:

> The processes of social organization occur as social actors interact in patterned and recurrent relationships to create social ordering (Olsen, 1968, p. 62).

This definition has the merit of being able to incorporate any degree or level of complexity involved in the notion of social organization. It permits us to go back and forth from concrete individual interactions to complex social products of such interactions, here referred to as structures. It also avoids the dangers of reifying social structures as well as neglecting their flexibility and variability (Collins, 1975; Long, 1977).

Our view of social organization follows the premises of the conflict approach as stated by Collins:

> The basic premises of the conflict approach are that everyone pursues his own best line of advantage according to resources available to him and to his competitors; and that social structures--whether formal organizations or informal acquaintances--are empirically nothing more than men meeting and communicating in certain ways. The outlooks men derive from their past contacta are the subjective side of their intensions about the future. Men are continually recreating social organization. Social change is what happens when the balance of resources

> shifts one way or another so that the relations men negotiate over and over again come out in a changed form (Collins, 1975, p. 89).

The relationships humans create in the process of production form a crucial set of experiences; how people relate to others with whom they reside, have sex, play, worship, and spend leisure time are other crucial sets of experiences. How men and women line up for potentially violent struggles, to defend their interests is yet another crucial set of phenomena. These sets of relationships experienced by men correspond to the basic dimensions of class, status, and politics, which are the defining elements of the concept of social stratification (Collins, 1975). Social stratification, then, is the backbone of social organization.

In the present study, social organization is basically viewed in terms of the class and status variables, which in conjunction with elements of the productive structure of rural areas, constitute what is generally referred to as agrarian structures (Stavenhagen, 1975; Furtado, 1976). This conceptualization of agrarian structures is intimately related with the Marxist notion of modes of production.

> By "mode of production" we mean that complex made up of the forces of production (i.e., technical rules, resources, and instruments of labour and labour-power) and the social relations of production. Production is the process by which men with their labour-power and instruments of labour transform the object of labour (in this case, land) in order to reap some material or economic return. The object of labour and the instruments used constitute what we cann the means of production, but the process itself requires the participation of men who are brought together in terms of a specific set of social relations. These social relations are principally

> defined in terms of the ownership and control of the means of production and of the social product. Thus, in theoretical terms, a mode of production equals the combination of social relations of production and the level of development of the productive forces (Long, 1977, p. 96).

The concept of "mode of production" used to depict agrarian structures--and thus the main elements of agricultural organization--calls for a typological treatment, that is, a characterization of different "combinations" of "productive forces" and "social relations of production." Long (1977) thus discusses four main non-capitalist modes in rural Peru: the traditional hacienda, the smallholder property type, the sharecropping type, and the indigenous peasant community type. Paige (1975), using a similar approach, constructs a typology of export agriculture organization with the commercial hacienda, sharecropping system, migratory labor estate, small holding system, and the plantation as his main categories. In this study, however, which is based in secondary aggregate data, no such typology is attempted. The concepts of modes of production and agrarian structures are used mainly as a way of organizing a set of macro-level variables which refer to indicators of class and status and the productive structures at the municipal level. These variables include the following: farm size, land inequality, land tenure, rural labor force composition, rural wages, rural literacy, land use, crop mix, subsistence production, agricultural technology, and productivity.

Farm size and land inequality refer to use and control of a crucial resource for agricultural production--land--which is a major factor behind class formation in rural areas. Patterns of land tenure and labor arrangements constitute the main elements of the social relations of production arising out of prevailing systems of land control. Rural wages and literacy rates can be viewed both as part of the control of the social product--material and non-material--and as aggregate indicators of generalized individual resources for material well-being and status. The variables of land use and crop mix provide indications of the broad patterns of agricultural activities in the municipios, which, together with agricultural technology and productivity indicators, refer to the "means of production" in agriculture. Improvements of technical levels in agricultural activities are generally seen as essential for productivity increases, which in turn are viewed as major requirements for output growth and increases social wealth. This is the main reason why technological change has been placed at the center of discussions related to agricultural development (Johnston and Kilby, 1975; Griffin, 1974; Schuh, 1975; Figueroa, 1977; Havens, 1972). This is also why we have chosen technological change as our main focus in this study. In the remaining sections of this chapter--and throughout this work--we will discuss key issues involved in the process of technological change.

REGIONAL INEQUALITY AND PATTERNS OF CHANGE: THE THEORETICAL HERITAGE AND DEVELOPMENT OF HYPOTHESES

Theoretical Perspectives

The first major research question addressed in this study deals with unveiling the patterns of change in municipal level agrarian structures of Minas Gerais over the last two decades. In this section we will discuss some alternative theoretical views and empirical evidence which can guide the derivation of general working hypotheses on this problem.

In the broad and long-term processes associated with economic growth and structural transformation--mass production and technology, industrialization, urbanization, specialization of production and social roles, the growth of markets, and differentiation of economic and social institutions--the relationships between agriculture and national development have been viewed in different ways. Some observers have stressed the economic backwardness and traditionalism of rural areas, suggesting that economic inefficiency and conservative attitudes act as barriers to more widespread modernization. Others have emphasized the positive and dynamic role agriculture has played in promoting the initial stages of industrialization through the capital earned with exports. Another view postulates that the rural sector has been a principal locus of exploitation and surplus extraction by the more powerful urban-industrial sectors of the political economy (Long, 1977; Fugeroa, 1977). These views highlight some of the basic issues involved in different approaches to agricultural development.

Such approaches can be roughly classified into two broad camps in terms of more or less shared assumptions and views of the world--the neoclassical-functionalist-equilibrium and the Marxist-conflict-dependency approaches (Havens, 1972). Not all views on agricultural development can be clearly assigned to one or the other camp, nor do writers of one or another orientation always agree with each other as to the relevance and interpretations of a given issue. Nevertheless, these two broad perspectives seem to effectively capture the major epistemological and methodological differences that cut across a wide variety of "development" issues.

Most views on the dyanmics of social change (or socio-economic development) at the macro or national level make use in one way or another of the center and periphery distinction. The societal center or core is that region or portion of socio-economic space which contains "the most dynamic, modern sectors of the economy and/or the state apparatus? (Buttel and Flinn, 1977, p. 261) and the occupational groups deriving income from those sectors. The periphery is represented by those regional and socio-economic sectors linked only marginally to the centers of economic growth and social change in the country (de Janvry, 1975). Many of the major theoretical divergences and controversies among analysts subscribing to one or another of the theoretical orientations referred to above lie in the nature and relationships evolving between center and periphery in the course of economic growth and social change.

The so-called socio-economic dualism, diffusionism, and modernization approaches focus on the development question from the perspective of "traditional" versus "modern" sectors or groups. A basic tenet of these approaches is that in pre-industrial stages of national development, the core and periphery are characterized by functional isolation; that is, they form two distinct socio-economic and cultural groupings, and prevailing social relationships occur <u>within</u> center or periphery, rather than <u>between</u> them. When the process of national development takes place--engendered by industrialization, urbanization, and all their implications for economic, social and political institutions--the linkages between center and periphery are strengthened, and the modern social structures and culture of the center are assumed to diffuse into the periphery, "extending the forces of modernization throughout the society" (Buttel and Flinn, 1977, p. 261). Such approaches recognize that development (or growth) initially tends to be concentrated--given the locational requirements and economies of scale of the more dynamic industrial activities--exacerbating regional and sectoral inequalities. Eventually, however, a diffusion effect will ensue, bringing the incorporation of the periphery into the national political economy (Babarovic, 1971). As we have pointed out in Chapter 1, original versions of the concepts of traditional versus modern have been subjected to severe attacks, especially those conceptions stressing the structural and cultural homogeneity of traditional agriculture, its economic ineffícnecy (given available resources), the predominance of conservative values and attitudes in the shaping of traditional social organization, and the functional isolation between traditional and modern sectors (Long, 1977; Figueroa, 1977). But these alterations do not alter the basic diffusionist perspective of center-periphery relations. Similarly, the recognition of discriminatory policies toward the agricultural periphery which benefit the urban-industrial center, articulated and popularized by the neo-classical economists of the monetarist school, does not challenge the diffusionist view (de Janvry, 1976-77). On the contrary, in their opinion, the periphery has lagged behind in most Third World countries because of a combination of the initially concentrated character of economic growth, compounded by policy mistakes that might have curbed the original tendencies.[1]

On the other hand, we find differing interpretations given to center-periphery relations by authors with a Marxist or conflict orientation and articulated under the labels of dependency, internal colonialism, or materialist-Marxist views (de Janvry, 1975, 1976-77; Long, 1977; Buttel and Flinn, 1977; Oxaal, Barnett and Booth, 1975). The basic tenet of such theories--whether or not explicitly using a Marxist analysis--is that the relationships between the center and periphery are characterized by domination or exploitation; that is, the center grows at the expense of the periphery. Marxist-oriented analyses typically emphasize a world-wide process of capital accumulation which occurs in a structurally heterogeneous world system formed by the center, at one pole, and the periphery, on the other. The contradictions of capital accumulation in the center (stagnation, underconsumption, and the tendency for the rate of profit to fall) create necessary relations with the periphery. The accumulation of capital in the periphery in turn creates necessary relations with the center. Such relationships at the same time have an organic solidarity and a domination component (de Janvry, 1976-1977). Thus, a single world-scale process of capital accumulation is able to create development in the center and underdevelopment in the periphery. The underdevelopment of the periphery is characterized by what de Janvry calls "social disarticulation" between capital and labor, with the latter being a cost to capital and not simultaneously a -enefit, as is the case in center nations (de Janvry, 1976-77).

Following de Janvry's analysis, Levinson, Rosenberg and Yansane (1977) have summarized the economic, social, and spatial interrelations within the larger world capitalist system. They depict the dynamics <u>within</u> center and peripheral capitalist formations, as well as <u>between</u> them, in the following way. We quote at length their discussion of the nature of center capitalism--that is, capitalism as it functions within the dominant nation-states of the world-system:

> Assume that the economic system is divided into four sectors: (1) exports; (2) mass consumption goods; (3) luxury goods; and (4) capital goods. The sectors represent both productive activity and a social division of labor. In a center economy linkages between sectors 2 and 4 are the determining

> relationship. That is, the basis of the system's ability to expand and reproduce itself is determined by that linkage. Sector 4 goods are used in the production both of sector 2 goods and sector 4 goods; and sector 2 produces wage goods for the workers of sector 2 and sector 4. Assume two social classes, workers and capitalists, and assume that wages are associated with workers (social and material reproduction) and that profits are associated with capitalists (for investment, i.e., expansion of the productive capacity of the economic system). The economic system's consumptive capacity is located in the return to labor (wages) while the productive capacity is located in the return to capital (profit). The expansion of the production capacity requires investment; the greater the expansion of the productive capacity the greater the investment needed. The social distribution of income between wages and profits determines the rate of expansion possible in the economic system. Thus, the greater the profits the less the wages; in other words, an increases in the conomic system's productive capacity decreases the system's ability to consume the product (Levinson et al., 1977, p. 640).

They argue that a crucial element in the functioning of a center economy is the internal market. The essence of the internal market is that mass consumption goods are produced for purchase by workers employed in the mass consumption and capital goods producing sectors of the economy. This highlights the fact that for the capitalist to <u>realize</u> profits, he or she must not only <u>produce</u> the commodity, but also <u>sell</u> the commodity. Thus, if the working class lacks suggicient wages to purchase the commodities produces, profits cannot be realized--ushering in a crisis of underconsumption.

For Levinson and his colleagues, persistent underconsumption crises play a key role in the "integration" of peripheral social formations into the larger world-system. They argue:

> If we accept as either Marx or Keynes did that as the amount of capital (relative to labor) in the economic system increases, there is a tendency for the rate of profit to fall, it follows that capitalists must change the social division of income in order to maintain the rate of profit. But this means decreasing the ability of the work force to realize the product, thus creating a crisis of underconsumption. From this contradiction of capital accumulation arises the need to export capital to an economy where labor does not create the demand for the commodity produced, that is, where labor is not both a cost and a benefit to capital. Another form of the resolution to the contradictions of capital accumulation is to obtain the inputs to the center economic system (raw materials and food products) at a lower cost than available in the center (thus increasing profits). The key to understanding the above comes about through the realization that individual capitalist logic and the needs of capital (collectively) conflict (Levinson et al., 1977, p. 641).

These considerations decisively shape the structure and functioning of peripheral capitalism. Using the same sectoral notations as in our first passage of quoted material, Levinson, Rosenberg and Yansane (1977:641) suggest that

> the determinant structural relation of the peripheral economy is located in the coupling of sector 1 and sector 3. That is, the conomy's linkages are between the export sector and the luxury goods sector. The distinction between the mass consumption goods, sector 2, and the luxury goods, sector 3, is that demand for sector 2 goods is created from the return to labor while the demand for sector 3 goods is created from profits (return to capital). The market for the goods produced in sector 1 lie external to the economy. Thus the domestic capitalist class that is associated with the export sector depends upon the external relationships to realize its profits from the sale of its products. Wages paid in a center structure function both as a cost and as a benefit to capital. However, under peripheral capitalist structures, wages only function as a cost to capital.

This in turn explains why capitalist growth in peripheral nations tends to be accompanied by progressive aggravation of inequalities of wealth and income.

Non-explicitly Marxist approaches, articulated under the label of internal colonialism theories and drawing from a Weberian persp-ctive of social organization, also view the core-periphery relations as being of an exploitative nature:

> The theory of internal colonialism holds that national development is characterized, in part, by the fortification of initial, spatially unequal distributions of power and privilege into a politically dominant societal core and its peripheral "colony." Elites of the core institutions seek to maintain or enhance their existing power and privilege by politically incorporating peripheral regions into the national economy and polity--that is, by institutionalizing the stratification system over a larger territory (Buttel and Flinn, 1977, p. 262).

Such approaches have been criticized by both "insiders" and "outsiders." Among these criticisms, we can emphasize their frequently overdeterministic and simplistic views, which when expressed in more vulgar versions of the development question, typically involve the playing down of internal and local factors and the possibilities of different configurations between center and periphery (Long, 1977). The applicability of such approaches at the micro-level and in the short run has also been questioned. In addition, of course, one often sees unequivocal rejection of the relevance of such perspectives by those more clearly committed to the neoclassical-functionalist-equilibrium orientations (see Kahl's summary, 1976).

The important point in the context of this study, however, is that the proponents of dependency/internal colonialism approaches assume that the inequalities between center and periphery will be checked neither by further "development" nor by piecemeal institutional reforms put into effect by a center-dominated state, since the fortification of dualistic structures is an essential ingredient of the capitalist growth in the periphery (Furtado, 1976; de Janvry, 1975, 1976-77; Baer, 1976, quoting Bacha). An important corollary of this perspective, then, is the increasing marginality of the masses of population created by the dynamics of accumulation. In agriculture, marginalized groups largely consist of those who do not benefit from the processes of "modernization" (technological innovation, commercialization, and penetration of capitalist modes of production)--landless laborers, the "minifundistas," and those farmers "who see their economic condition deteriorate as they retain traditional production techniques" (de Janvry, 1975, p. 491).

The Brazilian Context

The concepts of center and periphery are dealt in this study, paraphrasing Schuh's (1975) expression, both "in the large," that is, at a macro; contextual level through a regional location typology and "in the small," that is, at the micro or municipal level, by means of the urbanization and industrialization variables. We thus utilize the notions of center and periphery to pertain to socio-spatial entities within the Third World, in our case, Brazil and Minas Gerais (see Galtung, 1971). This within-nation conception of center and periphery parallels the international application of these concepts, recognizing that the tendencies toward unequal and uneven development within the periphery have a decided regional expression.

We have noted in Chapter 2 how regional disparities have been a major chracteristic of historical patterns of the Brazilian development experience. We have also demonstrated the exacerbation of these regional inequalities at the national level during the period of 1950 to 1970. This exacerbation has been particularly pronounced for indicators most clearly associated with economic development--industrialization, urbanization, wages, literacy, and agricultural technology and productivity--and are all biased in favor of the Southeastern and South regions (mainly São Paulo). We have also indicated how the state of Minas Gerais has become increasingly peripheral in relation to the national centers of growth represented by the Rio de Janeiro-São Paulo axis. At the same time, Minas Gerais' evolution has been marked by very high differentiation and disarticulation among regions within the state (Governo do Estado de Minas Gerais, 1967, Vol. 1; Leloup, 1970). Incorporation into the national center has occurred in Minas Gerais--basically--through the urban and industrial development of the capital city, Belo Horizonte, and its metropolitan area of influence (Bank of London & South America Review, July, 1976). We can expect, then, that in

Minas Gerais, as for Brazil as a whole, regional location is an important factor in conditioning levels of development as well as the pace of social change. We have divided the state into eight main regions established according to well-recognized state subdivisions.[2] Such regions are intended to reflect the relative degrees of influence of the national metropolises: São Paulo, Rio de Janeiro and Belo Horizonte. We assume that

> at least they represent whole clusters of indicators, and at most they are structural contexts in which municipal organization functions (Wheelock and Young, 1973, p. 10).

The center-periphery concept is also dealt with "in the small"--or at the level of our units of analysis, the municipios--by considering the variables of urbanization and industrialization. These variables reflect the overall complexity of local social organization as well as the relative degrees of articulation with, linkages to, or incorporation in the national centers (Wheelock and Young, 1973). The more urban and industrial a municipio, the most it is assumed to be integrated into the national political and economic centers of the country.

As noted in Chapter 2, Brazilian historical development experiences have failed to encourage substantial rates of structural change within the agricultural sector and in rural areas. On the contrary, the various forms of agricultural organization developed in the past--given the abundance of land and continuous natural growth of the rural labor force--have allowed the agricultural sector on the whole to mobilize increasing agricultural surpluses to the growing urban domestic and export markets without major structural changes (Schuh, 1975; Rezende, 1975, The Ohio State University Research Team Report, 1975). The data presented in Chapter 2 indicate that the minifundio-latifundio structure and the high levels of land inequality are still prevalent, farm land is still used quite extensively (especially in livestock activities), tenancy arrangements and forms of family labor are prevalent, and rural literacy and wage levels are still very low in absolute and relative terms (when compared to the urban counterparts). But the data have also indicated increasing (although uneven) tendencies for agricultural technological innovation as well as increasing urbanization, rural net migration, and industrialization. We can say, then that even though prevailing forms of agricultural organization in the country have failed to exhibit substantial structural change, they are by no means static. Given the increasing pace of urban-industrial development, we see continuous accommodations and adjustments in the agricultural sector that may be seen as reactions to the overall patterns of change in the national economy.

We recognize that the ecological nature of our data does not allow us a detailed account of local agrarian structures since we agree with Long (1977) that different modes of production (or a relatively capitalist or pre-capitalist nature) coexist and are articulated within the same empirical context. This is also a major criticism made by Goodman (1976) as to the adequacy of official census data to deal with the dynamics of rural social organization. We are especially hampered with such data in analyzing the problems of dualistic structures at the municipal level. However, we believe that some general patterns and clues can be unveiled with this type of data.

The aggregate data presented in Chapter 2 have indicated that the Minas Gerais agricultural sector has historically been very traditional and has exhibited less dynamism when compared to other regions and states of the country. We anticipate, however, that a different picture will be revealed with our municipal-level data. A picture of wide municipal variation in the levels of and rates of change in the variable indicators of rural social organization should emerge. We also expect such variations to be closely related to the municipios' regional location. The regions of the state can be seen to represent the center-periphery concept, as well as the larger contexts for the historical evolution of social organizational patterns.

We can now summarize the major working hypotheses developed in the context of our first research question:

1. There are wide municipal variations in the 1950 and 1970 levels as well as in the rates of change in rural and non-rural social organizational variables.
2. Regions form a meaningful context within which to capture differences in patterns of local social organization, as well as change trends during the 1950-1970 period.

3. The effects of regional location are expected to be stronger for the variables most directly linked with the process of economic development: agricultural technology, wages, literacy, industrialization and urbanization, with the trends being biased toward the metropolitan center region of Belo Horizonte and those under the influence of the São Paulo center.
4. Regional disparities in indicators of "development" or "well-being" will tend to increase between 1950 and 1970. These growing disparities will be most pronounced in connection with variables more closely linked to the economic development process, as depicted above.

In Chapter 5 we will present the results pertaining these hypotheses as well as general patterns of change in other variables of concern to this study.

SOCIAL ORGANIZATION AND AGRICULTURAL TECHNOLOGY

Technology is related to social organization in very complex ways as both cause and consequence. Technological developments are an important background for determination of the organizational structure of a society insofar as "they bear both on economic productivity and on the structure of political organization" (Collins, 1975, p. 436). On the other hand, social structures themselves are likely to affect the possible and probable types of technological innovations that occur (Johnston and Kilby, 1975). The important point to stress is that attempts to evaluate both determinants and impacts of technological change must bring elements of social organization into the picture since these broad dimensions are in constant interaction within the framework of a political economy. Such recognition is a major consequence of the wave of re-evaluation now witnessed in the social sciences with respect to development issues, as noted in Chapter 1. In the present study, the indicators of social organizational constructs to be examined in connection with technological change pertain both to the domains of agrarian and urban-industrial structures and their linkages to national centers of growth and dynamism. The focus on technological change seems warranted, as we observed before, because of its status as an essential ingredient of agricultural development strategies--whether these are viewed from either an economic growth and productivity perspective, or a more distribution-oriented one.

The data presented in Chapter 2 have amply documented that Brazilian agriculture is generally characterized by low levels of technological innovation (with the exception of São Paulo and certain states of the South), despite the increased tempo of technological change in the last decades. The relative lack of technological change seems to be related to: (1) the extraction of surplus from agriculture to foster the initial drives for industrialization, leaving agriculture increasingly a peripheral sector within the economy, and (2) the fact that governmental policies have been primarily concerned with maintaining cheap food for the growing urban masses through short-run market incentives (Smith, 1969; Schuh, 1970; Nicholls, 1975). It is also widely recognized that throughout most of the period this study is concerned with, technological innovation in agriculture has not been a key governmental priority. Instead, the problem has largely been dealt with in terms of subsidies for the import of modern inputs (tractors, machinery, fertilizers, etc.) and credit for their use. Further, institutions generally linked with the creation and diffusion of agricultural technologies (such as research and extension systems, the expansion of supply industries) have remained largely underdeveloped. No major breakthroughs had occurred either in the modifications of the systems of land inequality, land tenure and labor arrangements. In general, the rural populations throughout the country have not shared in the benefits of economic development, such as significant income gains, higher rates of literacy and educational levels, and better housing and health services (Schuh, 1970; Paiva, Schattan and Freitas, 1973; Paiva, 1975). Despite the more favorable orientation towards the agriculture adopted by the national government since the late 1960's, it is safe to say that the strategies pursued for agricultural modernization in Brazil follow more or less what Johnston and Kilby (1975, p. 127) have called a "bimodal" pattern--that is a "crash modernization strategy that concentrates resources in a highly commercialized subsector" which is made viable. This viability is made possible by, among other factors, a very unequal structure of farm size distribution coupled with an emphasis on short-run output maximization (Barros and Graham, 1977; The Ohio State University Research Team Report, 1975). This situation gives rise to a technological dualism in agriculture meaning that technological innovation does not spread to a majority of farm operators. Agriculture comes to be characterized by a small subsector of modern farms (highly capitalized, commercialized and employing new technologies) and a larger subsector of traditional farms where production may be mainly of a commercial or subsistence nature but usually conducted through traditional methods of cultivation and labor arrangements (Paiva, 1975, 1975a). Technological dualism is just one facet of the more generalized dualistic structures which have been at the center of the debates over the Brazilian development model, as shown in Chapter 2.

It is not our purpose here to make an overall analysis and evaluation of the process of agricultural modernization in Brazil. Within the limited scope of this study, the above comments are sufficient to establish a background of facts and issues toward which our more specific inquiries and results are directed. We will return to some of these facts and issues as they bear more directly upon the materials of this study in this and other chapters.

Technological change at the municipal level is viewed here as both dependent and independent variable--that is, both as being preceded by, and in turn having consequent impacts on, rural local social organization. We deal initially, with technological change as a dependent variable, and in the next section we consider the ways in which technological change can be considered an independent variable.

However, before we bein the discussion and presentation of specific hypotheses, it is necessary to clarify what the concept of agricultural technology encompasses in this study. When we consider "abstract technology, i.e., technology divorced from its institutional context" (Gotsch, 1972, p. 327), a major distinction is usually made between neutral and non-neutral technical change. The first, economists argue, is a change in

> the production function, but for which the capital-labor ratios remain constant. Non-neutral change may be either capital-using (labor-saving)--if the ratio of capital to labor employed in the production rises--or labor-using (capital-saving) if the capital-labor ratio falls. The significant point is that if factor prices remain constant, technical change that is labor using increasing the relative share of labor, and capital-using technical change increases the relative share of capital (Gotsch, 1972, p. 328).

Griffin (1974), writing on the same topic, refers to labor-using techniques as "peasant-biased," and capital-using ones as "landlord-biased." Neutral techniques that are efficient from the point of view of both capital and labor are called "ultra-superior" and would tend to be acopted by the majority of farmers since all could conceivably benefit from them (Griffin, 1974, p. 49-51). Similar distinctions are noted by Paiva (1975, 1975a). It is customary to equate bio-chemical innovations with capital-(land) saving change and mechanization with labor-saving change. This is not altogether accurate in Gotsch's view (1972).

Gotsch notes that there are biochemical innovations (such as insecticides and herbicides) that are, on balance, labor saving, and mechanical technologies that are relatively labor-using (like tubewells and other mechanical devices for providing supplementary water) in impact. It seems plausible to posit, however, a distinction between bio-chemical and mechanical technologies. On the whole, bio-chemical technologies tend to be <u>relatively</u> neutral with respect to size of farm holdings due to their high degree of divisibility and their tendency to require more labor than do mechanical technologies. Mechanical technologies, on the other hand, tend to be <u>relatively</u> landlord-biased due to their "lumpiness" (or individisibility) and their frequent consequence of labor-displacement. This distinction accords with widely accepted conceptions from a variety of view-points (Johnston and Kilby, 1975; Gotsch, 1972; Griffin, 1972; Cline, 1973). It seems, nevertheless, that much of the course of tec-nological change depends less on the intrinsic character-istics of technology--their neutrality, factor requirements, or whatever--than on the interactions between technology and its institutional context--the elements of social organization depicted above. Even though the empirical consequences of the distinction between bio-chemical and mechanical innovations may be variable, this very ambiguity warrants a consideration of both groups of technologies in this study. Our agricultural technology variable, then, is divided into two components: <u>bio-chemical innovation</u>, which refers to relative consumption in municipal farms of modern inputs such as seeds, fertilizers and insecticides, and mechanization, which refers to the relative numbers of tractors reported for the municipios. Technological change is viewed in terms of the relative gains in the indicators of these two components during the 1950 to 1970 period.[3]

SOCIAL ORGANIZATIONAL PATTERNS AS ANTECEDENTS OF CHANGE IN AGRICULTURAL TECHNOLOGY

In this section we discuss and present our working hypotheses concerning the relationships between social organization and change in agricultural technology, with the former dimensions considered as antecedents of the latter. Each of the independent variables is derived from prevailing literature that posits a significant theoretical or empirical relationships between this variable and technological change.

Farm Size and Land Inequality

We have observed above that land is a crucial resource for agricultural production, and control of land is a basic mechanism of class formation and political power in rural (as well as non-rural) areas (Collins, 1975; Stavenhagen, 1975). A number of analysts of varying theoretical postures have emphasized the effects of land concentration or the size distribution of operational farm holdings in conditioning change in agricultural technology and resulting patterns of rural development (Johnston and Kilby, 1975; Griffin, 1975, 1976; Furtado, 1976; Paiva, 1975; Figueroa, 1977; de Janvry, 1975, 1976-77; Gotsch, 1972). Empirical studies at both the micro and aggregate levels within and outside Brazil have consistently revealed a tendency toward concentration of technological innovation in relatively large farms--this tendency being even more pervasive for mechanization, given its more distinctive large farm bias (Barros and Graham, 1977; The Ohio State University Team Report, 1975; Hoffman and Silva, 1975; Clements, 1969; Griffin, 1974; Rogers and Shoemaker, 1971). It thus appears warranted to hypothesize a positive relationships between farm size and land concentration, and technological change in Minas Gerais municipios, with these relationships being particularly strong with respect to mechanization.

An important caveat must be made explicit at this point, however. These relationships are not posited on the basis of any presumed linkages between farm size and intensity of land use, or the relative economic efficiency of small versus large farm holdings. These phenomena, which quite obviously could have major impacts on technological change, have been major topics of debate concerning the effects of the agrarian structures on rates of agricultural modernization, and the consequent discussions on the need and possible effects of land reform programs (Cline, 1973; Dorner, 1972; Furtado, 1976; Schuh, 1970, 1976; Paiva, 1975; Figueroa, 1977; de Janvry, 1975, 1976-77; Johnston and Kilby, 1975; Griffin, 1974, 1976; Lewis, 1955; Paige, 1975).

Our data and study objectives do not allow us to address these issues.[4] The intention of the stated hypothesis, nevertheless, is only to argue that larger farms (be they considered latifundios or not), despite labor extensive activities, often made a greater use or modern technology because of their privileged access to credit, information and other resources (de Janvry, 1976-1977).

Our first hypothesis can thus be stated as follows:

1. Average farm size, the proportion of large farms (200 hectares or larger), and level of land inequality are positively related to technological change from 1950 to 1970. These relationships are stronger with respect to mechanization than for bio-chemical technologies.

Before leaving this topic, a further comment must be made in connection with the linkages of farm size and land inequality with technological change. We are anticipating a positive association between land concentration and technological change, given the general character of Brazilian agriculture with respect to both land distribution and agricultural "modernization." Land inequality implies a relatively large number of small farms and minifundios. Thus, even though we expect these units to be marginal to the process of technological change, given the aggregate nature of our data (which cannot test these relationships directly) we may also find positive associations between the proportion of very small farms and technological change. Such relationship would logically flow from the overall character of the land inequality variable and its anticipated association with technological change. We have also pointed out above that a substantial group of analysts tend to see the minifundios as functionally related with the larger commercial farms, rather than in competition with them (Goodman, 1976; de Janvry, 1975). This is an empirical question to be explored.

A useful criterion for assession our presumption of "functionality" (as opposed to "competition") is the following: If the proportion of large farms and the proportion of small farms are both positively associated with technological change, support for the functionality thesis would be obtained. On the other hand, support for the competition thesis would flow from a positive association of the proportion of large farms with technological change, along with an inverse association of the proportion of small farms with such change.

Land Tenure

The land tenure variable basically refers to different forms or degrees of control over the land by those who work on it. In this sense, land tenure systems are tied to farm size and land inequality in complex ways that unfortunately cannot be disentangled within the type of data available to us in this study. OUr data permit only the description of four large tenure groups: owners, tenants, squatters (those who occupy a piece of land without any title to it or permission from official owners), and administrators or farm managers (who operate and manage land holdings on behalf of their owners). It is recognized that tenure arrangements--which represent an important dimension of the relations of production--tend to be extremely complex in the relatively traditional systems of agriculture which exhibit substantial local differentiation (Stavenhagen, 1975; Griffin, 1974; Forman, 1975). These arrangements embody both economic and cultural components arising from particular historical experiences which made precise generalizations difficult.

The literature on the theme is controversial and does not lead to unambiguous hypotheses as to the direction of the associations between land tenure patterns and agricultural technology changes (especially when considering our data limitations). It can be argued, however, as Griffin (1974) has done, that there is a strong tradition, at least within the Anglo-Saxon literature, favoring owner-operated farms and opposing tenant farming--particularly sharecropping--when economists discuss the effects of land tenure on agricultural modernization. Many of these discussions are centered on the behavioral effects of relative degrees of tenure insecurity on farm operators in terms of their risks, perceived or actual economic advantages or disadvantages, and overall economic efficiency (Griffin, 1974; Lewis, 1955; Furtado, 1976; Figueroa, 1977; Johnston and Kilby, 1974). These discussions on land tenure thus are intimately tied with those linking farm size and economic efficiency which we have referred to before, especially so with reference to tenure and labor arrangements within latifundio systems (Furtado, 1976; de Janvry, 1975, 1976-77; Figueroa, 1977; Griffin, 1974). Despite arguments in favor of ownership patterns which avoid division of responsibility toward innovation risks and reduce the problem of allocating percentage shares of outputs, it would appear, as Griffin (1974) and Johnston and Kilby (1975) have observed, that the type of land tenure per se (basically, ownership vs. tenancy) is not a barrier to agricultural innovation. That is, under specific local conditions--which cannot generally be specified a priori--a given form of tenure arrangements may be positively or negatively related to technological change. This would lead us to expect relatively low associations with our municipal data.

The data presented in Table 3 of Chapter 2 give only limited insight into this phenomenon. The indicate that, in general, non-ownership forms of land tenure have increased throughout Brazil from 1950 to 1970. Minas Gerais has followed the same tendencies--albeit less so than other states--and retains the highest proportions among all states of owner-operators in both years. The predominance of the ownership tenure pattern in Minas Gerais suggests that this group may be very heterogeneous in terms of material and non-material resources, with this netero-geneity reinforcing our anticipation of a meager correlation of this tenure pattern with technological change. A study by Contador (1975), using farm-level data from Brazil for the periods of 1962/64 and 1969/70, found generally low associations between land tenure categories (owners, tenants, and squatters) and technological levels and technological change.[5] Considering that the squatter group is the one with most insecure land tenure and is probably found in larger proportions in the relatively peripheral areas of the state where technological change is expected to be less pronounced, we assume that a negative association will be found. Given the predominance of administrators on relatively larger farms (Feder, 1971), we expect the relationship between this aggregate tenure category and technological change to be a moest, positive one. Due to the largely residual nature of the tenancy category in our data, as well as the lack of more clear guidance from the literature, we make no predictions concerning the relationships between this group and technological change.

We can now summarize the general hypotheses with respect to land tenure in the following way:

2. The prevalenee of farms within the various land tenure categories will be only modestly related to change in agricultural technology. The prevalence of owners and administrators will be positively related to technological change. The prevalence of squatters will be inversely associated with technological change.

Rural Literacy

In Chapter 2 we observed the very low levels of educational attainment in Brazil--particularly among the rural population. Literacy can be regarded as a socially significant indicator of the level of human resources. We observed in the first section of this chapter that literacy and wage variables can be viewed as indicators of the differential control of the social product--the net results of men's economic and social activities which are the components of social organizational processes and structures. It is in this context that both variables are often linked to stratification studies. Also, given the new perspectives in the conceptualization of "development" as a process of enlarging people's access to a nation's social product, these variables become interpretable as indicators of generalized social well-being.

At the most abstract level, higher literacy rates indicate that more people can expand their universe of interaction and interest and have the potential to understand and manipulate information to their benefit. However, the specific status of education (or literacy, in this case) as an independent variable has remained a matter of some controversy. A significant group of social scientists, drawing on consistent correlations between general educational levels and income (or social and occupational mobility, returns to investments in education, etc.), tend to emphasize the independent autonomous role of education in development (Langoni, 1973; Schuh, 1975, 1977). This has led to the policy prescription that investment in "human resources"--a neoclassical euphemism for education--will yield substantial progress toward modernization and development. Others have emphasized that educational differentials are themselves indicators of a particular type of inequality that flows from antecedent and prevailing modes of production. Critics of the "human resources" perspective on education argue that increasing overall levels of education will do little to alter the fundamental barriers to development, especially within the rural periphery (Collins, 1971, 1975; Costa, 1975; Cline, 1973). That is, correlations found between education and income (or income-generating characteristics such as occupational levels or mobility, agricultural technology adoption) are a product of the educational qualifications becoming a screening device for allocation of people to positions and/or reflecting original inequality of access to educational training. As general educational levels in a society increase, such relationships tend to decrease (Cline, 1973; Collins, 1971).

Again, our data do not permit us to assess the relative merits of each point of view, since the situation we are dealing with is one of high original literacy differentials. In 1950, only 26 percent of the rural population in Minas Gerais was literate, and this proportion barely reached 43 percent in 1970. Due to such differentials--as well as because we assume that literacy (by permitting people to increase their abilities to understand, decode, or manipulate information linked with new production technology) is complementary to increased technological change in agriculture (Schuh, 1975)--we expect positive associations between these two variables to be revealed by our data. Of course, we recognize that the mental or psycological abilities linked with literacy qualifications would mean realtively little in terms of technological innovation if the first was prevalent among the rural population, while the access to the second remained highly skewed.

The general hypothesis for the literacy rates then, is:

3. Rural literacy is positively related to change in agricultural technology.

Land Use and Crop Mix

Land use and crop mix variables, which attempt to depict broad patterns of agricultural production activities of municipios, are theoretically interpretable as elements of productive structures (or the "forces of production"), along with technological levels themselves. Technological innovations do not occur evenly across various types of agricultural activities. We observed above, in Chapter 2 that pastures occupy the largest proportion of farmland in Brazil, and that livestock activities are generally conducted in an extensive way. There is also a large body of evidence that such activities are characterized by low technological and productivity levels in most parts of Brazil and Minas Gerais (Schuh, 1970; Nicholls, 1975; Contador, 1975; Furtado, 1976; Paiva, Schattan and Freitas, 1973; Governo do Estado de Minas Gerais, 1967, Vol. 1; Hoffman and Silva , 1975). In addition, the types of technological variables used in this study basically refer to crop activities (especially so with bio-chemical technologies). It would therefore be plausible to expect a positive relationship between the proportion of farmland in crops and technological change. However, the predominance of croplands may not be as important as the types of crops that are prevalent in a municipio. It has become conventional to classify agricultural activities in underdeveloped countries into export vs. non-export crops or cash/commercial vs. food/subsistence crops (Schuh, 1975; Paige, 1975; Paiva, 1975, 1975a). This distinction arises from consistent observations that agricultural modernization generally tends to be confined to the export crop sector and/or those crops with higher commercial value. Staple food crops consumed by the masses of population likewise tend to lag behind in terms of technological and productivity improvements. In this sense, the export/commercial vs. non-export/food crop distinction parallels the traditional vs. modern sectoral categories we have referred to frequently in this study. in Brazil, as our discussions in Chapter 2 have indicated, the distinction between the export and non-export sectors in agriculture has been a meaningful one from the beginnings of the country's colonization and has marked the whole of its economic (and social-political) history. We have shown how dependence on successive export-monocultures (sugar-cane, cotton, coffee) has had a lasting impact on the formation and maintenance of prevailing agrarian structures. The hierarchical and patriarchal forms of social organization have likewise presented significant constraints toward Brazil's overall path of "dependent" economic development. Despite rapid industrialization and increased diversification of the economy experienced during recent decades, Brazil is still heavily dependent on agricultural exports and likely to reamin so in the future. The present export-orientation continues to be principal mechanism for financing ever larger foreign debt service and imports associated with the country's strategies for economic growth. Despite the persistence of coffee as the key export crop, Brazilian agricultural exports have become much more diversified in recent years, with a growing importance of both "new" and "old" products such as sugar, meat, soybeans, cotton, and cocoa, among others (Paiva, Schattan and Freitas, 1973; The Ohio State University Team Report, 1975). Another relevant point is that even though Brazil's exports have increased in volume and importance recently, exports of Brazilian agricultural goods represent a relatively small percentage of the country's agricultural production. Data presented by Paiva, Schattan and Freitas (1973, p. 58) indicate that for the fifteen main agricultural products for the period of 1953 to 1970, the percentages of exports varied between 3.7 percent to 8.4 percent. This suggests that factors related domestic markets may be important--and in certain cases even more important than the export-non-export distinction--in determining the rate of "modernization" for specific crops or products. It is beyond our purposes here to discuss the factors associated with differential technological improvements among specific agricultural commodity sectors. Nevertheless, it seems sufficient to point out that such differentials are widely recognized (Paiva, Schattan and Freitas, 1973; Barros and Graham, 1977; The Ohio State University Research Team Report, 1975; Schuh, 1975) and tend to be biased in favor of an export tradition and/or potential, or with higher commercial value. Such characteristics allow producers to capture the benefits of technological improvements in terms of economic rents (Schuh, 1975). At the same time, food crops consumed by the masses of the population do not offer similar "incentives" once the logic of cheap food/cheap labor is maintained (Schuh, 1975; de Janvry, 1975, 1976-77). Given these considerations, it seems plausible to expect that the types of agricultural crops prevalent in an area tend to have an impact on the amount and rate of technological change it experiences.

One of the points we have been stressing throughout this study is that Brazilian social and economic conditions are so diversified that if is difficult to propose accurate generalizations for the country as a whole. The classification of crops is a case in point. There are no clear lines separating export/ non-export, commercial/subsistence, or traditional/modern crops. A particular crop can be classified differently in different regions, as Patrick (1975) demonstrates. Our own illustration of productivity (physical yields) data for certain crops (Table 6, Chapter 2) indicates significant regional differences for similar crops, as well as among different crops. In the case of Minas Gerais, another aspect must be amphasized--the general backwardness of the state's agriculture when compared with the more dynamic Southern and Western states. Despite having a diversified agriculture, Minas Gerais has neither developed as a national "Breadbasket" nor has it been the primary location of the most dynamic crops in terms of growth and technological improvements during recent decades. Therefore, the relative impacts of specific crop mixes on rates of technological change in the state may not have been as ironclad as much of the literature would suggest. The limited number of crops for which complete data were available from the agricultural censuses further constrains the analysis. Despite these limitations, however, we believe that three dimensions of municipal crop mix may be important in influencing technological change: (1) a specialization dimension, that is, the relative importance of the one most predominant crop in terms of area used; (2) the relative degree of concentration in export/commercial crops (coffee, cotton, sugar and rice); and (3) the relative importance of specific crops, selected among the most important ones in the state.[6] The general hypothesis we follow is that patterns of crop mix tend to have an impact on the levels and rates of agricultural change. These impacts are expected to be positive for the most export or commercial crops and negative for the more typically food or subsistence crops.

We can summarize the general hypothesis concerning the land use and crop mix variables as follows:

4. The proportion of farm land in crops is positively related to change in agricultural technology. The level of crop specialization and level of concentration in export/commercial crops is positively related to change in agricultural technology.

Regional Location, Urbanization and Industrialization

The theoretical context of these variables has been discussed in the second section of this chapter. Here, we turn to the expected locational and urban-industrial impacts on agricultural technology changes. These variables are dealt with in this study within a center-periphery framework; that is, regional location and local degrees of urbanization and industrialization reflect differential linkages or modes of incorporation to the national centers of the country (which are basically of an urban-industrial nature). Social scientists have long emphasized the importance of the linkages between agriculture and other sectors of the economy (Johnston, 1970; Johnston and Kilby, 1975; Paiva, 1975, 1975a; Schuh, 1975), in terms of capital, labor and commodity flows, and increased rural-urban interactions and progressive incorporation of rural areas into a "mass society" (Pearse, 1971; Stavenhagen, 1975). Again, the nature, extent, and long-run tendencies of center-periphery linkages in both their spatial and structural dimensions are differently interpreted by analysts working from alternative theoretical orientations. But the important point is that the closer a municipio is linked to the urban-industrial center, the higher its rate of economic growth is likely to be. Alternatively, the more central (or beneficiently linked to the dominant centers) regions, sectors (industry vs. agriculture, urban vs. rural), or sub-sectors (modern vs. traditional) and groups (social, economic and political) are, they more they are able to benefit from the processes of social change associated with economic development. Less directly linked (although not "isolated") peripheral regions, sectors, subsectors, and groups conversely will tend to be marginalized through the economic growth process.

Insofar as regional location reflects the center-periphery dimension, we expect that those regions formed by the metropolitan center of Belo Horizonte and those regions most directly affected by the dynamic national center of São Paulo to exhibit higher levels and rates of change in technological innovation. Regions under relatively direct influence of the metropolitan center of Rio de Janeiro are not expected to show the same levels of dynamism with respect to technological change. Agriculture-industry interactions with Rio de Janeiro have characteristically been less intense than those developed with São Paulo.[7] It is well recognized that Rio de Janeiro has had a less dynamic role in the "modernization" of its rural periphery than São Paulo. The Minas region closest to Rio de Janeiro, known as the Mata region (which was one of the pioneer coffee areas in the 19th century), has in fact been one of the more economically depressed areas of the state. The most technologically backward regions, however, are expected to be those in the northern half of the state, which can be characterized more as characteristically rural peripheries (Leloup, 1970).

The locational phenomenon has been explicitly linked to agricultural technology diffusion or adoption in other contexts (Singh, 1977; Contador, 1975), with similar predictions. With respect to Minas Gerais, Clements (1969), studying the development of mechanization in Minas during the 1950's and part of the 1960's, found regional location as one of the major factors behind municipal variations in number of tractors, with the regions close to São Paulo and Belo Horizonte far more advanced than others.

Our regional location variable has been defined basically in terms of municipal linkages with the national centers of growth, represented by the metropolises of São Paulo, Rio de Janeiro, and Belo Horizonte. The concept of spatially uneven growth--confined principally in urban-industrial centers--has also been applied to the effects of growth on surrounding agricultural areas by Schultz (1953), who developed the so-called "urban-industrial impact hypothesis." This hypothesis, recently discussed by Schuh (1975) in the context of Brazilian agricultural "modernization," has been empirically tested in São Paulo (Nicholls, 1969) and Minas Gerais (Rios, 1969). Even though Schultz was not directly interested in agricultural modernization, but rather in explaining regional differentiation in agricultural incomes in U.S., he reasoned that "the existing economic organization functions best at or near the center of a particular matrix of development, and also in those agricultural zones located favorably in relation to such a matrix" (Schuh, 1975, p. 16). The point here is the same we have stressed before: The closer the proximity to the center (in both spatial and structural terms), the more benefits the region's population is likely to derive from economic growth. Our interest in this hypothesis lies in its micro rather than its macro character. We have noted above the importance attributed to the macro-processes of urbanization and industrialization in terms of their subsequent impacts on agricultural transformation (Johnston, 1970; Johnston and Kilby, 1975; Paiva, 1975, 1975a; Schuh, 1975; Fandino, 1975). However, industrialization and urbanization in the context of this study are micro-processes or characteristics--that is, pertaining to the local level of analysis. To wit, we are concerned with the relative impact of municipal urbanization and industrialization on rates of technological innovation in their rural sectors. In the context of the urban-industrial hypothesis, local urbanization and industrialization mean higher demand for farm products, expansion of credit institutions, ease of access to modern input markets, expansion of non-farm labor opportunities with their potential impacts on agricultural reorganization, enhanced social overhead (education, roads, communication channels, agricultural support services, etc.) which tend to occur as a result of agglomeration (Rios, 1969; Schuh, 1975).

These accumulated advantages point toward an expected association between the urbanization and industrialization variables and change in agricultural technology.

Before we summarize the hypotheses concerning these variables, we must make explicit a further caveat: We do not wish to propose a single direction of causation here. We are aware that the linkages between rural and urban-industrial areas or between the agricultural and non-agricultural sectors are complex and do not entail a fixed or permanent type of dependence of the former from the latter. Rather, as is the case with most social science phenomena, the situation is likely to be one of reciprocal and sequential causation. Agriculture need not always be an induced sector, nor do all types of urbanization or industrialization have determinate effects on agriculture (Ryff, 1976; Rios, 1969; Johnston and Kilby, 1975; Schuh, 1975). Nevertheless, our theoretical presumption that industrialization and urbanization exert influence over the course of agricultural transformation seems plausible for the time and area of the study, considering that Minas Gerais agriculture during this period has generally been a lagging sector and that the urban-industrial sectors have been considerably more dynamic. Our general hypothesis concerning these variables is presented below:

5. Municipios located in the state metropolitan center and in regions under the influence of São Paulo will tend to experience higher rates of technological change (both mechanization and bio-chemical innovation) than peripheral

municipios. Urbanization and industrialization are positively related to change in agricultural technology.

SOCIAL ORGANIZATIONAL PATTERNS AS CONSEQUENCES OF CHANGE IN AGRICULTURAL TECHNOLOGY

In this last section we discuss the hypotheses pertaining to possible impacts or consequences of agricultural technology on selected dimensions of local rural social organization. It has been precisely through a consideration of such consequences that many of the devastating critiques of applied social scientific approaches to the problems and challenges of agricultural development have been made (Havens, 1972; Cline, 1973; Griffin, 1974; de Janvry, 1975, 1976-77; Johnston and Kilby, 1975; Paiva, 1975; Figueroa, 1977; Gotsch, 1972). Early unqualified enthusiasm toward technological change--both in terms of its effects on output and productivity, as well as on the distribution of those net gains--has been challenged by recent developments in Third World countries and the analyses they have generated. The issue is now well recognized, and we have referred to it previously both in a general context and with reference to Brazil. At this point, we just need to make a few further comments. It appears that the literature on agriculture technology in general tends to overestimate or overstate technological impacts--either positive or negative. That is, technology is itself viewed as a major source of change in agriculture, for better or worse. In this way, both radicals and conservatives tend to more or less espouse a kind of technological determinism. However, the autonomous impacts of technology may be relatively meager in the short run and may not lead to similar results or easy generalizations for structural change in varying contexts.

Three observations must be made with this respect. Firstly, if we assume that agricultural technology change has a gradualistic and disciminatory character (Ryff, 1976)--in other words, it is not an instantaneous (or dramatic, in the short run) process and does not simultaneously reach different regions, sectors or groups, it can be concluded that its impacts may tend to be minimized in the aggregate. Technological changes in their <u>initial</u> stages cannot always be expected to have major impacts on rural social organization. This point is of particular relevance in the context of this study when considering the generally low levels of technological diffusion in the state of Minas Gerais as a whole. A second observation deals with the interactions between techno-economic changes and social structures. As Long (1977, p. 20) has argued, drawing from anthropological studies of rural social change:

> Only where a reallocation of existing agricultural resources occurs or where the labour or capital requirements of the new technology cannot be met along traditional lines, can one expect major transformations in the rural social structure.

What this point stresses is that there is a certain inertia in social structures, and we can expect certain accommodations to occur between previous forms of social organization and the newer ones as well, as previous elite groups attempt to capture the initial benefits of technological change. We have referred to these aspects before when commenting on both elements of historical continuity in Brazilian agrarian structures as well as on their probable effects on technological change.

The third observation we wish to make refers to the problem of attempting to estimate the independent impact of change in agricultural technology when other changing-producing factors are simultaneously operating (Long, 1977; Fugeroa, 1977). This, of course, is not a problem specific to this topic, but a general methodological constraint for causal analysis under non-experimental conditions (that is, the conditions the macro social sciences typically must deal with) (Heise, 1975). An approximation to causality is established if an association is found between conceptually and operationally distinct variables, if there is a temporal and/or logical demonstration that the imputed cause precedes the imputed effects, and if evidence is presented that relationships with other variables, representing rival hypotheses do not hold (Wheelock and Young, 1973). Recognizing these problem, we approach the analysis of consequences of technological change on selected aspects of rural social organization with an evaluation of probable associations, the introduction of temporal controls and the inclusion of other alternative changing-producing ("contol") variables. Even though not flawless, the approach is a conscious effort to disentangle some possible impacts of agricultural technology, given the theoretical, methodological and data limitations of this study. Further details on this approach will be given in Chapter 4. Presently, we wish only to point out that the most logical candidates as alternative or "rival" changing-producing factors are those variables representing the center-periphery dimension of economic development and social change--regional location, urbanization and industrialization. We assume that our previous discussions and the general character of these variables as representatives of the broad processes of structural transformation provide a compelling rationale for their choice as control variables in the context of this study. With these observations in mind, we proceed below with a discussion of the general hypotheses pertaining to the probable consequences of agricultural technology on selected aspects of municipal rural social organization in Minas Gerais.

Productivity

Increases in productivity are the most direct, established, and sought for consequences of technological innovation in agriculture. They constitute the essence of the economic rationality of technological change (Schuh, 1970, 1975; Johnston and Kilby, 1975; Paiva, Schattan, and Freitas, 1975; Griffin, 1974; Barros and Graham, 1977; Contado, 1975). They are also the most widely perceived benefits and the rationale behind the initially unqualified positive bias surrounding the goal of technological change. This is not a study of productivity advances, and our data impose limitations on the ways this variable can be dealt with. However, given the importance of productivity in the context of this research, we attempt an exploratory treatment of the received hypothesis alluded to above.

Overall productivity--"a rise in output per unit of total input" (Ruttan, 1973, p. 1)--consists of partial productivity ratios; in the case of agriculture, land and labor productivities are usually considered (Ruttan, 1973; Johnston and Kilby, 1975). In the present study, data are available only for land productivity measured in terms of physical yields in the form output per hectare.[8] It is common to associate bio-chemical types of technology (seeds, fertilizers, etc.) with land-saving techniques that enhanced land productivity (or yields), while mechanical technologies are considered to be labor saving technologies that lead to advances in labor productivity (Ruttan, 1973; Johnston and Kilby, 1975; Cline, 1973; Griffin, 1974). While the expected linkages between bio-chemical innovations and yields are often well established, the same cannot be said with respect to mechanization (especially, tractor mechanization). The literature (using the above authors as a guide) does not offer a clear conclusion in this respect. In fact, the yield-effects of tractor-mechanization are part of the larger debate on the relative adequacy or social benefits of this type of technology for developing countries (Griffin, 1974; Johnston and Kilby, 1975; Cline, 1973; Paiva, 1975a; Ryff, 1976). Evidence, according to Cline who has computed estimates for

117 rice farms in southern Brazil, "is usually inconclusive due to the failure to remove the influence of other inputs" (Cline, 1973, p. 150). However, given the aggregate nature of our data which allows only indirect inference at the municipal level, and the probable associations between the two components of the agricultural technology, we also expect to find a positive--albeit possibly spurious--association between mechanization and yield increase during the 1950 to 1970 period. Our hypothesis, then, can be stated as it follows:

1. Levels of and changes in agricultural technology are positively related to changes in agricultural productivity. The relationship is stronger with respect to bio-chemical technology than with mechanization.

Farm Size and Land Inequality

The question of concern here is whether change in agricultural technology has had any impact on farm size and land inequality variables. We can begin this discussion by recalling that the data presented in Chapter 2 indicated a general trend toward fragmentation of farm units, with a sizeable increase in minifundios (farms with less than two hectares) and a consequent decline in the average farm sizes in practically all regions and selected states. On the other hand, those data also reveal remarkable stability in the land inequality indexes during the 1950's and 1960's. What is interesting is that these tendencies seem to hold for all regions and states of Brazil, while technological innovation has been highly concentrated in specific regions or states. This situation could indicate that the processes behind changes in farm size are independent of technological innovation--or at least that no general propositions should be made. But univariate data for such large aggregates as states or multistate regions may not provide accurate indications of the bivariate tendencies for farm size and technological change at a more local level of analysis. Nevertheless, the literature reviewed in this chapter fails to offer a clear picture in this case either, because of the disparate nature of agricultural technologies and context. One of the characteristics of bio-chemical types of technology is that they at least theoretically are neutral to scale of production (Griffin, 1975; Johnston and Kilby, 1975; Gotsch, 1972); their impacts on farm size are thus indeterminate. Mechanization, on the other hand, tends to have a more characteristic large farm bias. In the United States, for example, where agricultural modernization has heavily relied on mechanization--tractors and sophisticated machinery--a large number of studies, reviewed by Goss and Rodefeld (1977), tend to point toward increased average farm size, concentration of farm holdings (resource concentration in large farms), increased average farm sales/income, and a concentration of farm sales in favor of largest farms as direct consequences of intense mechanization during the 1935-1975 period. The problem in the context of this study is to determine whether mechanization has been sufficiently intense during the 1950-1970 period in certain Minas municipios to have had an impact on farm size characteristics. Given the high degree of land inequality, for example, mechanization could proceed within the already established large farms before beginning to present any pressure for further land concentration.

One of the main points in the debates over the consequences of agricultural technology change in developing countries has been its unequal distributional impacts (Havens, 1972; Griffin, 1974; Johnston and Kilby, 1975). In Brazil, these debates over agricultural technology have also been tied with issues of increasing inequalities associated with the country's economic growth model (Barros and Graham, 1977; Paiva, 1975; Langoni, 1973; Fishlow, 1972), and the Brazilian controversies have focused on income distribution--a more sensitive and malleable characteristic in the short run. We lack income distribution data at the municipal level for 1950 and 1970, unfortunately. The only inequality indicator available from the census sources used in this study is the Gini coefficient of land inequality. Land inequality, though affecting the distribution of income in rural areas, is more an indicator of the distribution of property and wealth than it is of income. As such, and as Hoffman and Silva (1975) have observed, these wealth indicators tend to be much more stable over time in an absence of dramatic pressure for change that would affect the distribution of wealth itself. Further, land inequality in Brazil was quite high at the beginning of the period--implying relatively little room for experiencing significant degrees of further land concentration. Although we expect the Minas Gerais municipios to present more substantial variance in terms of land inequality than the more macro aggregates used in Chapter 2, we assume the average levels of Gini coefficients to be high.

Given these considerations, we expect only moderate associations between agricultural technology and change in farm size and land inequality indicators. The general hypothesis relative to these variables is stated as follows:

2. Levels of and changes in agricultural technology are moderately and positively related to changes in farm size and land inequality. These relationships are larger for mcheanization than for bio-chemical types of technologies.

Land Tenure

We have already discussed the main characteristics and limitations of the study's data with respect to this variable. The literature reviewed in this chapter again fails to offer us any clear guides. It appears that the realtive impacts of technological changes are highly dependent on specific local conditions in terms of land, labor, and the particular forms of tenure arrangements and social relations of production prevalent at a given time. There is a tendency in the literature to acknowledge some differential impacts of technological change in terms of benefits it can bring to different groups. Owners (particularly those who command larger resources) tend to derive more benefits than tenants, and tenants more so than landless laborers who have as assets only their labor power and minimal skills associated with manual labor (Gotsch, 1972). In the present study, however, such differential benefits cannot be directly evaluated, given the type of the available data. Rather, we can only assess whether technological change is associated with increases or decreases in the proportions of large tenure categories. Our general hypothesis is that those associations at the municipal level will tend to be small. This seems reasonable, given both the data base and the still limited intensity of the technological change in Minas Gerais. The associations, however, are expected to be positive (although possibly not significant) with respect to owner and administrator categories, and negative with resepct to squatters. Technological change will tend to provide incentives for landowners to operate their farms directly or with the help of farm managers (administrators). On the other hand, technological change and associated commercialization of agriculture may marginalize or displace squatters since land use may become more profitable for its owners (Ryff, 1976). The impact on tenancy is even more difficult to predict, since this relationship would depend on the flexibility of specific sharecropping and renting arrangements as perceived and used by landlords in their attempts to take advantage of technological innovations (Griffin, 1974; Johnston and Kilby, 1975; Clements, 1969; Goodman, 1976).[9] This question is thus left open for empirical verification.

The hypothesis concerning the land tenure variables may thus be stated:

3. Levels of and changes in agricultural technology are positively related to changes in the proportions of owners and administrators, and inversely related to changes in the proportion of squatters.

Rural Labor Force

Labor arrangements along with land tenure patterns represent the social relations of production in the rural areas within our analytical framework and available data. Labor arrangement ariables depict how rural labor is organized--more specifically, how this organization is reflected in the relative proportions of broad labor groups. In the present case, the rural labor force is classified into four groups (the same as those employed in Chapter 2). Family labor (those workers represented by the farm operators and members of their families), sharecroppers (basically, those working under a centralized sharecropping system--that is, under the supervision of a central farm management), permanent wage workers (those who work on a long-term or essentially annual basis), and temporary wage workers (those who work on a short-term basis, usually for specific tasks). The last three groups essentially constitute landless rural laborers. Landless laborers, however, form a larger proportion of rural workers than acknowledged by the census data if one included tenant and squatter groups, plus a sizeable proportion of those classified under the family labor category, given the large proportion of small farms in the country which cannot provide full time employment for all family members (Paiva, 1975; Goodman, 1976; Goodman and Redclift, 1977). We thus recognize that our four rural labor groups do not offer a full picture of rural labor force distribution. The situation is still further complicated with the prevalence of mixed labor and tenure arrangements within the low-income groups. For example, a single worker can be at the same time a landowner and a tenant--and still work as wage worker (Forman, 1975; Patrick and Carvalho Filho, 1975). Despite these limitations, we attempt to verify the patterns of relationships to be found between technological change in agriculture and changes in the relative importance of these rural labor force groups in Minas Gerais municipios.

Prevalence of family labor indicates the extent to which production is organized in relatively small operational units. One of the distinctive features of agriculture is that so-called "economies of scale" and specialization of roles are generally less effective within, or at least not a firm requirement of, technological innovation in this sector, as they are with many sectors of industry (Paige, 1975; Johnston and Kilby, 1975; Galeski, 1971). In other words, farming in large, plantation-type units, using hired labor is not a technological requirement for efficiency. Here we again touch on the issue of the relative efficiency of various farm sizes referred to above in the previous section with reference to types of farm labor. Again, it must be stressed that evaluating this issue is beyond the scope of this study. The point we wish to make is that technological change may not, in theory, imply a decline in family labor. The relative impact of technological change on family labor is dependent on the characteristics of this labor within the historical development of agrarian strctures and the character of prevailing state strategies for agricultural "modernization." In the case of Brazil, we have seen from the outset that agrarian structures were characterized by the dominance of the large, commercial/export estate relying initially on slave labor and later on different forms of semi-servile and wage labor. Family labor has historically tended to be connected with peasantry structures, rather than with commercial farming (with exception of the Southern regions) (Forman, 1975; Rezende, 1975; Furtado, 1976). The rapid increase of family labor from 1950 to 1970 revealed by the data presented in Chapter 2 has been interpreted in the light of the pronounced multiplication of farms during the period--particularly, the high rates of farm holdings fragmentation as well as relative increases of tenant and squatter groups. It was also observed that in the Northeast and Southeast regions, where the large commercial/export estate has been most important, the relative proportions of family labor were smallest in 1950 and 1970. These considerations lead to a conclusion that family labor is associated more with peasant rather than with commercial agriculture (Shanin, 1971). On the other hand, given the type of "modernization" strategies adopted in the country (which, as we have noted above, tend to favor large, commercial farms), it seems reasonable to anticipate that family labor and agricultural technology changes tend to be inversely correlated. Such correlations may be stronger in terms of mechanization due to the more distinctive capital and scale bias of this technology.

One of the major topics of debate concerning the expansion and modernization of agriculture in developing countries, and consequent penetration of a market economy throughout the countryside, is the extent to which the social relations of production have become more clearly capitalist in nature (Griffin, 1974; Paige, 1975; Galeski, 1971; Johnston and Kilby, 1975; Goodman, 1976; Lond, 1977; Goodman and Redclift, 1977). We have discussed this before pointing out an alternative thesis that market penetration does not necessarily imply the supplanting of "traditional" forms of labor relations. Fragmentary evidence in Brazil is available for both theses (Goodman, 1976). A Corollary of the thesis that increases commercialization of agriculture involves a transition toward capitalist relations of production is that one should be able to observe a progressive tendency toward an increased prevalence of wage labor in an agrarian structure such as Brazil's characterized by high proportions of landless laborers and dominance of large farms. However, the data presented in Chapter 2 show a systematic <u>decrease</u> in the relative proportion of wage labor from 1950 to

1970 (accompanying increases in family labor and non-ownership forms of tenure). Such data could at face value be patent evidence in favor of the opposite thesis. However, these phenomena do not lend themselves to so simplistic an interpretation. These data only indicate that the growth of minifundios and the surplus labor power associated with them may have likely prevented a more than proportional growth of the wage labor force. This situation, as Goodman (1976) noted, may be compatible with both a more "traditional" and a more capitalist mode of production. Further, there is another consideration that should be recognized: These general trends may merely reflect the persistent importance of the subsistence of "traditional" sectors in Brazilian agriculture--or in other words, its dualistic character. Wage labor, however, could well be increasing in the areas more linked with a market economy and where technological change is a central factor (i.e., the center), while the elaboration of the traditional mode of production may yet be the case in the peripheral agricultural regions. We use this as our working hypothesis in the present study.

The data presented in Chapter 2 also reveal a consistent decline in the proportion of sharecroppers throughout Brazil from 1950 to 1970. Sharecroppers, as observed, are farm workers who labor on consolidated plots of land under central management. They thus constitute the non-wage counterpart of the landless labor force who has only its labor power and limited skills to sell on the market. Paige (1975), commenting on the effects of market expansion (and technological diffusion) in agricultural systems characterized by centralized sharecropping (such as the cotton plantations of the American South), observes that the tendency is toward eviction of sharecroppers and adoption of wage labor, since the burden of centralized management is already present. The opposite may occur within decentralized sharecropping or other forms of tenancy where management and coordination are left to individual farm operators. This interpretation is consistent with both relative increases in tenancy and decreases in sharecropping as revealed by the national data of Chapter 2. We would thus expect agricultural technology change to be inversely related with change in the prevalence of sharecropping.

We can now summarize the hypotheses concerning the associations between technological change and rural labor force:

4. Levels of and changes in agricultural technology are inversely related to changes in proportion of family labor and sharecroppers, and directly related to changes in the proportion of permanent and temporary wage laborers.

Rural Wages

A general theoretical interpretation of this variable in the context of the study was given in the first section of this chapter, as well as in the third section where we discussed its theoretical meaning in conjunction with rural literacy. We have seen that rural wages can be interpreted both as appropriation of or access to the social product by labor and as a generalized indicator of material bell-being. In Chapter 2, we presented data on this indicator for macro aggregates (regions and states) and the country as a whole for 1950 and 1970. Large regional and rural-urban disparities were observed despite sizeable rural wage increases during the period. Those observations were the basis for an anticipation of higher average wage levels and increases for the most central regions of the state in the second section of this chapter. We also anticipated a positive association between agricultural technology change and proportion of wage labor. These conclusions flow from the acknowledged impact that the spatially uneven processes of economic development and capital accumulation have on the more central regions, sectors, sub-sectors, and groups.

The rural wages indicator basically refers to the condition of a subordinate (or marginal) agrarian class. It is recognized that such groups may not have been able to improve their relative condition during the recent development process. On the contrary, their relative condition seems to have even worsened, as recent Brazilian income inequaltiy data would indicate. Nevertheless, rural workers in "central" regions are considerably better off in relation to their counterparts in more peripheral areas. Therefore, wages are higher in more developed areas even though income inequality there may also be high (Langoni, 1973). Insofar as agricultural technology is presumed to be more prevalent in relatively "central" areas, we expect to find a positive relationship between technological change and rural wages. This hypothesis is stated below:

5. Levels of and changes in agricultural technology are positively related to changes in the average wage levels of permanent and temporary farm workers.

Rural Literacy

At this point, we assume that many of our previous discussions about the uneven rates of incorporation of rural areas into the societal centers of growth, along with the interrelations among different socio-economic development indicators in these areas, offer a compelling rationale for our next hypothesis. Because technological innovation in agriculture is part of this incorporation process as well, we can expect to find positive associations between technological changes and increases in rural literacy rates. This hypothesis is consistent with the data presented in Chapter 2, which show higher literacy levels for the Southeast and South regions of the country in both 1950 and 1970. The hypothesis is also consistent with the systematic biases favoring more developed regions which were noted with respect to indicators most directly associated with economic development.

The hypothesis pertaining to technoological change and rural literacy rates can thus be stated as follows:

6. Levels of and changes in agricultural technology are positively related to change in rural literacy levels.

Land Use

We have stressed above that the technological innovations dealt with in this study are more likely to affect output and productivity of crops than other penomena linked with the primary sector. However, one of the most frequent generalizations concerning Brazilian agriculture is that agricultural output has grown mainly due to the expansion of croplands rather than through physical productivity increases (Schuh, 1970, 1975; Patrick, 1975; Nicholls, 1975; Barros and Graham, 1977). The data presented in Chapter 2 show a significant increase in the percent of farmland devoted to crops from 1950 to 1970--particularly so in the Southern states where commercial agriculture has dramatically advanced during recent decades. It is interesting to observe that in São Paulo--where as the above studies show, productivity gains have been more important for output growth--the proportion of farmland in crops did not increase substantially. However, this is mainly due to the fact that no significant "frontier" remained in São Paulo, which by 1950 had the highest proportion of farmland in crops (22 percent) of all the Brazilian states. Technological innovation has been very important in the Southern states during this period, especially the tendency toward mechanization, as the data in Table 6 in Chapter 2 indicate. In fact, as Ryff (1976) has pointed out, mechanization has been an important vehicle for the expansion of cropland agriculture in these areas. In the state of Minas Gerais, on the other hand, the proportion of farmland in crops has remained stable during the period, with additional incorporated lands used primarily for pastures. It has been a contention of this study, however, that aggregate data for the state conceal large inter-regional and inter-municipal differentials that characterize Minas Gerais. We can thus expect that the observed trend which links increased mechanization with expansion of croplands in a situation of land abundance such as that of the Southern states can be also found within Minas Gerais. This would particularly be the case in the western regions of the state which are most closely linked with São Paulo and have been the most rapid to embark on the mechanization process in the state (Clements, 1969). Insofar as the two modes of technological change--adoption of mechanical and bio-chemical inputs--are interrelated among Minas Gerais municipios, a positive association of change in agricultural technology with expansion of croplands is expected. The hypotehsis may thus be stated:

7. Levels of and changes in agricultural technology (especially mechanization) are positively related to change in the proportion of farmland used for crops.

Subsistence Production

This variable has not been considered above because of its ambiguous status within the larger concepts of agrarian structure and mode of production which have been the analytical basis for our major variables. This variable has been suggested by the availability of certain kinds of data in census records and its possible relevance in the context of the study. Its theoretical meaning was framed initially in previous literature with reference to the concept of "traditional agriculture," and it is in this connection that subsistence production is linked with the larger conceptual framework present-d in this chapter. It was noted in Chapter 1 that there are severe limitations to the concept of "traditional agriculture" when it is used to depict a homogeneous, unchanging, isolated agricultural system. However, the subsistence production concept can be useful for identifying those agricultural sub-sectors which tend to be relatively close to the ideal type of agricultural system characterized by: (1) cultivation and transformation of staple food crops in small plots; (2) by small farmers, tenants or resident workers; and (3) with a relatively simple technology and a resulting limited output used for domestic and local consumption rather than larger national and international markets. With such a definition in mind, (traditional) subsistence production agriculture here refers to what is usually known as peasant agriculture (Shanin, 1971).

The subsistence production variable touches upon the concept of traditional peasant agriculture because it depicts the relative importance of the subsistence production of corn, cassava, and beans by resident farm workers. In other words, this variable reflects the proportion of the total production of these staple crops that is produced not as the principal commercial enterprise of farm units, but rather as a consequence of the practice of allowing farm workers residing on farms to cultivate subsistence plots for their own use. This practice, which is quite widespread throughout Brazil, is part of the traditional system of farming (Rezende, 1975; Furtado, 1976; Forman, 1975). It corresponds, in part, to the non-monetary income of farm workers and the conventional way through which the large estates of the traditional agricultural sector have managed to maintain a "captive" labor force during idle periods. It has been observed that the penetration of a more capitalist type of labor realtions in rural areas as a consequence of the expansion of a market economy in the agricultural sector may be reducing the practice of using access to land for subsistence production as a form of payment for agricultural work--thereby transforming farm labor into a more clear-cut, wage labor force (Paiva, 1975; Forman, 1975; Goodman, 1976). We have already noticed that this is merely a hypothesis to be investigated more thoroughly within specific local conditions, and the data available for this study are inappropriate for the task. However, the subsistence production variable can provide an indication of the relative importance of payment in kind to farm workers. Since the relative proportions of hired farm workers have tended to decline in the aggregate in both Minas Gerais and other states and regions of Brazil during the 1950 to 1970 period, we could expect that levels of subsistence production would also tend to decline.

We have proposed in a previous hypothesis that despite their aggregate decline, use of hired farm workers could be increasing in municipios experiencing high rates of technological change. This is because hired farm workers presumably are concentrated in that segment of larger farms which must rely on hired labor. If these additional increments of hired labor associated with technological change are more typically wage labor, with basically a monetary income, the prevalence of subsistence production should then be negatively associated with technological change. If such patterns do occur, we may be providing an indirect evidence for the capitalist penetration thesis in those regions experiencing most rapid technological change, at least with reference to labor relation tendencies.

We may state the hypothesis pertaining to subsistence production as:

8. Levels of and changes in agricultural technology are inversely related to change in subsistence production.

Rural Net Migration

Population variables, despite their recognized importance as the "raw material" for social organization, have largely been ignored in this study. This was because the main objectives of this research involved emphasizing the linkages between agricultural technology changes and patterns of rural social organization. While this is not conceived as a demographic study, there is a significant demographic variable--rural net migration--that suggests itself due to its centrality in related literature on the socioeconomic impacts of agricultural technology (see, for example, Griffin, 1974).

One of the main aspects of the population dynamics historically associated with economic growth and social change is transfer of persons from rural to urban areas (Johnston, 1970; Johnston and Kilby, 1975). Fandino (1975) has pointed out that while the European and early developed nations reached new and stable rural-urban population proportions by well-synchronized processes of industrialization, fertility reduction, overseas migration, and a slow pace of transition, the developing nations of the 20th century have not enjoyed such fortuitous circumstances. The results are the well-known problems of high population growth rates, excess or "premature" urbanization associated with rural-urban migration, retarded and non-lablr generating industrialization, and overall low rates and inegalitarian distributions of per capita economic growth.

The picture of Brazil we presented in Chapter 2 does not decidedly differ from the scenario depicted above. A widespread process of rural out-migration has occurred in recent decades; by 1970, Brazil had crossed the 50 percent plateau of urbanization. Not surprisingly, social analysts have tended to view rural out-migration from different perspectives. Some have stressed the negative aspects of limited access to plentiful land resources and excessive growth of cities as compounding problems of unemployment and underemployment, housing, crime, health, sanitation, lack of public services, and the need for orienting the agricultural sector toward providing increased supplies of foodstuffs and other primary products for the urban and industrial sectors (Forman, 1975; Feder, 1971; Stavenhaven, 1975). Others, while recognizing the problems of poverty and underemployment in cities, have a basically positive view of the rural out-migration process and consequent increases in urbanization. Out-migration and urbanization are viewed as essential and should be encouraged if social and economic differentials between the rural and urban sectors are to decrease and agriculture is to modernize (Schuh, 1975, 1977). Still others, while considering the importance of population transfers over the long run, advocate that measures should be taken to help those in rural areas to improve their lot while awaiting for better chances in the non-agricultural sectors; the rural out-migration process should thus be curtailed within the regions of origin to decentralize the urbanization process and hopefully foster less uneven spatial development (Paiva, 1975; Tolosa, 1977). These issues are sufficiently important to suggest specific studies focusing on them. In the context of the present research, however, they cannot be fully treated. Our more limited objectives in dealing with rural net migration are restricted to: (1) verification of regional migration patterns observed in the state of Minas Gerais during the 1950 to 1970 period, and (2) examination of the possible associations that change in agricultural technology might have with rates of rural net migration.

We have seen that the state of Minas Gerais has tended to be a net loser of population during recent decades. Since this out-of-state migration has not appreciably dampened the high rates of urbanization registered during this same period, it is obvious that a pronounced rural out-migration process was occurring at the same time. The data presented in Chapter 2 show exactly this; Minas had the second highest rural out-migration figure during the 1950 to 1970 period among all regions and selected states examined (see Table 10). We may thus expect that most regions of the state will exhibit negative net migration rates.

Many factors are usually considered as influencing rural net migration, and they tend to be generally classified as "pull" and "push" factors (Fandino, 1975)--respectively, those factors in the region of origin which tend to drive people out, and those in the receiving regions which tend to attract people toward them. It has been observed that rural push factors have probably been more important in influencing rural out-migration than have pull factors (Tolosa, 1977). It seems ironic that agricultural stagnation--allied with skewed land distribution which limits access to this resource for production--as well as agricultural "modernization"--particularly in the form of mechanization--can both be viewed as push factors (Forman, 1975; Schuh, 1975; Fandino, 1975).

The relationship between technological change and rural net migration in the context of Minas Gerais, however, may be expected to be less pronounced than that exhibited in other Third World contexts. This expectation has several substantive bases. Technological innovation in Minas Gerais likely has not yet reached sufficient levels to have an independent effect on rural net migration rates over and above other possible "push" factors. Further, mechanization has been most pervasive in the Western region, known as Minas Triangle, where rural population densities have been generally low (Leloup, 1970; Clements, 1969). As Fandino (1975) has noted, technological change (even of the mechanzation type) may be positively related to rural net migration in areas of virgin lands and/or low rural population densities. In addition, it is apparent that one of the regions with an especially high rural population density--the Mata region in the Southeast area of the state-- and high level of rural out-migration due to its stagnant economy, is a region ill-suited to mechanization because of its hilly terrain (Clements, 1969).

The hypotheses concerning the rural net-migration variable can, then, be stated as it follows:

9. Mean regional values for rural net migration during the 1950-1970 period are negative.
10. Levels of and changes in agricultural technology are unrelated to rural net migration rates.

SUMMARY

The foregoing has been devoted to the development of hypotheses on the research problems pertaining to several selected dimensions of social organization and agricultural change. Our primary concern has been in the associations between change in agricultural technology change and rural social organization in Brazil and Minas Gerais. In the remaining chapters of this study, we subject these hypotheses to empirical examination. Before we do so, however, we address outselves to the methodological considerations pertaining to the available data and the strategies for data anlaysis in the next chapter.

FOOTNOTES

1. For an application of this perspective to the modernization of Brazilian agriculture, see Schuh (1975).

2. Details of the regional location subdivision used in this study will be presented in Chapter 4.

3. Details relative to the construction of specific indicators will be given in Chapter 4.

4. The ecological data of this study cannot offer significant insight into this issue because the great diversity of crops and configurations of farm sizes inhibits precise inferences.

5. The study by Contador (1975) has included other variables of interest, in the context of this dissertation, such as farm size, educational levels and main economic activity (crops vs. livestock). Such variables have been less important than others such as credit access, land values and rates of return to investments, but follow expected directions.

6. The specific procedures and crops used for these indicators will be detailed in Chapter 4.

7. Schuh (1975), in fact, when commenting on this topic considers this to be another "puzzle" of the Brazilian development experience. We may speculate on some reasons to this disparity. When technological change in agriculture began to take place in earnest, Rio de Janeiro was being supplanted by São Paulo as the predominant national growth center (Lodder, 1977). The urban, industrial and political elites of the Rio de Janeiro metropolis had fewer ties with the agricultural sector than their São Paulo counterparts (Schuh, 1975). Therefore, the rural countryside surrounding Rio de Janeiro essentially became a structural periphery.

8. We have devised a method to get relative average productivities (on the basis of physical yields of the crop data avaialble for this study), for the municipio level and also will use municipal yields for specific crops. Details are given in Chapter 4.

9. For this reason, plus the dubious validity of the tenancy category across time in census materials, no specific hypothesis is made with respect to change in agricultural technology and prevalence of tenancy.

CHAPTER VI

DATA AND METHODS

The present chapter provides a detailed discussion of the unit of analysis for this study (the municipio), data sources, operational definitions of variables, the plan of analysis, and statistical techniques employed. Each of these topics constitutes a major section of the chapter.

UNIVERSE AND UNIT OF ANALYSIS

The unit of analysis for this research is the intermediate aggregate which in Brazil is called the municipio. The municipio is for most politico-administrative, economic, social and statistical purposes, the smallest unit in the country, roughly equivalent to the U.S. county. Ecologically, a municipio is a territorial unit which includes a main township, a rural hinterland, and other urban aggregates or villages. The latter, however, may or may not be present. The main township usually is the municipal seat and constitutes the most urban nucleus of the municipio.

The municipios of MInas Gerais are extremely varied in terms of territorial size, history, demographic composition, and economic and social characteristics. Despite such differences, federal legislation imposes a similar politico-administrative and fiscal organization on all municipios. The result is that the municipal institutions of government tend to be inefficient--lacking in autonomy and financial resources to deal with many local problems and issues (Brasileiro, 1973). Such considerations, however, do not preclude the adoption of the view that municipios can be considered complex, local social systems. As such, municipios are more than mere ecological units; rather, they constitute tangible loci for social processes and structures, i.e., social organization (Warren, 1963). The use of such units in the context of social research allows us to "scale down" macro-level propositions derived from analyses of national or larger sub-national aggregates and "scale up" micro-level propositions generated by individually-focused (e.g., farm-level) surveys.

As noted in Chapter 1, threr presently are more than 4,000 municipios in Brazil, and this research is concerned only with those municipios belonging to the state of Minas Gerais. Our universe, then, is constituted by all municipios of this state. According to the 1970 census, Minas Gerais at the time had a total of 722 municipios. However, municipios in Brazil do not have stable frontiers and may exhibit territorial changes in the short run. This occurs because Brazilian legislation permits a village or urban aggregate and its immediate rural surroundings to apply for emancipation from a municipio to which it belongs. If the application is successful, a new municipio is legally formed. When a new municipio is created, it usually takes one or more districts from established municipios. A district is a politico-administrative subdivision of municipios, formed by a village and its rural environment. For most practical purposes, the district is just a part of a municipio and has no autonomy. Many municipios do not even have distrital subdivisions. This is out rationale for disregarding the district unit in the present research--in addition to the more important consideration that only fragmentary statistical information is available at this level.

Given these considerations, it is not surprising to find that the 1950 census records a total of only 387 municipios for Minas Gerais. The number of units in the study universe thus has nearly doubled in the 20 year period from 1950 to 1970. Most of this increase has occurred during the 1960's, since the 1960 census reports only 483 municipios for the state.

The instability of units over time causes problems for a longitudinal analysis. Since social change is a main perspective of this study, this issue had to be dealt with at the outset. The first step taken was to look at both 1950 and 1970 lists of municipios and identify the ones created since the first date. The demographic synopses of the 1960 and 1970 censuses a complete history of municipal territorial changes during the previous decades (I.B.G.E., 1962; F.I.B.G.E., 1971). With this material, the "origin" of each new municipio was detected. It was observed that nearly all new municipios had a single municipal origin--that is, they came from just one of the older municipios. This means that the process of creation of new municipios is a process of fragmentation of the larger units and does not involve territorial changes in neighboring municipios. This finding was rewarding because it was then possible to devise a method for obtaining comparable observation units for both 1950 and 1970.

The units of analysis thus are the municipal groupings of 1950. For 1970, each unit is defined in terms of original 1950 boundaries. For example, the municipio of Viçosa has been fragmented into four municipios since 1950: Viçosa, Sao Miguel do Anta, Cajuri, and Canaã. These four municipios are thus re-aggregated for 1970 to form the same unit as in 1950. The same procedure was applied for all municipios experiencing fragmentation during the period.

This study deald with the entire universe of municipios in the state of Minas Gerais as of 1950. However, some municipios had to be eliminated from the analysis. Four municipios on the 1970 list--Mantena, Mendes Pimentel, Central de Minas and Itabirinha--have been eliminated because they are located in the area (Serra dos Aimorés) adjacent to the state of Espirito Santo, which was claimed by both states at the time of the 1950 census. The 1950 data for this area are published separately and were not available at the time our data were processed. The 1950 municipio of Ataléia (which in 1970 formed the municipios of Ataléia and Ouro Verde de Minas) was eliminated because its main township in 1950 belonged to the contested area referred to above. Therefore, data for that municipio do not cover the entire territorial unit. A second municipio of 1950, Nova Era (Nova Era plus Bela Vista de Minas, in 1970), was deleted from the analysis because the agricultural census data for that year were missing. Because of these omissions, the study population includes 385 municipios of 1950, and 385 comparable, re-aggregated municipios of 1970 (from an original list of 714).

DATA SOURCES

The data for this research, as noted, came from the Brazilian censuses of 1950 and 1970 (regional series publications for the state of Minas Gerais). The specific sources for the raw data were: the agricultural censuses (I.B.G.E., 1955a; F.I.B.G.E., 1975a), the demographic censuses (I.B.G.E., 1954; F.I.B.G.E., 1973); and the industry, commerce and service censuses (I.B.G.E., 1955b; F.I.B.G.E., 1974, 1975b, 1975c).

From the published tables available for the municipal level, 274 (1950) and 215 (1970) items of comparable information for the two periods were coded into extensive data files from which an original list of 208 indicators was constructed for each year. Such indicators cover the following broad areas: agricultural technology, farm size distribution and land tenure, land use, agricultural activities and physical productivities, rural labor force, population, and characteristics of the urban (industry, commerce, and services) sectors. These areas encompass nearly all types of information available for both 1950 and 1970 censuses. Information available for just one period was not included in the data files. To insure comparability among municipios and between periods, all indicators are standardized in terms of percentages, ratios, or other more complex indexes. These indicators are extensive and tend to represent alternative measures of similar concepts. All variables included in this study and discussed in Chapter 3 are operationalized from the available indicators. Given the extensiveness of the data, even a study of a broad scope such as this can effectively utilize only a portion of the available data. We will comment in more detail below on the indicators selected for use in the present research.

It is our feeling that this type of data can yield valuable information on dimensions of rural social organization not easily depicted through surveys. The data have a broad span of coverage, i.e., refer to a large number of units with comparable measures over time which enable us to verify dispersion and rates of change in the indicators of social organization (Linz, 1974). This is particularly relevant for a developing country such as Brazil which is undergoing a profound process of change and does not always have available abundant and reliable statistical data.

We are, nevertheless, aware of the limitations involved in the use of such data. Among these limitations is the restricted range of content of the indicators which constrains both the definitions and operationalizations of a number of variables of theoretical and empirical interest. The level of aggregation itself does not always allow for direct consideration of generalizations derived from micro-level or non-ecological analyses and could quite possibly give rise to ecological fallacies (Valkonen, 1974; Alker Jr., 1974). This suggests a cautious interpretation of results. Finally, the precise reliability of the data is unknown. The task of collecting and processing this enormous amount of census information under less than favorable conditions as those still prevailing in Brazil is quite formidable and might well lead to a certain amount of error in the reporting of data. However, we here take a positive attitude, assuming that the data meet adequate standards of reliability.[1]

In any event, we are explicitly attempting to maximize the possible uses of the compiled data for this and future pieces of research. Presently, two time periods have been chosen for the analysis of social change in Minas Gerais: 1950 and 1970. The last year is the data of the most recent census survey in Brazil. The 1950 census data have the largest number of published tables comparable with those for 1970--especially for the agricultural sector. There is also a feeling among social researchers in Brazil that these two censuses are generally of higher quality than those of other periods. Lastly, it was demonstrated above that this particular 20-year time span has been crucial in terms of social change and economic growth in the country.

THE RESEARCH VARIABLES:: OPERATIONAL DEFINITIONS

We have already noted that the original data compiled from the Minas Gerais municipal censuses are extensive, including alternative measures of similar concepts and variables. To keep the analysis and interpretation within manageable proportions, we have to face the problem of reducing the number of indicators to be used in this study. Our variables were defined a priori--that is, on the basis of theoretical and empirical relevance as well as the general content of the census materials. Our general strategy was to combine logical and statistical criteria to select a minimum number of meaningful indicators for each of the variables previously defined. The general criteria used can be summarized in the following way: We have initially considered only those more general indicators which appear to have high face validity to represent each variable. Indicators with very low mean values and small variances (in other words, with low potential discriminatory power) were eliminated.

Similarly, higher correlated (over .60) indicators were eliminated since they would provide largely redundant information, in addition to complicating our multivariate analyses through the multi-collineasity problems they generate. In these cases, only the indicator judged more general and closer to the variable definition was retained. However, some variables are represented by more than one indicator when this was deemed necessary on the basis of both concept coverage and the type of data available. The discussion of each of the indicators selected for use in this research will follow. Before, however, we must address ourselves to the operationalization of the only nominal variable of this study: the regional location typology.

Regional Location

Our comments in previous chapters have hopefully established the theoretical and empirical rationale for the regional sub-division of the state, which is a contextual variable in this study (Fandino, 1975). The regional typology adopted here seeks to represent the center-periphery dimension--that is, the relative influence of the national centers--and at the same time maintain the maximum amount of consistency with regional sub-divisions well known and/or adopted in government publications (I.B.G.E., 1954, 1955a,b, 1968; F.I.B.G.E., 1968; Governo do Estado de Minas Gerais, 1967, vols. 1-4; Estado de Minas Gerais, 1971).

Before 1968, for primarily statistical purposes, the municipios of Minas Gerais was grouped into geographical regions ("zonas fisiograficas"). These geographical regions, nine in number in 1922, increased to 15 after 1962 (Leloup, 1970). The 1950 census includes 13 such regions. During the 1960's, the agency for national statistics in Brazil[2] began a massive project to reorganize the official regional sub-divisions in the country. The results of this project were published in 1968 (I.B.G.E., 1968 and F.I.B.G.E., 1968), creating a new basis for regional sub-divisions in Brazil--the so-called "micro-regions." These micro-regions total 361 for the entire country and are defined as relatively homogeneous ecological and socio-economic spaces. The micro-regions are formed by groups of municipios and are, in turn, aggregated to form the five major national macro-regions we have reported in Chapter 2. These comprise the new regional classifications adopted in the 1970 census. The state of Minas Gerais is divided into 46 micro-regions. More inclusive regional aggregations for the state devised since 1968 have taken these micro-regions into account (Estado de Minas Gerais, 1971). It is important to note that independent studies of regional spaces and urban hierarchies conducted in the state during the late 1960's tend to be very consistent in identifying areas under the influence of the major metropolitan centers (F.I.B.G.E., 1968; Leloup, 1970; Ferreira, 1972).

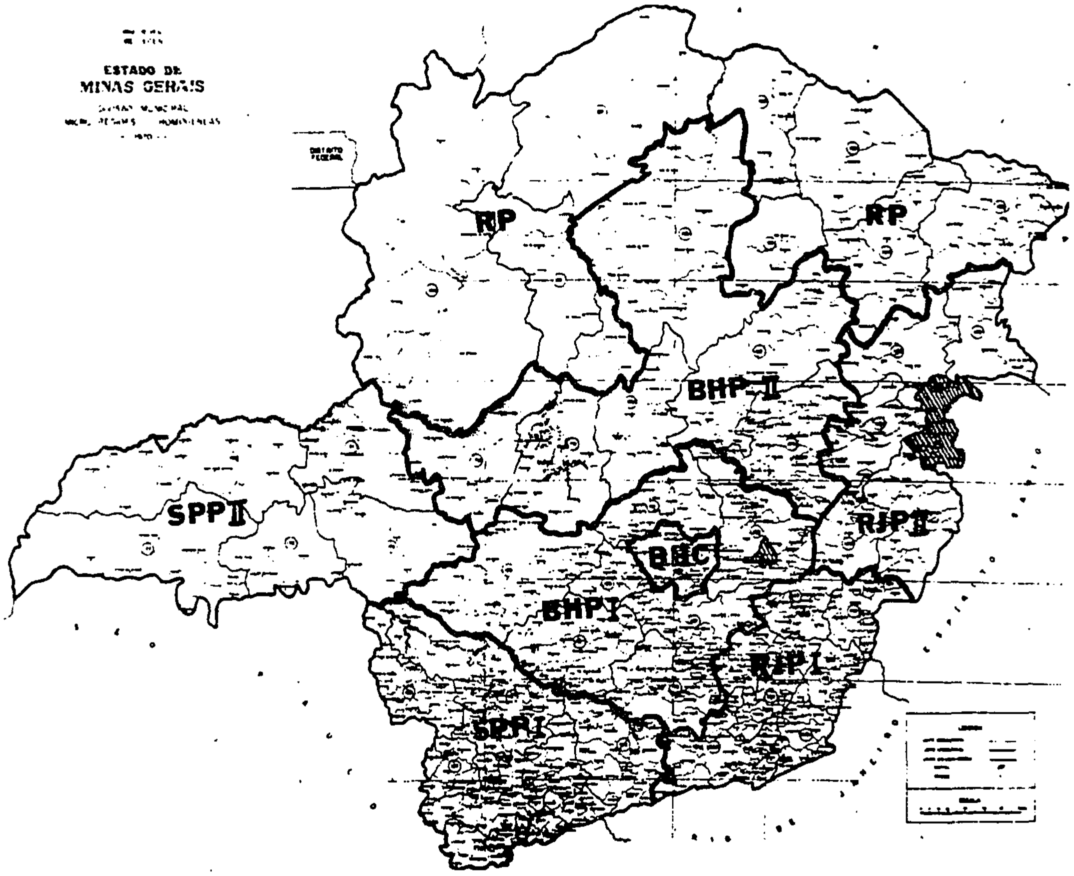

Figure 2. Map of Minas Gerais showing the regional sub-division adopted in the study.

BHC - Belo Horizonte Center
BHP I - Belo Horizonte Periphery I
BHP II - Belo Horizonte Periphery II
SPP I - São Paulo Periphery I
SPP II - São Paulo Periphery II
RJP I - Rio de Janeiro Periphery I
RJP II - Rio de Janeiro Periphery II
RP - Rural Periphery

Using the studies referred to above and the existing micro-regions as the units of selection, we arrived at a general classification presented in Figure 2. The state is divided into eight regions, whose names are given according to their location relative to the major metropolitan centers: São Paulo, Rio de Janeiro and Belo Horizonte. Some of our regions follow well-known and long-established classifications. Our São Paulo Periphery I region corresponds exactly with the area known as the South of Minas, which is an old settlement area under direct influence of São Paulo. The São Paulo Periphery II corresponds to the area known as Minas Triangle, a fertile region of more recent colonization whose development has also been largely under the influence of São Paulo. The Rio de Janeiro Periphery I is another old area in the state, which was heavily involved in the 19th century coffee boom in Minas Gerais and is an area with close linkages with the city of Rio de Janeiro. It corresponds with the so-called Mata zone. The Rio de Janeiro Periphery II corresponds largely to the previous regions known as Rio Doce and Mucuri, which were also brought under the influence of Rio de Janeiro, particularly after the opening of the highway axis in the 1950's linking Rio de Janeiro to the Northeast. Because of the center-periphery strategy, our other regions do not clearly follow conventional regional classifications. The Belo Horizonte Center region is formed by the Belo Horizonte micro-region--rather than only the metropolitan area of the city. As an I.B.G.E. (1968, p. 304) study shows, the whole region is characterized by the presence and dominance of the capital, with all neighboring municipios having extensive linkages with Belo Horizonte. The regions of Belo Horizonte Periphery I and Belo Horizonte Periphery II essentially follow the delimitation of the areas under the influence of Belo Horizonte arrived at by the studies of F.I.B.G.E. (1968), Leloup (1970) and Ferreira (1972). The urban system formed by Belo Horizonte, according to the above references, is still in the process of being structured and fortified, since this is a relatively new metropolis which has rapidly expanded its regional influences during the last decades. In any event, we expect the Southern half of the Belo Horizonte Periphery--the Belo Horizonte Periphery I, formed by the old regions of West, Metalurgica and Campos das Vertentes--to be generally more developed and more dynamic than the Northern half--the Belo Horizonte PeripheryII--which appears to share more characteristics with the Rural Periphery region. This last region--located on the frontiers of the states of Goias and Bahia, from the Northwestern to the Northeastern areas of Minas Gerais--is the most rural and locationally disadvantaged. This region has never been under the influence of any metropolis in the country and represents the most backward and peripherical pole of the center-periphery continuum.

These regions are treated in this study as a nominal, contextual variable which is expected to shape the characteristics of local social organization and their rates of change during the 1950-1970 period. We now turn to the operationalization of the other variables of concern to this research.

Agricultural Technology

We have noted in the last chapter that two dimensions of the agricultural technology variable must be considered in this study: bio-chemical innovations and mechanization. From the available indicators derived from comparable 1950 and 1970 data, four measures of agricultural technology--two for each dimension--were selected on the basis of the criteria detailed at the beginning of this section. These indicators are:

Bio-chemical Innovation. Cruzeiros of modern bio-chemical inputs (seeds, fertilizers and insecticides) per farm and cruzeiros of modern bio-chemical inputs (seeds, fertilizers and insecticides) per hectare of cropland were the two measures of bio-chemical technology. These correspond to the most general indicators which could be derived from census data. Cruzeiros of 1970 were used for both years. The 1950 values were adjusted according to the General Price Index #2, published in the Brazilian economic journal, Conjuntura Economica (various issues). The indicators are standardized in two ways: (1) by the number of farms in the municipios (which provides an indication of the extent of technological diffusion across all farms) and (2) by hectares of cropland (which provides an indication of technological diffusion on a per hectare basis). These indicators, however, are very correlated (.39 for 1950 and .89 for 1970).[3]

Mechanization. Percent of farms having tractors and tractors per 1000 hectares of cropland were the two measures chosen to represent the extent of mechanization. These again are the most general and comparable indicators available and are also standardized by number of farms and hectares of cropland. Their intercorrelations are even greater than those for bio-chemical innovation; .88, in 1950, and .90, for 1970.

These four indicators are treated as separate variables throughout the study. The evaluation of the hypotheses developed in Chapter 3 will be made in terms of the empirical behavior of each of the four indicators.

Farm Size

Before we present the indicators selected for this variable, it is useful to comment on the census definition of a farm which must necessarily be followed in this study. This definition considers the farm as a contiguous area of land, of any size, under a single management, where agricultural activities are conducted. Agricultural activities are broadly conceived to include soil cultivation, livestock raising, and exploitation of soil resources (I.B.G.E., 1955a; F.I.B.G.E., 1975a). The 1950 agricultural census excludes from its definition those units where soil cultivation is done only for domestic consumption, while the 1970 definition explicitly omits only backyards and domestic gardens. This indicates that the 1970 definition is somewhat more inclusive than the 1950 one. Such a discrepancy perhaps may in part explain the very large increases in farm units observed during the 1950-1970 period, as we noted in Chapter 2. Two elements of the census definition of farm are particularly crucial. The first refers to the contiguity of land; areas under the same management (and/or ownership), but which are not contiguous, are considered separate farm units. The other is the element of management itself; contiguous areas under the same ownership, but with different operators, are also classified as separate farms. The census definition, then, sqresses the notion of farms as operational units, rather than the area under a single form of control of ownership. The criteria of operational unit and ownership control of course need not always coincide. In fact, they can be quite different--especially so when the prevalent tenure pattern has a substantial share of non-owner-operated units (Griffin, 1974; Paige, 1975). We are thus faced with certain definitional and comparability problems with respect to farm size and farm-related variables.

Nevertheless, the farm size indicators include the following:

1. Average (mean) farm size.
2. Percent of farms with less than 2 hectares.
3. Percent of farms with more than 200 hectares.
4. Median category size of farms cropland.

These indicators tend to reflect both central tendency as well as skewness in the distribution of farm sizes. An indicator of relative size of farm cropland is warranted on the basis that it may be a more sensitive indicator of response to demand for output growth. This measure may thus be most sensitive to technological change. The selection of the specific sizes for relatively large and relatively small farms was somewhat arbitrary, but tends to reflect a general consensus that farms with less than 2 hectares are generally too small to be a viable economic unit for a family, and farms with more than 200 hectares are at least twice as large as the average farm size in the state in both 1950 and 1970. Further, these divisions may be seen to best capture, respectively, the prevalence of latifundios and minifundios.

Land Inequality

Using the published tables reporting number of farms and the total area (in hectares) they occupy for 14 farm size categories, Gini coefficients have been calculated for all municipios in both years. These Gini coefficients constitute our indicator of land inequality, or more specifically, our indicator of inequality of operational farm holdings. The computational formula used--which is similar to those employed in other studies (Flora, 1971, p. 15; Hoffman and Silva, 1975, p. 264)--is presented below:

$$\text{Gini} = 1 - \sum_{1=1}^{n} f_i \, (g_i + g_i - 1)$$

Where n = number of farm size grouping (14)
f_i = percent of farms in size grouping i
g_i = cumulative percent of land in size grouping i

The Gini coefficient is the most widely used index of inequality and is generally considered one of the best (Costa, 1974). As with all inequality indexes applied to various distributions of attributes, the Gini index, properly speaking, has only a relative, not an absolute, meaning. The question of interpretation is important because inequality, in having a decided negative connotation, is often confused with absolute levels of well-being. In other words, it is possible to have two identical Gini coefficients which depict similar degrees of inequality, but which refer to decidedly different situations with respect to the overall levels of the attribute in question (land, income).[4] However, Gini coefficients have the advantage of being easily interpretable, in addition to being distribution free and relatively simple to compute. As Costa (1974) has pointed out, the meaning of the Gini is associated with the Lorenz curve, considered the ideal inequality summary. The Gini coefficient can be viewed as a ratio of the existing degree of inequality to the maximum possible degree of inequality. The higher the value of the coefficient, the higher the existing degree of inequality.

Land Tenure

Census data in Brazil can be used to assess the relative importance of only four broad tenure groupings. These groups, as referred to before, include owners, tenants, squatters, and administrators or managers. However, the Brazilian tenure situation is quite complex. In addition to the fact, pointed out in Chapter 3, that tenure arrangements in rural Brazil are much more varied than the four broad categories can capture, there are further measurement problems--principally, problems of comparison between periods.

The 1970 census introduced the concept of "producer" (produtor) in place of "operator" (responsavel) definition used in previous censuses, including 1950. The operator definition indicates the person who effectively runs the farm, be he an owner, a tenant, an administrator, or a squatter (I.B.G.E., 1955a, p. XVII). The producer definition, however, refers to the person or legal entity (pessoa jurídica) maintaining responsibility for the farm activities (F.I.B.G.E., 1975a, p. XXIII). As a consequence of this definition, the administrator or manager category was omitted from the tenure group classification for 1970, since a manager is a hired employee, rather than an independent producer. That manager/administrator category is presented in a separate table dealing with the form of farm management--whether by the producers themselves or by administrators. A comparison problem between periods thus arises because administrators in the 1970 census do not form a mutually exclusive tenure category as in previous censuses. We can still compute the relative number of administrators for both years. However, in 1950, managers/administrators were considered a different land tenure group, while in 1970, they are included in the other tenure groups. The consequence, espcially in those municipios with high proportions of administrators, is to inflate the 1970 proportions of the other tenure groups. This is especially the case for the owner category, since most administrators presumably work for large landowners (hired management being a characteristic of absentee-ownership).

The tenant category is essentially a residual one in Brazilian census data; all forms of renting and sharecropping arrangements are lumped together. The 1970 data do contain a distinction between sharecroppers and renters which is unfortunately not available for 1950. Census definitions of the tenure groups are as follows: (a) owners--those who have ownership and use of farmland; (b) tenants--those who are granted the use of the land on a contractual basis (written or verbal), for a fixed price (rent) or a share of the production; (c) squatters--those who use public or private land with or without approval of owners, and with no payment in return; and (d) administrators--those who are hired to direct farming activities (I.B.G.E., 1955a; F.I.B.G.E., 1975a).

Given the problems and considerations above, indicators for the land tenure variable have to be interpreted with caution. However, since the general measurement approach used in both censuses is similar--as the above definitions indicate--it seems warranted to attempt an inter-censal comparison of the tenure categories. The indicators selected are:

1. Percent of farms operated by owners.
2. Percent of farms operated by tenants.
3. Percent of farms operated by squatters.
4. Percent of farms operated by administrators.

Rural Labor Force

We have already noted in previous chapters that the Brazilian census details four rural labor groups. The first category is family labor which is defined as including the farm operator and members of his family who effectively assist in the farm operation without any remuneration. The other three groups constitute hired labor--persons who are remunerated (in kind, in wages, or both) for their work. These include: (a) permanent rural workers, effectively employed on the farm on a long-run basis; (b) temporary rural workers, those workers hired for specific tasks on a short run basis; and (c) sharecroppers, workers under the supervision of the farm management, but whose remuneration is a share of the crops produced (I.B.G.E., 1955a; F.I.B.G.E., 1975a). The indicators selected for this study reflect the relative importance of each of these groups in the total rural labor force of the municipios for each year. These indicators are:

1. Family labor as percent of total rural labor.
2. Permanent rural workers as percent of total rural labor.

3. Temporary rural workers as percent of total rural labor.

4. Sharecroppers as percent of total rural labor.

As is the case with the tenure categories, the rural labor force categories employed in the census cannot totally capture the variety and complexity of labor arrangements prevalent in rural Brazil. However, the labor force categories available are sufficiently relevant to the Brazilian rural context that they may provide important insight into the processes of change in the organization of relations of production in rural areas of Minas Gerais.

Rural Wages

The 1950 census reports little income data, while the 1970 census is much more complete in this respect. Given our particular interest in inter-censal comparisons as a method for evaluating patterns of rural social change at the municipal level, little rural income data are available for this study. The only comparable piece of information in this respect pertains to the average wage values of hired rural workers. To construct this indicator we have used information on total farm wage expenses and divided this value by the total number of permanent and temporary farm workers (the presumed major recipients of such wages) in each municipio. The rural wages indicator is thus a derived per capita index and suffers all the limitations attendant to such measures. Constant 1970 cruzeiros were used in the computations. We observed in Chapter 2 that the significance of such an indicator lies more in its relative than in its absolute meaning, given the margin of error involved both in the census wage expenses figures and in our standardization method. Nevertheless, the rural wages indicator is defined as the average annual wages of hired farm workers.

A similar procedure was used to derive an index of the average wages of industrial workers to be used in Chapter 5. The value of total wages paid to production workers in industry was divided by the recorded number of such workers, as published in the industrial censuses of 1950 and 1970. Constant 1970 cruzeiros were used in the computations. The indicator derived is the average annual wages of industrial workers.

Rural Literacy

The rural literacy rate indicator and its urban counterpart refer to the percent of population 5 years old and above with the ability to read and write. The indicators were calculated from tables published in the demographic censuses. The classification into rural and urban follows census definitions. The rural population is defined as that living outside the limits of cities and villages, in the countryside. Urban population is that living in towns (municipal seats) and villages or urban aggregates (distrital seats) (I.B.G.E., 1954; F.I.B.G.E., 1973). Rural and urban literacy rates are thus defined as:

1. Percent of rural population 5 years old and above with the ability to read and write.

2. Percent of urban population 5 years old and above with the ability to read and write.

Land Use

This variable is represented by two indicators of land use patterns in Minas Gerais municipios. These indicators are:

1. Percent of total farmland used for crops.

2. Percent of total farmland used for pastures.

Crop Mix

We commented in Chapter 2 concerning our approach to constructing indicators of crop mix. Three types of information have been developed to reflect the municipal crop mix patterns: (1) a specialization index, (2) a commercial/export crop concentration index and (3) indexes of the relative importance of certain crops.

The point of departure for each of the indexes was the hectares of municipal croplands devoted to each of ten crops recorded in the agricultural censuses. These crops are: corn, coffee, rice, beans, sugar cane, cassava, bananas, cotton, potatoes, and oranges. The censuses also report physical output figures for 37 other crops, which were not included because of the lack of cropland data they account for. The percent of cropland used for each of the above crops was directly calculated from the raw data taken from the 1970 census. The 1950 census, however, does not report data for total areas devoted to annual ("temporary") crops as does the 1970 census. The cropland data in the 1950 census are given only for crops cultivated singly or in association with other crops, but it is not available for all recorded types of crop associations. Therefore, when sizeable production occurs under a type of crop association for which the area is not recorded, the area information is underestimated, introducing error in indicators using cropland data. To cope with this problem, the total cropland area for a given crop in 1950 was estimated by using physical yield indicators.[5] Yield values were calculated on the basis of the available production and area information. Then, assuming that yields were the same for different types of cultivation, we have estimated the area for the culvitation type for which data were lacking by calculating the <u>expected area</u> from the production data available, given specific per hectare yield values. The expected area was summed with the other area information, giving the estimated total cropland area (in hectares) for any crop in 1950. With this procedure, 1950 cropland estimates should be reasonably comparable with the 1970 estimates.

Cropland estimates for each of the ten crops referred to above (as a percent of total farm cropland in the municipio) were used to derive the crop mix indicators. The <u>specialization index</u> is the percent of cropland devoted to the most prevalent crop in the municipio. In other words, for each municipio, ten indicators pertaining to the percent of cropland devoted to each crop were computed. The specialization index thus becomes the highest of these indicators for each municipio. The rationale for this index is that the larger the percentage that the one most prevalent crop accounts for, the more specialized is the municipio. The commercial/export concentration index corresponds to the percent of total cropland that is devoted to coffee, rice, cotton, and sugar-cane. The selection of these specific crops was made on the basis of their relative importance as commercial or export crops in the country, rather than their specific "behavior" within the Minas Gerais context. We do not claim that these are the only crops that are exported, or that the entirety of each crop is exported. Rather, the index is an empirical indicator that seems most suitable in the context of this study. In addition to these two indicators, we have selected a small number of specific crop indicators to be analyzed separately. These crops were selected primarily on the basis of their importance--in terms of total cropland--for Minas Gerais agriculture. Table 11 presents the distributions of the ten available crops in terms of their relative importance in Minas Gerais municipios. It can be observed that with exception of cotton and potatoes, all other crops are cultivated in the majority of municipios in both 1950 and 1970. However, there are wide variations among these crops in terms of the relative amount of cropland devoted to them in various municipios. Corn is clearly the most popular crop; it was the first crop in terms of percent of cropland in 71 percent of the municipios in 1950,

Table 11. Distributionsof First and Second Major Crops in Terms of Percentage of Municipal Cropland, Minas Gerais (Brazil) Municipios, 1950 and 1970

Crops	1950					1970				
	N of Cases Recorded	First		Second		N of Cases Recorded	First		Second	
		N	%	N	%		N	%	N	%
Corn	384	273	70.90	85	22.08	385	300	77.92	71	18.44
Coffee	358	57	14.81	53	13.77	363	28	7.27	48	12.47
Rice	384	36	9.35	75	19.48	382	38	9.87	84	21.82
Beans	384	14	3.64	155	40.25	384	5	1.30	144	37.39
Sugar Cane	373	1	0.26	4	1.04	366	6	1.56	12	3.12
Cassava	353	2	0.52	6	1.56	374	6	1.56	6	1.56
Banana	366	1	0.26	3	0.78	376	1	0.26	7	1.82
Cotton	137	1	0.26	1	0.26	96	1	0.26	3	0.78
Potatoes	230	-	-	2	0.52	198	-	-	6	1.56
Oranges	318	-	-	1	0.26	361	-	-	4	1.04
Total	-	385	100.00	385	100.00	-	385	100.00	385	100.00

and 78 percent in 1970. Coffee, rice, and beans follow as important crops, with sugar cane being less important. These five crops, then, were also selected as crop mix indicators. This group of variables is formed by the following indicators:

1. Crop specialization index.
2. Commercial/export crop concentration index.
3. Coffee cropland as percent of total cropland.
4. Rice cropland as percent of total cropland.
5. Sugar-cane cropland as percent of total cropland.
6. Beans cropland as percent of total cropland.
7. Corn cropland as percent of total cropland.

Productivity

It has been observed in previous chapters that the only municipal-level productivity data available from both 1950 and 1970 censuses are those pertaining to physical yields, i.e., land productivit-. We have dealt with the measurement of productivity in two ways: one, more specific, and another, more general. The specific measures basically consist of yield indicators for five selected crops: coffee, rice, sugar-cane, beans, and corn. All yield measures are calculated in terms of tons per hectare. The general measure is an average productivity index. Such an index attempts to reflect the relative position of municipios with respect to all ten crops under consideration. The index was constructed according to the following steps. The point of departure was the individual crop yields indicators for the ten crops. For each crop yield distribution, the mean and standard deviation were computed. With these values, a standardized yield value was computed for each municipio and each crop, using the general standardization formula:

$$\text{standard yield score} = \frac{X_i - \bar{X}}{\text{s.d.}}$$

where: X_i = the yield value of a crop in each municipio

$\bar{X}$ = the mean yield value of the crop for all municipios

s.d. = the standard deviation of crop yields values for all municipios.

The standard yield score that each municipio received for each crop is thus a relative indicator of its position in a standard score distribution which varies from minus to plus and has a mean of zero across all municipios. In other words, we have standardized the yield values for each crop. The standardization procedure then allows us to put yield values for different crops into a similar scale of measurement. Therefore, we can sum the standard yield scores across crops within each municipio. However, since crops vary in their relative importance in the municipios, we must take this into consideration to avoid bias. The percent of total cropland devoted to each of the ten crops for each municipio was thus used as a weighting factor in conjunction with the standard yield scores. Summing for each municipio the individual crops' standard scores times the percent of cropland devoted to each of the crops, and dividing by the sum of relative weights (percent of croplands),[6] we arrived at a general productivity index for each municipio. The same procedure was applied to the 1950 and 1970 data. The formula for the index was:

$$\text{Average productivity} = \frac{\sum_{i=1}^{10} (\text{Standard yield scores}) \times (\text{Percent crop cropland})}{\sum_{i=1}^{10} (\text{percent crop cropland})}$$

This average productivity index is a relative number that depicts the position of any municipio with respect to the others in the state in terms of yields of all ten crops considered here. The index ranges from positive to negative values because it is based on the crops standard yield scores. The higher the value, the higher the average productivity of a municipio.

Subsistence Production

The indicator used for this variable is farm residents private production of corn, beans, and cassava as a percent of total commercial production of these crops (all quantities measured in tons). We observed in Chapter 3 that this indicator was suggested by the availability in census data of output figures for private crop production by farm residents. Such figures are not included in the main production data reported at the municipio level, since they are not of major importance to the commercial farm sector. Subsistence production constitutes secondary production which is basically a return to labor and a form of non-monetary income. Only three of the major staple crops in the state have been considered to avoid cumbersome computations with respect to a large number of crops with little aggregate importance. The indicator is a ratio of two production figures (taken times 100)--the first obtained as a sum of resident farm personnel production of corn, beans, and cassava, and the second, the total production of these crops as recorded in the main production census tables. We have termed the latter commercial production to indicate that these production data correspond to farm enterprises as economic units, not as return to labor, even though we recognize that some proportion of these figures may in reality constitute subsistence production in the sence referred to above. A final observation is that the values for this indicator may exceed 100 percent. This of course occurs when the production values recorded for the private farm residents' output for the three crops is larger than those recorded as the main production data for municipal farms.

Urbanization

The indicator of urbanization used here is the most conventional one in Brazilian social statistics: percent of total municipal population classified as urban. As we pointed out when discussing the literacy rates variables, the census definition of urban and rural is basically an administrative one. All municipios. despite their population size and the size of the municipal seat (be it a truly urban aggregate or just a village), have some urban population according to the

Brazilian census. Such an administrative definition tends to overestimate the actual levels of urbanization in a municipio (Leloup, 1970). Students of urbanization point to the necessity of a more stringent conception of an urban nucleus (Leloup, 1970; Redwood, 1975; Lodder, 1977). We have attempted to create alternative indicators of urbanization, such as the percentage of population residing in the municipal seat, and the urban labor force as a percent of the total municipal labor force. However, all three indicators were highly intercorrelated (correlations ranged from .60 to .94, considering both 1950 and 1970 data).[7] The standard indicator had the highest correlations with the alternative indicators (all in excess of .80), and given its standard use and general meaning, was selected for use in this study.

Industrialization

The indicator employed to represent the extent of industrialization in this research was industrial labor force as percent of total labor force. This indicator was chosen on the basis of the general criteria for selection specified at the beginning of this section; it has a general meaning, apparent face validity, substantial variance among Minas Gerais municipios (high potential discriminatory power), and exhibits significant correlations with alternative indicators of the same measure (ranging from .33 to .82, considering data for both 1950 and 1970).

The industrial labor force data were taken from industrial census tables. Total labor force figures were obtained by summing the labor force figures for the industrial, commerce, service, and agricultural sectors. We are aware that these total figures do not always coincide perfectly with total labor force data--the size of the economically active population (PEA)--recorded in the 1970 demographic census. In fact, some authors have noted related discrepancies among the various 1970 census volumes (Patrick, 1975; Goodman, 1976). The decision to use summated total labor force figures was made for an important pragmatic reason. PEA values were not available for 1950, as they were for 1970. The procedure we use thus is the only one which could yield an approximation of the total labor force which is comparable between the two years.

Rural Net Migration

This variable has been calculated using the same procedure followed by Fandino (1975) in his study of rural net migration in Colombia:

> The residual of the difference between the observed in time two (1970, here) and the projection of the population in time one (1950, here) through time two (1970) on the basis of natural population growth gives the net migration. Since vital statistics are lacking, the population growth rate in the span calculated from the population censuses is used (Fandino, 1975, p. 46).

The national rate of population growth was used because of the acknowledged high rate of out-of-state migration in Minas Gerais during the period under consideration. The national figure is thus a more accurate proxy of the natural rate of population growth in Minas Gerais than the aggregate population growth rate for Minas alone. International migration in the country has been neglible during the last twenty years, making the national rate of population growth nearly identical to its presumed rate of natural increase. The rural net migration indicator was calculated according to this formula:

$$\text{Rural Net Migration} = \frac{Po_2 - P_p}{P_p} \times 100$$

where: Po_2 = observed rural population in 1970 (time two).

P_p = projected rural population in 1970, according to the growth rate of 2.92 percent per year applied to the observed 1950 rural population size.

The index is standardized by the projected population and multiplied by 100 to give a net difference, in percentage terms, between the actual rural population size and what is should have been under the hypothesis of no net spatial movement--that is, no migration. If the net effect is positive, this means that the observed rural population is larger than it should have been on the basis of only natural growth; therefore, some net in-migration has occurred. On the other hand, if the net difference is negative, the opposite interpretation is warranted; the actual rural population is smaller than would be expected on the basis of natural growth alone, and thus some net rural out-migration has occurred during the time span under consideration.

In connection with the hypothesis linking rural net migration and technological change, we have used rural population density as a control variable, following insight from the existing literature (Fandino, 1975). This variable has been measured in terms of rural population per hectare of arable land.

This concludes our discussion of the indicators used in the present study. Certain others had been initially selected as alternative indicators of the variables discussed above, but were eliminated from the analyses that follow. They are, however, included in the descriptive statistics tables and the general correlation matrix presented in Appendixes A and B.

PLAN OF ANALYSIS AND STATISTICAL PROCEDURES

In this final section we briefly discuss the analytical strategies and statistical procedures applied in this research. As noted in Chapter 1, the results are presented in three chapters, each of which deals with one of the main research questions proposed at the beginning of this study. We follow the same three-part organization below in discussing the methods that pertain to each of our main research objectives.

The Analysis of Change Tendencies

The focus of this study is the analysis of social change. As Cohen and Cohen (1975) point out, the importance of the study of change in the social and behavioral sciences is patent:

> Whether the context is one of manipulative experiment or the non-experimental observations of events in the natural flux, the very heart of the study of causal mechanisms and systems is intimately bound up with the assessment of change and its correlates (Cohen and Cohen, 1975, p. 378).

However, the study of change is far from being as simple or straightforward as it may intuitively seem. In fact, the most intuitively appealing way to measure change--that is, by means of simple difference or gain scores between time one and time two--is also the most criticized one, on various methodological grounds (Bohrnstedt, 1969; Cohen and Cohen, 1975). The most important critique echoed by these authors is that simple difference scores do not merely reflect change. The difference between two temporal measurements of a variable tends to be dependent on the initial level, i.e., the level at time one. The correlation between such change scores and time one values is not zero, but on the contrary, tends to be negative (the higher the initial value, the lower is the expected change). The heart of the problem, then, is that the change measure embodies some of the effects of the initial value of the variable. Thus correlations between the change measure and other variables are distorted by the unaccounted effect of the initial values.[8] The basic point made by these methodologists is that an adequate measure of change is one that truly removes the effect of the initial values. Such a measure can be obtained by using partial correlation coefficients and/or regression coefficients. We apply these estimates of change in our analyses of technological change and social organization in Chapters 6 and 7 and discuss their operationalizations below. For the first empirical chapter, however, which is largely inductive and exploratory, we rely on descriptive statistics for the variables derived from Minas Gerais municipal data.

The results for Chapter 5 are presented in tables pertaining to each of the variables of the study. The following descriptive statistics are reported: mean, median, standard deviation, minimum and maximum values, and skewness. We include specific distributions for all municipios in the state of Minas Gerais (385) and for each of the eight regional sub-divisions we have defined for the state. For each of these nine aggregates, the statistics for three different distributions (1950, 1970, and percent change, 1950-1970) are presented. The objectives of these tables are to provide an extensive--and at the same time, concise--view of the general characteristics and patterns of change in the variables of the study for the various regions of the state. Such information, when compared with our national benchmark data from Chapter 2, will allow us to gain some insight into the patterns of local social organization and change in Minas Gerais.

We noted above the methodological critiques of measures of change which do not explicitly eliminate the influence of original levels of the variable. Nevertheless, even though these reservations are sound from a methodological perspective, from a substantive point of view these considerations may be less important for descriptive analyses. For purposes of descriptive analysis it may be quite useful to explicitly consider how observed change does relate to initial levels of the attribute. As seems to be the case in a socially and spatially uneven development process, initial values may be powerful determinants of the future rates of change, representing the unleashing of forces that lead to further and more rapid accumulation in privileged regions. One must, then, be interested not only in more or less "pure" change--that is, change independent of initial levels--but also in the differential status of the units of the study with respect to the levels of an attribute in different time periods. This will be the approach used in the descriptive portion of the study in Chapter 5. In Chapter 5 we compare the relative levels of the variables in 1950 and 1970 for the entire state and within regions. In addition, we use percent change statistics as our change measure.[9] Percent change values were calculated as follows:

$$\text{Percent change} = \frac{\text{1970 value} - \text{1950 value}}{\text{1950 value}} \times 100$$

This is essentially a gain score measure of change, standardized by the original value. It was our initial purpose to use this as one alternative measure of change in the study and compare the results thus obtained with the other measures. However, the presence of initial values of zero for certain variables (particularly for the agricultural technology indicators), which makes the calculations of the percent change values impossible, only enabled us to use these measures in the largely descriptive Chapter 5.

The Analysis of Antecedents of Technological Change

We have used several statistical procedures to evaluate the relative impact of social organization variables on agricultural technology change in Minas Gerais municipios. These procedures are first-order partial correlation coefficients, cross-lagged correlations, and multiple classification analysis. A fourth procedure, multiple regression, has been applied using only the significant indicators found in the previous analyses. These results, however, are not fully discussed in the text but are presented in Appendix C, since the main interest here is to evaluate specific hypotheses concerning the relationships of social organization and agricultural technology, rather than provide a complete explanatory model of technological change on the basis of local social organization variables.

Before we briefly comment on these methods, a general consideration must be stated concerning the transformations applied to the data prior to the analyses. It will be observed in the tables in Chapter 5 that the distributions of a large number of variables in the study are very skewed--that is, characterized by the presence of outlyer values, and with the majority of values clustered to one side the mean. Skewed distributions tend to diminish linear relationships such as those we wish to estimate with the statistical procedures used in this study. Following suggestions by Hibbs (1973) and Cohen and Cohen (1975), we applied a natural logarithmic transformation to our indicators before proceeding with the statistical analysis. Such a transformation, which is especially valuable when variables are measured in terms of proportions, has the effect of "stretching the tails" of the distributions "in order to achieve a unit of measurement which is more nearly linearly related to other variables" (Cohen and Cohen, 1975, p. 255). All our variables, then, for 1950 and 1970, have been log-transformed. This procedure, of course, does not apply to the descriptive results in Chapter 5.

We have noted in the previous section the case made by some methodologists for a measure of change that is free from the effects of the initial values. The method for achieving this goal is to compute "regressed," "partialled," or "residualized" change scores. Assume that Y_1 is the measure of a variable at time one, Y_2 is a measure of the same variable at time two, and ΔY is a measure of change to be derived from Y_1 and Y_2. A residualized change score procedure involves computing ΔY by regressing Y_2 on Y_1, ΔY being the standardized residual from the regression line. This measure of change may be considered a function of the effects of other variables ($X_1 \ldots X_i$) and measurement error (Bohrnstedt, 1969; Cohen and Cohen, 1975), since the effects of Y_1 on ΔY have been removed.

One alternative way to deal with the analysis of change as described above is by using first-order partial correlation coefficients (Bohrnstedt, 1969; Cohen and Cohen, 1975). This method for analyzing change will be used to assess hypotheses concerning the possible antecedents of technological change in Minas Gerais municipios from 1950 to 1970. First-order partial correlation coefficients will be calculated for the effects of hypothesized 1950 independent variables (indicators of municipal social organizational characteristics) on 1970 levels of agricultural technology indicators, controlling for the 1950 level of technology. Such coefficients can be interpreted as reflecting the level of shared variance between the 1950 social organization variable and the 1970 agricultural technology variable, exclusive of their shared variance with the 1950 agricultural technology variable. In other words, this coefficient reflects the more or less "pure" association between an antecedent indicator of local social organization and change in agricultural technology.

The second procedure used, cross-lagged correlation, reveals the associations between 1950 levels of local social organization indicators with the 1970 levels of agricultural technology indicators. This procedure, subjected to vehement criticism for evaluating change because it does not take the original values of the dependent variable into account (Bohrnstedt, 1969) is employed here for reasons of comparison and to enable us to gauge the substantive importance of the extent to which change is dependent on the initial values. These unpartialized coefficients are expected to generally be larger than those generated by using the partial correlation method described above.

The third procedure employed in Chapter 6 has to do with the inclusion of regional location--a nominal variable--in the analysis. Multiple classification analysis (MCA) is especially suited for evaluating the effects of the nominal-level variables on interval-level dependent variables such as the agricultural technology indicators. These effects are presented in terms of the deviations of subcategory means for each category of the independent variable from the grand mean of the dependent variable. The MCA procedure when employed with one nominal-level independent variable yields a summary statistic, eta, which is equivalent to a simple beta from the bivariate linear regression of the dependent variable on the factor (Nie et al., 1975, p. 410). When more than one factor and/or covariates is used in conjunction with MCA, this summary statistic, now called beta, can be interpreted as being analagous to the standardized partial regression coefficient in a multiple regression context.[10] This statistical procedure, then, allows us to evaluate the overall impact of regional location on municipios' agricultural technology levels in 1950 and 1970, and 1950-1970 change, as well as a specification of the regional disparities that exist (by means of the regional deviations from the grand means and the magnitude of the eta statistics).

The Analysis of Consequences of Technological Change

The main procedures used to evaluate possible impacts of change in agricultural technology on change in indicators of rural local social organization are: (1) computing simple correlations between residualized change scores, and (2) multiple regression analysis. The first procedure allows us to estimate the associations between change in agricultural technology and change in social organizational characteristics. Our third main research question, again, is basically concerned with impacts of technological change rather than the impacts of initial technological levels. This is because it is acknowledged that agricultural technology levels in 1950, as measured by our indicators, were generally very low and may not be expected to show significant "independent" effects on social organizational changes. Nevertheless, this rival hypothesis will be assessed with the second set of procedures--multiple regression analysis. Initial technology levels are employed as an additional independent variable to determine the relative impacts of initial levels of and changes in agricultural technology on change in patterns of local rural social organization.

A residualized change score operationalization, as noted above, is an alternative technique (in addition to computation of the first order partial correlation coefficients) for dealing with change scores that are independent from initial values. The residualization of the 1970 variable values from their corresponding 1950 ones involves computing the difference between the observed 1970 values (time two) and those estimated or predicted by least squares procedures from 1950 (time one) values. These deviations are in turn standardized by dividing by the standard error of the estimate ($S_{y.x}$). These standardized deviations from the regression line become the measure of change. A correlation between two such change scores is, strictly speaking, a correlation between two measures of change, removing the effects of the initial levels of both variables.

Our analysis then proceeds in the following way: Firstly, we compute simple correlations between the residualized change scores of the agricultural technology indicators and the residualized change scores of the rural local social organization indicators, selected according to the hypotheses laid out in Chapter 3, and conducted according to the procedure just described. Independent variables with "significant" effects (according to an arbitrary criterion of exhibiting a correlation of ±.10 or larger) are selected for further analysis. A second procedure--multiple regression analysis--is used for this purpose. We test initially the rival hypotheses referred to above--that is, whether the initial level of technology is more important than technological change in shaping change in local rural social organization. We thus compute multiple linear regression equations in which specific residualized change score indicators of local rural social organization are regressed on 1950 technology levels and the residualized change scores for agricultural technology. Again, these two independent variables are perfectly uncorrelated due to the way the change measure has been constructed. Hibbs, a highly regarded politimetrician, in his cross-national study of mass political violence (1973), has used regression models in which both change and initial levels variables have been included simultaneously as independent variables. Guidance as to the applicability of or pitfalls in this procedure cannot be easily obtained because of the paucity of literature on this methodological issue. Nevertheless, use of the procedure seems warranted due to the precedent that such a respected methodologist as Hibbs has set.

We have chosen an arbitrary criterion for proceeding with the analysis. This refers to the selection of the dependent variables for further probling. In this next step we consider only those social organization change indicators for which at least five percent of their variance was accounted for by the agricultural technology indicators. For these dependent variables we compute multiple linear regression equations which include the center-periphery variable as an additional antecedent. As noted in Chapter 3, the center-periphery construct represents the most likely counter-hypothesis relative to the impact of the agricultural technology indicators in the context of this study. The regional location variable is treated as a series of dummy variables in the multiple regression equations. However, the coefficients reported below for regional location are the beta statistics obtained through separate multiple classification analysis equations which includes the same independent variables as the multiple regression models do. The betas are reported given the intuitive appeal of their interpretation as being analagous to standardized partial regression coefficients.

SUMMARY

The methodological procedures depicted in the foregoing were designed to provide a comprehensive glimpse at an extensive body of data, while also acknowledging the applicability and testing for the plausibility of rival or alternative hypotheses. While the statistical techniques used may be considered sophisticated and powerful, we stop short of applying techniques such as causal modeling (Heise, 1975; Duncan, 1975) and the decomposition of effects (i.e., total, direct, and indirect effects in path analysis; Alwin and Hauser, 1975). We do so for several reasons. Firstly, the data base employed herein is so extensive as to prohibit convenient summarization in one, two, or even 10 causal models. Secondly, studies of agrarian structure and social change in Third World Milieus using ecological data are largely nill, meaning that theoretical closure is hardly present for comprehensive causal modeling. Lastly, our data pertain to the local (municipal) level, and the full range of causes of technological change and change in local rural social organization is likely to be found, in part, in <u>non-local</u> phenomena (e.g., political decisions, the changing character of the world-system and the differential integration of Brazil into that system over time, and so forth). Thus any given causal model that is specified at the municipal level is likely to lack important causal mechanisms exogenous to Minas Gerais (or totally lacking from the data available to us). We thus feel that the statistical procedures employed are suitable for the research problems set forth at the outset--recognizing and presuming that more sophisticated methodological approaches may follow in the wake or preliminary inquiries such as this.

The legnth of this chapter attests to the fact that the operationalizations of variables are not always ideal. Frequently, a specific variable of interest is either totally lacking in the census volumes or its definition changes between census period. This of course is a problem endemic to ecological analysis, even for advanced society such as the U.S. (Duncan, Gizzort and Duncan, 1961). Despite the limitations of the data, however, one might be more impressed with the inter-censal reliability[11] exhibited in the data used herein, especially considering the conditions under which these data were collected. Nevertheless, we recognize the limitations of the data base and the operationalizations this base makes possible, while viewing these data largely adequate for exploring the research problems and hypotheses set forth above.

FOOTNOTES

1. We have also some empirical confirmation for the adequate reliability levels of these data: Since we have replicated data--that is, similar indicators measured in two different times--we can interpret similar values for correlations found in these two sets of data as a kind of stability test for reliability. For example, we expect that indicators reflecting alternative measures of the same concept to be highly correlated in both periods. This is pecisely the outcome with variables across the 1950 and 1970 data indicating that the data tend to be stable over time. This suggests adequate reliability of measurement across the two time periods. Intercorrelations for the file utilized in this study can be found in Appendix B.

2. This agency is the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografía e Estatistica) known as I.B.G.E. Recently, I.B.G.E. has been reorganized as a foundation, thus the new abbreviation becomes: F.I.B.G.E.

3. Appendix B presents a comprehensive correlation matrix for all variables used in this study, including the 1950, 1970, and residual (1950 to 1970) change values.

4. See Costa (1974, 1975a) for further detail on the ambiguity of the Gini coefficients to reflect two different situations when Lorenz curves that cross each other represent similar inequality areas. It should also be noted that the Gini coefficients of land inequality reported below will substantially underestimate the actual level of inequality because of the way that the census agency defines "farm." However, one can reasonably assume that there is consistent underestimation, so that our inequality indicator is proportional to the actual degree of inequaltiy.

5. Total physical yields do include output from both single and associated cultivation, from which area data was available, in 1950, and total output and area, in 1970.

6. This is necessary because the 10 selected crops do not comprise 100 percent of the cropland within most of the municipios.

7. All correlations reported in this chapter are Pearsonian product-moment correlation coefficients.

8. Another basic problem with difference scores is their relatively lower reliability (which is dependent on the original pre-post values' reliabilities) which causes further distortions--generally lowering their correlations with other variables (Cohen and Cohen, 1975; Bohrnstedt, 1969). We may also note that rate of change scores suffer from the same biases as do difference or gain scores.

9. The use of percent change statistics can be considered a conservative estimate of change under a general hypothesis of increasing regional inequality. This is because the formula for calculating the rate of change uses the 1950 value as the denominator, thereby leading to a bias such that the rate of change will tend to be inversely correlated with scores at time one (i.e., 1950).

10. Further detail on the characteristics and uses of this technique can be found in Nie et al. (1975), in their chapter on the analysis of variance and covariance. For this and all statistical procedures in this study, the SPSS statistical package has been used for the calculations. Also note that bivariate MCA is identical to one-way ANOVA, the only difference being the explicit reporting of subcategory deviations from the grand mean in MCA.

11. Again, as noted above, very high degrees of inter-censal reliability were inferred from consistent (and typically high) intercorrelations among several alternative indicators of the same concept (e.g., urbanization, farm size, etc.).

CHAPTER V

STRUCTURAL CHANGE IN MINAS GERAIS MUNICIPIOS, 1950-1970

In this chapter we present the results pertaining to our first major research question. As emphasized above, the materials of this chapter are essentially descriptive in nature. We here attempt to derive insights into the patterns of social change at the municipal level in Minas Gerais. The hypotheses in this respect stated in Chapter 3 are quite general, reflecting the largely inductive and exploratory character of this chapter. The descriptive statistics tables referred to in Chapter 4 are presented and discussed in the order the variables have been organized in the context of this study--that is, firstly, the indicators of agrarian structure with their two broad dimensions of relations of production (class and status variables) and productive forces, followed by the "non-rural" indicators (the center-periphery dimension and rural net migration). In a final section, we present a brief composite summary of the major tendencies detected and an evaluation of the general hypotheses detailed concerning anticipated change patterns. We have constructed descriptive statistics tables for all indicators selected for this study. However, given their large numbers, we discuss in this chapter only the most representative variables, leaving others in Appendix A. A further observation must be made at this point; only general discussions of the tables are made in this chapter for the sake of brevity and clarity, given the considerable amount of information they contain. The strategy is to compare the tendencies for indicators of the same variable among regions of Minas Gerais (and also by comparison with the more encompassing macro-regional data presented in Chapter 2).

FARM SIZE AND LAND INEQUALITY

The farm size and land inequality data are presented in Tables 12, 13, 14 and 15. The most general tendencies revealed by these tables follow the patterns described for the macro-aggregates in Brazil; average farm size tends to decrease, and prevalence of very small farm units (less than 2 hectares) tends to increase, the prevalence of larger farm units (more than 200 hectares) tends to slightly decrease, and land inequality tends to remain stable in Minas Gerais municipios between 1950 and 1970. It can also be seen that there are decided regional variations in terms of the farm size indicators in both years, but this is not the case with respect to the land inequality index. These regional characteristics of the municipal distributions are also consistent with the general national patterns depicted in Table 1 in Chapter 2. Regions located in the upper half of the state (São Paulo Periphery II, Belo Horizonte

Table 12 Descriptive Statistics for Average Farm Size (in Ha.) All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	155.4	90.4	203.2	15.4	2730.4	6.7
	385	1970	99.5	64.3	104.4	13.4	1031.9	3.5
	385	% Change	-29.0	-32.3	26.9	-82.0	73.5	0.89
S. Paulo Peri-phery I	103	1950	95.2	71.7	73.3	25.7	512.1	2.8
	103	1970	53.8	43.8	32.1	13.4	200.0	1.9
	103	% Change	-36.6	-40.5	23.8	-78.4	48.6	1.0
S. Paulo Peri-phery II	33	1950	359.5	310.5	163.7	138.8	921.3	1.4
	33	1970	231.6	205.8	90.3	124.3	422.2	0.72
	33	% Change	-32.6	-34.1	16.1	-59.1	-1.7	0.15
Belo Horizonte Center	14	1950	110.1	88.1	65.6	15.4	234.3	0.48
	14	1970	61.6	62.8	31.0	16.0	142.3	0.92
	14	% Change	-30.8	-31.7	35.4	-77.2	51.2	0.58
Belo Horizonte Periphery I	77	1950	111.6	92.2	65.8	33.2	402.6	1.9
	77	1970	71.6	60.0	40.7	20.0	200.3	1.3
	77	% Change	-29.7	-35.1	29.0	-82.0	50.4	0.54
Belo Horizonte Periphery II	39	1950	203.4	152.0	143.1	17.3	645.3	1.0
	39	1970	142.1	111.9	90.1	14.2	401.4	0.88
	39	% Change	-24.3	-25.5	21.5	-68.1	30.4	0.45
Rio de Janeiro Periphery I	62	1950	84.6	72.2	51.3	23.8	310.1	2.0
	62	1970	52.9	45.1	28.1	17.9	123.7	1.0
	62	% Change	-34.3	-37.0	16.9	-72.7	7.0	0.30
Rio de Janeiro Periphery II	27	1950	90.9	76.4	55.3	28.8	279.6	2.1
	27	1970	98.1	68.0	77.6	35.1	397.5	2.4
	27	% Change	5.4	3.4	32.6	-52.0	73.5	0.22
Rural Periphery	30	1950	412.7	211.6	454.2	29.3	2730.4	2.8
	30	1970	242.7	154.0	225.9	25.5	1031.9	1.7
	30	% Change	-22.3	-24.1	30.2	-77.1	51.5	0.57

1/ No missing cases.

Table 13. Descriptive Statistics for Percent of Farms with Less than 2 Ha., All Observations (State), and by Regional Location, Minas Gerais (Brazil), Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	1.9	0.56	3.3	0	28.4	3.2
	385	1970	4.2	2.0	5.9	0	48.7	2.7
	260	% Change	343.7	54.8	987.5	-100.0	8871.5	5.6
S. Paulo Periphery I	103	1950	2.2	1.0	3.0	0	16.2	2.1
	103	1970	5.8	3.9	5.6	0	27.5	1.6
	103	% Change	552.4	151.5	1233.3	-100.0	8226.5	4.3
S. Paulo Periphery II	33	1950	0.59	0	1.0	0	4.6	2.2
	33	1970	0.27	0.001	0.57	0	3.0	3.3
	81	% Change	-47.6	-80.7	76.7	-100.0	142.8	1.3
Belo Horizonte Center	14	1950	5.7	0.68	9.1	0	28.4	1.6
	14	1970	16.0	10.9	12.7	3.2	48.7	1.6
	9	% Change	1226.4	108.9	2909.7	-61.9	8871.5	2.2
Belo Horizonte Periphery I	77	1950	2.5	1.1	3.5	0	16.4	2.0
	77	1970	4.7	2.2	5.5	0	23.8	1.8
	56	% Change	201.2	12.1	441.9	-100.0	2383.9	2.7
Belo Horizonte Periphery II	39	1950	2.2	0.32	3.3	0	11.1	1.6
	39	1970	1.1	0.28	2.8	0	11.5	2.0
	28	% Change	97.0	-47.1	290.1	-100.0	894.9	1.5
Rio de Janeiro Periphery I	62	1950	2.0	0.89	2.9	0	13.0	2.0
	62	1970	5.2	3.6	5.1	0	24.6	1.4
	47	% Change	205.4	93.8	719.0	-88.4	3789.4	3.1
Rio de Janeiro Periphery II	27	1950	0.34	0.01	0.56	0	2.0	1.5
	27	1970	1.8	0.54	3.0	0	13.4	2.6
	13	% Change	485.9	110.4	884.4	-100.0	2993.7	2.0
Rural Periphery	30	1950	0.27	0	0.80	0	4.0	3.7
	30	1970	0.15	0.04	0.26	0	1.3	3.0
	10	% Change	-70.0	-97.8	50.1	-100.0	52.8	1.5

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Table 14. Descriptive Statistics for Percent of Farms with More than 200 Ha., All Observations (State), and by Regional Location, Minas Gerais (Brazil), Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	15.2	10.5	13.4	0	78.3	1.6
	385	1970	10.3	6.4	10.9	0	52.0	1.7
	385	% Change	-32.3	-38.1	38.6	-95.7	134.8	1.3
S. Paulo Periphery I	103	1950	10.8	7.8	9.5	1.0	50.7	1.9
	103	1970	5.2	3.5	5.3	0.31	29.6	2.3
	103	% Change	-50.0	-54.4	26.8	89.1	53.9	1.1
S. Paulo Periphery II	33	1950	37.1	35.7	11.6	16.0	67.6	0.62
	33	1970	29.0	28.2	10.9	14.7	50.6	0.46
	33	% Change	-21.3	-20.8	18.1	-53.8	13.5	0.01
Belo Horizonte Center	14	1950	12.0	9.7	9.9	0	39.2	1.4
	14	1970	6.5	5.9	4.2	0	16.9	0.81
	13	% Change	-25.9	-28.6	50.7	-84.8	92.4	0.93
Belo Horizonte Periphery I	77	1950	12.5	10.8	6.8	0	35.4	0.81
	77	1970	7.2	5.3	6.2	0.54	28.3	1.5
	76	% Change	-37.9	-50.2	37.0	-95.8	68.3	0.74
Belo Horizonte Periphery II	39	1950	19.9	17.3	12.4	0.21	53.9	0.87
	39	1970	15.6	13.8	10.3	0.22	42.1	0.70
	39	% Change	-19.3	-24.0	26.7	-77.2	47.0	0.46
Rio de Janeiro Periphery I	62	1950	9.6	6.7	8.9	0.93	51.8	2.4
	62	1970	4.7	3.3	4.2	0.23	19.0	1.6
	62	% Change	-48.2	-51.5	24.2	-90.0	21.7	0.70
Rio de Janeiro Periphery II	27	1950	8.0	6.6	5.7	1.7	23.6	1.6
	27	1970	10.2	7.8	10.1	1.6	49.0	2.3
	27	% Change	25.9	24.8	59.4	-67.7	134.8	0.15
Rural Periphery	30	1950	27.4	22.3	20.5	1.0	78.3	0.81
	30	1970	21.6	16.5	15.0	0.83	52.0	0.53
	30	% Change	-8.9	-20.5	43.9	-61.8	134.3	1.8

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Table 15. Descriptive Statistics for Land Inequality (Gini coefficients), All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Municipios 1/	Year	Statistics Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	0.63	0.63	0.08	0.42	0.90	0.18
	385	1970	0.63	0.62	0.07	0.46	0.88	0.56
	385	% Change	0.74	-0.64	10.6	-22.9	42.5	0.76
S. Paulo Periphery I	103	1950	0.64	0.63	0.06	0.47	0.80	-0.08
	103	1970	0.63	0.62	0.06	0.46	0.80	0.36
	103	% Change	-1.5	-2.2	8.2	-19.2	25.5	0.61
S. Paulo Periphery II	33	1950	0.65	0.64	0.05	0.52	0.76	-0.08
	33	1970	0.62	0.61	0.05	0.49	0.72	-0.03
	33	% Change	-5.1	-6.7	7.2	-19.6	11.1	0.35
Belo Horizonte Center	14	1950	0.70	0.68	0.10	0.49	0.83	-0.56
	14	1970	0.73	0.73	0.06	0.63	0.87	0.24
	14	% Change	7.1	0.96	13.2	-11.6	28.1	0.35
Belo Horizonte Periphery I	77	1950	0.64	0.64	0.07	0.42	0.90	0.01
	77	1970	0.64	0.62	0.07	0.50	0.83	0.61
	77	% Change	0.86	-1.1	12.8	-22.9	33.1	0.53
Belo Horizonte Periphery II	39	1950	0.68	0.66	0.08	0.50	0.88	0.24
	39	1970	0.67	0.65	0.08	0.52	0.88	0.52
	39	% Change	-0.88	-2.2	8.5	-14.6	16.2	0.40
Rio de Janeiro Periphery I	62	1950	0.60	0.59	0.06	0.44	0.76	0.02
	62	1970	0.60	0.59	0.05	0.49	0.75	0.72
	62	% Change	1.6	0.48	9.3	-13.9	42.5	1.3
Rio de Janeiro Periphery II	27	1950	0.58	0.57	0.06	0.45	0.73	0.30
	27	1970	0.64	0.64	0.06	0.47	0.80	-0.20
	27	% Change	10.5	9.1	11.6	-21.2	41.1	0.13
Rural Periphery	30	1950	0.65	0.62	0.11	0.46	0.84	0.13
	30	1970	0.66	0.64	0.07	0.50	0.81	0.07
	30	% Change	2.9	0.40	10.3	-14.9	27.2	0.56

1/ No missing cases.

Periphery II, and the Rural Periphery--the more "frontier" areas of the state) tend to have the larger average farm sizes. The areas of older colonization (particularly the São Paulo Periphery I and Rio de Janeiro Periphery I), on the other hand, generally have smaller average farm sizes. Similar patterns are found with the other two farm size indicators. Regions with larger average farm sizes generally tend to have lower percentages of small farms and higher percentages of larger farms, the converse being the case for regions with lower average farm sizes. Despite these regional tendencies, municipal distributions for the farm size indicators generally have considerable dispersion (measured in terms of standard deviations and minima-maxima) and high skewness. This supports our anticipation of high variability among municipios and a tendency for farm size scores to be clustered to the left of the mean--that is, to be generally smaller than the mean. Variability is highest for the percent of farms with less than two hectares indicator, which interestingly, also experienced increased variability (i.e., an increased standard deviation) from 1950 to 1970.

Rate of change distributions tend to be characterized by relatively low, negative mean values for indicators of average farm size and percent of farms with more than 200 hectares in most regions of the state. On the other hand, the percent of farms with less than two hectares indicator shows wide municipal and regional variations in its rate of change distributions.

The average rate of change for small farms tends to be negative in a few regions (São Paulo Periphery II and Rural Periphery, for example), but positive and substantial in most other regions--particularly the Belo Horizonte Center. By comparison with the farm size variables, the Gini coefficient indicators are characterized by small regional variations and relative stability during the period, as observed with national data (Table 1, Chapter 2). These values, however, tend to be smaller than those for the macro-aggregates in Brazil. The most interesting variations are those among municipios themselves, as represented by the minimum and maximum values of the various distributions. They indicate that land inequality at the municipal level in Minas Gerais varies from moderately high (Gini coefficients of approximately .40) to very high (around .80), but such values are extreme, since the majority of municipios tend to have inequality levels quite close to the overall mean (as revealed by relatively small standard deviation and skewness statistics). These observations indicate that despite large municipal variations with respect to farm size and land inequality, the most significant patterns of change at the local level are quite consistent with national ones.

LAND TENURE

Descriptive statistics for the land tenure categories are presented in Tables 16 through 19. Table 16 refers to the percent of farms operated by owners. It can be observed that prevalence of owners is very high in all regions and in both years. These values are very close to aggregate figures for the entire state of Minas Gerais, as presented in Table 3 in Chapter 3. If the state of Minas Gerais exhibits the highest proportion of owners among farm operators in Brazil as well as general stability in these proportions during the 1950-1970 period (contrary to the trend in most other regions of the country), the internal picture for the state (in terms of its regions) is basically much the same. Only small regional variations are observed for this indicator, and the mean values of the rate of change distributions are minimal. Another indication of the importance and relative stability of the proportion of owner-operators in Minas Gerais municipios is given by the minimum values for 1950 and 1970; in only two of the eight regions were there any values lower than 50 percent. Further, negative signs for the skewness statistics indicate that the majority of values tends to be larger than their respective means.

However, the tenant indicator presented in Table 17 reveals a very different and more complex picture among Minas Gerais municipios. The most general trend observed for all regions is an increase in the proportion of tenant-operators between

Table 16. Descriptive Statistics for Percent of Farms Operated by Owners, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	88.3	89.4	6.8	49.5	100.0	-1.7
	385	1970	86.0	80.0	11.1	9.8	100.0	-0.32
	385	% Change	-2.2	-1.1	13.9	-89.0	44.2	-2.1
S. Paulo Periphery I	103	1950	89.1	89.2	5.4	65.9	98.9	-0.94
	103	1970	86.4	88.4	7.8	58.0	100.0	-0.81
	103	% Change	-2.5	2.4	10.9	-36.9	30.8	-0.01
S. Paulo Periphery II	33	1950	85.4	85.5	7.9	65.7	97.1	-0.83
	33	1970	83.7	86.7	9.9	55.6	98.2	-0.90
	33	% Change	-1.4	-1.4	12.0	-33.5	23.2	-0.36
Belo Horizonte Center	14	1950	80.7	82.5	10.0	58.3	91.9	-1.0
	14	1970	82.0	82.5	9.3	61.8	97.1	-0.52
	14	% Change	2.6	2.2	13.3	-19.4	23.5	0.07
Belo Horizonte Periphery I	77	1950	90.1	91.3	5.8	62.6	100.0	-1.8
	77	1970	89.8	90.6	4.5	77.1	99.0	-0.69
	77	% Change	0.01	-1.1	7.4	-13.1	32.7	1.7
Belo Horizonte Periphery II	39	1950	90.3	91.0	5.9	68.6	97.7	-1.5
	39	1970	87.8	89.4	6.9	66.8	96.0	-1.0
	39	% Change	-2.3	-1.4	9.8	-23.1	37.3	1.3
Rio de Janeiro Periphery I	62	1950	86.6	87.2	6.2	65.1	97.7	-1.2
	62	1970	87.3	88.7	6.7	65.1	99.0	-1.0
	62	% Change	0.79	0.57	10.7	-49.2	29.3	-1.1
Rio de Janeiro Periphery II	27	1950	89.5	91.5	6.8	61.2	96.9	-2.6
	27	1970	83.0	90.7	16.6	36.5	97.3	-1.4
	27	% Change	-6.8	-0.96	19.0	-60.0	11.7	-1.4
Rural Periphery	30	1950	87.1	88.6	8.9	49.5	96.6	-2.5
	30	1970	76.7	86.2	25.6	9.8	97.1	-1.7
	30	% Change	-11.4	-5.2	30.3	-89.0	44.2	-1.3

1/ No missing cases.

Table 17. Descriptive Statistics for Percent of Farms Operated by Tenants, All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Changes 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	3.4	2.3	3.8	0	24.6	2.5
	385	1970	7.9	6.0	6.8	0	50.4	2.2
	362	% Change	451.0	147.6	1158.5	-100.0	16550.1	8.8
S. Paulo Periphery I	103	1950	4.2	3.4	3.7	0	24.6	2.3
	103	1970	9.5	7.7	6.3	0	35.4	1.3
	100	% Change	331.2	130.7	546.8	-100.0	3086.4	2.9
S. Paulo Periphery II	33	1950	5.9	3.6	6.3	0.20	24.3	1.8
	33	1970	11.4	7.9	9.0	1.4	38.0	1.3
	33	% Change	339.9	110.2	739.7	-85.6	3683.5	3.4
Belo Horizonte Center	14	1950	5.1	2.6	5.7	0	19.8	1.3
	14	1970	7.2	5.7	5.2	0.94	18.4	0.56
	12	% Change	110.2	6.5	227.3	-88.8	740.7	1.8
Belo Horizonte Periphery I	77	1950	2.9	2.5	2.0	0	9.8	1.1
	77	1970	6.1	5.1	3.6	0.91	18.4	1.1
	73	% Change	194.5	82.4	372.8	-31.0	1783.9	3.1
Belo Horizonte Periphery II	39	1950	3.1	1.7	4.3	0	21.2	2.5
	39	1970	4.8	3.5	4.4	0.28	18.8	1.7
	37	% Change	262.0	141.9	459.4	-87.0	2564.4	3.7
Rio de Janeiro Periphery I	62	1950	3.1	2.1	3.1	0	15.0	1.5
	62	1970	9.4	7.6	5.8	0.73	28.5	1.0
	61	% Change	526.5	286.2	685.3	-40.4	3177.5	2.3
Rio de Janeiro Periphery II	27	1950	1.2	0.61	1.7	0	8.3	2.8
	27	1970	10.1	5.0	13.3	0.70	50.4	1.9
	23	% Change	1830.2	638.4	3620.7	-73.3	16550.1	3.1
Rural Periphery	30	1950	1.0	0.20	2.7	0	12.1	3.3
	30	1970	2.6	1.4	2.8	0.20	10.8	1.4
	23	% Change	848.3	323.2	1460.4	-68.9	6617.2	2.8

1/ The number of municipios within regions, varies because of the missing cases in the percent distribution.

1950 and 1970, as found in most regions of Brazil (Table 3, Chapter 2). However, the intensity of this tendency varies widely among Minas Gerais municipios, and to some extent, among regions as well. The average proportions in both years, however, are quite low, even in regions experiencing relatively high rates of change in terms both of means and medians.[1] We noted in Table 3 (Chapter 2) that Minas Gerais has one of the smallest proportions of tenant-operated farms among the regions and selected states in Brazil. The variance of these proportions among Minas Gerais municipios, nevertheless, is large and increasing (for the entire state distribution as well as those for specific regions).

The proportion of farm operators classified as squatters (Table 18) reveals tendencies similar to, but more pronounced than, that of the tenant category. The mean proportion of squatters is generally low, but shows discernible increases in all regions. Paradoxically, the highest rates of increase are observed in the most central--Belo Horizonte Center--and the most peripheral--Rural Periphery--regions of the state, reaching mean levels for 1970 much higher than those observed for the entire state and the Southeast region. Variability of the distributions is very high and increased in most regions between 1950 and 1970. We can thus say that Minas Gerais municipios, despite the generally low prevalence of squatters, tend to vary substantially in the relative proportions of farm operators who hold no legal rights to the land, as well as in their rates of change between 1950 and

Table 18. Descriptive Statistics for Percent of Farms Operated by Squatters, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	1.8	0.78	3.7	0	38.6	6.0
	385	1970	6.0	3.8	9.6	0	89.8	6.0
	327	% Change	746.2	239.4	1745.1	-100.0	18190.0	5.9
S. Paulo Periphery I	103	1950	1.3	0.74	1.6	0	8.2	2.1
	103	1970	3.9	3.5	3.1	0	15.9	1.1
	85	% Change	676.4	155.3	1313.6	-100.0	7945.7	3.2
S. Paulo Periphery II	33	1950	1.1	0.70	1.7	0	5.0	1.5
	33	1970	4.7	5.0	3.3	0	12.2	0.42
	29	% Change	529.8	298.3	640.9	-100.0	1884.9	1.0
Belo Horizonte Center	14	1950	2.1	0.43	4.1	0	15.3	2.5
	14	1970	10.7	7.2	6.6	1.8	22.7	0.67
	10	% Change	1231.1	561.9	1658.5	47.7	5607.5	1.9
Belo Horizonte Periphery I	77	1950	1.9	0.88	4.2	0	31.0	5.3
	77	1970	3.9	3.2	2.4	0	10 0	0.43
	63	% Change	400.8	177.3	601.8	-100.0	2485.2	1.9
Belo Horizonte Periphery II	39	1950	2.6	1.4	3.2	0	12.9	1.6
	39	1970	7.3	5.0	6.3	0.69	22.7	1.2
	35	% Change	843.0	191.0	1547.6	-39.7	6635.7	2.5
Rio de Janeiro Periphery I	62	1950	0.80	0.57	0.86	0	4.3	1.7
	62	1970	3.1	2.1	3.1	0	16.5	2.0
	51	% Change	442.9	241.0	695.9	-100.0	3891.4	3.1
Rio de Janeiro Periphery II	27	1950	2.9	0.67	6.8	0	34.6	3.9
	27	1970	6.7	3.6	11.1	0	47.3	3.6
	24	% Change	985.9	241.5	2551.8	-100.0	12249.7	3.7
Rural Periphery	30	1950	4.0	1.2	7.3	0	38.6	3.5
	30	1970	20.5	10.0	25.8	2.5	89.8	1.8
	26	% Change	2109.0	465.0	4267.1	-54.3	18190.0	2.8

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

1970. These variations among units are sufficiently large to blur distinctions among regions.

Table 19 presents descriptive statistics for the proportion of farms operated by administrators. Here, the general tendencies approach more those of the owners group--that is, modest regional variation and relative stability in the average proportions in all regions. By contrast, of course, administrators are much less prevalent overall than owners. These characteristics are similar to those revealed by the national data of Table 3 (in Chapter 2), and despite the intercensal comparison problems referred to in Chapter 4. Certain regions in Minas Gerais exhibit small increases in the prevalence of administrators, while others show modest decreases. These distributions, as with those for the other land tenure indicators, are characterized by the wide variability among municipios.

In conclusion, it can be said that there are large _municipal variations_, with respect to the relative importance of land tenure categories, but relatively small regional variations (or at least these variations fail to show a clear-cut, more-or-less "linear" pattern across the continuum). Owners clearly represent the most prevalent tenure category in both years, and along with administrators have relatively low average rates of change. These tendencies more closely reflect those found for the entire state of Minas than those apparent for most macro-regions and selected states of Brazil. Tenants and squatters constitute only small proportions of farm operators, but did exhibit some tendency to increase

Table 19. Descriptive Statistics for Percent of Farms Operated by Administrators, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	6.4	5.4	4.2	0	24.6	1.4
	385	1970	5.7	4.7	4.3	0	41.5	2.5
	383	% Change	13.3	-9.6	101.0	-100.0	1043.9	4.0
S. Paulo Periphery I	103	1950	5.4	5.0	3.3	0.43	20.1	1.4
	103	1970	4.3	3.7	2.6	0	12.8	0.84
	103	% Change	14.9	-19.6	139.5	-100.0	1043.9	4.7
S. Paulo Periphery II	33	1950	7.4	6.7	4.4	1.4	24.2	1.9
	33	1970	7.5	6.9	4.8	2.3	26.6	1.9
	33	% Change	50.5	22.3	161.7	-81.2	789.1	3.0
Belo Horizonte Center	14	1950	11.9	10.2	7.0	0	22.2	-0.11
	14	1970	13.1	8.9	10.4	0	41.5	1.4
	13	% Change	27.2	8.3	79.4	-70.3	192.0	0.71
Belo Horizonte Periphery I	77	1950	4.8	3.9	2.8	0	14.2	1.1
	77	1970	5.6	4.8	3.2	0	18.7	1.1
	76	% Change	40.7	6.3	94.9	-100.0	422.0	1.4
Belo Horizonte Periphery II	39	1950	3.8	3.5	2.0	0.56	8.2	0.42
	39	1970	4.1	4.4	1.9	0.37	8.3	-0.08
	30	% Change	32.7	6.3	81.4	-78.0	253.9	1.0
Rio de Janeiro Periphery I	62	1950	9.3	8.8	4.7	1.9	24.6	0.93
	62	1970	5.1	3.9	3.2	0.58	13.4	0.88
	62	% Change	-40.4	-54.7	33.5	-94.9	73.1	1.1
Rio de Janeiro Periphery II	27	1950	6.3	6.3	2.7	1.0	12.5	0.33
	27	1970	6.9	6.5	4.8	0.97	19.7	1.1
	27	% Change	35.3	12.2	109.0	-92.2	378.6	1.4
Rural Periphery	30	1950	7.6	7.6	4.4	1.3	16.1	0.21
	30	1970	7.2	6.2	5.4	0.66	17.5	0.41
	30	% Change	-10.4	-10.6	43.9	076.0	98.7	0.31

1/ The number of municipios within regions, varies because of missing cases in the percent distributions.

throughout the state during the 1950-1970 period.

RURAL LABOR FORCE

Descriptive statistics for indicators of rural labor force composition are presented in Tables 20 to 23 below. Statewide distributions for percent of rural family labor, percent of sharecroppers, and percent of permanent and temporary rural workers reveal general tendencies very similar to those observed in Table 4 of Chapter 2 for the entire state of Minas Gerais, as well as for the different macro-regions and selected states. The proportion of family labor tends to increase during the 1950-1970 period, while the proportions of the two hired labor categories tend to decrease. When looking at regional distributions within Minas Gerais, we can see that regional variations (for both 1950 and 1970 levels, as well as for rates of change) are generally modest for family labor and temporary rural workers, but are much larger for the proportions of sharecroppers and permanent rural workers. The percent of family labor in the rural labor force shows sizeable increases in all regions of the state during the 20 year period--increasing on the average from around 30 percent in 1950 to approximately 60 percent in 1970. The relative variability of the proportion of family labor also tends to be quite similar throughout the regions of the state. The rates of change distributions even tend to follow the same pattern.

Table 20. Descriptive Statistics for Rural Family Labor as Percent of Rural Labor Force, All Observations (State), and By Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	39.8	38.9	13.7	15.7	78.2	0.56
	385	1970	62.5	63.6	14.1	27.2	97.0	-0.17
	385	% Change	69.7	61.1	53.0	-51.1	364.1	0.99
S. Paulo Peri-phery I	103	1950	40.6	40.5	13.5	17.3	75.0	0.36
	103	1970	62.2	64.8	16.8	30.1	91.9	-0.29
	103	% Change	60.3	56.0	38.8	-15.9	171.0	0.64
S. Paulo Peri-phery II	33	1950	39.0	41.5	13.8	15.7	73.8	0.43
	33	1970	56.1	58.7	14.2	27.2	81.5	-0.15
	33	% Change	59.4	44.3	61.1	-51.1	171.0	0.50
Belo Horizonte Center	14	1950	41.6	40.4	13.7	21.3	68.5	0.29
	14	1970	58.0	56.7	16.5	36.1	97.0	0.83
	14	% Change	47.9	34.1	43.5	-28.1	143.5	0.44
Belo Horizonte Periphery I	77	1950	37.4	35.1	12.3	18.1	73.7	0.76
	77	1970	65.1	66.4	11.9	37.5	91.1	-0.12
	77	% Change	89.5	89.6	63.8	-17.8	364.1	1.1
Belo Horizonte Periphery II	39	1950	40.7	38.1	14.0	21.8	70.8	0.62
	39	1970	66.8	67.2	13.9	36.5	83.7	-0.17
	39	% Change	76.2	61.2	53.8	2.6	258.8	1.4
Rio de Janeiro Periphery I	62	1950	31.0	39.5	7.9	15.9	48.9	0.05
	62	1970	57.5	56.2	11.2	37.4	78.9	0.00
	62	% Change	94.0	85.9	48.2	0	203.5	0.29
Rio de Janeiro Periphery II	27	1950	47.3	46.3	13.1	27.2	76.1	0.49
	27	1970	63.8	62.0	9.7	43.9	82.1	0.06
	27	% Change	44.9	32.6	44.6	-27.4	149.2	0.55
Rural Periphery	30	1950	53.1	52.5	13.2	25.2	78.2	-0.13
	30	1970	69.1	67.0	10.3	52.1	90.2	0.29
	30	% Change	36.5	26.1	33.5	0.4	142.7	1.3

1/ No missing cases.

The picture that arises from Table 21, pertaining to the prevalence of sharecroppers, is not so homogeneous. Even though the basic tendency is toward decreased prevalence of sharecropping, the rate of change distributions are highly skewed. This indicates that at least in some municipios there is an opposite tendency, i.e., sizeable increases in the relative proportion of sharecroppers. The most striking element in the regional distributions of this labor group is the original (1950) regional differences in the relative prevalence of sharecroppers. These differences persist in 1970. It is interesting to observe that regions with the highest proportions of sharecroppers in both years are the São Paulo Periphery II and the Rio de Janeiro Periphery I--that is, regions with very different socio-economic conditions and agricultural development experiences.[2] Another observation is that the proportions of sharecroppers in most regions are above those for the entire state, reported in Table 4. This is more interesting when we observe that Minas Gerais in both 1950 and 1970 had the highest overall prevalence of this labor category among the macro-regions of Brazil. In addition, the variability and skewness of the various regional distributions tend to decrease from 1950 to 1970. These statistics indicate that despite the trend toward smaller proportions of sharecropping labor in Minas Gerais, this labor arrangement form is still important in many municipios of the state.

The mean proportion of permanent workers also exhibits significant regional variation. The São Paulo Periphery I,

Table 21. Descriptive Statistics for Sharecroppers as Percent of Rural Labor Force, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	18.6	15.8	13.7	0	70.2	0.76
	385	1970	10.4	7.9	9.0	0	45.2	1.0
	381	% Change	-8.9	-49.7	199.2	-100.0	2104.3	8.0
S. Paulo Peri-phery I	103	1950	12.6	12.0	8.4	0	39.1	0.93
	103	1970	7.4	5.2	7.6	0	36.2	1.6
	102	% Change	-9.2	-55.7	144.4	-100.0	648.6	3.0
S. Paulo Peri-phery II	33	1950	26.6	26.8	16.6	0.31	70.2	0.29
	33	1970	12.1	10.6	6.4	0	24.5	0.11
	33	% Change	45.9	-60.8	396.9	-100.0	2194.3	4.9
Belo Horizonte Center	14	1950	8.4	10.1	5.7	0	16.7	-0.36
	14	1970	5.0	5.4	3.3	0	9.3	-0.25
	12	% Change	-3.7	-44.9	167.7	-100.0	522.9	2.7
Belo Horizonte Periphery I	77	1950	19.5	18.0	10.0	1.4	44.4	0.50
	77	1970	10.6	9.5	7.2	0.31	35.1	0.86
	77	% Change	-21.0	-56.9	180.4	-98.2	1492.4	7.9
Belo Horizonte Periphery II	39	1950	16.7	14.6	12.5	0.13	39.3	0.38
	39	1970	9.7	7.2	9.5	0.01	45.2	1.7
	39	% Change	-23.4	-49.1	75.2	-97.9	233.8	1.6
Rio de Janeiro Periphery I	62	1950	28.4	29.5	15.0	0	60.9	0.06
	62	1970	17.4	16.7	10.0	0.19	39.3	0.21
	61	% Change	-32.8	-39.0	37.8	-98.3	98.0	1.0
Rio de Janeiro Periphery II	27	1950	28.2	33.2	16.6	1.4	55.7	-0.03
	27	1970	14.5	11.7	11.3	0.51	34.4	0.36
	27	% Change	42.9	-50.1	36.8	-93.2	73.5	1.1
Rural Periphery	30	1950	6.5	3.1	7.2	0.15	22.8	1.2
	30	1970	3.9	1.8	5.2	0.02	22.2	2.1
	30	% Change	57.9	-46.0	394.0	-97.5	2067.5	4.5

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Belo Horizonte Center, and Rio de Janeiro Periphery I regions tend to have relatively larger proportions of permanent workers in both years. However, a more interesting observation with respect to this labor group revealed by Table 22 is the mixed pattern of change during the period of concern. In some regions (São Paulo Periphery II, Belo Horizonte Center, Rio de Janeiro Periphery II and even the Rural Periphery), average rates of change are positive. In two other regions there are negative changes (São Paulo Periphery I and Rio de Janeiro Periphery I), but both regions had high initial levels of permanent rural workers. This suggests that even though the relative prevalence of permanent rural labor tends to decrease (as is the case throughout Brazil, according to the dat in Table 4), in many municipios the opposite tendency prevails and is sufficiently strong to affect average values. There, of course, is high skewness in many of these regional distributions, but the median values (which are less affected by extreme scores) also indicate the same mixed tendencies.

With respect to temporary workers (Table 23), there again is a more homogeneous situation. The mean proportion of temporary workers does not vary substantially among regions in any of the two years, nor do the average rates of change vary across regions (which essentially exhibit only negative values). The patterns here are similar to those observed with national data in Table 4, where the state of Minas Gerais (as well as the states in the Northeast), which had the highest proportion of temporary

Table 22. Descriptive Statistics for Permanent Rural Workers as Percent of Rural Labor Force, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	14.6	9.3	13.4	0.85	72.6	1.6
	385	1970	12.9	9.5	10.9	0.38	59.0	1.4
	385	% Change	12.2	-10.7	106.2	-93.5	1430.9	7.2
S. Paulo Periphery I	103	1950	24.0	20.5	15.7	3.3	62.0	0.61
	103	1970	18.3	14.4	13.6	0.38	59.0	0.94
	103	% Change	-16.9	-26.7	50.2	-88.2	234.1	1.8
S. Paulo Periphery II	33	1950	9.5	8.1	7.0	2.5	32.6	1.7
	33	1970	12.9	11.4	7.2	1.5	29.4	0.87
	33	% Change	65.1	33.5	105.1	-81.2	397.8	2.0
Belo Horizonte Center	14	1950	19.3	16.5	12.6	2.8	46.6	0.81
	14	1970	18.4	16.9	10.2	1.4	42.0	0.57
	14	% Change	10.8	4.9	62.4	-69.4	163.6	0.98
Belo Horizonte Periphery I	77	1950	9.2	6.5	7.1	1.3	39.4	2.0
	77	1970	9.8	6.7	8.3	0.7	46.2	1.9
	77	% Change	27.1	-5.3	173.7	-87.4	1430.9	7.1
Belo Horizonte Periphery II	39	1950	6.7	5.5	4.4	1.0	23.1	1.8
	39	1970	6.5	6.2	3.6	0.94	14.9	0.60
	39	% Change	8.6	-7.9	57.2	-75.8	164.3	1.2
Rio de Janeiro Periphery I	62	1950	19.3	13.6	15.6	1.7	72.6	1.3
	62	1970	13.4	10.1	11.3	0.88	46.2	1.2
	62	% Change	-23.0	-31.3	42.4	-93.5	123.2	1.1
Rio de Janeiro Periphery II	27	1950	5.8	5.5	2.1	1.1	10.9	0.25
	27	1970	10.0	6.4	8.3	1.8	37.8	1.6
	27	% Change	72.7	82.4	99.3	-58.9	325.0	0.55
Rural Periphery	30	1950	8.3	7.1	6.1	0.85	22.4	0.77
	30	1970	9.6	5.7	7.8	0.89	28.7	0.96
	30	% Change	40.2	8.7	130.3	-65.7	635.4	3.2

1/ No missing cases.

Table 13. Descriptive Statistics for Temporary Rural Workers as Percent of Rural Labor Force, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici- pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	26.8	25.9	12.9	0	72.1	0.39
	385	1970	14.0	12.1	9.2	0.67	51.2	1.1
	384	% Change	-30.8	-49.9	119.5	-98.2	2039.4	13.8
S. Paulo Periphery I	103	1950	22.7	21.6	10.9	2.4	49.0	0.29
	103	1970	11.9	10.4	7.6	1.3	33.6	0.84
	103	% Change	-38.1	-47.5	42.2	-94.2	113.1	1.0
S. Paulo Periphery II	33	1950	24.6	23.7	9.7	8.0	44.3	0.25
	33	1970	18.8	15.5	13.5	0.67	48.0	0.78
	33	% Change	-13.0	-9.7	61.3	-97.5	138.1	0.71
Belo Horizonte Center	14	1950	30.5	30.1	9.3	6.8	44.1	-1.0
	14	1970	18.4	16.5	13.5	1.4	51.2	0.85
	14	% Change	-37.3	-50.9	43.3	-95.4	78.6	1.1
Belo Horizonte Periphery I	77	1950	33.6	34.2	13.4	0	72.1	0.21
	77	1970	14.4	12.6	7.5	1.6	36.3	1.1
	76	% Change	-47.2	-49.6	48.3	-96.1	225.2	3.3
Belo Horizonte Periphery II	39	1950	35.7	34.1	10.8	16.6	60.3	0.32
	39	1970	16.9	17.8	8.8	1.7	47.2	0.84
	39	% Change	-49.5	-53.1	30.0	-91.3	25.9	1.0
Rio de Janeiro Periphery I	62	1950	21.1	20.3	11.9	1.9	48.1	0.44
	62	1970	11.5	9.9	7.9	0.3	41.0	1.2
	62	% Change	3.1	-47.6	269.7	-98.2	2039.4	7.0
Rio de Janeiro Periphery II	27	1950	18.6	18.1	11.1	3.1	48.5	0.73
	27	1970	11.4	8.8	8.8	0.69	37.2	1.0
	27	% Change	-12.9	-39.8	114.0	-96.4	495.3	3.3
Rural Periphery	30	1950	31.9	28.9	12.8	14.8	78.6	1.0
	30	1970	17.3	16.6	9.8	5.2	42.7	0.78
	30	% Change	-43.7	-49.0	27.1	-87.6	11.8	0.43

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

labor in 1950, also experienced the largest decrease during the period.

In summary, rural labor force categories in Minas Gerais municipios present different dynamics in relation to each other within the regions of the state. The proportion of family labor, as is the case throughout Brazil, tends to exhibit sizeable increases in all regions of Minas Gerais. The proportion of sharecroppers tends to decrease in more regions, but some significant variations among regions were observed. The permanent rural workers category varies both in terms of its mean proportions among regions and in the regional change trends observed during the period. The proportion of temporary workers category is characterized by similar means across regions as well as comparable rates of decline from 1950 to 1970. These rural labor force composition distributions underscore the high degree of variability among municipios in terms of the proportions of each labor category and their change trends.

RURAL AND URBAN WAGES

The data pertaining to per capita wages of farm and industrial workers are presented in Tables 24 and 25 below. The most striking characteristic of these data is the remarkable consonance of the observed tendencies with those found in national data reported in Table 7 of Chapter 2. In all regions, for both 1950 and 1970, average farm workers' wages lag behind those of industrial workers,

Table 24. Descriptive Statistics for Annual Average Wages of Farm Workers (In Constant Cruzeiros of 1970), All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	406	372	240	30	2,348	1.9
	385	1970	1,019	945	542	68	4.267	1.3
	284	% Change	214.4	161.3	253.2	-88.5	3,206.5	5.4
S. Paulo Periphery I	103	1950	497	483	158	168	917	0.21
	103	1970	1,283	1,304	396	264	2.244	-0.09
	103	% Change	181.6	172.0	122.1	-16.6	575.7	1.0
S. Paulo Periphery II	33	1950	564	494	244	152	1,111	0.41
	33	1970	1,115	1,019	525	281	2.919	1.2
	33	% Change	133.3	104.3	149.2	-35.8	640.7	1.4
Belo Horizonte Center	14	1950	618	482	233	333	1,040	0.66
	14	1970	1,245	1,251	430	437	2,047	-0.38
	14	% Change	123.5	115.4	109.3	-23.4	358.9	0.58
Belo Horizonte Periphery I	77	1950	336	305	198	98	1,393	2.8
	77	1970	1,062	881	709	214	4,267	2.3
	77	% Change	260.6	204.8	208.2	-78.4	1,046.6	1.2
Belo Horizonte Periphery II	38	1950	186	158	105	45	425	0.77
	39	1970	743	561	515	94	2,428	1.4
	38	% Change	358.0	279.9	328.1	-2.8	1,455.5	1.8
Rio de Janeiro Periphery I	62	1950	477	444	309	78	2,348	3.6
	62	1970	889	857	417	68	2,579	1.0
	62	% Change	160.8	100.4	407.0	-88.5	3,206.4	6.8
Rio de Janeiro Periphery II.	27	1950	354	318	185	53	751	0.68
	27	1970	811	829	447	130	2,255	1.2
	27	% Change	153.4	136.6	118.3	-18.1	467.3	0.99
Rural Periphery	30	1950	173	154	101	30	403	0.63
	30	1970	601	527	302	104	1,162	0.07
	30	% Change	324.0	235.3	287.1	-6.3	1.146.6	1.5

1/ The number of municipios within regions, varies because of missing cases.

Table 25. Descriptive Statistics for Annual Average Wages of Industrial Workers (In Constant Cruzeiros of 1970) All Observations (State), and by Regional Location Minas Gerais (Brazil), Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	379	1950	1,429	1,326	596	176	5,538	2.1
	372	1970	2,335	2,091	1,031	235	8,750	2.1
	368	% Change	86.6	70.4	114.1	-86.8	1,036.3	3.4
S. Paulo Periphery I	103	1950	1,396	1,326	406	708	2,541	0.85
	101	1970	2,275	2,167	749	236	4,825	0.64
	101	% Change	74.4	69.4	69.8	-86.8	227.8	0.58
S. Paulo Periphery II	32	1950	1,738	1,638	87	30	4,212	1.2
	31	1970	2,225	2,190	72	86	3,976	0.19
	30	% Change	66.8	24.3	153.7	-72.9	801.9	3.7
Belo Horizonte Center	14	1950	1,824	1,517	903	695	3,892	1.0
	14	1970	3,548	3,730	1,623	356	5,971	-0.22
	14	% Change	119.7	102.4	114.9	-59.7	287.3	-0.01
Belo Horizonte Periphery I	77	1950	1,389	1,323	440	374	2,925	0.89
	76	1970	2,758	2,292	1,458	821	8,750	2.1
	76	% Change	108.9	89.2	105.8	-65.8	579.8	1.8
Belo Horizonte Periphery II	38	1950	1,322	1,171	872	203	5,538	3.3
	35	1970	1,987	1,882	690	500	3,368	0.16
	35	% Change	101.3	84.1	154.6	-81.7	827.0	3.1
Rio de Janeiro Periphery I	61	1950	1,466	1,298	551	810	4,271	2.5
	62	1970	2,107	1,944	673	1,125	5,162	1.6
	61	% Change	55.9	50.8	45.5	-61.1	210.1	0.32
Rio de Janeiro Periphery II	26	1950	1,411	1,301	575	437	2,867	0.49
	26	1970	2,074	1,888	813	235	4,455	0.70
	25	% Change	75.1	41.5	93.2	-83.4	249.1	0.59
Rural Periphery	28	1950	1,194	1,196	490	176	2,471	0.23
	27	1970	2,089	1,945	932	684	5,773	2.1
	26	% Change	137.1	70.9	217.3	-45.1	1,036.3	2.8

1/ The number of municipios within regions, varies because of missing cases.

despite relatively higher rates of increase for farm workers' wages. The rural-industrial gap observed in Table 7 is reproduced at the level of Minas Gerais municipios. A second feature of Tables 24 and 25 is the tendency for average wage levels to be higher in more central regions of the state. The predominance of the Belo Horizonte Center region is very clear for both rural and industrial workers' wages. However, it is also apparent that the four more central regions (Belo Horizonte Center, São Paulo Periphery I, São Paulo Periphery II and Belo Horizonte Periphery II) tend to have systematically higher averages than the more peripheral regions (Rio de Janeiro Periphery I, Rio de Janeiro Periphery II, Belo Horizonte Periphery II and Rural Periphery) in terms of both rural and industrial wages. Furthermore, these disparities are more clear in 1970 than in 1950, and are more pronounced for industrial than for rural wages. Mean levels of rural wages for the four more central regions in Minas Gerais (Table 7). However, even in the metropolitan area of Belo Horizonte, rural wages do not reach the levels reported for the entire states of São Paulo and Rio Grande do Sul in 1970. Regional averages for industrial wages do not widely diverge from mean values for the entire state. This, however, does not diminish the argument that the industrialization has affected only selected municipios--even in the more central regions. In this connection, it can be observed that the <u>dispersion</u> measures are generally higher for the industrial than for the rural wages. The same is the case with respect to skewness statistics. Finally, it can be observed that despite very clear regional disparities in wages, distributions for both types of wages within regions are characterized by relatively large variances, reflecting high municipal heterogeneity. Thus, while regions are a substantively useful organizing framework, the regions are by no means homogeneous.

RURAL AND URBAN LITERACY RATES

Tables 26 and 27 report descriptive statistics for the rural and urban literacy indiators. The general tendencies revealed by those tables can be summarized as follows: (a) As is the case throughout Brazil (see Table 8, Chapter 2), there are large rural-urban differentials in average literacy levels within all regions of Minas Gerais for both 1950 and 1970; (b) These differentials--contrary to what we have observed with respect to rural and urban wages--show some tendency to decrease from 1950 to 1970; (c) There is also a discernible literacy gap between the more central versus the more peripheral regions of the state in favor of the more central regions in both 1950 and 1970. Such differentials are more pronounced for rural than urban literacy; (d) A corollary trend--again contrary to that observed with respect to the wage indicators--is that variances for rural literacy rates distributions tend to be higher than those for their urban counterparts; and (e) The distributions (especially for urban literacy) tend to have negative skewness,

Table 26. Descriptive Statistics for Rural Literacy Rate, All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	28.8	30.9	11.1	3.2	61.3	-0.20
	385	1970	47.9	51.1	13.7	5.0	77.2	-0.91
	385	% Change	75.1	65.1	56.3	-81.0	452.1	1.9
S. Paulo Periphery I	103	1950	30.4	29.6	6.4	14.6	45.9	0.10
	103	1970	51.8	54.5	11.9	5.0	74.9	-1.6
	103	% Change	74.3	72.6	44.5	-81.0	215.8	-0.49
S. Paulo Periphery II	33	1950	33.3	33.7	5.1	24.0	41.3	-0.22
	33	1970	58.8	59.0	5.9	47.5	77.2	0.71
	33	% Change	80.4	72.6	36.7	41.0	215.1	1.7
Belo Horizonte Center	14	1950	50.8	52.4	6.9	38.6	61.3	-0.32
	14	1970	59.0	58.3	5.9	51.0	69.7	0.22
	14	% Change	17.6	13.7	16.4	-6.6	51.0	0.55
Belo Horizonte Periphery I	77	1950	37.2	37.3	8.1	19.8	57.5	0.25
	77	1970	52.6	53.2	9.9	17.8	69.9	-1.2
	77	% Change	45.4	43.1	35.5	-40.1	142.6	0.51
Belo Horizonte Periphery II	39	1950	20.1	18.9	9.6	5.2	37.9	0.07
	39	1970	37.4	36.7	13.8	10.4	59.8	-0.09
	39	% Change	102.2	87.8	49.4	35.9	211.3	0.87
Rio de Janeiro Periphery I	62	1950	33.2	33.5	5.8	20.2	44.3	-0.38
	62	1970	49.8	50.6	6.8	23.8	64.1	-0.96
	62	% Change	53.4	50.0	25.9	-40.8	137.8	0.19
Rio de Janeiro Periphery II	27	1950	17.6	17.7	8.1	6.3	36.5	0.35
	27	1970	35.2	36.6	10.9	15.3	54.9	-0.40
	27	% Change	119.5	98.1	66.2	43.3	320.4	1.3
Rural Periphery	30	1970	11.7	10.1	5.7	3.2	28.5	1.1
	30	1970	25.5	23.3	8.8	12.2	46.7	0.91
	30	% Change	194.8	108.7	95.8	43.1	452.1	1.7

1/ No missing cases.

Table 27. Descriptive Statistics for Urban Literacy Rate, All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici- pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	60.0	61.1	9.0	27.8	98.0	-0.69
	385	1970	68.4	70.3	9.3	6.7	97.1	-1.8
	385	% Change	14.9	13.7	17.8	-89.3	116.6	-0.49
S. Paulo Periphery I	103	1950	62.2	61.8	7.4	41.7	98.0	0.63
	103	1970	71.3	71.8	8.2	6.7	82.8	-4.6
	103	% Change	14.7	15.6	18.9	-89.3	72.8	-1.8
S. Paulo Periphery II	33	1950	59.7	59.0	6.5	45.8	73.0	-0.02
	33	1970	71.5	71.9	5.5	52.9	78.9	-1.3
	33	% Change	20.7	19.9	13.4	-1.4	61.6	1.0
Belo Horizonte Center	14	1950	69.0	70.6	4.9	62.0	77.4	-0.07
	14	1970	74.5	74.1	2.8	70.2	80.6	0.69
	14	% Change	8.2	7.5	6.2	-0.4	18.7	0.09
Belo Horizonte Periphery I	77	1950	63.1	62.7	6.1	43.0	74.1	-0.53
	77	1970	71.0	71.5	7.1	34.5	97.1	-1.2
	77	% Change	13.2	11.3	13.2	-48.9	54.1	-0.34
Belo Horizonte Periphery II	39	1950	54.8	55.3	8.2	27.8	68.5	-1.0
	39	1970	63.4	64.9	7.2	43.7	75.1	-0.83
	39	% Change	17.2	16.7	15.1	-12.3	57.1	0.41
Rio de Janeiro Periphery I	62	1950	64.6	65.2	5.1	49.2	76.1	-0.40
	62	1970	70.7	73.1	9.4	18.7	81.6	-3.0
	62	% Change	9.8	10.8	15.7	-71.2	34.7	-2.8
Rio de Janeiro Periphery II	27	1950	51.3	52.6	7.8	36.2	63.0	-0.21
	27	1970	58.8	58.7	7.1	42.9	70.8	-0.41
	27	% Change	12.7	14.4	23.6	-80.5	61.9	-1.9
Rural Periphery	30	1950	45.5	46.5	9.3	29.3	70.2	0.19
	30	1970	55.8	56.1	7.8	39.2	71.4	-0.18
	30	% Change	26.5	21.6	27.0	-26.3	116.6	1.4

1/ No missing cases.

indicating that the majority of the values lies above the mean. In sum, regional patterns of rural and urban literacy among Minas Gerais municipios tend to closely mirror the general tendencies observed for larger aggregates within the country in Table 8 of Chapter 2.

LAND USE AND CROP MIX

Data for the indicator of the percent of municipal farmlands used for crops are presented in Table 28. The mean value for the statewide distribution among municipios reveals similar low proportions as those for the state as an aggregate (presented in Table 2 of Chapter 2). The municipal distribution likewise shows no increase in the period of 1950 to 1970. The regional picture, however, is more diversified. Regions in the northern half of the state (Rural Periphery, Belo Horizonte Periphery II and São Paulo Periphery II) have relatively low mean proportions of land in crops in both years. On the other hand, the "old" settlement regions of São Paulo Periphery I and Rio de Janeiro Periphery I and II exhibit relatively high proportions of cropland. Change tendencies vary across regions. São Paulo Periphery I and Belo Horizonte Center--two of the most dynamic regions in the state--show positive rates of change along with the Rural Periphery. The Rio de Janeiro Periphery regions, on the other hand, show sizeable declines in the proportion of cropland. These declines can be explained in large part by the coffee

Table 28. Descriptive Statistics for Percent of Farm Land used for Crops, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici- pios 1/	Year	Statistics Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	13.1	11.2	8.9	0.27	43.5	0.87
	385	1970	12.1	11.1	6.9	0.82	38.1	0.79
	385	% Change	20.4	-1.1	128.4	-71.0	1796.1	8.9
S. Paulo Periphery I	103	1950	16.0	13.7	8.0	3.9	43.5	0.75
	103	1970	14.5	13.7	5.7	4.2	30.5	0.60
	103	% Change	1.8	-2.0	35.1	-53.1	118.1	0.71
S. Paulo Periphery II	33	1950	5.4	4.3	5.0	0.52	22.3	1.8
	33	1970	8.1	6.3	5.8	1.6	24.4	1.3
	33	% Change	167.9	20.2	366.3	-26.6	1796.1	3.1
Belo Horizonte Center	14	1950	8.6	9.0	3.5	1.9	13.6	-0.27
	14	1970	11.0	10.0	3.7	4.5	20.7	1.0
	14	% Change	48.6	4.9	73.2	-30.9	198.0	0.77
Belo Horizonte Periphery I	77	1950	10.4	9.4	4.9	2.5	36.4	2.1
	77	1970	10.2	9.5	4.7	1.5	32.4	1.8
	77	% Change	2.2	-0.2	31.3	-51.6	153.4	1.6
Belo Horizonte Periphery II	39	1950	7.4	6.5	4.8	1.7	20.4	0.95
	39	1970	8.4	6.6	5.3	1.9	23.7	1.1
	39	% Change	23.0	14.0	47.2	-49.5	140.0	0.94
Rio de Janeiro Periphery I	62	1950	22.2	21.9	9.2	5.2	41.2	-0.02
	62	1970	18.2	18.2	7.9	4.0	38.1	0.22
	62	% Change	-15.4	-15.1	23.2	-60.1	92.3	1.4
Rio de Janeiro Periphery II	27	1950	18.3	19.0	8.1	3.9	30.1	-0.34
	27	1970	12.9	12.1	7.2	1.2	26.5	0.14
	27	% Change	-30.9	-36.1	23.9	-71.0	18.8	0.17
Rural Periphery	30	1950	4.6	3.4	3.8	0.27	13.0	0.91
	30	1970	5.6	4.0	4.6	0.82	17.1	1.2
	30	% Change	72.9	25.9	145.5	-61.9	608.0	2.2

1/ No missing cases.

eradication programs of the early 1960's which disproportionately affected the Rio de Janeiro regions in Minas Gerais.[3] As is common in most tables of this chapter, even when substantial regional variations are noted, the regional distributions are characterized by sizeable variability among municipios, particularly so in terms of their rates of change.

In contrast to this diversified picture concerning the percent of farmland used for crops, the proportion devoted to pastures (presented below in Table 56, Appendix A) reveals more homogeneous tendencies. Not only does the level of variability among regions tend to be less (all municipios showing values of over 50 percent of farmland used in pastures in both years), there is also an overall trend toward an increase in the proportion of pastures during the period of the study. These patterns at the local level reflect the aggregate tendency observed for the entire state in Table 2 of Chapter 2. In sum, these data indicate the widespread importance of livestock activities throughout Minas Gerais.

The crop mix indicators used in this study, as noted in Chapter 4, are basically measured in terms of the proportions of municipal cropland used for particular crops. We have used two composite indicators--crop specialization and concentration--and the percentages of municipal croplands devoted to coffee, rice, sugar cane, beans and corn (the most important crops in the state, as revealed in Table 11 of Chapter 4). Here we present descriptive statistics only for the crop specialization index (Table 29), leaving others to Appendix A (Tables 57 to 62). The data in Table 29 indicate that there are only minor regional variations in the specialization index. The only differences that emerge are those between the São Paulo Periphery II and Belo Horizonte Center regions--the former being the most specialized region and becoming increasingly so, while the latter is the least specialized one and showing a tendency toward further diversification. The other regions exhibit similar mean levels of specialization (averages in the area of 30 percent and mixed, but generally small, rates of change).

The most striking feature of Table 29, is again, the large variations among municipios, independent of their regional location. A similar picture is revealed in Table 57 (in Appendix A), which reports the data for the export/commercial crop concentration index. The specific crop indicators reveal large municipal variations in the proportion of cropland devoted to such crops and their rates of change from 1950 to 1970. Regional variations are also evident. For example, coffee has been most important in the Rio de Janeiro Periphery regions and São Paulo Periphery I. Coffee production has experienced a general decrease in terms of its average proportion of cropland in all regions. This decrease, however, has been lowest in relative terms in the São Paulo Periphery I area, where the state's coffee production has become particularly concentrated in 1970. Rice cropland is concentrated in the São Paulo Periphery II region--more so in 1970 than 1950. Sugar cane cropland is generally

Table 29. Descriptive Statistics for Percent of Cropland Devoted to most Prevalent Crop (Crop Specialization Index), All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Changes 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	30.3	29.8	14.6	3.5	80.0	0.48
	385	1970	28.3	25.7	14.7	4.2	79.9	0.85
	385	% Change	7.9	-6.7	65.5	-82.6	379.4	2.1
S. Paulo Periphery I	103	1950	29.4	31.5	14.6	3.5	64.4	0.14
	103	1970	27.2	27.1	11.1	6.3	62.1	0.44
	103	% Change	10.0	-9.1	64.0	-63.3	379.4	2.8
S. Paulo Periphery II	33	1950	49.1	52.6	13.2	21.0	70.1	-0.27
	33	1970	50.8	54.1	13.7	16.3	72.9	-0.63
	33	% Change	10.1	1.1	50.6	-60.1	121.9	0.75
Belo Horizonte Center	14	1950	24.4	19.1	18.1	5.7	80.0	2.1
	14	1970	13.4	10.0	7.6	4.5	31.1	0.99
	14	% Change	-27.8	-39.1	48.2	-76.7	63.3	0.64
Belo Horizonte Periphery I	77	1950	24.7	22.1	12.5	5.3	58.9	0.90
	77	1970	21.8	19.2	10.7	4.2	59.9	0.98
	77	% Change	10.7	-4.2	77.8	-82.6	317.4	1.8
Belo Horizonte Periphery II	39	1950	31.0	29.1	11.3	10.7	56.3	0.52
	39	1970	26.4	21.7	16.5	5.9	70.2	1.2
	39	% Change	-9.7	-33.7	55.7	-74.3	177.0	1.2
Rio de Janeiro Periphery I	62	1950	33.5	32.5	13.3	4.7	64.5	0.07
	62	1970	33.2	30.8	14.6	7.4	66.9	0.51
	62	% Change	12.3	2.0	65.4	-80.3	364.7	2.6
Rio de Janeiro Periphery II	27	1950	26.8	27.9	9.4	11.8	42.4	0.06
	27	1970	23.4	21.3	8.5	14.0	54.0	1.8
	27	% Change	2.8	-24.9	66.9	-58.9	277.3	1.8
Rural Periphery	30	1950	25.4	23.0	11.7	4.6	45.6	0.17
	30	1970	27.0	25.6	11.7	10.0	54.2	0.67
	30	% Change	26.1	-2.1	70.8	-61.7	209.3	1.1

1/ No missing cases.

much less prevalent and not so regionally concentrated. However, sugar cane's regional concentration has increased during the period, particularly in the regions that originally are most significant--Rio de Janeiro Periphery I and II and Belo Horizonte Periphery. Bean cropland shows a systematic tendency to decrease in all regions, but remained more concentrated in the peripheral regions in 1970 than was the case in 1950. Finally, corn, as expected, is the most widespread crop throughout the regions of Minas Gerais, although sizeable municipal variations are apparent. The general tendency is for moderate increases in corn cropland during the 1950-1970 period in all regions except Belo Horizonte Center. These observations indicate the complexity of the tendencies pertaining to the crop mix indicators which challenge any simple generalization.

Before we leave this topic, a brief comment should be made concerning our subsistence production indicator. As expected, the descriptive statistics for this variable in Table 63 (Appendix A), indicate that levels of private production of corn, beans, and cassava as a percentage of commercial production of these crops have generally tended to decrease in all regions of the state from 1950 to 1970. The variability and dispersion of the regional distributions, however, are sufficiently large to consistently produce positive means and negative medians for the average rates of change. A final observation is that despite the high level of variability, the data do indicate that subsistence production is generally more important in the peripheral areas of the state, but more so in 1950 than 1970.

AGRICULTURAL TECHNOLOGY AND PRODUCTIVITY

Bio-Chemical Innovation

Descriptive statistics for the bio-chemical technology indicators are presented in Tables 30 and 31 below. The results are remarkably similar for both indicators and very closely follow the expectations developed in the course of our discussions in Chapters 2 and 3. Statewide municipal distributions for cruzeiros of modern bio-chemical inputs per farm and per hectare of cropland reveal averages close to the aggregate values calculated for the state and reported in Table 5 of Chapter 2. As expected, these distributions are characterized by extremely high variability, which tends to increase from 1950 to 1970 (along with increases in mean values). Even more striking than the distributions for specific years are those pertaining to rates of change. Municipal variability here is maximized, and the distributions for both indicators are highly and positively skewed--indicating that only a few municipios have experienced large positive changes in bio-chemical innovation, whkle the majority of municipios has experienced much slower change. The regional distributions show a very clear pattern of locational bias of technological change in agriculture. The more central regions (the four upper regions in the table) not only were originally privileged when compared with the more peripheral ones (with exception of the Rio de Janeiro

Table 30. Descriptive Statistics for Cruzeiros of Modern Biochemical Inputs Per Farm (In Constant Cruzeiros of 1970), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	129	58	197	0	1470	3.3
	385	1970	404	227	493	0	3820	2.9
	382	% Change	787.0	279.4	2201.0	-64.6	28800.0	8.1
S. Paulo Periphery I	103	1950	184	126	179	4	812	1.5
	103	1970	701	493	654	24	3820	2.2
	103	% Change	620.4	261.5	1162.7	-32.3	9343.7	4.8
S. Paulo Periphery II	33	1950	103	49	115	1	430	1.2
	33	1970	676	501	560	101	2239	1.2
	33	% Change	3146.9	847.8	6182.1	-34.0	28800.0	2.8
Belo Horizonte Center	14	1950	301	188	308	0	1046	1.4
	14	1970	706	424	708	0	2238	1.3
	13	% Change	223.1	144.1	250.5	-57.9	732.4	0.82
Belo Horizonte Periphery I	77	1950	95	51	173	5	1470	6.8
	77	1970	353	273	295	2	1764	2.2
	77	% Change	654.6	421.1	799.9	-64.6	4100.0	2.2
Belo Horizonte Periphery II	39	1950	34	19	35	2	152	1.8
	39	1970	118	78	123	15	647	2.5
	39	% Change	475.1	325.6	821.2	-43.1	5150.0	5.1
Rio de Janeiro Periphery I	62	1950	211	81	295	7	1241	2.1
	62	1970	239	192	175	48	871	1.7
	62	% Change	202.8	48.4	418.3	-63.4	2971.4	4.8
Rio de Janeiro Periphery II	27	1950	34	20	49	1	251	3.4
	27	1970	84	75	33	24	157	0.54
	27	% Change	1105.6	264.7	2440.8	-52.5	11600.0	3.3
Rural Periphery	30	1950	20	13	18	0	62	0.76
	30	1970	78	41	71	14	253	1.2
	28	% Change	665.1	344.5	944.8	-61.1	4000.0	2.1

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Table 31. Descriptive Statistics for Cruzeiros of Modern Biochemical Inputs per Ha. of Cropland (In Constant Cruzeiros of 1970), All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	11	6	18	0	175	5.4
	385	1970	52	35	58	0	478	3.0
	370	% Change	793.1	473.8	1306.3	-50.0	16000.0	6.8
S. Paulo Periphery I	103	1950	14	10	11	.001	55	1.6
	103	1970	94	82	68	.003	478	2.4
	103	% Change	1171.6	568.9	2157.7	10.2	16000.0	4.8
S. Paulo Periphery II	33	1950	5	5	4	0	15	0.59
	33	1970	41	35	25	10	138	1.8
	30	% Change	987.6	658.6	869.2	26.6	3700.0	1.3
Belo Horizonte Center	14	1950	38	22	45	0	175	2.1
	14	1970	120	72	125	0	409	1.2
	14	% Change	317.7	238.1	310.4	-36.3	1101.1	1.0
Belo Horizonte Periphery I	77	1950	9	5	12	1	86	3.9
	77	1970	56	48	40	7	275	2.7
	77	% Change	984.6	725.0	853.0	24.2	3337.5	1.3
Belo Horizonte Periphery II	39	1950	3	0.002	0.003	0	13	1.4
	39	1970	13	10	11	2	55	1.9
	37	% Change	436.1	300.4	376.2	-25.0	1300.0	0.86
Rio de Janeiro Periphery I	62	1950	15	6	28	1	175	3.8
	62	1970	31	25	22	55	123	1.7
	62	% Change	442.8	273.1	516.2	-29.7	4300.0	4.1
Rio de Janeiro Periphery II	27	1950	2	1	3	0	15	3.0
	27	1970	10	9	5	2	28	1.6
	22	% Change	399.7	304.1	314.7	-13.3	1000.0	0.48
Rural Periphery	30	1950	3	1	3	0	12	1.3
	30	1970	11	7	8	0	30	0.74
	30	% Change	414.8	300.0	453.7	-50.0	2000.0	1.7

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Periphery I), but have also tended to experience higher average rates of change. The technological gap is thus more pronounced in 1970 than in 1950. This pattern for Minas Gerais regions again mirrors the tendency observed in the overall Brazil context, according to the data in Table 5. It may be noted further that regions under the influence of the São Paulo metropolitan center generally were the most dynamic regions in terms of bio-chemical innovation. The Belo Horizonte Center exhibited the smallest rate of increase, but this has not prevented the region from maintaining its leadership in the state. However, the average levels of bio-chemical technology indicators in the Belo Horizonte Center are considerably below those recorded for the state of São Paulo (Table 5, Chapter 2), although higher than those for the states in the South region taken as a whole.

Mechanization

The data for the two indicators of mechanization are given in Tables 32 and 33. The first observation to be made with respect to the descriptive statistics for the percent of farms with tractors and tractors per 1000 hectares of cropland is the very incipient level of mechanization in Minas Gerais. In 1950, almost two-thirds of the state's municipios (224 out of 385) reported no tractors. In 1970, this number has been reduced to 23, but the mean values for both of the mechanization indicators are very low. This remains the case in 1970, despite very large, positive rates of change. These observations are consistent

Table 32. Descriptive Statistics for Percent of Farms with Tractors, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	0.31	0	0.94	0	13.5	8.5
	385	1970	2.3	1.0	3.5	0	26.8	3.2
	161	% Change	739.1	407.2	996.2	-100.0	6078.8	2.8
S. Paulo Periphery I	103	1950	0.26	0	0.54	0	3.4	3.2
	103	1970	2.9	2.0	2.7	0	10.6	1.0
	45	% Change	914.4	664.5	941.9	43.5	4193.8	1.9
S. Paulo Periphery II	33	1950	1.1	0.47	2.5	0	13.5	3.8
	33	1970	8.2	5.5	7.6	0	26.8	0.75
	22	% Change	966.0	397.7	1405.1	-2.9	6078.8	2.4
Belo Horizonte Center	14	1950	0.85	0.30	1.1	0	3.7	1.3
	14	1970	3.9	3.7	2.8	0	8.3	-0.1
	9	% Change	953.1	525.1	1109.7	-100.0	2992.9	0.91
Belo Horizonte Periphery I	77	1950	0.16	0	0.45	0	3.1	4.4
	77	1970	1.4	0.90	1.6	0	8.9	2.3
	24	% Change	702.2	458.2	886.9	58.8	4265.0	3.0
Belo Horizonte Periphery II	39	1950	0.06	0	0.14	0	0.80	3.7
	39	1970	0.66	0.45	0.72	0	3.5	2.1
	11	% Change	731.5	568.0	728.6	125.0	2306.1	1.4
Rio de Janeiro Periphery I	62	1950	0.42	0.10	0.75	0	4.8	3.6
	62	1970	1.2	0.66	1.5	0	7.7	2.3
	34	% Change	217.2	170.6	193.6	-63.7	636.4	0.62
Rio de Janeiro Periphery II	27	1950	0.08	0	0.14	0	0.47	1.8
	27	1970	1.1	0.59	1.2	0.03	4.4	1.5
	11	% Change	1245.5	609.9	1673.8	15.3	5818.4	1.9
Rural Periphery	30	1950	0.02	0	0.08	0	0.44	4.4
	30	1970	0.50	0.23	0.75	0	3.4	2.4
	5	% Change	405.6	470.7	227.3	158.9	678.0	-0.07

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Table 33. Descriptive Statistics for Tractors per 1000 Ha. of Cropland, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970, and Percent Change 1950-1970.

Regional Location	No. of Munici- pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	0.2	0	0.63	0	7.9	6.9
	385	1970	3.2	2.0	4.2	0	42.1	3.9
	161	% Change	1225.8	722.6	1618.9	-100.0	10909.5	3.3
S. Paulo Periphery I	103	1950	0.19	0	0.32	0	1.5	2.2
	103	1970	4.6	3.7	3.5	0	17.6	1.3
	45	% Change	1953.4	1181.2	2241.1	175.1	10909.5	2.4
S. Paulo Periphery II	33	1950	0.4	0.35	0.68	0	3.1	1.9
	33	1970	4.6	5.0	2.8	0	10.6	0.16
	22	% Change	752.9	481.2	802.3	134.0	2868.3	2.7
Belo Horizonte Center	14	1950	1.3	0.67	2.1	0	7.9	2.2
	14	1970	9.9	8.6	8.9	0	28.1	0.76
	9	% Change	1288.3	876.7	1331.1	-100.0	4393.1	1.4
Belo Horizonte Periphery I	77	1950	0.20	0	0.65	0	5.2	6.4
	77	1970	3.3	2.1	5.8	0	42.2	4.9
	24	% Change	1226.3	671.7	1183.2	140.3	4845.5	1.6
Belo Horizonte Periphery II	39	1950	0.08	0.001	0.20	0	0.84	2.9
	39	1970	1.0	0.57	1.1	0	3.9	1.2
	11	% Change	946.7	421.2	1193.3	165.8	4101.7	2.2
Rio de Janeiro Periphery I	62	1950	0.26	0.09	0.37	0	01.3	1.4
	62	1970	1.8	0.94	2.3	0	14.2	2.6
	34	% Change	621.3	446.5	545.7	-41.8	2356.1	1.4
Rio de Janeiro Periphery II	27	1950	0.06	0	0.12	0	0.35	1.6
	27	1970	1.4	1.0	1.3	0.06	5.1	1.1
	11	% Change	2008.8	829.8	2619.4	171.7	9184.1	1.9
Rural Periphery	30	1950	0.03	0	0.12	0	0.66	4.5
	30	1970	0.82	0.33	1.3	0	6.3	2.9
	5	% Change	610.6	424.2	363.2	251.5	1121.1	0.44

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

with the picture of tractor-mechanization revealed by the national data of Table 5 (in Chapter 2) where we noted that Minas Gerais has clearly lagged behind São Paulo and the Southern states. This similarity is carried further when we inspect regional distributions of the mechanization indicators within Minas Gerais. Here again, the data reveal the concentration of mechanization in the more central regions vis á vis the peripheral ones--particularly in the São Paulo Periphery II and Belo Horizonte Center. In the former, the mean percent of farms with tractors reached about eight, while in the latter, the mean percent of farms with tractors reached 3.9 in 1970. In the peripheral regions these values never exceed the one percent level. In terms of average rates of change, even stronger trends can be detected for the more central regions, even though the Rio de Janeiro Periphery II was the region that experienced the highest observed rate of change for both mechanization indicators. However, given the extreme low initial values of the indicators for the municipios of this region, such changes did not substantially affect its relative position in the state. In this respect, more spectacular gains were experienced by the São Paulo Periphery I region. However, the more mechanized regions of Minas Gerais, even for 1970, exhibit average levels far below those of São Paulo state but closer or superior to those of the Southern states. As was the case with indicators of bio-chemical innovation, dispersion and variability of the distributions of mechanization indicators are very high and are generally larger in 1970. This highlights the unevenness of the processes of change and the heightening of regional disparities. In summary, we can note that the agricultural technology indicators for Minas Gerais municipios show similar behavior in terms of spatial patterning and rates of change, and that this behavior is largely consistent with the national patterns discussed in previous chapters.

Productivity

We observed in Chapter 4 that producitivity in this study is measured only in terms of physical yields and that six such indicators will be used: one average productivity index and the yields indicators for five selected crops (coffee, sugar cane, rice, beans and corn). Here we present Tables 34, 35 and 36 which contain descriptive statistics for coffee, beans and corn, respectively. The first is a typical export/commercial crop; the second, a typical food/subsistence crop; and the latter is a mixed type, given its overall importance throughout the state. Data for other crops are presented in Appendix A. The average productivity index is also not discussed here because its meaning is a relative one rather than a substantive one.

National data on coffee yields in Table 6 of Chapter 2 indicated relative yield increases during the 1950-1970 period--particularly in the old coffee regions of São Paulo and Minas Gerais. Mean municipal yield values in Minas Gerais also reveal such an increase. These yield gains have been concentrated in the São Paulo Periphery I, a traditional coffee area of the state,

Table 34 . Descriptive Statistics for Coffee Yields (In Kg. per Ha.), All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	353	1950	748	689	372	135	3,079	2.2
	358	1970	848	722	464	065	3,315	1.3
	340	% Change	36.9	7.5	103.0	-83.3	656.5	2.4
S. Paulo Periphery I	100	1950	673	642	276	143	1,734	1.1
	101	1970	1,271	1,266	450	389	3,315	1.0
	99	% Change	117.9	89.5	121.4	-41.6	656.5	2.0
S. Paulo Periphery II	29	1950	762	592	577	179	3,079	2.5
	23	1970	804	727	497	200	2,411	1.5
	23	% Change	36.1	-20.0	112.4	-70.8	385.4	1.7
Belo Horizonte Center	10	1950	813	771	364	228	1,333	3.0
	9	1970	508	489	268	143	1,000	0.50
	8	% Change	-0.81	-22.8	85.2	-70.9	192.5	1.9
Belo Horizonte Periphery I	71	1950	880	784	460	333	2,821	2.1
	74	1970	719	629	331	156	1,800	0.78
	69	% Change	-6.8	-17.6	54.9	-83.3	238.4	1.7
Belo Horizonte Periphery II	31	1950	775	734	402	167	2,200	2.0
	37	1970	688	665	287	167	1,630	0.79
	31	% Change	10.1	-16.6	78.0	-78.5	349.1	2.9
Rio de Janeiro Periphery I	61	1950	737	703	225	135	1,391	0.08
	60	1970	644	606	201	314	1,307	0.69
	59	% Change	-2.3	-13.9	43.2	-60.0	159.2	1.2
Rio de Janeiro Periphery II	27	1950	694	681	243	289	1,207	0.31
	26	1970	521	517	204	65	1,079	0.56
	26	% Change	-20.0	-39.5	37.1	-77.5	92.6	1.2
Rural Periphery	25	1950	685	561	382	333	2,300	2.1
	28	1970	764	560	589	222	2 950	2.5
	25	% Change	32.0	-2.3	111.7	-75.0	491.1	3.1

1/ The number of municipios within regions, varies because of missing cases.

Table 35. Descriptive Statistics for Beans Yield (In Kg. per Ha.), All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	390	346	181	134	1,354	1.6
	384	1970	316	286	100	167	897	2.3
	384	% Change	6.1	-13.6	43.3	-77.9	265.3	1.5
S. Paulo Periphery I	103	1950	333	299	113	100	925	1.8
	103	1970	305	283	080	186	635	1.5
	103	% Change	0.21	-3.7	37.8	-74.4	.130.0	0.78
S. Paulo Periphery II	33	1950	392	382	169	193	1,000	1.8
	33	1970	324	296	119	167	739	2.0
	33	% Change	-6.6	-14.6	43.6	-77.3	134.1	1.2
Belo Horizonte Center	13	1950	570	545	327	163	1,111	0.51
	13	1970	369	314	173	222	897	2.6
	13	% Change	-12.9	-28.0	60.1	-73.8	144.4	1.6
Belo Horizonte Periphery I	77	1950	333	286	153	134	835	1.3
	77	1970	296	280	71	187	551	1.1
	77	% Change	2.3	-4.6	39.5	-59.7	120.1	0.77
Belo Horizonte Periphery II	39	1950	423	393	181	188	973	0.98
	39	1970	328	282	106	221	774	2.2
	39	% Change	-10.0	-23.9	44.4	-64.3	143.3	1.4
Rio de Janeiro Periphery I	62	1950	354	328	125	172	776	1.1
	62	1970	307	278	103	178	855	3.0
	62	% Change	3.5	-12.7	49.2	-66.9	265.3	3.1
Rio de Janeiro Periphery II	27	1950	580	511	248	240	1,354	1.3
	27	1970	289	280	60	214	575	3.3
	27	% Change	-43.2	-48.3	21.0	-77.9	9.5	0.46
Rural Periphery	30	1950	512	483	184	269	977	0.99
	30	1970	395	358	135	214	747	1.3
	30	% Change	-12.5	-24.1	47.4	-68.1	127.5	1.6

1/ There is one missing case for the Belo Horizonte Center and the State distributions.

Table 36. Descriptive Statistics for Corn Yields (In Kg. per Ha.), All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Municipios	Year	Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	1,178	1,140	288	603	2,202	0.71
	385	1970	1,171	1,149	372	355	2,918	0.51
	384	% Change	2.6	-1.2	34.0	-72.2	154.2	0.71
S. Paulo Periphery I	103	1950	1,156	1,130	281	632	2,122	0.95
	103	1970	1,297	1,253	389	533	2,918	1.0
	103	% Change	16.4	10.6	38.7	-52.9	154.2	1.0
S. Paulo Periphery II	33	1950	1,393	1,377	228	952	1,850	0.15
	33	1970	1,429	1,437	281	862	1,952	0.01
	33	% Change	4.5	8.7	22.5	-53.4	50.0	0.34
Belo Horizonte Center	13	1950	1,201	1,232	238	854	1,639	0.24
	14	1970	1,090	1,091	310	412	1,634	-0.27
	13	% Change	-5.5	-8.3	31.3	-71.2	31.5	-0.75
Belo Horizonte Periphery I	77	1950	1,243	1,222	261	802	1,869	0.45
	77	1970	1,225	1,233	287	615	1,919	-0.06
	77	% Change	0.75	-1.7	25.1	-50.1	78.6	0.67
Belo Horizonte Periphery II	39	1950	1,274	1,189	293	760	2,202	0.88
	39	1970	1,109	1,042	304	556	1,807	0.45
	39	% Change	-10.3	-10.4	26.7	-54.6	51.6	0.68
Rio de Janeiro Periphery I	62	1950	1,014	1,026	206	603	1,435	-0.04
	62	1970	1,081	1,033	348	548	2,499	1.4
	62	% Change	8.9	0.12	33.1	-52.2	87.7	0.54
Rio de Janeiro Periphery II	27	1950	1,102	1,095	214	669	1,429	-0.13
	27	1970	854	843	281	366	1,307	-0.08
	27	% Change	-19.5	-21.0	30.9	-70.6	40.0	0.28
Rural Periphery	30	1950	1,128	990	415	647	2,201	1.3
	30	1970	901	826	416	355	1,804	0.58
	30	% Change	-14.9	-24.3	38.8	-72.2	61.1	0.37

1/ The number of municipios within regions, varies because of missing cases.

where this crop has remained as an important and dynamic one (see Table 34). This situation contrasts with that of other coffee regions--the Rio de Janeiro Periphery I and II--which have experienced not only decreases in the proportion of coffee cropland as we have seen, but also decreases or small net gains in coffee yields during the period of the study. Among the other regions where coffee has been less important, only in São Paulo Periphery II have mean municipal coffee yields increased; all others exhibited small yield decreases. Another general observation can be made from Table 34. It refers to the low variability of the yield averages among the various _regions_ except São Paulo Periphery I. However, there is wide variability in coffee yields among _municipios_ in both 1950 and 1970.

Table 6 indicated stagnation--even decreases--in bean yields throughout Brazil from 1950 to 1970. The picture that emerges for Minas Gerais in Table 35 is similar. Bean yields tend to be stable among Minas Gerais municipios, with generally small, but largely negative, rates of change. No striking regional variations are apparent in either average yields or in their rates of change--except perhaps the more intense yield declines in Rio de Janeiro Periphery II and the Rural Periphery. Another observation relative to the decline of the bean yields throughout the state is the systematic decrease in the range and dispersion values from 1950 to 1970.

Corn yields also tend to be quite stable among the Minas Gerais municipios, as expected from the national and state figures in Table 6. Only in the São Paulo Periphery I and II regions do the mean rates of change for corn yields tend to be positive. Those two regions also have the higher mean yields in 1970, while the most peripheral regions have typically lower yields. There is also a tendency for increased dispersion in the various distributions, indicating general unevenness in the process of change.

Tables 65 and 66 of Appendix A indicate general decreases in yields of rice and sugar cane in all regions, despite gains registered for certain municipios (especially for sugar cane). The yield data presented here illustrate, at the level of Minas Gerais municipios, the general tendencies noted in previous chapters: relatively low per hectare productivity gains of Brazilian agriculture in general, as well as the highly concentrated character of these gains in particular regions and for certain crops.

URBANIZATION AND INDUSTRIALIZATION

The data in Table 37 report descriptive statistics for the percent or urban population among Minas Gerais municipios. As expected, the general tendency throughout the state is toward increasing levels of urbanization from 1950 to 1970. Mean rates of change among regions do not greatly vary, but rather reflect something of a "catching up" process in the sense that these rates are somewhat larger for initially less urbanized

Table 37. Descriptive Statistics for Percent Urban Population All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	25.7	21.9	15.5	4.5	96.6	1.6
	385	1970	41.1	37.2	19.6	4.3	99.4	0.76
	385	% Change	72.5	63.2	51.3	-23.7	402.0	2.0
S. Paulo Periphery I	103	1950	28.4	24.7	15.1	10.2	87.4	1.5
	103	1970	43.1	39.1	17.3	15.5	93.9	0.99
	103	% Change	61.9	61.9	33.1	3.2	223.4	1.2
S. Paulo Periphery II	33	1950	25.0	20.6	16.9	6.2	77.6	1.7
	33	1970	43.8	38.6	21.1	14.7	89.3	0.66
	33	% Change	93.1	79.8	56.6	13.8	216.0	0.70
Belo Horizonte Center	14	1950	53.0	44.3	23.6	20.7	96.6	0.56
	14	1970	69.0	66.6	21.5	26.1	99.4	-0.38
	14	% Change	40.2	23.3	53.7	-23.7	192.6	1.6
Belo Horizonte Periphery I	77	1950	30.0	28.0	14.6	8.6	75.3	0.96
	77	1970	48.9	46.0	20.0	11.5	92.0	0.34
	77	% Change	72.6	58.0	51.9	7.0	358.0	2.6
Belo Horizonte Periphery II	39	1950	17.0	15.1	8.4	5.5	41.3	1.2
	39	1970	31.3	29.6	14.0	8.2	65.9	0.77
	39	% Change	94.2	77.3	59.6	7.0	259.0	1.0
Rio de Janeiro Periphery I	62	1950	24.3	22.9	12.1	7.0	62.2	1.3
	62	1970	37.9	36.4	17.0	12.6	88.7	0.78
	62	% Change	60.6	57.6	36.0	-6.2	259.5	2.7
Rio de Janeiro Periphery II	27	1950	16.1	12.9	8.9	6.4	39.0	1.0
	27	1970	31.5	27.8	15.5	8.5	75.8	1.5
	27	% Change	112.6	88.7	78.1	22.9	402.0	1.8
Rural Periphery	30	1950	16.3	13.2	8.7	4.5	42.2	1.2
	30	1970	26.2	22.8	14.4	4.3	59.5	0.47
	30	% Change	61.0	55.3	46.2	-3.4	206.7	1.1

1/ No missing cases.

regions. Another way to view the overall process of urbanization in Minas Gerais municipios during the 1950-1970 period is in terms of the general decrease in skewness from 1950 to 1970 (with the exception of Rio de Janeiro Periphery II), As anticipated, the Belo Horizonte Center region is the most urbanized one. Not surprisingly, mean proportions of urban population tend to be higher in the more central than the more peripheral regions. But again, there is a wide variability in the urbanization levels of Minas Gerais municipios, which is reflected in all regional distributions.

Our discussion in Chapters 2 and 3 emphasized the spatial unevenness of the Brazilian industrialization process. Data in Table 9 in Chapter 9 illustrated the point--revealing the absolute dominance of the Southeast region, and within it, of the state of Sao Paulo. The picture for Minas Gerais, based on municipal distributions of the percent of employed population in the industrial labor force, is very consistent with national patterns. Descriptive statistics presented in Table 38 below show that industrial employment in the state is concentrated in the metropolitan region dominated by the capital city of Belo Horizonte. As anicipated, the differential between this region and the others has increased during the 20-year period of this study. The extremely uneven nature of the industrialization process in the state is also revealed by other characteristics of the data in Table 38. All distributions are highly and positively skewed. That skewness is much smaller in the metropolitan center of

Table 38 . Descriptive Statistics for Percent of Employed Population in the Industrial Labor Force, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici- pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	5.8	1.9	11.7	0	86.3	4.1
	385	1970	6.9	2.0	12.0	0	84.2	3.2
	385	% Change	115.5	20.6	345.2	-100.0	3371.0	5.5
S. Paulo Periphery I	103	1950	4.5	2.7	4.7	0.53	25.5	2.2
	103	1970	5.2	2.5	7.2	0.50	48.9	3.3
	103	% Change	20.9	-1.2	81.0	-87.6	336.6	1.4
S. Paulo Periphery II	33	1950	2.5	1.5	3.2	0	14.5	2.4
	33	1970	4.4	1.7	6.1	0.23	24.9	2.9
	32	% Change	169.5	38.7	479.1	-84.7	2615.6	4.2
Belo Horizonte Center	14	1950	36.9	13.8	32.5	1.3	86.3	0.42
	14	1970	35.3	30.2	26.5	1.2	84.2	0.47
	14	% Change	62.5	-7.9	147.0	-90.0	402.1	1.0
Belo Horizonte Periphery I	77	1950	9.9	3.7	13.9	0.14	66.0	2.1
	77	1970	12.1	5.3	15.3	0.37	66.1	1.7
	77	% Change	83.8	28.4	228.7	-76.4	1862.2	6.4
Belo Horizonte Periphery II	39	1950	1.4	0.69	2.7	0	16.1	4.3
	39	1970	2.0	0.95	3.2	0.15	13.2	2.6
	38	% Change	146.9	6.17	279.2	-72.4	1330.1	2.4
Rio de Janeiro Periphery I	62	1950	5.0	2.2	8.0	0.1	45.8	3.0
	62	1970	6.0	2.3	8.4	0.2	41.1	2.4
	62	% Change	78.7	23.7	208.6	-73.3	1446.2	4.8
Rio de Janeiro Periphery II	27	1950	1.7	0.87	2.4	0.01	10.1	2.2
	27	1970	2.6	1.3	4.3	0.15	19.3	2.9
	27	% Change	260.8	27.4	705.5	-61.9	3371.0	3.4
Rural Periphery	30	1950	0.4	0.31	0.54	0.02	2.7	2.5
	30	1970	1.2	0.52	1.8	0	8.9	2.7
	30	% Change	394.2	129.8	611.7	-100.0	2645.0	2.1

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

Belo Horizonte because it is a more uniformly industrialized region. A further indication of uneven development is reflected in the large differences between mean and median values in all regions (excluding again the Belo Horizonte Center), particularly for rates of change. Despite the large range of values in the distributions of most regions, the data still reveal a decided distinction--more pronounced in 1970 than in 1950--between the more central regions and the more peripheral ones. Data on urbanization and industrialization among Minas Gerais municipios thus are quite consistent with our expectations and underscore the uneven process of economic development in this state.

RURAL NET MIGRATION

Descriptive statistics for the rural net migration indicator are presented in Table 39. The general tendency for all regions is toward negative mean values--that is, rural outmigration. There are no striking differences among the mean regional values. Nevertheless, the Rural Periphery region does exhibit the lowest mean rate of rural outmigration. Differences among regions can be detected more in terms of dispersion and variability statistics. In this connection we can observe that the "old" agricultural regions of Rio de Janeiro Periphery I and São Paulo Periphery I are the most typicall rural "push" areas since they have the highest negative means, the lowest standard deviations, and the lowest negative maximum values. We also see empirical confirmation

Table 39. Descriptive Statistics for Rural Net Migration Residuals, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950 to 1970.

Regional Location	No. of Munici-pios 1/	Statistics					
		Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	381	-45.8	-51.1	27.4	-70.8	33.86	8.4
S. Paulo Periphery I	103	-52.4	-54.5	8.8	-69.2	-23.8	0.6
S. Paulo Periphery II	33	-44.4	-57.3	37.0	-70.8	13.08	3.4
Belo Horizonte Center	14	- 5.1	-48.4	10.63	-68.2	33.86	2.5
Belo Horizonte Periphery I	77	-52.2	-53.0	9.1	-69.5	-19.7	0.7
Belo Horizonte Periphery II	39	-41.2	-43.5	14.7	-59.7	19.2	2.0
Rio de Janeiro Periphery I	62	-52.4	-53.5	0.08	-69.4	-32.5	0.4
Rio de Janeiro Periphery II	27	-42.5	-43.7	13.5	-68.1	-19.8	-0.15
Rural Periphery	30	-22.3	-29.1	23.2	-59.3	28.2	0.6

1/ No missing cases.

of a point made in Chapter 3 that both agricultural modernization and stagnation can function as push factors for rural outmigration--especially under conditions of relatively high rural population densities. Our data in this chapter have clearly demonstrated the more modern, dynamic character of the agricultural sector in the São Paulo Periphery I as compared with the more stagnant and depressed one in the Rio de Janeiro Periphery I. Mean levels of rural population per hectare of arable land (our rural population density indicator as reported in Table 68 of Appendix A) reveal the relatively high densities in these two regions, particularly for the Rio de Janeiro Periphery I. These data are also consistent with the general Brazilian picture, presented in Table 10 of Chapter 2. We observed that both the more dynamic Southeast macro-region and the more depressed Northeast macro-region experienced high outmigration during the period, especially in comparison with the more peripheral, less dynamic, sparsely populated North.

SUMMARY AND CONCLUSIONS

The findings of this chapter generally tend to confirm the broad working hypotheses developed in Chapter 3 on the basis of theoretical and empirical considerations concerning the recent Brazilian development experience. In this section, we summarize these findings and attempt an evaluation of them in the light of those hypotheses. We first present the general tendencies or patterns of change between 1950 and 1970, as revealed by our Minas Gerais municipal distributions. We then address outselves to the major regional differences in these distributions which constitute the focus of the hypotheses pertaining to this chapter.

Farm size indicators showed tendencies similar to those of the state and multi-state aggregates presented in Chapter 2. Average farm size and the proportion of large farms (over 200 hectares) tend to decrease--the former more so than the latter--and the proportion of very small farms (under two hectares) tends to increase. In contrast, Gini coefficients of land inequality, as was generally the case throughout Brazil, have essentially been stable during the period among Minas Gerais municipios. With respect to the land tenure categories, the proportion of owner-operators tends to exhibit small decreases in Minas Gerais municipios as was revealed by the aggregate figures for the state. The tenant group exhibited a modest general increase, and the percentage of squatters showed similar, but more pronounced, tendencies. Administrators tended to show stable proportions during the period of concern. Owners represent the largest tenure category in most municipios of the state in both years.

The general tendencies for the indicators of rural labor force composition in Minas Gerais municipios closely follow the national patterns depicted in Chapter 2. The proportion of family labor tends to increase, that of temporary workers tends to decrease, and the proportion of sharecroppers also decreases. Change in the permanent workers category, however, is mixed--increasing in some municipios and regions and decreasing in others. The result is a general stability in the permanent rural labor force in the statewide averages. This mixed pattern is contrary to national trends revealed in Chapter 2, where we noted a more definite decrease for this labor category.

Rural and urban wages preaviling among Minas Gerais municipios revealed remarkable similarity to national trends, however. Both tend to increase during the period--somewhat more so for rural than urban wages, but not enough to substantially narrow the gap between them. On the other hand, this convergence trend is much more clear with rural and urban literacy rates. Both rates increased during the period, but the rural counterpart increased much more rapidly than the urban aggregate.[4]

While statewide means among MInas Gerais municipios indicate only small gains in the proportion of farmland devoted to crops (as aggregate figures for the state also reveal), the picture is mixed on a regional basis. Some municipios and regions exhibit increases in the percentage of cropland, while others show sizeable decreases. The proportion of land in pastures showed consistent gains throughout the state, as anticipated. The crop mix indicators, however, show very heterogeneous change patterns among Minas Gerais municipios so as to preclude the observation of any general tendency. The subsistence production indicator shows general decreases throughout the state, despite its high variability among the municipal units.

As expected, mean levels of bio-chemical technology among Minas Gerais municipios are lower than those of the more "modern" states in Brazil, although relatively high average gains were experienced during the period. A similar situation pertains to patterns of mechanization--very low initial levels but sizeable, concentrated, positive rates of change. These tendencies within Minas Gerais quite consistently reflect those found for Brazil as a whole. Patterns of change observed with respect to the physical yield indicators of productivity also reveal expected general stagnation, indicating the general backwardness of Minas Gerais agriculture.

The results of this chapter, on the other hand, document the more dynamic character of the urban-industrial sectors in the state, with our indicators of urbanization and industrialization experiencing discernible increases across the municipal distributions. The tendency toward urbanization has been more widespread than for industrialization, as was the case for Brazil generally during the period of the study. We observed above that Minas Gerais is characterized by high rates of both out-of-state migration and rural out-migration. Our indicator of rural net-migration documents this widespread tendency for rural out-migration in most of the municipios of the state. This assumes even more importance in light of the heterogeneous character of local agrarian structures and their rates of change during the 1950 to 1970 period.

Our first general hypothesis concerning the characteristics of and patterns of change in dimensions of municipal social organization in Minas Gerais has emphasized precisely their extreme variability. The data presented in this chapter are sufficiently clear in this respect to make extensive elaboration unnecessary. Practically all distributions (both statewide and regional) presented in this chapter reinforce this point. Even for indicators characterized by high mean values and modest rates of change (such as the land inequality index and proportion of owner-operators), one notes significant variability in both levels and rates of change among municipios. This heterogeneity is particularly pronounced iwth respect to the rates of change. Further, even for variables such as bio-chemical technology innovation that show rapid rates of change in one direction or another, contradictory tendencies for specific municipios can be detected in practically all statewide distributions and most of the regional ones. This would appear to support our contention that municipios do form relevant units of analysis in the Brazilian context. These municipal variations, which tend to be diminished in highly aggregated data, may be seen to represent both explanatory conditions for accounting for development and change, as well as variables to be explained in their own right. Comparative studies of municipal structures can thus provide insight into the mechanisms of continuity and change of local social organization under the impact of the forces of modernization and economic development.

Given the observed municipal heterogeneity in Minas Gerais, it has been rewarding to detect for a large number of indicators significant and consistent regional variations, as anticipated by our second hypothesis.

Regional location is thus a meaningful framework within which to capture differential patterns of local social organization and change. The regional location of municipios has been less important with respect to certain indicators than with others, but the point we wish to stress is that regional disparities have been significant for those indicators we expected them to be--that is, those indicators most closely linked with the process of economic development. This in turn constitutes oru third general hypothesis. No substantial or clear-cut regional variations were noted for indicators such as land inequality, certain land tenure categories (owners and administrators) and rural labor force categories (family labor, temporary workers) or rural net-migration. Various degrees of regional inequality were observed for several other indicators. However, certain of these regional inequalities could be imputed basically to differences in the historical patterns of settlement and development in the various areas of the state, and only secondarily to the conventional meaning of the center-periphery distinction. Such were the differences found, for example, in indicators of farm size, certain tenure (squatters and tenants) or labor force categories (sharecroppers and permanent workers), and, particularly, patterns of land use and crop mix. Nevertheless, as predicted in the third hypothesis for this section of the study, our regions have clearly captured the center-periphery dimension for the indicators closely linked with the process of economic development. We observed that the more central regions--Belo Horizonte Center, Belo Horizonte Periphery I and the São Paulo Peripheries Iand II--have exhibited systematically higher means for indicators of rural and urban wages, rural and urban literacy rates, both bypes of agricultural technology (bio-chemical innovation and mechanization), urbanization, and industrialization, when compared with the more peripheral regions (Rio de Janeiro Peripheries I and II, Belo Horizonte Periphery II and Rural Periphery). These differences are maximized if we consider only the Belo Horizonte Center region in comparison with the Rural Periphery. Further, such regional differences tend to be more pronounced in 1970 than in 1950. We can thus say that both our second and third hypotheses have been confirmed by the data presented in this chapter. Further, our regional location variable does seem to reflect the spatial unevenness of the Brazilian development process.

The last hypothesis stated in connection with the univariate patterns of social change among Minas Gerais municipios, and suggested both by the empirical evidence on Brazilian socio-economic change and theoretical interpretations of the center-periphery distinction, stresses an expectation of increasing regional inequalities in indicators of "development" and "well-being." Our data do reveal increasing regional disparities to the benefit of the more central regions (and particularly the metropolitan region of Belo Horizonte) in the indicators of agricultural technology (both bio-chemical and mechanical forms), industrialization, and rural and industrial wages. In terms of these indicators, central regions not only began with higher levels but also experienced substantial rates of increase--enlarging the relative gap between them and other regions. However, our data also reveal something of a "catching-up" process among regions with respect to indicators such as urbanization and literacy rates (particularly the urban ones), even though sizeable regional differentials remain in 1970. We must conclude that evidence concerning this last hypothesis is mixed and that increasing regional disparities pertain most clearly again to indicators closely linked to the economic development process. The hypothesis is most strongly supported by our indicators of industrialization and agricultural technology, especially is we consider the privileged position of the metropolitan region of Belo Horizonte. But these tendencies are not so clear for other indicators nor are the regional differentials for most regions clearly in the predicted direction. In addition, as observed above, the dispersion measures for municipios within the same regions tend to be high for all such indicators, suggesting spatial unevenness of the change process even <u>within</u> regions. Further, evidence not in accordance with the hypothesis is that mean rates of change are not systematically higher for all indicators in the more central regions. These results again point to the heterogeneity of the local structures and the dangers of attempting sweeping generalizations in countries so diversified as Brazil. In other words, we can detect tendencies for both marginalization of the state's peripheries as well as for their incorporation. It seems that the particular mechanisms through which such processes occur and acquire dominance must be viewed in specific contexts. Or as Long (1977) argues, we must look at the differential modes of articulation between central and marginal sectors (both in their spatial and structural dimensions) at the local level. In the next chapter, we present and discuss the results concerning the question of the relative impact of local antecedent social organization dimensions on the process of agricultural technology change in Minas Gerais municipios.

FOOTNOTES

1. In this table, as in several others, we observe extremely skewed rate of change distributions as well as very high change values for certain variables. The original indicators have been computed with three places past the decimal. These were taken into account when calculating the rate of change scores. Given, in certain cases, very low initial values (below 1) the result is to maximize certain rates of change values, due to the formula used. Decimals were retained in an attempt to minimize the missing cases for the rates of change distributions.

2. The São Paulo Periphery II region, the so-called Triangulo Zone, is one of the more dynamic agricultural areas of the state, with a predominance of larger farms, commercial agriculture, and low rural population densities. The Rio de Janeiro Periphery I (the Mata Zone) is a minifundio region, depressed economically, and characterized by a large subsistence sector.

3. See Paiva, Schattan and Freitas (1973, p. 158) for further detail on this program to deal with coffee overproduction. See also Table 58 in Appendix A of this study that shows the drastic declines in the proportions of cropland used for coffee in these two regions from 1950 to 1970.

4. In part, however, this finding may be due to the "ceiling effect" of initial high urban literacry scores. These high percentages prohibit high rates of change, introducing the kind of bias Bohrnstedt (1969) and others have emphasized.

CHAPTER VI

SOCIAL ORGANIZATIONAL PATTERNS AS ANTECEDENTS OF CHANGE IN AGRICULTURAL TECHNOLOGY

In this chapter, we deal with our second major research question--the associations between the social organization variables and change in agricultural technology, with the former viewed as antecedents to the latter. We here present the results and discuss the relevant hypotheses developed in Chapter 3. The results largely consist of first-order partial correlation and cross-lagged correlation coefficients, which as explained in Chapter 4, represent alternative methods for exploring research questions of this Chapter. In addition, we also report cross-sectional correlations for the same variables. These data will be referred to occasionally in the text, although they do not constitute the major focus of the analysis. The final portion of this chapter reports multiple classification analyses performed for the regional location variable and the agricultural technology indicators. Finally, for reasons stated in Chapter 4, multiple regression results are reported in Appendix C and are briefly discussed in the last section of the present chapter. The organization of this chapter follows the structure set forth in Chapter 5. Following this introduction, we discuss each of the variables of the study in the same order they have been presented throughout this study, evaluating the working hypotheses developed in connection with each variable. A final section makes a brief summary of the main conclusions to be derived from this Chapter's results.

FARM SIZE AND LAND INEQUALITY

The main findings of this chapter are summarized in Tables 40 and 41 below. The coefficients reported in Table 40--first-order partial correlations--are interpreted in terms of the shared variance between the 1950 social organization indicators and the 1970 agricultural technology indicators after the effects of the 1950 agricultural technology indicators have been partialled out from both variances, as explained in Chapter 4. In the present case, these coefficients can be viewed as the magnitude of shared variance between 1950 levels of social organization indicators and change in agricultural technology--that is, residual 1970 variance in agricultural technology not explained by original 1950 levels of technology. The coefficients in Table 41, on the other hand, correspond to simple cross-lagged correlations between 1950 measures of social organization indicators and 1970 measures of agricultural technology indicators.

Table 40. First-Order Partial Correlation Coefficients for the Association of Selected Independent Variables (1950) with Indicators of Agricultural Technology (1970), Controlling for Level of Agricultural Technology (1950), Minas Gerais (Brazil) Municipios.

Independent Variables 1/	CR$ Modern Bio-chemical Inputs per Farm, 1970 2/	CR$ Modern Bio-chemical Inputs per Ha. of Crop-land, 1970 3/	Percent Farms with Tractors 1970 4/	Tractors per 1000 Ha. of Cropland, 1970 5/
Average Farm Size	.109*	-.178**	.231**	.117**
% Farms Less 2 Ha.	.089*	.186**	-.003	.057
% Farms More 200 Ha.	.127**	-.128**	.246**	.130**
Median Category Size Farms Cropland	-.106*	-.087	.116*	.008
Inequality Farm Size	.209**	.130**	.225**	.234**
% Owners	-.024	-.040	-.205**	-.169**
% Tenants	.241**	.356**	.296	.333**
% Squatters	-.024	-.021	-.088*	-.098*
% Administrators	.063	.010	.262**	.203
% Croplands	-.072	.167**	-.034	-.014
% Pasturelands	.265**	.246**	.267**	.302**
Crop Specialization	.212**	.058	.241**	.076
Concentration Commercial Crops	.170**	.052	.305**	.184**
% Coffee Cropland	.097*	.208**	.045	.036
% Rice Cropland	.252**	.104*	.326**	.258**
% Sugar Cropland	-.303**	-.319**	-.250**	-.247**
% Beans Cropland	-.174**	-.268	-.224**	-.260**
% Corn Cropland	-.016	.107*	-.123**	-.035
Rural Literacy Rate	.429**	.589**	.333**	.401**
% Urban Population	.211**	.440**	.378**	.464**
% Industrial Labor Force	.231**	.474**	.377**	.488**

1/ Controlled for each of the 1950 indicators of Agricultural Technology.

2/ Controlled for 1950 level of CR$ of Modern Biochemical Inputs per Farm.

3/ Controlled for 1950 level of CR$ of Modern Biochemical Inputs per Ha. of Cropland.

4/ Controlled for 1950 level of Percent of Farms with Tractors.

5/ Controlled for 1950 level of Tractors per 1000 Ha. of Cropland.

* Indicates the first-order partial correlation coefficient is significant at the .05 level.

** Indicates the first-order partial correlation coefficient is significant at the .05 level.

Table 41. Product-Moment Correlations Between Levels of Selected Independent Variables in 1950 and 1970 Levels of Indicators of Agricultural Technology, Minas Gerais (Brazil) Municipios.

Selected Inde-dependent Variables	CR$ Modern Bio-chemical Inputs per Farm, 1970	CR$ Modern Bio-chemical Inputs per Ha. of Crop-land, 1970	Percent of Farms with Tractors, 1970	Tractors per Ha. of Crop-land, 1970
Average Farm Size	.018	-.183**	.240**	.118**
% Farms Less 2 Ha.	.137**	.207**	.001	.060
% Farms More 200 Ha.	.073	-.124**	.257**	.130**
Median Category Size Farms Cropland	.067	-.105*	.122	.004
Inequality Farm Size	.203**	.143**	.219**	.234**
% Owners	-.126**	-.073	-.219**	-.170**
% Tenants	.354**	.367**	.308**	.333**
% Squatters	-.084	-.065	-.080	-.095*
% Administrators	.180**	.075	.266**	.202**
% Croplands	.143**	.168**	-.039	-.017
% Pasturelands	.277**	.258**	.276**	.303**
Crop Specialization	.215**	.029	.242**	.073
Concentration Commercial Crops	.237**	.050	.204**	.179**
% Coffee Croplands	.190**	.201**	.038	.033
% Rice Cropland	.220**	.078	.331**	.256**
% Sugar Cane Cropland	-.339**	-.339**	-.253**	-.247**
% Beans Cropland	-.278**	-.308**	-.234**	-.261**
% Corn Cropland	-.046**	.036	-.132**	-.035
Rural Literacy Rate	.546**	.600**	.338**	.402**
% Urban Population	.444**	.501**	.383**	.464**
% Industrial Force	.438**	.520**	.376**	.588**

* Indicates the product moment correlation coefficient is significant at the .05 level.

** Indicates the product moment correlation coefficient is significant at the .01 level.

Bio-Chemical Innovation

The indicators of farm size and land inequality of concern here are average farm size, percent of farms over 200 hectares, percent of farms less than 2 hectares, median category of farm cropland, and Gini coefficients of land inequality. The results in Tables 40 and 41 for the associations between these indicators and those of bio-chemical technology generally reveal that 1950 aggregate farm size characteristics of Minas Gerais municipios have only moderate impacts on 1950 levels of and 1950-1970 changes in bio-ch emical technology. Land inequality, on the other hand, has positive and significant influences on levels of and changes in bio-chemical technology. Average farm size and percent of farms over 200 hectares show similar effects on bio-chemical technology indicators which is expected--given the high correlations between both in 1950 and 1970 (see Appendix B). Both farm size variables are very mildly but positively linked with bio-chemical innovation when bio-chemical technology is measured in relation to farm units, and somewhat larger but negative relationships emerge when the bio-chemical innovation indicator is measured on a per hectare of cropland basis. It is interesting to note that a basically similar pattern emerges in the cross-sectional correlations for 1950 and 1970 (Table 42). Two observations can be made with respect to these results. The first deals with the point often made that bio-chemical technology is, at least in theory, less biased with respect to farm size than mechanization. Further, extremely

Table 42. Product-Moment Correlations Between Agricultural Technology Indicators and Selected Variables, Minas Gerais (Brazil) Municipios, 1950 and 1970.

Selected Variables	CR$ Modern Biochemical Inputs per Farm		CR$ Modern Biochemical Inputs per Ha. of Cropland		Percent Farms with Tractors		Tractors per 1000 Ha. of Cropland	
(1950 and 1970)	1950	1970	1950	1970	1950	1970	1950	1970
Average Farm Size	-.112*	-.031	-.047	-.279**	.119**	.241**	.046	.071
% Farms Less 2 Ha.	.109	.289**	.096*	.461**	.050	.092*	.153**	.246**
% Farms More 200 Ha.	.046	.016	-.013	-.243**	.128**	.281**	.038	.099*
Median Category Size Farms Cropland	.246**	.106**	-.067	-.251**	.054	.231**	-.162**	-.045
Inequality Farm Size	.060	.083	.061	.069	-.046	.114*	.010	.170**
% Owners	-.176	.117*	-.103*	.080	-.153**	.031	-.105*	.042
% Tenants	.283**	.335**	.101*	.313**	.162**	.269*	.124*	.281**
% Squatters	-.108*	-.220**	-.130*	-.137*	.070	-.173**	.094*	-.133**
% Administrators	.215**	.251**	.188**	.130**	.053	.371**	-.039	.325**
% Croplands	.326**	.274**	.033	.195**	-.049	.083*	.167**	.019
% Pasturelands	.111*	.190**	.082	.178**	.115*	.278**	.125**	.299**
Crop Specialization	.077	.160**	-.072	.033	-.012	.096*	-.139**	-.013
Concentration Commercial Crops	.071**	.226**	.003	.044	.010	.221**	-.129**	.090*
% Coffee Cropland	.188**	.158**	.016	.187**	-.057	-.022	-.138**	-.034
% Rice Cropland	.032	.105*	-.056	-.030	.065	.192**	.023	.105*
% Sugar Cane Cropland	-.168**	-.309**	-.119*	-.286**	-.051	-.313**	.000	-.290**
% Beans Cropland	-.236**	-.331**	-.174**	-.156**	-.119*	-.429**	-.083	-.249**
% Corn Cropland	-.055	-.159**	-.178**	-.054	-.094*	-.208**	.008	-.145**
Average Productivity Index	.035	-.008	.010	-.080	.171**	.041	.129**	-.005
Coffee Yield	-.001	.339**	.014	.343**	-.035	.241**	.019	.277**
Rice Yield	.112*	.250**	.069	.263**	.128**	.219**	.122**	.267**
Sugar Cane Yield	-.009	.127**	-.059	.096*	-.010	.090*	-.000	.103*
Beans Yield	-.079	-.022	.004	-.013	.023	.010	.022	.021
Corn Yield	-.048	.511	-.078	.483**	.045	.389**	.092	.416**
Subsistence Production	-.033	-.168**	.059	-.202**	-.032	-.032	-.047	-.121**
% Rural Family Labor	-.436**	-.499**	-.025	-.235**	-.101*	-.508**	.117	-.358**
% Sharecroppers	.089*	.113*	-.128**	.029	-.076	.072	-.136	.005
% Permanent Rural Workers	.575**	.508**	.298**	.347**	.107*	.570**	.003	.517**
% Temporary Rural Workers	-.121**	.084*	-.083	-.027	.007	.118**	.060	.058
Average Rural Wages	.470**	.523**	.258**	.480**	.096*	.436**	.020	.478**
Rural Literacy Rate	.418**	.462**	.159**	.483**	.071	.317**	.049	.362**
% Urban Population	.491**	.503**	.312**	.497**	.072	.481**	.064	.537**
% Industrial Force	.452**	.413**	.259**	.443**	.003	.406**	.019	.500**
Rural Net Migration	.117*	.071	-.049	.126**	-.016	.005	-.049	.040

* Indicates the product-moment correlation coefficient is significant at the .05 level.

** Indicates the product-moment correlation coefficient is significant at the .01 level.

large farms (which tend to affect the values of both indicators) are not the most dynamic ones in terms of technology adoptions in Brazil, as Hoffman and Silva (1975) have pointed out. Thus, the low relationships found with cruzeiros of modern bio-chemical inputs per farm are not totally unexpected in the context of Minas Gerais municipios. A second observation refers to the larger negative correlations found with cruzeiros of modern bio-chemical inputs put hectare of cropland. Though not predicted, these results do seem consistent with the notion that larger farms tend to use land extensively--a point generally made in connection with the debate on farm size and economic efficiency, as we have referred to in Chapter 3. In other words, these negative correlations can be interpreted by reasoning that where land is abundant--that is, where the proportion of larger farms tends to be higher--there is little incentive to pursue a land intensive pattern of technological innovation. Or when large farms do employ bio-chemical technology, such technology might be used on only a small proportion of the farm cropland, which would then contribute to the contradictory results revealed by our data. The median size category of farm cropland indicator exhibits more or less similar patterns of relationship with both 1970 levels of and change in bio-chemical technology. These relationships can be interpreted in the same way as for the other farm size variables, even though the relationships tend to be quite small.[1] The percent of farms with less than 2 hectares tends to be positively related to both indicators of bio-chemical technology change (and 1970 levels) but more so for cruzeiros of modern bio-chemical inputs per hectare of cropland. The same pattern is observed in the cross-sectional correlations of Table 42. As observed in Chapter while commenting on the expected associations of farm size and technological change, such positive relationships would logically flow from a situation of high land inequality. High levels of land inequality tend to combine a substantial number of large farms along with a high proportion of small farms in the same area. We can thus observe that the Gini index of land inequality is also consistently and significantly related to bio-chemical innovation. It is interesting to observe that these two indicators (percent of farms with less than two hectares and land inequality) are more important in explaining bio-chemical innovation than those reflecting the proportion of larger farms. In other words, it appears that relative inequality of land--and consequently, inequality of access to resources--rather than sheer farm size accounts for technological change at the local level.[2] As we observed in Chapter 3, even though it is reasonable to expect that the minifundio units, in general, tend to be marginal to the process of technological change in Brazil, the aggregate positive relationships found with our data might, as predicted, be an indication of the "functionality" between minifundios and large commercial farms. In other words, a high prevalence of minifundios does not inhibit bio-chemical innovation at the municipal level; on the contrary, the prevalence of minifundios is positively related to such innovation.

Table -3. Product-Moment Correlation Coefficients for the Relationships Between Indicators of Mechanization and Selected Variables, For Municipios with at Least One Tractor, 1950 (N=161).

Selected Variables	Percent Farms with Tractors	Tractors per 1000 Ha. of Cropland
Average Farm Size	.367**	.257**
% of Farms Less 2 Ha.	.011	.189**
% of Farms More 200 Ha.	.442**	.301**
Median Category Size Farms Cropland	.260**	-.110
Inequality Farm Size	.115	.281**
% Owners	-.412**	-.376**
% Tenants	.468**	.454**
% Squatters	.032	.068
% Administrators	.347**	.193**
% Croplands	-.003	-.245**
% Pasturelands	.315**	.375**
Crop Specialization	.137*	-.094
Concentration Commercial Crops	.244**	.014
% Coffee Cropland	-.108	-.262**
% Rice Cropland	.324**	.295**
% Sugar Cane Cropland	-.129	-.048
% Beans Cropland	-.320*	-.276**
% Corn Cropland	.298**	-.084
Average Productivity Index	.230*	.160**
Coffee Yield	-.067	.039**
Rice Yield	.303**	.329**
Sugar Cane Yield	.032	.064
Beans Yield	-.015	-.027
Corn Yield	.133*	.247**
Subsistence Production	-.083	-.122
% Family Rural Labor	-.515**	-.169*
% Sharecroppers	-.103	-.130*
% Permanent Rural Workers	.463**	.329
% Temporary Rural Workers	-.047	.085
Average Rural Wages	.599**	.508**
Rural Literacy Rate	.445**	.464**
% Urban Population	.400**	.453**
% Industrial Labor Force	.305**	.411**
Rural Net Migration	.006	-.061

* Indicates the product-moment correlation coefficient is significant at the .05 level.

** Indicates that the product-moment correlation coefficient is significant at the .01 level.

Mechanization

The partial correlation coefficients in Table 40 and the cross-lagged correlations from Table 41 show a clearer pattern of association between the farm size indicators and levels of and changes in mechanization during the 1950-1970 period, as predicted in our first hypothesis. Average farm size and percent of farms over 200 hectares are significantly and positively related to both indicators of mechanization--percent of farms with tractors and tractors per 1000 hectares of cropland--although generally higher for the former than the latter. These results are consistent with the characterization of tractor-mechanization as a large farm-biased innovation. Although not reported here, tabulations with other indicators available in census data indicate that the predominant type of tractors adopted in Minas Gerais municipios are larger ones with relatively high power (over 10 horsepower). This suggests that larger farm units benefit most from this pattern of technological improvement.

On the other hand, the percent of farms with less than two hectares (in 1950) shows no relationship with mechanization trends or 1970 mechanization levels. Minifundios tend to be marginal to the mechanization process, as noted in Chapter 3. It is interesting to note that lack of any inverse association between the prevalence of minifundios and change in mechanization in Tables 40 and 41. However, it can be observed that the cross-sectional correlations presented in Tables 42 and 43[3] show significantly positive coefficients for the associations between proportion of minifundios and tractors per 1000 hectares of cropland, and a modest but significant association with percent of farms with tractors in 1970.

The median size category of farm cropland indicator is positively associated with change in mechanization as well as with 1970 mechanization levels when measured in terms of percent of farms with tractors. However, the relationship between the median size indicator and mechanization standardized on a per hectare basis is a modest, inverse one.

The land inequality indicator exhibits strong positive associations with both bio-chemical and mechanical types of technological change--but more so, as predicted, with mechanization. All coefficients reported in this connection in Tables 40 and 41 are significant at the .01 level. Thus, our findings concerning the linkages between farm size and land inequality with mechanization are more consistent with hypothesis 1 than the findings pertaining to bio-chemical technology (see Chapter 3).

LAND TENURE

Bio-Chemical Innovation

The four tenure groups considered in this study show different directions and degrees of relationship with bio-chemical innovation in Minas Gerais municipios. In general, however, we can say that our expectation of modest relationships stated in hypothesis 2 has been confirmed by the results. The proportion of owners in 1950 shows no association with bio-chemical technology change (Table 40) and only very low inverse associations with 1970 levels of bio-chemical technology (Table 41). As observed in Chapter 3, the generally high proportion of owner-operators in Minas Gerais tends to make this a very heterogeneous category, which in part may account for these meager aggregate correlations. These findings are also consistent with the lack of any substantial relationship in the cross-sectional correlations of Table 42.

The 1950 proportion of squatters (which on the average tended to be very low, as the descriptive tables of Chapter 5 indicated) also shows no major associations with bio-chemical innovation. Nevertheless, the signs are in the predicted direction--that is, negative. A similar but more substantial pattern of relationships is found in the cross-sectional coefficients of Table 42. The proportion of administrators shows consistent positive and increasingly stronger associations with bio-chemical innovation as we move from the first-order partial to the cross-lagged correlations and finally to the cross-sectional correlations. This tendency is in the predicted directions according to hypothesis 2. These results indicate that inter-censal definition problems for the administrator category (noted in Chapter 4) do not seem to substantially affect our conclusions.

We made no specific prediction for the tenancy category because of conceptual and empirical ambiguities discussed in previous chapters. Our results, however, show no such ambiguities; the proportion of tenants is systematically, significantly, and positively associated with bio-chemical innovation. In other words, higher proportions of tenants are associated with higher levels and larger increases in bio-chemical innovation. Further, these associations are the highest among all tenure groups. This finding can be due to one or both of two factors. Firstly, the tenant group within prevailing socio-economic conditions of Minas Gerais municipios may have had a bona fide impact on the rate of technological change--in other words, there was a tendency for tenants to adopt new technologies more rapidly than other tenure groups. However, the relationship as revealed by the aggregate data may be spurious; that is, tenancy arrangements may be most common in municipios which, for other reasons, experienced high rates of bio-chemical innovation. We have attempted some limited explorations into this question. Despite the heterogeneity of the tenant group as measured by our data, it seems reasonable to assume that a sizeable component of the tenancy category is formed by small sharecroppers and other peasant-like tenants. Such sharecroppers and peasants, given the general character of agricultural transformation in Brazil, have not likely been able to adopt significant amounts of new technology. Simple correlations reported in Appendix B show coefficients of about .20 in both years for this association between the proportion of tenants and minifundios. If part of the association found between the proportion of tenants and bio-chemical innovation is due to the effects of the prevalence of minifundios--which we have seen bears a significant relation to technological change--controlling for the 1950 proportion of minifundios we should result in smaller strength of relationship. We have calculated second-order partial correlation coefficients for the relationship between the proportion of tenants and bio-chemical innovation, controlling for the 1950 proportion of minifundios. The second-order partials are: .229 for cruzeiros of modern bio-chemical inputs per farm, and .330 for cruzeiros of modern bio-chemical inputs per hectare of cropland. These second-order partials are quite similar to the first-order partials in Table 40. Thus, the proportion of minifundios cannot account for the observed relation between the tenant category and technological change.[4]

A second exploration into the nature of the relationship between the tenant category and bio-chemical innovation was performed using the percent of cropland devoted to rice as a control variable. The choice of this indicator was made on the following basis. This indicator, as we will see later, shows the strongest relationships with technological change of all specific crop variables. As Paige (1975) has observed, rice is a crop quite conducive to tenancy (particularly sharecropping) arrangements. Also, our data in Chapter 5 indicated the importance of rice in one of the most dynamic agricultural regions of Minas Gerais (São Paulo Periphery II). Further, the correlation matrix in Appendix B reveals that rice is the only specific crop indicator which has a positive association with the proportion of tenants (.130 in 1950, and .192 in 1970). The same procedure for calculating second-order partial correlations was used, with both 1950 technology levels and the 1950 proportion of cropland in rice as control variables. The coefficients were: .219, for cruzeiros of modern bio-chemical inputs per farm, and .347, for cruzeiros of modern inputs per hectare of cropland. These results again do nothing to alter the positive associations between the tenant category and bio-chemical innovation. The cautious conclusion our data seem to point to is that contrary to prevailing views, the prevalence of tenancy in Minas Gerais municipios has in some way been "functional" to bio-chemical innovation at the local level.

Mechanization

As was the case with the farm size indicators, relatively stronger impacts of the land tenure groups on mechanization than on bio-chemical innovation are apparent. The coefficients are systematically higher with mechanization than with bio-chemical technology in Tables 40 and 41 (and also in general in Tables 42 and 43, which report the 1970 and 1950 cross-sectional correlations). These differential associations were not anticipated in hypothesis 2. The patterns of association, however, are the same as those revealed for bio-chemical technological innovation. Contrary to our expectations, the proportion of owners is substantially and inversely correlated with mechanization increases and 1970 mechanization levels. We may speculate that despite the heterogeneity of this tenure group, owner-operated farms tend to have less than optimum sizes for the types of tractors adopted in Minas Gerais. Simple cross-sectional correlations between the proportion of owners and indicators of average farm size and proportion of farms over 200 hectares are negative in both 1950 and 1970 (see Appendix B), although less strong than one might expect. On the other hand, the proportion of administrators, which shows overall significant positive correlations with mechanization in all four tables presented above, is also more typically associated with the prevalence of large farms, as the data in Appendix B demonstrate. Since both the proportion of administrators as well as the levels of and rates of change in mechanization are related to the prevalence of larger farms, the positive associations between the proportion of administrators and change in mechanization are consistent with our expectations. The inverse relationships between the proportion of squatters and mechanization are also consistent in this respect. However, these coefficients tend to be smaller than those found for the associations between the other tenure groups and mechanization. The tenure insecurity and small farm sizes characteristic of the squatter group would thus appear to act as barrier to mechanization. The effects of the tenancy category with respect to mechanization are exactly the same as observed with bio-chemical innovation. The relationships are all positive and somewhat stronger than comparable coefficients pertaining to bio-chemical technology. We have also calculated two sets of second-order partial correlation coefficients. The first equations control for the percent of farms with less than two hectares and the second set controls for percent of rice cropland (with both sets of equations controlling for 1950 mechanization). The results were similar in the sense that no significant reductions in the effects of the tenancy category were observed.[5]

The results pertaining to the associations between land tenure categories and mechanization tend to be less in agreement with hypothesis 2 than those pertaining to bio-chemical innovation. The major disparity was the relatively strong associations observed as opposed to the meager ones predicted. Only the squatter category exhibited the modest correlations that were anticipated. A second finding not in accordance with our expectations was the inverse relationship between the proportion of owners and mechanization. The theoretical notions consistently supported by the data correspond to the negative associations between the proportion of squatters and mechanization, and the positive relationships between the proportion of administrators and the mechanization indicators.

RURAL LITERACY RATE

Bio-Chemical Innovation

Data reported in Tables 40 and 41 indicate, as predicted, strong associations between original (1950)levels of rural literacy and 1970 levels of and 1950-1970 change in bio-chemical technology. Relevant cross-sectional correlations for both 1950 and 1970 are similarly very strong and positive. The evidence thus clearly and unambiguously supports hypothesis 3. However, there are very strong simple correlations between rural literacy rates and our two municipal-level indicators of the center-periphery dimension--urbanization and industrialization--which were also predicted to be closely linked with the process of technological innovation in agriculture in Minas Gerais municipios (see Appendix B). It is therefore appropriate to use urbanization and industrialization as control variables to more fully explor the literacry/mechanization relationship. We have thus calculated third-order partial correlation coefficients between rural literacy rates and 1970 bio-chemical technology, controlling for the 1950 technology as well as 1950 urbanization and industrialization levels. If a substantial portion of the initial first-order correlations was due to the spurious impact of these additional control variables, the third-order partials should be significantly decreased. Unfortunately, computations could be done only for the indicator of cruzeiros of modern bio-chemical inputs per farm, since scores for the per hectare technology indicator were generally too low to permit the computation of stable parameter estimates. Nevertheless, the third-order partial for the effect of rural literacy on cruzeiros of modern bio-chemical inputs per farm (.371) shows substantial decrease from its first-order partial, but not enough to fully account for the original observed relationship.

Mechanization

The same pattern of strong positive relationships is found between rural literacy and mechanization. The relationships are consistently large in all four tables (see Tables 40 to 43). Hypothesis 3 is thus confirmed by our data. However, third-order partials computed by introducing controls for 1950 levels of urbanization and industrialization indicate more important effects of the control variables than was the case with bio-chemical innovation. These third-order partials were .135 for the percent of farms with tractors indicator and .150 for the number of tractors per 1000 hectares of cropland indicator. The relationships between rural literacy rate and change in mechanization during the 1950-1970 period became much less pronounced--even though still significant--when the control variables are introduced. We may thus conclude that hypothesis 3 is confirmed, although much of the relationship between literacy rate and agricultural technology change tends to be the spurious result of municipal variations in urbanization and industrialization--particularly with respect to mechanization.

LAND USE AND CROP MIX

Bio-Chemical Innovation

As noted in Chapter 2, we have selected two general indicators for land use patterns in Minas Gerais municipios: percent of farmland devoted to crops and percent of farmland devoted to pastures. The considerations set forth in Chapter 3 have suggested a positive relationship between the proportion of farmland in crops and technological change. The results presented in Tables 40 and 41 do not lend strong support to this hypothesis. The 1950 proportion of cropland is significantly, but not strongly correlated with 1970 bio-chemical technology levels (Table 41) and shows a positive impact on bio-chemical technology change (Table 40) only when the latter is measured in terms of cruzeiros of modern bio-chemical inputs per hectare of cropland. In sum, the size of the coefficients is much smaller than we originally anticipated.

On the other hand, the proportion of pastures indicator (for which no specific prediction was made) shows consistently strong, positive relationships with 1970 levels of and 1950-1970 change in bio-chemical technology (Tables 40 and 41). The reasons for this apparent paradox perhaps can be found in the aggregate nature of our data which can provide only indirect evidence of technological adoption--rather than a direct on at farm level. Secondly, we believe that the regional composition of the state and the overall importance of livestock activities in Minas Gerais can be viewed as the major factors behind these correlations. We noted in Chapter 5 that the most dynamic region in terms of average rates of change in bio-chemical technology was São Paulo Periphery II, which is also the region with the highest mean proportion of land in pastures in both years. This region is traditionally recognized as a major livestock area in Minas Gerais. Similarly, the São Paulo Periphery I and the Belo Horizonte Center--both very central and dynamic regions--also exhibited high mean proportions of land in pastures. Further, it should be recognized that despite the relatively low levels of modernization of livestock activities in Minas Gerais as a whole, these activities are largely a commercial--rather than subsistence--endeavor. It is thus reasonable to argue that municipios where livestock activities predominate also tended to develop stronger commercial linkages between agricultural and non-agricultural sectors which in turn would present conditions favorable for technical improvement in agriculture.

The crop mix indicators show a varied picture in terms of their relative impacts on 1970 levels of and 1950-1970 change in bio-chemical technology. However, these patterns, to a certain degree, tend to confirm the expectations summarized in hypothesis 4. Before discussing these results, it is important to emphasize the ecological and indirect nature of these findings. We cannot ascertain if specific crops have or have not been directly affected by technological improvements, but can only infer certain linkages between the predominance of these crops and the process of technological change.

The first two indicators of crop mix--crop specialization and concentration on commercial/export crops (rice, coffee, cotton, and sugar cane)--show significant positive associations with bio-chemical innovation both in terms of change and 1970 levels when the technology variable is measured on a per farm basis. However, there are only small relationships when bio-chemical technology is measured on a per hectare basis. Given the relatively low values of the cruzeiros of modern bio-chemical inputs per hectare of cropland indicator even in 1970 (see Table 31 in Chapter 5), these results are not totally unexpected.

The relationships for the five selected crops tend to be different, as expected, although not a disparate as originally presumed. The proportions of cropland devoted to coffee and rice have positive associations with 1970 levels of and change in bio-chemical technology. It is interesting to observe that coffee has been particularly important in São Paulo Periphery I, and rice in São Paulo Periphery II--both of which are very dynamic regions in terms of technological innovation in agriculture (see Chapter 5). The data also reveal systematic negative correlations between the proportion of cropland in beans and bio-chemical technology indicators (see Tables 40 and 41). This was anticipated since beans remain a traditional food crop in Brazil which has remained outside the rubric of technological improvement in agriculture. We have also observed in Chapter 5 some tendency for beans to be most prevalent in the more peripherical regions of the state.

The relatively strong, inverse relation between the proportion of cropland in sugar cane and bio-chemical innovation as reflected by both the first-order partials (Table 40) and cross-lagged correlations (Table 41) does not follow our theoretical expectation. As Patrick (1975) has shown, sugar cane is a commercial export crop which has experienced technological advance in most regions of the country--particularly so in the neighboring states of São Paulo and Rio de Janeiro. The fact that Minas Gerais municipios where this crop has been relatively important have lagged behind others in bio-chemical innovation seems to point to the relative backwardness of the state's agriculture. It is interesting to note in this connection that sugar cane has been most prevalent in the eastern regions of the state (particularly Rio de Janeiro Periphery I) which have been much less dynamic than those in the South and West.

Corn, essentially a universal crop throughout the state, exhibits ambiguous relationships. The prevalence of corn shows positive but small associations with bio-chemical technology innovation in both Tables 40 and 41 when technology is measured in terms of cruzeiros of modern bio-chemical inputs per hectare of cropland. However, the relationship is small and negative with cruzeiros of modern bio-chemical inputs per farm. Such patterns are not surprising, given the widespread importance of the crop in Minas Gerais. The data indicate that corn is grown under a variety of technological conditions. In other words, even though corn tends to remain a very traditional crop in most municipios, it has also been a focus for some technological improvement in other areas. For example, the diffusion of hybrid seeds was among the earliest efforts of the state's extension service. Nevertheless, we can say that hypothesis tends to be confirmed with respect to bio-chemical technology, with sugar cane being the major exception to our expectations.

Mechanization

The patterns of relationship between the 1950 land use/ crop mix indicators and mechanization variables revealed in Tables 40 and 41 are generally similar to those discussed above with respect to bio-chemical innovation. The percent of farmland in crops bears no relationship whatsoever with mechanization. On the other hand, the proportion of farmland in pastures is significantly and positively associated with mechanization. It is worthwhile noting the leading position of the São Paulo Periphery II region in terms of mechanization. The São Paulo Periphery II also exhibits the highest proportion of pastureland and the lowest of cropland in both 1950 and 1970 (see Chapter 5). The characteristics of this region thus have decisively influenced the results obtained here. The cross-sectional coefficients in Tables 42 and 43 show similar patterns of association--generally indicating only small linkages between percent of farmland in crops and mechanization, and substantial positive associations between percent of farmland in pastures and mechanization.

The general crop mix indicators--crop specialization and concentration in commercial/export crops--reveal the same patterns of association found with respect to bio-chemical innovation. That is, the higher the 1950 levels of crop specialization and concentration in coffee, sugar cane, rice or cotton, the higher the 1970 level of and 1950-1970 change in mechanization when measured in terms of percent of farms with tractors. The relationship is smaller but still significant when mechanization is measured in terms of tractors per 1000 hectares of cropland. One discernible difference when we compare these results with those obtained for the bio-chemical innovation indicators is that the coefficients obtained for relationship between the export concentration index and mechanization (standardized on a per 1000 hectare basis) are systematically larger than those for the bio-chemical innovations. This suggests that the relative importance of export or commercial crops is more crucial in shaping mechanization than it is for bio-chemical innovation. For a system of agriculture such as that prevalent in Brazil--one historically characterized by a commercial sector basically consisting of large farms where land is not a limiting factor--the mechanization option may be a very rational one for the large landholder. This interpretation corresponds with observations made by Johnston and Kilby (1975) and Griffin (1974) when comparing the "private" versus the "social" benefits of mechanization.

Indicators of the relative importance of the five crops considered in this study again show differential impacts on mechanization. Percent of cropland in rice generally exhibits the largest positive effects on 1970 levels of and change in mechanization (see Tables 40 and 41). Percent of cropland in coffee is unrelated to mechanization. This is a reasonable finding since coffee is not a crop suitable for mechanization (Paige, 1975), especially of the type studied here. Beans cropland is again consistently and negatively related to mechanization, as expected. The same type of relationship is found for sugar cane. The prevalence of corn shows largely negative impacts, but the correlations are quite low as was the case with bio-chemical innovation.

The patterns of association between the land use/crop mix variables and indicators of agricultural technology thus are complex and defy an easy summary. With respect to mechanization, hypothesis 4 failed to receive support in terms of the cropland and sugar cane indicators. The evidence pertaining to the other indicators has been more consistent with the hypothesis. The most intriguing results pertain to the relative unimportance of the percent of cropland indicator in accounting for technological change at the municipal level in Minas Gerais, as well as the consistent negative effects of percent of cropland devoted to sugar cane on technological change. These findings, however, do underscore a picture of Minas Gerais agriculture as being generally backward and heavily involved in land extensive, livestock-oriented activities.

REGIONAL LOCATION, URBANIZATION, AND INDUSTRIALIZATION

The indicators of regional location, urbanization and industrialization, as noted in Chapter 3, represent the center-periphery concept in its spatial and structural dimensions. Regional location pertains to the macro or contextual level of analysis, while urbanization and industrialization refer to the center-periphery construct in its micro or municipal context. These variables are assumed to reflect differential linkages to or modes of incorporation within the national centers of the country. In this sense, these variables are expected to capture the spatial and structural unevenness of the social processes of change--particularly so for those processes linked with economic growth and development. Such center-periphery variables are here considered to be "non-rural" variables, which as our previous discussion has pointed out, are predicted to have major impacts on the process of change in agricultural technology among Minas Gerais municipios. These variables in turn are the focus of hypothesis 5.

Bio-Chemical Innovation

The relative impacts of the regional location variable on agricultural technology change (as well as agricultural technology levels in 1950 and 1970) are evaluated in Tables 44 and 45 below. These tables report the results of multiple classification analysis (MCA) equations described in Chapter 4. The data in Table 44 leave no doubt as to the importance of regional location in accounting for residual change in bio-chemical technology in Minas Gerais municipios from 1950 to 1970. The summary statistics (eta coefficients) are clearly significant for both technology indicators. The eta values, as noted above, can be interpreted similarly to the standardized beta of a simple regression equation--that is, the average change (in standard units) on the bio-chemical technology indicators per standard "unit change" in regional location (i.e., as one moves from the more peripherical to the more central regions). Since the beta coefficient in a bivariate regression equation is, of course, equal to the simple correlation coefficient, the eta values thus correspond to the level of shared variance between the residualized change scores of the bio-chemical technology indicators and the regional location categories. As noted in Chapter 4, these residualized change scores have a mean of zero (because of standardization by the standard error of the stimate). The particular impact of each region can be evaluated in terms of its specific deviation from the grand mean for all regions. We can thus observe in Table 44 that the regions can

Table 44. Multiple Classification Analysis Summary Statistics for the Effects of Regional Location on 1950-1970 Change in Indicators of Agricultural Technology, Minas Gerais (Brazil) Municipios.

Regional Location	Change in CR$ Modern Biochemical Inputs per Farm 1/	Change in CR$ Modern Biochemical Inputs p.Ha. Cropland	Change in Percent Farms with Tractors	Change in Number of Tractors p. 1000 Ha. Cropland
	Dependent Variables			
	Deviations from the Grand Mean			
Grand Mean	.00	.00	.00	.00
Rural Periphery	-.39	-.49	-.32	-.41
Belo Horizonte Periphery II	-.34	-.45	-.30	-.40
Rio de Janeiro Periphery II	-.41	-.48	-.17	-.28
Rio de Janeiro Periphery I	-.54	-.50	-.37	-.33
Belo Horizonte Periphery I	-.02	.10	-.15	.06
S. Paulo Periphery II	.62	-.05	1.10	.09
S. Paulo Periphery I	.47	.63	.22	.37
Belo Horizonte Center	.18	.38	.12	.74
Eta	.48**	.54**	.52**	.38**

1/ All measures of change are computed in terms of residualized change scores.

** Indicates the Eta coefficient is statistically significant at the .01 level, according to an F-test.

Table 45. Multiple Classification Analysis Summary Statistics for the Effects of Regional Location on Levels of Indicators of Agricultural Technology, Minas Gerais (Brazil) Municipios, 1950 and 1970.

Regional Location	CR$ Modern Bio-chemical Inputs per Farm		CR$ Modern Bio-chemical Inputs per Ha. of Crop-land		Percent of Farms with Tractors		Tractors per 1000 Ha. of Cropland	
	1950	1970	1950	1970	1950	1970	1950	1970
	Deviations from the Grand Mean							
Grand Mean	-2.85	-1.48	-4.97	-3.46	-.40	.11	-.44	.58
Rural Periphery	-1.15	-1.45	-.27	-1.42	.01	-.96	.11	-1.04
Belo Horizonte Periphery II	-1.03	-1.05	-.71	-1.15	-.13	-.79	.01	-.91
Rio de Janeiro Periphery II	-1.20	-1.07	-.08	-1.25	.37	-.50	-.43	-.63
Rio de Janeiro Periphery I	.56	-.16	-.03	-.22	-.03	-.37	-.18	-.45
Belo Horizonte Periphery II	-.07	.15	-.21	.36	.03	-.21	.14	.05
S. Paulo Periphery II	-.26	.77	.07	.09	.34	1.42	.13	.70
S. Paulo Periphery I	.65	.72	.30	.85	-.01	.49	-.04	.65
Belo Horizonte Center	1.46	.88	1.60	1.17	.30	1.06	.61	1.25
Eta	.53**	.68**	.29**	.75**	.18	.54**	.23**	.56**

** Indicates the Eta coefficient is statistically significant at the .01 level according to an F-test.

be clearly ranked in terms of their differential impact on technological change. Furthermore, this ranking basically follows the expected direction. The more peripheral regions tend to have large negative deviations from the grand means of bio-chemical technology indicators, while the more central regions tend to have large positive deviations. We should note that the central regions, as defined a priori (i.e., the Belo Horizonte Center and the São Paulo peripheries) clearly follow the expected pattern stated in hypothesis 5.

The results for the impacts of regional location on bio-chemical technology levels in both 1950 and 1970 are in the same direction. Not only are the eta coefficients all significant at the .01 level, but the deviations about the grand mean for the eight regions follow the same center-periphery pattern observed with the bio-chemical technology change. Moreover, the regional deviations in Table 45 reveal the same differences observed in Chapter 5 concerning the dynamism of two regions: Rio de Janeiro Periphery I (less dynamic and worse off in 1970) and Belo Horizonte Periphery I (more dynamic and better off in 1970). A second interesting observation from Table 45 is that the eta values for the bio-chemical technology indicators (as well as for mechanization) are much larger in 1970 than they were in 1950. Again, these results are perfectly consistent with our previous findings in Chapter 5 concerning increasing regional inequalities with respect to agricultural technology.

The urbanization and industrialization indicators, as predicted by hypothesis 5, show very positive associations with both changes in bio-chemical innovation and 1970 bio-chemical technology levels, according to the coefficients reported in Tables 40 and 41. The argument developed in Chapter 3 concerning the so-called urban-industrial impact hypothesis seems to be valid in the context of Minas Gerais municipios. Likewise, Rios (1969), in his more detailed evaluation of this hypothesis in Minas Gerais, though using different indicators and working at the regional level, found consistent positive associations between his urban and industrial indicators and use of mechanical and electrical power on farms.

We earlier observed very high correlations between our indicators of urbanization and industrialization (over .70 in both 1950 and 1970; see Appendix B). Since urbanization is a broader phenomenon in both spatial and structural terms, we have decided to calculate second-order partial correlation coefficients for the relationships between 1950 industrialization level and 1970 bio-chemical technology indicators, controlling for both 1950 urbanization and 1950 bio-chemical technology. These coefficients are: .128, for the cruzeiros of modern bio-chemical inputs per farm indicator; and .249, for the cruzeiros of modern bio-chemical inputs per hectares indicator. We can thus observe a sizeable decrease in the values of the second-order partials when compared with the first-order coefficients reported in Table 40, even though both coefficients are still significant at the .01 level. It can be concluded, then, that a substantial portion of the shared variation between municipal industrialization levels and change in bio-chemical technology is due to the effects of urbanization. This point is consistent with our discussion of the processes of urbanization and industrialization in Minas Gerais, with the latter being much more concentrated spatially (being dominated basically by a steel industry sector largely directed toward a national market). Urbanization is clearly more widespread and more likely to affect local agricultural conditions.

Mechanization

Tables 44 and 45 present the results for the effects of regional location on changes in mechanization during the 1950-1970 period as well as on mechanization levels of 1950 and 1970. The results are strikingly similar to those discussed above for bio-chemical innovation. Looking first at Table 44, we observe that the etas for the associations between regional location and change in mechanization are large and significant at the .01 level. Secondly, the regions themselves are ranked more or less in the same way as before--that is, the São Paulo peripheries and the Belo Horizonte Center show typically positive deviations from the grand means, while the more peripheral regions show systematic negative deviations. The data in Table 45 reveal in a much more clear way the increasing regional unevenness of the mechanization process from 1950 to 1970. The 1970 eta values are substantially larger than those for 1950. In fact, in 1950, when mechanization levels were extremely low in the state, the eta coefficient for the effect of regional location on percent of farms with tractors failed to achieve statistical significance. These differences can be interpreted, as before, in terms of increasing regional disparities in the process of technological change. This sharpening of regional inequality is more visible and important for mechanization than for bio-chemical innovation.

The patterns of association between original urbanization and industrialization levels and changes in mechanization during the study period (as well as 1970 mechanization levels) are also the same as found for bio-chemical innovation. The data show very strong, positive partial and simple correlations, as indicated in Tables 40 and 41. The same comments made above with respect to bio-chemical innovation are valid here. We have, in addition, calculated second-order partial correlation coefficients for the relationships between 1950 industrialization and 1970 mechanization, controlling for 1950 urbanization and mechanization levels. These coefficients were: .152 for the percent of farms with tractors indicator, and .238 for the number of tractors per 1000 hectares of cropland indicator. These coefficients again are typically lower (although still significant at the .01 level) than the first-order partials presented in Table 40. The same conclusion noted above is again warranted: the high correlations between industrialization and mechanization indicators can be accounted for in large part by the urbanization variable. Nevertheless, industrialization does exhibit some independent effects on mechanization indicators (as was the case for bio-chemical innovation), but to a lesser degree than initially implied by the data in Table 40.

The general conclusion with respect to the relative impact of the center-periphery variables is that they have proved to be vitally important in accounting for agricultural technology levels and technological changes in Minas Gerais municipios during the 1950-1970 period. The coefficients reported herein have been consistently large and positive for both groups of agricultural technology indicators. Hypothesis 5 thus is fully accepted given the results just presented, even with the qualification made with respect to the relative impact of industrialization.

SUMMARY AND CONCLUSIONS

The results of this chapter are not characterized by clear-cut consistencies or inconsistencies relative to the predicted patterns of relationships stated in the five hypotheses of Chapter 3. In fact, we can say that most hypotheses are both partially confirmed and partially disconfirmed or qualified by our data, indicating the rather preliminary nature of these results. In this final section, we summarize these results and point out some conclusions in terms of our original hypotheses.

A brief comment is also made with respect to the multiple regression approach used in connection with the antecedents of agricultural technology change at the municipal level in Minas Gerais. These regression results, as observed in Chapter 4, are found in Appendix C. The first hypothesis predicted positive relationships between the farm size/land inequality indicators and agricultural technology change--particularly with respect to mechanization. The results revealed only moderate to negligible impacts of the farm size indicators on bio-chemical innovation, with certain coefficients even being negative. On the other hand, we observed that farm size indicators generally were better able to explain mechanization, as expected. In other words, our results are consistent with the characterization of mechanization as a large-farm-biased innovation, while bio-chemical technology tends to be less so. The land inequality indicator followed the predicted pattern, being a significant antecedent of both bio-chemical and mechanical forms of agricultural technology, and at the same time, more important to the latter than to the former. The relatively strong association between the proportion of minifundios and bio-chemical innovation represents a departure from our hypthesis. And the indicator of median size category of farm cropland proved to be unrelated to technological change in the Minas Gerais context. The general conclusion from our findings relative to the first hypothesis is that the hypothesis is generally confirmed, but only with certain qualifications.

The expectation of only modest associations between the tenure categories and change in agricultural technology formulated in hypothesis 2 was borne out more clearly with respect to bio-chemical innovation than with mechanization. For bio-chemical forms of technology, the coefficients were generally modest, while for mechanization, the coefficients were generally stronger and significant. Two of the tenure variables--the proportions of squatters and administrators--behaved in the predicted manner. The squatter category shows negative associations with both types of technology, while the administrators category has a significant positive impact on mechanization, its relationship with bio-chemical innovation is quite small. The proportion of owners variable tends to be negatively rather than positively associated with technological innovation in Minas Gerais municipios. Again, these relationships are stronger with mechanization than with bio-chemical technology. The general interpretation given for this finding is that despite the heterogeneity of the owners category, a large proportion of owner-operators in a municipio tends to imply a high proportion of proportion of relatively small farms which are unlikely to engage in mechanization. The most unexpected finding pertaining to the land tenure groups is the consistent positive associations between the proportion of tenants and technological change. The general conclusion with respect to hypothesis 2 is that the hypothesis pertains relatively well for bio-chemical forms of technological change and less well for mechanization.

Hypothesis 3, referring to the anticipated positive impacts of 1950 rural literacy levels on technological change in agriculture is generally confirmed by our results. This remains the case even when we have controlled for the possible spurious influence of 1950 levels of urbanization and industrialization. The third-order partial coefficients were more affected by these center-periphery indicators in the case of mechanization than for bio-chemical innovation. Nevertheless, the relationships remained substantial, and we can conclude that our data support the hypothesis.

The results with respect to relationship between land use indicators and technological change reveal only minor impacts of proportion of farmland used for crops on bio-chemical innovation, and no impact whatsoever with respect to mechanization. The positive associations predicted in hypothesis 4 thus are not confirmed by our data. On the other hand, the proportion of pasturelands exhibited consistent positive relationship with both forms of technological change. The specialization and commercial/export crop concentration indicators exhibited relationships consistent with our expectations--that is, positive and significant impacts on technological change. These relationships, however, were much stronger for the agricultural technology indicators standardized by the number of farm units rather than those standardized by hectares of cropland. The former indicator, as noted, is a more sensitive indicator of technological expansion than the latter, at least in the initial stages of technological innovation such as that of Minas Gerais. The impacts of indicators of the relative importance of five specific crops on technological change reveal positive associations for rice and coffee (but with the coffee indicator showing little relation with mechanization, as understandable), negative relationships for beans and sugar cane, and mixed patterns for corn. These results are more or less within our expectations given the characteristics of Minas Gerais agriculture previously discussed in this study. As noted above, the results pertaining to the associations between the land use/crop mix indicators and technological change in Minas Gerais municipios are complex. However, we can cautiously note that the results do tend to accord with hypothesis 4.

Regional location throughout this study has proved to be a crucial variable for explaining rates of change in agricultural technology in Minas Gerais. This variable, as our results clearly suggest, is in fact the single most crucial explanatory factor for technological change in Minas Gerais municipios. The influence of the various regions follow the expected pattern of technological levels and change being biased in favor of the most central regions (Belo Horizonte Center, the São Paulo peripheries, and, to some extent, Belo Horizonte Periphery I). Regional location has similar strong impacts on both forms of technological change. Further, regional location is more strongly correlated with technological levels in 1970 than in 1950--again reflecting increasing regional disparities within the state of Minas Gerais and parelleling the patterns found for Brazil as a whole. The urbanization and industrialization indicators--representing the micro-level dimension of the center-periphery concept--also show expected positive impacts on both types of technological change. Given the high inter-correlations between urbanization and industrialization, and considering the former the more general process in the context of Minas Gerais, we have calculated second-order partial correlation coefficients between industrialization and technological change, controlling for initial urbanization levels. The results for both types of technological change indicate the more pronounced effect of urbanization. Despite these qualifications, hypothesis 5 has been fully and consistently confirmed by our data.

The results of this chapter reveal two additional characteristics of the process of technological change in Minas Gerais. The first concerns the relatively stronger effects of "non-rural" factors--represented here by the center-periphery indicators--on agricultural technology change when compared with those indicators of agrarian structure itself. This finding is consistent with the view expressed in previous chapters that Minas Gerais agriculture has tended to be a less dynamic and a largely induced sector. It is primarily through closer connections with the spatial and structural centers of growth in the country that certain rural areas of Minas Gerais have experienced both higher levels of and more rapid trends toward technological change. Alternatively, prevalent characteristics of agrarian structures may have only fostered further adjustments or functioned as barriers to the processes of change, since these characteristics do not appear as central causal factors.

A second point suggested by these results if largely methodological in nature. We may note the generally similar behavior revealed by the simple cross-lagged and the first-order partial correlation coefficients in depicting patterns of association between the social organization variables and the agricultural technology indicators. The major consequence of partialling out the effects of 1950 technology was a modest weakening of the relationships. In this sense, both methods proved useful for our purposes in the study.

The final statistical procedure employed in connection with this chapter, but which was not considered essential for exploring the hypotheses, was the multiple linear regression approach. Tables 71 and 72 in Appendix C report these results. Given the large number of independent variables considered herein, as well as the problem of multicollinearity, we have selected only a limited number of variables for inclusion in the linear multiple regression equations. The independent variables appearing in Tables 71 and 72 are those which met both of the following criteria: (a) exhibited first-order partial correlations of $\pm.20$ or larger with at least two of the four agricultural technology indicators, and (b) had intercorrelations of $\pm.50$ or less with other independent variable (with the exception of regional location). In addition, the proportion of cropland indicators were considered too specific to be included in the models. The results of the multiple regressions, as expected, reveal the importance of the regional location variable (dealt with as dummy variables in this context) in explaining technological change. The equations in Table 71, for which the 1970 agricultural technology indicators are regressed on the 1950 levels of social organization indicators, have higher explanatory power (ass R^2 in excess of .45) than do those of Table 72, in which the dependent variables are measured in terms of residualized change scores (see Chapter 4). Nevertheless, both sets of equations again attest to the centrality of regional location in conditioning the technological change process.[6] The next chapter now considers possible consequences of this technological change process for structural change and transformation in Minas Gerais municipios.

FOOTNOTES

1. It is worth noting that the median-size category is significantly and positively correlated with average farm size and percent of farms over 200 hectares in both 1950 and 1970 (see Appendix B).

2. The Gini coefficients in both 1950 and 1970 show the largest positive correlation with percent of farms less than 2 hectares, as compared to all other farm size indicators (see Appendix B).

3. Table 43 presents correlations between the social organizational indicators and mechanization indicators for the 161 municipios which reported at least one tractor in 1950. This procedure was undertaken in order to detect more clearly the patterns of correlation, which when computed among all municipios, are generally weakened.

4. The proportion of tenants was not correlated with indicators of farm size in 1950, but shows somewhat negative correlations in 1970 (see Appendix B). Further analysis was undertaken in which average farm size was introduced as a control variable so that second-order partial correlation coefficients between the percent of tenants and technological change could be computed. The results were similar to those reported above; the partial correlation coefficients are nearly identical to those coefficients derived without the inclusion of average farm size as a control variable.

5. The second-order partial correlation were: (a) controlling for 1950 percent farms with tractors and 1950 percent farms with less than two hectares, .307; (b) controlling for 1950 tractors per 1000 hectares of cropland and 1950 percent farms with less than two hectares, .328; (c) controlling for 1950 percent farms with tractors and 1950 percent of cropland in rice, .274; (d) controlling for 1950 tractors per 1000 hectares of cropland and 1950 percent cropland in rice, .313.

6. We should note that throughout this chapter and the one that follows we use significance tests basically as a decision rule to accept or reject our working hypothesis. Significance tests are not used in a strict inferential framework, since we are not working with a sample and do not attempt generalization to a larger universe of units. The criterion for significance of the partial regression coefficients used here is the same as employed by Hibbs (1973) for similar purposes. That criterion is that the absolute value of the coefficient is at least twice its standard error.

CHAPTER VII

SOCIAL ORGANIZATIONAL PATTERNS AS CONSEQUENCES OF CHANGE IN AGRICULTURAL TECHNOLOGY

The present chapter deals with the third and final major research question of this study: What are the consequences of technological change for observed changes in local patterns of rural social organization? We again proceed by analyzing the results pertaining to the ten working hypotheses developed in Chapter 3, using the analytical methods described in Chapter 4. Following this introduction, we discuss each hypothesis in the order set forth in Chapter 3. In a final section we undertake a brief summary of the results and the conclusions they suggest.

PRODUCTIVITY

Bio-Chemical Innovation

The productivity indicators used in this study are restricted to physical yield values (in tons per hectare) for five selected crops, plus a general index of relative crop productivity, as noted in Chapter 4. Table 46 presents the results for the first step in the analysis of the impacts of bio-chemical

Table 46. Product-Moment Correlations Between Change in Indicators of Agricultural Technology and Change in Selected Variables, Minas Gerais (Brazil) Municipios, 1950 to 1970.

Change in Selected Variables 1/	Change in CR$ Modern Biochemical Inputs per Farm	Change in CR$ Modern Biochemical Inputs per Ha. of Cropland	Change in Percent of Farms with Tractors	Change in Number of Tractors per 1000 Ha. of Cropland
Average Productivity Index	.357 **	.298 **	.200 **	.282 **
Coffee Yield	.329 **	.318 **	.079	.186 **
Rice Yield	.048	.122 **	.033	.127 **
Sugar Cane Yield	.230 **	.139 **	.159 **	.196 **
Beans Yield	.045	-.001	.032	.085
Corn Yield	.264 **	.222 **	.236 **	.238 **
Average Farm Size	.079	-.081	.148 **	-.002
% Farms Less 2 Ha.	-.092 *	.170 **	-.070	.185 **
% Farms More 200 Ha.	.083	-.058	.176 **	.009
Median Category Size Farms Cropland	.282 **	-.074	.363 **	-.048
Inequality Farm Size	-.049	.014	-.075	.079
% Croplands	.266 **	-.006	.192 **	.037
% Pasturelands	.001	.076	.005	.048
% Owners	.093 *	.029	-.004	.039
% Tenants	-.018	.030	.130 *	.097 *
% Squatters	-.099 *	-.065	-.084 *	-.107 *
% Administrators	.217 **	.117 *	.197 **	.151 **
Subsistence Production	-.125 **	-.115 **	-.060	-.067
% Rural Family Labor	-.354 **	-.107 *	-.386 **	-.273 **
% Sharecroppers	-.101 *	-.152 **	-.005	-.042
% Permanent Rural Workers	.365 **	.190 **	.203 **	.250 **
% Temporary Rural Workers	.198 **	.028	.270 **	.079
Average Rural Wages	.235 **	.257 **	.060	.315 **
Rural Literacy Rate	.111 *	.083 *	.184 **	.034
Rural Net Migration 2/	-.009	-.062	.124 **	.031
Rural Net Migration 3/	-.052	-.080	.049	-.210 **

1/ All measures of change are computed in terms of residualized change scores.

2/ The rural net migration indicator is itself a residualized change measure. These correlations are based on all cases of the study: 385 Municipios.

3/ These correlations are based on only those cases with an above mean rural population density: 215 Municipios.

* Indicates the product-moment correlation coefficient is significant at the .05 level.

** Indicates that the product-moment correlation coefficient is significant at the .01 level.

technology on productivity changes during the 1950-1970 period. The correlation coefficients in Table 46 pertain to inter-correlations between residualized change scores of both the technological independent variables and social organizational dependent variables. The correlations between change in bio-chemical technology and change in productivity indicators are generally significant at the .01 level. Exceptions include the beans and rice yield indicators, the former showing no relation with bio-chemical technological change, while the latter shows a significant relation only with change in cruzeiros of modern bio-chemical inputs per farm. Nevertheless, change in bio-chemical technology thus does appear to result in increases in crop yields, as expected.

These bivariate tendencies stand in contrast with the univariate tendencies (described in Chapter V) which reveal declining or stagnant average yields for most of the five selected crops and the average productivity index, along with relatively rapid increases in the agricultural technology indicators. It is generally conceded that technological levels in most areas of Brazil have remained too low to have major impacts on aggregate yields for larger units such as states or regions (Schuh, 1970; Knight, 1971). However, at the municipal level of aggregation, the impacts of bio-chemical technology are more readily apparent. It is interesting to observe the more or less similar pattern of correlations found with the change scores and with the 1970 cross-sectional correlation coefficients (reported in Table 42, Chapter 6). With the exception of the average productivity index and the indicator for beans yields, the other coefficients in Table 42 indicate positive and significant associations between bio-chemical innovation and crop yields.

Following the sequence set forth in Chapter 4, we now proceed with the second step of the analysis, regressing the productivity indicators which exhibited correlations of .10 or larger in Table 46 on the initial (1950) bio-chemical technology levels and bio-chemical technology change scores. The results for these regressions are reported in Tables 47 and 48 below. For the cruzeiros of modern bio-chemical inputs per farm variable, both the original technology level and the technological change measure tend to have significant impacts on change in the productivity indicators (Table 47). However, only technological change seems to have a clear impact on change in productivity when technology is measured in terms of cruzeiros of modern bio-chemical inputs per hectare of cropland (Table 48). The reason for this discrepancy may lie in the generally lower values and restricted variability characteristic of the distribution of this indicator in 1950 (see Table 31, Chapter 5). These results just described, nevertheless, allow us to conclude that bio-chemical technology tends to have a discernible aggregate impact on productivity changes for selected crops in Minas Gerais municipios. The most ambiguous performance is registered for rice yields, which, as observed in Table 65 of Appendix A, exhibited systematic declines during the 1950-1970 period.

Table 47. Regression Estimates for the Effects of 1950 Level of and and 1950-1970 Change in Cruzeiros of Modern Biochemical Inputs Per Farm on Change in Selected Dependent Variables Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	CRS Modern Biochemical Inputs per Farm, in 1950			Change in CRS Modern Biochemical Inputs per Farm 1/			R^2
	b	S.E.b.	Beta	b	S.E.b.	Beta	
Average Productivity Index	.181*	.032	.260	.316*	.052	.320	.194
Coffee Yield	.163*	.033	.234	.335*	.053	.297	.163
Rice Yield	.049	.035	.073	.042	.057	.038	.007
Sugar Cane Yield	.108*	.034	.159	.229*	.055	.208	.078
Corn Yield	.195*	.032	.290	.242*	.052	.223	.153
Average Farm Size	-.089*	.021	-.216	.074*	.034	.110	.052
% Farms Less 2 Ha.	.227*	.032	.339	-.152*	.052	-.141	.121
% Farms More 200 Ha.	-.104*	.019	-.276	.075	.030	.122	.081
Median Category Size Farms Cropland	-.159*	.033	-.235	.346*	.053	.316	.134
% Croplands	.033	.020	.084	.163*	.032	.225	.078
% Tenants	.107*	.034	.160	-.044	.055	-.041	.025
% Squatters	-.126*	.035	-.180	-.084	.057	-.074	.042
% Administrators	-.000	.031	.001	.218*	.051	.217	.047
Subsistence Production	-.027	.032	-.044	-.119*	.051	-.119	.018
% Rural Family Labor	-.036	.030	-.059	-.343*	.048	-.346	.129
% Sharecroppers	-.005	.029	-.008	-.092	.047	-.101	.010
% Permanent Rural Workers	-.004	.022	.008	.270*	.036	.365	.134
% Temporary Rural Workers	-.050	.035	-.072	.234*	.057	.209	.045
Average Rurál Wages	.117*	.033	.178	.224*	.053	.210	.086
Rural Literacy Rate	-.013	.024	-.028	.087*	.038	.116	.013

1/ All measures of change are computed in terms of residualized change scores.

* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

Table 48. Regression Estimates for the Effects of 1950 Level of and 1950-1970 Change in Cruzeiros of Modern Biochemical Inputs Per Ha. of Cropland on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	CRS Modern Biochemical Inputs per Ha. of Cropland, 1950 b	S.E.b.	Beta	Change in CRS Modern Biochemical Inputs per Ha. Cropland 1/ b	S.E.b.	Beta	R^2
Average Productivity Index	.056	.032	.085	.337*	.056	.292	.096
Coffee Yield	.035	.032	.054	.363*	.056	.315	.104
Rice Yield	.022	.033	-.034	.141*	.057	.125	.016
Sugar Cane Yield	.065	.033	.100	.148*	.058	.132	.029
Corn Yield	.058	.032	.091	.239*	.055	.215	.058
Average Farm Size	.009	.020	.023	-.057	.035	-.083	.007
% Farms Less 2 Ha.	.112*	.031	.178	.174*	.050	.157	.060
% Farms More 200 Ha.	.018	.018	.049	-.039	.032	-.062	.006
Median Category Size Farms Cropland	-.067*	.033	-.105	-.075	.057	-.067	.017
% Croplands	.010	.019	.026	-.006	.033	-.008	.001
% Tenants	-.016	.033	-.026	.036	.057	.032	.002
% Squatters	.059	.034	.088	-.083	.059	-.072	.012
% Administrators	.067	.030	.114	.112*	.052	.109	.027
Subsistence Production	.004	.030	.007	-.118*	.052	-.116	.013
% Rural Family Labor	-.099	.029	-.170	-.096	.051	-.095	.040
% Sharecroppers	-.008	.027	-.015	-.142*	.048	-.152	.024
% Permanent Rural Workers	.070	.021	.161	.140*	.038	.185	.065
% Temporary Rural Workers	.003	.033	.004	.032	.059	.028	.001
Average Rural Wages	.048	.031	.076	.275*	.054	.251	.072
Rural Literacy Rate	-.042	.022	-.096	.069	.039	.091	.016

1/ All measures of change are computed in terms of residualized change scores.

* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

The third step in the analysis involves the inclusion of the center-periphery indicators--regional location and urbanization.[1] Again, these variables proved to be the most important antecedents of technological change in Minas Gerais munícipios according to the results of Chapter 6. The relevant data are presented in Tables 51 and 52. According to the criterion of retaining only those dependent variables for which at least five percent of their variance could be explained by technology indicators in at least one regression equation, the data in Tables 51 and 52 do not include the indicator of change in rice yields. The data in Tables 51 and 52 generally indicate that introducing controls for the center-periphery variables does not substantially diminish the observed impacts of bio-chemical technology on change in productivity. While regional location does appear to be a significant influence on changes in productivity, 1950 urbanization is much less so. When bio-chemical technology is measured in terms of cruzeiros of modern bio-chemical inputs per farm (Table 51), we again find the same pattern of results obtained in Table 47--that is, both initial technology levels and technological change are significantly related to productivity changes. When bio-chemical technology is measured in terms of cruzeiros of modern inputs per hectare of cropland, however, only technological change had any significant impact on productivity change indicators. These results are consistent with those obtained in step two. We can thus conclude that hypothesis 1 is confirmed by our results: Levels of and changes in bio-chemical technology generally are positively related to changes in productivity

Mechanization

The correlation coefficients in Table 46 indicate significant and positive associations between change in mechanization and change in productivity for most of the reported crops. Again, no such relationship is found for bean yields, and the effect of mechanization on rice and coffee yields is quite small. The same contrasts between the univariate (see Chapter 5) and bivariate tendencies noted with respect to bio-chemical innovation are repeated here. The correlations in Table 46 based on residualized change scores are also consistent with the 1970 cross-sectional data reported in Table 42 (Chapter 6).

Up to this point the findings for the mechanization form of technology parallel those obtained for bio-chemical innovation. However, the first relevant difference that emerges is revealed by the data in Tables 49 and 50 below. When regressing the productivity indicators on both initial level of and change in mechanization, we observe that 1950 mechanization has no significant impacts on productivity changes from 1950 to 1970. All observed effects are restricted to the mechanization change measures. This finding is not surprising, since we noted above (in Chapter 5) the scant levels of mechanization in Minas Gerais municipios in 1950.

Table 49. Regression Estimates for the Effects of 1950 Level of and 1950-1970 Change in the Percent of Farms with Tractors on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	Percent of Farms with Tractors, 1950 b	S.E.b.	Beta	Change in Percent of Farms with Tractors 1/ b	S.E.b.	Beta	R^2
Average Productivity Index	-.007	.057	-.006	.252*	.063	.200	.040
Coffee Yield	.019	.058	.016	.092	.064	.073	.006
Rice Yield	.009	.058	.008	.041	.063	.034	.001
Sugar Cane Yield	.021	.056	.019	.195*	.062	.159	.026
Corn Yield	-.027	.054	-.025	.287*	.060	.237	.057
Average Farm Size	-.018	.034	-.028	.111*	.038	.149	.023
% Farms Less 2 Ha.	.047	.055	.044	-.086*	.062	-.071	.007
% Farms More 200 Ha.	-.049	.031	-.080	.122*	.034	.178	.038
Median Category Size Farms Cropland	.058	.052	.052	.442*	.058	.362	.135
% Croplands	.004	.032	.068	.137*	.036	.192	.042
% Tenants	.032	.055	.029	.157*	.061	.124	.018
% Squatters	.042	.058	.037	-.107	.065	-.085	.008
% Administrators	-.001	.051	-.001	.221*	.056	.197	.039
Subsistence Production	.041	.051	.141	-.068	.056	-.061	.005
% Rural Family Labor	-.135*	.046	-.135	-.425*	.052	-.384	.168
% Sharecroppers	-.035	.047	-.038	-.005	.052	-.005	.001
% Permanent Rural Workers	.059	.037	.079	.166*	.041	.202	.048
% Temporary Rural Workers	.141*	.055	.125	.336*	.061	.268	.089
Average Rural Wages	-.029	.055	-.027	.072	.061	.060	.004
Rural Literacy Rate	-.037	.038	-.050	.155*	.042	.186	.037

1/ All measures of change are computed in terms of residualized change scores.

* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

Table 50. Regression Estimates for the Effects of 1950 Level of and 1950-1970 Change in Tractors Per 1000 Ha. of Cropland on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	Tractors per 1000 Ha. of Cropland, 1950			Change in Tractors per 1000 Ha. of Cropland 1/			R^2
	b	S.E.b.	Beta	b	S.E.b.	Beta	
Average Productivity Index	-.069	.057	-.058	.314*	.054	.284	.083
Coffee Yield	-.067	.059	-.057	.209*	.056	.188	.038
Rice Yield	-.044	.048	-.038	.138*	.054	.128	.018
Sugar Cane Yield	.000	.057	.001	.212*	.054	.196	.039
Corn Yield	-.095	.056	-.084	.256*	.053	.241	.064
Average Farm Size	.001	.035	.001	-.002	.034	-.003	.000
% Farms Less 2 Ha.	.045	.056	.040	.196*	.053	.185	.036
% Farms More 200 Ha.	-.009	.033	-.014	.006	.031	.010	.000
Median Cateogry Size Farms Cropland	.013	.058	.011	-.053	.055	-.049	.003
% Croplands	.044	.034	.006	.022	.132	.036	.006
% Tenants	-.037	.057	-.032	.105	.054	.099	.011
% Squatters	.010	.060	.084	-.122*	.057	-.110	.019
% Administrators	.013	.053	.012	.149*	.050	.150	.023
Subsistence Production	.038	.053	.037	-.067	.050	-.069	.006
% Rural Family Labor	-.085	.051	-.083	-.225*	.048	-.231	.061
% Sharecroppers	-.025	.050	-.027	-.038	.046	-.042	.002
% Permanent Rural Workers	.031	.038	.040	.181*	.035	.250	.064
% Temporary Rural Workers	.132*	.059	.114	.084	.056	.077	.019
Average Rural Wages	-.041	.054	-.037	.332*	.051	.317	.100
Rural Literacy Rate	-.036	.040	-.047	.023	.037	.036	.003

1/ All measures of change are computed in terms of residualized change scores.

* Indicates the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

When the center-periphery indicators are introduced into the multiple regression equations (see Tables 53 and 54), a second departure from the patterns observed for bio-chemical technology becomes apparent. The standardized partial regression coefficients for the net effects of change in mechanization on changes in productivity are significant in most cases, but these effects are considerably smaller than those indicated in Tables 46, 49 and 50. Much of the gross influence of mechanization on productivity is due to the influence of regional location on productivity increases. Despite these discrepancies, however, the results of these analyses point to a similar conclusion reached for bio-chemical innovation; change in mechanization (although not initial mechanization levels) is positively associated with change in productivity from 1950 to 1970 in Minas Gerais municipios. In general, then hypothesis 1 has been confirmed by our data, including our anticipation of relatively stronger impacts for bio-chemical innovation than for mechanization on productivity changes.

FARM SIZE AND LAND INEQUALITY

Bio-Chemical Innovation

Hypothesis 2 anticipated only moderate relationships between technological change and change in farm size indicators. The data in Table 46 pertaining to bio-chemical technology indicators more or less follow this expectation, since most of the reported

Table 51. Regression Estimates for the Effects of 1950 Level of and 1950-1970 Change in Cruzeiros of Modern Biochemical Inputs Per Farm, 1950 Level of Urbanization and Regional Location on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	CR$ Modern Biochemical Inputs per Farm, 1950			Change in CR$ Modern Biochemical Inputs per Farm			Level of Urbanization, 1950			Regional Location 2/	R^2
	b	S.E.b.	Beta	b	S.E.b.	Beta	b	S.E.b.	Beta	Beta	
Average Productivity Index	.164*	.040	.235	.316*	.058	.281	-.011	.097	-.006	.22**	.239
Coffee Yield	.137*	.035	.196	.223*	.051	.198	-.011	.085	-.006	.52**	.416
Sugar Cane Yield	.093*	.042	.136	.225*	.062	.203	.034	.103	.020	.11	.089
Corn Yield	.175*	.039	.261	.146*	.057	.135	-.087	.094	-.052	.28**	.216
Average Farm Size	-.055*	.024	-.133	.093*	.035	.139	.242*	.058	.235	.44**	.207
% Farms Less 2 Ha.	.132*	.038	.197	-.201*	.055	-.186	-.100*	.092	-.060	.42**	.253
% Farms More 200 Ha.	-.063*	.022	-.166	.104*	.032	.170	.154*	.053	.163	.42**	.215
Median Category Size Farm Cropland	-.056	.037	-.082	.379*	.054	.346	-.091	.091	-.054	.41**	.289
% Croplands	.023	.024	.059	.166*	.036	.259	-.076	.059	-.077	.19**	.112
% Rural Family Labor	-.030	.036	-.048	-.398*	.052	-.401	-.170	.087	-.111	.28**	.201
% Permanent Rural Workers	.021	.027	.046	.303*	.039	.409	.202*	.064	.177	.30**	.217
% Temporary Rural Workers	-.014	.043	-.020	.260*	.063	.232	.069	.105	.040	.25**	.101
Average Rural Workers	.094*	.040	.142	.151*	.059	.141	.084	.098	.051	.22**	.133

1/ All measures of change are computed in terms of residualized change scores.
2/ The Beta coefficients were obtained through Multiple Classification Analyses, with the other variables as covariances of Regional Location.
* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.
** Indicates the Beta coefficient is statistically significant at the .01 level according to an F-test.

Table 52. Regression Estimates for the Effects of 1950 Level of and 1950-1970 Change in Cruzeiros of Modern Biochemical Inputs Per Ha. of Cropland, 1950 Level of Urbanization and Regional Location on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	CR$ Modern Biochemical Inputs Per Ha. Cropland, 1950			Change in CR$ Modern Bio-chemical Inputs per Ha. Cropland			Level of Urbanization, 1950			Regional Location 2/	R^2
	b	S.E.b.	Beta	b	S.E.b.	Beta	b	S.E.b.	Beta	Beta	
Average Productivity Index	.043	.033	.065	.244*	.064	.212	.117	.097	.068	.28**	.176
Coffee Yield	.019	.029	.029	.121*	.056	.105	.104	.085	.060	.55**	.368
Sugar Cane Yield	.054	.035	.084	.114	.067	.102	.085	.050	.101	.16	.057
Corn Yield	.043	.032	.067	.102	.062	.092	.043	.094	.026	.35**	.168
Average Farm Size	.013	.020	.033	.037	.038	.053	.187*	.057	.181	.48**	.186
% Farms Less 2 Ha.	.059	.031	.093	.074	.060	.067	-.027	.091	-.016	.42**	.215
% Farms More 200 Ha.	.030	.018	.085	.062	.035	.099	.081	.052	.085	.49**	.190
Median Category Size Farm Cropland	-.042	.032	-.065	.026	.061	.023	-.102	.093	.061	.42**	.199
% Croplands	.001	.020	.002	-.068	.039	-.104	-.056	.059	-.057	.29**	.065
% Rural Family Labor	-.072*	.031	-.124	-.142*	.059	-.140	-.155	.089	-.102	.26**	.102
% Permanent Rural Workers	-.059	.022	.135	.196*	.043	.260	.191*	.064	.167	.31**	.149
% Temporary Rural Workers	-.007	.035	-.010	.093	.068	.081	.070	.103	.040	.26**	.064
Average Rural Wages	.028	.033	.045	.154*	.063	.141	.155	.095	.094	.21**	.120

1/ All measures of change are computed in terms of residualized change scores.

2/ The Beta coefficients were obtained through Multiple Classification Analyses, with the other variables as covariates of Regional Location.

* Indicates the absolute value of the unstandardized regression coefficient is at least twice as large as the standard errors.

** Indicates the Beta coefficient is statistically significant at the .01 level according to an F-test.

Table 53. Regression Estimates for the Effects of 1950 Level of and 1950-1970 Change in Percent of Farms with Tractors, 1950 Level of Urbanization, and Regional Location on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios

	Percent Farms with Tractors, 1950			Change in Percent Farm with Tractors			Level of Urbanization, 1950			Regional Location 2/	R^2
Change in Selected Dependent Variables 1/	b	S.E.b.	Beta	b	S.E.b.	Beta	b	S.E.b.	Beta	Beta	
Average Productivity Index	-.037	.055	-.033	.158*	.070	.125	.131	.095	.075	.32**	.153
Coffee Yield	.029	.048	.026	.004	.061	.003	.112	.083	.064	.59**	.360
Sugar Cane Yield	.006	.056	.005	.151*	.072	.123	.110	.065	.098	.15	.055
Corn Yield	-.065	.052	-.060	.163*	.067	.135	.064	.090	.038	.35**	.175
Average Farm Size	-.020	.032	-.030	.088*	.041	.119	.190*	.055	.185	.46**	.194
% Farms Less 2 Ha.	.026	.051	.024	-.092	.065	-.077	.017	.088	.010	.45**	.209
% Farms More 200 Ha.	-.038	.029	-.062	.128*	.037	.188	.094	.050	.098	.44**	.208
Median Category Size Farm Cropland	.060	.049	.054	.409*	.063	.335	-.161	.085	-.095	.34**	.279
% Croplands	.031	.032	.049	.132*	.041	.185	-.062	.056	-.063	.22**	.084
% Rural Family Labor	-.144*	.046	-.145	-.461*	.059	-.417	-.168*	.080	-.110	.22**	.217
% Permanent Rural Workers	.055	.037	.075	.140*	.047	.170	.214*	.164	.188	.22**	.111
% Temporary Rural Workers	.134*	.055	.119	.363*	.070	.290	.033	.096	.019	.21**	.132
Average Rural Wages	-.047	.054	-.044	-.022	.068	-.018	.172	.093	.105	.28**	.106

1/ All measures of changes are computed in terms of residualized change score.

2/ The Beta coefficients were obtained through Multiple Classification Analyses with the other variables as covariates of Regional Location

* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

** Indicates the Beta coefficient is statistically significant at the .01 level according to an F-test.

Table 54. Regression Estimates for the Effect of 1950 Level of and 1950-1970 Change in Tractors Per 1000 Ha. of Cropland, 1950 Level of Urbanization, and Regional Location on Change in Selected Dependent Variables, Minas Gerais (Brazil) Municipios.

Change in Selected Dependent Variables 1/	Tractors per 1000 Ha. of Cropland, 1950			Change in Tractors per 1000 Ha. Cropland			Level of Urbanization 1950			Regional Location 2/	R^2
	b	S.E.b.	Beta	b	S.E.b.	Beta	b	S.E.b.	Beta	Beta	
Average Productivity Index	-.076	.056	-.065	.242*	.056	.219	.088	.094	.051	.31**	.185
Coffee Yield	-.040	.050	-.034	.076	.050	.069	.097	.083	.056	.58**	.365
Sugar Cane Yield	.005	.059	.004	.183*	.059	.169	.082	.098	.048	.16	.069
Corn Yield	-.118*	.054	-.104	.162*	.054	.152	.037	.090	.022	.36**	.189
Average Farm Size	-.001	.033	-.000	.040	.033	.062	.186*	.056	.181	.48**	.186
% Farms Less 2 Ha.	.018	.053	.016	.091	.053	.086	.006	.089	.004	.43**	.211
% Farms More 200 Ha.	.000	.031	.000	.055	.031	.092	.089	.051	.094	.47**	.184
Median Category Size Farm Cropland	.019	.054	.017	.021	.054	.019	-.138*	.091	-.082	.42**	.196
% Croplands	.025	.034	.037	-.007	.034	-.011	-.052	.057	-.052	.25**	.059
% Rural Family Labor	-.101	.051	-.098	-.224*	.051	-.231	-.155	.085	-.102	.26**	.129
% Permanent Rural Workers	.026	.038	.034	.175*	.038	.241	.189	.166	.063	.26**	.136
% Temporary Rural Workers	.102	.060	.088	.108*	.059	.098	.039	.100	.022	.24**	.075
Average Rural Wages	-.057	.054	-.051	.252*	.054	.240	.117	.091	.071	.22**	.155

1/ All measures of change are computed in terms of residualized change scores.

2/ The Beta coefficients were obtained through Multiple Classification Analyses with the other variables as covariates of Regional Location.

* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

** Indicates the Beta coefficient is statistically significant at the .01 level according to an F-test.

coefficients are not significant. However, the signs of the correlations differ between the two indicators of change in bio-chemical technology. These discrepancies follow the same pattern observed in the previous chapter when relating 1950 farm size indicators to change in bio-chemical technology. The data in Table 46 thus emphasize how varying measurement strategies in ecological data may yield somewhat different conclusions. For example, when bio-chemical technological change is measured on a per farm basis, the results would seem to suggest the tendency toward a "large-farm bias" of such technology. However, measurement of bio-chemical technology on a per hectare basis would yield a different conclusion--a tendency toward a "small-farm bias." This discrepancy is apprently due to the fact that a per farm standardization criterion is much more sensitive to the distribution of technology than is the per hectare criterion. Nevertheless, the coefficients for the relation between change in bio-chemical technology and change in farm size are generally modest and suggest only minor linkages.

The median size category of farm cropland indicator, which was generally unimportant as an antecedent of technological change in Minas Gerais municipios, assumes greater importance as a consequence of change. We can, in fact, observe that for change in both bio-chemical or mechanical technology, there is a significant correlation with change in the median size category of farm cropland, when the technology indicators are standardized by the number of farm units. In Table 46, it is apparent that there are very small, non-significant correlations between change in agricultural technology and change in land inequality. This result is not unreasonable or even unexpected, given the observations made above concerning: (1) the high mean initial values of land inequality in Minas Gerais municipios, and (2) general stability in land inequality between 1950 and 1970. Under these conditions, there is little variability in the change scores of the land inequality indicator to be explained by technological change or other variables. These results thus suggest that land inequality in Minas Gerais is more of a conditioning factor that has shaped the paths technological change has taken, rather than being a result or consequence of such change. The finding is consistent with the observations by Hoffman and Silva (1975) concerning stability of the distribution of wealth in societies that experience only quantitative (i.e., technological)--not qualitative (i.e., revolutionary)--types of social structural change. Thus, given the generally non-significant relationships between technological change and change in land inequality, this indicator has been omitted from further steps in the analysis.

The data in Tables 47 and 48 reflect the independent effects of bio-chemical technology change on change in the farm size indicators as compared with those of the initial levels of such technologies. We can observe that the bio-chemical technology indicator standardized by farm units is a stronger correlate (both in terms of 1950 level and change; Table 47) than the indicator standardized by hectares of cropland (Table 48).

Nevertheless, the purpose of Tables 47 and 48 is to determine the relative impacts of the 1950 level versus the 1950-1970 change measures. The results in this respect are inconclusive, but do exhibit some tendency toward larger impacts for 1950 levels of bio-chemical technology.

Disparities in the impacts of the two measures of bio-chemical technology--that is, one standardized by number of farm units and the other standardized by hectares of cropland--can again be detected in the multiple regressions which include the center-periphery indicators (Tables 51 and 52). In Table 51, we observe that the standardized partial regression coefficients for the effects of bio-chemical technology (standardized by number of farms) are generally significant, while comparable coefficients in Table 52 (where bio-chemical technology is standardized by hectares of cropland) are generally small. Further, in Table 51, both 1950 bio-chemical technology and technological change continue to have significant effects despite the relevance of urbanization and regional location in accounting for changes in the farm size indicators. Table 52, on the other hand, shows that none of the bio-chemical technology indicators remains significant; only the regional location variable appears as a significant explanatory factor for farm size changes. These results lead us to conclude, as anticipated in hypothesis 2, that technological change of the bio-chemical form has had only minor impacts on change in farm size in Minas Gerais municipios. While there is some evidence for the large farm bias of the process, this tendency is a very modest one.

Mechanization

We expected according to hypothesis 2, that mechanization has relatively stronger impacts on changes in farm size, given the acknowledged large farm bias of this type of technology. The correlations in Table 46, however, only partially support this contention. Most coefficients pertaining to the indicator of change in percent of farms with tractors are significant and in the expected direction. However, the coefficients for the indicator of change in number of tractors per 1000 hectares of cropland are generally smaller and fail to achieve statistical significance. The differences observed here tend to parallel those found in the previous chapter, perhaps indicating the lower sensitivity of indicators standardized by area as compared to those standardized by number of farm units. As observed in the previous section with respect to bio-chemical technology, change in the median size category of farm cropland is substantially correlated with change in mechanization (when measured in terms of farm units), while change in land inequality shows no concommitant covariation with mechanization.

The regression estimates reported in Tables 49 and 50 repeat the pattern of differential relevance of the mechanization indicators according to the basis of standardization. In Table 49, it is apparent that change in mechanization rather than the

1950 mechanization level (which we recall again, was very low in Minas Gerais) had the greatest impact on farm size changes. The data in Table 50 weaken this conclusion, since only one of the partial regression coefficients is significant. The results are very similar in the multiple regression equations which include the center-periphery indicators as additional control variables (Tables 53 and 54). Given these findings we can cautiously conclude that hypothesis 2 is only partially confirmed by our data; the findings reflect much more complex patterns of relationships than anticipated. With respect to bio-chemical innovation, both 1950 technology and technological change had certain impacts on farm size changes, while for mechanization these impacts are restricted to the change measures. The directions of the relationships tend to follow predicted patterns, with positive associations detected for the prevalence of large farms and negative relationships with indicators of the prevalence of small farms. The correlations tended to be slightly higher for mechanization changes than for change in bio-chemical technology.

LAND TENURE

Bio-Chemical Innovation

The correlation coefficients of Table 46 generally accord with our expectation of only moderate to low correlations between technological change and change in the relative importance of tenure groups in Minas Gerais municipios. As expected, we can observe positive associations between the change in bio-chemical technology and change in the proportions of owners and administrators. The first set of coefficients is smaller and barely significant, while the second set is stronger. Given the observations made in previous chapters relative to the heterogeneity of the owners category and the clearer connections of the administrator or farm manager group with larger farms, these results are consistent with expectations and previous results. The relationships found between changes in bio-chemical technology and the proportion of squatters are small and inverse. The results in Table 46 thus follow the relevant hypothesis for bio-chemical technology.[2]

The regression estimates reported in Tables 47 and 48 reveal the restricted explanatory power of the bio-chemical technology indicators with respect to change in land tenure patterns in Minas Gerais municipios. Despite this, however, we can observe that 1950 bio-chemical technology level (when measured in terms of farm units, see Table 47) is most strongly related to changes in the proportions of tenants and squatters, while technological change is most important in accounting for change in the proportion of administrators (see Tables 47 and 48). Since none of the equations which regress change in land tenure categories on the agricultural technology indicators meets the five percent criterion for the coefficient of determination (R^2), we conclude the analysis at this point.

The general conclusion, thus, is support for hypothesis 3 with respect to the bio-chemical technology indicators.

Mechanization

The relevant data in Table 46 show that the correlations between changes in mechanization and the proportions of squatters and administrators follow the expected patterns and tend to be stronger than those observed for the bio-chemical indicators. Correlations with change in the proportion of owners are essentially zero, while those with the proportion of tenants are positive (and significant). The latter pattern thus differs from that revealed with bio-chemical technology.

The results of Tables 49 and 50 again point to the predominance of mechanization change rather than 1950 mechanization levels in accounting for changes in the proportions of tenants, squatters, and administrators. These impacts are relatively modest, however, and do not warrant further multivariate analysis. We can thus conclude that the expectations specified in hypothesis 3 in connection with the effects of agricultural technology levels and change on change in the relative proportions of land tenure categories in Minas Gerais municipios are largely confirmed by our data.

Bio-Chemical Innovation

We have previously advanced the noation that relationships between rural labor force characteristics and agricultural technology largely involve the former being dependent on the latter. In other words, we have assumed that technological change has an impact on changes in the relative proportions of different rural labor force groups. The data in Table 46 reveal relatively strong associations between change in bio-chemical technology and change in various labor groups' proportions in Minas Gerais municipios from 1950 to 1970.

Our expectation of negative correlations between bio-chemical innovation and change in percent of rural family labor is confirmed by the significant coefficients found for both indicators of that form of technology. These correlations parallel those found in the cross-sectional coefficients for 1950 and especially those for 1970 (see Table 42, Chapter 6). We anticipated such relationships on the basis of inferring a close linkage between prevalence of family labor and a peasant-like agricultural system, given the historical experiences of Brazil and Minas Gerais discussed in Chapter 2 and 3. The data reported in the correlation matrix of Appendix B provide empirical support for this interpretation: The simple correlation coefficients for the associations between family labor and average farm size, percent of farms over 200 hectares, median category of farm size, crop specialization, and crop concentration are all negative and significant in both 1950 and 1970. The correlations between change in bio-chemical technology and change in the proportion of sharecroppers follow the same patterns: significant, negative coefficients are found like those with respect to rural family labor, as expected. These results are consistent with other findings such as Paige's (1975) concerning the tendency toward eviction of tenants under the impact of market expansion and technological change in a centralized sharecropping system. It is interesting to note that these results differ from the cross-sectional correlations in Table 42 in Chapter 6. The cross-sectional coefficients are generally smaller and mostly positive.

The associations between change in bio-chemical technology and change in the prevalence of wage labor (both permanent and temporary) tend to be large and significant, according to data in Table 46. Even though these two labor groups (particularly temporary workers) have tended to decline in overall importance in Minas Gerais municipios, as noted in Chapter 5, they have tended to increase where bio-chemical innovation has been prevalent. This finding contrasts with the tendency observed for rural family labor; rural family labor has tended to show overall increases during the period but exhibits an inverse relation with change in bio-chemical technology.

Our previous results provide two further fragments of evidence concerning the probable impact of technological change on rural wage labor in Minas Gerais municipios. Firstly, we have noted consistent positive associations between the percent of administrators--a privileged fraction of the wage-labor group--and technological change. Secondly, a companion observation was made in Chapter 5 with respect to regional rates of change in the proportion of permanent workers as revealed by Table 21. In two of the most advanced and technologically dynamic regions of Minas Gerais--Belo Horizonte Center and São Paulo Periphery II--permanent rural workers have increased in prevalence, rather than experiencing the declines noted for most other regions. It thus seems warranted to conclude that hypothesis 3 receives full support from these data.

We have proceeded with the analysis by computing the regression equations summarized in Tables 47 and 48. Again, these equations were computed to detect whether the impacts of bio-chemical technology on changes in rural labor force composition can be primarily attributed to the original levels or to the change process itself. The results clearly point out that only the technological change indicators have significant impacts on changes in the relative proportions of the various labor groups. As has been common throughout this chapter, the bio-ch emical indicator standardized by the number of farm units is the most sensitive. These results do not appreciably change when the center-periphery indicators are introduced in the regression model (see Tables 51 and 52). The standardized partial regression coefficients for the change in bio-chemical technology indicators remain generally significant, indicating persistent independent effects even when controlling for those of regional location and urbanization. Our findings concerning hypothesis 3 thus are supportive.

Mechanization

The data in Table 46 for the relationships between change in mechanization and change in rural labor force indicators show patterns similar to those with bio-chemical innovation. We observe strong negative associations between change in mechanization and change in rural family labor, and strong positive associations between change in mechanization and change in the proportions of wage labor (both permanent and temporary). The sharecropper category exhibits a very small, inverse correlation with change in mechanization. The observations made above in connection to the linkages between prevalence of family labor and a more peasant-like agricultural system again apply here. In fact, the similarity of the impacts that both forms of technological change have on change in the rural labor force composition is itself a finding of interest. This suggests that technological innovation in both the bio-chemical and mechanical forms tends to comprise a "modernization package." This can also be inferred from the increasing intercorrelations between both forms of technology from 1950 to 1970 (see Appendix B).

Tables 49 and 50 report the results of regression equations that estimate the relative impacts of 1950 mechanization and change in mechanization on rural labor force composition. These equations reveal some limited independent effects of initial mechanization levels--the only instance in which such effects are apparent in this study. The regression coefficients for 1950 mechanization are significant and negative for change in rural family labor, and significant and positive for change in percent of temporary rural workers (see Table 49). The latter finding is also significant in Table 50. Nevertheless, the change score indicators have more pronounced effects on changes in labor force composition, as can be observed in Tables 49 and 50. Two further observations can be made in connection with the data in Tables 49 and 50. Firstly, we see a high degree of consistency in the signs of the regression coefficients across all equations. The coefficients for change in percent of rural family labor and percent of sharecroppers are systematically negative, and those for change in the proportion of wage labor (both permanent and temproary) are consistently positive. A second observation refers to the relatively stronger effects of mechanization on change of labor force composition--especially for change in family labor--compared with the effects of bio-chemical technology. Though similarity of trends for both forms of technological innovation is patent, as observed before, mechanization does exhibit the largest impact. The full regression models reported in Tables 53 and 54 continue to indicate the greater importance of the mechanization indicators even when controlling for the center-periphery variables. Again, the indicators standardized by the number of farms (see Table 53) are better able to account for variance in the labor force measures than technological indicators standardized on a per hectare basis (see Table 54).

The results of these analyses for both technological variables are quite consistent in point out that the expansion of technology in Minas Gerais municipios has been accompanied by discernible changes in rural labor force composition. These associated changes, as revealed by our data, basically involve a relative decline in the relevance of the family labor and centralized sharecropping system, coupled with an increased prevalence of the wage labor.

These data could lead us to infer as others have (see Goodman, 1976; Goodman and Redclift, 1977), a progressive proletarization of the rural work force in Brazil under the impact of capital accumulation and market penetration into the countryside. We prefer, however, to stop short of this conclusion in the present study. We do so in face of limitations of the data base, as well as other evidence reported above that defies such a simplistic explanation, e.g., the positive association found between technological change and proportions of minifundios and tenants, as well as the general tendency for increasing proportions of minifundios, tenants, squatters, and family labor in Minas Gerais municipios during the 1950-1970 period.

These phenomena can be interpreted rather in terms of marginalization *within* the context of "traditional" forms of social organization and relations of production in rural areas. Our study has also revealed extreme local and regional variability of social structures and patterns of change in Minas Gerais municipios. This suggests the inapplicability of attempting simple generalizations concerning broad directions of change such as the unambiguous transformation of "traditional" relations of production into more "capitalist" ones. In fact, it appears that our findings point more toward a simultaneous reinforcement of traditional structures and the superimposition of new dependent capitalist "modes of production." We could then hypothesize, following some suggestions from the literature (Goodman, 1976; Long, 1977; Goodman and Redclift, 1977; de Janvry, 1975, 1976-77), that agricultural modernization in countries such as Brazil, rather than implying the systematic transformation of traditional structures into "modern," capitalist ones, may reinforce dualistic patterns, which are functionally--albeit assymetrically--related to one another. This final point, however, is merely a hypothesis, which receives some amount of support from our findings. In the present context, we can simply say that our data do support the expectations formally stated in hypothesis 4.

RURAL WAGES

Bio-Chemical Innovation

The correlation coefficients in Table 46 clearly suggest substantial positive associations between change in bio-chemical technology and change in average rural wages, as anticipated by hypothesis 5. This finding parallels those discussed above with respect to the positive impacts of technological change on change in wage labor in rural areas in Minas Gerais. The regression estimates reported in Tables 47 and 48 again show clear effects of bio-chemical innovation on wage changes, although 1950 bio-chemical technology levels are relevant only when this independent variable is measured in terms of cruzeiros of modern bio-chemical inputs per farm. The same patterns are repeated for the regression results which include the center-periphery variables (Tables 51 and 52). Despite the overall importance of regional location on change in average rural wages, the bio-chemical technology indicators still reveal independent effects on rural wage changes.

Mechanization

The coefficients in Table 46 indicate a strong positive relationship between change in average rural wages and change in mechanization when the latter is measured on a per hectare basis. However, there is essentially no relationship when mechanization is measured on a farm unit basis. The reason for this discrepancy is elusive, particularly so because the pattern is the reverse of the usual one when relevant differences were observed for the two indicators of the same form of technology. We merely suggest that the evidence from Table 46 is less compelling for mechanization than for bio-chemical innovation. The results for the multiple regression equations relating change in rural wages to 1950 mechanization levels and 1950-1970 mechanization change are reported in Tables 48 and 49. They reveal a familiar pattern of the predominant impact of change in mechanization on change in the average rural wages. The regression estimates for the full regression models containing the center-periphery variables (Tables 53 and 54) indicate (similar to the coefficients in Table 46) a significant impact for change in mechanization only when measured in terms of number of tractors per 1000 hectares of cropland (Table 54). None of the other regression coefficients is significant in these equations. This confirms the suggestion that the impact of mechanization on change in rural wages tends to be less pronounced than that of the bio-chemical indicators. Nevertheless, the overall pattern of the data argues for the acceptance of hypothesis 5. Our reasoning in Chapter 3 that rural workers in "central" regions are considerably better off in relation to their counterparts in more peripherical areas seems to be corroborated by these findings--particularly those revealed by the full regression models. Though inequality may be even more pronounced in more "developed" areas, average wage levels do tend to be higher. This result is also consistent with the data and discussions pertaining to the Brazilian development experience presented in Chapter 2.

RURAL LITERACY RATE

Bio-Chemical Innovation

We earlier proposed hypothesis 6 which predicts positive impacts of technological change on rural literacy changes. Both variables were presumed to reflect dimensions of the differential and uneven process of incorporation of local units into national centers of growth. The results in Chapter 5 have pointed in this same direction, since we there observed systematic biases in favor of the more central regions for most indicators of economic development and "well-being." The data in Table 46 also bear out the prediction of positive associations between change in bio-chemical technology and change in rural literacy rates but the correlations tend to be quite modest. However, in this chapter we are primarily interested with detecting the independent or net effects of initial levels and change in technology on change in the social organizational characteristics. Such impacts are evaluated in the regression models (summarized in Tables 47 to 54). The results in Tables 47 and 48 further indicate the modest impacts of bio-chemical technology on changes in rural literacy. In only one case is the value of the standardized partial regression coefficient significant, and none of the coefficients of determination for the equations in Tables 47 and 48 reaches the minimum criterion of five percent to justify further analysis. Since we noted in Chapter 6 that 1950 levels of rural literacy had sizeable effects as antecedents of technological change, we may conclude that literacy is more an antecedent than a consequence of change in bio-chemical technology.

Mechanization

The correlation coefficients reported in Table 46 indicate a positive association between change in mechanization and change in rural literacy in Minas Gerais municipios during the 1950-1970 period when the former is measured in terms of percent of tractors per farm. However, when mechanization is measured in terms of number of tractors per 1000 hectares of cropland there is no such relationship. These modest relationships thus parallel the tendencies noted above with respect to bio-chemical innovation. The regression results in Table 48 and 49 indicate that initial levels of mechanization had no effect on change in rural literacy rates. The change indicators show the same results as in Table 46; one of the partial coefficients (Table 49) is significant, and the other (Table 50) is not. These results suggest the expansion of technology has had little impact on the general increase in rural literacy rates observed throughout Minas Gerais. These results also contrast with the large cross-sectional correlations found in Tables 42 and 43 of Chapter 6, as well as the particular results of that chapter which link 1950 literacy levels to change in agricultural technology in Minas Gerais municipios. These findings thus suggest that, in the context of the period and area of the study, rural literacy rate has been more important as an antecedent than as a consequence of technological change in agriculture.

LAND USE

Bio-Chemical Innovation

The simple correlations between the residualized change indicators of bio-chemical technology and land use patterns are presented in Table 46. We can observe that change in the proportion of farmland deveoted to crops is significantly related to change in bio-chemical technology when technology is measured in terms of farm units (but not when technology is standardized on a per hectare basis). In this sense, these results are the reverse of thos obtained in Table 40 (in Chapter 6), even though the value of the significant first-order partial correlation coefficient (in Table 40) was smaller. Another contrast with the results of the previous chapter is represented by the non-significant correlations between change in bio-chemical technology and change in pasturelands (Table 46). While the 1950 proportion of farm land devoted to pastures was significantly correlated with technological change, technological change itself is not associated with change in the proportion of pastureland during the 20-year period of the study. This finding is reasonable given both the interpretation for that unanticipated relationship offered in Chapter 6, and the expectation of closer linkages between the technology indicators and the proportion of cropland developed in Chapter 3. The results of Tables 47 and 48 further document that the indicator of bio-chemical technology measured in terms of cruzeiros of modern inputs per hectare of cropland (Table 48) is less sensitive and exhibits no significant impact on change in the proportion of croplands. Onthe other hand, the indicator of change in bio-chemical technology measured in terms of cruzeiros of modern bio-chemical inputs per farm (Table 47) has a significant impact on change in the percent of farmland in crops.

The same picture is repeated in the full equation models summarized in Tables 50 and 51 where the center-periphery indicators are introduced as control variables. The only significant coefficient that appears pertains to the technological change indicator in Table 51. In other words, the inclusion of the control variables does not appreciably diminish the effect of change in bio-chemical technology (standardized on a per farm basis) on a change in the proportion of croplands (see Table 51). Even though these results are too modest to establish a definite impact of bio-chemical innovation on change in the proportion of farmland devoted to crops, the results do suggest some tendency in this direction among Minas Gerais municipios.

Mechanization

The results referring to the impacts of mechanization on changes in patterns of land use almost totally parallel those obtained above for bio-chemical technology. These results are reported in Tables 46, 49, 50, 53, and 54. The main observation we might offer with respect to the predictions constituting hypothesis 7 is that our results do not support the expectations that mechanization--a more land-extensive type of technology--would have relatively stronger impacts on change in the proportion of farmland devoted to crops than would bio-chemical technology. In fact, the coefficients for mechanization (simple correlations and beta-weights) are generally lower in this case. We can thus conclude that hypothesis 7 is only partially and not strongly confirmed by the results of this study. Changes in bio-chemical technology as well as in mechanization do have small positive impacts on change in the proportion of land devoted to crops. We may recall in this respect the relatively low dynamism observed in the overall tendencies for change in cropland area in Minas Gerais municipios. This in trun is consistent with the stagnation in agricultural productivity observed in Chapter 2 for Minas Gerais when compared with other areas of Brazil.

SUBSISTENCE PRODUCTION

Bio-Chemical Innovation

Given the discussion in Chapter 3 linking our subsistence production indicator to more "traditional" forms of production relations which could be negatively affected by increasing expansion of technology into the countryside, we have predicted negative relationships between change in technology and change in subsistence production. The initial results reported in Table 42 (Chapter 6) pointed to generally negative cross-sectional correlations between subsistence production and bio-chemical technology. Further, these correlations were larger in 1970 than in 1950.

The coefficients in Table 46 similarly reveal that bio-chemical technology change is significantly and inversely related to change in subsistence production, as anticipated by hypothesis 8. The results in Tables 47 and 48 indicate that bio-chemical technology change rather than 1950 technology has the most significant impacts on change in the subsistence production indicator for Minas Gerais municipios. However, these effects were not sufficiently pronounced to meet the five percent criterion for the coefficient of determination to warrant further analysis. In summary, we can say that the patterns of association found between subsistence production and bio-chemical technology are in the expected direction, but are not as strong as initially expected.

Mechanization

The coefficients relating change in mechanization to change in the subsistence production indicator are generally much too weak to lend support to hypothesis 8. In fact, the only evidence for the hypothesis is that the relationships tend to be in the predicted (negative) direction. All relevant coefficients (reported in Tables 42 and 43, in Chapter 6; and Tables 46, 49, and 50 of this Chapter) are small and non-significant, with the single exception of the significant cross-sectional correlation between subsistence production and number of tractors per 1000 hectares of cropland in 1970.

We commented in Chapter 3 that the indicator used here to represent subsistence production--private production of corn, beans, and cassava by resident farm workers as a percentage of the commercial production of these crops--reflects only tangentially the concepts of subsistence agriculture and traditional production relations. The weakness of our indicator may thus account for our inability to detect the predicted relationships. But despite the limitations of the subsistence production indicator, the results may in fact have importance in the debate over the extent to which capitalist production relations accompany technological expansion. The data reported above suggest that capitalist penetration does not necessarily imply the elimination of non-capitalist (i.e., "peasant") relations of production within the same local system. Subsistence production continues to be important even in the most technologically advanced municipios. suggesting that labor remuneration in such municipios is not restricted to wages.

RURAL NET MIGRATION

Our discussion of this variable in Chapter 3 led us to predict negative mean regional values for rural neg migration, as stated in hypothesis 9. The results in Table 39 (Chapter 5) left no doubt as to the applicability of the hypothesis. All mean values for the regional distributions of rural net migration were negative. In addition, Chapter 5 pointed out that both the São Paulo Periphery I and Rio de Janeiro Periphery I regions (which had similarly high rural population densities in 1950), although exhibiting strikingly different experiences in terms of agricultural and technological development, are the most important rural "push" regions in Minas Gerais. This point serves as an empirical referent for predicint little or no relationship between rural net migration and technological change, as stated in hypothesis 10.

Bio-Chemical Innovation

The coefficients for the relationship between rural net migration and levels of bio-chemical technology as reported in Table 42 of Chapter 6 tend to support hypothesis 10. In fact, all correlations in both 1950 and 1970 are low, and despite two significant coefficients, do not show any consistent patterns of association. The coefficients in Table 46 for the associations between change in bio-chemical technology and rural net migration are all small and negative. The same finding pertains when the relationships are computed among 215 municipios with rural population densities above the mean (in 1950) for the state as a whole. First-order partial correlation coefficients remain low even when 1950 rural population density is controlled in multiple regression equations.[3] The data thus confirm our expectation of little impact of change in bio-chemical technology on rural net migration among Minas Gerais municipios during the 1950-1970 period.

Mechanization

Correlations between mechanization levels in 1950 and 1970 and rural net migration reported in Tables 42 and 43 of Chapter 6 are essentially zero. Coefficients for the relationships between change in mechanization and rural net migration (Table 46), on the other hand, show inconsistent tendencies between the two mechanization indicators, both in terms of direction and strength of relationship. When 1950 rural population density is used as a control variable in the computation of first-order partial correlation coefficients, the impact of mechanization on rural net migration, however, is consistently insignificant.[4] These results seem to suggest that the impact of mechanization on rural net migration is minor--presumably, as argued in Chapter 3, because mechanization in Minas Gerais is still too incipient to have independent effects on migration rates. In sum, our results confirm the expectations summarized in hypothesis 10.

SUMMARY AND CONCLUSIONS

In this final section we present a brief evaluation of the main findings of this chapter. We emphasize the net effects of both 1950 technological levels and change in technology on change in social organization patterns, as depicted in the hypotheses of Chapter 3. In addition, the impacts of alternative change-producing factors--i.e., the center-periphery variables--in the context of this study are discussed.

The first hypothesis evaluated in this chapter refers to the positive relationships of agricultural technology to changes in land productivity. Our results have generally confirmed these expectations for both types of technology--but particularly so for bio-chemical innovation, as predicted. Initial technological levels were significant only for bio-chemical technology. Measures of technological change, however, had larger impacts on change in productivity--especially when controls for the center-periphery variables were introduced. We can thus conclude that technological innovation has had a significant net impact on change in land productivity. As expected, the impacts of technological change were greatest for the more typical commercial/export crops (coffee and sugar cane) than for staple/subsistence crops (beans and corn). This finding is consistent with the patterns depicted for Brazil as a whole in Chapter 2.

The results relative to the second hypothesis--that is, the impacts of levels of and changes in technology on change in the farm size indicators--do not lend themselves to an unambiguous summary since varying tendencies were observed. There were systematic differences associated with the two types of standardization procedures used in connection with the agricultural technology indicators. The indicators standardized by hectares of cropland for both bio-chemical and mechanical forms were generally unimportant in accounting for changes in farm size. Indicators standardized by number of farm units were generally more sensitive and better able to explain variance in farm size changes. An interpretation given above for this discrepancy emphasizes the incipient stage of technological adoption in Minas Gerais municipios during the 20-year period of the study. Indicators measured on a per hectare basis reflect more clearly Minas Gerais' incipient level of technological change. There were some significant differences in the direction of the relationships involving indicators with varying bases of standardization. In general, however, we concluded that there are only minor impacts of bio-chemical technology on changes in farm size, as predicted by hypothesis 2. The directions of the associations, though not completely consistent, were generally as expected; technological change, on balance, seems to reveal some tendency toward an increasing prevalence of larger farms.

The data also revealed two similar tendencies for both forms of technology. Firstly, a relatively strong impact of technological change on change in the median size category of farm cropland is apparent, suggesting (as in Chapter 4) that this is a more sensitive indicator for detecting incentives for larger farm operations. Secondly, we can note the overall unimportance of technological change in accounting for change in land inequality. We have interpreted this lack of relationship in terms of both the high initial levels of land inequality and their strong tendency toward stability in the short run. With these considerations in mind, we can conclude that hypothesis 2 is only partially confirmed by our data. Technological change in general had only minor impacts on changes in farm size indicators, and the patterns that emerge from our data are complex and do not lend themselves to simple generalizations.

Hypothesis 3, which refers to the relative impacts of agricultural technologies on change sin the prevalence of land tenure groups, is generally confirmed by our data. The results indicate that these impacts are modest for both types of technology, but do follow the predicted directions. Technological change had a positive impact on change in the proportion of administrators, and a negative relation to the proportion of squatters. The effects of technology on change in the proportion of owners are generally small (but tend to be more positive for bio-chemical innovation). On the other hand, the effects of technological change on change in the proportion of tenants tend to be small for bio-chemical innovation and more positive for mechanization. Initial levels of bio-chemical technology were better able to explain changes in the land tenure categories than were changes in bio-chemical technology. With respect to mechanization technology, the effects of the change scores were larger than those of 1950 mechanization. However, all such effects were too small to justify further data analysis.

We can point out that the most significant impacts of technological change in Minas Gerais municipios were on the productivity and the rural labor force indicators. As observed above, our results very clearly indicate that both forms of technological innovation have systematically led to decreases in the proportion of rural family labor. Our initial reasoning pointed toward a close linkage of rural family labor with a peasant-like agricultural system, and that technological change would tend to involve supercession of this form of labor relations. Similar negative bivariate relationships were found with change in the proportion of sharecroppers (which in this case basically refers to a centralized sharecropping systems). Our results have also revealed that these tendencies are particularly pronounced in relation to change in agricultural technology; these relationships persist even when the center periphery variables are controlled and show remarkable similarity across both types of technological innovation. Hypothesis 4 thus has been fully confirmed by our results. Nevertheless, we have not concluded, given the limitations of our data as well as other available evidence, that technological change implies a complete transformation of production relations in the countryside toward more capitalistic forms. We prefer to opt for more cautious interpretation. This interpretation emphasizes both local variability in adjustments to change, as well as the posibility of the reinforcement of dualistic structures fostered by the broad agricultural trnasformation process of which technological change is a crucial element. This interpretation, however, is nothing more than a hypothesis suggested by the literature (Long, 1977; Goodman, 1976; Goodman and Redclift, 1977) and the empirical evidence available from this study.

As anticipated by hypothesis 5, technological change has a positive impact on change in average rural wages, even when the center-periphery variables are controlled. Initial (1950) levels of technology were relevant only for the bio-chemical form, which also revealed stronger associations with change in wages. These municipal level results are consistent with empirical evidence at the national level (presented in Chapter 2) which pointed toward a tendency for rural wages to be higher in the states with more "modern" agricultural systems, particularly São Paulo. On the other hand, the associations between technological change and change in rural literacy levels were modest and generally did not lead to the acceptance of hypothesis 6. We can conclude that rural literacy rates have been more important as antecedents than as consequences of technological change.

Hypothesis 7 is also only partially and not strongly supported by our results. Initial levels of and change in both forms of technology had just minor positive impacts on change in the proportion of croplands. In all cases, only technological indicators standardized by number of farms have been significant, and the mechanization impacts, contrary to our expectation, were less than those observed for bio-chemical innovation.

The findings pertaining to the relative impacts of technological levels and technological change on change in the subsistence production indicator only partially confirm the predictions of hypothesis 8. Although these impacts were generally negative, they were also very small and in the case of mechanization, even trivial. The interpretation given to these results emphasized the empirical and conceptual limitations of the indicator used for representing subsistence production in the context of this study, as well as the still restricted average technological levels of Minas Gerais municipios. Furthermore, if we grant that agricultural "modernization" does not imply a liquidation of older forms of production relations in rural areas, then these small relationships are even more meaningful. The evidence here leads one to conclude, albeit tentatively, that the expansion of agricultural technology does not imply clear-cut ascendancy of capitalist production relations. Rather, technological expansion tends to involve superimposition of capitalist production relations on more traditional social relations of production which build upon and reinforce the dualistic patterns depicted in Chapter 3.

The data presented in this and previous chapters leave no doubt as to the applicability of hypotheses 9 and 10. All mean values for the regional distributions of rural net migration were negative (as predicted by hypothesis 9). Analyses of the relationships between technological levels and change with rural net migration revealed, as expected (hypothesis 10), only small effects. We have concluded that in Minas Gerais municipios, technological change during the 1950-1970 period has been too restricted to have an independent impact on rural net migration rates. Other rural "push" factors--likely including agricultural stagnation and land inequality--have probably been more significant factors affecting these municipal migration rates.

When discussing general problems in evaluating the consequences of technological change for local rural social organization in Chapter 3, we emphasized three aspects to which we now return in connection with this chapter's results. Our findings seem to support the observation that given the gradualistic and discriminatory character of technological change in agriculture--and particularly the initial stages of this process in the state of Minas Gerais--the net impacts of such technological change will likely tend to be circumscribed. Throughout the chapter we have observed only moderate to low relationships in this respect. The results are more significant in pointing toward the <u>directions</u> of the probable impacts rather than their strength. In addition, it is also clear from the data that such impacts were more important for those aspects of the social organization of production more directly linked with the levels of production technology (such as physical productivity, labor force composition, and rural wages) than for others (such as farm size and land inequality, land tenure, rural literacy rate, and rural net migration). This is consistent with our second observation in Chapter 3 concerning the relative inertia of the social structures. Technological change may <u>not</u> be a major source of structural change if certain accomodations occur between previous forms of social organization and newer ones resulting directly from technological advancement.

Finally, in attempting an evaluation of the consequences of technological change, we have considered the confounding influence of other change-producing factors. In the context of this study, the issue has been dealt with by considering the direct effects of 1950 technological levels as well as two selected center-periphery variables (1950 levels of urbanization and regional location). The use of such controls proved useful to underscore our contention that measures of technological change were usually more important than those of initial technological levels in accounting for socio-economic change (particularly with respect to mechanization). Furthermore, the center-periphery controls have indicated the decisive importance of regional location in shaping the course of socio-economic transformation of Minas Gerais municipios. In virtually all multiple regression equations, regional location proved to be the one most crucial variable for explaining changes in indicators of local rural social organization. An interesting observation is that urbanization itself was a relatively poor predictor of structural change in these equations; its only consistent effect was on changes in wage labor force categories. The results of this chapter thus appear to corroborate the observation found in a recent review article on the prospects for and challenges of Minas Gerais development efforts:

> Its ultimate success as an economic entity will therefore depend on the degree to which it not only develops its economy, but also integrates it into an interdependent whole (Bank of London & South America Review, July, 1976, p. 376).

Regional disparities and spatially and socially uneven development have deeply characterized the historical experience of the state of Minas Gerais and continue to represent a major challenge for the future.

FOOTNOTES

1. The industrialization indicator has not been included in these multiple regression equations because of its high intercorrelation with urbanization (which inhibits stable parameter estimation; Hibbs, 1973). Further, as was noted in Chapter 6, the associations between industrialization and technological change were largely accounted for by the effects of urbanization.

2. Though we have not made any formal hypotheses concerning the relationships between bio-chemical technology change and change in the proportion of tenants, both coefficients in Table 46 are essentially zero. These results sharply contrast with those found in Chapter 6 which exhibited a substantial correlation between the 1950 proportion of tenants and technological change.

3. The value of the first-order partial correlation for the relationship between 1970 cruzeiros of modern bio-chemical inputs per farm and rural net migration was -.123; for 1970 cruzeiros of modern bio-chemical inputs per hectare of cropland, -.140; for change in cruzeiros of bio-chemical inputs per farm, -.028; and for change in bio-chemical inputs per hectare, .060.

4. The value of the first-order partial correlation for the relationship between 1970 percent of farms with tractors and rural net migration was -.071; for 1970 number of tractors per thousand hectares of cropland, -.065; for change in percent of farms with tractors, .094; and for change in number of tractors per thousand hectares of cropland, .024.

CHAPTER VIII

SUMMARY AND CONCLUSIONS

In this study we have attempted an exploratory, though systematic, inquiry into patterns of local social change in Minas Gerais municipios by examining the available census data for 1950 and 1970. We assumed at the outset that municipios would form a meaningful unit of analysis for the study of rural social organization and change in Brazil. It was also presumed that this intermediate level of aggregation would unveil the diversity of social formations that constitute the rural sector of a country so complex and heterogeneous as Brazil. We were also aware of the problems and limitations involved with the use of census data, but again assumed that the available information about local social structures in a large territorial entity such as that of the state of Minas Gerais would be sufficiently interesting to justify the risks of invalidity and unreliability. There was, finally, a conscious effort to strike a balance between elements of both an inductive and exploratory approach, and a deductive and hypothesis-testing posture. It is important to point out that this study was not conceived with the notion that all local social organization variables could fully explain all aspects of the process of agricultural technological diffusion and adoption. Rather, the interactions between agricultural technology and social organization at the local level have remained virtually unexplored in Brazil, and this study sought to fill this void. This is assumed to be the main contribution of this research. In this final chapter, we made a brief summary of the principal findings of the study, point out some general conclusions they auggest, and recommend some future areas for research with both the present data set as well as with other types of data.

SUMMARY

Since we have presented a detailed summary of the study's findings at the end of each empirical chapter, we limit ourselves here to brief comments pertaining to each of the working hypotheses developed in the context of the three major research questions.

Structural Change in Minas Gerais Munitipios, 1950-1970

The findings relative to the overall change tendencies among Minas Gerais municipios during the period of the study generally parallel those observed for Brazil as a whole (as well as for the macro-regions and other selected states) in Chapter 2. There was a tendency for substantial increases in the number of farm units--particularly smaller farms--while at the same time land inequality has remained very high and stable. We observed a general tendency for an increasing proportion of non-owners among the tenure groups, as well as an increasing prevalence of family labor at the expense of other labor categories (including wage workers). There was also a clear tendency for increases in rural and urban wages and rural and urban literacy rates. However, sizeable rural-urban differentials in wages and literacy persisted in 1970. A further tendency among Minas Gerais municipios was toward a secular increase in the proportion of pastureland, with very little overall growth of the proportion of cropland. Nevertheless, there were large mean increases in agricultural technology, but physical yield indicators failed to exhibit sizeable gains during the period. The indicators of urbanization and industrialization experienced high mean rates of increase, suggesting the moe dynamic character of the non-rural sectors of Minas Gerais municipios. Finally, high average rates of rural out-migration were observed for the period of the study.

Our first general hypothesis concerning patterns of change in Minas Gerais municipios emphasized an expectation of extreme variability among the units of analysis. This assertion was fully supported by the data. The various descriptive statistics analyzed in Chapter 5 clearly pointed toward the heterogeneity of local characteristics and change tendencies exhibited by the municipios of the state. Given such findings, it was rewarding to observe, as predicted by hypothesis 2, that regional location has been a meaningful framework within which to capture significant and consistent variations of social organizational and technological variables. This was particularly the case for indicators more closely linked with the process of economic development, in line with the predictions of hypothesis 3. Our results, however, provided only partial evidence for hypothesis 4, which predicted increasing regional disparities from 1950 to 1970 for those indicators most associated with socio-economic development. There was confirmation of the hypothesis with the data on agricultural technology, rural and industrial wages and industrialization. However, something of a "catching up" process-that is, regional convergence--was observed for indicators such as urbanization and literacy rates.

Social Organization Patterns as Antecedents of Change in Agricultural Technology

The results pertaining to this section of the study were characterized by complex patterns of associations, which only partially confirmed the hypotheses set forth in Chapter 3. Hypothesis 1 predicted positive associations between farm size/ land inequality indicators and change in agricultural technology. The data indicated that farm size generally had only minor impacts on bio-chemical technology but had relatively sizeable effects on mechanization. The land inequality index behaved as predicted, being a significant antecedent of both forms of technological change. The strong association between proportions of minifundios and technological change was unanticipated because previous farm-level research in the context of Minas Gerais and other areas of Brazil suggests that minifundios are generally unlikely to experience technological change. The expectation of only modest associations between the land tenure groups and technological change, as formulated according to hypothesis 2, was more clearly supported by our data. The relationships were on the predicted direction. The most unexpected finding was the strong positive association between the proportion of tenants and technological change. Again, further inquiry into this relation is needed because of its contradiction with existing farm-level research. Hypothesis 2 generally pertained well for bio-chemical forms of technological innovation and less well for mechanization.

The anticipation of positive relationships between rural literacy levels and technological change (hypothesis 3) was generally confirmed by our results. The initial proportion of farmland in crops, however, did not prove to be positively associated with technological change, as we predicted, but proportion of pasturelands did show such a relationship. On the other hand, the indicators of crop specialization and concentration in commercial/export crops did exhibit positive relationships with technological change, as predicted by hypothesis 4. Similarly, the indicators of proportion of cropland devoted to coffee, rice, and beans have exhibited the expected associations with technological change. Departures from the hypothesis occurred with the indicators of the proportion of cropland devoted to sugar cane and corn.

Regional location throughout this study proved to be a crucial variable for explaining technological change in Minas Gerais municipios. Similarly, the urbanization and industrialization indicators--which along with regional location formed our center-periphery variables--were also significantly associated with technological change. In this regard, hypothesis 5 has been fully supported in the context of this study.

Social Organizational Patterns as Consequences of Change in Agricultural Technology

The findings with respect to the relative impacts of technological change on change in indicators of rural social organization in Minas Gerais municipios were generally consistent with the expectations stated in the hypotheses of Chapter 3. The net impacts of technological change were evaluated against those of original (1950) technology levels as well as selected center-periphery indicators (regional location and urbanization). Our results have confirmed the first hypothesis which anticipated positive impacts of both forms of technological change on productivity gains. This point assumes particular importance when compared with the overall tendency toward stagnation of land productivity levels in Minas Gerais during the 1950-1970 period. The patterns of relationship found for the impacts of technological change on farm size were very complex and defy brief summarization. However, the results do follow the expectations predicted in hypothesis 2 in the sense that the relationships were only modest in strength. The directions of the associations were not always consistent across the various indicators of farm size and technology. The indicators of technological change tended to show larger effects than 1950 technology levels. The median size category of farm cropland proved to be most sensitive as consequence of technological change. Land inequality, on the other hand, was more relevant as an antecedent of change than as a consequence.

Hypothesis 3, predicting generally minor impacts of technological change on land tenure changes, was confirmed by our findings--both in terms of the strength of the associations as well as their directions. Similarly, hypothesis 4 was fully supported by the data; technological change was inversely related to change in proportions of family labor and sharecropping, and positively related to change in the proportion of wage labor. These variables, along with change in productivity, constitute the municipal-level indicators which were most affected by technological change.

As anticipated by hypothesis 5, technological change had a positive impact on rural wages, and a positive, though insignigificant, effect on rural literacy rate, thus leading to the rejection of hypothesis 6. The results pertaining to hypotheses 7 and 8--the former predicting a positive impact of technological change on change in cropland, and the latter anticipating negative impacts on change in subsistence production--tended to be confirmed by the data, though not in a compelling way. Hypotheses 9 and 10, on the other hand, were fully confirmed by our results. Not only were all average regional values for the net rural migration indicator negative, as predicted, but no consistent or significant patterns of associations emerged between technological change and rural net migration.

Our results have generally indicated that technological change in Minas Gerais--given both the characteristics of the agricultural "modernization" process in Brazil as well as the initial stages of the technological adoption process in most of the municipios of the state--had only moderate impacts on changes in rural social organization. Such impacts were more noticeable in the indicators most directly affected by production technology such as productivity and labor force characteristics. Nevertheless, the directions of these impacts were generally as predicted. Finally, regional location, which proved to be a crucial variable for explaining technological changes, showed equally large effects on changes in the social organization indicators. While these regional impacts have been pervasive, those for 1950 urbanization levels were negligible when 1950 technology and regional location were controlled.

We present, in Appendix D (Table 74), a schematic summary of the major hypotheses and results of this study. The Appendix is to be used as a quick reference to our results.

CONCLUSIONS

The results of this study allow us to draw some general conclusions with respect to patterns of local social organization and change in agricultural technology in Minas Gerais municipios during the 1950-1970 period. In the following paragraphs we present what seem to be the major theoretical, methodological, and empirical implications of the study.

The first general conclusion suggested by the results deals with the relevance of municipios as an intermediate unit of analysis that can yield valuable insights into the dynamics of social change in Brazil and other Third World nations. We have argued that macro-aggregates such as states and larger regions tend to conceal significant local variability, while micro-surveys are generally too specific to a particular area to yield information on broad patterns of local social change. The results of this study have confirmed the expectation of wide municipal variability in patterns of social organization as well as in rates of change among Minas Gerais municipios. Even more important was the observation of contradictory local trends found for different indicators of social organization. This suggests the fragility of sweeping generalizations based either on case studies or analyses of larger aggregates, particularly in a country with so diverse a social structure as Brazil. The potential of intermediate units of analysis for the study of agricultural development and change has been pointed out in the work of Young and associates (Wheelock and Young, 1973; Young and Young, 1973; Young, 1972, 1977). The importance of local variability in both organizational patterns and rates of change also underscores the problems involved in excessive concentration on national development patterns and broad historical processes of change at the expense of attention to the differential dynamics within a country's boundaries. We believe that research strategies focused on intermediate units of analysis can yield valuable information on patterns of social organization and change.

The second general conclusion refers to the relevance of regional context for capturing both characteristics and dynamics of social organizational patterns in Brazil. The striking regional variations in this country are well-known. The important point in this study, however, is the parallelism found between the regions _within_ Minas Gerais and with the macro-regions of Brazil. As we have pointed out above, this finding was of particular interest, given wide municipal variability in patterns and rates of change in social organization. The overall importance of the regional location variable--particularly with respect to the indicators more closely related to economic development--reveals the congruence between our results and previous interpretations of the uneven nature of the development process, as captured by the center-periphery dimensions. Municipios located in regions more closely linked with national centers of growth began and ended the period of the study in a privileged position, even though the hypothesis of overall increasing regional inequality was not totally confirmed by our data. In fact, this study points to tendencies toward both regional "incorporation" as well as "marginalization" for different indicators associated with the development experience. The character of this conclusion also reveals another benefit of an approach focused on intermediate units of analysis; this approach allows one to go beyond dichotomous or categorical types of statements concerning directions of change, substituting for them more realistic differential tendencies that call for conditional statements to be pursued in future analyses.

A third general conclusion is, as expected, that no major qualitative structural transformations have occurred in patterns of social organization among Minas Gerais municipios. Rather, continuous accommodations and adjustments to broad processes of change generated at the national level and impacting on the non-rural sectors were observed. However, this does not imply the passivity of original local rural structures to the forces fostered by technological change. We have concluded that despite the overall importance of the non-rural indicators, prevailing characteristics of agrarian structures have conditioned further adjustments or functioned as barriers to the processes of change. Among these characteristics, land inequality and rural literacy rates emerge as the most significant local rural antecedents of technological change.

The fourth general conclusion is that expansion of agricultural technology change in Minas Gerais municipios was basically accompanied by productivity gains and changes in rural labor force composition. The latter changes primarily involve a decrease in the prevalence of family labor and forms of sharecropping and increases in the prevalence of wage labor. This result, which could be interpreted as evidence of increased proletarization of the rural labor force and the predominance of capitalist production relations, must be considered along with other findings associating technological change with a prevalence of both tenancy and minifundios. These latter tendencies, on the other hand, could be interpreted in terms of progressive marginalization within the framework of traditional agrarian structures. Our data seem to suggest, rather, the reinforcement of dualistic structures ("modern" versus "traditional")--functionally, albeit asymmetrically, articulated at the local level. However, as observed before, this conclusion more properly is a hypothesis which calls for types of data other than those available for this study. The relatively circumscribed impacts of technological change on other aspects of rural social organization were interpreted mainly in terms of both the still limited levels of technological change in Minas Gerais municipios as well as the relative inertia or permanence of historically developed social structure.

A final conclusion refers to distinctions between the two forms of technological innovation--bio-chemical technology and mechanization. In generaly, as expected, mechanization is a more typically large farm-biased innovation, though we have found some evidence of the privileged position of larger farms with respect to bio-chemical innovation as well. Our data seem to suggest that a focus on the interactions between social organization and technological change seems to be a more relevant focus for analysis than the characteristics of the technology per se. The fact that technological change in Brazil, as observed in Chapter 2, is superimposed on an initially very unequal agrarian structure also set the stage for unequal and dualistic impacts of such changes.

SUGGESTIONS FOR FURTHER RESEARCH

This study, despite its broad scope, has very decided empirical, theoretical and methodological limitations which have been detailed in previous chapters and need not be repeated here. Research attempting to overcome some of the limitations is necessary for our results to be considered conclusive evidence. Within the context of the data already available for Minas Gerais, a particularly useful strategy, given the overall importance of our regional location variable, would be to evaluate the patterns of associations between social organization and technological change *within* specific regions. A major objective thus would be to evaluate regional differences with respect to the patterns of associations found for the entire range of Minas Gerais municipios. A second strategy would be to further explore some of the patterns of associations found by using alternative indicators of the same variables. Further, it would be valuable to systematize the results of the present study into a series of structural equation models (see Duncan, 1975; Alwin and Hauser, 1975). However, it seems to us that the already available data can be used to address more specifically other research problems not considered in this study or only tangentially considered herein such as the determinants and impacts of rural net migration, further analysis of change in rural labor force composition and associated factors, an elaboration on the problem of rural poverty and inequality, and so on. Further, given the relative payoffs of research with the type of units used in this study, we can attempt further validation of our results in terms of antecedents and impacts of technological change by conducting comparable analyses in other Brazilian states. It would be useful to explore data for states such as São Paulo and Rio Grande do Sul, which experienced both higher initial levels and rates of change in agricultural technology than Minas Gerais, and also exhibit characteristics of agrarian structures which evolved historically along different lines--the former relying primarily on hired labor, while the latter evolved with a system of family farms.

Despite the value of our approach, nevertheless, many of its limitations can be attributed to the kind of data available from census materials. Therefore, further refinement of our results calls for different types of analyses which can unveil the internal characteristics and dynamics of the rural sector within selected municipios. This notion is particularly relevant with respect to certain empirical "puzzles" detected above such as the associations of the proportion of tenants and proportion of minifundios with technological change. Furthermore, evidence for the apparent reinforcement of both traditional and capitalist "modes of production" in municipios experiencing technological change and market expansion is a hypothesis that cannot be satisfactorily dealt with in the context of this data. It calls for both a case study/historical and a survey approach to more fully explore the situation in selected areas.

These are just some of the ways through which further research efforts can be expanded. It seems to us that this research approach can yield valid information to policy makers and agents working in area development programs in terms of being able to understand the probable impacts of their actions as well as providing capability for monitoring local social change in its varied forms. Continuous analyses of the interactions between social structures and "policy" or "institutional" variables seem to be well worth pursuing--particularly in a country such as Brazil characterized by such regional and local disparities which, at the same time, experiences high levels of government intervention in the various sectors of the political economy. We have refrained from making "policy" suggestions on the basis of this study which because of its inherent exploratory nature as well as the fact that its broad scope would make such suggestions overly general. However, we believe that more specific and "applied" studies can be developed by using the general research strategy of this study.

APPENDIX A

DESCRIPTIVE STATISTICS FOR STATEWIDE AND REGIONAL DISTRIBUTIONS OF INDICATORS USED IN THE STUDY--1950, 1970, AND PERCENT CHANGE, 1950-1970

Table 55. Descriptive Statistics for Median Category Size of Farm Cropland, All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	3.6	3.6	0.67	2	6	0.24
	385	1970	3.0	2.9	0.62	1	5	0.38
	385	% Change	-15.8	-23.4	20.7	-66.6	66.6	0.86
S. Paulo Periphery I	103	1950	3.5	3.5	0.60	2	5	0.25
	103	1970	2.8	2.8	0.51	2	4	-0.24
	103	% Change	-19.3	-24.1	17.3	-60.0	50.0	0.47
S. Paulo Periphery II	33	1950	3.7	3.7	0.78	3	5	0.37
	33	1970	3.7	3.7	0.83	2	5	0.13
	33	% Change	2.1	-0.46	27.5	-40.0	66.6	0.66
Belo Horizonte Center	14	1950	3.3	3.5	0.74	2	4	-0.62
	14	1970	2.5	2.7	0.64	1	3	-1.1
	14	% Change	-22.0	-24.1	19.5	-50.0	0	-0.11
Belo Horizonte Periphery I	77	1950	3.5	3.4	0.66	2	5	0.29
	77	1970	2.0	2.8	0.56	1	4	-0.48
	77	% Change	-18.2	-24.1	21.7	-66.6	50.0	0.67
Belo Horizonte Periphery II	39	1950	3.7	3.7	0.60	3	5	0.20
	39	1970	3.1	3.0	0.59	2	4	-0.02
	39	% Change	-15.7	-23.2	15.7	-40.0	33.3	0.83
Rio de Janeiro Periphery I	62	1950	4.0	4.0	0.63	3	6	0.33
	62	1970	3.0	3.0	0.51	2	4	0.05
	62	% Change	-23.8	-24.8	14.2	-60.0	33.3	0.77
Rio de Janeiro Periphery II	27	1950	3.7	3.7	0.59	3	5	0.11
	27	1970	3.1	3.1	0.39	3	4	1.5
	27	% Change	12.8	-18.1	16.8	-40.0	33.3	0.50
Rural Periphery	30	1950	3.2	3.1	0.62	2	5	0.65
	30	1970	3.1	3.0	0.54	2	5	1.3
	30	% Change	-1.2	-0.44	22.6	-50.0	50.0	0.43

1/ No missing cases.
Categories: 1 = > 1 Ha.; 2 = 1 to 2 Ha.; 3 = 2 to 5 Ha.; 4 = 5 to 10 Ha.; 5 = 10 to 20 Ha.; 6 = 20 to 50 Ha.

Table 56. Descriptive Statistics for Percent of Farm Land used for Pastures, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	56.7	60.4	20.3	6.9	92.7	-0.34
	385	1970	69.4	72.4	13.7	19.9	92.8	-0.97
	385	% Change	45.2	16.0	106.4	-32.4	1074.6	6.5
S. Paulo Periphery I	103	1950	55.7	60.0	18.4	7.2	83.2	-0.89
	103	1970	72.4	73.5	7.4	42.4	83.6	-1.0
	103	% Change	68.7	21.6	158.7	-10.0	1015.8	4.2
S. Paulo Periphery II	33	1950	78.8	80.1	11.0	49.8	92.7	-0.59
	33	1970	81.9	84.6	10.2	59.9	92.8	-1.0
	33	% Change	4.7	2.3	11.9	-24.1	41.0	0.70
Belo Horizonte Center	14	1950	57.6	62.3	14.0	30.3	75.0	-0.78
	14	1970	59.0	67.5	15.9	31.2	75.5	-0.61
	14	% Change	3.3	3.0	20.0	-28.6	47.3	1.0
Belo Horizonte Periphery I	77	1950	65.3	68.5	15.2	6.9	89.4	-1.3
	77	1970	70.6	75.1	14.4	26.4	90.3	-1.3
	77	% Change	22.8	8.1	122.9	-32.4	1074.6	8.4
Belo Horizonte Periphery II	39	1950	56.1	58.9	22.6	16.5	92.2	-0.02
	39	1970	69.8	72.3	14.9	30.9	89.2	-1.1
	39	% Change	39.3	22.1	48.3	-12.7	203.9	1.6
Rio de Janeiro Periphery I	62	1950	48.0	43.0	18.0	14.5	78.7	0.24
	62	1970	64.0	62.7	10.1	45.8	78.8	-0.05
	62	% Change	48.2	44.1	49.5	-3.9	294.8	2.2
Rio de Janeiro Periphery II	27	1950	33.7	35.5	8.7	18.8	51.6	0.29
	27	1970	67.2	66.9	14.2	38.6	88.8	-0.12
	27	% Change	107.1	104.8	52.9	3.1	236.9	0.70
Rural Periphery	30	1950	48.2	41.5	20.9	9.3	81.7	-0.001
	30	1970	59.3	57.1	19.7	19.9	84.8	-0.34
	30	% Change	32.0	24.7	31.9	2.4	158.6	2.3

1/ No missing cases.

Table 57. Descriptive Statistics for Percent of Cropland Devoted to Coffee, Sugar Cane, Cotton and Rice (Commercial Concentration Index), All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Municipios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	35.8	34.6	18.1	2.9	83.5	0.32
	385	1970	32.2	28.7	18.8	0	80.4	0.51
	385	% Change	-8.9	-10.7	35.1	-100.0	173.2	0.89
S. Paulo Periphery I	103	1950	43.3	44.2	20.8	2.9	83.4	-0.34
	103	1970	37.8	40.0	19.4	0	80.4	-0.14
	103	% Change	-11.7	-10.7	31.3	-100.0	131.1	1.4
S. Paulo Periphery II	33	1950	48.4	49.7	17.1	16.1	76.9	-0.33
	33	1970	54.3	55.2	16.1	21.9	79.7	-0.50
	33	% Change	21.7	11.0	45.3	-36.9	173.2	1.4
Belo Horizonte Center	14	1950	17.7	17.6	8.2	7.1	30.6	-0.01
	14	1970	11.9	9.7	8.0	1.6	30.9	1.3
	14	% Change	-25.4	-39.5	43.1	-83.5	41.0	0.28
Belo Horizonte Periphery I	77	1950	27.5	24.5	15.0	3.7	65.0	0.75
	77	1970	24.7	20.1	15.4	0.29	71.9	1.0
	77	% Change	-8.6	-12.1	32.8	-92.3	123.7	0.64
Belo Horizonte Periphery II	39	1950	24.0	23.1	8.4	9.8	51.4	0.83
	39	1970	20.4	19.2	8.4	7.7	56.3	1.9
	39	% Change	-9.4	-13.4	34.7	-70.3	79.7	0.48
Rio de Janeiro Periphery I	62	1950	40.0	38.8	17.0	12.0	75.1	0.07
	62	1970	37.9	37.7	10.0	6.6	74.3	0.25
	62	% Change	-4.6	-7.4	28.6	-56.9	47.3	0.03
Rio de Janeiro Periphery II	27	1950	35.6	34.8	10.6	15.5	55.5	0.16
	27	1970	29.3	30.9	9.9	1.8	45.1	-0.62
	27	% Change	-14.5	-15.5	30.0	-89.9	43.8	-0.12
Rural Periphery	30	1950	33.7	35.0	10.2	10.2	54.5	-0.09
	30	1970	23.5	20.8	11.7	1.7	53.9	0.32
	30	% Change	-29.6	-29.1	31.4	-86.4	35.4	0.04

1/ No missing cases.

Table 58. Descriptive Statistics for Percent of Cropland with Coffee, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970, and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	358	1950	15.6	10.7	15.5	0.01	64.5	0.9
	367	1970	10.0	4.5	12.7	0	60.9	1.5
	345	% Change	25.7	-40.0	77.1	-99.8	728.5	4.3
S. Paulo Periphery I	100	1950	23.4	23.3	16.8	0.05	64.4	0.29
	101	1970	18.1	17.5	13.5	0.07	51.0	0.36
	99	% Change	0.1	-21.5	99.3	-85.1	778.5	5.2
S. Paulo Periphery II	29	1950	5.1	0.68	10.7	0.03	49.4	3.1
	23	1970	4.9	0.19	11.8	0.003	54.1	3.5
	23	% Change	-37.6	-78.2	84.5	-99.1	181.3	1.7
Belo Horizonte Center	10	1950	2.8	1.2	6.0	0.06	20.0	3.0
	10	1970	1.7	0.16	4.3	0.04	13.9	3.1
	8	% Change	-39.0	-36.5	48.1	-93.6	27.5	0.12
Belo Horizonte Periphery I	71	1950	10.7	6.5	12.1	0.03	54.0	1.5
	75	1970	5.6	1.4	9.7	0.03	51.7	2.8
	70	% Change	-42.2	-54.3	48.8	-95.4	200.0	2.1
Belo Horizonte Periphery II	33	1950	5.8	4.8	7.5	0.02	35.8	2.5
	39	1970	4.6	1.4	8.9	0.01	52.5	4.4
	33	% Change	-8.8	-22.4	63.6	-82.1	168.8	1.2
Rio de Janeiro Periphery I	59	1950	24.1	20.6	15.2	0.38	64.5	1.7
	60	1970	12.3	4.8	15.1	0.02	60.9	1.4
	59	% Change	-55.3	-64.1	38.9	-99.8	96.9	1.4
Rio de Janeiro Periphery II	27	1950	19.8	19.1	11.0	3.6	41.7	0.24
	26	1970	10.2	10.5	6.1	0.73	22.5	0.20
	26	% Change	-44.2	-56.9	34.7	-93.2	73.2	1.5
Rural Periphery	27	1950	3.9	1.4	5.5	0.01	20.5	1.7
	29	1970	1.9	0.31	3.0	0.01	13.6	2.3
	26	% Change	-0.3	-44.6	111.6	-96.1	327.2	1.6

1/ The number of municipios regions, varies because of missing cases.

Table 59. Descriptive Statistics for Percent of Cropland with Rice, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	16.3	11.8	13.8	0.34	70.1	1.7
	382	1970	17.3	12.4	15.3	0.09	72.9	1.6
	382	% Change	18.7	2.6	75.2	-91.1	389.0	1.8
S. Paulo Periphery I	103	1950	17.6	13.9	12.2	0.82	57.3	1.1
	102	1970	16.2	15.3	11.4	0.79	62.1	1.2
	102	% Change	-1.8	-7.0	43.1	-75.4	223.8	1.7
S. Paulo Periphery II	33	1950	44.0	49.2	19.1	1.2	70.1	-0.68
	33	1970	48.0	53.1	18.4	1.7	72.9	-1.2
	33	% Change	18.2	7.7	42.6	-52.1	121.9	1.7
Belo Horizonte Center	14	1950	11.9	13.2	8.3	1.5	27.9	0.57
	12	1970	4.4	3.8	4.9	0.92	19.2	2.6
	12	% Change	-60.3	-69.5	20.5	-84.3	-18.9	1.0
Belo Horizonte Periphery I	77	1950	12.8	11.6	7.4	0.34	36.9	0.93
	77	1970	13.2	11.0	8.7	0.16	35.4	0.78
	77	% Change	14.0	-2.1	67.3	-96.0	234.6	1.1
Belo Horizonte Periphery II	39	1950	11.1	9.4	6.1	2.6	25.3	1.9
	39	1970	10.1	9.5	4.9	2.7	22.4	0.58
	39	% Change	10.6	-3.0	78.7	-76.7	388.9	3.1
Rio de Janeiro Periphery I	62	1950	12.0	9.2	8.5	3.2	40.9	1.8
	62	1970	18.4	14.0	16.1	1.6	66.9	1.6
	62	% Change	13.0	52.1	98.9	-65.8	337.0	1.2
Rio de Janeiro Periphery I	27	1950	8.5	8.3	3.9	3.1	21.8	1.4
	27	1970	13.6	12.8	6.8	0.43	34.2	1.1
	27	% Change	76.6	57.8	85.6	-86.3	340.1	1.1
Rural Periphery	30	1950	15.2	9.2	13.3	1.1	45.6	1.2
	30	1970	10.5	7.7	9.1	0.09	33.1	1.1
	30	% Change	-15.9	-29.4	64.2	-98.1	173.1	1.3

1/ The number of municipios within regions, varies because of missing cases.

Table 60. Descriptive Statistics for Percent of Cropland with Sugar Cane, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	373	1950	3.5	2.4	4.1	0.01	35.1	3.1
	366	1970	4.3	2.1	7.1	0.01	47.8	3.7
	362	% Change	79.9	-2.9	414.4	-99.6	5004.0	7.5
S. Paulo Periphery I	96	1950	1.6	0.71	2.8	0.01	15.2	2.6
	90	1970	2.4	0.55	7.7	0.01	47.9	4.6
	88	% Change	52.2	-34.2	5.1	-98.6	2216.0	5.1
S. Paulo Periphery II	32	1950	1.1	0.83	1.2	0.13	7.1	3.8
	32	1970	1.8	0.20	4.6	0	23.8	3.8
	31	% Change	230.8	-71.1	970.8	-99.6	5004.0	4.4
Belo Horizonte Center	13	1950	2.7	2.5	1.9	0.30	5.7	0.21
	13	1970	2.8	1.9	3.3	0.14	11.6	1.8
	12	% Change	48.0	-49.5	249.4	-96.8	795.0	3.8
Belo Horizonte Periphery I	75	1950	3.8	2.6	3.7	0.19	18.1	1.9
	75	1970	4.6	2.9	6.8	0.04	45.6	4.2
	75	% Change	93.5	-2.3	397.2	-98.2	2214.4	4.5
Belo Horizonte Periphery II	39	1950	4.9	3.5	4.7	0.65	27.0	3.0
	39	1970	5.6	5.6	4.4	0.01	18.5	1.0
	39	% Change	37.0	6.7	131.3	-98.3	698.6	3.4
Rio de Janeiro Periphery I	61	1950	5.8	3.9	6.3	0.02	35.1	2.6
	60	1970	7.8	4.4	10.0	0.45	47.8	2.6
	60	% Change	109.6	23.5	439.2	-92.5	3295.4	6.7
Rio de Janeiro Periphery II	27	1950	3.5	3.6	1.8	0.64	7.2	0.39
	27	1970	4.3	3.8	2.8	0.98	13.2	1.5
	27	% Change	36.4	35.1	77.1	-68.3	300.3	1.6
Rural Periphery	30	1950	4.6	4.3	2.8	0.71	13.4	1.0
	30	1970	4.1	2.5	4.6	0.35	20.3	2.2
	30	% Change	19.1	-36.3	128.2	-89.8	456.4	1.8

1/ The number of municipios within regions, varies because of missing cases.

Table 61. Descriptive Statistics for Percent of Cropland with Beans, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	18.8	15.6	12.5	.28	59.8	1.0
	384	1970	15.7	13.3	11.4	0.07	70.2	1.5
	384	% Change	11.1	-19.3	161.6	-99.5	2741.1	12.8
S. Paulo Periphery I	103	1950	12.9	10.6	7.8	1.4	39.4	1.2
	103	1970	13.1	11.4	6.5	2.6	35.4	0.83
	103	% Change	23.2	-2.2	73.5	-70.4	359.6	1.7
S. Paulo Periphery II	33	1950	20.1	18.1	12.7	3.2	59.0	1.3
	33	1970	10.8	6.2	11.0	0.07	31.4	0.53
	33	% Change	-49.7	-70.7	64.1	-99.5	228.0	2.7
Belo Horizonte Center	13	1950	14.1	11.0	11.7	2.2	42.3	1.1
	13	1970	5.5	4.8	3.5	1.4	14.2	1.1
	13	% Change	-25.3	-66.3	100.9	-81.7	289.7	2.9
Belo Horizonte Periphery I	77	1950	17.7	12.4	13.7	0.28	58.9	1.3
	77	1970	13.7	10.9	10.2	2.8	59.6	1.8
	77	% Change	44.4	-25.0	327.6	-88.6	2741.0	7.5
Belo Horizonte Periphery II	39	1950	30.1	28.5	11.9	10.7	56.3	0.49
	39	1970	24.3	19.9	17.0	4.9	70.2	1.2
	39	% Change	-14.2	-36.0	57.5	-82.5	177.0	1.2
Rio de Janeiro Periphery I	12	1950	21.4	17.0	14.5	2.3	59.8	0.70
	12	1970	17.8	13.6	12.0	0.31	64.9	1.1
	12	% Change	8.18	-9.5	83.2	-95.5	364.7	1.8
Rio de Janeiro Periphery II	27	1950	21.7	19.4	9.6	8.8	42.4	0.81
	27	1970	16.7	18.1	8.9	0.12	37.1	-0.14
	27	% Change	-14.0	-23.3	54.4	-99.1	88.7	0.40
Rural Periphery	30	1950	21.1	18.2	9.7	4.6	44.7	0.51
	30	1970	23.4	18.9	12.0	9.5	54.2	1.2
	30	% Change	28.3	15.4	65.7	-62.8	194.9	0.60

1/ There is one missing case for the Belo Horizonte Center and the State distributions.

Table 62. Descriptive Statistics for Percent of Cropland with Corn, All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	41.4	40.9	17.1	4.1	88.7	1.2
	385	1970	44.6	43.8	16.5	4.8	90.5	0.10
	384	% Change	20.1	5.9	56.0	-76.1	387.0	2.2
S. Paulo Periphery I	103	1950	38.1	37.1	15.1	11.8	82.8	0.54
	103	1970	41.8	39.3	14.9	10.9	77.6	0.33
	103	% Change	19.6	8.7	48.8	-58.3	234.8	1.6
S. Paulo Periphery II	33	1950	33.7	30.2	13.6	12.8	66.7	0.88
	33	1970	34.9	34.3	10.7	16.6	59.6	0.19
	33	% Change	19.7	4.7	61.6	-63.5	194.4	1.2
Belo Horizonte Center	13	1950	42.6	41.5	14.7	20.7	76.1	0.59
	14	1970	32.1	30.7	14.3	8.6	74.0	1.8
	13	% Change	-20.0	-28.7	29.1	-76.1	27.4	-0.15
Belo Horizonte Periphery I	77	1950	53.6	53.1	16.0	21.8	88.6	0.07
	77	1970	52.2	50.1	15.3	16.9	90.5	0.14
	77	% Change	3.4	-2.3	42.0	-61.1	213.0	2.7
Belo Horizonte Periphery II	39	1950	49.6	51.1	14.4	13.2	77.4	-0.22
	39	1970	57.0	57.5	13.4	25.3	78.6	-0.14
	39	% Change	24.7	12.0	53.3	-21.3	271.8	2.9
Rio de Janeiro Periphery I	62	1950	43.1	41.9	15.6	13.2	80.6	0.32
	62	1970	46.0	45.4	15.5	20.5	81.5	0.08
	62	% Change	13.2	5.3	38.3	-46.9	134.6	1.3
Rio de Janeiro Periphery II	27	1950	31.8	33.0	12.9	4.3	50.0	-0.46
	27	1970	43.8	48.5	16.6	8.5	71.1	-0.52
	27	% Change	47.4	42.1	42.7	-27.2	125.6	0.27
Rural Periphery	30	1950	24.6	25.5	14.4	4.1	49.8	0.31
	30	1970	33.3	34.5	16.9	4.8	62.3	-0.08
	30	% Change	65.7	19.3	104.9	-63.3	387.9	1.3

1/ The number of municipios within regions, varies because of missing data.

Table 63. Descriptive Statistics for Level of Subsistence Production,*All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Municipios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	16.1	5.2	27.0	0	186.4	3.1
	385	1970	7.7	3.3	14.0	0	151.0	6.0
	337	% Change	254.0	-43.5	2121.6	-100.0	31865.1	12.5
S. Paulo Periphery I	103	1950	22.1	10.8	28.1	0	181.2	2.5
	103	1970	7.2	5.3	8.1	0	40.8	2.2
	98	% Change	13.4	-62.7	194.8	-100.0	980.9	2.8
S. Paulo Periphery II	33	1950	5.3	2.2	6.4	0	21.8	1.1
	33	1970	5.8	2.2	6.7	0	43.1	2.6
	25	% Change	1392.2	-60.7	6365.0	-100.0	31865.1	4.5
Belo Horizonte Center	14	1950	4.1	0.78	6.1	0	18.5	1.3
	14	1970	1.9	0.54	2.6	0	8.2	1.3
	10	% Change	7.0	-73.7	168.4	-100.0	451.0	1.9
Belo Horizonte Periphery I	77	1950	3.2	1.1	5.2	0	28.4	2.9
	77	1970	2.4	1.5	3.0	0	14.7	2.1
	61	% Change	174.3	-6.6	463.8	-100.0	1968.5	2.6
Belo Horizonte Periphery II	39	1950	10.5	6.0	11.8	0	51.1	1.7
	39	1970	5.7	3.8	5.0	0.64	20.1	1.2
	37	% Change	62.6	-33.9	252.6	-97.8	1181.6	2.9
Rio de Janeiro Periphery I	62	1950	8.0	2.3	12.2	0	62.8	2.2
	62	1970	8.0	5.4	11.2	0	75.2	3.7
	49	% Change	325.1	-11.7	1066.4	-100.0	4921.6	3.3
Rio de Janeiro Periphery II	27	1950	29.1	20.0	27.1	1.1	98.7	1.0
	27	1970	12.1	7.1	12.5	0.57	47.1	1.3
	29	% Change	36.9	-52.2	248.4	-97.2	894.4	2.4
Rural Periphery	30	1950	57.9	47.7	51.7	0.04	186.4	0.90
	30	1970	25.1	12.6	37.3	0.09	151.0	2.4
	30	% Change	651.1	-60.7	3797.0	-95.5	20752.8	5.1

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

* Farm residents production of corn, beans, and cassava as percent of total commercial production of these crops.

Table 64. Descriptive Statistics for the Average Productivity Index, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970, and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	0.31	0.14	0.77	-1.1	3.2	0.96
	385	1970	0.15	0.07	0.83	-1.5	3.6	0.89
	385	% Change	103.1	-25.0	1315.3	-5421.0	14080.0	6.1
S. Paulo Periphery I	103	1950	0.04	-0.05	0.58	-1.1	1.9	0.73
	103	1970	0.47	0.44	0.86	-1.4	3.4	0.72
	103	% Change	526.8	94.5	1871.0	-730.0	14080.0	5.7
S. Paulo Periphery II	33	1950	1.1	1.1	0.79	-0.16	3.2	0.58
	33	1970	0.55	0.57	0.60	-0.79	1.6	0.05
	33	% Change	-2.1	-54.7	190.6	-163.7	848.3	3.1
Belo Horizonte Center	14	1950	0.98	0.92	0.99	-0.33	3.2	0.91
	14	1970	-0.02	-0.10	0.64	-1.4	1.1	-0.01
	14	% Change	-565.2	-108.3	1433.5	-5414.2	116.9	-2.9
Belo Horizonte Periphery I	77	1950	0.18	0.13	0.53	-0.82	1.5	0.48
	77	1970	0.10	0.08	0.66	-1.3	2.8	1.1
	77	% Change	-55.1	-35.4	445.6	-2760.0	1400.0	-2.7
Belo Horizonte Periphery II	39	1950	0.44	0.15	0.76	-0.55	1.9	0.43
	39	1970	-0.13	-0.24	0.64	-1.2	1.6	0.66
	39	% Change	-283.0	-104.6	1053.3	-5421.0	978.6	-3.8
Rio de Janeiro Periphery I	62	1950	-0.04	-0.01	0.58	-1.1	1.5	0.30
	62	1970	0.05	-0.03	0.88	-1.5	3.0	1.0
	62	% Change	258.7	16.1	1622.4	-1345.4	10874.0	5.3
Rio de Janeiro Periphery II	27	1950	0.55	0.47	0.89	-1.1	3.2	0.84
	27	1970	-0.46	-0.49	0.48	-1.3	0.53	0.23
	27	% Change	-193.9	-148.5	579.7	-2195.3	1700.0	-0.30
Rural Periphery	30	1950	0.65	0.39	0.89	-0.73	3.0	0.73
	30	1970	0.01	-0.54	1.1	-1.4	3.6	1.2
	30	% Change	-69.9	-107.0	724.0	-2541.6	2235.0	-0.21

1/ No missing cases.

Table 65. Descriptive Statistics for Rice Yields (In Kg. per Ha.), All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Municipios 1/	Year	Statistics: Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	384	1950	894	829	318	325	2,192	1.1
	382	1970	760	714	281	255	2,000	0.8
	382	% Change	-8.2	-14.1	39.2	-77.2	195.6	1.2
S. Paulo Periphery I	103	1950	885	829	299	453	1,813	0.78
	102	1970	820	815	257	386	1,473	0.34
	102	% Change	-2.8	-4.6	29.1	-71.1	85.6	0.43
S. Paulo Periphery II	33	1950	1,296	1,314	378	538	1,977	0.14
	33	1970	859	836	167	580	1,198	0.25
	33	% Change	-28.1	-32.2	25.6	-66.3	42.6	1.2
Belo Horizonte Center	13	1950	1,076	1,070	305	585	1,759	0.57
	12	1970	610	595	186	370	956	0.57
	12	% Change	-39.1	-44.6	26.7	-77.2	9.6	0.57
Belo Horizonte Periphery I	77	1950	815	785	236	517	2,192	2.7
	77	1970	712	691	233	285	1,386	0.62
	77	% Change	-7.3	-10.2	36.7	-75.5	93.4	0.65
Belo Horizonte Periphery II	39	1950	771	716	219	408	1,275	0.53
	39	1970	575	543	194	255	1,123	0.63
	39	% Change	-20.1	-27.8	34.3	-75.1	94.9	1.2
Rio de Janeiro Periphery I	62	1950	858	743	297	511	1,727	1.0
	62	1970	824	728	377	275	1,935	0.80
	62	% Change	0.26	-7.0	42.5	-64.7	124.7	0.74
Rio de Janeiro Periphery II	27	1950	841	766	322	325	1,814	1.1
	27	1970	679	670	105	371	946	0.30
	27	% Change	-6.7	-19.6	44.3	-62.5	98.7	0.67
Rural Periphery	30	1950	888	803	306	435	1,829	1.3
	30	1970	807	673	379	355	2,000	1.1
	30	% Change	1.5	-18.4	65.6	-72.1	195.6	1.8

1/ The number of municipios within regions, varies because of missing cases.

Table 66. Descriptive Statistics for Sugar Cane Yields (In Kg. per Ha.), All Observations (State), and by Regional Location, Minas Gerais (Brazil), 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	373	1950	20,005	18,598	7,237	7,000	50,429	1.1
	366	1970	17,500	14,600	10,718	6,000	93,185	2.7
	362	% Change	-4.8	-19.6	61.9	-75.1	538.7	3.3
S. Paulo Periphery I	96	1950	20,704	18.658	8.926	7,000	48,753	0.95
	90	1970	21,402	18,030	14,377	6,000	93,185	2.2
	88	% Change	14.7	-7.2	87.5	-73.7	538.7	3.1
S. Paulo Periphery II	32	1950	19,546	20,123	4,995	10,429	28,379	-0.13
	32	1970	19,815	15,184	12,068	7,700	40,229	1.7
	31	% Change	12.9	-18.6	81.3	-62.8	307.5	1.9
Belo Horizonte Center	13	1950	24,644	27,250	7,221	9,500	35,740	-0.53
	13	1970	18,029	16,714	6,315	10,400	31,143	0.60
	12	% Change	-27.8	-31.9	37.6	-68.9	78.9	2.2
Belo Horizonte Periphery I	2	1950	19,937	18,443	5,320	12,296	39,992	1.4
	2	1970	16,658	14,098	9,304	6,000	60,675	2.4
	2	% Change	-14.0	-24.7	48.7	-72.9	244.9	2.9
Belo Horizonte Periphery II	39	1950	20,566	19,930	5,292	11,291	32,958	0.42
	39	1970	14,790	13,517	5,669	7,479	33,535	1.3
	39	% Change	-23.6	-30.9	33.9	-70.8	68.2	0.96
Rio de Janeiro Periphery I	61	1950	18,851	16,330	6,978	8,750	40,479	1.2
	60	1970	17,587	16,930	6,433	7,312	33,023	0.64
	60	% Change	1.7	-11.5	46.6	-72.6	169.6	1.3
Rio de Janeiro Periphery II	27	1950	19,227	14,805	9,509	10,812	50,429	1.9
	27	1970	12,747	12,052	4,233	7,255	29,022	2.1
	27	% Change	-24.5	-22.8	27.9	-75.0	15.2	-.3
Rural Periphery	30	1950	18,738	16,255	7,404	10,248	42,509	1.2
	30	1970	13,558	11,866	5,658	6,440	32,313	1.7
	30	% Change	-19.1	-34.8	40.5	-71.3	87.8	1.1

1/ The number of municipios within regions, varies because of missing cases.

Table 67. Descriptive Statistics for Hectares of Arable Land per Farm Worker, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location 1/	No. of Munici- pios	Year	Statistics Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	18.3	10.9	23.8	1.6	219.1	4.2
	385	1970	21.0	13.7	20.1	1.8	139.3	2.6
	385	% Change	45.3	29.4	77.5	-75.9	628.2	2.2
S. Paulo Periphery I	103	1950	12.9	10.5	7.6	3.6	43.1	1.6
	103	1970	14.2	11.9	7.4	5.2	45.7	2.1
	103	% Change	21.9	18.1	43.2	-48.7	206.1	1.1
S. Paulo Periphery II	33	1950	53.3	36.6	34.4	13.6	147.5	1.1
	33	1970	51.7	45.1	25.2	18.7	139.3	1.6
	33	% Change	29.4	14.8	79.3	-75.9	231.0	1.0
Belo Horizonte Center	14	1950	14.3	12.3	9.7	4.0	34.4	1.1
	14	1970	12.0	11.8	4.8	3.4	19.6	-0.11
	14	% Change	0.61	-5.1	45.1	-70.3	97.9	0.2
Belo Horizonte Periphery I	77	1950	13.0	11.2	8.1	2.3	58.6	2.8
	77	1970	17.3	14.2	11.5	4.8	65.1	2.0
	77	% Change	46.3	29.5	89.9	-63.9	628.3	3.9
Belo Horizonte Periphery II	39	1950	20.7	15.3	19.6	1.7	88.6	2.2
	39	1970	24.9	17.5	20.8	1.9	98.2	1.8
	39	% Change	39.8	34.8	60.5	-53.4	246.1	1.3
Rio de Janeiro Periphery I	62	1950	8.3	6.1	6.3	2.2	31.3	1.7
	62	1970	12.5	10.0	8.5	3.8	48.5	1.8
	62	% Change	69.6	49.9	72.7	-51.6	352.5	1.3
Rio de Janeiro Periphery II	27	1950	8.6	6.7	8.6	2.5	37.6	2.7
	27	1970	19.1	12.8	18.7	5.3	88.1	2.4
	27	% Change	132.9	117.4	103.7	-16.5	350.5	0.6
Rural Periphery	30	1950	40.1	16.1	52.8	3.2	219.1	2.1
	30	1970	38.7	25.8	35.1	2.7	129.7	1.0
	30	% Change	39.6	23.4	80.2	-63.5	316.7	1.4

1/ No missing cases.

Table 68. Descriptive Statistics for Total Population Size, All Observations (State) and by Regional Location Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	20013.8	15015.0	22241.8	2503	352724	9.3
	385	1970	29446.9	17471.0	67104.1	2030	123501	15.2
	385	% Change	32.5	14.8	101.9	-33.8	1748.8	12.8
S. Paulo Periphery I	103	1950	12825.4	10999.0	7091.6	2503	40465	1.1
	103	1970	15144.7	11999.0	11501.5	2030	59984	2.0
	103	% Change	12.5	7.0	28.3	-31.5	128.4	1.3
S. Paulo Periphery II	33	1950	17553.9	13475.0	15913.7	3594	69434	1.8
	33	1970	27743.6	16847.0	32726.4	3358	128080	2.0
	33	% Change	41.5	22.8	77.6	-33.8	353.3	2.0
Belo Horizonte Center	14	1950	36285.2	10885.5	91252.1	5276	352724	3.1
	14	1970	117565.5	25642.0	322763.1	5118	1235001	3.1
	14	% Change	225.6	81.7	446.3	-2.9	1748.8	3.0
Belo Horizonte Periphery I	77	1950	17208.1	13018.0	11798.9	3727	68285	1.7
	77	1970	24232.5	16537.0	22813.6	4104	121841	2.2
	77	% Change	32.4	14.1	62.8	-20.1	449.1	4.3
Belo Horizonte Periphery II	39	1950	26542.1	23432.0	14764.3	8361	71736	1.3
	39	1970	35505.7	30383.0	25650.8	9846	137409	2.1
	39	% Change	28.4	24.4	29.4	-17.0	139.1	1.5
Rio de Janeiro Periphery I	62	1950	21442.1	16050.0	17922.5	5535	126989	3.5
	62	1970	25314.3	15263.0	32740.5	5092	251262	5.4
	62	% Change	7.4	1.4	20.3	-20.6	97.8	1.5
Rio de Janeiro Periphery II	27	1950	32611.4	30602.0	19587.9	10953	87316	1.1
	27	1970	46556.5	33037.0	40416.5	8355	175413	1.8
	27	% Change	34.0	22.2	58.9	-33.8	274.1	2.3
Rural Periphery	30	1950	24231.7	21965.0	11149.9	8955	63696	1.7
	30	1970	38221.6	32021.0	18822.5	9921	86940	0.82
	30	% Change	57.5	52.4	42.4	-1.5	161.6	0.70

1/ No missing cases.

Table 69. Descriptive Statistics for Rural Population per Ha. of Arable Land, All Observations (State), and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location	No. of Munici-pios 1/	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	0.30	0.25	0.32	0.01	5.4	10.7
	385	1970	0.21	0.18	0.20	0.02	2.8	6.2
	385	% Change	-22.1	-30.4	35.2	-81.5	275.3	4.2
S. Paulo Periphery I	103	1950	0.26	0.26	0.10	0.07	0.55	0.35
	103	1970	0.18	0.18	0.07	0.05	0.39	0.69
	103	% Change	-26.6	-28.6	15.5	-58.3	34.8	1.0
S. Paulo Periphery II	33	1950	0.07	0.06	0.04	0.02	0.18	0.96
	33	1970	0.05	0.04	0.01	0.02	0.09	0.42
	33	% Change	-9.3	-27.7	60.6	-55.1	256.5	2.9
Belo Horizonte Center	14	1950	0.76	0.34	1.3	0.13	5.4	3.0
	14	1970	0.72	0.37	0.74	0.12	2.8	1.6
	14	% Change	30.6	-7.0	89.9	-47.3	275.3	1.5
Belo Horizonte Periphery I	77	1950	0.29	0.25	0.16	0.06	0.91	1.2
	77	1970	0.20	0.17	0.11	0.03	0.76	1.7
	77	% Change	-30.1	-33.7	19.6	-81.5	49.6	1.0
Belo Horizonte Periphery II	39	1950	0.26	0.18	0.24	0.04	1.1	2.2
	39	1970	0.18	0.14	0.17	0.03	0.80	2.2
	39	% Change	-23.8	-32.8	21.2	-50.8	16.2	0.55
Rio de Janeiro Periphery I	62	1950	0.43	0.40	0.18	0.08	0.86	0.42
	62	1970	0.28	0.26	0.12	0.06	0.68	0.66
	62	% Change	-33.1	-36.8	14.9	-53.8	24.9	1.3
Rio de Janeiro Periphery II	27	1950	0.38	0.35	0.18	0.10	0.80	0.75
	27	1970	0.24	0.23	0.10	0.07	0.46	0.29
	27	% Change	-32.9	-33.3	19.2	-65.2	11.2	0.45
Rural Periphery	30	1950	0.16	0.14	0.11	0.01	0.46	1.0
	30	1970	0.16	0.12	0.12	0.02	0.53	1.3
	30	% Change	10.4	-4.3	47.8	-40.0	175.0	1.6

1/ No missing cases.

Table 7o. Descriptive Statistics for Percent of Homes with Electricity, All Observations (State) and by Regional Location, Minas Gerais (Brazil) Municipios, 1950, 1970 and Percent Change 1950-1970.

Regional Location 1/	No. of Munici- pios	Year	Statistics					
			Mean	Median	S.D.	Minimum	Maximum	Skwns.
State	385	1950	16.1	12.4	14.3	0	82.4	1.5
	385	1970	31.7	30.0	18.9	0.45	89.0	0.64
	383	% Change	385.5	123.1	1533.1	-26.6	21417.3	9.8
S. Paulo Periphery I	103	1950	22.3	18.2	13.2	1.5	68.4	1.2
	103	1970	40.3	36.4	15.2	17.5	83.3	0.99
	103	% Change	121.6	94.0	175.4	-26.6	1736.8	7.2
S. Paulo Periphery II	33	1950	13.9	10.0	14.0	0.22	54.6	1.6
	33	1970	31.1	31.0	18.3	3.5	73.2	0.90
	33	% Change	654.3	143.1	1410.2	25.1	6798.7	3.0
Belo Horizonte Center	14	1950	37.2	29.4	23.5	6.7	82.4	0.63
	14	1970	57.9	54.1	19.0	23.5	89.0	0.24
	14	% Change	118.6	65.9	182.2	-10.7	704.3	2.5
Belo Horizonte Periphery I	77	1950	17.5	14.2	12.9	0.50	60.0	1.4
	77	1970	35.8	32.3	16.2	7.0	70.9	0.54
	77	% Change	170.8	132.2	194.5	18.1	1284.7	4.5
Belo Horizonte Periphery II	39	1950	5.7	4.1	5.5	0	22.3	1.6
	39	1970	14.2	12.0	9.1	0.45	36.7	0.86
	38	% Change	330.5	176.8	519.9	-7.8	2876.5	3.8
Rio de Janeiro Periphery I	62	1950	18.6	16.7	11.6	4.8	67.7	1.8
	62	1970	36.1	35.7	16.3	7.5	85.4	0.70
	62	% Change	111.6	100.1	57.9	-21.6	292.1	0.93
Rio de Janeiro Periphery II	27	1950	4.6	3.2	4.2	0.10	15.8	1.2
	27	1970	15.3	12.7	9.6	2.7	44.1	1.3
	27	% Change	758.8	273.6	1276.6	36.4	5004.8	2.2
Rural Periphery	30	1950	2.3	1.2	2.7	0	10.3	1.5
	30	1970	8.5	7.1	6.0	1.0	29.2	1.6
	29	% Change	202.5	265.0	4908.3	25.7	21417.3	2.8

1/ The number of municipios within regions, varies because of missing cases in the percent change distributions.

APPENDIX B

CORRELATION MATRIX FOR ALL INDICATORS SELECTED FOR THE STUDY--1950, 1970, AND RESIDUALIZED CHANGE SCORES

Table 71. Correlation Matrix for all Indicators Selected for the Study—1950, 1970, and Residualized Change Scores

	VARIABLE	V8	V202	V12	V196	V30	V36	V38	V42	V44	V46	V48
V8	CR$ MOD INPUT/FARM	1000										
V202	CR$ MOD INPUT/HA CROPLAND	887**	1000									
V12	% FARMS WITH TRACTORS	695**	495**	1000								
V196	TRACTORS/1000 HA CROPLAND	677**	637**	898**	1000							
V30	AVERAGE FARM SIZE	-030	-279**	241**	072	1000						
V36	% FARMS LESS THAN 2 HA	289**	462**	093*	246**	-597**	1000					
V38	% FARMS MORE THAN 2000 HA	016	-242**	282**	097*	953**	-565**	1000				
V42	MED CAT SIZE FARM CROPLAND	106*	-250**	231**	-044	518**	-492**	528**	1000			
V44	% OWNERS	117*	081	032	042	-107*	100*	-092*	107*	1000		
V46	% TENANTS	335**	314**	269**	282**	-153**	205**	-131**	-009	-081	1000	
V48	% SQUATTERS	-220**	-137**	-172**	-132**	081	-055	069	-152**	-491**	-111*	1000
V53	% ADMINISTRATORS	251**	130**	372**	325**	416**	-036	449**	136**	-108*	-052	-023
V113	SUBSISTENCE PRODUCTION	-167**	-202**	-085*	-121**	167**	-105*	171**	077	-151**	-120**	099*
V121	% SHARE CROPPERS	113*	029	073	005	-059	006	-057	102*	128**	277**	-205**
V122	% RURAL FAMILY LABOR	-498**	-235**	-507**	-357**	-274**	011	-322**	-354**	-091*	-197**	202**
V125	% RURAL PERMANENT WORKERS	509**	348**	570**	517**	307**	037	390**	232**	-023	152**	-192**
V126	% RURAL TEMPORARY WORKERS	064*	-026	119**	059	225**	-080	231**	148**	017	-026	107*
V138	HA ARABLE LAND/WORKER	037	-125**	274**	172**	884**	-485**	849**	403**	-102*	002	005
V139	AVERAGE RURAL WAGES	523**	481**	437**	479**	091*	130**	128**	090*	058	263**	-219**
V141	TOTAL POPULATION SIZE	-143**	-190**	-044	-031	157**	-106*	155**	-010	-092*	-123**	238**
V151	RURAL LITERACY RATE	462**	484**	317**	363**	-125**	236**	-107*	-068	214**	347**	-271**
V152	URBAN LITERACY RATE	301**	360**	173**	226**	-181**	217**	-161**	-143**	158**	347**	-086*
V160	RURAL POPULATION DENSITY	-053	092*	-221**	-139**	-779**	477**	-732**	-365**	037	-032	016
V163	% HOUSES WITH ELECTRICITY	601**	647**	443**	531**	-264**	413**	-203**	-147**	153**	384**	-274**
V171	AVERAGE URBAN WAGES	191**	208**	143**	203**	007	142**	021	-075	151**	056	-118**
V190	% URBAN POPULATION	564**	498**	482**	537**	066	221**	127**	-056	010	168**	-122**
V191	INEQUALITY OF FARM SIZE	083	069	115*	170**	142**	193**	128**	-168**	006	-055	179**
V193	RURAL NET MIGRATION	071	126**	005	040	-170**	173**	-115*	-055	062	044	-202**
V200	% INDUSTRIAL LABOR FORCE	414**	443**	407**	500**	-029	278**	015	-134**	082	193**	-133**
V203	% CROPLAND	275**	196**	084*	019	-748**	424**	-672**	-013	192**	228**	-238**
V204	% PASTURELAND	191**	178**	278**	299**	286**	-088*	342**	117*	-007	173**	-206**
V206	AVERAGE PRODUCTIVITY INDEX	-007	-079	041	-005	093*	-041	114*	082	-122**	025	-012
V207	CROP SPECIALIZATION	161**	033	097*	-013	082	-170**	063	219**	027	024	-119**
V208	COMMERCIAL CROP CONCENTRATION	226**	044	221**	091*	013	-094*	039	341**	162**	066	-196**
V75	COFFEE YIELD	339**	344**	251**	277**	-168**	163**	-133**	-071	041	067	-071
V76	% COFFEE CROPLAND	158**	187**	-022	-034	-400**	221**	-316**	-035	055	116*	-187**
V87	RICE YIELD	250**	263**	220**	268**	-029	067	-094*	-054	-112*	110*	-032
V88	% RICE CROPLAND	106*	-030	192**	106*	094*	-139**	082	276**	232**	192**	-279**
V95	SUGAR CANE YIELD	127**	096*	090*	103*	-034	029	-035	-009	-067	-006	060
V96	% SUGAR CANE CROPLAND	-309**	-265**	-312**	-290**	-162**	049	-173**	-098*	015	-193**	035
V99	BEANS YIELD	-021	-012	011	022	122**	-079	091*	-041	-109*	-173**	114*
V100	% BEANS CROPLAND	-331**	-155**	-428**	-294**	-187**	-018	-225**	-275**	010	-181**	005
V107	CORN YIELD	511**	484**	389**	416**	-079	139**	-097*	-041	072	214**	-111*
V108	% CORN CROPLAND	-156**	-054	-207**	-144**	-186**	029	-210**	-152**	307**	182**	-176**

Table 71 (continued).

	VARIABLE	V8	V202	V12	V196	V30	V36	V38	V42	V44	V46	V48
X8	CR$ MOD INPUT/FARM	606**	598**	479**	507**	-237**	383**	-181**	-163*	080*	260**	-188**
X202	CR$ MOD INPUT/HA CROPLAND	290**	350**	246**	287**	-049	191**	-021	-139**	-063	-011	009
X12	% FARMS WITH TRACTORS	076	045	110*	053	055	032	061	037	-063	093*	-040
X196	TRACTORS/1000 HA CROPLAND	-005	049	-001	022	019	052	006	-073	-066	024	051
X30	AVERAGE FARM SIZE	019	-183**	242**	119**	876**	-454**	822**	396**	-089*	-057	098*
X36	% FARMS LESS THAN 2 HA	137**	207**	002	061	-258**	299**	-248**	-245**	103*	071	-051
X38	% FARMS MORE THAN 2000 HA	073	-124**	257**	131**	807**	-412**	830**	390**	-079	-031	037
X42	MED CAT SIZE FARM CROPLAND	063	-104*	122**	005	055	-030	077	298**	059	140**	-206**
X44	% OWNERS	-125**	-073	-218**	-170**	-178**	-033	-195**	-025	163**	-226**	-061
X46	% TENANTS	356**	368**	309**	333**	-005	211**	041	-088*	071	431**	-142**
X48	% SQUATTERS	-084*	-065	-079	-095*	129**	-063	130**	-024	-136**	-017	171**
X53	% ADMINISTRATORS	180**	075	267**	202**	191**	-033	208**	142**	-112*	051	-067
X113	SUBSISTENCE PRODUCTION	-020	-083	073	041	201**	-149**	198**	099*	-227**	-114*	115*
X121	% SHARE CROPPERS	074	014	-022	-071	-117*	050	-108*	097*	145**	275**	-264**
X122	% RURAL FAMILY LABOR	-345**	-168**	-301**	-212**	-059	-094*	-117*	-239**	-169**	-244**	255**
X125	% RURAL PERMANENT WORKERS	535**	469**	510**	509**	-008	219**	042	042	-003	224**	-223**
X126	% RURAL TEMPORARY WORKERS	-102*	-092*	-079	-053	239**	-119**	271**	022	020	-090*	216**
X138	HA ARABLE LAND/WORKER	106*	010	262**	216**	741**	-361**	697**	242**	-105*	013	111*
X139	AVERAGE RURAL WAGES	600**	535**	526**	519**	-035	257**	-016	057	042	357**	-291**
X141	TOTAL POPULATION SIZE	-217**	-261**	-142**	-148**	088*	-130**	100*	-008	-082	-083	180**
X151	RURAL LITERACY RATE	564**	601**	339**	402**	-197**	342**	-161**	-111*	203**	386**	-292**
X152	URBAN LITERACY RATE	430**	493**	224**	300**	-295**	391**	-272**	-198**	262**	365**	-255**
X160	RURAL POPULATION DENSITY	-065	086*	-259**	-182**	-800**	454**	-745**	-334**	083	008	-082
X163	% HOUSES WITH ELECTRICITY	526**	586**	353**	438**	-338**	402**	-283**	-205**	175**	342**	-251**
X171	AVERAGE URBAN WAGES	231**	178**	239**	224**	-038	085*	-010	041	104*	124**	-117*
X190	% URBAN POPULATION	444**	501**	393**	464**	-054	304**	006	-188**	017	163**	-064
X191	INEQUALITY OF FARM SIZE	203**	144**	219**	235**	302**	011	285**	-016	066	-040	057
X193	RURAL NET MIGRATION	071	126**	005	040	-170**	173**	-115*	-055	062	044	-202**
X200	% INDUSTRIAL LABOR FORCE	439**	520**	376**	488**	-146**	353**	-094*	-212**	078	226**	-142**
X203	% CROPLAND	143**	169**	-038	-017	-751**	425**	-672**	-144**	130**	190**	-278**
X204	% PASTURELAND	277**	259**	277**	303**	287**	-045	329**	088*	-011	128**	-049
X206	AVERAGE PRODUCTIVITY INDEX	026	-004	062	036	105*	-025	092*	046	-016	-019	-002
X207	CROP SPECIALIZATION	216**	029	242**	073	097*	-104*	103*	276**	085*	046	-150**
X208	COMMERCIAL CROP CONCENTRATION	237**	051	305**	180**	090*	-139**	117*	325**	016	-015	-174**
X75	COFFEE YIELD	-022	-011	-043	-057	-067	027	-075	026	094*	-048	113*
X76	% COFFEE CROPLAND	190**	201**	038	033	-386**	229**	-320**	-008	023	159**	-263**
X87	RICE YIELD	197**	129**	253**	208**	123**	-058	078	084*	-004	063	-026
X86	% RICE CROPLAND	221**	078	331**	257**	217**	-132**	208**	223**	048	090*	-117*
X95	SUGAR CANE YIELD	074	-010	074	051	096*	-040	102*	129**	039	-141**	005
X96	% SUGAR CANE CROPLAND	-339**	-353**	-253**	-246**	-005	-064	-030	-017	030	-222**	051
X99	BEANS YIELD	-250**	-238**	-124**	-154**	113*	-123**	089*	-041	-163**	-155**	197**
X100	% BEANS CROPLAND	-277**	-303**	-233**	-261**	063	-127**	-013	048	018	-094*	036
X107	CORN YIELD	158**	120**	144**	152**	191**	-058	175**	054	153**	068	-027
X108	% CORN CROPLAND	-046	037	-132**	-035	-215**	182**	-242**	-132**	287**	198**	-106*

Table 71 (continued).

	VARIABLE	V8	V202	V12	V196	V30	V36	V38	V42	V44	V46	V48
R8	CR$ MOD INPUT/FARM	-092*	-100*	-047	-081	-003	-008	018	-060	-042	-021	-005
R202	CR$ MOD INPUT/HA CROPLAND	-120**	-164**	-048	-103*	082	-119**	092*	068	-080	-040	063
R12	% FARMS WITH TRACTORS	-109*	-154**	-129**	-179**	111*	-051	117*	062	-026	-003	002
R196	TRACTORS/1000 HA CROPLAND	-106*	-097*	-153**	-164**	-077	105*	-051	-067	-006	-087*	026
R30	AVERAGE FARM SIZE	009	126**	-062	020	-182**	151**	-241**	-178**	005	038	000
R36	% FARMS LESS THAN 2 HA	-097*	-074	-017	004	086*	-066	079	-130**	-075	001	085*
R38	% FARMS MORE THAN 2000 HA	045	055	067	110*	076	088*	035	019	-021	132**	-035
R42	MED CAT SIZE FARM CROPLAND	049	-062	113*	002	-033	068	-033	124**	001	156**	-004
R44	% OWNERS	-025	-058	083	044	102*	-064	084*	086*	-152**	-024	047
R46	% TENANTS	-056	-043	-026	-042	-075	017	-079	-017	-032	-089*	-062
R48	% SQUATTERS	-143**	-182**	-054	-099*	092*	-172**	083	040	-186**	-100*	-190**
R53	% ADMINISTRATORS	-075	-036	-090*	-064	-031	-031	-049	-069	-083	009	040
R113	SUBSISTENCE PRODUCTION	123**	086*	144**	107*	070	017	058	013	-003	-021	-071
R121	% SHARE CROPPERS	045	042	-004	-038	-035	027	-032	066	-057	013	-022
R122	% RURAL FAMILY LABOR	-081	-112*	024	019	088*	-006	068	040	000	009	-030
R125	% RURAL PERMANENT WORKERS	-022	043	-078	-006	-099*	151**	-125**	-141**	035	-034	-014
R126	% RURAL TEMPORARY WORKERS	-022	-025	-004	-003	006	-023	-019	061	-026	028	-026
R138	HA ARABLE LAND/WORKER	-052	044	-136**	-072	-092*	042	-141**	-159**	003	043	019
R139	AVERAGE RURAL WAGES	-064	-070	-111*	-110*	-113*	000	-123**	030	-017	-021	-006
R141	TOTAL POPULATION SIZE	-113*	-146**	-080	-095*	086*	-054	087*	010	-078	-066	141**
R151	RURAL LITERACY RATE	-092*	-050	-085*	-073	-048	017	-055	-079	-088*	-118**	118**
R152	URBAN LITERACY RATE	-156**	-206**	-144**	-194**	057	-123**	032	113*	-051	-090*	-009
R160	RURAL POPULATION DENSITY	-003	-015	011	-002	176**	-174**	173**	084*	098*	018	-058
R163	% HOUSES WITH ELECTRICITY	-170**	-171**	-079	-098*	071	-040	051	-034	-067	-154**	161**
R171	AVERAGE URBAN WAGES	013	-006	-006	-007	-011	006	003	029	004	-112*	044
R190	% URBAN POPULATION	-112*	-074	-090*	-075	-100*	062	-111*	-089*	067	-103*	119**
R191	INEQUALITY OF FARM SIZE	-015	-024	010	-004	078	-064	090*	069	-014	061	-009
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	-081	-041	-116*	-101*	-076	002	-080	-022	005	-107*	026
R203	% CROPLAND	-102*	-094*	-039	-054	102*	-069	047	-025	-079	-012	051
R204	% PASTURELAND	-089*	-112*	-055	-088*	008	-031	-000	029	084*	-073	-010
R206	AVERAGE PRODUCTIVITY INDEX	-049	-095*	-029	-048	052	-029	037	041	-093*	-026	-035
R207	CROP SPECIALIZATION	-060	-052	109*	066	167**	-074	154**	065*	-036	030	002
R208	COMMERCIAL CROP CONCENTRATION	056	021	077	060	076	-026	077	006	-044	-012	-013
R75	COFFEE YIELD	054	009	119**	088*	052	-012	090*	053	-097*	-004	041
R76	% COFFEE CROPLAND	122**	146**	-026	-015	-317**	141**	-263**	-011	020	115*	-235**
R87	RICE YIELD	-022	-019	-058	-045	004	-010	-024	-024	-055	-022	-063
R88	% RICE CROPLAND	118**	120**	127**	156**	082	-023	074	-033	-023	-045	046
R95	SUGAR CANE YIELD	008	-048	078	055	093*	-050	089*	035	000	052	-075
R96	% SUGAR CANE CROPLAND	067	-003	106*	064	139**	-145**	139**	158**	-017	003	-017
R99	BEANS YIELD	019	024	-032	-033	099*	-065	081	055	-034	-022	039
R100	% BEANS CROPLAND	-006	-023	042	020	065	-004	052	-033	-082	064	028
R107	CORN YIELD	063	024	072	027	080	-066	095*	114*	050	-030	-030
R108	% CORN CROPLAND	-045	-039	-031	-036	020	004	009	-052	-028	-055	-003

Table 71 (continued).

	VARIABLE	V53	V113	V121	V122	V125	V126	V138	V139	V141	V151	V152
V8	CR$ MOD INPUT/FARM											
V202	CR$ MOD INPUT/HA CROPLAND											
V12	% FARMS WITH TRACTORS											
V196	TRACTORS/1000 HA CROPLAND											
V30	AVERAGE FARM SIZE											
V36	% FARMS LESS THAN 2 HA											
V38	% FARMS MORE THAN 2000 HA											
V42	MED CAT SIZE FARM CROPLAND											
V44	% OWNERS											
V46	% TENANTS											
V48	% SQUATTERS											
V53	% ADMINISTRATORS	1000										
V113	SUBSISTENCE PRODUCTION	071	1000									
V121	% SHARE CROPPERS	-001	-216**	1000								
V122	% RURAL FAMILY LABOR	-323**	013	-251**	1000							
V125	% RURAL PERMANENT WORKERS	508**	170**	-079	-536**	1000						
V126	% RURAL TEMPORARY WORKERS	084*	-024	-137**	-423**	032	1000					
V138	HA ARABLE LAND/WORKER	362**	138**	003	-167**	364**	091*	1000				
V139	AVERAGE RURAL WAGES	267**	-045	030	-076	532**	-411**	307**	1000			
V141	TOTAL POPULATION SIZE	182**	112*	-100*	-007	082	119**	-015	-136**	1000		
V151	RURAL LITERACY RATE	096*	-265**	338**	-110*	098*	-088*	044	333**	-254**	1000	
V152	URBAN LITERACY RATE	-039	-140**	181**	-029	028	-051	-078	186**	-036	610**	1000
V160	RURAL POPULATION DENSITY	-219**	-096*	-004	096*	-210**	-104*	-859**	-174**	124**	-109*	041
V163	% HOUSES WITH ELECTRICITY	172**	-172**	123**	-234**	420**	-079	-083	447**	-028	523**	393**
V171	AVERAGE URBAN WAGES	169**	-122**	023	-068	231**	-042	069	252**	223**	183**	136**
V190	% URBAN POPULATION	354**	-099*	028	-254**	489**	042	187**	456**	178**	370**	213**
V191	INEQUALITY OF FARM SIZE	194**	022	-234**	-071	151**	232**	021	-003	280**	-093*	-014
V193	RURAL NET MIGRATION	006	-046	070	-018	077	-066	-076	031	-075	103*	062
V200	% INDUSTRIAL LABOR FORCE	349**	-141**	-000	-223**	460**	032	092*	420**	231**	331**	270**
V203	% CROPLAND	-266**	-145**	208**	-133**	-063	-083	-749**	-000	-114*	142**	133**
V204	% PASTURELAND	202**	006	216**	-097*	263**	-056	522**	295**	-219**	288**	068
V206	AVERAGE PRODUCTIVITY INDEX	109*	060	-074	-125**	126**	065	049	001	049	-144**	-063
V207	CROP SPECIALIZATION	-001	000	213**	-147**	002	-039	065	004	-065	125**	069
V208	COMMERCIAL CROP CONCENTRATION	-036	022	137**	-209**	162**	-042	018	119**	-074	124**	038
V75	COFFEE YIELD	-107*	036	-086*	-126**	223**	-049	-103*	224**	-213**	092*	062
V76	% COFFEE CROPLAND	-082	139**	104*	-027	185**	-256**	-331**	149**	-134**	010	037
V87	RICE YIELD	-024	-102*	142**	-122**	034	-052	031	161**	-108*	144**	035
V88	% RICE CROPLAND	-061	-177**	333**	-130**	-031	-011	183**	070	-146**	274**	123**
V95	SUGAR CANE YIELD	071	-077	001	-040	-010	018	-051	030	141**	130*	100*
V96	% SUGAR CANE CROPLAND	-046	-067	-008	068	-204**	042	-294**	-303**	225**	-241**	-144**
V99	BEANS YIELD	079	014	-230**	005	037	052	042	-314	174**	-175**	-135**
V100	% BEANS CROPLAND	-127**	049	005	265**	-222**	-142**	-181**	-200**	077	-192**	-101*
V107	CORN YIELD	035	-290**	211**	-225**	062	010	-009	247**	-127**	412**	284**
V108	% CORN CROPLAND	-249**	-254**	273**	129**	-404**	-030	-153**	-176**	-059	178**	190**

Table 71 (continued)

	VARIABLE	V53	V113	V121	V122	V125	V126	V138	V139	V141	V151	V152
X6	CR$ MOD INPUT/FARM	162**	-118**	059	-315**	429**	-042	-165**	404**	-022	292**	215**
X202	CR$ MOD INPUT/HA CROPLAND	152**	009	-095*	-166**	309**	-032	010	227**	-001	086*	013
X12	% FARMS WITH TRACTORS	-019	-071	-032	-186**	103*	085*	082	013	-232**	018	-012
X196	TRACTORS/1000 HA CROPLAND	-069	-100*	-085*	-030	005	096*	049	-037	-187**	011	-010
X30	AVERAGE FARM SIZE	365**	140**	-001	-250**	273**	215**	827**	126**	114*	003	-050
X36	% FARMS LESS THAN 2 HA	-013	-132**	-012	-002	-019	-035	-246**	-005	-043	076	020
X38	% FARMS MORE THAN 2000 HA	381**	112*	023	-301**	346**	206**	796**	186**	070	062	-013
X42	MED CAT SIZE FARM CROPLAND	080	044	289**	-256**	153**	-057	069	139**	-065	113*	052
X44	% OWNERS	-245**	-080	034	214**	-288**	-031	-163**	-132**	-176**	024	032
X46	% TENANTS	038	-132**	094*	-211**	269**	034	132**	285**	-103*	307**	211**
X48	% SQUATTERS	-021	098*	-197**	078	-039	083	098*	-071	062	-167**	-164**
X53	% ADMINISTRATORS	441**	096*	155**	-308**	434**	-047	182**	191**	111*	042	-013
X113	SUBSISTENCE PRODUCTION	125**	347**	-216**	-060	270**	-043	165**	147**	099*	-290**	-198**
X121	% SHARE CROPPERS	-015	-192**	616**	-098*	-142**	-059	-055	-003	-100*	300**	144**
X122	% RURAL FAMILY LABOR	-200**	080	-257**	520**	-382**	-105*	-051	-215**	-006	-211**	-137**
X125	% RURAL PERMANENT WORKERS	316**	110*	-009	-431**	726**	-015	093*	481**	-080	234**	166**
X126	% RURAL TEMPORARY WORKERS	-031	-035	-162**	038	-038	261**	194**	-065	145**	-115*	-069
X138	HA ARABLE LAND/WORKER	272**	085*	-026	-118**	226**	137**	811**	198**	-035	156**	039
X139	AVERAGE RURAL WAGES	272**	-030	158**	-376**	497**	-102*	099*	508**	-193**	468**	237**
X141	TOTAL POPULATION SIZE	115*	131**	-031	048	-038	071	-057	-181**	918**	-277**	-045
X151	RURAL LITERACY RATE	132**	-359**	341**	-204**	191**	-061	-023	372**	-245**	773**	451**
X152	URBAN LITERACY RATE	-003	-230**	210**	-147**	131**	-095*	-181**	288**	-059	513**	445**
X160	RURAL POPULATION DENSITY	-237**	-112*	015	146**	-209**	-161**	-839**	-135**	029	-072	044
X163	% HOUSES WITH ELECTRICITY	076	-188**	132**	-177**	315**	-071	-193**	364**	-032	453**	394**
X171	AVERAGE URBAN WAGES	131**	003	-003	-120**	242**	-050	-016	185**	053	147**	101*
X190	% URBAN POPULATION	276**	-130**	-043	-197**	413**	047	064	376**	127**	316**	212**
X191	INEQUALITY OF FARM SIZE	239**	012	-142**	-190**	233**	238**	256**	118**	137**	016	-003
X193	RURAL NET MIGRATION	006	-046	070	-018	077	-066	-076	031	-075	103*	062
X200	% INDUSTRIAL LABOR FORCE	246**	-168**	-011	-146**	370**	-051	-022	409**	079	406**	343**
X203	% CROPLAND	-212**	-076	169**	-052	-024	-172**	-710**	010	-117*	077	085*
X204	% PASTURELAND	204**	-066	064*	-142**	247**	113*	420**	230**	-157**	266**	148**
X206	AVERAGE PRODUCTIVITY INDEX	046	013	-034	-053	095*	025	093*	003	071	014	055
X207	CROP SPECIALIZATION	066	-012	230**	-218**	047	-042	048	042	-037	117*	036
X208	COMMERCIAL CROP CONCENTRATION	102*	103*	066	-238**	303**	-095*	086*	188**	-048	030	-037
X75	COFFEE YIELD	-041	-167**	-000	-011	-086*	030	-113*	-071	-009	-021	-045
X76	% COFFEE CROPLAND	-025	129**	197**	-088*	217**	-284**	-309**	179**	-131**	049	028
X87	RICE YIELD	079	-145**	070	-116*	077	039	129**	049	-005	112*	010
X88	% RICE CROPLAND	081	-160**	192**	-157**	094*	030	302**	167**	-103*	226**	053
X95	SUGAR CANE YIELD	110*	-071	086*	-103*	024	050	019	-050	145**	-018	-062
X96	% SUGAR CANE CROPLAND	-025	-102*	051	079	-202**	076	-136**	-301**	171**	-174**	-082
X99	BEANS YIELD	075	037	-115*	140**	-085*	-088*	-003	-155**	217**	-271**	-183**
X100	% BEANS CROPLAND	-063	-036	184**	124**	-307**	030	-019	-241**	148**	-115*	-113*
X107	CORN YIELD	093*	-153**	071	-042	-014	100*	195**	004	033	152**	068
X108	% CORN CROPLAND	-208**	-272**	243**	119**	-310**	068	-150**	-089*	-090*	271**	216**

Table 71 (continued).

	VARIABLE	V53	V113	V121	V122	V125	V126	V138	V139	V141	V151	V152
R8	CR$ MOD INPUT/FARM	064	109*	-010	-079	-023	002	-068	-140**	146**	-097*	-066
R202	CR$ MOD INPUT/HA CROPLAND	050	126**	-075	-035	073	-019	-004	-053	119**	-167**	-133**
R12	% FARMS WITH TRACTORS	021	023	059	-057	-058	067	056	-117*	061	006	020
R196	TRACTORS/1000 HA CROPLAND	008	023	-029	-004	-117*	065	-143**	-113*	006	-068	-053
R30	AVERAGE FARM SIZE	-105*	060	007	120**	-058	-073	-075	039	-037	089*	145**
R36	% FARMS LESS THAN 2 HA	076	097*	005	024	-053	129**	068	-144**	150**	-048	-048
R38	% FARMS MORE THAN 2000 HA	020	074	039	-031	138**	004	160**	174**	017	154**	097*
R42	MED CAT SIZE FARM CROPLAND	-049	-017	146**	-107*	-008	-006	-049	023	004	083	136**
R44	% OWNERS	054	111*	-092*	-004	061	-008	116*	032	-041	-083	-106*
R46	% TENANTS	-037	-017	-073	043	-056	014	-102*	-047	-063	-030	007
R48	% SQUATTERS	062	197**	-083	017	051	-113*	063	-014	023	-143**	-145**
R53	% ADMINISTRATORS	-059	-035	-034	019	-028	-029	-024	-014	015	-070	-050
R113	SUBSISTENCE PRODUCTION	131**	-200**	040	-141**	108*	040	088*	080	-037	036	-019
R121	% SHARE CROPPERS	003	-025	-080	-081	-036	-002	-062	-038	-057	-068	-021
R122	% RURAL FAMILY LABOR	105*	028	-055	-089*	-025	-009	024	-009	086*	-078	-033
R125	% RURAL PERMANENT WORKERS	-040	-010	051	016	-166**	-101*	-069	-020	-080	067	016
R126	% RURAL TEMPORARY WORKERS	-037	-017	036	-024	-096*	-064	-010	-065	-018	025	-012
R138	HA ARABLE LAND/WORKER	-062	000	-022	121**	-079	-082	-100*	-078	-002	-031	019
R139	AVERAGE RURAL WAGES	-120**	-110*	057	-008	-142**	038	-148**	-095*	-086*	044	017
R141	TOTAL POPULATION SIZE	111*	118**	-017	-015	017	041	-000	-078	484**	-163**	-085*
R151	RURAL LITERACY RATE	-033	034	-141**	081	-054	-037	-094*	-062	058	-220**	-098*
R152	URBAN LITERACY RATE	-060	039	-067	018	-121**	047	-005	-137**	-066	-151**	-200**
R160	RURAL POPULATION DENSITY	022	-059	016	-017	028	003	167**	023	-004	053	-029
R163	% HOUSES WITH ELECTRICITY	057	058	-130**	-019	-057	144**	-019	-166**	057	-207**	-181**
R171	AVERAGE URBAN WAGES	078	-090*	-020	-015	012	017	-063	-006	014	-050	-066
R190	% URBAN POPULATION	-097*	-081	-102*	156**	-191**	-036	-126**	-096*	001	-032	002
R191	INEQUALITY OF FARM SIZE	-028	027	-013	-080	064	-000	087*	050	-022	-048	-012
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	-082	-049	-016	117*	-165**	-090*	-117*	-086*	-092*	-042	023
R203	% CROPLAND	027	092*	-056	089*	-067	-123**	000	023	-017	001	-002
R204	% PASTURELAND	-064	-002	-038	019	-063	013	-058	-070	019	-110*	-053
R206	AVERAGE PRODUCTIVITY INDEX	033	120**	-050	-064	076	-016	020	-001	018	-103*	-005
R207	CROP SPECIALIZATION	043	-018	038	-079	023	010	134**	024	-006	-031	-055
R208	COMMERCIAL CROP CONCENTRATION	037	015	026	-000	090*	-107*	098*	162**	034	-028	-018
R75	COFFEE YIELD	066	059	-104*	-134**	177**	020	017	002	020	-034	-012
R76	% COFFEE CROPLAND	-026	073	212**	-052	130**	-200**	-272**	121**	-054	088*	083
R87	RICE YIELD	-007	028	-122**	-055	011	105*	-033	-081	039	-094*	-052
R88	% RICE CROPLAND	084*	-080	-030	-072	080	033	066	093*	-032	080	006
R95	SUGAR CANE YIELD	044	-004	-084*	-022	081	028	102*	078	-026	003	009
R96	% SUGAR CANE CROPLAND	105*	069	003	-058	091*	030	137**	074	-139**	058	009
R99	BEANS YIELD	029	034	-108*	002	-003	-004	073	021	-040	-071	-102*
R100	% BEANS CROPLAND	048	-082	061	-011	-101*	010	001	-048	066	016	052
R107	CORN YIELD	070	043	018	-130**	180**	086*	055	021	-032	-040	-045
R108	% CORN CROPLAND	077	047	005	032	037	-040	035	014	-031	-002	-049

Table 71 (continued).

	VARIABLE	V160	V163	V171	V190	V191	V193	V200	V203	V204	V206	V207
V8	CR$ MOD INPUT/FARM											
V202	CR$ MOD INPUT/HA CROPLAND											
V12	% FARMS WITH TRACTORS											
V196	TRACTORS/1000 HA CROPLAND											
V30	AVERAGE FARM SIZE											
V36	% FARMS LESS THAN 2 HA											
V38	% FARMS MORE THAN 2000 HA											
V42	MED CAT SIZE FARM CROPLAND											
V44	% OWNERS											
V46	% TENANTS											
V48	% SQUATTERS											
V53	% ADMINISTRATORS											
V113	SUBSISTENCE PRODUCTION											
V121	% SHARE CROPPERS											
V122	% RURAL FAMILY LABOR											
V125	% RURAL PERMANENT WORKERS											
V126	% RURAL TEMPORARY WORKERS											
V138	HA ARABLE LAND/WORKER											
V139	AVERAGE RURAL WAGES											
V141	TOTAL POPULATION SIZE											
V151	RURAL LITERACY RATE											
V152	URBAN LITERACY RATE											
V160	RURAL POPULATION DENSITY	1000										
V163	% HOUSES WITH ELECTRICITY	093*	1000									
V171	AVERAGE URBAN WAGES	036	344**	1000								
V190	% URBAN POPULATION	-122**	765**	362**	1000							
V191	INEQUALITY OF FARM SIZE	028	-042	180**	088*	1000						
V193	RURAL NET MIGRATION	130**	207**	088*	161**	-121**	1000					
V200	% INDUSTRIAL LABOR FORCE	074	717**	474**	788**	130**	158**	1000				
V203	% CROPLAND	662**	271**	-021	-030	-131**	109*	015	1000			
V204	% PASTURELAND	-527**	188**	-002	264**	-284**	160**	111*	-298**	1000		
V206	AVERAGE PRODUCTIVITY INDEX	-006	-035	015	005	078	-025	-063	009	-036	1000	
V207	CROP SPECIALIZATION	-170**	-050	-095*	-089*	-142**	-017	-182**	121**	044	086*	1000
V208	COMMERCIAL CROP CONCENTRATION	-134**	067	-120**	007	-144**	-061	-127**	295**	059	011	521**
V75	COFFEE YIELD	016	188**	065	063	-015	-004	025	201**	096*	-022	109*
V76	% COFFEE CROPLAND	310**	192**	-089*	-003	-220**	167**	-048	423**	034	-026	156**
V87	RICE YIELD	-093*	114*	003	061	053	-104*	019	029	100*	-063	272**
V88	% RICE CROPLAND	-328**	040	-030	-026	-192**	-059	-121**	117*	257**	014	486**
V95	SUGAR CANE YIELD	044	033	034	065	080	021	056	098*	-017	026	217**
V96	% SUGAR CANE CROPLAND	373**	-176**	-024	-141**	127**	089*	-029	134**	-340**	014	-086*
V99	BEANS YIELD	046	-096*	-027	011	254**	-129**	020	-142**	-180**	085*	-044
V100	% BEANS CROPLAND	174**	-191**	-044	-213**	005	089*	-184**	-090*	-064	038	-032
V107	CORN YIELD	-121**	265**	031	171**	044	-064	084*	164**	210**	-059	226**
V108	% CORN CROPLAND	052	000	044	-135**	-058	034	-113*	036	022	-112*	-191**

Table 71 (continued).

	VARIABLE	V160	V163	V171	V190	V191	V193	V200	V203	V204	V206	V207
X8	CR$ MOD INPUT/FARM	214**	567**	247**	475**	141**	118**	469**	327**	-032	047	-044
X202	CR$ MOD INPUT/HA CROPLAND	119**	239**	104*	289**	091*	-048	301**	-013	012	-028	-032
X12	% FARMS WITH TRACTORS	-013	050	-032	048	-039	-016	063	-007	063	111*	035
X196	TRACTORS/1000 HA CROPLAND	009	009	-013	026	-020	-048	055	-110*	044	086*	-044
X30	AVERAGE FARM SIZE	-749**	-155**	060	113*	165**	-225**	039	-679**	285**	060	085*
X36	% FARMS LESS THAN 2 HA	224**	199**	052	106*	082	060	132**	192**	-015	-052	-124**
X38	% FARMS MORE THAN 2000 HA	-717**	-062	084*	189**	072	-136**	097*	-602**	394**	063	081
X42	MED CAT SIZE FARM CROPLAND	-029	114*	059	057	-159**	051	024	214**	041	002	109*
X44	% OWNERS	067	-169**	-139**	-221**	-176**	-021	-217**	118**	050	-088*	076
X46	% TENANTS	-146**	457**	211**	369**	030	169**	333**	008	263**	-023	-095*
X48	% SQUATTERS	-082	-151**	-085*	-031	197**	-046	-097*	-182**	-075	063	-071
X53	% ADMINISTRATORS	-039	220**	141**	235**	005	-026	243**	-040	059	041	109*
X113	SUBSISTENCE PRODUCTION	-132**	-119**	-078	000	037	-068	-113*	-132**	041	106*	060
X121	% SHARE CROPPERS	002	119**	020	012	-171**	155**	001	236**	157**	-040	148**
X122	% RURAL FAMILY LABOR	-008	-312**	-160**	-259**	-058	-133**	-225**	-235**	-092*	-030	-094*
X125	% RURAL PERMANENT WORKERS	003	536**	182**	463**	060	116*	424**	145**	182**	047	049
X126	% RURAL TEMPORARY WORKERS	-166**	-125**	043	000	155**	-074	-017	-293**	045	-017	-136**
X138	HA ARABLE LAND/WORKER	-807**	-039	071	185**	048	-182**	069*	-686**	464**	032	073
X139	AVERAGE RURAL WAGES	-041	593**	214**	501**	012	135**	438**	164**	215**	023	119**
X141	TOTAL POPULATION SIZE	116*	-077	134**	054	192**	035	084*	-046	-177**	056	003
X151	RURAL LITERACY RATE	003	702**	293**	513**	-089*	175**	496**	208**	247**	-150**	004
X152	URBAN LITERACY RATE	163**	634**	203**	393**	-057	153**	436**	265**	027	-101*	-063
X160	RURAL POPULATION DENSITY	900**	147**	006	-076	-043	236**	059	675**	-466**	-026	-145**
X163	% HOUSES WITH ELECTRICITY	150**	849**	340**	629**	-000	207**	610**	324**	079	-019	-053
X171	AVERAGE URBAN WAGES	053	244**	145**	210**	051	120**	222**	148**	-081	043	074
X190	% URBAN POPULATION	000	747**	350**	888**	114*	153**	751**	007	159**	-035	-128**
X191	INEQUALITY OF FARM SIZE	-245**	055	146**	176**	648**	-081	150**	-236**	-023	060	-026
X193	RURAL NET MIGRATION	130**	207**	088*	161**	-121**	1000	158**	109*	160**	-025	-017
X200	% INDUSTRIAL LABOR FORCE	097*	749**	444**	748**	109*	209**	811**	072	101*	-099*	-198**
X203	% CROPLAND	661**	267**	-013	-013	-154**	274**	028	826**	-209**	-013	022
X204	% PASTURELAND	-427**	225**	092*	297**	-054	072	223**	-280**	576**	-038	022
X206	AVERAGE PRODUCTIVITY INDEX	-036	032	018	054	103*	-005	076	-072	-020	132**	002
X207	CROP SPECIALIZATION	-118**	-019	-138**	-048	-033	-057	-165**	204**	054	060	512**
X208	COMMERCIAL CROP CONCENTRATION	-157**	053	-123**	056	-087*	-076	-065	210**	087*	049	476**
X75	COFFEE YIELD	098*	-070	-048	-078	001	-063	-059	062	-141**	-100*	-066
X76	% COFFEE CROPLAND	304**	233**	-090*	062	-240**	187**	010	438**	064	-049	102**
X87	RICE YIELD	-135**	077	-003	063	038	-084*	041	-017	079	076	227**
X88	% RICE CROPLAND	-396**	016	-046	051	-037	-116*	-028	-012	291**	065	393**
X95	SUGAR CANE YIELD	-034	-080	-017	-023	052	020	-025	023	-000	032	193**
X96	% SUGAR CANE CROPLAND	176**	-242**	-062	-107**	113*	009	-067	-014	-256**	-041	005
X99	BEANS YIELD	140**	-210**	010	-134**	112*	-098*	-049	-153**	-218**	051	-111*
X100	% BEANS CROPLAND	-021	-345**	-153**	-343**	015	-026	-330**	-048	-077	002	009
X107	CORN YIELD	-264**	024	017	058	165**	-039	016	-149**	169**	014	171**
X108	% CORN CROPLAND	032	090*	087	-074	-034	021	013	093*	061	-144**	-209**

Table 71 (continued).

	VARIABLE	V160	V163	V171	V190	V191	V193	V200	V203	V204	V206	V207
R8	CR$ MOD INPUT/FARM	099*	-060	-065	-073	085*	033	-045	012	-072	115*	077
R202	CR$ MOD INPUT/HA CROPLAND	035	-130**	-059	-103*	032	-063	-084*	-030	-120**	163**	034
R12	% FARMS WITH TRACTORS	-091*	-102*	-027	-109*	-014	-095*	-078	-058	-024	031	093*
R196	TRACTORS/1000 HA CROPLAND	.155**	-108*	-092*	-128**	024	066	-133**	068	-137**	090*	-009
R30	AVERAGE FARM SIZE	069	170**	020	041	-108*	-007	059	026	-024	018	048
R36	% FARMS LESS THAN 2 HA	-008	-069	020	-021	175**	-066	013	-139**	-021	020	-130**
R38	% FARMS MORE THAN 2000 HA	-182**	195**	198**	194**	-019	007	209**	-103*	189**	-078	-040
R42	MED CAT SIZE FARM CROPLAND	072	028	-008	-035	-085*	020	-002	219**	-046	-002	085*
R44	% OWNERS	-075	-074	-071	-033	001	-053	-044	-058	048	124**	-000
R46	% TENANTS	051	-001	-056	-040	058	018	-032	063	-044	008	008
R48	% SQUATTERS	-017	-105*	-092*	-043	-073	011	-074	-048	-001	165**	047
R53	% ADMINISTRATORS	086*	-009	012	-035	-039	-008	033	-032	-047	-043	-133**
R113	SUBSISTENCE PRODUCTION	-062	068	-000	107*	-002	001	098*	-012	075	-003	053
R121	% SHARE CROPPERS	081	-024	-032	-029	-027	009	-052	050	-107*	089*	013
R122	% RURAL FAMILY LABOR	-029	-005	007	-036	069	-051	030	-050	-054	088*	-023
R125	% RURAL PERMANENT WORKERS	077	033	-045	-006	-109*	-033	003	002	-001	-006	020
R126	% RURAL TEMPORARY WORKERS	-037	-023	030	-034	-086*	-031	-045	-003	-055	-092*	021
R138	HA ARABLE LAND/WORKER	069	-007	-040	-126**	-054	-039	-088*	-047	-080	-123**	-081
R139	AVERAGE RURAL WAGES	103*	-051	-149**	-092*	-069	038	-050	134**	-117*	-025	001
R141	TOTAL POPULATION SIZE	074	-035	076	044	093*	042	066	-050	-094*	101*	-005
R151	RURAL LITERACY RATE	116*	-095*	-017	-058	008	-030	-046	-017	-062	-022	-007
R152	URBAN LITERACY RATE	012	-235**	-098*	-213**	-089*	-094*	-200**	003	-082	053	113*
R160	RURAL POPULATION DENSITY	-151**	047	053	091*	-038	003	075	-180**	040	-050	015
R163	% HOUSES WITH ELECTRICITY	074	-256**	-036	-150**	144**	-033	-127**	-089*	-115*	067	-051
R171	AVERAGE URBAN WAGES	084*	-025	-006	-017	122**	027	-007	048	-084*	-052	-022
R190	% URBAN POPULATION	122**	-105*	-069	-205**	069	-018	-110*	052	-139**	-086*	-108*
R191	INEQUALITY OF FARM SIZE	-018	055	015	050	-012	-048	092*	-064	-043	010	-009
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	107*	-134**	-083	-184**	017	-073	-227**	019	-094*	-022	000
R203	% CROPLAND	-071	-062	-040	-082	023	-030	-039	-130**	-074	016	037
R204	% PASTURELAND	106*	-070	093*	-081	043	-066	-027	024	-233**	146**	-037
R206	AVERAGE PRODUCTIVITY INDEX	011	-037	056	-063	048	044	-051	004	-052	500**	-002
R207	CROP SPECIALIZATION	-075	-041	-040	014	038	-032	043	-109*	042	035	-065
R208	COMMERCIAL CROP CONCENTRATION	-056	012	026	004	018	-104*	052	-031	129**	053	-017
R75	COFFEE YIELD	022	008	-008	039	088*	-024	023	016	-024	144**	-077
R76	% COFFEE CROPLAND	252**	180**	-030	047	-224**	159**	000	340**	014	-056	163**
R87	RICE YIELD	066	014	-013	004	010	051	034	-008	-024	061	-015
R88	% RICE CROPLAND	-086*	055	018	114*	110*	-104*	070	-084*	-010	034	-076
R95	SUGAR CANE YIELD	-122**	-025	-037	-018	072	-030	004	-009	012	164**	115*
R96	% SUGAR CANE CROPLAND	-154**	006	-015	037	-019	-059	028	-040	070	076	127**
R99	BEANS YIELD	-087*	-059	-053	007	022	-073	-061	-120**	028	028	-041
R100	% BEANS CROPLAND	-014	-061	015	-044	089*	032	-011	-049	-006	129**	140**
R107	CORN YIELD	-013	066	-023	082	055	020	041	013	-038	276**	050
R108	% CORN CROPLAND	009	-008	-049	006	037	-045	-001	-033	007	056	068

Table 71 (continued).

	VARIABLE	V208	V75	V76	V87	V88	V95	V96	V99	V100	V107	V108
V8	CR$ MOD INPUT/FARM											
V202	CR$ MOD INPUT/HA CROPLAND											
V12	% FARMS WITH TRACTORS											
V196	TRACTORS/1000 HA CROPLAND											
V30	AVERAGE FARM SIZE											
V36	% FARMS LESS THAN 2 HA											
V38	% FARMS MORE THAN 2000 HA											
V42	MED CAT SIZE FARM CROPLAND											
V44	% OWNERS											
V46	% TENANTS											
V48	% SQUATTERS											
V53	% ADMINISTRATORS											
V113	SUBSISTENCE PRODUCTION											
V121	% SHARE CROPPERS											
V122	% RURAL FAMILY LABOR											
V125	% RURAL PERMANENT WORKERS											
V126	% RURAL TEMPORARY WORKERS											
V138	HA ARABLE LAND/WORKER											
V139	AVERAGE RURAL WAGES											
V141	TOTAL POPULATION SIZE											
V151	RURAL LITERACY RATE											
V152	URBAN LITERACY RATE											
V160	RURAL POPULATION DENSITY											
V163	% HOUSES WITH ELECTRICITY											
V171	AVERAGE URBAN WAGES											
V190	% URBAN POPULATION											
V191	INEQUALITY OF FARM SIZE											
V193	RURAL NET MIGRATION											
V200	% INDUSTRIAL LABOR FORCE											
V203	% CROPLAND											
V204	% PASTURELAND											
V206	AVERAGE PRODUCTIVITY INDEX											
V207	CROP SPECIALIZATION											
V208	COMMERCIAL CROP CONCENTRATION	1000										
V75	COFFEE YIELD	134**	1000									
V76	% COFFEE CROPLAND	349**	247**	1000								
V87	RICE YIELD	133**	168**	-155**	1000							
V88	% RICE CROPLAND	730**	-003	030	259**	1000						
V95	SUGAR CANE YIELD	216**	104*	051	160**	082	1000					
V96	% SUGAR CANE CROPLAND	026	-205**	-076	-130**	-098*	163**	1000				
V99	BEANS YIELD	-037	-021	-167**	289**	-142**	053	073	1000			
V100	% BEANS CROPLAND	-297**	-014	171**	-124**	-210**	003	166**	-041	1000		
V107	CORN YIELD	227**	261**	-008	530**	305**	160**	-210**	136**	-031	1000	
V108	% CORN CROPLAND	-331**	-066	-109*	-093*	048	-092*	026	-174**	359**	146**	1000

Table 71 (continued).

	VARIABLE	V208	V75	V76	V87	V88	V95	V96	V99	V100	V107	V108
X8	CR$ MOD INPUT/FARM	090*	270**	132**	159**	-035	097*	-053	064	-088*	290**	-059
X202	CR$ MOD INPUT/HA CROPLAND	-093*	101*	016	061	-179**	055	-046	022	-038	025	-155**
X12	% FARMS WITH TRACTORS	-007	053	-049	033	018	-031	002	-017	-072	-030	-065
X196	TRACTORS/1000 HA CROPLAND	-107*	002	-113*	-007	-045	-024	011	-034	-015	-064	-044
X30	AVERAGE FARM SIZE	-014	-091*	-409**	038	104*	-022	-214**	120**	-197**	-018	-131**
X36	% FARMS LESS THAN 2 HA	-086*	035	058	-120**	-129**	-035	030	-077	030	099*	058
X38	% FARMS MORE THAN 2000 HA	-003	-051	-333**	-007	112*	-014	-239**	053	-212**	-022	-130**
X42	MED CAT SIZE FARM CROPLAND	142**	-007	038	010	122**	033	046	-119**	-052	015	086*
X44	% OWNERS	025	046	022	-063	073	075	046	-033	135**	-050	154**
X46	% TENANTS	-052	137**	-024	122**	099*	-073	-222**	-140**	-188**	289**	111*
X48	% SQUATTERS	-014	-054	-052	-040	-094*	-020	054	092*	044	-003	-039
X53	% ADMINISTRATORS	089*	009	126**	073	-012	047	-028	067	-076	017	-240**
X113	SUBSISTENCE PRODUCTION	042	128**	199**	033	-113*	010	-174**	074	060	-128**	-257**
X121	% SHARE CROPPERS	080	-149**	040	046	273**	034	081	-231**	022	143**	320**
X122	% RURAL FAMILY LABOR	-211**	-070	-133**	-003	-137**	-079	-072	060	102*	-209**	-037
X125	% RURAL PERMANENT WORKERS	200**	293**	313**	158**	013	040	-196**	017	-138**	195**	-289**
X126	% RURAL TEMPORARY WORKERS	-156**	-051	-190**	-173**	-099*	-025	064	013	039	-073	052
X138	HA ARABLE LAND/WORKER	-028	003	-388**	106*	171**	-060	-387**	041	-252**	090*	-131**
X139	AVERAGE RURAL WAGES	176**	148**	118**	270**	123**	006	-278**	-059	-331**	288**	-177**
X141	TOTAL POPULATION SIZE	-001	-205**	-014	-129**	-069	180**	269**	096*	164**	-143**	002
X151	RURAL LITERACY RATE	036	094*	022	169**	165**	042	-186**	-119**	-220**	425**	191**
X152	URBAN LITERACY RATE	-024	091*	046	075	054	008	-119**	-077	-112*	326**	251**
X160	RURAL POPULATION DENSITY	-075	-015	373**	-121**	-262**	046	376**	-015	211**	-137**	116*
X163	% HOUSES WITH ELECTRICITY	075	170**	179**	088*	068	012	-114*	-100*	-139**	310**	070
X171	AVERAGE URBAN WAGES	236**	064	145**	010	105*	070	-036	-002	-292**	044	-204**
X190	% URBAN POPULATION	-041	102*	005	023	-084*	052	-079	031	-133**	138**	-121**
X191	INEQUALITY OF FARM SIZE	-026	072	-195**	099*	-010	018	-054	199**	-020	231**	-020
X193	RURAL NET MIGRATION	-061	-004	167**	-104*	-059	021	089*	-129**	089*	-064	034
X200	% INDUSTRIAL LABOR FORCE	-148**	071	-072	041	-127**	-026	-096*	007	-199**	144**	-000
X203	% CROPLAND	163**	130**	464**	002	002	076	207**	-182**	106*	053	094*
X204	% PASTURELAND	019	078	-163**	094*	165**	-070	-197**	-091*	-192**	222**	-048
X206	AVERAGE PRODUCTIVITY INDEX	-065	-027	-124**	032	000	-042	008	096*	-115*	-049	-119**
X207	CROP SPECIALIZATION	508**	131**	185**	154**	351**	195**	-036	054	-081	311**	-119**
X208	COMMERCIAL CROP CONCENTRATION	629**	192**	349**	210**	564**	223**	-022	034	-210**	198**	-370**
X75	COFFEE YIELD	-011	128**	-001	-014	-096*	056	078	039	037	075	062
X76	% COFFEE CROPLAND	385**	146**	819**	-030	102*	123**	062	-129**	131**	059	-137**
X87	RICE YIELD	136**	044	-188**	274**	240**	040	-101**	083	-238**	211**	-227**
X88	% RICE CROPLAND	537**	124**	-135**	335**	744**	126**	-163**	000	-246**	375**	-132**
X95	SUGAR CANE YIELD	196**	063	048	009	108*	470**	085*	-047	044	067	-063
X96	% SUGAR CANE CROPLAND	061	-241**	-108*	-001	048	225**	603**	078	143**	-155**	020
X99	BEANS YIELD	-212**	-148**	-124**	-073	-231**	-096*	141**	205**	076	-260**	-138**
X100	% BEANS CROPLAND	-069	-101*	-056	-090*	038	057	124**	-025	443**	072	248**
X107	CORN YIELD	065	075	-114*	105*	251**	003	-123**	004	-018	320**	135**
X108	% CORN CROPLAND	-251**	-088*	-173**	-072	072	-086*	009	-212**	170**	221**	623**

Table 71 (continued).

	VARIABLE	V208	V75	V76	V87	V88	V95	V96	V99	V100	V107	V108
R8	CR$ MOD INPUT/FARM	-022	-055	017	-033	-081	008	078	081	-026	-115*	-054
R202	CR$ MOD INPUT/HA CROPLAND	-048	-083	-034	-081	-114*	-061	-042	084*	014	-163**	-083
R12	% FARMS WITH TRACTORS	069	-076	-059	-057	069	025	044	-028	-141**	-087*	003
R196	TRACTORS/1000 HA CROPLAND	-016	-085*	-003	-098*	-095*	020	094*	025	056	-090*	-048
R30	AVERAGE FARM SIZE	-029	044	081	076	002	031	-098*	-035	063	038	010
R36	% FARMS LESS THAN 2 HA	-226**	-095*	-144**	021	-125**	-107*	-050	122**	013	-050	040
R38	% FARMS MORE THAN 2000 HA	-073	-037	-026	043	003	-003	-094*	-111*	-052	-047	024
R42	MED CAT SIZE FARM CROPLAND	075	026	008	029	077	-018	035	-061	-219**	055	033
R44	% OWNERS	-020	009	-058	-048	-012	-111*	-081	007	-061	-060	-098*
R46	% TENANTS	001	-018	-011	073	008	029	047	-017	050	041	040
R48	% SQUATTERS	062	-004	042	-015	019	-092*	164**	003	030	-137**	-099*
R53	% ADMINISTRATORS	-065	-170**	-033	-017	-056	-050	051	-022	-041	-140**	-046
R113	SUBSISTENCE PRODUCTION	033	019	012	054	032	079	-093*	030	-072	043	-113*
R121	% SHARE CROPPERS	-053	-080	-043	033	-040	-056	000	-015	-062	-019	-016
R122	% RURAL FAMILY LABOR	006	-126**	-058	065	059	-071	099*	031	-016	-079	-004
R125	% RURAL PERMANENT WORKERS	039	-030	013	042	-010	033	082	-028	052	-010	-021
R126	% RURAL TEMPORARY WORKERS	-001	-048	-061	038	054	-011	007	-033	-111*	027	036
R138	HA ARABLE LAND/WORKER	-374	-033	058	023	-074	-024	-011	067	028	-043	-037
R139	AVERAGE RURAL WAGES	085*	-061	-029	-032	090*	-018	178**	-060	-037	-009	125**
R141	TOTAL POPULATION SIZE	-022	-053	-004	-119**	-083	038	125**	-023	063	-136**	-071
R151	RURAL LITERACY RATE	-040	036	008	-009	-078	036	032	076	042	-136**	-091*
R152	URBAN LITERACY RATE	054	-063	040	-051	018	-059	003	045	-038	-149**	-061
R160	RURAL POPULATION DENSITY	063	-086*	-098*	-045	107*	-057	-016	014	-075	-040	-025
R163	% HOUSES WITH ELECTRICITY	-097*	-031	-121**	-054	-151**	-048	031	212**	123**	-068	-036
R171	AVERAGE URBAN WAGES	048	-045	027	-023	-042	021	136**	091*	-095*	011	-073
R190	% URBAN POPULATION	-047	045	-072	-093*	-074	-034	024	044	045	054	063
R191	INEQUALITY OF FARM SIZE	-025	-006	-032	-047	-024	-105*	-029	100*	-038	-040	-047
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	-044	-037	-015	010	-047	-086*	055	-046	095*	019	055
R203	% CROPLAND	-020	-065	-069	031	-013	062	047	045	052	-056	010
R204	% PASTURELAND	012	-019	021	-134**	-015	-041	072	031	067	-141**	-004
R206	AVERAGE PRODUCTIVITY INDEX	-030	043	024	-043	-059	030	001	074	034	-110*	-096*
R207	CROP SPECIALIZATION	-066	-044	-164**	064	-051	027	025	075	-181**	006	-045
R208	COMMERCIAL CROP CONCENTRATION	-109*	067	-064	158**	-093	036	-070	060	-067	011	-051
R75	COFFEE YIELD	-062	016	-030	041	-053	048	-008	041	-053	-032	-087*
R76	% COFFEE CROPLAND	255**	029	557**	035	114*	139**	104*	-095*	176**	076	-015
R87	RICE YIELD	028	-051	-033	-005	-054	023	099*	058	-034	-110*	-141**
R88	% RICE CROPLAND	-087*	042	-179**	169**	-103*	057	-099*	100*	-167**	157**	-050
R95	SUGAR CANE YIELD	106*	006	-019	029	075	-047	042	048	-088*	010	-104*
R96	% SUGAR CANE CROPLAND	155**	027	-050	080	117*	-031	-111*	089*	-087*	100*	-158**
R99	BEANS YIELD	-000	-028	-123**	049	-007	001	-075	090*	-042	037	-041
R100	% BEANS CROPLAND	-093*	-056	-109*	064	-031	009	000	073	-057	108*	016
R107	CORN YIELD	012	042	072	-040	-012	-067	-090	051	008	-069	-067
R108	% CORN CROPLAND	-001	047	-011	-012	-005	-071	-043	059	-055	-083	-149**

Table 71 (continued).

	VARIABLE	X8	X202	X12	X196	X30	X36	X38	X42	X44	X46	X48
X8	CR$ MOD INPUT/FARM	1000										
X202	CR$ MOD INPUT/HA CROPLAND	390**	1000									
X12	% FARMS WITH TRACTORS	056	095*	1000								
X196	TRACTORS/1000 HA CROPLAND	-056	101*	883**	1000							
X30	AVERAGE FARM SIZE	-111*	-046	120**	046	1000						
X36	% FARMS LESS THAN 2 HA	109*	096*	051	154**	-347**	1000					
X38	% FARMS MORE THAN 2000 HA	-045	-012	120**	039	929**	-344**	1000				
X42	MED CAT SIZE FARM CROPLAND	246**	-066	054	-162**	209**	-329**	270**	1000			
X44	% OWNERS	-175**	-102*	-152**	-105*	-131**	-107*	-113*	042	1000		
X46	% TENANTS	284**	101*	163**	125**	014	218**	078	-016	-494**	1000	
X48	% SQUATTERS	-107*	-130**	070	094*	101*	100*	070	-163**	-391**	125**	1000
X53	% ADMINISTRATORS	215**	189**	054	-038	178**	-086*	193**	144**	-475**	064	-150**
X113	SUBSISTENCE PRODUCTION	-032	060	-032	-046	142**	-159**	123**	-013	-056	-135**	-011
X121	% SHARE CROPPERS	089*	-128**	-075	-135**	-090*	011	-044	274**	075	105*	-138**
X122	% RURAL FAMILY LABOR	-435**	-025	-100*	118**	-193**	042	-268**	-522**	141**	-210**	051
X125	% RURAL PERMANENT WORKERS	575**	298**	108*	004	085*	020	155**	213**	-237**	245**	-058
X126	% RURAL TEMPORARY WORKERS	-121**	-082	-007	061	283**	-040	315**	-041	033	047	170**
X138	HA ARABLE LAND/WORKER	-159**	-005	092*	118**	832**	-194**	784**	-064	-130**	193**	100*
X139	AVERAGE RURAL WAGES	471**	258**	096*	020	012	093*	047	117*	-249**	380**	-067
X141	TOTAL POPULATION SIZE	-059	-084*	-301**	-292**	015	-073	-001	000	-120**	-103*	011
X151	RURAL LITERACY RATE	419**	159**	071	050	-060	169**	017	125**	-063	451**	-160**
X152	URBAN LITERACY RATE	422**	120**	050	-001	-182**	223**	-133**	129**	-123**	464**	-146**
X160	RURAL POPULATION DENSITY	230**	070	-032	-042	-820**	195**	-753**	053	102*	-124**	-092*
X163	% HOUSES WITH ELECTRICITY	572**	144**	-016	-040	-237**	194**	-143**	044	-133**	438**	-128**
X171	AVERAGE URBAN WAGES	269**	083	009	-061	025	023	023	063	-209**	126**	060
X190	% URBAN POPULATION	492**	312**	072	064	006	194**	094*	-049	-214**	357**	-025
X191	INEQUALITY OF FARM SIZE	060	062	-046	010	231**	266**	132**	-290**	-207**	169**	183**
X193	RURAL NET MIGRATION	118**	-048	-016	-048	-225**	060	-136**	051	-021	169**	-046
X200	% INDUSTRIAL LABOR FORCE	452**	259**	004	019	-038	132**	046	011	-174**	399**	-087*
X203	% CROPLAND	327**	033	-048	-166**	-786**	176**	-680**	280**	091*	034	-191**
X204	% PASTURELAND	111*	083	116*	126**	363**	000	430**	-031	-030	299**	-035
X206	AVERAGE PRODUCTIVITY INDEX	036	011	172**	130**	184**	-149**	168**	019	-049	-037	065
X207	CROP SPECIALIZATION	078	-072	-011	-138**	074	-061	048	192**	-018	-054	-009
X208	COMMERCIAL CROP CONCENTRATION	171**	004	011	-128**	056	-156**	064	203**	-022	-066	-078
X75	COFFEE YIELD	-060	015	-035	019	-095*	076	-100*	-026	061	-058	046
X76	% COFFEE CROPLAND	169**	017	-057	-137**	-413**	056	-337**	118**	008	-023	-120**
X87	RICE YIELD	110*	070	128**	123**	134**	024	086*	-143**	-076	118**	-055
X88	% RICE CROPLAND	032	-055	066	023	231**	-115*	229**	044	-001	130**	-042
X95	SUGAR CANE YIELD	-006	-058	-009	-000	060	091*	081	019	006	-003	048
X96	% SUGAR CANE CROPLAND	-167**	-119**	-050	001	-059	-030	-099*	-029	119**	-242**	031
X99	BEANS YIELD	-078	004	023	023	057	-075	001	-076	-060	-171**	-053
X100	% BEANS CROPLAND	-236**	-173**	-119**	-083	020	-045	-052	045	130**	-227**	078
X107	CORN YIELD	-047	-077	046	093*	170**	083	130**	-213**	-023	177**	090*
X108	% CORN CROPLAND	-055	-179**	-093*	009	-132**	180**	-133**	012	119**	170**	005

Table 71 (continued).

	VARIABLE	X8	X202	X12	X196	X30	X36	X38	X42	X44	X46	X48
R8	CR$ MOD INPUT/FARM	-020	-045	021	-029	008	-027	042	049	-077	-010	-012
R202	CR$ MOD INPUT/HA CROPLAND	-042	019	-063	-079	011	-014	018	036	-036	-098*	-031
R12	% FARMS WITH TRACTORS	-101*	-021	010	-014	130**	-044	153**	031	002	-020	-014
R196	TRACTORS/1000 HA CROPLAND	-058	-060	-006	-007	-096*	028	-051	007	-023	-080	060
R30	AVERAGE FARM SIZE	024	068	-022	-002	-044	-020	-094*	-065	039	001	-053
R36	% FARMS LESS THAN 2 HA	-077	-002	027	063	085*	014	063	-138**	-130**	072	088*
R38	% FARMS MORE THAN 2000 HA	098*	025	-003	-034	246**	-135**	295**	231**	000	052	-048
R42	MED CAT SIZE FARM CROPLAND	123**	-037	128**	017	073	-232**	087*	540**	-096*	119**	-020
R44	% OWNERS	001	015	059	044	054	-075	058	-031	-086*	-003	069
R46	% TENANTS	067	-066	059	060	-079	031	-075	-008	003	-005	029
R48	% SQUATTERS	-059	-033	100*	060	041	035	029	007	-092*	-085*	086*
R53	% ADMINISTRATORS	-049	055	030	041	-063	093*	-075	-086*	-103*	014	-026
R113	SUBSISTENCE PRODUCTION	025	054	117*	082	063	020	073	-046	-005	035	-003
R121	% SHARE CROPPERS	012	108*	030	021	-031	036	-040	-016	005	-022	-047
R122	% RURAL FAMILY LABOR	-089*	-023	018	003	042	-071	040	008	039	-042	-045
R125	% RURAL PERMANENT WORKERS	-036	104*	028	038	-062	087*	-063	028	067	-097*	-070
R126	% RURAL TEMPORARY WORKERS	-066	-095*	022	064	008	-002	-009	-017	-065	026	086*
R138	HA ARABLE LAND/WORKER	-068	050	-060	-004	-075	077	-121**	-087*	040	-040	-054
R139	AVERAGE RURAL WAGES	-110*	-090*	025	015	-100*	-014	-098*	060	121**	-127**	-024
R141	TOTAL POPULATION SIZE	-031	005	-126**	-143**	090*	-069	097*	090*	-073	-053	049
R151	RURAL LITERACY RATE	-062	-042	016	017	-056	010	-054	-099*	055	-169**	044
R152	URBAN LITERACY RATE	-153**	-071	060	038	021	-018	-002	-014	015	-155**	055
R160	RURAL POPULATION DENSITY	000	-061	-019	-015	148**	-110*	119**	020	-050	063	-063
R163	% HOUSES WITH ELECTRICITY	-087*	042	058	072	075	024	037	-116*	-027	-122**	017
R171	AVERAGE URBAN WAGES	034	043	036	021	-005	-003	-031	-017	-056	-019	041
R190	% URBAN POPULATION	-069	-052	-055	000	-092*	054	-106*	-141**	031	-001	050
R191	INEQUALITY OF FARM SIZE	023	003	049	064	059	024	030	-019	-009	005	-044
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	-039	-016	021	090*	-062	074	-085*	-085*	004	-090*	093*
R203	% CROPLAND	-089*	-030	-008	-020	046	-109*	-006	002	-058	-032	064
R204	% PASTURELAND	-067	037	104*	117*	-042	-032	-055	-033	-021	-092*	-007
R206	AVERAGE PRODUCTIVITY INDEX	-010	013	042	053	029	008	000	-024	-044	-065	-040
R207	CROP SPECIALIZATION	-012	072	063	076	126**	074	109*	-032	-069	096*	058
R208	COMMERCIAL CROP CONCENTRATION	057	009	-000	007	109*	-046	133**	019	-002	028	-041
R75	COFFEE YIELD	103*	066	052	012	041	-040	061	052	-001	002	050
R76	% COFFEE CROPLAND	148**	067	-072	-120**	-318**	045	-249**	118**	-006	-017	-059
R87	RICE YIELD	-052	-057	055	079	-022	017	-044	-041	-004	-055	-030
R88	% RICE CROPLAND	125**	050	-019	001	143**	-039	127**	-024	-011	-028	-028
R95	SUGAR CANE YIELD	-004	-023	-031	-024	089*	-055	069*	018	004	-014	-007
R96	% SUGAR CANE CROPLAND	-029	-076	-023	-003	114*	-024	106*	-056	033	-041	-056
R99	BEANS YIELD	-085*	024	-030	027	062	024	035	-109*	-000	055	042
R100	% BEANS CROPLAND	-050	-123**	-053	-036	049	-005	035	-049	-040	031	033
R107	CORN YIELD	091*	092*	-098	-016	076	-030	096*	-005	-056	-062	006
R108	% CORN CROPLAND	-069	004	073	045	030	018	024	068	-043	-004	050

Table 71 (continued).

	VARIABLE	X53	X113	X121	X122	X125	X126	X138	X139	X141	X151	X152
X8	CR$ MOD INPUT/FARM											
X202	CR$ MOD INPUT/HA CROPLAND											
X12	% FARMS WITH TRACTORS											
X196	TRACTORS/1000 HA CROPLAND											
X30	AVERAGE FARM SIZE											
X36	% FARMS LESS THAN 2 HA											
X38	% FARMS MORE THAN 2000 HA											
X42	MED CAT SIZE FARM CROPLAND											
X44	% OWNERS											
X46	% TENANTS											
X48	% SQUATTERS											
X53	% ADMINISTRATORS	1000										
X113	SUBSISTENCE PRODUCTION	204**	1000									
X121	% SHARE CROPPERS	025	-171**	1000								
X122	% RURAL FAMILY LABOR	-235**	053	-308**	1000							
X125	% RURAL PERMANENT WORKERS	434**	245**	-166**	-407**	1000						
X126	% RURAL TEMPORARY WORKERS	-195**	-058	-237**	-237**	-154**	1000					
X138	HA ARABLE LAND/WORKER	102*	097*	-141**	097*	068	179**	1000				
X139	AVERAGE RURAL WAGES	322**	016	156**	-153**	573**	-463**	178**	1000			
X141	TOTAL POPULATION SIZE	086*	124**	029	-044	-115*	084*	-138**	-240**	1000		
X151	RURAL LITERACY RATE	129**	-321**	314**	-301**	307**	-120**	091*	556**	-288**	1000	
X152	URBAN LITERACY RATE	098*	-284**	214**	-289**	254**	-126**	-092*	399**	-066	712**	1000
X160	RURAL POPULATION DENSITY	-082	-149**	098*	-055	-006	-210**	-890**	-026	105*	026	193**
X163	% HOUSES WITH ELECTRICITY	161**	-156**	157**	-257**	492**	-154**	-096*	544**	-053	636**	622**
X171	AVERAGE URBAN WAGES	225**	-003	-029	-229**	232**	024	000	234**	020	183**	131**
X190	% URBAN POPULATION	245**	-029	-064	-206**	449**	022	110*	459**	020	488**	410**
X191	INEQUALITY OF FARM SIZE	016	020	-154**	-024	132**	149**	253**	114*	082	036	014
X193	RURAL NET MIGRATION	-026	-068	155**	-133**	116*	-074	-182**	135**	035	175**	153**
X200	% INDUSTRIAL LABOR FORCE	191**	-114*	017	-160**	426**	-062	110*	527**	-037	592**	530**
X203	% CROPLAND	-022	-071	274**	-241**	156**	-318**	-821**	153**	036	147**	255**
X204	% PASTURELAND	058	-090*	016	-154**	192**	193**	514**	178**	-181**	313**	119**
X206	AVERAGE PRODUCTIVITY INDEX	-011	-016	-079	004	062	022	164**	133**	008	-017	-046
X207	CROP SPECIALIZATION	101*	036	145**	-277**	080	-147**	-023	102*	032	059	-021
X208	COMMERCIAL CROP CONCENTRATION	231**	243**	-019	-261**	340**	-162**	-010	181**	025	-052	-112*
X75	COFFEE YIELD	-049	-096*	-039	-018	-109*	101*	-118**	-096*	-036	026	026
X76	% COFFEE CROPLAND	225**	169**	131**	-221**	374**	-254**	-421**	175**	002	055	077
X87	RICE YIELD	074	-077	-025	-005	080	-038	260**	196**	-065	089*	021
X88	% RICE CROPLAND	031	007	122**	-079	072	-028	317**	122**	-085*	128**	-026
X95	SUGAR CANE YIELD	069	056	078	-120**	020	090*	-008	-078	179**	-046	-051
X96	% SUGAR CANE CROPLAND	-025	-180**	030	-017	-191**	131**	-212**	-336**	197**	-160**	-150**
X99	BEANS YIELD	097*	096*	-199**	176**	-130**	045	-049	-162**	153**	-305**	-212**
X100	% BEANS CROPLAND	-119**	-075	149**	062	-316**	042	-094*	-303**	209**	-183**	-157**
X107	CORN YIELD	-084*	-124**	037	-014	-096*	145**	243**	-026	-006	105*	012
X108	% CORN CROPLAND	-216**	-406**	318**	030	-229**	061	-046	-071	-088*	314**	330**

Table 71 (continued).

	VARIABLE	X53	X113	X121	X122	X125	X126	X138	X139	X141	X151	X152
R8	CR$ MOD INPUT/FARM	075	052	-035	-077	-045	040	-097*	-128**	140**	-148**	-069
R202	CR$ MOD INPUT/HA CROPLAND	124**	163**	-052	038	-011	-044	-043	-071	112*	-203**	-092*
R12	% FARMS WITH TRACTORS	-017	-067	024	-037	-092*	077	092*	-107*	081	-031	-042
R196	TRACTORS/1000 HA CROPLAND	-025	-091*	-023	-007	-085*	001	-123**	-032	013	-075	-012
R30	AVERAGE FARM SIZE	-012	-079	-045	063	074	-008	007	044	-072	068	114*
R36	% FARMS LESS THAN 2 HA	064	-022	044	072	-147**	065	106*	-062	117*	-024	012
R36	% FARMS MORE THAN 2000 HA	047	079	090*	-155**	222**	048	195**	164**	-008	110*	032
R42	MED CAT SIZE FARM CROPLAND	026	-081	111*	-245**	068	-016	-043	073	013	082	116*
R44	% OWNERS	071	129**	-014	055	042	-056	055	021	-067	-110*	-125**
R46	% TENANTS	-034	079	-015	062	-017	-078	-063	008	-069	-063	-059
R48	% SQUATTERS	100*	145**	-002	-029	045	-090*	-003	033	060	-150**	-179**
R53	% ADMINISTRATORS	115*	034	-019	056	-059	-040	-039	015	-017	-039	-036
R113	SUBSISTENCE PRODUCTION	093*	099*	-014	-032	087*	-019	055	086*	-061	066	-033
R121	% SHARE CROPPERS	-002	010	106*	032	-052	-101*	-053	022	-076	-034	-052
R122	% RURAL FAMILY LABOR	-006	085*	-040	-003	-038	000	-000	-014	083	-107*	-049
R125	% RURAL PERMANENT WORKERS	-046	-046	-019	085*	001	-072	-051	039	-111*	067	032
R126	% RURAL TEMPORARY WORKERS	-038	-018	043	082	-071	-058	072	041	-033	040	017
R138	HA ARABLE LAND/WORKER	029	-023	-026	169**	-048	-075	003	-049	005	013	038
R139	AVERAGE RURAL WAGES	-100*	-140**	093*	-084*	-148**	051	-156**	-068	-095*	070	094*
R141	TOTAL POPULATION SIZE	038	034	-051	-038	-025	036	-041	-124**	530**	-178**	-057
R151	RURAL LITERACY RATE	009	013	-169**	122**	-047	-000	-051	-107*	036	-154**	-138**
R152	URBAN LITERACY RATE	-022	078	-061	093*	-137**	-042	-025	-110*	-062	-170**	-182**
R160	RURAL POPULATION DENSITY	032	-088*	016	-072	011	069	113*	022	014	048	047
R163	% HOUSES WITH ELECTRICITY	028	-008	-134**	126**	-089*	-021	002	-113*	014	-186**	-147**
R171	AVERAGE URBAN WAGES	055	-013	014	-061	-013	-008	-079	-053	-010	003	-095*
R190	% URBAN POPULATION	-133**	-140**	-031	104*	-207**	075	-090*	-138**	-024	-031	-039
R191	INEQUALITY OF FARM SIZE	086*	-040	-048	016	048	-020	041	061	-045	025	020
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	-036	015	012	020	-120**	014	-079	-110*	-122**	-028	-008
R203	% CROPLAND	036	039	-006	060	-093*	-049	044	-019	023	-061	-063
R204	% PASTURELAND	007	037	-060	072	-082	-022	-094*	-092*	-012	-096*	-107*
R206	AVERAGE PRODUCTIVITY INDEX	098*	120**	-052	037	033	-080	-002	-038	022	-129**	-094*
R207	CROP SPECIALIZATION	-002	003	062	023	-041	-011	126**	059	-054	023	-003
R208	COMMERCIAL CROP CONCENTRATION	056	056	-009	-009	075	-009	094*	051	005	-020	-044
R75	COFFEE YIELD	-022	092*	-091*	-090*	134**	019	022	072	006	-041	-022
R76	% COFFEE CROPLAND	179**	052	156**	-235**	246**	-086*	-353**	046	043	096*	079
R87	RICE YIELD	059	036	-108*	007	054	-016	-056	-006	015	-068	-058
R88	% RICE CROPLAND	016	-019	-094*	-011	113*	-036	178**	156**	-102*	086*	061
R95	SUGAR CANE YIELD	-069	094*	-056	044	062	-009	110*	058	-018	-046	-102*
R96	% SUGAR CANE CROPLAND	059	-001	-095*	-036	066	030	143**	059	-158**	034	-047
R99	BEANS YIELD	-000	036	-075	073	-005	035	095*	032	-012	-047	-043
R100	% BEANS CROPLAND	-027	-097*	091*	-050	-143**	083	012	-081	047	034	-000
R107	CORN YIELD	129**	076	-056	-051	183**	018	048	085*	-031	-059	-065
R108	% CORN CROPLAND	033	061	-006	049	067	-038	053	063	-055	-016	-015

Table 71 (continued).

	VARIABLE	X160	X163	X171	X190	X191	X193	X200	X203	X204	X206	X207
X8	CR$ MOD INPUT/FARM											
X202	CR$ MOD INPUT/HA CROPLAND											
X12	% FARMS WITH TRACTORS											
X196	TRACTORS/1000 HA CROPLAND											
X30	AVERAGE FARM SIZE											
X36	% FARMS LESS THAN 2 HA											
X38	% FARMS MORE THAN 2000 HA											
X42	MED CAT SIZE FARM CROPLAND											
X44	% OWNERS											
X46	% TENANTS											
X48	% SQUATTERS											
X53	% ADMINISTRATORS											
X113	SUBSISTENCE PRODUCTION											
X121	% SHARE CROPPERS											
X122	% RURAL FAMILY LABOR											
X125	% RURAL PERMANENT WORKERS											
X126	% RURAL TEMPORARY WORKERS											
X138	HA ARABLE LAND/WORKER											
X139	AVERAGE RURAL WAGES											
X141	TOTAL POPULATION SIZE											
X151	RURAL LITERACY RATE											
X152	URBAN LITERACY RATE											
X160	RURAL POPULATION DENSITY	1000										
X163	% HOUSES WITH ELECTRICITY	215**	1000									
X171	AVERAGE URBAN WAGES	040	210**	1000								
X190	% URBAN POPULATION	008	695**	173**	1000							
X191	INEQUALITY OF FARM SIZE	-355**	050	009	187**	1000						
X193	RURAL NET MIGRATION	236**	267**	120**	153**	-081	1000					
X200	% INDUSTRIAL LABOR FORCE	110*	716**	131**	752**	105*	209**	1000				
X203	% CROPLAND	781**	298**	077	026	-274**	274**	070	1000			
X204	% PASTURELAND	-440**	172**	028	259**	108*	072	220**	-327**	1000		
X206	AVERAGE PRODUCTIVITY INDEX	-086*	039	072	053	025	-005	046	-134**	101*	1000	
X207	CROP SPECIALIZATION	-062	010	133**	-109*	043	-057	-186**	078	008	-019	1000
X208	COMMERCIAL CROP CONCENTRATION	-094*	045	238**	-003	009	-076	-138**	157**	032	-033	534**
X75	COFFEE YIELD	105*	-056	002	-016	038	-063	-034	020	-087*	-096*	031
X76	% COFFEE CROPLAND	392**	219**	094*	049	-211**	187**	023	510**	-122**	-120**	241**
X87	RICE YIELD	-183**	033	199**	060	075	-084*	007	-169**	141**	141**	079
X88	% RICE CROPLAND	-366**	036	096*	-023	158**	-116*	-096*	-172**	267**	-023	439**
X95	SUGAR CANE YIELD	-036	-050	042	-038	095*	020	-081	001	-043	032	181**
X96	% SUGAR CANE CROPLAND	165**	-182**	-039	-132**	-001	009	-139**	-025	-129**	-060	042
X99	BEANS YIELD	096*	-198**	-012	-103*	-040	-093*	-096*	-130**	-185**	224**	-181**
X100	% BEANS CROPLAND	-012	-268**	-213**	-350**	016	-026	-332**	-053	-201**	-038	352**
X107	CORN YIELD	-264**	-020	075	-003	263**	-039	-017	-266**	176**	030	109*
X108	% CORN CROPLAND	036	174**	-171**	-058	033	021	102*	011	055	-099*	-124**

Table 71 (continued).

	VARIABLE	X160	X163	X171	X190	X191	X193	X200	X203	X204	X206	X207
R8	CR$ MOD INPUT/FARM	066	-093*	042	-059	-033	033	-090*	039	-087	-072	019
R202	CR$ MOD INPUT/HA CROPLAND	026	-119**	034	-094*	-076	-063	-110*	-010	-131**	-015	-088*
R12	% FARMS WITH TRACTORS	-111*	-114*	048	-110*	-016	-095*	-088*	-109*	057	-021	020
R196	TRACTORS/1000 HA CROPLAND	164**	-085*	-061	-097*	-071	066	-098*	078	-115*	-033	-043
R30	AVERAGE FARM SIZE	028	109*	056	087*	-083	-007	047	-017	-037	112*	-084*
R36	% FARMS LESS THAN 2 HA	-067	-065	-066	-035	087*	-066	013	-124**	101*	-048	-162**
R38	% FARMS MORE THAN 2000 HA	-167**	126**	-017	172**	-068	007	208**	-097*	104*	010	-196**
R42	MED CAT SIZE FARM CROPLAND	068	-012	094*	-098*	-214**	020	011	171**	-027	-006	078
R44	% OWNERS	-082	-060	004	-054	000	-053	-044	-047	-014	125**	-011
R46	% TENANTS	037	026	-026	-030	-027	018	-024	046	-044	-036	-001
R48	% SQUATTERS	008	-086*	006	-058	-019	011	-064	016	019	144**	042
R53	% ADMINISTRATORS	060	015	002	031	-047	-008	020	-004	-058	-061	-097*
R113	SUBSISTENCE PRODUCTION	-033	038	095*	100*	-010	001	003	-046	085*	058	073
R121	% SHARE CROPPERS	033	-061	-029	-026	-006	009	-033	008	-077	077	-084*
R122	% RURAL FAMILY LABOR	-011	-015	-028	-038	-003	-051	-010	-045	-027	-026	018
R125	% RURAL PERMANENT WORKERS	064	017	-053	019	-077	-033	-025	010	-032	-028	040
R126	% RURAL TEMPORARY WORKERS	-054	-029	013	-056	-043	-031	018	-065	-030	051	-014
R138	HA ARABLE LAND/WORKER	053	-008	-024	-055	-054	-039	-030	-046	-047	019	-114*
R139	AVERAGE RURAL WAGES	134**	-023	027	-109*	-097*	038	-019	094*	-049	025	-001
R141	TOTAL POPULATION SIZE	053	-064	086*	018	003	042	-022	-019	-094*	043	-005
R151	RURAL LITERACY RATE	060	-076	-000	008	-042	-030	-060	-030	-058	-074	-045
R152	URBAN LITERACY RATE	-019	-224**	-012	-197**	-076	-094*	-165**	-028	-116**	-051	049
R160	RURAL POPULATION DENSITY	-049	043	088*	044	-056	003	069	-121**	080	054	078
R163	% HOUSES WITH ELECTRICITY	006	-181**	-071	-109*	060	-033	-141**	-114*	-108*	-007	-034
R171	AVERAGE URBAN WAGES	063	-045	157**	-046	042	027	-045	029	-037	011	006
R190	% URBAN POPULATION	081	-048	-060	-095*	002	-018	-051	-011	-077	052	011
R191	INEQUALITY OF FARM SIZE	-011	040	-034	060	069	-048	086*	-064	009	-033	-035
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	085*	-097*	-099*	-156**	-052	-073	-084*	-007	-029	-035	001
R203	% CROPLAND	-029	-121**	-013	-100*	017	-030	-065	-038	-058	077	-003
R204	% PASTURELAND	083	-094*	005	-070	-025	-066	-034	007	-281**	-064	-064
R206	AVERAGE PRODUCTIVITY INDEX	-023	-062	-015	-092*	036	044	-059	003	-034	-061	-033
R207	CROP SPECIALIZATION	-099*	-073	023	-024	040	-032	032	-150**	048	-021	043
R208	COMMERCIAL CROP CONCENTRATION	-081	018	012	-034	-025	-104*	-009	-081	075	-012	033
R75	COFFEE YIELD	-002	-009	-007	038	052	-024	014	002	-020	116*	-053
R76	% COFFEE CROPLAND	306**	147**	033	044	-181**	159**	021	394**	-066	-127**	120**
R87	RICE YIELD	053	044	-029	035	-019	051	028	-010	-026	-005	-074
R88	% RICE CROPLAND	-124**	046	069	075	106*	-104*	132**	-163**	140**	037	-002
R95	SUGAR CANE YIELD	-115*	-009	-042	-058	123**	-030	-022	-073	025	043	112*
R96	% SUGAR CANE CROPLAND	-149**	016	043	012	102*	-059	000	-143**	104*	-082	139**
R99	BEANS YIELD	-093*	-061	-037	-017	069	-073	-017	-133**	024	-024	-099*
R100	% BEANS CROPLAND	-006	-029	007	-082	100*	032	-016	-072	072	042	103*
R107	CORN YIELD	-031	028	028	073	072	020	042	-014	-012	135**	-348
R108	% CORN CROPLAND	-013	-021	016	027	042	-045	014	-025	-022	037	-012

Table 71 (continued).

	VARIABLE	X208	X75	X76	X87	X88	X95	X96	X99	X100	X107	X108
X6	CR$ MOD INPUT/FARM											
X202	CR$ MOD INPUT/HA CROPLAND											
X12	% FARMS WITH TRACTORS											
X196	TRACTORS/1000 HA CROPLAND											
X30	AVERAGE FARM SIZE											
X36	% FARMS LESS THAN 2 HA											
X38	% FARMS MORE THAN 2000 HA											
X42	MED CAT SIZE FARM CROPLAND											
X44	% OWNERS											
X46	% TENANTS											
X48	% SQUATTERS											
X53	% ADMINISTRATORS											
X113	SUBSISTENCE PRODUCTION											
X121	% SHARE CROPPERS											
X122	% RURAL FAMILY LABOR											
X125	% RURAL PERMANENT WORKERS											
X126	% RURAL TEMPORARY WORKERS											
X138	HA ARABLE LAND/WORKER											
X139	AVERAGE RURAL WAGES											
X141	TOTAL POPULATION SIZE											
X151	RURAL LITERACY RATE											
X152	URBAN LITERACY RATE											
X160	RURAL POPULATION DENSITY											
X163	% HOUSES WITH ELECTRICITY											
X171	AVERAGE URBAN WAGES											
X190	% URBAN POPULATION											
X191	INEQUALITY OF FARM SIZE											
X193	RURAL NET MIGRATION											
X200	% INDUSTRIAL LABOR FORCE											
X203	% CROPLAND											
X204	% PASTURELAND											
X206	AVERAGE PRODUCTIVITY INDEX											
X207	CROP SPECIALIZATION											
X208	COMMERCIAL CROP CONCENTRATION	1000										
X75	COFFEE YIELD	-067	1000									
X76	% COFFEE CROPLAND	437**	-182	1000								
X87	RICE YIELD	137**	010	-135**	1000							
X88	% RICE CROPLAND	591**	-075	-081	246**	1000						
X95	SUGAR CANE YIELD	262**	053	109*	100*	127**	1000					
X96	% SUGAR CANE CROPLAND	033	121**	-003	-058	-025	179**	1000				
X99	BEANS YIELD	-076	064	-094*	291**	-152**	004	103*	1000			
X100	% BEANS CROPLAND	-183**	132**	-077	-049	045	130**	268**	-054	1000		
X107	CORN YIELD	063	135**	-151**	394**	347**	129**	010	133**	080	1000	
X108	% CORN CROPLAND	-486**	090*	-184**	-146**	-015	042	103*	-262**	348**	097*	1000

Table 71 (continued).

	VARIABLE	X208	X75	X76	X87	X88	X95	X96	X99	X100	X107	X108
R8	CR$ MOD INPUT/FARM	011	-077	-004	002	-095*	020	076	054	-088*	-061	-155**
R202	CR$ MOD INPUT/HA CROPLAND	005	-046	-042	009	-127**	-000	-014	170**	-085*	-088*	-140**
R12	% FARMS WITH TRACTORS	-005	071	-079	043	022	-008	137**	-052	030	050	008
R196	TRACTORS/1000 HA CROPLAND	-096*	122**	-053	-104*	-143**	011	090*	044	042	-103*	-025
R30	AVERAGE FARM SIZE	-082	-015	070	090*	-065	-040	-081	-045	-010	-032	054
R36	% FARMS LESS THAN 2 HA	-186**	-040	-170**	079	-064	-078	-020	144**	-010	086*	008
R38	% FARMS MORE THAN 2000 HA	-031	-070	-009	-034	002	-046	-106*	-074	-094*	-077	058
R42	MED CAT SIZE FARM CROPLAND	055	035	-025	006	013	-132**	-074	-013	-007	-097*	-029
R44	% OWNERS	037	-045	-062	027	012	-087*	-079	057	-041	-047	-112*
R46	% TENANTS	026	-075	-010	015	000	-051	039	017	020	-038	030
R48	% SQUATTERS	145**	-118**	091*	-043	002	-074	037	068*	-035	-040	-206**
R53	% ADMINISTRATORS	-056	020	-005	009	-043	-087*	059	112*	-065	-088*	-015
R113	SUBSISTENCE PRODUCTION	085*	032	-017	055	099*	093*	-003	-045	-068	-012	-116*
R121	% SHARE CROPPERS	-071	-074	012	023	-094*	-018	-054	080	-117*	-078	003
R122	% RURAL FAMILY LABOR	032	-080	013	-065	110*	-088*	126**	071	017	025	004
R125	% RURAL PERMANENT WORKERS	009	-060	053	-031	-006	-017	102*	028	004	-010	022
R126	% RURAL TEMPORARY WORKERS	-070	-016	-034	081	031	015	-063	-069	025	057	105*
R138	HA ARABLE LAND/WORKER	-122**	103*	046	076	-105*	-065	-002	101*	097*	-011	036
R139	AVERAGE RURAL WAGES	041	024	-009	-025	001	-033	156**	011	020	-036	088*
R141	TOTAL POPULATION SIZE	005	-001	-026	012	-067	067	068	144**	100*	-025	-123**
R151	RURAL LITERACY RATE	-071	007	-013	040	-090*	020	063	-065	-000	-123**	-048
R152	URBAN LITERACY RATE	041	-023	-016	025	009	-031	027	054	047	-045	-036
R160	RURAL POPULATION DENSITY	062	-126**	-030	118**	091*	-034	001	032	-016	097*	-036
R163	% HOUSES WITH ELECTRICITY	-108*	-017	-185**	024	-102*	027	012	162**	118**	-023	-048
R171	AVERAGE URBAN WAGES	024	-026	052	016	-034	021	074	021	-037	008	-028
R190	% URBAN POPULATION	-088*	046	-103*	051	-034	007	052	063	164**	049	145**
R191	INEQUALITY OF FARM SIZE	-046	-003	-040	016	013	-043	-017	063	-032	046	-011
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	-058	094*	-034	-001	-035	026	039	080	089*	067	054
R203	% CROPLAND	-020	-008	-119**	046	-049	029	-012	107*	042	-034	-054
R204	% PASTURELAND	-001	-008	-033	004	-061	-031	113*	081	-002	022	-068
R206	AVERAGE PRODUCTIVITY INDEX	001	-123**	-006	065	-001	018	-016	024	010	-000	-060
R207	CROP SPECIALIZATION	-071	-006	-116*	138**	-015	035	108*	025	-000	059	007
R208	COMMERCIAL CROP CONCENTRATION	054	-018	-013	102*	069	-015	-006	088*	-034	091*	-084*
R75	COFFEE YIELD	-022	-051	-028	084*	-000	033	-011	050	-065	-044	-079
R76	% COFFEE CROPLAND	291**	-052	701**	-052	-053	121**	109*	-115*	-007	-121**	-031
R87	RICE YIELD	-004	-029	007	095*	-085*	032	038	065	-044	-096*	-098*
R88	% RICE CROPLAND	-051	098*	-170**	126**	108*	-030	-040	-016	-068	081	016
R95	SUGAR CANE YIELD	115*	001	-036	055	141**	031	-048	015	-011	110*	-108*
R96	% SUGAR CANE CROPLAND	172**	056	-025	098*	158**	-070	167**	-056	-047	115*	-096*
R99	BEANS YIELD	-019	028	-080	036	018	001	-034	108*	-027	046	021
R100	% BEANS CROPLAND	-120**	041	-092*	099*	-009	001	025	074	135**	165**	037
R107	CORN YIELD	041	018	058	057	-006	006	-115*	043	-071	012	-151**
R108	% CORN CROPLAND	001	-041	001	-016	022	013	-025	043	-043	-123	-066

Table 71 (continued).

	VARIABLE	R8	R202	R12	R196	R30	R36	R38	R42	R44	R46	R48
R8	CR$ MOD INPUT/FARM	1000										
R202	CR$ MOD INPUT/HA CROPLAND	179**	1000									
R12	% FARMS WITH TRACTORS	180**	-013	1000								
R196	TRACTORS/1000 HA CROPLAND	140**	073	202**	1000							
R30	AVERAGE FARM SIZE	-112*	-164**	-027	-042	1000						
R36	% FARMS LESS THAN 2 HA	123**	058	072	049	023	1000					
R38	% FARMS MORE THAN 2000 HA	000	017	-003	-107*	159**	-049	1000				
R42	MED CAT SIZE FARM CROPLAND	053	003	081	036	-020	-034	156**	1000			
R44	% OWNERS	035	196**	-018	-039	-039	049	040	-010	1000		
R46	% TENANTS	045	054	-055	016	-063	-029	017	024	218**	1000	
R48	% SQUATTERS	028	-018	043	-025	-038	-020	009	-051	139**	-042	1000
R53	% ADMINISTRATORS	059	133**	007	015	017	017	040	-124**	042	-029	112*
R113	SUBSISTENCE PRODUCTION	006	-015	030	035	-043	-029	-002	016	-023	035	-028
R121	% SHARE CROPPERS	-003	026	022	-001	070	-015	-016	-004	008	007	-008
R122	% RURAL FAMILY LABOR	101*	009	092*	022	-044	011	035	-024	-003	031	-041
R125	% RURAL PERMANENT WORKERS	055	010	002	024	028	-093*	011	-097*	-024	022	006
R126	% RURAL TEMPORARY WORKERS	-065	003	-000	-058	046	-015	-002	079	-059	-097*	097*
R138	HA ARABLE LAND/WORKER	-018	-008	071	011	163**	066	014	-021	-034	-108*	-064
R139	AVERAGE RURAL WAGES	-064	-028	023	024	-004	-072	080	108*	034	005	121**
R141	TOTAL POPULATION SIZE	052	119**	134**	067	032	091*	094*	099*	-034	-047	-029
R151	RURAL LITERACY RATE	051	059	092*	061	082	013	-116*	-067	077	118**	-026
R152	URBAN LITERACY RATE	069	046	004	-010	-054	041	-038	-007	117*	072	049
R160	RURAL POPULATION DENSITY	-086*	-068	050	-061	-011	-006	-052	-060	017	-088*	050
R163	% HOUSES WITH ELECTRICITY	090*	124**	-012	121**	-073	112*	-111*	-040	075	031	-035
R171	AVERAGE URBAN WAGES	063	-043	047	068	-038	-013	-065	-042	-071	-031	-013
R190	% URBAN POPULATION	-053	-077	017	073	-009	-005	-109*	-023	-016	052	012
R191	INEQUALITY OF FARM SIZE	-025	-002	-019	-023	-006	102*	016	-039	006	-090*	067
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	015	-014	-040	105*	020	146**	-120**	-060	020	047	-014
R203	% CROPLAND	-018	062	-019	-002	-011	003	-022	049	016	-011	120**
R204	% PASTURELAND	009	066	032	-013	-047	-005	041	009	-023	-036	083
R206	AVERAGE PRODUCTIVITY INDEX	169**	094*	110*	030	002	-033	-010	-008	-015	035	069
R207	CROP SPECIALIZATION	-098*	046	081	-054	-061	113*	-088*	032	-015	023	019
R208	COMMERCIAL CROP CONCENTRATION	-000	039	-000	-062	-052	051	086*	124**	-018	020	003
R75	COFFEE YIELD	024	099*	004	003	-003	-043	034	-001	012	047	033
R76	% COFFEE CROPLAND	-017	-084*	-073	-027	069	-081	-039	-001	-119**	037	009
R87	RICE YIELD	025	-022	017	003	110*	-016	-002	-030	-025	-060	020
R88	% RICE CROPLAND	-046	010	039	-054	014	062	-003	-010	-049	068	-076
R95	SUGAR CANE YIELD	-048	094*	016	001	-103*	-043	040	035	013	032	014
R96	% SUGAR CANE CROPLAND	065	010	077	060	-154**	-003	-089*	-103*	021	007	-020
R99	BEANS YIELD	-002	115*	003	-000	067	-027	-063	-104*	079	-057	004
R100	% BEANS CROPLAND	034	024	041	053	-039	099*	-079	010	-023	-047	020
R107	CORN YIELD	-043	139**	-056	-033	000	-038	095*	001	032	-066	001
R108	% CORN CROPLAND	105*	016	009	099*	010	123**	010	030	010	-028	049

Table 71 (continued).

	VARIABLE	R53	R113	R121	R122	R125	R126	R138	R139	R141	R151	R152
R8	CR$ MOD INPUT/FARM											
R202	CR$ MOD INPUT/HA CROPLAND											
R12	% FARMS WITH TRACTORS											
R196	TRACTORS/1000 HA CROPLAND											
R30	AVERAGE FARM SIZE											
R36	% FARMS LESS THAN 2 HA											
R38	% FARMS MORE THAN 2000 HA											
R42	MED CAT SIZE FARM CROPLAND											
R44	% OWNERS											
R46	% TENANTS											
R48	% SQUATTERS											
R53	% ADMINISTRATORS	1000										
R113	SUBSISTENCE PRODUCTION	103*	1000									
R121	% SHARE CROPPERS	-053	-002	1000								
R122	% RURAL FAMILY LABOR	061	056	075	1000							
R125	% RURAL PERMANENT WORKERS	104*	039	-004	101*	1000						
R126	% RURAL TEMPORARY WORKERS	004	-006	043	036	-046	1000					
R138	HA ARABLE LAND/WORKER	150**	-040	-043	-033	-007	069	1000				
R139	AVERAGE RURAL WAGES	036	-009	-005	-015	033	-011	-021	1000			
R141	TOTAL POPULATION SIZE	-007	-034	-063	-028	-065	-053	-011	-076	1000		
R151	RURAL LITERACY RATE	-010	-029	-013	-041	-081	-004	032	-036	004	1000	
R152	URBAN LITERACY RATE	038	043	026	052	001	125**	-049	072	-007	132**	1000
R160	RURAL POPULATION DENSITY	-064	-042	-024	011	006	047	-004	-064	027	-043	-000
R163	% HOUSES WITH ELECTRICITY	014	051	064	001	030	-052	024	-029	017	016	105*
R171	AVERAGE URBAN WAGES	097*	101*	059	-016	-045	011	003	-058	014	-008	011
R190	% URBAN POPULATION	016	-053	025	-068	066	-019	-011	021	003	058	-036
R191	INEQUALITY OF FARM SIZE	041	114*	-002	008	-001	130**	032	-074	013	-044	052
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**	*00**
R200	% INDUSTRIAL LABOR FORCE	021	-090*	068	019	-000	000	013	-048	-101*	-007	-004
R203	% CROPLAND	-069	-002	-016	066	000	006	041	048	030	-031	-022
R204	% PASTURELAND	058	-017	-027	078	011	066	-040	054	021	-035	032
R206	AVERAGE PRODUCTIVITY INDEX	022	-011	093*	098*	066	-116*	-048	001	041	016	044
R207	CROP SPECIALIZATION	040	112*	120**	-062	-028	038	022	014	031	-034	132**
R208	COMMERCIAL CROP CONCENTRATION	014	191**	-037	088*	043	-092	-046	-016	-006	-075	-047
R75	COFFEE YIELD	100*	059	057	079	-024	041	-020	-035	-016	-003	015
R76	% COFFEE CROPLAND	024	-042	030	-023	013	-092	050	-061	-069	-006	029
R87	RICE YIELD	091*	007	089*	099*	070	-048	041	079	024	094*	164**
R88	% RICE CROPLAND	-071	-042	-040	-039	-079	033	065	-089*	-019	-032	045
R95	SUGAR CANE YIELD	-051	-039	-036	015	112*	059	-023	005	001	-071	-012
R96	% SUGAR CANE CROPLAND	036	003	-088*	098*	048	-001	-075	015	-124**	-005	-056
R99	BEANS YIELD	-012	-065	-004	-051	036	-012	114*	-017	-043	025	-021
R100	% BEANS CROPLAND	000	064	-029	-051	012	048	-031	046	036	-101*	-016
R107	CORN YIELD	-063	-053	026	-049	-054	-057	-055	067	106*	-021	011
R108	% CORN CROPLAND	046	-001	023	-032	037	-103*	-020	-105*	021	-026	035

Table 71 (continued).

	VARIABLE	R160	R163	R171	R190	R191	R193	R200	R203	R204	R206	R207
R8	CR$ MOD INPUT/FARM											
R202	CR$ MOD INPUT/HA CROPLAND											
R12	% FARMS WITH TRACTORS											
R196	TRACTORS/1000 HA CROPLAND											
R30	AVERAGE FARM SIZE											
R36	% FARMS LESS THAN 2 HA											
R38	% FARMS MORE THAN 2000 HA											
R42	MED CAT SIZE FARM CROPLAND											
R44	% OWNERS											
R46	% TENANTS											
R48	% SQUATTERS											
R53	% ADMINISTRATORS											
R113	SUBSISTENCE PRODUCTION											
R121	% SHARE CROPPERS											
R122	% RURAL FAMILY LABOR											
R125	% RURAL PERMANENT WORKERS											
R126	% RURAL TEMPORARY WORKERS											
R138	HA ARABLE LAND/WORKER											
R139	AVERAGE RURAL WAGES											
R141	TOTAL POPULATION SIZE											
R151	RURAL LITERACY RATE											
R152	URBAN LITERACY RATE											
R160	RURAL POPULATION DENSITY	1000										
R163	% HOUSES WITH ELECTRICITY	-047	1000									
R171	AVERAGE URBAN WAGES	-031	032	1000								
R190	% URBAN POPULATION	055	191**	100*	1000							
R191	INEQUALITY OF FARM SIZE	154**	171**	-018	002	1000						
R193	RURAL NET MIGRATION	*00**	*00**	*00**	*00**	*00**	1000					
R200	% INDUSTRIAL LABOR FORCE	065	-014	069	101*	-064	*00**	1000				
R203	% CROPLAND	069	074	-003	006	016	*00**	-069	1000			
R204	% PASTURELAND	049	021	016	032	073	*00**	032	029	1000		
R206	AVERAGE PRODUCTIVITY INDEX	-004	092*	044	001	040	*00**	-011	076	083	1000	
R207	CROP SPECIALIZATION	-014	004	014	015	056	*00**	-035	032	-024	045	1000
R208	COMMERCIAL CROP CONCENTRATION	-000	007	-077	017	005	*00**	-037	015	-107*	067	215**
R75	COFFEE YIELD	-067	-030	010	-122**	041	*00**	-074	-057	-082	061	-046
R76	% COFFEE CROPLAND	-063	-156**	-003	-058	-033	*00**	047	-100*	-106*	024	-051
R87	RICE YIELD	011	000	-111*	-097*	-058	*00**	033	-072	-061	100*	-045
R88	% RICE CROPLAND	092*	-018	010	-072	096*	*00**	056	-099*	-037	-046	128**
R95	SUGAR CANE YIELD	-012	056	-042	032	040	*00**	-056	126**	035	125**	075
R96	% SUGAR CANE CROPLAND	096*	-056	-002	059	011	*00**	-003	-002	033	047	-017
R99	BEANS YIELD	141**	027	-020	-035	004	*00**	072	023	-088*	037	-006
R100	% BEANS CROPLAND	011	057	030	-043	041	*00**	-016	116*	-088*	-001	097*
R107	CORN YIELD	011	-006	-047	-096*	112*	*00**	049	-036	109*	248**	-045
R108	% CORN CROPLAND	-073	136**	019	-031	-011	*00**	006	-042	038	-009	027

Table 71 (concluded).

	VARIABLE	R208	R75	R76	R87	R88	R95	R96	R99	R100	R107	R108
R8	CR$ MOD INPUT/FARM											
R202	CR$ MOD INPUT/HA CROPLAND											
R12	% FARMS WITH TRACTORS											
R196	TRACTORS/1000 HA CROPLAND											
R30	AVERAGE FARM SIZE											
R36	% FARMS LESS THAN 2 HA											
R38	% FARMS MORE THAN 2000 HA											
R42	MED CAT SIZE FARM CROPLAND											
R44	% OWNERS											
R46	% TENANTS											
R48	% SQUATTERS											
R53	% ADMINISTRATORS											
R113	SUBSISTENCE PRODUCTION											
R121	% SHARE CROPPERS											
R122	% RURAL FAMILY LABOR											
R125	% RURAL PERMANENT WORKERS											
R126	% RURAL TEMPORARY WORKERS											
R138	HA ARABLE LAND/WORKER											
R139	AVERAGE RURAL WAGES											
R141	TOTAL POPULATION SIZE											
R151	RURAL LITERACY RATE											
R152	URBAN LITERACY RATE											
R160	RURAL POPULATION DENSITY											
R163	% HOUSES WITH ELECTRICITY											
R171	AVERAGE URBAN WAGES											
R190	% URBAN POPULATION											
R191	INEQUALITY OF FARM SIZE											
R193	RURAL NET MIGRATION											
R200	% INDUSTRIAL LABOR FORCE											
R203	% CROPLAND											
R204	% PASTURELAND											
R206	AVERAGE PRODUCTIVITY INDEX											
R207	CROP SPECIALIZATION											
R208	COMMERCIAL CROP CONCENTRATION	1000										
R75	COFFEE YIELD	032	1000									
R76	% COFFEE CROPLAND	-001	-071	1000								
R87	RICE YIELD	001	005	019	1000							
R88	% RICE CROPLAND	100*	141**	-148**	-003	1000						
R95	SUGAR CANE YIELD	061	002	-126**	-023	-004	1000					
R96	% SUGAR CANE CROPLAND	-003	017	021	020	087*	080	1000				
R99	BEANS YIELD	-012	018	-102*	017	088*	-017	-007	1000			
R100	% BEANS CROPLAND	113**	-033	-056	-053	-065	040	098*	037	1000		
R107	CORN YIELD	010	054	018	002	128**	129**	014	-036	-041	1000	
R108	% CORN CROPLAND	036	004	013	-007	-046	-012	-004	022	038	-049	1000

APPENDIX C

REGRESSION ESTIMATES FOR THE EFFECTS OF SELECTED INDEPENDENT VARIABLES ON 1970 LEVELS AND 1950-1970 CHANGE IN AGRICULTURAL TECHNOLOGY INDICATORS

Table 72. Regression Estimates for the Effects of Selected 1950 Independent Variables on 1970 Agricultural Technology Indicators, Minas Gerais (Brazil) Municipios.

Selected Independent Variables, 1950	CR$ Modern Bio-chemical Inputs per Farm, 1970			CR$ Modern Bio-chemical Inputs per Ha. of Crop-land, 1970			Percent of Farms with Tractors, 1970			Tractors per 1000 Ha. of Cropland, 1970		
	b	S.E.b	Beta	b	S.E.b	Beta	b	S.E.b	Beta	b	S.E.	Beta
Land Inequality	1.100*	.318	.127	.531	.292	.063	1.083*	.409	.111	1.203*	.385	.131
% Tenants	-.014	.041	-.014	-.015	.038	-.014	.062	.052	.055	.034	.050	.032
% Administrators	.158*	.065	.098	.048	.059	.031	.273*	.083	.150	.205*	.078	.118
% Pasturelands	.107	.096	.044	.127	.085	.054	.206	.123	.075	.326*	.116	.126
Concentration Commercial Crops	.329*	.068	.184	.065	.062	.037	.461*	.088	.228	.243*	.082	.128
Rural Literacy Rate	.549*	.128	.246	.475*	.117	.219	.221	.164	.088	.198	.155	.083
Urbanization	.203*	.085	.102	.279*	.078	.144	.390*	.109	.174	.438*	.103	.207
Belo Horizonte Center	1.308*	.312	.218	1.480*	.286	.254	1.163*	.401	.172	1.290*	.378	.202
Sao Paulo Periphery I	1.511*	.209	.596	1.626*	.191	.659	.898*	.269	.314	1.171*	.253	.434
Sao Paulo Periphery II	1.339*	.242	.334	.774*	.222	.198	1.544*	.311	.342	.975*	.293	.229
Belo Horizonte Periphery I	.954*	.226	.340	1.035*	.207	.379	.325	.290	.102	.566*	.273	.190
Rio de Janeiro Periphery I	.596*	.221	.195	.572*	.202	.192	.034	.284	.010	.128	.267	.040
Rio de Janeiro Periphery II	.304	.210	.069	.080	.193	.019	.505	.270	.102	.531*	.254	.114
Belo Horizonte Periphery II	.265	.200	.071	.032	.183	.009	.209	.257	.050	.071	.242	.018
R^2		.582			.629			.456			.459	

* Indicates that the absolute value of the unstandardized regression coefficient is at least twice as large as the standard error.

Table 7x. Regression Estimates for the Effects of Selected 1950 Independent Variables on 1950-1970 Change in Agricultural Technology, Minas Gerais (Brazil) Municipios.

Selected Independent Variables	Change in CR$ Modern Biochemical Inputs per Farm 1/			Change in CR$ Modern Biochemical Inputs per Ha. of Cropland			Change in Percent of Farms with Tractors			Change in Number of Tractors per 1000 Ha. of Cropland		
	b	S.E.b	Beta	b	S.E.b	Beta	b	S.E.b	Beta	b	S.E.b	Beta
Land Inequality	.386	.322	.058	.072	.313	.011	.456	.286	.076	.305	.353	.045
% Tenants	-.008	.042	-.010	.004	.041	.005	-.016	.037	-.024	-.000	.046	-.000
% Administrators	.129	.065	.103	.118	.064	.095	.090	.058	.080	.072	.071	.056
% Pasturelands	-.006	.097	-.003	.002	.094	.001	.087	.086	.052	.149	.106	.077
Concentration Commercial Crops	.291*	.068	.210	-.022	.067	-.016	.164*	.061	.132	.146	.076	.103
Rural Literacy Rate	-.041	.129	-.024	-.024	.126	-.014	.079	.115	.051	.079	.142	.045
Urbanization	-.057	.086	-.037	-.081	.084	-.054	-.025	.076	-.018	.119	.094	.076
Belo Horizonte Center	.845*	.316	.182	.922	.308	.203	.392	.280	.094	.895*	.346	.189
Sao Paulo Periphery I	.960*	.211	.489	1.223	.206	.636	.496*	.187	.281	.617*	.232	.308
Sao Paulo Periphery II	.986*	.224	.317	.492*	.238	.162	1.225*	.217	.447	.219	.268	.069
Belo Horizonte Periphery	.619*	.228	.284	.699*	.222	.328	.170	.203	.087	.319	.250	.144
Rio de Janeiro Periphery I	-.111	.223	-.047	.021	.217	.001	-.125	.191	-.059	-.078	.244	-.032
Rio de Janeiro Periphery II	.034	.212	.010	.037	.207	.011	.193	.189	.063	.168	.233	.048
Belo Horizonte Periphery II	.247	.202	.086	.113	.197	.040	.079	.179	.031	.018	.221	.006
R^2		.288			.295			.301			.177	

1/ All measures of change are computed in terms of residualized change scores.

* Indicates that the absolute value of unstandardized regression coefficient is at least twice as large as the standard error.

APPENDIX D

SCHEMATIC PRESENTATION OF THE STUDY'S MAJOR HYPOTHESES AND RESULTS

Table 74. Schematic Presentation of the Study's Major Hypotheses and Results

Structural Change in Minas Gerais Municipios, 1950-1970

Hypotheses	Prediction	Results
1	High Municipal Variability	Confirmed
2	Significant Regional Variability	Partially Confirmed
3	Significant Regional Effects on Development Indicators	Confirmed
4	Increasing Regional Inequality on Development Indicators	Partially Confirmed

Social Organizational Patterns as Antecedents of Change in Agricultural Technology

Hypotheses	Independent Variables[1]	Dependent Variables[2]	Predicted Association	Results
1	Average Farm Size	Bio-chemical Technology	+	+-
Farm Size and	Proportion Larger Farms	" "	+	+-
Land Inequality	Land Inequality	" "	+	++
	Average Farm Size	Mechanization	++	++
	Proportion Larger Farms	"	++	++
	Land Inequality	"	++	++
2	Proportion Owners	Bio-chemical Technology	+	0 (negative direction)
Land Tenure	Proportion Administrators	" "	+	0 (positive direction)
	Proportion Squatters	" "	-	0 (negative direction)
	Proportion Owners	Mechanication	+	--
	Proportion Administrators	"	+	++
	Proportion Squatters	"	-	-
3	Rural Literacy Rate	Bio-chemical Technology	++	++
Rural Literacy	" " "	Mechanization	++	++

Table 74 (continued).

Hypotheses	Independent Variables[1]	Dependent Variables[2]	Predicted Association	Results
4 Land Use and Crop Mix	Proportion Croplands	Bio-chemical Technology	+	+
	Crop Specialization	" "	++	+
	Concentration Commercial/Export Crops	" "	++	+
	Proportion Croplands	Mechanization	+	0 (negative direction)
	Crop Specialization	"	++	+
	Concentration Commercial/Export Crops	"	++	+
	(Cropland proportions for specific crops are not reported here)			
5 Center-Periphery	Regional Location	Bio-chemical Innovation	++	++
	Urbanization	" "	++	++
	Industrialization	" "	++	++
	Regional Location	Mechanization	++	++
	Urbanization	"	++	++
	Industrialization	"	++	++

Social Organizational Patterns as Consequences of Change in Agricultural Technology

Hypotheses	Independent Variables[3]	Dependent Variables[4]	Predicted Association	Results
1 Productivity	Bio-chemical Technology	Average Productivity Index	++	++
	" "	Coffee Yield	++	++
	" "	Rice Yield	++	+
	" "	Sugar Cane Yield	++	++
	" "	Beans Yield	+	0 (mixed direction)
	" "	Corn Yield	++	++
	Mechanization	Average Productivity Index	++	++
	"	Coffee Yield	+	+
	"	Rice Yield	+	+
	"	Sugar Cane Yield	+	++
	"	Beans Yield	+	0 (positive direction)
	"	Corn Yield	+	++

Table 74 (continued).

Hypotheses	Independent Variables[3]	Dependent Variables[4]	Predicted Association	Results
2 Farm Size and Land Inequality	Bio-chemical Technology	Average Farm Size	+	0 (mixed directions)
	" "	Proportion Larger Farms	+	0 (mixed directions)
	" "	Land Inequality	+	0 (mixed directions)
	Mechanization	Average Farm Size	++	+
	"	Proportion Larger Farms	++	+
	"	Land Inequality	+	0 (mixed directions)
3 Land Tenure	Bio-chemical Technology	Proportion Owners	+	+
	" "	Proportion Administrators	+	+
	" "	Proportion Squatters	-	-
	Mechanization	Proportion Owners	+	0 (mixed directions)
	"	Proportion Administrators	+	++
	"	Proportion Squatters	-	-
4 Rural Labor Force	Bio-chemical Technology	Proportion Family Labor	-	--
	" "	Proportion Sharecroppers	-	--
	" "	Proportion Permenant Wage Labor	+	++
	" "	Proportion Temporary Wage Labor	+	+
	Mechanization	Proportion Family Labor	-	--
	"	Proportion Sharecroppers	-	0 (negative direction)
	"	Proportion Permanent Wage Labor	+	++
	"	Proportion Temporary Wage Labor	+	+
5 Rural Wages	Bio-chemical Technology	Average Rural Wages	+	++
	Mechanization	" " "	+	+
6 Rural Literacy	Bio-chemical Technology	Rural Literacy Rate	+	+
	Mechanization	" " "	+	+
7 Land Use	Bio-chemical Technology	Proportion Croplands	+	+
	Mechanization	" "	+	+
8 Subsistence Production	Bio-chemical Technology	Subsistence Production	-	-
	Mechanization	" "	-	0 (negative direction)

Table 74 (concluded).

Hypotheses	Independent Variables[3]	Dependent Variables[4]	Predicted Association	Results
9 Rural Net Migration	Regional Average Rural Out-Migration from 1950 to 1970			Confirmed
10 Rural Net Migration	Bio-chemical Technology	Rural Net Migration	0	0
	Meohahization	" " "	0	0

Notation: + Moderate Positive Associations — - Moderate Inverse Associations
++ Strong Positive Associations — -- Strong Inverse Associations
0 No Significant Associations — +- Mixed Pattern of Associations

Notes:
1. Measured in terms of 1950 values
2. Measured in terms of 1970 values and residual change (partial correlation coefficients)
3. Measured in terms of 1950 levels and residualized change scores
4. Measured in terms of residualized change scores

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