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Economic Efficiency of Grain Production
Systems for Traditional Agriculture In
Southeastern Minas Gerais, Brazil

presented by

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has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Agr. Economics

A handwritten signature in dark ink, appearing to read "Daniel D. Thompson". Below the signature is a horizontal line.

Major professor

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ECONOMIC EFFICIENCY OF GRAIN PRODUCTION SYSTEMS
FOR TRADITIONAL AGRICULTURE IN SOUTHEASTERN
MINAS GERAIS, BRAZIL

By

Carlos Antonio Moreira Leite

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ABSTRACT

ECONOMIC EFFICIENCY OF GRAIN PRODUCTION SYSTEMS FOR TRADITIONAL AGRICULTURE IN SOUTHEASTERN MINAS GERAIS, BRAZIL

By

Carlos Antonio Moreira Leite

This study is an attempt to understand rural poverty in the Zona da Mata region of Minas Gerais State in Brazil. This is a depressed area of the state where traditional agriculture predominates and socioeconomic problems are chronic. A comprehensive developmental program designed to meet the needs of poor farmers in the region has been implemented through a joint effort between local governmental institutions and the World Bank. Its objectives focus on revitalizing the agricultural economy of the Zona da Mata and upgrading the welfare of its population.

Many activities are found on different-sized farms as well as various opportunities for off-farm jobs, resulting in highly variable levels of farmer income. Grain production and consumption constitutes a relatively important source of food and income for farmers in the region. The specific objectives of this research were: (1) to develop a conceptual framework of income determination for Zona da Mata farmers. This provided a mechanism for identifying, among categories of farms, the differences in resource endowment, resource use and their return, management efficiency, farm output and its use, cash farm

income, off-farm income, and total family income; (2) to analyze the grain-production systems including the economic efficiency of input use and possible changes in resource allocation in order to improve farm incomes; and (3) to discuss the findings and implications of the research for future policy actions toward improving farm income of the study area.

Data for the analysis came from a sample of 550 family farms divided into five categories of farmers: sharecroppers, and landowners with 0-10 hectares, 10-50 hectares, 50-100 hectares, and 100-200 hectares.

Analysis of income determination revealed relatively low investment in capital. Family labor was the most intensive input used in the many activities performed in the region, but there was a tendency toward farm specialization in dairy and coffee production among farmers with more than 10 hectares. Among the many farm activities of smaller farmers (sharecroppers and landowners with less than 10 hectares), grain production was the most common. These farmers had a high percentage of illiteracy, receiving less assistance from the agricultural extension service, and only a small percentage participated in agricultural cooperatives. About 50 percent of the small farmers' family income was generated in off-farm jobs. The 10-50 hectares landowners' family income was about the average of the study area. Sharecroppers and 0-10 hectares landowners had relatively lower incomes, whereas those farmers with more than 50 hectares had incomes considerably higher than the region average.

The economic analysis of the grain subsector suggested no differences in farmers' production functions between small and large farmers. Econometric analysis of the production systems of corn, beans, and rice suggested different production functions for different subregions of the study area. Analysis of economic efficiency of inputs use indicated that in the corn-beans production system there was no statistical evidence of misallocation of labor and modern inputs. On the other hand, land, labor, and modern inputs are misallocated in rice production and in sole-cropped production systems of corn and beans. Additionally, small farmers could achieve high farm income by producing with the optimum combination of inputs.

Creation of off-farm jobs, enforcement of long-life contracts between landowners and landless, enlargement of social and agricultural services, cooperatives, and credit expansion for small farmers were among the recommendations derived from the empirical results, intended to raise farm income of the study area.

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CHAPTER I

INTRODUCTION

There is increasing concern about the poverty problem in Brazil. In attempting to determine the causes of the problem, several reasons have been found to explain why earnings of middle-income and upper-income groups have risen more rapidly than those of the poor. The capital-intensive type of development strategy adopted in Brazil after the Second World War has produced a greater concentration of income in contrast to other countries, such as Taiwan and Korea, which adopted policies that distributed more widely the benefits of modernization.¹ Fields used the absolute poverty measures in place of the usual relative inequality indices to deal with the problem of unequal distribution of income in Brazil during the 1960s.² He concluded that the poor in Brazil clearly did share in a decade of economic development. Some poor were lifted out of poverty. However, for those left behind, even though their income grew in absolute terms, in relative terms it did not grow as rapidly. Fields commented that

¹Hollins B. Chenery, "Poverty and Progress--Choices for the Developing World," Finance and Development 17 (June 1980): 12-16.

²Gary S. Fields, "Who Benefits From Economic Development? A Reexamination of Brazilian Growth in the 60's," The American Economic Review 64 (September 1977): 570-82.

the very rich became richer than before in both absolute and relative terms.

The bulk of the poverty problem in Brazil seems to be concentrated in the rural sector. Government efforts have been focused on understanding the critical conditioning factors of that problem and on implementing policies that would minimize them. An attempt in that direction was supported by the Brazilian government for a rather large research project (Development Alternatives for Low-Income Groups in Brazilian Agriculture) to be carried out jointly by six domestic institutions and one from abroad. Overall objectives of that project were (a) to gain an increased understanding of the rural poor and the environment in which they live and (b) to derive strategies whereby the income and welfare of this group could be improved. The regions included in that project were Canid , state of Cear ; Vale do Ribeira, state of S o Paulo; and Campo dos Vertentes and Zona da Mata, state of Minas Gerais.¹ The majority of research that came out of that project was macroeconomic in nature, and because of the very unequal distribution of land holdings, limited employment alternatives, and chronic concentrated income distribution, emphasis was placed on the Canid  region.

Despite the insights into the macroeconomic aspects of relative poverty in the agricultural sector of the Zona da Mata, very

¹For a summary of the project and its recommendations, see Guilherme Leite da Silva Dias, "Pobreza rural no Brasil: Caracteriza  o do problema e recomenda  es de pol tica," Cole  o An lise e Pesquisa, vol. 16 (Bras lia: Comiss o de Financiamento da Produ  o, Minist rio da Agricultura, Agosto 1979).

little research has been conducted with the objective of understanding its microeconomic dimensions. The present study is concerned with the process of determining household income and the economic efficiency of the major subsector of the region--the grain subsector.

Problem Statement

As is characteristic of Northeast Brazil, the Zona da Mata of the state of Minas Gerais is considered a depressed area. Among the many factors that contribute to that area's backward position relative to other regions of the state have been cited the lack of official developmental policies to promote agricultural research compatible with the resource endowment of the region,¹ lack of investment in human capital, and lack of governmental support to the farmers to start farming again after coffee eradication, which took place between 1962 and 1966.

Besides milk and coffee, which are produced mainly by large farmers, it is believed that, as an income generator, grains (corn, beans, and rice) are the second most important enterprise for farmers in the Zona da Mata. Even with the tendency of farmers in this region to produce cash crops, a large proportion of the rural

¹Most of the research conducted in the neighborhood research institutes was intended for mechanized or capital-intensive farms, which is not the case of most of the farmers in the Zona da Mata.

population of the Zona da Mata live in poverty¹ and practice traditional agriculture.²

A comprehensive developmental program intended to address the needs of poor farmers of the area has been implemented: Programa Integrado de Desenvolvimento da Zona da Mata, MG (PRODEMATA). This program is the result of a joint effort between domestic governmental institutions and the World Bank. An increase in the supply of credit is its main component. Indeed, one of the major hypotheses of the program is the positive correlation between farmers' income and use of modern production inputs, which is to be increased through increased use of credit.

Because of the many activities developed on different-sized farms as well as different opportunities for off-farm jobs, it should be useful to study the process by which farm income is determined. As the grain subsector constitutes a relatively important source of food and income for Zona da Mata farmers, coupled with the fact that this subsector is a potential recipient of a large percentage of credit from the PRODEMATA, it is also important to study the economic efficiency of producing beans, rice, and corn. It is argued that the knowledge of these factors may constitute valuable inputs for

¹Diagnóstico Econômico da Zona da Mata de Minas Gerais, Universidade de Federal de Viçosa, 1968, Ch. 7.

²The term "traditional" or "subsistence" agriculture is used here as defined by Clifton R. Wharton, Jr., "Subsistence Agriculture: Concepts and Scope," in Subsistence Agriculture and Economic Development, ed. Clifton R. Wharton, Jr. (Chicago: Aldine Publishing Co., 1969) and refers to farmers who use mainly family labor in the production process, and, although some output may be sold when a surplus occurs, production is devoted primarily to on-farm consumption.

development strategies in the region. For those responsible for agricultural policy implementation, that knowledge will be important in elaborating policies compatible with the real farm situation, whereas for research institutions such knowledge will be important in generating production techniques conforming with the characteristics of different groups of farmers.

Objectives of the Study

The overall objective of this study is to generate better knowledge about the process of income generation in the Zona da Mata farm sector. Particular emphasis is placed on the grain subsector because it is believed that this subsector plays a special role in the income generation of that sector.

To fulfill this goal, the following specific objectives were set:

1. To develop a conceptual framework of the income-determination process for the Zona da Mata farmers. This will provide a mechanism for identifying, among different categories of farms, the differences in resource endowment, resource uses and their return, management efficiency, farm output, on-farm consumption, marketable surplus and cash farm income, off-farm income, and total family income. This analysis will help identify typical combinations of enterprises for each class of farms.

2. To analyze the grain-production system in the study area and to verify differences in production among classes of farms. This analysis also should provide a basis for analyzing economic efficiency

of resource use in grain production and possible resource reallocation in order to improve farm incomes.

3. To discuss the findings and implications of the research for future actions toward improving farm income in the study region.

Organization of the Study

This study is organized into five chapters. Chapter I contains a discussion of the problem setting, the importance of the study, and the objectives of the research. A brief characterization of the agricultural sector of the study area as well as the goals and specific components of the PRODEMATA project are presented in Chapter II. The sampling procedure used to generate the data for this study is also explained. Chapters III and IV deal with research results. Analysis of the income-determination conceptual framework is developed in Chapter III. The economic efficiency analysis of the grain subsector is presented in Chapter IV. Finally, Chapter V contains a summary of the major findings of the study, their policy implications, and suggestions for further research.

CHAPTER II

GENERAL CHARACTERISTICS OF THE STUDY AREA
AND THE SAMPLING PROCEDURE

Introduction

The main objective of this chapter is to present selected characteristics of the study area and of the PRODEMATA. The initial sections of this chapter deal with key structural characteristics of the farm sector of the state of Minas Gerais and some general geographical and sociodemographic characteristics of the Zona da Mata. Some background information about the PRODEMATA project is presented later in the chapter, and its costs and component programs are examined. Concluding the chapter, the sampling procedure and data used in this study are discussed.

The Structure of the Farm Sector of the
State of Minas Gerais

This study was developed for the Zona da Mata, located in the eastern part of the state of Minas Gerais. (See Figure 2.1.) The agricultural sector of Minas Gerais is of great importance for the state itself and for the whole country. According to the agricultural census of 1975, the number of farms in the state was 454,465, and the total income of these farmers was about 15 billion cruzeiros (equivalent to US \$4,000 per farm).

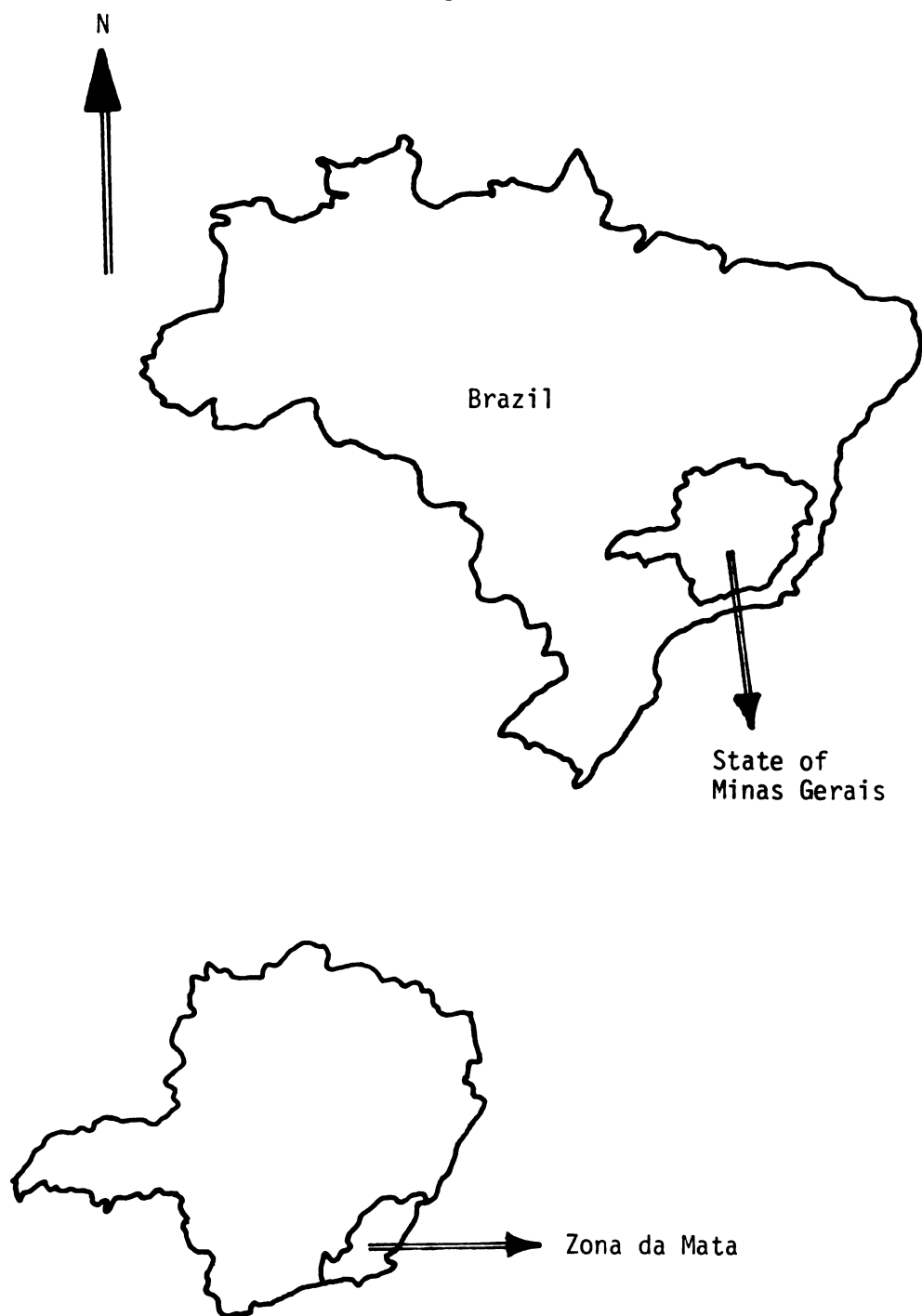


Figure 2.1.--Location of the Zona da Mata in Brazil.

There are relatively few large farms in the state. About 28 percent of the farms consist of fewer than 10 hectares, and about 81 percent of the farms consist of fewer than 100 hectares. Farms larger than 100 hectares represent about 19 percent of the total, but they earn about 61 percent of the total income of the sector (Table 2.1). The Gini Index of Income Concentration, or the Gini Income Ratio, derived from the data presented in Table 2.1, is about .537.¹

The census data show that farms with an area between 20 and 50 hectares are most common, accounting for about 30 percent of the total farms in the state. The farmers with the largest share of income owned farms of between 200 and 500 hectares and received 19.6 percent of the income generated in the agricultural sector in Minas Gerais in 1975.

The percentage of the rural population of the state has decreased since 1950 (Table 2.2). In 1975 it was estimated that about 40 percent of the state's population lived in rural areas. Since 1960, in fact, in absolute numbers, the rural population has decreased. The initial incentive for outmigration was the increased demand for labor during the construction of Brasilia, the new capital city, and lately the relatively more favorable wages in urban areas.

¹To compute the Gini Index of Income Concentration or the Gini Income Ratio, the following formula was used:

$$\text{Gini Ratio} = 1 - \sum_{i=1}^k (f_{i+1} - f_i) (y_i + y_{i+1})$$

(The variable definitions are presented in Appendix B.) A formal mathematical presentation of the Gini Ratio was made by Charles H. Riemen-schneider, "The Use of the Gini Ratio in Measuring Distributional Impacts" (M.S. research report, Michigan State University, 1976). See also James Morgan, "The Anatomy of Income Distribution," Review of Economics and Statistics 44 (1962): 270-83.

Table 2.1.--Distribution of farm sizes and income in Minas Gerais, 1974-1975.

Area (ha)	Farmers			Income (1,000 Cruzeiros)		
	Number of Farms	Percent of the Total	Accumulated Percentage	Thousands of Cruzeiros	Percent of the Total	Accumulated Percentage
≤1	7,039	1.55	1.55	142,648	0.92	0.92
1-2	11,712	2.58	4.13	89,813	0.58	1.50
2-5	51,164	11.26	15.39	403,018	2.60	4.10
5-10	58,358	12.84	28.23	553,082	3.56	7.66
10-20	73,043	16.07	44.30	891,782	5.75	13.41
20-50	104,471	22.99	67.29	1,981,101	12.77	26.18
50-100	62,033	13.65	80.94	2,008,101	12.94	39.12
100-200	42,686	9.39	90.33	2,323,400	14.98	54.10
200-500	29,702	6.54	96.87	3,035,302	19.56	73.66
500-1000	9,024	1.99	98.86	1,778,847	11.47	85.13
1000-2000	3,415	0.75	99.61	1,171,105	7.55	92.68
2000-5000	1,485	0.33	99.94	829,445	5.35	98.03
5000-10000	247	0.05	99.99	208,224	1.34	99.37
≥10000	86	0.02	100.00	98,425	0.63	100.00

Source: Fundação Instituto Brasileiro de Geografia e Estatística, Censo Agropecuário de Minas Gerais (Rio de Janeiro, 1975).

Table 2.2.--Urban, rural, and total population of Minas Gerais State and Zona da Mata, 1950-1975 (in thousands).

Year	Minas Gerais ^a			Zona da Mata ^a		
	Total	Rural (%)	Urban (%)	Total	Rural (%)	Urban (%)
1950	7,782.2	5,459.3 (70.2)	2,322.9 (29.8)	1,283.3	898.2 (70.0)	385.1 (30.0)
1960	9,657.7	5,832.5 (60.4)	3,825.2 (39.6)	1,523.0	955.8 (62.8)	367.2 (37.2)
1970	11,487.4	5,427.1 (47.2)	6,060.3 (52.8)	1,600.8	805.2 (50.3)	795.6 (49.7)
1975 ^b	12,550.6	5,199.9 (41.4)	7,350.7 (58.6)	1,623.7	789.1 (48.6)	834.6 (51.4)

Source: Fundação Brasileira de Geografia e Estatística (FIBGE), Anuário Estatístico do Brasil, 1955 and 1978 issues.

^aThe figures in parentheses are the percentages of rural and urban population.

^bEstimated by Fundação Brasileira de Geografia e Estatística (FIBGE), Anuário Estatístico do Brasil, 1978.

General Characteristics of the Zona da Mata

The Zona da Mata of Minas Gerais State covers an area of 36,012 km² bordering on the states of Rio de Janeiro and Espírito Santo.¹ The southern regions are rolling, becoming quite hilly toward the north, with areas of poor drainage in the valleys. It has been estimated that about 16 percent of the entire Zona da Mata

¹Fundação Instituto Brasileiro de Geografia e Estatística, Anuário Estatístico do Brasil (Rio de Janeiro, 1968).

is constituted of flat land, whereas 44 percent and 40 percent are rolling and hilly land, respectively.¹

The temperature of the region averages about 22°C. The mean annual rainfall is about 1,400 mm, with a dry period for six months from April to September.

It was estimated that in 1975 the total population of the Zona da Mata was about 1.6 million (Table 2.2). The population density was about 35 persons per km², about four times the average for Brazil. Estimates for 1975 indicated that about 49 percent of the Zona da Mata population was living in rural areas. That percentage has been decreasing since 1950, even though from 1950 to 1960, in absolute terms, that population increased.

Rural per capita income for the area was estimated in 1974-75 to be about US \$250 equivalent, which was about 25 percent of the per capita income of the country as a whole.² Considering the poverty level as one-third of national per capita income, the rural per capita income was below the national relative poverty level of US \$340 equivalent.

The region's social infrastructure is poor, and available health and education services are deficient.³ As observed in many

¹Tácito Cláudio Andrade Taveira, "Análise de Localização da Produção Agrícola em Relação ao Mercado de Juiz de Fora--Minas Gerais" (M.S. thesis, Universidade Federal de Viçosa, 1976).

²The World Bank, Brazil--Staff Project Report of the Integrated Rural Development Project in the State of Minas Gerais, Report No. 1291 Br. (Washington: World Bank, 1976).

³Ibid., p. 14.

underdeveloped regions in Brazil, the health status of the inhabitants of the Zona da Mata is characterized by high mortality and morbidity rates caused by communicable diseases; high infant mortality rate, caused mainly by infectious diseases; and serious incidence of malnutrition as a basic or associated cause of child mortality. It has also been observed that schistosomiasis is a widespread problem; in some localities, a high percentage of the population is infected.

State investment in education in the rural Zona da Mata is relatively low. It has been estimated that two-thirds of the education is financed by the municípios (municipalities) and one-third by the state government. Besides the serious lack of facilities, the inadequacy of the teaching services has also been observed. It has been estimated that a high percentage of the school staff members do not have the basic qualifications required by law, and the curricula are generally not compatible with the students' future needs. The limitations of educational opportunity seem to be reflected in the low educational attainment of the labor force. The population census of 1970 revealed that 60 percent of the agricultural workers of that region had not had any formal education.¹

The Farm Sector of the Zona da Mata

Colonization of the Zona da Mata was similar to that in many other areas in Brazil. The gold race and the desire to make a fortune from precious stones brought explorers from the Brazilian coast to the

¹Fundação Instituto Brasileiro de Geografia e Estatística, Anuário Estatístico do Brasil, 1978.

southeastern part of Minas Gerais during the seventeenth century. At that time, agriculture was either nonexistent or, in some areas, was conducted on a small scale largely at subsistence level. Mining profits were sufficient to pay for importing food and other necessities from other regions of the country.

About 1830, coffee plantations were introduced to the Zona da Mata. Cattle had also been introduced to the region. Mining productivity was declining. Because of the relatively good price of coffee, coffee growing became an incentive to farming in the Zona da Mata, and coffee became one of the most important products of the state's economy. Small-scale industries grew up in the Zona da Mata to supply the market demand generated by the coffee economy.¹

Until the first quarter of the twentieth century, the Zona da Mata occupied an important position among the other regions of the state. Since then, however, it has become relatively less important for many reasons:

1. Lack of development of new agricultural technology.

Because land and labor were abundant, little attention was given to these factors in public policy.

2. The land is hilly and the soil is poor. These facts imply a need for proper land management, which increases production costs and decreases the competitive market position of the Zona da Mata.

¹ Universidade Federal de Viçosa, Diagnóstico Econômico da Zona da Mata (Viçosa: Imprensa Universitária, 1971).

3. Limited basic education, health, and extension services in rural areas. These factors decrease labor productivity and consequently increase unit production costs.

4. Stagnation of the industrial sector followed by lack of dynamic business practices and obsolescence of the industrial sector.¹

After the program to eradicate coffee plantations from 1962 to 1966, which had as one objective to raise coffee prices, the economic degeneration of the Zona da Mata was accelerated because of the elimination of its most important source of income. It is worth noting that since the nineteenth century, besides coffee and sugar cane, cattle ranching was a subsidiary activity. The production of milk and meat in some regions became as important as coffee because of poor returns from producing coffee at low prices. With the elimination of coffee as a crop, the plan was to emphasize cattle raising. However, the introduction of more adapted and specialized animals changed the production cost structure. Animals with better genetic characteristics, capital investment and equipment, and specialized labor were the most important components. High production costs limited the substitution of cattle for coffee on small farms as well as many medium-sized farms. Only the large farmers were able to survive in this long economic crisis.

The number of farms in the Zona da Mata was about 67,474 in 1975 (Table 2.3). About 76 percent of these farms were smaller than

¹Universidade Federal de Viçosa, DER, Programa Integrado de Desenvolvimento da Zona da Mata--MG, Primeiro Relatório Anual de Avaliação (Viçosa: Imprensa Universitaria, Março 1979).

50 hectares, and 33 percent were smaller than 10 hectares. The World Bank estimates that there are also about 24,000 sharecroppers¹ engaged primarily in the production of subsistence food crops. The problem of land ownership has been indicated as being associated with the major economic problems of the Zona da Mata. Silva computed the distribution of land concentration (Gini Ratio) as being equal to .68, indicating concentration of land ownership in the region.²

Table 2.3.--Number of farms by size in the Zona da Mata, MG, 1975.

Class of Farm (ha)	Total Number of Farmers	Percentage of Farms	Cumulative Percentage of Farms
0- 10	22,171	32.9	32.9
10- 50	28,962	42.9	75.8
50-100	8,627	12.8	88.6
100-200	4,996	7.4	96.0
200 and higher	2,718	4.0	100.0
Total	67,474	100.0	--

Source: Fundação Instituto Brasileiro de Geografia e Estatística, Censo Agropecuário de Minas Gerais (Rio de Janeiro, 1975).

The relative abundance of labor and the relatively low yields of most crops are distinguishing characteristics of traditional agriculture in the Zona da Mata. Action toward bringing about

¹World Bank, op. cit., p. 1.

²Carlos Arthur B. da Silva, "Factors Affecting Enterprise Choice: An Analysis of Traditional Food Production in Southeastern Minas Gerais, Brazil" (Ph.D. dissertation, Michigan State University, 1981).

changes in the study area have been implemented. Several state organizations have combined their efforts with those of the World Bank to implement a comprehensive development program (PRODEMATA), which is described in some detail in the next section.

The Integrated Rural Development Program for the
Zona da Mata Region of Minas Gerais State

The Integrated Rural Development Program for the Zona da Mata Region of Minas Gerais (PRODEMATA) has financial participation from the World Bank. The main domestic agencies involved in this program are the State Secretariat of Planning (SEPLAN), which is responsible for its implementation; the State Rural Development Agency (RURALMINAS), which is the overall coordinator; and the Departamento de Economia Rural (DER) of the Universidade Federal de Viçosa, which is responsible for evaluation of the project through time.

The objectives of the PRODEMATA focus on revitalizing the agricultural economy of the Zona da Mata and upgrading the welfare of its population. These objectives are to be accomplished by:

1. Raising the income levels of the poor families by providing credit and technical services,
2. Increasing agricultural production by introducing technical innovations and expanding the variety of crop and livestock enterprises, and
3. Generally improving the quality of life by expanding and upgrading social services such as education, health, and sanitation. However, increased agricultural production would be the backbone of the project.

Project Cost and Components¹

The cost of the project is estimated at US \$139 million. About 60 percent of the project's total cost is allocated to the agricultural credit component. The beneficiaries of these services are primarily sharecroppers and small farmers with fewer than 100 hectares of rainfed land. Productive credit covers normal crop, livestock, and forestry production costs, including consumption credit for the smaller farmers and sharecroppers and hired labor and other inputs. Loans for investments are mainly for the establishment of sugar cane and fruit trees, pasture establishment and improvement, reforestation, the purchase of breeding stock, fencing, farm equipment, livestock handling facilities, and rural electrification. A special line of credit is available to large-sized farmers (100 to 200 hectares), especially for land reclamation and reforestation purposes.

The rural electrification component, with a total cost of about US \$6.2 million, is intended to provide electricity for home, farm, and agro-industrial use in parts of the project area where electricity is not available.

Under the land-reclamation component, it is estimated that about 8,000 hectares of individually owned, poorly drained valley-bottom land will be reclaimed by means of appropriate irrigation, drainage, land leveling, and flood control. RURALMINAS is the agency in charge of this project component, and it is estimated that the final

¹For more details concerning the project cost and components, see World Bank, op. cit., pp. 17-32.

payment by farmers for this land improvement will be about 70 percent of the market price for similar services.

The production support services component comprises mainly agricultural research, technical assistance, and extension and cooperative services. A relatively small program of applied agricultural research and demonstration is carried out under the project. About US \$1.2 million is the total investment in such a service. This share of the total project cost is intended to finance the cost of field trials, staff salaries, operating costs, and the purchase of equipment, including vehicles.

Technical assistance and extension services, which have been directed primarily at larger farmers of the area, are to be enlarged to serve smaller farmers and sharecroppers. About 150 new extension agents have been recruited and are being trained with assistance provided by the Universidade Federal de Viçosa and EPAMIG. It is estimated that a total of US \$10.3 million will be used to finance the cost of new equipment, including vehicles and other operational costs for enlargement of technical assistance services.

The plan concerning cooperatives in the Zona da Mata is at least to double the present 31 cooperatives with 1,600 members. The goal is to establish a new regional office of State Superintendency of Cooperatives (SUDECOPE) to (a) promote cooperation and encourage the formation of cooperatives among small farmers, (b) provide technical assistance to existing cooperatives; (c) organize training courses for cooperative managers and administrators; and (d) offer courses to cooperative members, especially on marketing and production.

Finally, the social services component includes investments in basic aspects of health and education. The main objectives of the health component would be to provide health posts distributed throughout the project area, to offer low-cost health services, and to emphasize preventive medicine and promotional activities. Further investments would be made in sanitation programs, with the objective of diminishing morbidity and mortality from diseases caused by poor sanitary conditions. In addition, a vaccination program would be implemented to diminish the incidences of communicable diseases in the area. Also, health authorities would develop a program to investigate schistosomiasis foci, especially in the varzeas (valley lowlands), of the project area. A nutrition program would also be carried out with the objective of preventing and diminishing caloric and protein malnutrition. Priorities of this program were established in the following order: pregnant women, lactating mothers, children under three years of age, and three- and four-year-old children who are undernourished.

With regard to investment in education, the strategies of the project are to expand the role of the rural school by making it a multipurpose center for the provision of adult education services; to expand and improve rural primary education; to disseminate, by means of school and out-of-school education activities, basic knowledge of agricultural technology, farm management, rural organization, and family education; and to develop better education-management capabilities by means of technical-assistance programs.

The Sample and the Data

The Sample

The Departamento de Economia Rural, Universidade Federal de Viçosa, selected the sample during July 1977. The sample comprised 851 family farms selected at random from the files of the National Institute of Colonization and Agrarian Reform (INCRA). Landowners and sharecroppers constituted the sample.

The sampling procedure was as follows:

1. Regionalization of the Zona da Mata according to the administrative division of the Extension Service Agency of Minas Gerais (EMATER), including the regions of Muriaé, Viçosa, and Juiz de Fora.
2. Identification of the municipalities in each of the three regions.
3. Identification of the villages and their populations in each municipality to be covered by EMATER-PRODEMATA.
4. Selection of four municipalities in each region, two of them selected at random and the other two having the following characteristics:
 - a. high population and large number of farms receiving assistance,
 - b. typical or traditional producers of products of interest to PRODEMATA (such as tobacco or sugar cane), not included in other municipalities.
5. Distribution of the sample members according to the number of properties in a selected municipality.

6. Random selection of 700 landowners within the selected municipalities, using the INCRA files for the year 1970. These farm owners were to be interviewed during the course of PRODEMATA.
7. Identification of sharecroppers,¹ as indicated by the selected landowners, because there are no records of this class of producers. The number of sharecroppers selected by region was 50. For each municipality selected at random, at least 12 sharecroppers were selected.²

Municipalities selected by region were the following:

<u>Region of:</u>		
<u>Juiz de Fora</u>	<u>Muriaé</u>	<u>Viçosa</u>
1. Alto Rio Doce	1. Carangola	1. Ervália
2. Juiz de Fora	2. Leopoldina	2. Ponte Nova
3. Santos Dumont	3. Manhuaçu	3. Raul Soares
4. São João Nepomuceno	4. Muriaé	4. Ubá

The sample distribution by regions and categories of farmers is presented in Table 2.4. See Figure 2.2 for geographical locations of the regions considered.

The three regions of the Zona da Mata (Juiz de Fora, Muriaé, and Vicosá) are relatively homogeneous in terms of agronomic characteristics; however, they differ in other aspects. Juiz de Fora

¹Sharecroppers and landless producers or tenants who, under contract, use landowners' land in exchange for payment in kind, in cash, and/or in production factor costs. (See Appendix A for more details.)

²Universidade Federal de Viçosa, DER, op. cit.

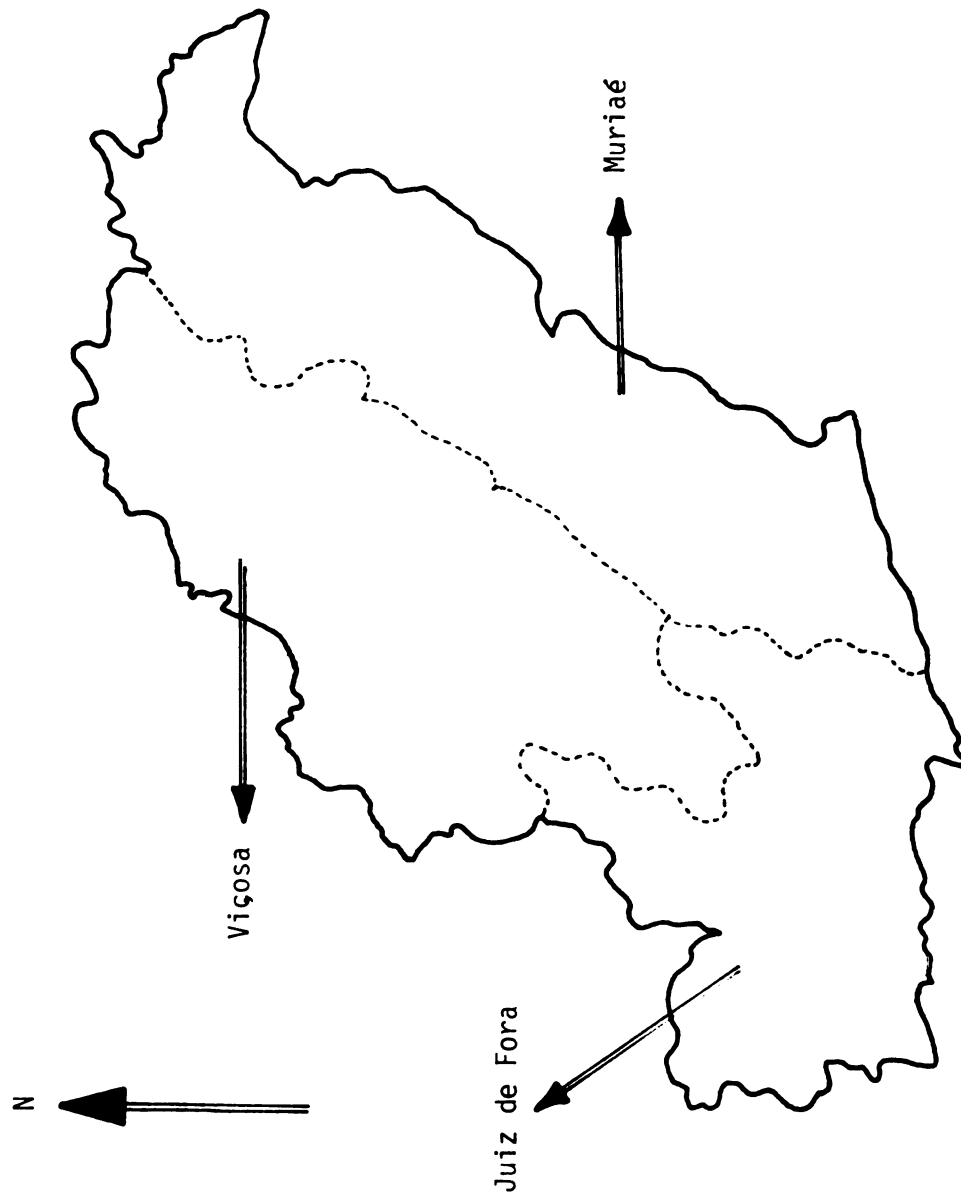


Figure 2.2.--Regions of Zona da Mata.

region, for instance, is considered the major milk-producer region of the Zona da Mata, supplying the local market and the market of Rio de Janeiro city. The region of Muriaé is also a relatively important one in dairy products in the Zona da Mata. However, coffee seems to be its more important enterprise. The region of Viçosa is characterized by a diversified agriculture. Traditional crops such as grains and sugar cane are among the main agricultural activities. The region of Juiz de Fora is characterized as the industrial center of the Zona da Mata. In the other two regions there are no major industries, and access of rural areas to demand centers is their peculiar characteristic.

Table 2.4.--Sample composition: PRODEMATA, Zona da Mata, Minas Gerais, 1976-1977.

Categories	Regions			Zona da Mata
	Juiz de Fora	Muriaé	Viçosa	
Sharecroppers	52	52	49	153
Landowners:				
0- 10 ha	64	94	74	232
10- 50 ha	62	165	89	316
50-100 ha	24	50	24	98
100-200 ha	18	25	9	52
Total	220	386	245	851

Source: Universidade Federal de Viçosa, DER, Programa Integrado de Desenvolvimento da Zona da Mata--MG, Primeiro Relatório Anual de Avaliação (Viçosa: Imprensa Universitária, Março 1979).

Following the orientation of the Universidade Federal de Viçosa, for the purposes of this research the sample size was reduced to 550 observations, including only those respondents whose answers were consistent throughout the questionnaire. The new sample was distributed among the categories of farmers as follows:

Sharecroppers	129 observations
Landowners:	
0- 10 ha	123 observations
10- 50 ha	220 observations
50-100 ha	59 observations
100-200 ha	19 observations

The Data

Basically, the questionnaire used to obtain the data sought information related to (a) agricultural production, (b) education, (c) health, (d) nutrition, and (e) sanitation. A general overview of the information obtained from the survey is presented below:

I. Agricultural Production (agricultural year 1976-77)

A. Stock of production inputs

1. Land with its use
2. Capital: buildings, machinery, and equipment
3. Labor: hired labor and family labor

B. Agricultural production

1. Area used for production, the total production, and participation of sharecroppers in the productive process
2. Percentage of production paid in kind by the sharecroppers to the landowners for each product

3. Home consumption, quantity sold, and price received
by the producer for each output
- C. Technology and input used in each enterprise
 1. Quantity of labor used
 2. Seeds and fertilizer used
 3. Pesticides, machinery, and animals used
 4. Amount spent on animal care and feed
 5. Sharecroppers' share of all expenses
- D. Use of credit in each enterprise
- II. Wages received outside the farm
 - A. Farm labor
 - B. Nonfarm labor
- III. Education
 - A. Family composition
 - B. Formal and informal education
 - C. Use of formal education received
 - D. Cooperatives and farmer involvement
 - E. Social groups
- IV. Health
 - A. Medical attention to the family
 - B. Medical service availability and use
- V. Nutrition: Description of the family's daily consumption
- VI. Sanitation
 - A. General household care with sanitation problems
 - B. Conditions of the water used at home
 - C. Stagnant water and waste disposal

Summary

This chapter presented general characteristics of the Zona da Mata region of the State of Minas Gerais and an overview of the integrated rural development program (PRODEMATA) that has been implemented in the region. The objectives of this project are to improve living standards and incomes of small farmers and sharecroppers in the study area through (a) increasing farm production by expanding the area under cultivation and raising yields and (b) expanding and improving social services to farmers and the general rural population. The major component of the project is provision of agricultural credit, which accounts for about 60 percent of the project's cost. Other major components are provision of supportive agricultural services; provision of social services, including investments in sanitation, health, and education; and rural electrification and land reclamation. In evaluating the project, the Universidade Federal de Viçosa surveyed about 851 family farms; this sample was later reduced to 550 farms. This reduced sample was used throughout the present study.

CHAPTER III

CHARACTERIZATION OF FARM PRODUCTION SYSTEMS

Introduction

Overall characteristics of the Zona da Mata farmers are presented in this chapter. The sample has been divided into five categories of farmers including: sharecroppers; and landowners with 0-10 hectares, 10-50 hectares, 50-100 hectares, and 100-200 hectares. A descriptive analysis of these categories of farmers will be made in terms of the conceptual framework presented in Figure 3.1. The objective of that framework is to characterize farmers in terms of their farm size and use of land, labor, and capital in the production process. Additionally, an attempt is made to identify production systems within different farm categories which include off-farm activities of the family members in order to better understand how total farm family income is determined in the study area.

A description of the conceptual framework is presented below.

Income Determination Conceptual Framework

Norman defined a farming system as a complex interaction of several interdependent components.¹ Among these components is the

¹David W. Norman, "The Farming System Approach: Relevancy for the Small Farmer," Michigan State University Rural Development Paper No. 5 (East Lansing: Michigan State University, 1980). See Appendix D for further details.

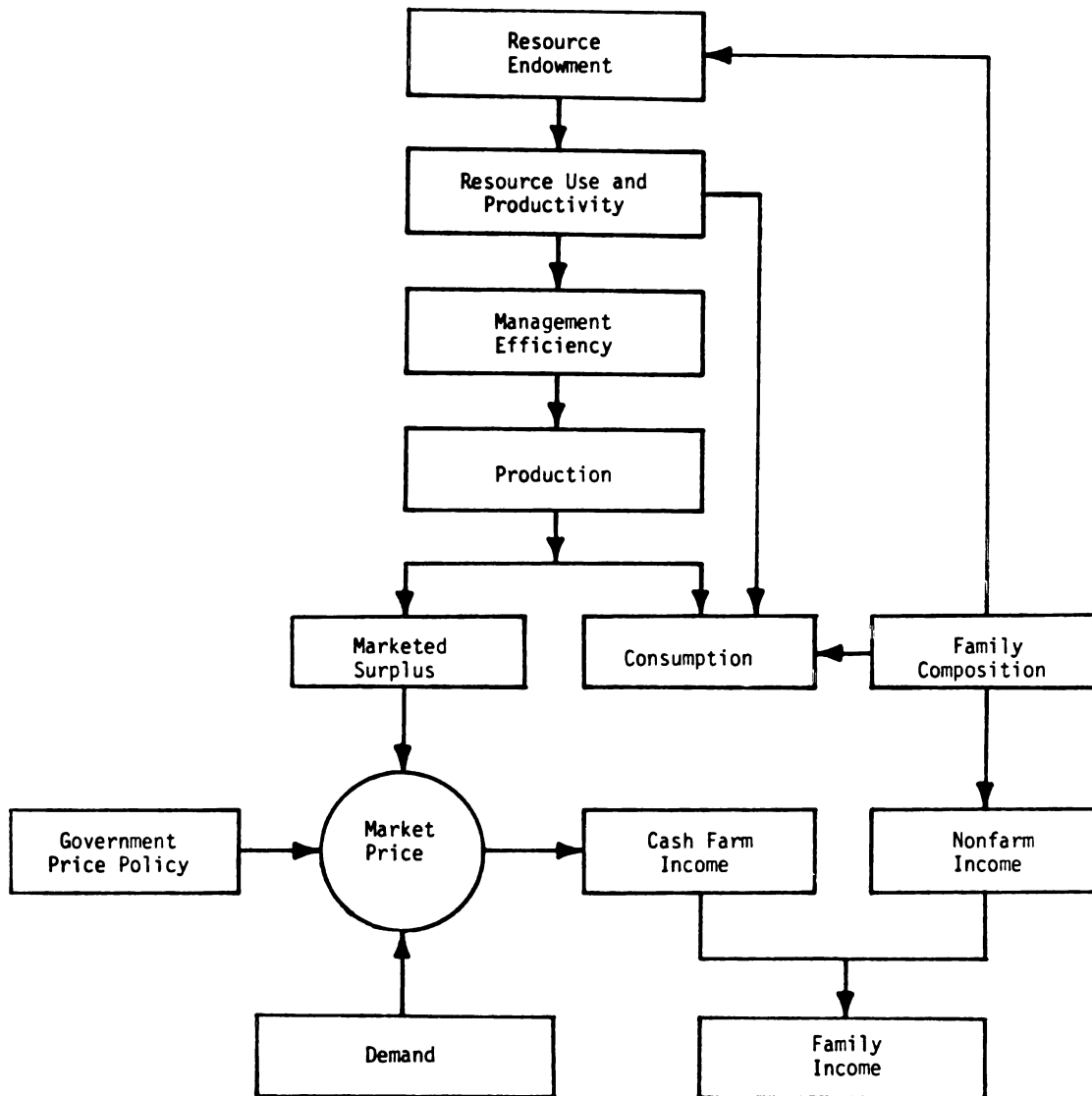


Figure 3.1.--Farm family income determination conceptual framework.

rural household acting as both a production and a consumption unit. If income growth and development are to be achieved, the multiple uses of farm and family resources must be understood, and the production-consumption-sales relationship must be related to the agricultural market and off-farm employment opportunities.

Farm income and farm profitability can be dealt with in a similar manner for the same time period. As Brown suggested, farm income can be viewed as a whole or as an isolated enterprise.¹ In the first approach, returns to farm labor, capital, and management invested in a given time period, say one year, are studied. In the second approach, the profitability of each phase can be measured at various stages, such as gross output, net output, gross margin, and profits.

Basic to the framework used in this research is that the cash farm income of a small-scale farm in the Zona da Mata will depend on the farm's marketed surplus and the compensation to family labor off the farm. Production is directly affected by (a) resource endowment, (b) resource use, and (c) management efficiency of the farmer, in addition to other exogenous variables, such as weather, that cannot be controlled by the farmer.

Resource endowment includes availability of land, labor, and capital. It is hypothesized in this conceptual framework that land supply is limited, capital investment is small, and labor is usually limited to the family supply. Operating capital may be closely related

¹Maxwell Brown, "Farm Budgets--From Farm Income Analysis to Agricultural Project Analysis," World Bank Occasional Paper No. 29 (Baltimore: Johns Hopkins University Press, 1979).

to farm income if improved seeds, fertilizer, and hired labor are used efficiently. Apart from credit availability, since operating capital is a function of savings, it can be concluded that the net farm income of a previous period is a critical factor determining current income level.

Concerning the resource use variable, which is closely related to farm income, some empirical researchers have shown inefficient resource allocation by small-scale farmers in Brazil. In two regions of Minas Gerais State--Zona da Mata and Campo das Vertentes--Garcia found that small-scale farmers were not efficient in labor allocation.¹ Assuming that farmers aim to maximize profit, it was found that the conditions for maximization were not satisfied. The farmers employed excessive labor. Consequently, the required equality of marginal product of labor and labor wage was not attained. Graber, studying the explanatory factors of farm production of small farms in Vale do Ribeira, São Paulo State, and Canid , Cear  State,² and Teixeira, analyzing the resource efficiency of small farmers in Canid ,³ concluded that there was a poor allocation of acquired production factors among these producers.

¹Jo o Carlos Garcia, "An lise de Aloca  o de Recursos por Propriet rios e Parceiros em Areas de Agricultura de Subsist ncia" (M.S. thesis, Universidade Federal de Vi osa, Imprensa Universit ria, 1975).

²Kenneth L. Graber, "Factors Explaining Farm Production and Family Earnings of Small Farmers in Brazil" (Ph.D. dissertation, Purdue University, 1976).

³Teot nio Dias Teixeira, "Resource Efficiency and the Market for Family Labor: Small Farms in the Sert o of Northeast Brazil" (Ph.D. dissertation, Purdue University, 1976).

The management ability of the farmer is critical to the level of income. Many factors determine a farmer's ability to make a correct decision. Management decisions are generally grouped as follows: (a) what to produce, (b) how much to produce, (c) the kinds and amounts of resources to use, (d) the technology to use, (e) when and where to sell and buy, and (f) how to finance the operation.¹

The final component to be discussed in this conceptual framework is farm family income. The cash income generated from the farm refers to farm sales. Another component of family income in addition to sales is the income generated by working off the farm, which might be an important income source for the smaller producers of the study region.

Analysis of the Farm Family Income Determination Conceptual Framework

Resource Endowment

Land. For the whole study area, the average farm size was about 27 hectares. The average land holding by sharecroppers was about 6.28 hectares, approximately the same as the average size of the 0-10 hectares farm category, which was 6.44 hectares. The coefficient of variation of farm size for the whole study region was 126.29 percent; it was 196.0 percent for the sharecroppers. As observed in Table 3.1, the coefficient of variation of land ownership among the categories of farmers analyzed was lower the higher farm size; however, it increased for the 100-200 hectares landowners.

¹J. H. Herbst, Farm Management--Principles, Budgets, Plans, 4th ed. (Champaign, Ill.: Stipes Publishing Co., 1976).

Table 3.1.--Average farm size and land use by class of producers, Zona da Mata, MG, 1976-77.^a

Class of Producers	Land Use (Hectares)					Average of Land Holdings by Class of Producers (Hectares)	Coefficient of Variation of Land Holdings by Class of Producers (%)
	Crops	Pasture	Forest	Lowland	Not Usable	Other Uses	
Share-croppers	4.04 (64.4) ^b	1.14 (18.2)	.35 (5.6)	.63 (1.0)	0 (0)	.11 (1.8)	196.00
0-10 ha	2.52 (39.1)	2.09 (32.5)	.57 (8.9)	.71 (1.1)	.21 (3.3)	.33 (5.1)	50.62
10-50 ha	6.67 (24.4)	14.18 (51.8)	2.92 (10.7)	2.32 (8.5)	.58 (2.1)	.68 (2.5)	46.47
50-100 ha	12.31 (16.5)	47.11 (63.3)	8.81 (11.8)	3.09 (4.2)	1.06 (1.4)	2.05 (2.8)	26.26
100-200 ha	17.02 (11.7)	103.41 (71.1)	15.15 (10.4)	7.36 (5.1)	.29 (.2)	2.23 (1.5)	35.29
Zona da Mata Average	6.08 (22.6)	15.03 (55.9)	2.85 (10.6)	1.83 (6.81)	.41 (1.53)	.66 (2.46)	126.29

Source: Sample survey.

^aThe total area held by the producer was computed by summing the area of the many kinds of land declared at the time of the interview.

^bThe figures in parentheses are percentage of land use by each group of producers.

The pattern of land use is directly related to the Zona da Mata's topography. Crops are grown on flat or less-hilly areas while pastures predominate in the relatively hilly areas. A limitation to increasing crop production in the Zona da Mata is the limited supply of crop land which includes only 23 percent of the total land area. About 56 percent of the area is used for pasture (hilly topography), and the rest is forest or not usable for other reasons.

Labor. An average of nearly 670 man-days¹ of labor was available per farm in the Zona da Mata (Table 3.2), which is equal to 2.23 man equivalents working 300 days per year. The availability of labor increased with size of farm. It was observed that the sharecroppers had more labor available than did the 0-10 hectares landowners. As expected, the most important source of labor was the family. Family labor as a whole accounted for 76 percent of the total labor available in the Zona da Mata while 16 percent and 9 percent of the available labor came from sharecroppers and hired labor, respectively. The greater relative importance of sharecroppers and hired labor as a source of labor for larger farmers is noted.

Table 3.3 indicates that about 86 percent of all labor comprised adult men; 11 percent adult women, and 3 percent children. The availability of adult-women labor from the family was highest for the 0-10 hectares landowners, with 21 percent of the total labor force. Adult-women labor from hired labor was not included in the labor

¹A man-day is a unit-measure of labor in a production unit and is defined as equal to 1.0 for adults between the ages of 16 and 64 years and 0.5 for those under or equal to 15 years, or above or equal to 65 years.

Table 3.2.--Types of labor available per productive unit, man-days,^a Zona da Mata, MG, 1976-77.

Class of Producers	Family Labor			Permanent Sharecroppers			Hired Labor			Total Man-Days Available		
	Adult Men	Adult Women	Child- dren	Total	Adult Men	Adult Women	Child- dren	Total				
Sharecroppers												
0-10 ha	421	46	20	487	--	--	--	2	0	0	2	489
10-50 ha	315	92	13	420	28	4	1	33	10	0	0	463
50-100 ha	467	57	23	547	81	2	2	85	49	0	2	683
100-200 ha	530	45	15	590	345	22	1	368	109	2	2	1,071
Zona da Mata Average	397	74	14	485	621	63	14	698	558	42	12	1,795
	427	61	19	507	97	6	1	104	53	3	2	669

Source: Sample survey.

^aA man-day is a unit-measure of labor in a production unit and is defined as equal to 1.0 for adults between the ages of 16 and 64 years and 0.5 for those under or equal to 15 years, or above or equal to 65 years.

Table 3.3.--Total adult-man, adult-woman, and child labor in man-days available by class of producers, Zona da Mata, MG, 1976-77.

Class of Producers	Total Units of Labor Available From:			Total Man-Days Available
	Adult Men	Adult Women	Children	
Sharecroppers	423 (86.5) ^a	46 (9.41)	20 (4.09)	489
0-10 ha	353 (75.9)	96 (20.6)	14 (3.01)	465
10-50 ha	597 (87.4)	59 (8.64)	27 (3.95)	683
50-100 ha	984 (91.9)	69 (6.44)	18 (1.68)	1,071
100-200 ha	1,576 (87.80)	179 (9.97)	40 (2.23)	1,795
Zona da Mata Average	577 (86.2)	70 (10.5)	22 (3.29)	669

Source: Sample survey.

^aThe figures in parentheses are percentages of the kind of labor over the total labor availability to that class of producers.

force of sharecroppers, 0-10 hectares landowners, or 10-50 hectares landowners. Among all classes of producers, sharecroppers had the most child labor available, which accounted for about 4 percent of the total labor. Producers with 50-100 hectares had the lowest share of child labor--about 2 percent.

Capital. The analysis of capital is considered through three major categories: (1) capital in the form of all buildings including animal facilities, (2) capital in terms of machinery and equipment, and (3) capital in the form of work animals and livestock.

The average investment in all buildings on Zona da Mata farms was about Cr\$30,000, which included the proprietor's and employees' houses, storage facilities, barns, poultry and hog houses, and other small buildings (Table 3.4). As expected, the larger the farm, the higher the investment. Total investment ranges from Cr\$4,377 on sharecropper units to Cr\$258,547 on farms with 100-200 hectares.

Over two-thirds of the capital invested in buildings is for the proprietor and employees housing. The largest amount is invested in the proprietor's house, but the absolute value of housing increases substantially for both the owner and employees as farm size increases. Housing, while small in total value, represents over 80 percent of building investment for sharecroppers and for farms with 0-10 hectares. This reflects the extremely low level of investment in buildings used for farm production purposes.

Investment in grain storage is the second most important building item on most farms--ranging from 7.1 to 11.5 percent of total

Table 3.4.--Capital stock in housing, storage, and animal facilities, Zona da Mata, MG, agricultural sector, 1976-77 (in 1977 cruzeiros).

Class of Producers	Housing		Grain Storage	Dairy Barns	Poultry Houses	Hog Houses	Other ^a	Total Investment in Buildings
	Proprietary	Employee						
Sharecroppers	2,624 (60.0) ^b	1,020 (23.3)	310 (7.1)	39 (.9)	84 (1.9)	146 (3.3)	152 (3.5)	4,377
0-10 ha	14,315 (79.8)	866 (4.8)	1,447 (8.1)	289 (1.6)	85 (.5)	303 (1.7)	622 (3.5)	17,950
10-50 ha	22,410 (53.9)	5,476 (13.2)	4,798 (11.5)	3,269 (7.9)	864 (2.1)	1,490 (3.6)	3,235 (7.8)	41,545
50-100 ha	32,288 (45.0)	12,279 (17.2)	8,008 (11.2)	9,416 (13.2)	830 (1.2)	1,808 (2.5)	6,805 (9.5)	71,437
100-200 ha	119,842 (46.4)	56,026 (21.7)	19,536 (7.6)	28,900 (11.2)	2,842 (1.1)	3,381 (1.3)	28,018 (10.8)	258,547
Zona da Mata Average	20,384 (53.3)	5,880 (15.4)	3,850 (10.1)	3,390 (8.9)	571 (1.5)	1,009 (2.6)	3,167 (8.3)	38,254

Source: Sample survey.

^aOther buildings include garages, machine sheds, bin, etc.

^bThe figures in parentheses are percentages of farm investment in the category of capital listed in the column.

building capital. The absolute amount increases with size of farm and reflects the fact that nearly all farmers produce some grains.

Buildings for cattle are significant only on farms larger than 10 hectares and become especially important for the two largest farm size groups. Most of this investment is for the dairy enterprise, which exists mainly on larger farms that have enough pasture area to support a dairy herd. Dairy barns account for 13.2 percent of total building investment on farms with 50-100 hectares. Poultry and hog houses are low-investment items for all farm size categories--a maximum of 2.1 percent for poultry and 3.6 for hogs.

The figures shown in Table 3.4 reflect in relative and absolute terms the extensive nature of livestock production in the Zona da Mata. Very little capital is invested in buildings and equipment to support the livestock enterprise. This reflects the fact that livestock productivity is low and is carried out on a traditional basis.

The capital stock in machinery and equipment averaged about Cr\$11,500 (Table 3.5). Sharecroppers had the lowest level of investment in this form of capital, and the total value of capital in machinery and equipment increased from the lowest class of landowner to the highest. The sharecroppers' largest investment was in tools and utensils such as hoes, axes, and hand-saws; for the other categories of farmers, motorcars (including tractors, pick-ups, and other automobiles) constituted the major investments except for the large farmers, who invested more in machinery and equipment that was less common for other categories of farmers due to their coffee and large-scale dairy operations.

Table 3.5.--Capital stock in machinery and equipment, Zona da Mata, MG, agricultural sector, 1976-77 (in 1977 cruzeiros).

Class of Producers	Tools, Equipment, & Utensils	Plows	Carts and Animal Pull Cars	Motor-cars	Other Machinery & Equipment	Total Investment in Machinery & Equipment
Sharecroppers	542 (35.3)	23 (1.5)	338 (22.1)	403 (26.3)	225 (14.7)	1,534
0-10 ha	301 (8.5)	90 (2.5)	825 (23.2)	1,959 (55.2)	374 (10.5)	3,551
10-50 ha	978 (8.7)	549 (4.9)	1,679 (14.9)	3,748 (33.4)	4,257 (38.0)	11,211
50-100 ha	1,797 (6.2)	1,288 (4.4)	2,616 (9.0)	17,398 (59.7)	6,014 (20.0)	29,114
100-200 ha	10,413 (13.2)	2,841 (3.6)	5,600 (7.1)	23,631 (29.8)	36,621 (46.3)	79,306
Zona da Mata Average	1,138 (9.9)	481 (4.2)	1,409 (12.3)	4,715 (41.0)	3,756 (32.7)	11,501

Source: Sample survey.

^aThe figures in parentheses are the percentages of farm investment in the capital listed in the column over the total investment in machinery and equipment.

The analysis of the percentage of capital invested in each category of capital presented in Table 3.5 shows that investment in plows, tools, equipment and utensils was about 15 percent of the total investment. This percentage was relatively low if we consider the relatively abundant labor in the study area.

Work animals and livestock. The stock of work animals and livestock at the end of the 1977 agricultural year indicates that the Zona da Mata investment in work animals and livestock was about Cr\$31,000 per farm (Table 3.6). As expected, the value of this capital increased with the size of the production unit. Indeed, a very large difference of investment in these classes of animals was observed among the many categories of producers. From one farm category to the next, investment in livestock more than doubled.

Sharecroppers and owners with 0-10 hectares had less investment in all kinds of animals than the average of the study area. This observation holds for both the value of the investment and the number of animals of each kind. Farmers with the highest percentage of land in pasture in the Zona da Mata also had the highest farm investment in cattle. The average number of cows per production unit was about seven, with higher concentrations among larger farmers. Relating data from Table 3.6 with land use, it was concluded that about 35 cows per farm with 100-200 hectares and about 20 cows per farm with 50-100 hectares were associated with pasture areas of about 103 hectares and 47 hectares, respectively.

Investment in animals for work was second in importance in value terms.

Table 3.6.--Average number and value of work animals and livestock in production units, Zona da Mata, MG, 1976-77 (in 1977 cruzeiros).

Kinds of Animals	Producer Class				Zona da Mata
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Work animals					
Number	.27	.80	1.97	2.89	4.73
Value	434 (16.1) ^a	1,273 (23.0)	4,014 (11.6)	6,908 (8.2)	11,263 (6.6)
Cows					
Number	.43	1.25	7.96	19.86	35.42
Value	968 (35.8)	2,755 (49.7)	22,149 (64.0)	61,101 (72.3)	116,789 (68.7)
Bulls and oxen					
Number	.30	.18	1.64	3.86	4.37
Value	86 (3.2)	162 (2.9)	2,925 (8.5)	7,225 (8.6)	29,100 (17.1)
Calves					
Number	.33	.73	4.78	10.61	20.95
Value	220 (8.1)	319 (5.8)	2,606 (7.5)	5,459 (6.5)	9,231 (5.4)
Poultry					
Number	14.81	18.96	34.55	37.19	46.21
Value	297 (11.0)	385 (6.9)	767 (2.2)	782 (.9)	1,017 (.6)
Pigs					
Number	1.88	1.97	5.01	5.03	4.73
Value	659 (24.4)	631 (11.1)	2,082 (6.0)	2,981 (3.5)	2,615 (1.5)
Other domestic animals					
Value	40 (2.5)	21 (.4)	67 (.2)	28 (.01)	10 (.01)
Total value of work and production animals	2,704	5,546	34,610	84,484	170,025
					30,656

Source: Sample survey.

^aThe figures in parentheses are percentage of group of farmers' investments in the category of animals listed in the row.

The investment in cows was the highest among investment in animals for all producer categories. Figures in Table 3.4 indicate that for landowners with more than 10 hectares the percentage of investment in dairy barns was the highest relative to investment in all animal facilities.

About 25 percent of investment in animals of sharecroppers was in swine, and the figures in Table 3.4 also indicate that these producers' highest investment in animal facilities was in hog houses.

The percentage of poultry investment over the total investment in animals decreased with farm size; however, this tendency was not observed for poultry facilities. The 0-10 hectares landowners had the lowest percentage investment in poultry houses, and the 10-50 hectares landowners were those with highest investment.

Despite sharecroppers' and 0-10 hectares landowners' relatively low investment in poultry and swine, it was recognized that such animals can represent an important source of financial income to these producers.

Final comments on resource endowment. Table 3.7 shows availability of capital and labor per hectare. The average value of investment in buildings and animal facilities per hectare for Zona da Mata was about Cr\$1,500. However, this amount did not express the productive capital directly and, when the values of proprietors' and employees' houses were excluded from the calculations, the average investment in productive buildings and animal facilities decreased to about Cr\$480. The relatively high investment in buildings by landowners with 0-10 hectares decreased from Cr\$3,100 to Cr\$480 with the

Table 3.7. --Capital and labor availability per hectare, Zona da Mata, MG, 1976-77.

	Producer Class					Average for Zona da Mata
	Share- croppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha	
Value of investment in build- ings and animal facilities/ha ^a	730.00	3,117.00	1,622.00	1,029.00	1,871.00	1,523.00
Value of investment in produc- tive buildings and animal facilities/ha ^b	126.00	477.00	533.00	387.00	598.00	477.00
Value of machinery and equipment/ha ^c	264.00	617.00	438.00	419.00	574.00	458.00
Value of investment in work animals and livestock/ha ^d	466.00	963.00	1,351.00	1,217.00	1,231.00	1,221.00
Availability of adult-man labor/ha ^e	72.97	61.59	23.29	14.19	11.41	22.99
Availability of adult-woman labor/ha ^e	7.98	16.73	2.36	1.00	1.30	2.80
Availability of child labor/ha ^e	3.52	2.48	1.11	0.29	0.29	.91

Source: Sample survey.

^aIncludes values of proprietary and employee houses, warehouses, barns, poultry houses, piggeries, and other buildings.

^bSame as (a), excluding value of proprietary and employee houses.

^cIncludes value of tools, equipment, and utensils; plows, carts and animal-pull cars, motor-cars, and other machinery and equipment.

^dIncludes value of work animals, calves, bulls and oxen, poultry, pigs, and other domestic animals.

^eMeasured in man-days equivalent.

new calculations, and similar decreases also occurred with other classes of producers.

The average value of machinery and equipment per hectare was about Cr\$460. The sharecroppers, 10-50 hectares and 50-100 hectares landowners' investment in machinery and equipment was below the average of the study area: the 0-10 hectares and 100-200 hectares landowners were those farmers with more investment in such a form of capital per hectare of farm land.

The average investment in work animals and livestock per hectare also varied among the many classes of producers. The sharecroppers and 0-10 hectares landowners had investment in animals below the study area average. The 50-100 hectares and 100-200 hectares landowners' investment in such a form of capital was about the average for the whole region, and the 10-50 hectares landowners were above that average.

The situation of labor availability seemed to be reversed. Those who owned more land, as expected, used less labor per hectare since they invested more in capital in the form of machinery and equipment. It was observed that the sharecroppers and the farmers who owned 0-10 hectares and 10-50 hectares had labor availability per hectare above the average of the study area in all forms of labor: adult men, adult women, and children.

Resource Use and Productivity

A description of resource use and productivity of the Zona da Mata farmers is presented below. The use of land for selected

activities is shown, and the output per hectare of important crops is compared among groups of producers. The use of labor and output per man-day of selected crops were also compared among farmer groups, and analysis of variance of ratios involving land, capital, and labor are analyzed. This section concludes with an analysis of farmers' use of credit and their participation in cooperative associations.

Land use. Approximately 60 percent of the land of the region is used for pasture (Table 3.8). Coffee, another nonsubsistence activity, occupied a considerable part of the region. Further, the amount of land allocated to these two uses increased with the farm size.

Sharecroppers used 10 percent of their land in coffee plantations. For landowners, the percentage of farm land allocated to coffee plantations decreased from 11.6 percent for 0-10 hectares landowners to 5 percent on 100-200 hectare units.

Because of the topography of the study area, pasture area increased with farm size. Sharecroppers used the least land for pasture. About 19 percent of their land was in pasture, and this increased to about 75 percent for the 100-200 hectares landowners.

The other three crops to which the Zona da Mata producers allocated most of their land were corn, beans, and rice. About 9 percent of the whole study area was used for corn production, and about 6 percent was used to produce beans and the same percentage to produce rice. About 40 percent of the cropped area was used to produce corn, and about 26 percent and 23 percent were used to produce beans and rice, respectively. These crops were of great importance

Table 3.8.--Use of the land in Zona da Mata, MG, for selected activities, by group of producers, 1976-77.^a

Activities	Group of Producers					Zona da Mata Average
	Share- croppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha	
-----Hectares-----						
Corn	2.03 (35.1) ^{b,c}	1.01 (17.5)	2.70 (9.8)	3.76 (5.4)	5.08 (3.7)	2.36 (9.4)
Beans	1.47 (25.3)	.59 (10.4)	1.67 (6.5)	2.73 (3.9)	4.08 (2.4)	1.57 (6.3)
Rice	1.20 (20.8)	.56 (9.8)	1.42 (5.5)	3.02 (4.4)	2.83 (2.1)	1.39 (5.6)
Sugar cane	.05 (.9)	.16 (2.8)	.39 (1.6)	1.24 (1.8)	.79 (.6)	.37 (1.5)
Tobacco	.16 (2.9)	.05 (.8)	.18 (.7)	.14 (.2)	-- --	.13 (.6)
Fruits	.01 (.2)	.03 (.6)	.08 (.3)	.03 (.05)	.11 (.1)	.05 (.2)
Vegetables	.03 (.6)	.04 (.7)	.05 (.2)	.05 (.09)	-- --	.04 (.2)
Coffee	.58 (10.0)	.66 (11.6)	2.09 (8.2)	3.71 (5.3)	6.92 (5.1)	1.76 (7.0)
Pasture	1.14 (19.2)	2.09 (36.3)	14.20 (47.8)	47.11 (67.9)	103.41 (74.9)	15.03 (59.9)

Source: Sample survey.

^aBecause of intercropping in the study area, these activity areas may exceed 100 percent of the land held by the producer group.

^bThe figures in parentheses are the percentage of the total farm area allocated to specific activities per group of producers.

^cTo compute the percentage of the cell, the declared farm area was used instead of a summation of the isolated activities.

for the smaller producers and sharecroppers. Sharecroppers allocated 35 percent of their land to corn production, more than any other use. This percentage decreased as the farm size increased; the 0-10 hectares landowners allocated about 17 percent of their land to corn production, and this decreased to 4 percent among the 100-200 hectares landowners group.

This pattern of land allocation is similar for beans and rice. Sharecroppers allocated more land to these crops: about 25 percent of their total land was in bean production, and about 21 percent in rice. This percentage decreased for each size group of farms up to 100-200 hectares. The largest landowners used only 3 percent of their land for beans and 2 percent for rice.

Tobacco production showed a similar pattern. The average area allocated to this crop in the Zona da Mata was less than one hectare per farm. The sharecroppers allocated about 3 percent of their land to this crop, and this percentage decreased as the farm size increased. Landowners with 100-200 hectares did not report any tobacco.

The percentage of the total farm area devoted to sugar cane was greatest among the 0-10 hectares landowners: about 3 percent of their farm area was allocated to this crop. Producers with 50-100 hectares of land had an average of 1.2 hectares of sugar cane, which represented nearly 2 percent of their land area.

Land used to grow vegetables and fruits in the Zona da Mata was less than 1 percent of the whole area. About 1 percent of the area held by the 0-10 hectares landowners was allocated to each of

these activities. Again, percentage of land used for these activities decreased with farm size. Landowners in the 100-200 hectares category did not produce vegetables.

Table 3.9 shows the means and significance level (ANOVA) for test of the hypothesis of equal output per hectare for selected farm activities among the producer categories. A general observation of the figures presented in this table is that outputs per hectare of all agricultural activities were not statistically different at the conventional 5 percent level among the different classes. This result seems to suggest that the technologies used by all farmers were not substantially different. However, this result should be interpreted with care because it deals only with output per hectare of land.

It should be noted that corn production per hectare was statistically different at the 18 percent level, and other crops considered as subsistence crops, such as beans and rice, were statistically different at the 46 and 74 percent levels, respectively, among the different producer categories. The landowners with 100-200 hectares were those who achieved the highest yields of the traditional crops (corn, beans, and rice). Following this category of farmers, sharecroppers had the highest yield of these traditional crops in the sense of return on production per unit of land. Sharecroppers attained the highest yield per hectare of sugar cane and the highest value per hectare of vegetables. Production of tobacco and coffee per hectare was highest among the large farmers. The production of coffee per hectare was highest among landowners with

Table 3.9.--Comparative output per hectare^a of selected enterprises among different groups of producers, Zona da Mata, MG, 1976-77.

Enterprises	Share-croppers	Arithmetic Means				ANOVA Signif. Level	General Mean
		0-10 ha	10-50 ha	50-100 ha	100-200 ha		
Corn	24.6	19.3	21.6	23.9	24.9	.18	22.3
Beans	5.2	5.3	4.9	4.8	9.8	.46	5.2
Rice	21.3	18.6	21.1	17.6	22.2	.74	20.2
Sugar cane	39.2	23.3	21.0	25.7	22.1	.29	24.0
Tobacco	15.8	12.7	16.3	24.3	--	.37	16.2
Coffee	17.3	16.6	19.9	17.5	28.6	.68	18.9
Fruits ^b	3,900	11,139	6,792	4,083	750	.63	7,141
Vegetables ^c	15,787	15,423	12,762	7,500	--	.81	14,021

Source: Sample survey.

^aOutput per hectare was measured as follows:

Corn: 60 kg bags/hectare
 Beans: 90 kg bags/hectare
 Rice: 50 kg bags/hectare
 Sugar cane: tons/hectare
 Tobacco "arrobas": 15 kg/hectare
 Coffee "arrobas": 30 kg/hectare
 Fruits: production value in 1977 cruzeiros per hectare
 Vegetables: production value in 1977 cruzeiros per hectare

^bIncluded citrus fruits and bananas as the main products, and on a small scale it also included avocados, pineapples, guavas, etc.

^cIncluded tomatoes, garlic, cabbage, lettuce, potatoes, etc.

100-200 hectares, and tobacco production per hectare was highest among the 50-100 hectares farmers. The highest return in cruzeiros per hectare of fruits was among the 0-10 hectares farmers; the large farmers had the lowest return on this activity.

Labor use. The average number of days of labor used per hectare for selected crops is presented in Table 3.10. From the ANOVA results, it is observed that use of labor in rice, bean, and corn production was statistically different at the 1 percent level among the five classes of producers. Labor used for production of other crops, such as coffee, sugar cane, fruits, and vegetables, was not statistically different at the 5 percent level among the various categories of producers. Farmers with 100-200 hectares of land tended to use less labor on subsistence crops such as rice, beans, and corn. Overall, the enterprises to which farmers allocated the most labor per hectare were fruits and vegetables.

Table 3.11 presents the means and significance levels (ANOVA) for the comparisons of output per man-day for different enterprises by different categories of producers. It was observed that production of rice per man-day was not statistically different among farmer groups at the 5 percent level. Concerning the production of beans and corn per man-day, the analysis indicated that the 100-200 hectares group had the highest returns. The 0-10 hectares group had the lowest production of beans and corn per man-day. The return to labor on other crops was not statistically different at the 5 percent level of significance.

Table 3.10.--Man-days of labor used per hectare for selected crops among different producer groups, Zona da Mata, MG, 1976-77.

Farm Production Activities	Share- croppers	Arithmetic Means				ANOVA Signif. Level	General Mean
		0-10 ha	10-50 ha	50-100 ha	100-200 ha		
Rice	50	79	51	36	50	.002	54
Beans	21	35	22	21	17	.004	23
Corn	35	49	28	28	23	.003	33
Coffee	43	75	48	53	36	.27	53
Sugar cane	96	54	43	28	32	.07	47
Fruits	20	186	60	--	76	.17	96
Vegetables	213	277	111	163	--	.35	195

Source: Sample survey.

Table 3.11.--Output per man-day^a for selected crops by different producer groups, Zona da Mata, MG, 1976-77.

Enterprises	Share-croppers	Arithmetic Means				ANOVA Signif. Level	General Mean
		0-10 ha	10-50 ha	50-100 ha	100-200 ha		
Rice	.48	.41	.52	.61	.76	.10	.51
Beans	.29	.17	.32	.27	1.07	.00	.31
Corn	.94	.63	.97	1.08	1.22	.00	.92
Coffee	.62	.41	.56	.62	.78	.24	.56
Tobacco	.24	.13	.30	.26	--	.54	.25
Sugar cane	.83	.59	.89	1.37	1.57	.19	.95
Fruits	240	173	243	600	375	.54	250
Vegetables	149	48	111	125	--	.35	103

Source: Sample survey.

^aUnits of output used were as follows:

Rice: 50 kg bags
 Beans: 60 kg bags
 Corn: 60 kg bags
 Coffee "arrobas": 30 kg
 Tobacco "arrobas": 15 kg
 Sugar cane: tons
 Fruits: production value in 1977 cruzeiros
 Vegetables: production value in 1977 cruzeiros

The figures summarized in Table 3.11 seem to indicate that producers with more land were using technologies that resulted in more return to labor used in the production process, such as machinery and other equipment. This inference is supported by the total investment in machinery and equipment of this class of farmers, presented in Table 3.5.

Comparisons between the figures presented in Tables 3.10 and 3.11 seem to imply that in bean and corn production 0-10 hectares landowners are using relatively more labor than other categories of farmers, or possibly other production factors have been used by the other categories of producers in substitution for labor.

Capital use. The analysis of the use of capital was broken down into four classes of capital:

1. Farm Assets (K_1). This class of capital included the value of all machinery, equipment, and work animals as reported by the farmers at the time of the study.
2. Livestock (K_2). Livestock capital included the value of all cattle, poultry, and swine reported by farmers in the survey.
3. Operating Expenses (K_3). This form of capital was computed as the value of all inputs used in crop production, such as seeds, chemical fertilizers, lime, pesticides, and the value of inputs used in livestock production, such as medicines and salt.
4. Permanent Structures (K_4). This category of capital included the value of permanent structures such as barns, storage facilities, and other permanent structures on the farm.

Two other aggregated classes of capital are also considered. They are defined as Total Capital 1 (K_A), which is the summation of $K_1 + K_2 + K_3 + K_4$. Total Capital 2 (K_B) included K_A plus the value of the proprietor's and employees' houses.

The analysis performed in this section is an extension of the analysis presented in the resource endowment section. Capital/land ratio and capital/labor ratio used in agricultural production units in the Zona da Mata are of primary interest. The analysis of these ratios is expected to bring realistic insights of how capital resources are related to land and labor. Analysis of variance is used for comparisons of the ratios for different farm classes, and at the end of this section some conclusions are drawn about the results of that analysis.

Table 3.12 presents the capital/land ratios by the categories of producers in the study area. With the exception of the operating expenses/land ratio (K_3/L), all other sharecroppers' ratios were the lowest ones among the groups of farmers. Consistently for all kinds of land (total farm land L , crop land L_1 , and pasture land L_2) considered in the ratios, farm assets/land ratios were not statistically different at the 5 percent level among the categories of producers. This result indicates that investments in machinery, equipment, and work animals per hectare of land do not differ statistically at the 5 percent level among farmer groups. Regarding other figures presented in Table 3.12, we may conclude that there is not a consistent correlation between ratio sizes and farm sizes.

Tables 3.13 and 3.14 are analyzed together. Table 3.13 presents different forms of capital/availability of labor ratios, and Table 3.14 presents similar ratios, but labor actually used in the production unit is used instead of labor available to the producer. (Available family labor, available sharecroppers labor, and available

Table 3.12.--Comparative analysis of different forms of capital/land ratios among the different groups of producers, Zona da Mata, MG, 1976-77.

Capital/Land Ratios (Cruzeiros/hectare)	Arithmetic Means					ANOVA Signif. Level	General Mean
	Share- croppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha		
<u>Total capital 1/land</u>							
K_A/L	1,464	2,622	2,577	2,114	2,552	.01	2,278
K_A/L_1	1,554	6,283	13,838	16,523	14,404	.00	9,486
K_A/L_2	1,188	7,376	5,910	3,494	3,518	.01	5,699
<u>Total capital 2/land</u>							
K_B/L	2,515	6,057	3,732	2,751	3,896	.00	3,863
K_B/L_1	2,498	13,204	23,253	22,313	21,725	.12	15,806
K_B/L_2	1,466	14,929	9,011	4,576	5,609	.00	9,409
<u>Farm assets/land</u>							
K_1/L	490	845	630	501	617	.30	629
K_1/L_1	474	1,917	3,787	4,095	3,561	.06	2,597
K_1/L_2	252	2,118	1,562	934	947	.16	1,543
<u>Livestock/land</u>							
K_2/L	470	858	1,210	1,096	1,143	.00	981
K_2/L_1	789	2,621	7,133	8,106	7,014	.01	5,042
K_2/L_2	822	2,287	2,418	1,614	1,468	.19	2,196
<u>Operating expenses/land</u>							
K_3/L	532	422	243	141	200	.00	336
K_3/L_1	441	678	1,091	769	1,081	.03	810
K_3/L_2	87	1,474	663	288	276	.00	754
<u>Permanent structures/land</u>							
K_4/L	365	722	571	399	593	.08	562
K_4/L_1	314	1,509	2,177	3,618	2,747	.02	2,013
K_4/L_2	35	1,967	1,393	698	828	.04	1,360

Source: Sample survey.

Table 3.13.--Comparative analysis of different forms of capital/availability of labor ratios among the different groups of producers, Zona da Mata, MG, 1976-77.

Capital/Stock of Labor Ratios (Cruzeiros/man-day)	Arithmetic Means					ANOVA Signif. Level	General Mean
	Share- croppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha		
<u>Total Capital 1/Availability of Labor</u>							
K_A/W	16	35	120	177	207	.00	85
K_A/W_1	17	51	188	361	869	.00	155
K_A/W_2	--	66	294	296	511	.03	279
K_A/W_3	130	227	328	588	698	.00	435
<u>Total Capital 2/Availability of Labor</u>							
K_B/W	25	97	166	227	300	.00	128
K_B/W_1	26	122	270	470	1,159	.00	226
K_B/W_2	--	166	423	381	934	.00	422
K_B/W_3	213	522	452	748	992	.01	617
<u>Farm Assets/Availability of Labor</u>							
K_1/W	5	9	26	41	39	.00	19
K_1/W_1	5	11	47	79	276	.00	39
K_1/W_2	--	11	83	80	85	.25	70
K_1/W_3	42	28	95	98	199	.32	110

Table 3.13.---Continued.

Capital/Stock of Labor Ratios (Cruzeiros/man-day)	Arithmetic Means				ANOVA Signif. Level	General Mean	
	Share- croppers	0-10 ha	10-50 ha	50-100 ha			100-200 ha
<u>Livestock/Availability of Labor</u>							
K ₂ /W	7	14	62	96	106	.00	46
K ₂ /W ₁	8	23	87	197	363	.00	81
K ₂ /W ₂	--	26	123	132	229	.10	122
K ₂ /W ₃	36	80	132	333	304	.00	201
<u>Operating Expenses/Availability of Labor</u>							
K ₃ /W	5	5	9	12	16	.00	8
K ₃ /W ₁	5	6	16	23	79	.00	13
K ₃ /W ₂	--	13	36	29	42	.65	31
K ₃ /W ₃	12	38	26	20	48	.11	30
<u>Permanent Structures/ Availability of Labor</u>							
K ₄ /W	4	10	25	31	45	.00	21
K ₄ /W ₁	5	16	41	66	150	.00	38
K ₄ /W ₂	--	26	58	56	154	.00	63
K ₄ /W ₃	80	84	104	138	146	.36	117

Source: Sample survey.

Table 3.14.--Comparative analysis of different forms of capital/labor used in agricultural production ratios among the different groups of producers, Zona da Mata, MG, 1976-77.

Capital/Labor Used Ratio (Cruzeiros/man-day)	Arithmetic Means				ANOVA Signif. Level	General Mean
	Share- croppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha	
Total Capital 1/Labor Used in Agriculture K_A/UW	37	142	200	333	742	181
Total Capital 2/Labor Used in Agriculture K_B/UW	56	354	292	428	978	288
Farm Assets/Labor Used in Agriculture K_1/UW	12	35	46	84	159	44
Livestock/Labor Used in Agriculture K_2/UW	16	59	100	181	410	97
Operating Expenses/Labor Used in Agriculture K_3/UW	11	18	16	18	73	18
Permanent Structures/Labor Used in Agriculture K_4/UW	9	43	42	53	100	43

Source: Sample survey.

hired labor are represented by W_1 , W_2 , and W_3 , respectively, and UW is labor actually used on the farm.) Labor availability is very well known by producers and is one of the variables that influence farmers' decisions on investment of capital in the production process.

In most of the cases analyzed in Tables 3.13 and 3.14, the ratios increase with farm size. Statistical results presented in Table 3.14 indicated that all ratios of capital/utilized labor were statistically different among farm classes at the 5 percent level.

Labor/land ratios. The figures in Table 3.15 dealing with labor/land ratios complement the analysis of capital presented above. In this table all sources of available labor as well as labor actually used on the farm are considered. The general observation of the figures in this table is a tendency for the ratios to decrease with increasing farm size. Comparing the figures of this table with those presented in Table 3.12, we may conclude that there is not a straightforward trend of land, capital, and labor ratios with increasing farm size. This fact may suggest that as farm size increases, different enterprise mixes are emphasized (which requires different resource combinations), or resources of land, capital, and labor might not be homogeneous in the study area. However, there seems to be a trend for larger producers to substitute capital for labor when labor is not available. Further analysis will clarify this point.

Use of credit and cooperative associations. The use of credit and cooperative services is analyzed in this section. Table 3.16 shows the average per farm and per group of farmers as well as the percentage of farmers who used technical assistance along with credit.

Table 3.15.--Comparative analysis of different forms of available and used labor/land ratios among the different groups of producers in Zona da Mata, MG, 1976-77.

Labor/Land Ratios (Man-days/hectare)	Arithmetic Means				ANOVA Signif. Level	General Mean	
	Share- croppers	0-10 ha	10-50 ha	50-100 ha			100-200 ha
<u>Total Labor Available/Land</u>							
W/L	162	115	32	16	13	.00	79
W/L ₁	128	230	152	107	119	.01	157
W/L ₂	27	291	93	27	25	.00	123
<u>Family Labor Available/Land</u>							
W ₁ /L	162	110	27	9	5	.00	75
W ₁ /L ₁	128	225	137	67	71	.00	143
W ₁ /L ₂	27	274	80	15	12	.00	110
<u>Sharecroppers Labor Available/Land</u>							
Land	--	37	19	11	9	.00	19
W ₂ /L	--	64	53	62	63	.87	59
W ₂ /L ₁	--	119	53	18	14	.00	46
<u>Hired Labor Available/Land</u>							
Land	20	42	16	9	7	.00	15
W ₃ /L	17	37	69	51	25	.32	53
W ₃ /L ₁	--	152	43	14	9	.00	40
<u>Labor Used in Agriculture/Land</u>							
UW/L	57	35	17	9	7	.00	30
UW/L ₁	46	94	80	55	65	.21	71
UW/L ₂	11	117	48	18	12	.00	57

Source: Sample survey.

Table 3.16.--Use of credit in the agricultural business by selected groups of farmers, Zona da Mata, MG, 1976-77.

Items	Group of Farmers				
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Average amount of credit ^a	2,815	12,786	28,342	44,040	117,950
Number of borrowers	13	42	105	34	12
Percentage of borrowers per class of farmers	10	34	48	58	63
Percentage of borrowers who received technical assistance with credit	12	29	30	62	82

Source: Sample survey.

^aFigures in 1977 cruzeiros.

The amount of credit is shown in the table in aggregated form, including credit from official institutional sources as well as credit from noninstitutional sources, such as from other farmers or from private businessmen.

The figures in this table seem to confirm the descriptions given in the introductory sections of this study concerning access to credit by wealthy farmers. Sharecroppers used less credit than the other groups. An average of about Cr\$2,800 was contracted per farm, and only about 10 percent of the sharecroppers used this service. The percentage of farmers using credit increased substantially as the size of farm increased. About 63 percent of the 100-200 hectares landowners used credit, which was close to nine times more credit than landowners with 0-10 hectares.

Concerning the use of technical assistance together with credit, which is a precondition for institutional farm loan, the figures in Table 3.16 seem to suggest that this mode of credit was positively associated with farm size. The reason for this may be related to the preference of extension service to work with larger farmers. About 80 percent of the largest producer group received technical assistance, in contrast with about 30 percent of the 0-10 hectares landowners and 12 percent of the sharecroppers. Concern about the tendency of the extension service to work mainly with larger farmers in Brazil has been pointed out by Souza.¹

¹Antônio Fagundes de Souza, "Pesquisa, Assistência Técnica e Extensão Rural," A Homern e o Campo, Fundação Milton Campos (Brasília: Senado Federal-Centro Gráfico, 1976).

The extent of participation in farm cooperatives is presented in Table 3.17. Sharecroppers did not use cooperatives at all, and only 6 percent of the 0-10 hectares landowners were active members. The percentage of participation jumped to about 30 percent, 50 percent, and 60 percent for the 10-50 hectares, 50-100 hectares, and 100-200 hectares landowners, respectively.

Farmers were asked about the kinds of services provided by the cooperatives with which they were associated. The figures in Table 3.17 seemed to imply that as farm size increased, farmers were more interested in "marketing cooperatives" than input-supply cooperatives. Only the group of farmers who owned 0-10 hectares of land had a high percentage of their members associated with cooperatives that had both supply and marketing services. However, it is not known whether all of these kinds of cooperatives were available to all the farmers in the study sample.

Summary and conclusions. As expected, family labor was the most important source of labor for the smaller producers of the Zona da Mata. About 75 percent of the total labor available for these producers was family labor. The presence of permanent sharecroppers and hired labor becomes more frequent as farm size increases. Permanent sharecroppers are an important source of labor for the larger landowners. The supply of family labor apparently is not adequate to meet the farm demand. Investment in all forms of capital also increased with farm size.

The difference in resource ratios reflects the differences in the quantities of land ownership, capital, and labor held by different

Table 3.17.--Farmers' participation in cooperative associations, Zona da Mata, MG, 1976-77.

Items	Group of Farmers			
	0-10 ha	10-50 ha	50-100 ha	100-200 ha
<u>Association with Cooperatives</u>				
Number of associated farmers	7	66	30	12
Percentage of associated farmers per class of producers	6	31	52	63
<u>Percentage of Associated Farmers Per Kind of Cooperatives</u>				
Inputs-supply cooperatives	0	4.7	10.3	5.3
Marketing cooperatives	1.6	14.9	22.4	31.6
Inputs-supply and marketing cooperatives	4.1	11.2	19.0	26.1
Not associated with cooperatives	94.3	69.3	48.3	36.8

Source: Sample survey.

Note: The sample was composed of 127 sharecroppers, 122 0-10 hectares farmers, 215 10-50 hectares farmers, 58 50-100 hectares farmers, and 19 100-200 hectares farmers.

groups of farmers. However, it is questionable if the share-leasing institutional arrangements between permanent sharecroppers and landowners led to the optimum sharing of costs and returns of farm operations and, consequently, these arrangements implied barriers for augmenting resource ownership (capital and land). It is also questionable, on the other hand, if relatively abundant family labor and permanent sharecroppers' labor compete with increasing use of capital services. Another factor that may be responsible for the differences in resource ratios is that rental arrangements by farmers may be a means of gaining control over greater quantities of land and capital.

The use of credit by sharecroppers was very low relative to other classes of producers. We may conclude that besides the credit limitations other factors such as education and share-leasing institutional arrangements may be a limiting factor for expanding capital use of this class of producers.

In turn, it seems that relatively greater capital/land ratios observed among landowners can be explained by the fact that even having permanent sharecroppers on their farms, they may be led to reinforce returns in contracts with sharecroppers that involve use of landowners' capital. On the other hand, in enterprises in which sharecroppers do not participate, the landowners have no intrafirm dissociation of costs and returns and, consequently, they would tend to increase capital-resources use, which is facilitated by the availability of credit.

The relatively high labor/land ratios of sharecroppers imply that their production systems are not restricted on labor availability.

For this category of producers, the marginal productivity of labor can be expected to be low because low capital/labor and high labor/land ratios were observed. Returns to land and capital can be expected to be relatively higher than returns to labor. However, this is a premature conclusion because resource productivities also depend on relative values of elasticities of production.

Overall, the ratios capital/labor, capital/land, and labor/land seem to imply low levels of technology employed by the small farmers of the Zona da Mata.

The use of land analyzed in this section implies two marked uses of land in the study area: (a) production of grains and (b) use in pasture. Production of grains (corn, beans, and rice) seemed to be of relatively greater importance for sharecroppers and smaller producers. Land used for pasture, on the other hand, increased with farm size. It should be pointed out that pasture land refers to natural pasture which is generally part of the farm that cannot be used to produce grains and other crops due to the hilly topography and low soil fertility.

Management Efficiency and Family Composition

Management efficiency. In the literature on agricultural development, attempts have been made to use proxies for management efficiency to better explain production variation.¹ In this section,

¹See, for instance, Martin Upton, "The Influence of Management on Farm Production on a Sample of Nigerian Farms," Farm Economist, 1970, pp. 526-36; J. Bessell, "Measurement of Human Factor in Farm Management," International Journal of Agrarian Affairs, July 1969,

four proxies for management efficiency are analyzed. They are:

(a) farmer age, (b) farmer education, (c) number of days the farmer worked off the farm, and (d) commercialization index.

The age of the farmer as a proxy for management efficiency has to do with acquiring experience throughout the years in the business; education to reflect the investment in human capital; number of days the farmer worked off the farm to indicate contact with the outside world or different society; and commercialization index to reflect attempt to produce surplus for the market.

For the whole sample, the arithmetic mean of the farmers' age was about 50 years (Table 3.18). The ANOVA conducted on this variable suggested that ages of farmers in different categories of farms were not different at the 5 percent level of significance.

The age distribution of the managers within each category of producers is presented in Table 3.19. About 33 percent of all sharecroppers were included in the age class between 40-50 years old. The ages of the producers who owned 0-10 hectares, 10-50 hectares, and 50-100 hectares of land were concentrated in the category 50-60 years old. The larger farmers (100-200 hectares landowners) were the oldest group of producers, and their ages were concentrated in the 60-70 years range.

A general description of the education of family heads and their wives is presented in Table 3.20. In general, the percentage of illiteracy decreased with an increase in farm size. Thus, the highest

Supplement, pp. 37-44; and Andrew B. Tench, Socio-economic Factors Influencing Agricultural Output (Saarbrücken, SSIP, 1975).

Table 3.18.--Comparative analysis of selected variables related to management among the different classes of farmers, Zona da Mata, MG, 1976-77.

Variables	Sharecroppers	Arithmetic Means				ANOVA Signif. Level	General Mean
		0-10 ha	10-50 ha	50-100 ha	100-200 ha		
Age (years)	43	50	51	53	56	.07	50
Number of days worked off of farm but in agricultural sector	169	66	40	33	0	.00	74
Number of days worked off the farm outside the agricultural sector	9	31	27	12	30	.07	22
Commercialization index (percentage)	33	31	43	59	60	.02	40

Source: Sample survey.

Table 3.19.--Age distribution of farmers within each category of producers, Zona da Mata, MG, 1976-77.

Age Classes	Categories of Producers				Number of Producers
	Share-croppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Less than 20	1 (1) ^a	5 (4)	6 (3)	--	--
20-30	17 (13)	6 (5)	5 (2)	1 (2)	--
30-40	38 (29)	17 (14)	32 (15)	9 (15)	4 (21)
40-50	43 (33)	25 (20)	59 (27)	12 (20)	3 (16)
50-60	20 (16)	36 (29)	66 (30)	18 (31)	4 (21)
60-70	7 (5)	28 (23)	35 (16)	13 (22)	5 (26)
70 and over	3 (2)	6 (5)	17 (8)	6 (10)	3 (16)

Source: Sample survey.

^aThe figures in parentheses are percentages of the producer category in the age class.

Table 3.20.--Selected educational characteristics of the farmers and wives of Zona da Mata, MG, 1976-77.

Educational Level of:	Categories of Producers				
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
<u>Family Heads</u>					
Illiterate	55 (43)	31 (25)	36 (16)	4 (7)	0 (0)
Less than four years of formal education	64 (50)	78 (63)	135 (62)	37 (63)	8 (42)
Four years or more of formal education	10 (08)	14 (11)	48 (22)	18 (31)	11 (58)
<u>Wives</u>					
Illiterate	53 (41)	59 (48)	75 (34)	13 (22)	2 (11)
Less than four years of formal education	63 (49)	53 (43)	98 (45)	24 (41)	8 (42)
Four years or more of formal education	13 (10)	11 (9)	47 (21)	22 (37)	9 (47)

Source: Sample survey.

^aNumber per group of farmers.

^bPercentage of family heads and wives with selected characteristics.

percentage of illiteracy was among the sharecropper heads of families--about 43 percent. All of the 100-200 hectares landowners group were literate.

The figures in Table 3.20 suggest that it is very common to have heads of families and their wives with fewer than four years of formal education. The 100-200 hectares landowners had the highest percentage of heads of families and their wives with more than four years of formal education.

The use of formal education was tested in the survey. The percentages of their affirmative or negative responses to selected questions by the five groups of producers are presented in Table 3.21. The figures presented in the table do not total 100 because of other alternatives available to the farmers in answering these items in the survey.

A variable that may be related to management efficiency--the use of material from the official agricultural extension service--received a negative response from about 90 percent of the sharecroppers. However, it was observed that the use of these materials increased with the size of the farm operation, and about 37 percent of the 100-200 hectares landowners made use of those materials.

Close to 50 percent of the sharecroppers did not know how to add or multiply. Again, the knowledge of such operations was relatively more widespread among those farmers who owned more land. Among the other mathematical operations farmers were asked about, the computation of percentages and interest was the most difficult. About 70 percent of the sharecroppers did not know how to compute percentages

Table 3.21.--Use of formal education by the head of the family, Zona da Mata, MG, 1976-77.^a

Use of Education	Categories of Producers				
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Uses official agricultural extension service material					
Yes	1	07	14	25	37
No	90	88	78	61	37
Can add					
Yes	57	63	82	90	100
No	43	37	17	10	0
Can multiply					
Yes	40	50	68	86	95
No	58	48	31	14	05
Can calculate interest					
Yes	29	46	64	85	89
No	70	52	35	15	11
Can calculate percentages					
Yes	26	39	58	78	89
No	71	56	40	20	11

Source: Sample survey.

^aThe figures indicate percentage of the category of producers.

or interest. These figures were better among the landowners; only about 10 percent of the 100-200 hectares landowners did not know how to perform these calculations.

The number of days farmers worked off of the farm was computed in two parts. The first was computed as the number of days the farmers worked in the agricultural sector; the second was the number of days they worked out of the agricultural sector. The number of days the farmers worked off of their own farms but in the agricultural sector was statistically different at the 5 percent level among groups of farmers. Sharecroppers, as expected, worked off their land more than did the other groups of producers. The average number of days other groups worked off of their farms decreased with the size of farm (see Table 3.18).

The second measure--the number of days the producers worked off the farm and outside the agricultural sector--presented a different result. The arithmetic means of this variable were not statistically different at the 5 percent level among the categories of producers. This may be an indication of widespread opportunities for off-farm jobs.

The commercialization index, which was computed by taking the percentage of the total production that was marketed is presented in Table 3.18. Using ANOVA, the arithmetic means of this index were found to be significantly different at the 5 percent level among the classes of producers. Those who had the highest commercialization index were the farmers who owned the most land. It is important to

notice that the sharecroppers had a higher commercialization index than did the 0-10 hectares landowners.¹

Family composition. The composition of the family living on the farm has an effect on farm composition, family labor supply, and off-farm income (see Figure 3.1).

The average family in the Zona da Mata was composed of 5.71 persons (including other people living with the family). The sharecroppers had the most sons and daughters, followed by farmers owning 50-100 hectares and those with 100-200 hectares (see Table 3.22). These results were expected because a larger percentage of sharecroppers are in the lower age brackets; consequently, more sons and daughters should be living with them. For larger farmers, more people could be living at home because more on-farm work opportunities are available.

The categories of producers that had more nonfamily members living at home were the 50-100 hectares landowners and the 10-50 hectares landowners, in that order.

Overall, the 50-100 hectares landowners had the largest families, with 6.31 persons. The sharecroppers had the next largest families, with an average of 6.11 people living together. The smallest families were found among the 0-10 hectares landowners, who averaged about 4.93 persons per family.

The availability of family labor can be inferred from the figures presented in Table 3.22, assuming that family members could

¹This result has also been reported by Garcia, 1975, op. cit.

Table 3.22.--Average family composition of the rural Zona da Mata, MG, 1976-77.

Family Composition	Categories of Producers				
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Sons:					
Under 15 years	1.63	.84	1.11	1.15	.47
16-30 years	.50	.44	.78	.80	.74
31-45 years	.01	.03	.06	.15	.16
Over 46 years	0	.01	.01	0	0
Total number of sons	2.14	1.34	1.96	2.10	1.37
Daughters:					
Under 15 years	1.32	.89	.90	.93	.42
16-30 years	.43	.49	.53	.75	.89
31-45 years	.01	.03	.04	.10	.11
Over 46 years	0	0	.01	0	0
Total number of daughters	1.76	1.41	1.48	1.78	1.42
Total number of sons and daughters living with family	3.90	2.75	3.44	3.88	2.79
Other people living with the family:					
Males	.09	.07	.21	.19	.21
Females	.12	.11	.16	.24	.05
Total number of other people living with family	.21	.18	.37	.43	.26
Number of persons per farm	6.11	4.93	5.81	6.31	5.05

Source: Sample survey.

work on the farm. This inference may be misleading, though, because the wealthier farmers could afford to hire labor and allocate the time of their family members to other activities, such as schooling. According to the data from Table 3.22, the sharecroppers and 0-10 hectares landowners had fewer family members over 16 years old who could work at home. Landowners with 10-50 hectares, 100-200 hectares, and 50-100 hectares had more people available over 16 years of age to work on their farms.

Summary and conclusions. The analyses of variance conducted in this section suggested that farmers' age and number of days worked off the farm and outside the agricultural sector were not significantly different among groups of farmers at the 5 percent level. Considering the limitations of the commercialization index as a proxy for management efficiency, it seems that education of the head of the family and of his wife may be a useful variable as a proxy for management.

The implications taken from the average family composition are important in understanding family consumption. That information, however, may be misleading if inferences concerning family supply of labor are to be drawn, because of the differential opportunity costs for attending formal schooling by different groups of farmers' family members.

Production, Consumption,
and Marketable Surplus

Because of the interrelationships among production, consumption, and marketable surplus, the analysis of these factors is presented in just one section.

Table 3.23 summarizes the production, consumption, and marketable surplus of 11 selected products of the Zona da Mata. The figures in this table concern the consumption/production and marketable surplus/production ratios and the number of producers of each product. Marketable surplus refers to that part of the production which is not intended for on-farm consumption. Thus, payments in kind and actual marketed surplus constitute marketable surplus. The part of the production intended for on-farm consumption, including feed use and retention of seeds for the next crop year, constitutes consumption.

The figures presented in Tables 3.23 through 3.28 provide valuable information about the allocation of agricultural production of the Zona da Mata as well as percentage of farmers who grow those products.

Corn was the most widely grown product in the region. Over 80 percent of the producers grew corn, and it also had the highest percentage retained on the farm. After corn, beans were the second most important product in terms of number of producers. About 70 percent of the farmers grew beans, and about 60 percent of their production was consumed on the farm. The third most important product of the region was rice. About 65 percent of the producers grew rice, and about 34 percent of their production was consumed on the farm.

Table 3.23.--Production, consumption, sales, and marketable surplus of selected products for the entire sample, Zona da Mata, MG, 1976-77.

Products ^a	Operations					No. of Producers ^b
	Production	Consumption	$\frac{\text{Consumption}}{\text{Production}}$	Marketable Surplus	$\frac{\text{Marketable Surplus}}{\text{Production}}$	
Rice	44.76	15.04	.34	29.72	.66	353 (64)
Beans	8.74	5.15	.59	3.59	.41	382 (69)
Corn	57.83	35.05	.61	22.78	.39	454 (83)
Coffee	77.16	5.74	.07	71.42	.93	192 (35)
Fruits	2,738.94	1,260.37	.46	1,478.57	.54	52 (9)
Vegetables	9,405.52	353.48	.04	9,052.04	.96	29 (5)
Cattle	12,261.79	2,586.00	.21	9,675.79	.79	139 (25)
Swine	5,787.75	2,818.67	.49	2,969.08	.51	140 (25)
Poultry	1,687.89	1,069.53	.63	618.36	.37	226 (41)
Milk	34,241.64	1,081.25	.03	33,160.39	.97	169 (31)
Milk products	4,675.40	379.67	.08	4,295.73	.92	50 (9)

Source: Sample survey.

^aRice was measured in 50-kg bags, beans and corn were measured in 60-kg bags, coffee was measured in 30-kg bags, and the other products were measured in 1977 cruzeiros.

^bSample size = 550 cases. The numbers in parentheses are percentages of farmers who produced the product indicated.

A high percentage of the production of other products such as poultry, swine, and fruits was consumed on the farm. The percentages of farmers who raised these products were about 45 percent, 25 percent, and 9 percent, respectively.

Analysis of the marketable surplus for cattle indicated a high percentage of production that was or could be marketed. Nearly 80 percent of the cattle constituted marketable surplus; however, only 25 percent of the farmers produced beef cattle.

Milk production also had the characteristics of a commercial enterprise. About 30 percent of the entire sample produced milk, and the percentage of marketable surplus from total production was about 97 percent. Over 90 percent of coffee and milk production was marketable surplus; the percentage of the sample involved in these activities was about 35 percent and 31 percent, respectively.

Even though only about 5 percent of the entire sample grew vegetables, this activity had commercial characteristics. Only about 4 percent of total vegetable production was used for farm consumption.

Table 3.24 shows the production, consumption, and marketable surplus of 11 selected products grown by the sharecroppers. The products raised by the most producers were corn, beans, and rice, which were grown by about 90 percent, 80 percent, and 60 percent of the sharecroppers, respectively. The percentage of these products consumed on the farm was about 90 percent of the bean production, 50 percent of the corn production, and 30 percent of the rice production. These producers' consumption of beans is above the average of

Table 3.24.--Production, consumption, sales, and marketable surplus of selected products for sharecroppers, Zona da Mata, MG, 1976-77.

Products ^a	Operations					No. of Producers ^b
	Production	Consumption	Consumption Production	Marketable Surplus	Marketable Surplus Production	
Rice	38.00	10.83	.29	27.17	.72	81 (63)
Beans	7.31	6.38	.87	.93	.13	101 (78)
Corn	47.83	22.76	.48	25.07	.52	115 (89)
Coffee	40.22	3.22	.08	37.00	.92	27 (21)
Fruits	4,733.34	3,740.00	.79	993.34	.21	3 (2)
Vegetables	11,600.00	176.00	.02	11,424.00	.98	6 (5)
Cattle	4,500.00	--	--	4,500.00	1.00	2 (2)
Swine	3,217.50	2,240.00	.70	977.50	.30	24 (2)
Poultry	1,463.66	823.00	.56	640.66	.44	47 (36)
Milk	19,783.00	730.00	.04	19,053.00	.96	3 (2)
Milk products	2,105.00	105.00	.05	2,000.00	.95	2 (2)

Source: Sample survey.

^aRice was measured in 50-kg bags, beans and corn were measured in 60-kg bags, coffee was measured in 30-kg bags, and the other products were measured in 1977 cruzeiros.

^bSample size = 129 cases. The numbers in parentheses are percentages of farmers who produced the product indicated.

the Zona da Mata region, and the consumption of corn and rice is below the average (see Table 3.23).

The percentages of farm consumption of the total production of fruits (79 percent), swine (70 percent), and poultry (56 percent) were relatively high; however, the percentage of sharecroppers who grew these products was not high. Only about 2 percent of the sharecroppers grew fruits, and about 36 percent and 2 percent, respectively, grew poultry and swine.

Only 2 percent of sharecroppers produced cattle, milk, and milk products, and these products were produced mainly for sale. Coffee was also produced primarily for commercial purposes; only 10 percent of its production was consumed at home. About 20 percent of the sharecroppers grew coffee.

The figures presented in Table 3.25 show that corn, rice, and beans were the crops grown by the highest percentage of farmers in the 0-10 hectares landowners group. More than 50 percent of the farmers in this category grew rice and beans, and about 75 percent of them grew corn. About 50 percent of the rice production was consumed on the farm, as were 75 percent of the bean and the corn production.

Other products with a high percentage of production allocated to home consumption were swine and poultry. Fruits, vegetables, milk, and milk products were consumed on the farm at a rate close to 10 percent of production; only about 10 percent of the 0-10 hectares group raised those products. Such products as coffee, fruits, vegetables, milk, and milk products, despite being grown by the smallest percentage

Table 3.25.--Production, consumption, sales, and marketable surplus of selected products for 0-10 ha landowners, Zona da Mata, MG, 1976-77.

Products ^a	Operations					No. of Producers ^b
	Production	Consumption	Consumption Production	Marketable Surplus	Marketable Surplus Production	
Rice	19.07	9.67	.51	9.40	.49	66 (54)
Beans	3.78	2.82	.75	.96	.25	64 (52)
Corn	24.42	18.76	.77	6.06	.25	93 (76)
Coffee	28.14	4.25	.15	23.89	.85	27 (22)
Fruits	3,907.00	477.50	.12	3,429.50	.88	10 (8)
Vegetables	8,414.28	622.00	.08	7,792.28	.93	7 (6)
Cattle	8,795.38	--	--	8,795.38	1.00	13 (11)
Swine	4,433.48	2,703.81	.61	1,729.67	.39	23 (19)
Poultry	1,190.27	704.64	.59	485.63	.41	51 (41)
Milk	8,899.82	903.81	.10	7,996.01	.90	13 (11)
Milk products	2,999.63	213.86	.07	2,785.77	.93	8 (7)

Source: Sample survey.

^aRice was measured in 50-kg bags, beans and corn were measured in 60-kg bags, coffee was measured in 30-kg bags, and the other products were measured in 1977 cruzeiros.

^bSample size = 123 cases. The numbers in parentheses are percentages of farmers who produced the product indicated.

of farmers in the 0-10 hectares group, had characteristics of commercial activities.

The production, consumption, and marketable surplus of the farmers who owned 10-50 hectares are presented in Table 3.26. Corn, beans, and rice were the most commonly grown crops among the farmers in this group. About 80 percent of the producers grew corn, and about 70 percent grew beans and rice. The percentage of rice consumed on the farm was about 40 percent; about 60 percent and 70 percent of bean and corn production, respectively, were consumed on the farm.

The activities that required relatively more land and capital, such as coffee and milk production, were more common in this category of producers than for sharecroppers and producers with 0-10 hectares. Besides poultry, corn, beans, and rice, all other products had commercial characteristics. However, the percentage of farmers who grew these products was not so high, as can be observed in Table 3.26.

The figures presented in Table 3.27 led to the conclusion that corn, beans, and rice were the most popular crops among those farmers who owned 50-100 hectares of land. About 85 percent of these farmers grew corn, and the farm consumption of this product was about 60 percent of production. About 80 percent of this category of farmers also grew rice and beans, and the farm consumption of each of these products accounted for approximately 30 percent of production. Other activities that were common among these farmers were the production of cattle, coffee, and milk. About 60 and 70 percent of these farmers produced cattle and milk, respectively, and about 50 percent grew coffee. The

Table 3.26.--Production, consumption, sales, and marketable surplus of selected products for 10-50 ha landowners, Zona da Mata, MG, 1976-77.

Products ^a	Operations					No. of Producers ^b
	Production	Consumption	<u>Consumption</u> Production	Marketable Surplus	<u>Marketable Surplus</u> Production	
Rice	39.21	15.68	.40	23.53	.60	149 (68)
Beans	8.61	5.29	.61	3.32	.39	157 (71)
Corn	59.53	40.02	.67	19.51	.33	181 (82)
Coffee	78.81	6.84	.09	71.97	.91	95 (43)
Fruits	2,329.19	1,093.26	.47	1,235.93	.53	31 (14)
Vegetables	9,893.08	323.00	.03	9,570.08	.97	13 (6)
Cattle	8,581.35	1,790.00	.21	6,791.35	.79	77 (35)
Swine	5,451.53	2,957.45	.55	2,494.08	.46	62 (28)
Poultry	1,946.91	1,239.46	.64	707.45	.36	97 (44)
Milk	23,108.19	998.58	.04	22,109.61	.96	97 (44)
Milk products	5,242.03	406.04	.08	4,835.99	.92	31 (14)

Source: Sample survey.

^aRice was measured in 50-kg bags, beans and corn were measured in 60-kg bags, coffee was measured in 30-kg bags, and the other products were measured in 1977 cruzeiros.

^bSample size = 220 cases. The numbers in parentheses are percentages of farmers who produced the product indicated.

Table 3.27.--Production, consumption, sales, and marketable surplus of selected products for 50-100 ha landowners, Zona da Mata, MG, 1976-77.

Products ^a	Operations				No. of Producers ^b
	Production	Consumption	$\frac{\text{Consumption}}{\text{Production}}$	$\frac{\text{Marketable Surplus}}{\text{Production}}$	
Rice	84.42	22.64	.27	61.78	45 (76)
Beans	15.09	5.20	.34	9.89	47 (80)
Corn	97.30	55.34	.57	41.96	50 (85)
Coffee	91.39	6.03	.07	85.36	28 (47)
Fruits	2,533.33	2,283.33	.90	250.00	6 (10)
Vegetables	7,600.00	130.00	.02	7,470.00	2 (3)
Cattle	19,915.29	3,500.00	.18	16,415.29	34 (58)
Swine	10,660.00	3,577.83	.34	7,082.17	24 (41)
Poultry	2,114.58	1,529.17	.72	585.41	24 (41)
Milk	47,043.96	1,367.09	.03	45,676.87	41 (69)
Milk products	4,085.83	525.00	.13	3,560.83	6 (10)

Source: Sample survey.

^aRice was measured in 50-kg bags, beans and corn were measured in 60-kg bags, coffee was measured in 30-kg bags, and the other products were measured in 1977 cruzeiros.

^bSample size = 59 cases. The numbers in parentheses are percentages of farmers who produced the product indicated.

on-farm consumption of these products accounted for only 18 percent, 3 percent, and 7 percent, respectively, of total cattle, milk, and coffee production.

Fruits and poultry were produced mainly for on-farm consumption. Vegetables were delivered directly to the market; however, only 3 percent of the farmers who owned 50-100 hectares of land grew vegetables.

As expected, the farmers who owned more land, such as the farmers with 100-200 hectares, were more trade oriented. The percentage of production that was marketable surplus of rice, beans, coffee, cattle, swine, milk, and milk products was more than 50 percent of the total farm production for each item. About 80 percent of the farmers in this group grew rice; about 10 percent were involved in fruit production, 70 percent in cattle production, 40 percent in swine production, 80 percent in milk production, and 16 percent in the production of milk products. Corn was grown by about 80 percent of the farmers in this group of producers; about 60 percent of the production was allocated to farm consumption. (See Table 3.28.) Much of the corn is fed to livestock.

All vegetables produced were consumed on the farm; however, only 5 percent of the farmers in this group grew vegetables. Poultry production was also mainly allocated to farm consumption; about 40 percent of the farmers raised this product.

Summary and conclusions. In light of the analysis presented in this section, one can conclude that production of corn, beans, and rice is the most common enterprise in the Zona da Mata. Corn was

Table 3.28.--Production, consumption, sales, and marketable surplus of selected products for 100-200 ha landowners, Zona da Mata, MG, 1976-77.

Products ^a	Operations					No. of Producers ^b
	Production	Consumption	<u>Consumption</u> Production	Marketable Surplus	<u>Marketable Surplus</u> Production	
Rice	152.00	36.15	.24	115.85	.76	12 (63)
Beans	22.85	5.50	.24	17.35	.76	13 (68)
Corn	189.53	107.80	.57	81.73	.43	15 (79)
Coffee	444.83	7.33	.02	437.50	.98	6 (32)
Fruits	875.00	250.00	.29	625.00	.71	2 (11)
Vegetables	450.00	450.00	1.00	--	--	1 (5)
Cattle	18,966.54	2,350.00	.12	16,616.54	.88	13 (68)
Swine	5,322.86	1,397.14	.26	3,925.72	.74	7 (37)
Poultry	1,766.71	1,235.43	.70	531.28	.30	7 (37)
Milk	56,099.63	1,703.00	.02	94,396.63	.98	15 (79)
Milk products	6,180.00	420.00	.07	5,760.00	.93	3 (16)

Source: Sample survey.

^aRice was measured in 50-kg bags, beans and corn were measured in 60-kg bags, coffee was measured in 30-kg bags, and the other products were measured in 1977 cruzeiros.

^bSample size = 19 cases. The numbers in parentheses are percentages of farmers who produced the product indicated.

grown by about 80 percent of the sampled farmers, and about 70 percent and 65 percent of those farmers produced beans and rice, respectively. As farm size increased it was observed that production of grains per farm also tended to increase, and also this was the tendency of these products' marketable surplus.

By verifying the percentage of farmers who grew each of the analyzed enterprises, we can conclude that sharecroppers are more concerned in producing subsistence crops such as corn, beans, and rice. There is a tendency, however, in raising poultry, and to participate in coffee and milk-production contracts in which their labor force represents important input for landowners' production process.

A relatively large percentage of 0-10 hectares landowners, besides grain production, raise poultry, coffee, and swine. Among the landowner groups, this group of farmers had a smaller proportion of the production of grains as marketable surplus. Their production of coffee, cattle, milk, and milk products, which tend to be cash enterprises in the Zona da Mata, had more commercial characteristics than subsistence ones for these producers.

The 10-50 hectares landowners tended to produce and commercialize coffee, cattle, milk, and milk products, besides grains.

Production of milk, cattle, coffee, and grains seemed to be the most important enterprises for the 50-100 hectares landowners. Following these enterprises, swine production seems to be also of relevance for this group of farmers.

Finally, for the group of 100-200 hectares landowners, besides grains, emphasis seemed to be on coffee, milk, and cattle

production. These farmers had 76 percent of their rice and beans production as marketable surplus. Because relative emphasis is also put on the production of swine and poultry in addition to milk production, a relatively small percentage of corn was marketed.

As expected, a small proportion of coffee, cattle, milk products, and milk were consumed on the farm. Swine and poultry production seemed to be subsistence activities for the smaller producers. The proportion of consumption of rice, corn, and beans decreased with the size of farms among landowners. The sharecroppers consumed the highest proportion of beans produced on their land and were the group of producers who had highest corn marketable surplus/production ratio among all categories of farmers.

As farm size increased, it was observed the inclusion of grain production among the many farm enterprises raised in the Zona da Mata. The economic importance of grains for each farm group will be analyzed in the next chapter.

Market Prices

Market prices are determined by supply and demand, and by government actions through official price policies. Prices used in this study are those reported by farmers surveyed. The price data obtained from the survey did not permit an analysis of prices farmers received throughout the survey year. It is assumed that reported prices correspond to the average of all sales farmers made throughout the year.

A statistical analysis of selected product prices is presented in Table 3.29. The importance of this analysis is associated with the development of the next section, which deals with farm income.

The ANOVA conducted on the arithmetic means of prices received by the five groups of farmers suggested that at the 5 percent level of significance, the prices of rice, beans, corn, coffee, cattle, poultry, and milk were not statistically different among the groups. The only product for which price was not statistically equal at the 5 percent level of significance among the many producer groups was swine. The explanation is that, except for swine, the producers of these products have similar storage facilities and sell their products in the market at similar periods of time and with similar quality. For products like milk, whose price is controlled by the government, possible differences reflect transportation costs.

A study conducted by Paniago et al.¹ showed that prices of hogs are higher from April through August. Assuming that sharecroppers and landowners with 0-10 hectares and 10-50 hectares raise hogs for their own subsistence and sell only the surplus, they market their products at times of higher prices. In contrast with these producer classes, the 50-100 hectares and 100-200 hectares landowners who raise swine for commercial purposes may not be able to avoid lower seasonal prices. An alternative explanation for the different prices received by groups of farmers is associated with the product marketed. Smaller

¹Euter Paniago et al., Estudos sobre uma Região Agrícola: Zona da Mata de Minas Gerais (II) (Rio de Janeiro: IPEA/INPES, 1973).

Table 3.29.--Analysis of variance of different prices received for selected products by farmers,
Zona da Mata, MG, 1976-77.^a

Selected Products	Arithmetic Means				ANOVA Signif. Level	General Mean
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha	
Rice	108.78	105.30	109.21	107.33	115.00	108.32
Beans	406.15	372.45	386.45	388.04	407.69	390.17
Corn	81.16	79.15	90.69	79.60	85.00	84.54
Coffee	359.20	270.83	404.46	349.64	381.25	392.85
Cattle	510.00	1,032.31	1,188.06	1,131.18	1,273.46	1,153.19
Swine	247.50	226.09	226.26	212.50	162.86	224.34
Poultry	21.51	24.76	24.01	22.36	23.14	23.46
Milk	3.27	2.35	2.76	2.69	2.66	2.71

Source: Sample survey.

^aThe price of rice was measured in 1977 cruzeiros/50-kg bag; the prices of beans and corn were measured in 1977 cruzeiros/60-kg bag; the price of coffee was measured in 1977 cruzeiros/30-kg bag; the prices of cattle and poultry were measured in 1977 cruzeiros/head of animal; the price of milk was measured in 1977 cruzeiros/liter; and the price of swine was measured in 1977 cruzeiros/15 kg of head of animal. Approximately 12.5 cruzeiros equal 1 U.S. dollar.

farmers generally slaughter animals on the farm, while larger farmers sell live animals to the slaughter house. Consequently, they receive lower price per head for their animals than the group of sharecroppers.

Farm Income, Off-Farm Income,
and Family Income

In this section family income is presented together with its components, i.e., the income generated on the farm and off-farm. The relative contribution of selected products to farmers' gross income is also given.

To compute the income generated on the farm, the following formula was used:

$$I = S + M - F \quad (3.1)$$

where I is the net farm income, S is the value of subsistence consumption, M is the value of households' produce sales, and F is the value of production inputs.¹ This concept of net farm income, according to Brown,² represents the farm family's compensation for their labor, capital investment, and management of the farm. For the purpose of this research, prices farmers reported they paid and received were used to compute net farm income. Farm cost included the sum of such expenses as hired labor, seeds, fertilizer, pesticides, machinery services, services of work animals, costs of vaccines

¹Robert P. King et al., "Income Distribution, Consumption Patterns and Consumption Linkages in Rural Sierra Leone," African Rural Economy Paper No. 16 (East Lansing: Michigan State University, 1977).

²Maxwell Brown, 1979, op. cit.

medicines for animals, rations, and salt. The costs generated from these calculations were about Cr\$1,828 for the sharecroppers, Cr\$2,044 for the 0-10 hectares landowners, Cr\$7,750 for the 10-50 hectares landowners, and Cr\$14,687 and Cr\$42,872 for the 50-100 hectares and 100-200 hectares landowners, respectively.

The net farm income of the Zona da Mata farmers is presented in Table 3.30. The smallest net farm income was that of the sharecroppers. The Zona da Mata average net farm income was about Cr\$29,500, which was above the income of sharecroppers and landowners with 0-10 hectares of land and was not too much different from that of the 10-50 hectares landowners. The net farm income of the group of farmers who owned 10-50 hectares of land was about four times that of the 0-10 hectares landowners. The incomes of the two largest groups of farmers (50-100 hectares and 100-200 hectares groups) were, respectively, about two times and eight times the average net farm income of the whole Zona da Mata.

The off-farm income of the Zona da Mata producers is also presented in Table 3.30. The arithmetic mean of off-farm income was about Cr\$7,600. Only the sharecroppers and the 100-200 hectares landowners had an off-farm income greater than the region's arithmetic mean.¹ The analysis of variance suggested that at the 5 percent

¹Figures presented in Table 3.18 also suggested such results. Sharecroppers worked off the farm but in agricultural sector more than other producer groups. The 100-200 hectares farmers are probably those with more business in the cities (Universidade Federal de Viçosa, DER, Programa Integrado de Desenvolvimento da Zona da Mata--MG, Primeiro Relatório Anuário de Avaliação (Viçosa, MG: Março 1979).

Table 3.30.--Net farm income, off-farm income, and family income of farmers, Zona da Mata, MG, 1976-77, in 1977 cruzeiros.^a

Source of Income	Group of Farmers				Zona da Mata Average
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Net farm income	6,161	7,600	29,724	58,285	238,472
					29,525
Off-farm income	7,630	5,640	7,505	6,667	24,020
					7,598
Family income	13,791	13,240	37,229	64,952	262,492
					37,123

Source: Sample survey.

^aApproximately 12.5 cruzeiros equal 1 U.S. dollar.

level, the arithmetic means of off-farm income differed statistically among groups of farmers.

In Table 3.31, the off-farm activities of the Zona da Mata producers are summarized. Sharecroppers worked off of their contract land on other farms an average of 169 days per year. An average of 70 percent of that time they worked as daily hired labor, and an average of 3 percent of that time they worked as sharecroppers on other properties. The other groups of farmers worked less time off their own land and in the agricultural sector. Large farmers did not have any income generated in the agricultural sector besides that from their own farms. However, the income this group of farmers earned outside the agricultural sector was the highest one among all groups of farmers. The side occupations in which this group of farmers was engaged were basically service and trade oriented. The 10-50 hectares group of farmers also had trade as their principal occupation in addition to the farm business.

Other incomes generated off the farm included rent on houses owned in town, rent on vehicles owned by the farmer, contributions from relatives, retirement compensation, and small-scale farm industries.

The aggregation of all these sources of income indicates that large farmers (100-200 hectares farm size) had the highest incomes from "other income" sources, followed by farmers in the 0-10 hectares farm-size group. The sharecroppers had the least income from nonagricultural sector and "other income" sources.

Table 3.31.--Average off-farm incomes of five groups of producers, Zona da Mata, MG, 1976-77.^a

Work Off Farm	Group of Farmers				
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Number of days worked in the agricultural sector	169	66	40	33	0
On daily hired basis (%)	70	25	8	5	0
As sharecropper (%)	3	8	2	0	0
Income generated off farm but in agricultural sector	6,852	2,026	2,101	3,712	0
Number of days worked out of the agricultural sector	9	31	27	12	0
Income generated off farm and out of agricultural sector	229	1,229	3,535	1,249	18,947
Other income	549	2,385	1,869	1,706	5,073
Total off-farm income	7,630	5,640	7,505	6,667	24,020

Source: Sample survey.

^aOff-farm incomes are expressed in 1977 cruzeiros. Approximately 12.5 cruzeiros equal 1 U.S. dollar.

The aggregation of all sources of income is presented in Table 3.30 as "Family Income." The arithmetic means of family income producer groups were statistically different at the 5 percent level of significance.

The computed Gini Ratio of the farmers' gross income was about .637. (See Appendix B.)

The sharecroppers' and 0-10 hectares landowners' family incomes were below the average of the Zona da Mata. The 10-50 hectares landowners' family income was very close to the general average, and the two groups of farmers who owned more than 50 hectares of land had incomes above the average for the whole region.

The percentage contribution of the value of selected products to gross income was computed for each group of farmers.¹ These results presented in Table 3.32 suggest that bean, corn, and coffee revenues constituted about 56 percent of the gross income of the sharecroppers. Corn was the product that contributed most to their gross income. Other products of importance to this group of farm producers were vegetables, swine, poultry, milk, and rice. It was observed that perennial crops like coffee, and activities that required land and capital, such as milk production, gained relative importance as farm size increased.

For the group of farmers who owned 0-10 hectares, 10-50 hectares, and 100-200 hectares of land, coffee sales made up the largest share of their gross income. For the 50-100 hectares group, milk

¹ Limitations of the data did not allow the calculation of net income from each enterprise.

Table 3.32.--Percentage contribution of the revenue of selected products to farmers' gross income,
Zona da Mata, MG, 1976-77.

Products	Group of Farmers				
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha
Rice	2	6	3	3	1
Beans	15	6	9	5	1
Corn	23	12	10	7	3
Coffee	18	29	31	16	61
Fruits	1	3	1	1	1
Vegetables	7	5	2	0.4	0
Cattle	1	10	8	16	5
Swine	7	9	4	6	1
Poultry	7	5	2	1	0.2
Milk	6	10	27	45	27
Milk products	0.4	2	2	1	0.4
Other agricultural products	13	3	2	0.4	0.6

Source: Sample survey.

revenue contributed the highest percentage--about 45 percent--to farmers' gross income.

The share of corn sales to farmers' gross income decreased with an increase in the size of the farms, constituting about 3 percent of the gross income of the 100-200 hectares farmers. However, much is fed to livestock on the farm.

Vegetables and poultry had relative importance for the sharecroppers and 0-10 hectares landowners; the relative shares of these products in gross farm income decreased with an increase in farm size. Milk products, an important potential source of income for the region through small-scale industry operation, still had minor importance for the Zona da Mata farmers. Fruit revenue, as with revenue from milk products, was of relatively minor importance to gross farm income.

Summary and conclusions. In this section family income and its components were presented, i.e., the part of that income generated on farm and off-farm. The net farm income and the family incomes of sharecroppers and 0-10 hectares landowners were below the average of the study area. The 10-50 hectares landowners' incomes, i.e., net farm income, off-farm income, and family income, were about the average of the study area. The family incomes of the 50-100 hectares and the 100-200 hectares groups, on the other hand, were about two times and seven times the average of the Zona da Mata family income.

Off-farm income is of special importance for sharecroppers and landowners with 0-10 hectares. About 55 percent and 43 percent

of sharecroppers' and 0-10 hectares landowners' family incomes came from labor wages, donations from relatives, retirement compensation, etc.

The computed Gini Ratio of the farmers' gross income was about .637, expressing relatively high income concentration in rural Zona da Mata.

The analysis of the percentage contribution of the revenue of selected products to farmers' gross income confirmed the hypothesis developed in the previous sections about the relative importance of grain production for smaller producers (see Table 3.33).

About two-thirds of all producers raise rice and beans, and about 80 percent grow corn. With the exception of sharecroppers, the average of rice and beans consumption as a percentage of production declines as farm size increases. This trend is also observed for corn; however, it is not as pronounced as for the former products.

Beans, corn, and rice revenues contributed 40 percent, 24 percent, and 22 percent of sharecroppers', 0-10 hectares and 10-50 hectares landowners' gross income, respectively. The relative importance of grains for the gross income of 50-100 hectares and 100-200 hectares landowners was relatively small.

Besides grains, other products of importance for the sharecroppers' gross income were coffee, vegetables, swine, poultry, and milk. Considering that production of coffee and milk involves special contracts because of the land and capital requirements and that few producers have the opportunity to engage in such contracts because they primarily involve family partnerships, the production of other

Table 3.33.--Percentage of farmers growing grains and percentage of the production used on farm
by farm size categories, Zona da Mata, MG, 1976-77.

Farm Categories	Rice		Beans		Corn	
	Percentage of Producers	Percentage Consumed on Farm	Percentage of Producers	Percentage Consumed on Farm	Percentage on Producers	Percentage Consumed on Farm
Sharecroppers	63	29	78	87	89	48
0-10 hectares	54	51	52	75	76	75
10-50 hectares	68	40	71	61	82	67
50-100 hectares	76	27	80	34	50	57
100-200 hectares	63	24	68	24	79	57
Zona da Mata Average	64	34	69	59	83	61

Source: Sample survey.

enterprises should be regarded as potential income generators for the sharecroppers.

The revenue from grains, coffee, cattle, and milk accounted for 73 percent of the 0-10 hectares landowners. It is worth noting that production of vegetables, swine, and poultry was also of relative importance for these producers' gross income.

The characteristics of the 10-50 hectares landowners are similar to those of the 0-10 hectares landowners. About 89 percent of the 10-50 hectares group was composed by grain, coffee, milk, and cattle revenues.

About 92 percent of the 50-100 hectares group's gross income was constituted by grain, coffee, cattle, and milk sales. Milk revenue alone accounted for 45 percent of this group's gross revenue. Swine production also was of importance for this class of producers' gross revenue.

The 100-200 hectares landowners' gross income was most dependent on coffee, milk, and cattle production. Coffee revenue alone accounted for 61 percent of the total gross income of this group of farmers.

By examining the farm family income composition as well as the percentage of the farmers who raised the products described in this chapter and the share of those products' revenue on farmers' gross income, an attempt was made to identify typical farmers of each class of producers. These typical farmers are as follows:

Sharecroppers: For this class of producers, production of grains (corn, beans, and rice) constitutes the most typical farm

enterprises. However, off-farm income constitutes the most important source of income for these producers--about 55 percent of their income was generated off the farm. Adjacent enterprises of importance for these producers are poultry and coffee production.

0-10 hectares landowners: The most typical farm of this class of producers is characterized by production of grains. Off-farm income is also of major importance for these producers--about 43 percent of their income was generated off the farm. Poultry, coffee, and swine production are adjacent enterprises of this group of producers.

10-50 hectares landowners: Production of grains, milk, poultry, coffee, cattle, and swine are the most common enterprises in a typical farm of this group of producers. Off-farm income is of relatively less importance for these producers than it is for sharecroppers and 0-10 hectares landowners.

50-100 hectares landowners: The typical farm of this group of producers raises grains, milk cows, coffee, swine, and poultry.

100-200 hectares landowners: Production of milk and corn are the most common enterprises, followed by cattle, beans, rice, poultry, swine, and coffee.

Similar enterprises were observed in both 50-100 hectares and 100-200 hectares groups of farmers. However, for the former group of farmers the highest share of their gross income was from milk sales and, for the latter, coffee generated the highest income share.

CHAPTER IV

ECONOMIC EFFICIENCY OF THE GRAIN SUBSECTOR

In the preceding chapter, the process of income determination in the Zona da Mata farm sector was discussed. The importance of the grain subsector for the various classes of farmers was evident. This chapter deals with the production side of the grain subsector. The analysis that follows was motivated by the need for more knowledge about the economic efficiency of resource use in the grain-production process in the study area. The results of this analysis can be a valuable component of future development efforts for the area, particularly in reallocating resources in the grain subsector with the objective of increasing farmers' income.

The Grain Cropping System in the Zona da Mata

It has been estimated that 75 percent of the total area used to produce rice in Minas Gerais State is upland, and the rest is lowland without controlled irrigation.¹ Among the biological requirements of the rice crop, soil moisture is the most limiting factor. It has been estimated that under controlled irrigation it is possible

¹ Empresa da Pesquisa Agropecuária de Minas Gerais, "A Cultura de Arroz em Minas Gerais," Informe Agropecuário (Belo Horizonte) 5 (Julho 1979): 9.

to increase rice yields from four to five times relative to yields under the rainfall system.¹

Rice production in the Zona da Mata is developed principally in lowland areas with no water control during the growing season. A traditional production system prevails; i.e., improved seeds, fertilizers, pesticides, and other modern inputs are not generally used. About 64 percent of the Zona da Mata farmers produced rice in the 1976-77 agricultural year.²

The production of beans and corn is also widespread in the Zona da Mata. About 70 percent and 80 percent of the producers in that region grew beans and corn, respectively, in the 1976-77 agricultural period.³ Vieira estimated that 90 percent of the bean production in the Zona da Mata is intercropped with corn. This intercropping system is used primarily by small farmers, and hand-cultivation systems are the rule. Referring to the corn-beans intercropping system, Vieira pointed out that "it reduces the incidence of pests, utilizes family labor more intensively (which is relatively abundant in the region), reduces risk, and guarantees diversity of diet and income sources. On the other hand, this production system impedes the utilization of agricultural practices that

¹Orlando Peixoto Moraes, Fernando Linho, and Plinio César Soares, "Exigencias Climáticas da Cultura do Arroz," Informe Agropecuário (Belo Horizonte) 5 (Julhy 1979): 16-19.

²See Table 3.33.

³Ibid.

lead to higher yields."¹ Research efforts have been concentrated on the corn-beans combination since researchers and extension workers have failed in their attempts to encourage farmers to plant improved crop varieties in sole stands.

In both cropping systems, corn and beans planted separately and intercropped, the use of relatively flat land has been observed. As the topography becomes more hilly, the intercropped system is recommended because it protects the soil from erosion.

In summary, the grain subsector of the Zona da Mata, which is the focus of this chapter, is composed of rice, beans, and corn sole cropped, as well as corn and beans intercropped. The production of all these crops largely uses traditional technologies.

Specification of Grain-Production Functions and Some Theoretical Considerations

Assuming neoclassical pure competition, a firm will select its levels of production and input use so as to maximize its profit function, where the total revenue (TR) minus total cost (TC) equals profit. Total revenue equals product price (PY) multiplied by output (Y). Output (Y) is a function of the input combinations $\emptyset(X_i, i=1\dots n)$. Total cost equals the sum over all the inputs of unit

¹Clibas Vieira, "Cultivo Consorciado de Milho con Feijão," Informe Agropecuário (Belo Horizonte) 4 (Out. 1978): p. 42. For similar evidence of advantages of the intercropping systems in other traditional agriculture, see D. W. Norman, D. Pryor, and C. J. N. Gibbs, "Technical Change and the Small Farmer, Hausaland, Northern Nigeria," African Rural Economy Paper No. 21 (East Lansing: Department of Agricultural Economics, Michigan State University, 1979), p. 59.

price (PX_i) multiplied by the quantity used (X_i). Thus, profit can be defined as:

$$\text{Profit} = PY \cdot \phi(X_1, \dots, X_n) - \sum_{i=1}^n PX_i \cdot X_i \quad (4.1)$$

where $\phi(X_1, \dots, X_n)$ is the production function of Y .

Assuming the law of diminishing returns, profit is maximized when the first-order conditions are met:

$$\frac{\partial \text{Profit}}{\partial X_i} = PY \phi_{1:X_i} - PX_i = 0 \quad (4.2)$$

where $\phi_{1:X_i}$ is the first derivative of the production function with respect to input X_i ($i=1, \dots, n$), and $PY \phi_{1:X_i}$ is the marginal value product ($MVP_{X_i}:Y$) of X_i in production of Y . Thus, under the assumption of pure competition, profit is maximized when the level of input use is such that $MVP_{X_i}:Y$ equals the factor cost.

Production Function Specification

To verify whether grain producers of the Zona da Mata combine inputs in order to maximize profits, the marginal value product of Y for X_i must be determined. This can be done by estimating the production functions of the grains under study. The production function as stated before is as follows:

$$Y_j = \phi_j(X_{1j}, \dots, X_{nj}) \quad (4.3)$$

where Y_j is rice ($j=1$), bean ($j=2$), corn ($j=3$), and corn-beans combination ($j=4$), and X_i ($i=1, \dots, n$) are the inputs. The production function above constitutes what Aigner and Chu called an "average

production function."¹ According to them, it would be correct to use the concept of "average" when one wishes to estimate how much output, "on the average," could be obtained for a firm in the industry with a certain set of inputs. Other important uses of the average function are that (a) in some cases one can approximate the industry's aggregate production function when aggregate data cannot be obtained but data at the firm level are available and (b) one can approximate an "average" firm production function when he has data only on industry aggregates.

The explanatory variables included in estimating equation (4.3) are as follows:

Y_j = production of grain j , measured in 50 kg bags of rice, 60 kg bags of beans, 60 kg bags of corn, and the value of corn-beans combination, measured in 1977 cruzeiros;

X_{1j} = quantity of land used to produce commodity j , measured in hectares;

X_{2j} = quantity of labor used to produce commodity j , measured in man-days;

X_{3j} = quantity of seeds used to produce commodity j , measured in kg of seeds;

X_{4j} = value of pesticides used in production of commodity j , measured in 1977 cruzeiros;

X_{5j} = value of fertilizers used to produce commodity j , measured in 1977 cruzeiros;

¹D. J. Aigner and S. F. Chu, "On Estimating the Industry Production Function," American Economic Review 58 (1968): 826-39.

x_{6j} = value of machinery services used in production of commodity j, measured in 1977 cruzeiros;

x_{7j} = value of bullock plowing services used in production of commodity j, measured in 1977 cruzeiros;

x_{8j} = proxy for management, which is the average of years of formal education of the head of the family and his wife, measured in years of education;

D_{1j} & D_{2j} = dummy variables. These variables were included in the function to capture environmental differences among subregions of the Zona da Mata. Three subregions were considered: Juiz de Fora, Muriaé, and Viçosa. For $D_{1j}=1$, Juiz de Fora is identified, and for $D_{2j}=1$, Muriaé is identified.

A possibility of management and environmental bias may occur in estimated production functions when proxies for management ability and environmental differences are not included in the equations. As discussed in Chapter III, the education of the farmer may be a variable associated with management efficiency and is included in the present analysis. This procedure was used successfully by Yotopoulos in a study of efficiency of resource use in subsistence agriculture.¹ Many other techniques for dealing with the problem of management bias have been presented in related literature.²

¹Pan A. Yotopoulos, "On the Efficiency of Resource Utilization in Subsistence Agriculture," Food Research Institute Studies, Stanford University 7(2) (1968): 125-35.

²See, for example, B. F. Massell, "Elimination of Management Bias From Production Functions Fitted to Cross-Section Data: A Model

In considering efficiency, it is worth noting that different researchers have used their own definitions. Hall and Winsten used various concepts or types of efficiency to reflect judgments on different aspects of farming. Their primary concern was, however, managerial efficiency. They stressed that especially when making judgments about the relative performance of managers, allowance must be made for the nature of the physical environment facing each manager. If different managers face different constraints on their maximizing behavior, judgments about their relative performance will be useless unless these constraints are understood.¹ Farrell, on the other hand, used the term "technical efficiency," which he defined as judging a firm's success "in producing maximum output from a given set of inputs." He also defined "price efficiency" as meaning to judge the firm's "success in choosing an optimal set of inputs."² Marshak and Andrews seemed to use the same concepts and terms as Farrell employed but called them "technical" and "economic" efficiencies.³

and an Application to African Agriculture," Econometrica 35 (July-October 1967): 495-508; Irving Hoch, "Estimation of Production Functions Parameters Combining Time-Series and Cross-Section Data," Econometrica 30 (January 1962): 34-53; Yair Mundlak, "Empirical Production Function Free of Management Bias," Journal of Farm Economics 43 (February 1961): 44-56.

¹M. Hall and C. Winsten, "The Ambiguous Notion of Efficiency," Economic Journal 14 (March 1959): 71-86.

²M. J. Farrell, "The Measurement of a Productive Efficiency," Journal of the Royal Statistical Society, Series A, General, Part 3 120 (1957): 252-81.

³J. Marshak and W. Andrews, "Random Simultaneous Equations and the Theory of Production," Econometrica 12 (July 1944): 143-205. For a detailed revision on the definition and measurement of technical efficiency, see C. Peter Timmer, "On Measuring Technical Efficiency,"

Production-Function
Estimation Procedure

Generally, in production-function studies in agricultural economics, much of the concern is about economic efficiency. Some statistical difficulties are present in estimating the production functions which could result in misleading conclusions about efficiency. These difficulties include identification problems, specification bias, simultaneous equation bias, and multicollinearity.

Equation (4.3) in a standard Cobb-Douglas production function is:

$$\log Y_{jk} = \sum_i \beta_{ij} \log X_{ijk} + u_{jk} \quad (4.4)$$

where Y_{jk} = output j of farm k

X_{ijk} = amount of input i of farm k used to product output j

β_{ij} = elasticity of production of input i of output j

u_{jk} = stochastic term

To obtain consistent and efficient estimates of β_{ij} , it would be useful to achieve variations in the inputs from a stochastic process.¹ However, under perfect competition, the decision of how much to produce as well as the choice of inputs is made according to the rules of profit maximization. Considering a specific product for any farmer, we have

Food Research Institute Studies, Stanford University 9(2) (1970). See also Peter Schmidt and C. A. Knox Lovell, "Estimating Technical and Allocative Inefficiency Relative to Stochastic Production and Cost Frontiers," Journal of Econometrics 9 (1979): 343-66.

¹Andrew B. Tench, Socioeconomic Factors Influencing Agricultural Output (Sozialökonomische schrissten zur agrarentwicklung Heft 12 Saarbrücken, 1975).

$$\frac{\partial Y_k}{\partial X_{ik}} = \frac{\beta_i Y_k}{X_{ik}} = R_{ik} \quad (4.5)$$

where R_{ik} = the price of input i to firm k , divided by the price of output. The factor prices and product prices are the same for all farmers, and the elasticity of production of various inputs is known. Equation (4.5), written logarithmically, and with an error term added, becomes

$$x_{ik} = -\log R_i + y_k + \log \beta_i + w_{ik} \quad (4.6)$$

where $x_{ik} = \log X_{ik}$, $y_k = \log Y_k$, and w_{ik} is the error term. Then, equation (4.6) is unidentifiable.¹

However, relaxation of some assumptions of the perfect-competition model allows for identifiability. For instance, if the assumption of certainty is relaxed, entrepreneurial ability will vary the inputs used in the production process. On the other hand, imperfect factor markets and different elasticities of supply of inputs affect input levels. Differences in physical environment--the stock of capital, for instance--would also affect the use of inputs. The constancy of production elasticities and profit-maximization principle retained are aspects of the model. The former aspect is retained to make the function measurable, and the latter is retained to interpret the results against established neoclassical economic theory.

Specification bias occurs because the true functional form and the complete range of variables that it should contain are

¹Hoch, op. cit.

unknown. Heady and Dillon showed how the ordinary least-squares method, the most frequently used method in estimating production functions, may bring bias to the estimations when: (a) an incorrect functional form is used, (b) some variables are omitted from the model specification, and (c) when aggregation within and aggregation over inputs occur.¹

Simultaneous equation bias results from the situation in which the disturbance term is not truly independent of the inputs. We can consider that the production function is one equation in a system, and if it is functionally related to other equations, the single equation estimation will generate inconsistent estimations for the parameters.² However, consider that a farmer makes a decision on planned output. The planned output in some sense determines the levels of inputs to be used, and it differs from the actual output by the farmers' degree of success. One way to avoid the problem of simultaneous equation bias is to assume that firms make input decisions on the basis of anticipated output rather than current output.

¹Earl O. Heady and John L. Dillon, Agricultural Production Functions (Ames: Iowa State University Press, 1966). For other approaches dealing with specification bias, see Z. Griliches, "Specification Bias in Estimates of Production Functions," Journal of Farm Economics 39 (1957): 8-20. See also H. Theil, "The Analysis of Disturbances in Regression Analysis," Journal of the American Statistical Association 60 (Dec. 1965): 1067-79; J. B. Ramsey, "Tests for Specification Errors in Classical Linear Least-Squares Regression Analysis," Journal of Royal Statistical Society, Series B, 31,2 (1969): 350-71; James B. Ramsey and Peter Schmidt, "Some Further Results on the Use of OLS and BLUS Residuals in Specification Error Tests," Journal of the American Statistical Association 71 (June 1976): 389-90.

²G. S. Maddala, Econometrics (New York: McGraw-Hill Book Co., 1977), p. 220.

This assumption, according to Tench, seems reasonable in the agricultural sector, and the ordinary least-squares technique can be used to estimate the parameters.¹

The fourth problem of concern in this section related to the production-function estimation is multicollinearity, which exists if the columns of the matrix of the explanatory variable observations are linearly dependent.² This could be the case, for instance, if there is a fixed method of cultivation with less chance of between-input substitution. In such a situation it is likely that as one input increases, another input also increases.

The main consequence of multicollinearity is that the precision of estimation falls so that it becomes very difficult, and sometimes impossible, to separate the relative influences of the various explanatory variables. This loss of precision has three aspects: "Specific estimates may have very large errors; these errors may be

¹Tench, op. cit. A classical article referring to the problem of simultaneous equation bias was presented by A. Zellner, J. Kmenta, and J. Drèze, "Specification and Estimation of Cobb-Douglas Production Function Models," Econometrica 34 (Oct. 1966): 784-95; and I. Hoch, "Simultaneous Equation Bias in the Context of the Cobb-Douglas Production Function," Econometrica 26 (Oct. 1958): 566-78. Other related references are J. Johnston, Econometric Models (New York: McGraw-Hill Book Co., 1972); Y. Mundlack and I. Hoch, "Consequences of Alternative Specifications in Estimation of Cobb-Douglas Production Functions," Econometrica 33 (Oct. 1965): 814-28; and M. Nerlove, Estimation and Identification of Cobb-Douglas Production Functions (Chicago: Rand McNally, 1965).

²Peter Schmidt, Econometrics (New York and Basel: Marcel Dekker, Inc., 1976).

highly correlated, one with another; and the sampling variances of the coefficients will be very large."¹

Selecting Subsamples for the Production-Function Analysis

The first step in determining the subsamples for the grain-production-functions analysis was to identify the farmers who grow corn, beans, and rice, sole cropped, and corn and beans combined in the same stand. Because farmers who own more than 100 hectares are not potential members of PRODEMATA, 19 farmers in this category were eliminated from the 550 original cases in the sample. After verification of all values of variables included in the production function stated in the preceding section, and eliminating those cases that presented enumeration or key-punching problems,² the total number of grain producers was estimated and is presented as "total number of producers" in Table 4.1.

Under the inputs grouping specified in the production functions, a substantial number of zero observations occurred. Because of these observations, some procedure should be used to estimate the log-log production function specified. King and Byerlee had a similar problem, and among the possible solutions they cited was to drop households with zero observations in a particular variable from the

¹Johnston, op. cit., p. 160.

²Some of the eliminated cases had zero observations in inputs such as land or labor.

analysis.¹ Alternatively, they preferred to replace zero observations with some arbitrary small number;² however, they recognized that parameter estimates based on the log-log model must be interpreted with caution.

Table 4.1.--Total number of grain producers of the Zona da Mata and number of cases selected for grain-production-function analysis.

Enterprises	Total Number of Producers	Number of Cases Selected ^a		Total
		Small Producers	Large Producers	
Rice	334	138	188	326
Beans	48	20	25	45
Corn	92	48	42	90
Corn-beans	274	112	148	260

Source: Sample survey.

^aSmall producers = sharecroppers and 0-10 hectares landowners; large producers = 10-50 hectares and 50-100 hectares landowners.

¹Robert P. King and Derek Byerlee, "Income Distribution, Consumption Patterns, and Consumption Linkages in Rural Sierra Leone," African Rural Economy Paper No. 16 (East Lansing: Department of Agricultural Economics, Michigan State University, 1979).

²This procedure was also adopted by Massell, "Elimination of Management Bias From Production Functions," and Benton F. Massell and R. W. M. Johnson, "Economics of Smallholder Farming in Rhodesia. A Cross-Section Analysis of Two Areas," Food Research Institute Studies in Agricultural Economics, Trade, and Development, Supplement to Vol. VIII, 1968.

For the purpose of the present research, it was decided to aggregate some inputs in order to eliminate all zero observations. Two classes of modern inputs (MI) were considered: MI_1 , which included value of fertilizers and pesticides, and MI_2 , which included machinery services and value of bullock plowing services. For some products in the analysis, there were still zero observations, which would imply small degrees of freedom for further estimations. To eliminate this problem, MI_1 and MI_2 were aggregated with the value of seeds used in the production process of commodity j . The subsample sizes are shown in Table 4.1. Because of the aggregation of inputs, the production function explicative variables of equation (4.3) were reduced to: X_{1j} = quantity of land used to produce commodity j , measured in hectares; X_{2j} = quantity of labor used to produce commodity j , measured in man-days; MI_j = value of "modern inputs"--seed, machinery and bullock plowing services, and pesticides and fertilizers; X_{8j} = average years of education of the head of the family and his wife; and dummy variables D_{1j} and D_{2j} , introduced in the function to capture the environmental differences among the three subregions of the Zona da Mata: Juiz de Fora, Muriaé, and Viçosa.

Estimations of the Grain-Production Functions

In the process of estimating average production functions of grains for the Zona da Mata, an attempt was made to verify possible differences between small and large farms' production functions. This was done because of the evidence of different resource endowment

and resource use by various classes of producers, presented in Chapter III.

Tables 4.2 and 4.3 summarize the production functions of beans, corn, rice, and corn-beans intercropped for small and large farmers, respectively. The ordinary least-squares method was used for the estimations; with the exception of education and the two dummy variables, all variables were taken in logarithms. This functional form provided expected coefficient signs of all variable inputs as well as desirable levels of significance for the coefficients.

For the small farmers' grain-production functions, the corrected coefficient of determination ($\bar{R}^2$) ranged from .4882 to .7080. In all equations land and labor were statistically significant at levels ranging from 1 percent to 10 percent. (See Table 4.2.) The coefficient of the modern input variable in the bean equation was not statistically significant at the 20 percent level and presented an unexpected negative sign. However, it was significant and positive in the other equations. Education was statistically significant at the 1 percent level in the rice equation but was not significant in the other equations. The estimated coefficient of the dummy variable D_1 in the rice equation was statistically significant at the 1 percent level, indicating a distinct intercept for the Juiz de Fora subregion among other subregions of the Zona da Mata.

For the larger farmers' grain-production functions, the corrected coefficient of determination ($\bar{R}^2$) ranged from .4983 to .7587. The estimated coefficients of the variables land, labor, and modern inputs were statistically significant at the 20 percent level or less.

Table 4.2.--Production functions of grains for small farmers of the Zona da Mata, MG, 1976-77.^a

Inputs	Beans	Corn	Rice	Corn-Beans
Constant term	.3563 (1.9642)	-.3111 (.5026)	-.7184 (.4293)	4.8916 (.5476)
Land	.9353** (.3989)	.2697** (.1226)	.4068* (.0915)	.3080* (.0925)
Labor	.3023*** (.4652)	.6277* (.1154)	.5027* (.1061)	.2952* (.1067)
Modern inputs	-.0489 (.2231)	.1808* (.0662)	.2922** (.0644)	.3041* (.0611)
Education	.5171 (.2659)	.1059 (.0944)	.1565* (.0658)	.0230 (.0574)
D ₁	-.4973 (.5504)	-.2227 (.2105)	-.3423*** (.1773)	-.0077 (.1318)
D ₂	-.2034 (.5427)	-.0256 (.1884)	-.0706 (.1422)	-.0122 (.1472)
R ²	.5141	.7080	.6362	.4882
df	13	41	131	105
SSE	6.5808	11.1132	66.4146	32.6601

^aSmall farmers = sharecroppers and 0-10 hectares landowners. The figures in parentheses are standard error of the coefficients.

*Coefficient significantly different from zero at 1 percent level.

**Coefficient significantly different from zero at 5 percent level.

***Coefficient significantly different from zero at 10 percent level.

Table 4.3.--Production functions of grains for large farmers of the Zona da Mata, MG, 1976-77.^a

Inputs	Beans	Corn	Rice	Corn-Beans
Constant term	-1.6519 (.9323)	.7643 (.7058)	-.6619 (.3164)	4.2186 (.4954)
Land	.4268*** (.2337)	.2383*** (.1402)	.3151* (.0746)	.3566* (.0769)
Labor	.6622* (.1685)	.3129** (.1407)	.5165* (.0803)	.5361* (.0958)
Modern inputs	.2103*** (.1243)	.2926* (.0747)	.2617* (.0401)	.2319* (.0598)
Education	.1153** (.0654)	.0624 (.0617)	.0471* (.0229)	.0204 (.0215)
D ₁	-.7922*** (.3931)	-.8786** (.3361)	-.0943 (.1716)	-.0909 (.1451)
D ₂	-.3140 (.2405)	-.4757*** (.2450)	.1923*** (.1023)	.2086** (.1016)
R ²	.7587	.4983	.7097	.6042
df	18	35	181	141
SSE	3.5905	10.0715	70.2725	40.7014

^aLarge farmers = 10-50 hectares and 50-100 hectares landowners. The figures in parentheses are standard error of the coefficients.

*Coefficient significantly different from zero at 1 percent level.

**Coefficient significantly different from zero at 5 percent level.

***Coefficient significantly different from zero at 10 percent level.

****Coefficient significantly different from zero at 20 percent level.

Education as proxy for management was statistically significant in the beans equation (at the 10 percent level) and in the rice equation (at the 1 percent level). Dummy variable D_1 as intercept shifter was statistically significant in the beans and corn equations, and dummy variable D_2 was statistically significant in the corn, rice, and corn-beans combination equations.

The same procedure was used to estimate production functions including both subgroups of farmers. These pooled functions are presented in Table 4.4. Tests conducted on the results of these equations failed to reject the hypothesis that both groups of observations, those for small and large farmers, belong to the same regression model.¹

Under the assumption that the variance of the error term is proportional to the square of the independent variable, a test suggested by Park found no heteroscedasticity problems in any of the equations presented in Table 4.4.²

¹For details about the tests used, see Gregory C. Chow, "Tests of Equality Between Sets of Coefficients in Two Linear Regressions," Econometrica 28 (July 1960): 591-605. The ratio

$$\frac{[SSE_T - (SSE_1 + SSE_2)]/K}{(SSE_1 + SSE_2)/(T - 2K)}$$

is distributed as $F(K, T-2K)$ under the null hypothesis that both subgroups of farmers belong to the same regression model. The computed ratios for beans, corn, rice, and corn-beans combination were 1.06, 1.01, 1.08, and 1.09, respectively. For rejection of the null hypothesis at the 5 percent level of significance, F would have to be at least 2.33, 2.17, 2.01, and 2.01 for beans, corn, rice, and beans-corn combination, respectively.

²R. E. Park, "Estimation With Heteroscedastic Error Terms," Econometrica 34 (Oct. 1966): 888. Heteroscedasticity tests proposed by Park are presented in Appendix C.

Table 4.4.--Production functions of grains for the Zona da Mata, MG, 1976-77.^a

Inputs	Beans	Corn	Rice	Corn-Beans
Constant term	-.7906 (.9003)	.0680 (.3919)	-.5952 (.2548)	4.5165 (.3514)
Land	.6263* (.2058)	.2662* (.0908)	.3471* (.0571)	.3352* (.0578)
Labor	.4893** (.1830)	.4676* (.0870)	.4960* (.0637)	.4374* (.0700)
Modern inputs	.1139 (.1156)	.2536* (.0482)	.2730* (.0335)	.2625* (.0413)
Education	.1881** (.0731)	.0774**** (.0499)	.0558* (.0217)	.0158 (.0195)
D ₁	-.5403*** (.2731)	-.4932* (.1731)	-.2127*** (.1194)	-.0074 (.0944)
D ₂	-.2319 (.2485)	-.1613 (.1389)	.1027 (.0832)	.1335**** (.0821)
R ²	.6381	.6518	.6940	.6127
df	38	83	319	253
SSE	12.6133	23.1390	140.0200	75.6912

^aInclude sharecroppers and less-than-100-hectares landowners. The figures in parentheses are standard error of the coefficients.

*Coefficient significantly different from zero at 1 percent level.

**Coefficient significantly different from zero at 5 percent level.

***Coefficient significantly different from zero at 10 percent level.

****Coefficient significantly different from zero at 20 percent level.

The corrected multiple determination coefficients ranged from .6127 (for corn-beans combination) to .6940 (for rice); all four regressions were significant at the 1 percent level.

Overall, land and labor are important variables in explaining interfarm output differences. Consistently, for the products analyzed, land appeared to be a limiting factor, as one would expect. Labor was statistically significant at the 5 percent level in the estimated equation for beans, and it was significant at the 1 percent level in the other equations. The coefficients of modern inputs were statistically significant at the 1 percent level in the corn, rice, and corn-beans combination equations and was not significant in the beans production equation. Because of the large standard error of modern inputs in the bean equation relative to the estimated parameter, the results that follow concerning this variable must be interpreted with caution.

Education (as proxy for management) was significant in the bean regression (at the 5 percent level of significance), in the corn regression (at the 20 percent level of significance), and in the rice regression (at the 1 percent level of significance).

Dummy 1, which stands for the Juiz de Fora subregion, was significant in the bean and rice equations at the 10 percent level, and in the corn equation at the 1 percent level. In all of these three regressions this variable had a negative sign, indicating that regional differences among farms did have an effect on production of beans, corn, and rice, which were lower in the Juiz de Fora subregion

than in the rest of the Zona da Mata.¹ Turning to the corn-beans combination, it was observed that Dummy 2, which stands for the Muriaé subregion, was positive and significant at the 20 percent level. This result suggests that regional differences among farms did have an effect on corn-beans combination production.²

Elasticities of Production

In the functional form used in this study, the regression coefficients of land, labor, and modern inputs are equal to the production elasticities and independent of factor ratios.³ Elasticities of production indicate the expected increase (or decrease) in production that would occur if the amount of the input resource was increased (or decreased) by 1 percent, other input levels being held constant. All production elasticities for the various types of enterprises are positive.

The sum of the production elasticities is less than, equal to, or greater than unity for decreasing, constant, or increasing return to scale, respectively.

To test for constant returns to scale, the null hypothesis was that the production elasticities sum to unity for each crop. A

¹Note that for beans, corn, and rice regressions, variable D_2 (Dummy 2), which identifies the Muriaé subregion, was not significant at the 20 percent level.

²Note that D_1 (Dummy 1), which stands for regional differences of the Juiz de Fora subregion, was not statistically significant at the 20 percent level in the corn-beans combination regression.

³Earl O. Heady, "Technical Considerations in Estimating Production Functions," in Resource Productivity, Returns to Scale, and Farm Size, ed. Earl O. Heady, Glenn L. Johnson, and Lowell F. Hardin (Ames: Iowa State College Press, 1956).

two-tailed t-test was used, and none of the sums of the elasticities were significantly different from unity at the 5 percent level.¹ This finding was consistent with those of other comparable studies.²

Marginal Productivities

The marginal productivity of factor i in producing crop j is denoted by ϕ_{ij} and is given by

$$\phi_{ij} = E_{ij} \frac{Y_j}{X_{ij}} \quad (4.7)$$

where E_{ij} = the elasticity of factor i in producing crop j ;

Y_j = the output of crop j ; and

X_{ij} = the amount of input i used to produce grain j .

The estimated marginal productivities of land, labor, and modern inputs were calculated at the geometric means of these variables and the outputs. The factor marginal productivities as well as the marginal value products of land, labor, and modern inputs are presented in Table 4.5.

The marginal value product of each input indicates the expected increase in output forthcoming from the use of an additional unit of the input, the level of other inputs remaining unchanged. In a production process in which more than one production factor is

¹The standard errors computed for the tests were .3969 for the bean equation; .1658 for the corn equation; .6451 for the rice equation; and .1284 for the corn-bean combination equation.

²See, for instance, Massell, op. cit., and A. A. Walters, "Production and Cost Functions: An Econometric Survey," Econometrica 31 (January-April 1963): 1-66.

Table 4.5.--Input and output sample means, factor marginal productivities, and marginal value productivities, Zona da Mata, MG, 1976-77.^a

Variables	Beans	Corn	Rice	Corn-Beans
Sample Means (Standard Deviations)				
Output ^{b,d}	4.390 (2.546)	27.189 (2.422)	19.452 (3.299)	5,826.780 (2.400)
Land ^b (hectares)	1.071 (1.913)	1.529 (2.105)	1.391 (2.460)	2.221 (2.196)
Labor ^b (man-days)	20.518 (1.941)	38.105 (2.071)	54.707 (2.245)	87.698 (1.934)
Modern inputs ^b (Cr.)	466.940 (2.565)	365.809 (4.006)	134.520 (4.296)	1,187.900 (2.249)
Education ^c (years)	1.644 (1.302)	1.433 (1.162)	1.905 (1.769)	1.925 (1.805)
D ₁ ^c	0.244 (.429)	0.211 (.408)	0.144 (.351)	0.250 (.433)
D ₂ ^c	0.556 (.497)	0.522 (.499)	0.488 (.500)	0.315 (.464)
Output price ^e (Cr.)	390.170	84.540	108.320	1.000
Factor Marginal Productivities				
Land	2.567	4.733	4.853	879.356
Labor	0.105	0.334	0.176	29.062
Modern inputs	0.001	0.018	0.039	1.288
Marginal Value Productivities				
Land	1,001.57	400.13	525.68	879.36
Labor	40.97	28.24	19.06	29.06
Modern inputs	0.39	1.52	4.22	1.29

^a12.50 cruzeiros equal 1 U.S. dollar.

^bGeometric means.

^cArithmetic means.

^dBeans and corn were measured in 60 kg bags, rice in 50 kg bags, and corn-beans in 1977 cruzeiros.

^eObtained from Table 3.29.

involved, the marginal productivity of any resource depends on the quantity used and on the proportion of the other resources with which it is combined.

There was considerable variation in the marginal productivity of inputs in the grains analyzed. The marginal value product of land was higher in the beans and corn-beans combination than in the corn and rice enterprises. The same tendency was also observed with the marginal value product of labor; however, a small difference was observed between corn and the corn-beans combination. It was found that the marginal value product of modern inputs was higher in the rice enterprise, followed by corn, corn-beans combination, and bean enterprises.

From the figures presented above, relating to the input marginal products, it follows that the greatest income-raising possibility is indicated by increasing crop land. The analysis that follows in the next section, however, deals more closely with factor limitations in grain production.

The Economic Efficiency of Input Use

For the study area there is no empirical evidence that farmers efficiently allocate inputs so as to maximize output value at market prices. It is, though, of interest to examine the extent to which the actual allocation deviates from an output-maximizing allocation, which is a developmental policy issue.

The opportunity costs used to analyze economic efficiency of resources were as follows: (a) for land, the average rent paid

per hectare of crop land in the survey year was used, which amounted to Cr\$583.00; (b) for labor, the average wage rate paid for daily labor during the agricultural year was used, which was Cr\$35.00; and (c) for modern inputs, an interest rate of 13 percent was assumed to be relevant, or Cr\$1.13 per Cr\$1.00 of input. This was believed to be a reasonable cost for "capital" and a price at which additional funds could be acquired.¹

Table 4.6 presents the marginal returns/factor cost ratios and the test for economic efficiency of resource use for each enterprise.²

According to the statistical results, producers of beans, on the average, were using land, labor, and modern inputs inefficiently. Modern inputs seemed to be used in excess, and land and labor were underused. The marginal return to opportunity cost of land ratio was higher than the ratio for labor, implying that land was scarcer than labor in the study region.

¹The average rent per hectare of crop land was reported by EPAMIG, Informe Agropecuario, ano 3, various issues; the wage rate was reported in the questionnaire.

²A t-test: $t = \frac{MVP_i - P_i}{S(MVP_i)}$ was used to test for efficiency, in which MVP_i is the marginal value product of resource X_i at the geometric mean; P_i is the price or opportunity cost of that resource, and $S(MVP_i)$ is the standard error of the marginal value product obtained as below. The null hypothesis was that $MVP_i - P_i = 0$, or that marginal return/price ratio was statistically not different from unity, which is the criterion used for efficiency. For computation of $S(MVP_i)$, Heady and Dillon's formula was used: $S(MVP_i) = Y/X \cdot S_{bxi}$, where prices of product and input are included in the calculations in order to compute MVP's. (See Heady and Dillon, Agricultural Production Functions, p. 231.) For an alternative computation of $S(MVP_i)$, see H. O. Carter and H. O. Hartley, "A Variance Formula for Marginal Productivity Estimates Using Cobb-Douglas Function," Econometrica 26 (Jan. 1958): 306-13.

Table 4.6.--Marginal returns/factor cost ratios and tests for differences of the ratios from unity of selected grains at the geometric means of resources, Zona da Mata, MG, 1976-77.

Variables	Beans	Corn	Rice	Corn-Beans
Marginal Return/Factor Cost Ratios ^a				
Land	1.72	0.69	0.90	1.51
Labor	1.17	0.81	0.54	0.83
Modern inputs	0.35	1.35	3.72	1.14
Tests for Differences of Ratios From Unity ^b				
Land	S	S	S	S
Labor	S	S	S	NS
Modern inputs	S	S	S	NS

^aFactor costs were as follows: Crop land rent = Cr\$583.00, labor (daily wage) = Cr\$35.00, and modern inputs = 13 percent interest rate.

^bS = significant difference at the 5 percent level; NS = no significant difference at the 5 percent level.

Statistical results for corn and rice seemed to be similar. Land and labor were used in excess, whereas modern inputs were under-used. In the case of rice, modern inputs were so underutilized in the production process that the value of marginal product was almost four times the assumed opportunity cost.

The statistical results for the corn-beans combination were different. On the average, farmers were using labor and modern inputs efficiently. Land seemed to be a limiting factor, so that its marginal return was still higher than its respective opportunity cost.

In summary, the most limiting resource for beans and corn-beans intercropped seemed to be land, and for corn and rice producers, modern inputs. Labor seemed also to be a limiting production factor for bean producers. This may be related to the fact that sole-cropped bean production may require more skilled labor because this production system requires more attention, such as pest control, improved seeds, fertilizers, and so on.¹

The results presented above suggest that in order to increase net returns, the use of modern inputs can be increased in corn and rice production until its marginal return is equal to the assumed opportunity cost of 13 percent, or Cr\$1.13 per Cr\$1.00 of input. Similarly, more land should be used for bean and corn-bean intercropped producers, whereas for bean producers labor use also should be expanded, ceteris paribus. On the other hand, labor and land used in corn and rice production should be reduced, and modern inputs used in bean production should also be reduced. However, with an increase in the use of modern inputs, for instance, the productivity of both land and labor in corn and rice production would be increased, which would imply that these conclusions could change substantially.

Minimum Cost Combination of Inputs

Table 4.7 presents the optimum input combination and deviations of the actual combination from the optimum at the geometric mean of production of small, large, and the average farms in the grain sub-sector of the study area. For these computations, factor-demand

¹Vieira, op. cit.

Table 4.7.--Optimum input combination and deviations of actual input combination from the optimum at the geometric mean of production of small farm, average farm, and large farm of bean, corn, rice, and corn-bean intercropped, Zona da Mata, MG, 1976-77.^a

	Resource Combination ^b					
	Small Farm		Average Farm		Large Farm	
	Actual	Optimum	Actual	Optimum	Actual	Optimum
Beans						
Land (ha)	.99	1.17	1.10	1.43	1.15	1.67
Labor (man-days)	21.14	15.22	20.50	18.56	20.03	21.75
Modern inputs (Cr\$)	372.80	109.74	466.90	133.82	599.09	156.81
Estimated production (60 kg bags)	3.40		4.40		5.34	
						(-45)
						(-9)
						(74)
Corn						
Land (ha)	1.31	.94	1.50	1.18	1.83	1.52
Labor (man-days)	37.11	27.60	38.10	34.47	39.28	44.45
Modern inputs (Cr\$)	257.53	463.52	365.80	599.03	546.10	746.73
Estimated production (60 kg bags)	21.83		27.20		34.95	
						(17)
						(-13)
						(-37)
Rice						
Land (ha)	1.04	.91	1.40	1.22	1.72	1.52
Labor (man-days)	47.18	21.63	54.70	29.13	60.99	36.25
Modern inputs (Cr\$)	83.98	368.75	134.50	496.71	190.10	618.08
Estimated production (50 kg bags)	13.95		19.40		24.83	
						(12)
						(41)
						(-225)
Corn-Beans						
Land (ha)	1.55	2.17	2.20	3.07	2.92	3.99
Labor (man-days)	67.86	38.57	87.70	54.58	106.49	70.97
Modern inputs (Cr\$)	753.67	875.73	1,187.90	1,239.18	1,676.14	1,611.48
Estimated production (Cr\$)	4,067.77		5,826.78		7,647.77	
						(-37)
						(33)
						(4)

^aSmall farms = sharecroppers and 0-10 hectares landowners; large farms = 10-50 hectares and 50-100 hectares landowners.

^bThe figures in parentheses are percentage deviation of actual from optimum combination.

equations were used. It is observed that relatively small land adjustments are required for small farm producers of beans. About six man-days and about 70 percent of expenditure in modern inputs could be allocated in other activities. About the same percentage of larger farms' expenditures in modern inputs could also be reallocated to other activities, whereas about 45 percent increase in planted land would be required to operate in the optimum input combination. Observe that, in contrast to the other farm sizes, the adjustment on large farms would require a 9 percent increase in labor used.

In the case of corn and rice, it is observed that relatively little land has been overused. However, especially in the case of rice, to attain minimum cost combination of inputs, about 50 percent and 40 percent of the labor of small and large farms, respectively, should be reallocated in other activities. About 26 percent of the labor force used for small farms exceeds the optimum labor level required in corn production, whereas it would be necessary to increase the labor used by large farms by 13 percent to attain that optimum. A possible intervention of the PRODEMATA for achievement of minimum combination of resources is associated with adjustments of modern inputs in production of corn and rice. The average farm of the Zona da Mata would require an additional 64 percent and 270 percent of modern inputs in corn and rice production, respectively. The small farms require an 80 percent increase in modern inputs for corn production and 340 percent for rice. About 40 percent and 225 percent additional modern inputs would be required for the large producers of corn and rice, respectively.

For the producers of corn-bean combination, land should be increased about 40 percent, the smaller farms require an additional 16 percent modern inputs, and about 40 percent of the labor force used in corn-bean combination should be allocated to other activities.

If the required land adjustment can be attained in practice and PRODEMATA is able to supply credit for increasing modern inputs to achieve the optimum input combination, the main concern falls in the labor arena. The increase in labor use in some activities analyzed seems to present no real problem because of the relatively abundant supply of labor in the region. However, the question that remains to be answered relates to the alternative employment for the labor to be released.

Gains From Operating at the Least-Cost Combination

Gains for the average farm from producing with the least-cost combination of resources are based on several assumptions. From the side of the input market, perfectly elastic supply is assumed. In the case of labor, for instance, one more required unit of this input in the productive process will be fully used and will receive its opportunity cost. On the other hand, if one unit of labor is released from the productive process, this input will be allocated into other farm activities or off-farm employment receiving the opportunity cost considered in the analysis (Cr\$35). This assumption is extended mutatis mutandis to other inputs. From the side of the output market,

perfectly elastic demand and no constraints in marketing the product in neighboring regions are assumed.

Under these assumptions, the average farm would gain Cr\$640 from rice production and about Cr\$600, Cr\$210, and Cr\$80, respectively, from corn-bean combination, bean, and corn production. These figures are especially important for sharecroppers and 0-10 hectares land-owners. For these small farmers who grow rice, that gain represents a 9 percent increase in their net income. For those who grow corn-beans combined in the same stand, beans, and corn, their net income would increase by 9 percent, 3 percent, and 1 percent, respectively.

Summary and Conclusions

In attempting to estimate production functions of grains (corn, beans, rice, and corn-bean combination) for the Zona da Mata, it was observed that the groups of small and large farms belong to the same regression model. In the pooled production functions, the estimated coefficients of land, labor, and modern inputs were statistically significant at the 5 percent level or less, with the exception of modern inputs in the bean equation, which was not significant even at the 20 percent level. The average years of education of the head of the family and his wife, as proxy for management, was not significant in the corn-bean equation even at the 20 percent level. The production functions of beans, corn, and rice for Juiz de Fora and the production function of corn-bean combination for Muriaé differed from the function for the rest of the study area. Tests conducted on the sum of the production elasticities indicated constant returns to

scale of grain production in the Zona da Mata, which is consistent with many empirical studies reported in the literature.¹

The analysis of marginal return/factor cost ratios indicated economic inefficiencies in land, labor, and modern inputs allocation in the production of beans, corn, and rice. In the case of corn-bean combination production, economic efficiency in labor and modern inputs allocation was observed; however, land was underused in this production process.

The figures presented in Table 4.8 illustrate the per hectare value of inputs and outputs in the study area. These figures help to understand the reallocation of resources suggested by the analysis developed in this chapter.

In light of the opportunity cost used in the analysis, for the average farm, it is suggested that the use of land for bean and corn-bean combination production be increased to 30 percent and 40 percent, respectively. The use of this factor should be decreased by 20 and 13 percent, respectively, in corn and in rice production.

Labor use should be expanded on large farms in bean and corn production, whereas for other enterprises and for the small farms it should be decreased. Decreasing labor use, on the other hand, is compensated by increasing the use of modern inputs. It is suggested by the analysis that in the combination corn-bean, corn, and rice production, for the average farm, modern inputs should be augmented by 4 percent, 64 percent, and 269 percent, respectively.

¹See Walters, 1963, op. cit.

Table 4.8.--Value of output and input per hectare of selected grains,
Zona da Mata, MG, 1976-77.

Output-Input	Types of Enterprises ^a			
	Beans	Corn	Rice	Corn-Beans
Output	1,841.25	1,633.93	32,100.20	2,886.22
Labor	657.30	861.25	1,305.41	1,294.15
Modern inputs:	536.34	442.42	258.73	630.90
Seeds	296.76	52.21	113.62	225.16
Fertilizers ^b	167.96	191.97	18.46	249.11
Pesticides	8.70	6.44	.74	7.49
Machinery services	10.59	72.78	18.30	52.05
Animal services	52.33	119.02	107.61	97.09
(1) Variable input cost	1,193.64	1,303.67	1,564.14	1,925.05
(2) Gross margin	647.61	330.26	536.06	961.17
Returns to variable cost (percentage) ^c	54	25	34	50

^aMeasured in cruzeiros per hectare. Approximately 12.50 cruzeiros equal 1 U.S. dollar.

^bIncludes chemical fertilizer and manure.

^cFor computation, the following formula was used:

$$[(2) \div (1)] \times 100.$$

Under the assumptions of perfectly elastic supply and perfectly elastic demand of input and output markets, respectively, the gains from operating at the least cost combination were estimated. For the average farm they were estimated to be about Cr\$210, Cr\$80, Cr\$640, and Cr\$600 for bean, corn, rice, and corn-bean combination

farms, respectively. The smaller farmers would benefit more from operating at the least cost combination. For producers of rice, net income would increase by 9 percent, whereas for producers of corn-bean combination, beans, and corn, their net income would increase by 9 percent, 3 percent, and 1 percent, respectively.

CHAPTER V

SUMMARY AND CONCLUSIONS

Introduction

The purpose of this chapter is to present the summary and conclusions of the study. The first section provides an overview of the study with a focus on the problem, objectives, and methodology. In the second section the summary of findings is presented. The implications and policy issues are presented in the third section. Finally, some limitations and suggestions for further research are included in the fourth and last section.

Summary of Problem, Objectives, and Methodology

Rural poverty has been of increasing concern among Brazilian policy makers. Among the many backward areas of rural Brazil is the Zona da Mata of Minas Gerais State, which is the study area of this research. In 1975 the rural per capita income of the Zona da Mata was about US \$250, which was 25 percent of the per capita income of the country as a whole. Per capita income in the study region was below the national poverty level, which was estimated to be about US \$340.¹

The region's social infrastructure is poor, and available health and education services are deficient. The health status of

¹World Bank, op. cit., p. 14.

the inhabitants of the region is characterized by high mortality and morbidity rates, caused by communicable diseases; a high infant mortality rate, caused mainly by infectious diseases; and a serious incidence of malnutrition.

Investment in education in the rural Zona da Mata is relatively low. The limitations of educational opportunities seem to be reflected in the low educational attainment of the labor force. In 1970, about 60 percent of the agricultural workers of the region had not received any formal education.

Action toward bringing about changes in the study area has been implemented. Several state organizations have combined their efforts with those of the World Bank to implement a conscious development program (PRODEMATA). The cost of the project is estimated at US \$139 million; agricultural credit is its main component (about 60 percent of the project cost). The beneficiaries of this service are primarily sharecroppers and small farmers with fewer than 100 hectares of rainfed land. Other important components of the PRODEMATA are rural electrification; land reclamation; production support services, including agricultural research, technical assistance, and cooperative services; and social services, including investments in basic aspects of health and education.

Because of the many activities developed on different-sized farms as well as different opportunities for off-farm jobs, it was considered important to study the process by which farm income is determined. Also, because grains are the principal source of food and income, especially for smaller farmers, coupled with the fact

that this subsector is a potential recipient of a large percentage of credit from the PRODEMATA, major attention was centered on the economic efficiency of production of food and feed grains. These factors constitute the central incentive for this study.

The overall objective of this research is to generate better knowledge about the process of income determination in the Zona da Mata farm sector. Particular emphasis was placed on microeconomic aspects of the farming system and managerial abilities of the farmer that constitute the center of all interactions of the components of the system. The specific objectives include: development of a conceptual framework of the income-determination process for the Zona da Mata farmers; analysis of the grain-production subsystem of the study area, especially the economic efficiency of this subsector; and, finally, in light of the results, suggestion of alternative actions to be incorporated in the project to improve small-farm income in the study area. Small-farm groups include sharecroppers and farmers with farms ranging in size from 0 to 100 hectares, who are potential beneficiaries of the PRODEMATA.

The instruments of the analysis used to reach the objectives of the study are mainly tabular analysis coupled with analysis of variance, neoclassical theory of production, and multiple regression analysis.

The conceptual framework developed in this study (Figure 3.1) identifies the major determinants of the farm income. The primary aim of the farming system research approach is "to increase the overall efficiency of the farming system; this can be interpreted as developing

technology that increases productivity in a way that is useful and acceptable to the farm family, given its goal(s), resources and constraints."¹ This was the main motivation for analyzing the income-determination conceptual framework and the economic efficiency of the grain-production subsector of the study area. The results of these analyses are presented in the following section.

Summary of Findings

This research followed the sample stratification used by the monitoring and evaluating team of the PRODEMATA. The strata analyzed were sharecroppers, and landowners with 0-10 hectares, 10-50 hectares, 50-100 hectares, and 100-200 hectares. The summary of findings presented below follows the income-determination conceptual framework presented in Figure 3.1.

The analysis of resource endowment in the study area suggested that land was a relatively scarce factor for the majority of farmers. Even within a particular class of producers, relatively high variation of land ownership was observed, suggesting a probable high concentration of ownership of this production factor. Indeed, empirical computation of the Gini Ratio of land ownership for the study area (about .68) suggested a high concentration of land ownership.² Conversely, family labor seemed to be a relatively abundant production factor in the study area. The major source of labor is

¹Norman, op. cit. For more information about this approach see John L. Dillon et al., "Farming Systems Research at the International Agricultural Research Centers" (Armidale: The University of New England, September 1978). (Mimeographed.)

²Silva, op. cit.

from males over 16 years old, who comprised 83 percent of the labor force of the study region. In general, investment in farm buildings and equipment was low. It was estimated that investment in housing (proprietary and employee houses) accounted for 70 percent of the total investments in buildings, including housing, storage, and animal facilities. Investment in machinery and equipment is generally low, especially among sharecroppers and 0-10 hectares landowners. As expected, investment in animals increased with farm size and, consequently, with availability of pasture and investment in animal facilities.

The analysis of resource use and productivity revealed that about 60 percent of the land of the region was used for pasture. Coffee, another nonsubsistence activity, occupied a considerable part of the region--about 7 percent. About 21 percent of the land was used for grain production; about 9 percent of the total farm land was used to produce corn, 6 percent to produce beans, and the same percentage to produce rice. About 40 percent of the cropped area was used to produce corn, and about 26 percent and 23 percent were used to produce beans and rice, respectively. Smaller farmers used a larger percentage of land in grain production.

In attempting to verify differences in output per hectare of the several enterprises (corn, beans, rice, sugar cane, tobacco, coffee, fruits, and vegetables), results of the analysis of variance suggested no statistical differences at the 5 percent level among the different classes of farmers. There was great variability of labor used per hectare of the most common crops grown in the study area,

especially in the grain subsector. However, production of rice per man-day was not statistically different among farmer groups at the 5 percent level.

Capital was divided into four categories: farm assets (K_1), livestock (K_2), operating expenses (K_3), and permanent structures (K_4). These various forms of capital were analyzed using ratios, with land and labor as the basis. The main conclusions drawn from the analysis are that investments in machinery, equipment, and work animals per hectare of land do not differ statistically at the 5 percent level among farmer groups. In turn, all ratios of capital/utilized labor were statistically different among farmer classes at the 5 percent level. The analysis of labor/land ratios, on the other hand, suggested a decreasing tendency of labor/land ratios as farm size increased. Finally, the smaller farmers used less credit and participated less in cooperatives.

Four proxies were used for management efficiency, including: (1) farmer age, (2) farmer education, (3) number of days worked off the farm, and (4) commercialization index. The arithmetic mean of farmers' age was about 50 years, and it did not differ statistically among groups of farmers at the 5 percent level of significance. In general, the percentage of illiteracy decreased as farm size increased. About 43 percent of the sharecroppers were illiterate, while all of the 100-200 hectares landowners group were literate. Sharecroppers also worked off the farm but in the agricultural sector more than did other groups of producers. On the other hand, that group of producers worked fewer days off the farm and outside the agricultural sector.

Finally, analysis of the commercialization index indicated that those farmers who had the highest commercialization index were those who owned the most land. The sharecroppers, however, had a higher commercialization index than did the 0-10 hectares landowners. Education seemed to be a good proxy for management and was the variable used in the grain subsector economic efficiency study developed in Chapter IV.

Average family size in the Zona da Mata comprised 5.71 persons (including other people living with the family). Sharecroppers had the most children, followed by farmers with 50-100 hectares and those with 100-200 hectares. Those with sons and daughters older than 15 years were more common among larger farmers.

Analyses of production, consumption, and marketable surplus were conducted for 11 products: rice, beans, corn, coffee, fruits, vegetables, cattle, swine, poultry, milk, and milk products. Initially, the analysis was conducted for the whole Zona da Mata; then the sample was broken down into the five categories of producers. In aggregated terms, it was observed that more than 50 percent of the production of beans, corn, and poultry was intended for on-farm consumption. Also, production of grains was very common among farmers. About 80 percent of the sampled farmers produced corn, and about 70 percent and 60 percent produced beans and rice, respectively. The sharecroppers seemed to be more involved in producing subsistence crops, such as corn, beans, and rice. There was a tendency, however, to raise poultry and to participate in coffee and milk-production contracts. Besides grain production, a large percentage of 0-10 hectares landowners grew coffee and raised poultry and swine. This

group of farmers had smaller amounts of grains as marketable surplus. In turn, production of coffee, cattle, milk, and milk products had characteristics of commercial enterprises. For farms larger than 10 hectares (besides grains), production of coffee, cattle, and milk was the most common in the study area.

Analysis of variance was conducted on prices received by farmers for eight products of the study area. The results suggested that, with the exception of swine production, prices did not differ among farmer classes at the 5 percent level of significance. These results seem to indicate that farmers had similar storage facilities or sold their commodities in a similar period of the year (except for swine, which seems to be the reverse).

The Zona da Mata average net farm income was about Cr\$29,500, several times more than sharecroppers' and 0-10 hectares landowners' net farm income--about Cr\$6,200 and Cr\$7,600, respectively. The 50-100 hectares and 100-200 hectares landowners' net farm incomes were above the average net farm income for the region. The 10-50 hectares landowners' net farm income was about the average level for the region. Off-farm income represented a substantial percentage of the total family income for sharecroppers and 0-10 hectares landowners--about 55 percent and 43 percent, respectively. The family incomes of these groups of farmers were below the regional average. The Gini Ratio of family income was about .64, implying a relatively high income concentration.

Considering the share of all products grown by the various classes of producers of the study region, as well as the percentage

of producers who grow these products, a typical farm was identified for each stratum analyzed. For the sharecroppers, production of grains (corn, rice, and beans) was the typical farm enterprise. Adjacent enterprises for these producers are poultry and coffee production. However, off-farm income constitutes their most important source of income. The typical farm of 0-10 hectares landowners also is characterized by production of grains. Other enterprises of importance for this category of farmers are poultry, coffee, and swine. Nevertheless, close to 50 percent of the family income of these producers is from off-farm sources. Off-farm income becomes relatively less important for the groups of farmers with more than 10 hectares of land. In the case of the 10-50 hectares landowners, production of grains, milk, poultry, coffee, cattle, and swine is the most common activity on a typical farm of this group. A typical farm of 50-100 hectares landowners raises grains, milk cows, coffee, swine, and poultry. A similar combination of enterprises is observed on a typical farm of 100-200 hectares landowners. However, for the 50-100 hectares farmers, the highest share of their gross income is from milk sales, and for the 100-200 hectares farmers, coffee generates the highest income share.

In the process of analyzing the production economics of the grain subsector of the study area, it was observed that the groups of small and large farmers belong to the same regression model. In the grain-production functions of beans, rice, corn, and corn-beans intercropped, the estimated coefficients of land, labor, and modern inputs were statistically significant at the 5 percent level or less,

with the exception of modern inputs in the beans equation, which was not significant even at the 20 percent level. The average years of education of the head of the family and his wife, as a proxy for management, was significant (at the 20 percent level or less) except in the corn-beans equation. The estimated coefficients of the dummy variables included in those production functions indicated that environmental differences of Muriaé did not have an effect on the production of beans, corn, and rice. The same effect was observed for environmental differences in Juiz de Fora on the production of corn-beans intercropped.

Economic inefficiencies in the allocation of land, labor, and modern inputs were observed in the production of beans, corn, and rice. In the case of corn-beans combination production, economic efficiency in labor and modern input allocation was observed; however, land was underused in this production process.

Factor demand equations were used to determine optimum input combinations at the geometric means of production for each enterprise of small farms, the average-sized farm, and large farms.¹ For the average Zona da Mata farm to operate at the optimum input combination, land should be increased about 30 percent in beans and about 40 percent in corn-beans combination production. In the case of the production of corn and rice, the average farm should decrease land use by about 20 percent and 13 percent, respectively. Labor use should be decreased

¹See footnote to Table 4.1 for the definition of farmer classes as well as the sample used in estimating the production functions.

in all enterprises and in all sizes of farms, with an exception in the case of beans and corn production on large farms, which would require a labor increase of about 10 percent.

Modern input use should be decreased by farmers producing beans and among the large producers of corn-beans combination. For the other producers of corn-beans combination as well as corn and rice, a substantial increase of this input is required, especially in rice and corn production.

Implications and Policy Issues

The most striking characteristics of the Zona da Mata farming system, evidenced in this study, are the different resource endowments, resource uses, and emphasis on different enterprise combinations, determining various levels of farm family incomes. It becomes logical, though, to define specific target groups and to design and test policies that meet their characteristics and needs so that developmental actions can be effective in changing the actual poverty scenario of the study region.

A group of producers that deserves the special attention of policy makers is the sharecroppers. This group of producers constitutes an important labor source for landowners. However, it is not clear to what extent that group constitutes a barrier to landowners for augmenting resource ownership, especially capital, and enabling them to move toward commercial agriculture. On the other hand, it is questionable whether the presence of sharecroppers on large farms is not a means whereby landowners can gain control over greater quantities of land and capital. Besides, sharecroppers might be the

part of the rural population that can migrate more easily to the urban areas since they do not have a high investment in their businesses. The problems brought about by migration are twofold: First, since the migrants have a low level of education and no training to engage in urban jobs, they will aggravate social problems in the large cities. The second problem is associated with adjustments farmers have to make to fill the outmigrant's position.

Because it is reasonable to assume that sharecroppers will continue to constitute a large proportion of the Zona da Mata population in the long run, actions should be taken to improve this group's level of living. Yet, because 0-10 hectares landowners' farming-system characteristics were found to be similar to those of the sharecroppers, policies aimed at increasing the incomes of both groups are examined together.

As defined by INCRA, the minimum farm size in the region that would provide full employment and income for a family with four workers is about the average farm size found in this study (about 27 hectares). Considering land as a scarce factor for these producers, it would be desirable to promote changes in the existent pattern of land distribution. Needless to mention, this measure would imply practical difficulties. However, gradual changes could be promoted to avoid the proliferation of small farms, such as prohibiting division of farms (in the case of inheritance, for instance). Also, the economic feasibility of cooperative farming should be evaluated

in the study area since it has been proven to have economic advantages for farm members in other regions of the country.¹

Other measures that could be undertaken and that could produce faster results are leasing contracts. Deals involving larger areas could be promoted, as should long-life contracts. These arrangements are likely to bring better resource efficiency in the study area as well as to increase agricultural output.²

Despite the peculiar resource limitations of these producers and the traditional agriculture they practice, in aggregated terms they represent a substantial proportion of the food suppliers for the region. Considering that the great majority of these producers have not received credit or technical assistance, it is believed that the implementation of the PRODEMATA might increase substantially the participation of these farmers in regional agriculture. However, all innovations brought by the project should be consistent with the farming system of these producers and in no way should the priorities of the family and the characteristics of their natural environment be disregarded. The level of education is a bottleneck for efficient credit use and adoption of new agricultural techniques. As much as

¹Dias, 1979, op. cit.

²Berry and Cline empirically observed that the small-farm sector makes better use of its available land than does the large-farm sector. Developmental strategies focusing on small farms--whether they involve land redistribution or improved access of small holders to credit, new technology, etc.--are likely not only to have beneficial distribution and employment effects but also to be efficient means of increasing output. See R. Albert Berry and William Cline, Agrarian Structure and Productivity in Developing Countries (Baltimore: The Johns Hopkins University Press, 1979).

possible, the extension service should increase their interaction with farmers in their decision making.

It is suggested that off-farm job opportunities for these producers be increased. Small agro-industries should be created in the study area, using regional raw material as well as the local labor force. On the other hand, out of the peak labor demand for agricultural production, surplus labor could be allocated to maintenance of secondary roads (as has been done in other regions of the country). Training should also be provided to these producers to increase their skills to be used in the farm sector as well as in the urban sector so that potential migrants could achieve better income levels.

Attention is now drawn to alternatives to increase income of 10-50 hectares landowners. Most of the considerations addressed to the sharecroppers and 0-10 hectares landowners also apply to the 10-50 hectares landowners. From this farm size category to larger ones, a certain level of specialization is observed, principally toward milk and coffee production. The increase in milk production of the 10-50 hectares landowners is limited primarily by the pasture land and animal facilities. Introduction of new technologies, especially in improved animal feeding systems such as silage, improved quality of the herd, and improvements of the animal facilities, is suggested. Coffee sales alone account for one-third of the income of those producers. A promising source of income for this category of farmers as well as a way to increase labor demand in the region would be to expand coffee plantations. A detailed economic-feasibility

study should be conducted and, because of the relatively high initial cost of such plantations, new forms of credit for this purpose should be explored.

Technologies that meet the characteristics of these producers' farming system should be coupled with agricultural extension service and agricultural credit to promote the harmonious flow of cash-crop and food-crop production. Labor-intensive technologies and partnerships should be emphasized.

Among the potential beneficiaries of the PRODEMATA, the 50-100 hectares landowners had the highest income. For some of these farmers, the observations made above about milk and coffee production are plausible measures to increase their incomes. The importance of this group is recognized for accomplishing suggested contracts with smaller producers, principally if labor-intensive technologies are emphasized in the area.

Finally, action toward verifying the possibility of reallocating resources in the enterprises of the region, especially in the grain subsector (which was empirically analyzed in this study), is recommended. Such action would provide economic benefits for the producers, especially if agricultural credit from the PRODEMATA could be coupled with the creation of new job opportunities in the area.

Limitations and Suggestions for Further Research

The data analyzed in this study were intended to capture general views of the region limiting further extensive analysis of the farming system. Additional characteristics of the exogenous and

endogenous factors of the human element of the analysis (see Appendix D) should be incorporated in future analyses. They might suggest new social relationships with other variables of the framework that could not be accomplished with the data analyzed.

It would also be relevant to investigate the farming systems in a dynamic perspective. In this sense, an interdisciplinary team (comprising both social and technical scientists) could generate periodic information about the system, providing a solid basis for possible policy intervention. The Universidade Federal de Viçosa, which is also responsible for evaluation of the PRODEMATA, is located in the Zona da Mata and could with least cost lead efforts to implement such a system.

Very little is known about the effects of Brazil's current inflationary trend on the farm sector, especially on small producers. Emphasis for research should be placed on determining better combinations of inputs, enterprises, and farm investments to hedge against inflation.

Questions remain to be answered about the use of credit, especially the correlation that exists between the use of credit and growth, as well as production efficiency. The role of capital in the farming system and priorities of credit application as well as effective policies and programs for the delivery and repayment of credit should be investigated.

As stressed in the above section, more should be learned about the regional labor market. The use of labor in periods of peak

demand and slack periods should be determined for actions toward creating off-farm jobs, and the potential effects of introducing small tractors and machinery into the region's labor market should be analyzed.

Research is also needed on the various markets in which the smaller farmers can participate. The crops and enterprises especially suited to small-scale production should be identified and investigated. Following this, the economic feasibility of creating cooperatives to provide inputs as well as to market farmers' output should be investigated.

Apart from the formal agricultural extension service, communications research for various enterprises could have high payoffs in the Zona da Mata. The radio could be tested as a means of informing farmers about prices and the proper times to employ various agricultural practices.

Pricing of agricultural products and inputs is a major area that demands the attention of policy-oriented research. Alternative pricing policies and their impact on production and consumption of major products (as well as inputs) deserve special research priority.

Finally, no risk component was considered in this study. It is suggested that the risk component of the farming system be identified and investigated so that developmental policies addressed to a target group of farmers could implicitly consider that group's risk preferences.

APPENDICES

APPENDIX A

SHARECROPPERS DEFINITION

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In this study the sharecroppers are defined as landless or tenants. Under contract, they use landowners' land in exchange for payment in kind, in cash and/or production costs. The institutional contracts between the landowners and sharecroppers are regulated by Law No. 4.504, "Estatuto da Terra," established on November 30, 1964. This law determines the rights and obligations of both parties under several circumstances the contracts are set. Specifically, it determines the minimum period of time for those deals, each party's share of the production under various arrangements of production cost sharing, etc. However, in practice, it is observed landowners exerting their power, imposing favorable deals for themselves. On the other hand, one may observe arrangements between landowners and their relatives benefiting the latter. This situation is more common for perennial crops in father-son sharecropping contracts.¹

Table A.1 presents the participation of the surveyed sharecroppers in some crop deals. In the case of grains, the most common contracts involve sharecroppers' payment in kind of 50 percent of the production. Few sharecroppers were engaged in contracts involving production of coffee, tobacco, and sugar cane. Most of these

¹Universidade Federal de Viçosa, DER, Programa Integrado do Desenvolvimento da Zona da Mata--MG. Primeiro Relatório Anual de Avaliação (Viçosa, MG: Março 1979).

contracts established one-third of the production as payment to the landowners.

Table A.1.--Participation of sharecroppers in contracts with landowners of selected enterprises, Zona da Mata, MG, 1976-77.^a

Crops	Number of Contracts	Production Proportion Paid to the Landowner			
		1/2	1/2	1/4	Others ^b
Rice	77	32 (41.6) ^c	39 (50.6)	4 (5.2)	2 (2.6)
Beans	94	17 (18.1)	74 (78.7)	2 (2.1)	1 (1.1)
Corn	109	17 (15.6)	88 (80.7)	1 (.9)	3 (2.8)
Coffee	22	19 (86.4)	3 (13.6)	--	--
Tobacco	6	6 (100.0)	--	--	--
Sugar cane	5	4 (80.0)	1 (20.0)	--	--

Source: Sample survey.

^aBased on a sample of 129 sharecroppers.

^bRefers to other arrangements between landowners and sharecroppers.

^cThe figures in parentheses are percentages of contracts of each kind.

APPENDIX B

THE GINI INDEX OF INCOME CONCENTRATION OF THE ZONA DA MATA

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THE GINI INDEX OF INCOME CONCENTRATION OF THE ZONA DA MATA

In determining the distribution of income among the Zona da Mata surveyed farms, gross farm income was computed and divided into 15 classes of income (Table B.1).

The figures in Table B.1 indicate that as farm size increased, gross farm income also tended to increase. About 60 percent of the sharecroppers and 0-10 hectares landowners had gross income less than Cr\$10,000. The percentage of the sample included in that income category was about 35.5 percent, which accounted for 4.4 percent of the total sample gross income. The concentration of income becomes more evident as one moves to subsequent classes of gross income. The first three classes of gross income, for example, which included about two-thirds of the entire sample, had only 19.5 percent of the total sample gross income. About 11 percent of the farmers had 54 percent of the gross income generated in the Zona da Mata.

The understanding of the computation of the Gini Ratio is facilitated by using the Lorenz Curve shown in Figure B.1. This curve is derived by plotting the cumulative fraction of the total income against the cumulative fraction of the units receiving this income, where the income-receiving units are arranged from poorest to richest income classes. If the Lorenz Curve coincides with the Line of Equality, every unit has the same income. On the other hand, in the absence of complete income equality, the Lorenz Curve lies below the

Table B.1.--Distribution of farm gross income among five classes of producers, Zona da Mata, MG, 1976-77.

Classes of Gross Income (Cruzeiros)	Percentage of Producer Classes					Frequencies (%)	
	Sharecroppers	0-10 ha	10-50 ha	50-100 ha	100-200 ha	Simple	Accumu- lated
≤10,000	57.4	62.6	18.2	6.8	0	35.5	35.5
10,000- 20,000	25.6	23.6	25.0	8.5	0	22.2	57.7
20,000- 30,000	6.2	8.1	14.1	5.1	10.5	9.8	67.5
30,000- 40,000	6.2	2.4	9.1	1.7	0	5.8	73.3
40,000- 50,000	.8	1.6	6.8	10.2	0	4.4	77.7
50,000- 60,000	2.3	0	5.5	16.9	5.3	4.7	82.4
60,000- 70,000	0	.8	4.1	3.4	5.3	2.4	84.8
70,000- 80,000	.8	.8	3.6	5.1	5.3	2.5	87.3
80,000-120,000	.8	0	7.3	16.9	15.8	5.5	92.8
120,000-160,000	0	0	2.3	13.6	5.3	2.5	95.3
160,000-200,000	0	0	1.8	8.5	15.8	2.2	97.5
200,000-240,000	0	0	.9	1.7	0	.5	98.0
240,000-280,000	0	0	.5	0	10.5	.5	98.5
280,000-320,000	0	0	.5	0	21.1	.9	99.4
320,000 and more	0	0	.5	1.7	5.3	.5	100.0

Source: Sample survey.

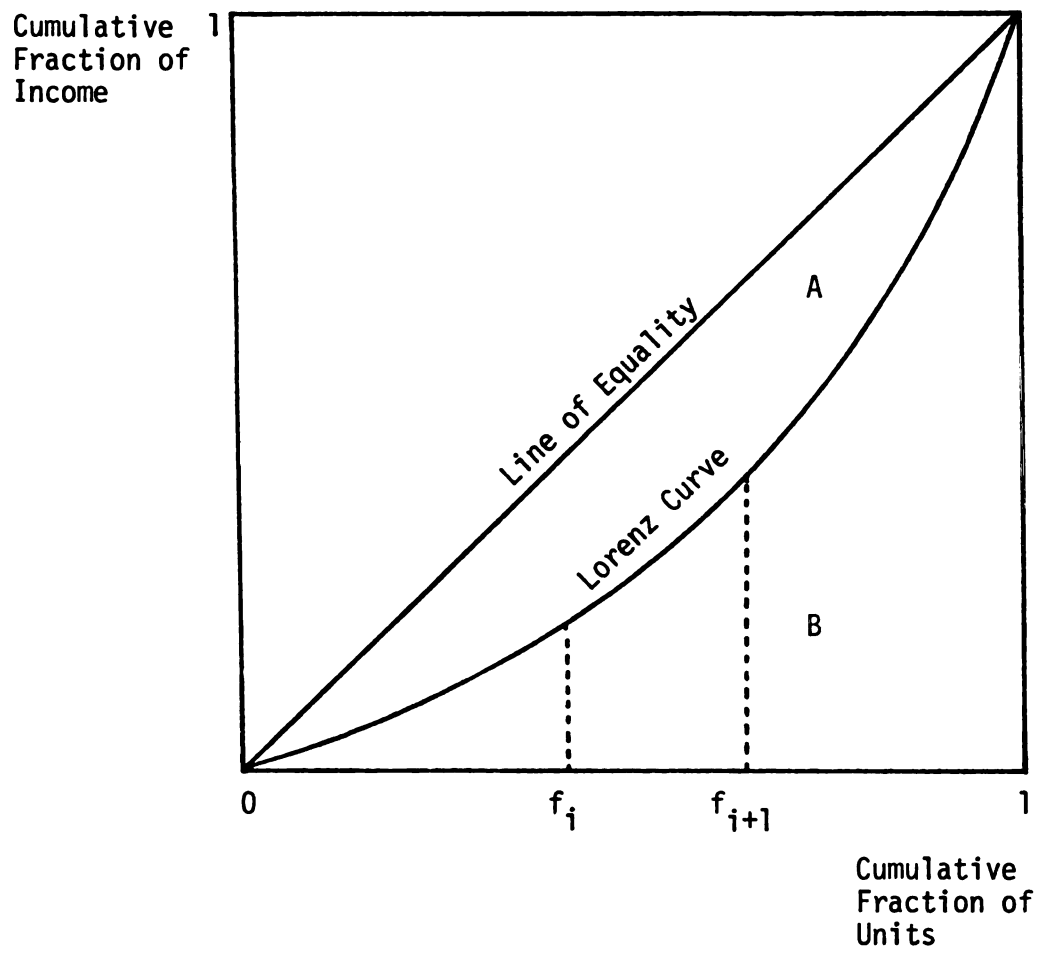


Figure B.1.--Illustration of a Lorenz Curve.

Line of Equality, as is the case shown in Figure B.1. The Gini Ratio can be derived from the Lorenz Curve, where it is the proportion of the total area under the diagonal that is between the Lorenz Curve and the diagonal.

Using Figure B.1, the Gini Ratio is expressed as follows:

$$\text{Gini Ratio} = \frac{A}{A + B} = \frac{\text{Area between the Lorenz Curve and the Line of Equality}}{\text{Area under the Line of Equality}} \quad (\text{C.1})$$

For the computation of the Gini Index of income concentration or the Gini Ratio, the following formula was used:

$$\text{Gini Ratio} = 1 - \sum_{i=1}^k (f_{i+1} - f_i) (y_i + y_{i+1}) \quad (\text{C.2})$$

where:

f_i = cumulative fraction of units

y_i = cumulative fraction of income

k = number of classes

This is the formal mathematical presentation by Riemenscheider¹ of Morgan's² discussion of the Gini Ratio.

The computed income Gini Ratio of the surveyed Zona da Mata farmers' farm income was about .64 in the 1976-77 agricultural year. This ratio indicates more income concentration in the study area relative to the state of Minas Gerais, whose estimated income Gini Ratio was about .54.

¹Riemenscheider, op. cit.

²Morgan, op. cit.

APPENDIX C

TESTS FOR HETEROSCEDASTICITY

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TESTS FOR HETEROSCEDASTICITY

This appendix presents tests for heteroscedasticity for the estimations presented in Table 4.4 of Chapter IV as well as the simple correlation matrices of the variables of those estimations.

Test for Heteroscedasticity

Park¹ formalized the graphical method by suggesting that σ_i^2 is some function of the explanatory variable X_i . The functional form he suggested was

$$\sigma_i^2 = \sigma^2 X_i^\beta e^{v_i} \quad (C.1)$$

or

$$\ln \sigma_i^2 = \ln \sigma^2 + \beta \ln X_i + v_i \quad (C.2)$$

where v_i is the stochastic disturbance term. Park suggested use of e_i^2 as a proxy for σ_i^2 because this parameter is generally not known.

The presence of heteroscedasticity in the data would be suggested if β is statistically significant. In turn, the homoscedasticity hypothesis may be accepted if β is not statistically significant.

The residuals obtained from regression presented in Table 4.4 were regressed on X_i (land, labor, modern inputs) as suggested in equation (C.2), presenting the following results:

¹Park, op. cit.

Beans

$$\ln e_i^2 = .2789 + .0191 \ln (\text{Land})$$

$$(.1025)$$

$$t = .1861 \quad R^2 = .0008$$

$$\ln e_i^2 = .0873 + .0639 \ln (\text{Labor})$$

$$(.0999)$$

$$t = .6394 \quad R^2 = .0094$$

$$\ln e_i^2 = .1402 + .0228 \ln (\text{Modern Inputs})$$

$$(.0706)$$

$$t = .3230 \quad R^2 = .0024$$

Corn

$$\ln e_i^2 = .2540 + .0073 \ln (\text{Land})$$

$$(.0527)$$

$$t = .1392 \quad R^2 = .0002$$

$$\ln e_i^2 = .1525 + .0287 \ln (\text{Labor})$$

$$(.0538)$$

$$t = .5340 \quad R^2 = .0032$$

$$\ln e_i^2 = .5103 - .0429 \ln (\text{Modern Inputs})$$

$$(.0279)$$

$$t = -1.5375 \quad R^2 = .0262$$

Rice

$$\ln e_i^2 = .4482 - .0566 \ln (\text{Land})$$

$$(.0382)$$

$$t = -1.4809 \quad R^2 = .0067$$

$$\ln e_i^2 = .5078 - .0196 \ln (\text{Labor})$$

$$(.0426)$$

$$t = -.4585 \quad R^2 = .0006$$

$$\ln e_i^2 = .5473 - .0240 \ln (\text{Modern Inputs})$$

$$(.0236)$$

$$t = -1.016 \quad R^2 = .0032$$

Corn-Beans

$$\ln e_i^2 = .3599 - .0863 \ln (\text{Land})$$

$$(.0437)$$

$$t = 1.9763 \quad R^2 = .0149$$

$$\ln e_i^2 = .0431 + .0554 \ln (\text{Labor})$$

$$(.0523)$$

$$t = 1.0589 \quad R^2 = .0043$$

$$\ln e_i^2 = .4178 - .0179 \ln (\text{Modern Inputs})$$

$$(.0330)$$

$$t = -.5419 \quad R^2 = .0011$$

As the estimated equations indicate, there is no statistically significant relationship between the two variables. Thus, following Park's test, one may conclude that there is no heteroscedasticity in the error variance.

Table C.1.--Simple correlations among the variables of estimated function for beans in Table 4.4.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Output	1.0000						
(2) Land	.7322	1.0000					
(3) Labor	.6136	.6528	1.0000				
(4) Education	.2949	-.0339	-.3037	1.0000			
(5) Modern Inputs	.4491	.5280	.2831	.2771	1.0000		
(6) Dummy 1	-.2286	-.0855	.0423	-.1008	.1021	1.0000	
(7) Dummy 2	.1969	.1890	-.0869	.2286	.1854	-.6359	1.0000

Table C.2.--Simple correlations among the variables of estimated function for corn in Table 4.4.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Output	1.0000						
(2) Land	.5997	1.0000					
(3) Labor	.6139	.4107	1.0000				
(4) Education	.2273	.1474	-.0069	1.0000			
(5) Modern Inputs	.5884	.4602	.2514	.2337	1.0000		
(6) Dummy 1	-.1969	-.0752	-.1238	-.0640	.1315	1.0000	
(7) Dummy 2	.0137	-.0261	-.1045	.0136	.0351	-.5408	1.0000

Table C.3.--Simple correlations among the variables of estimated function for rice in Table 4.4.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Output	1.0000						
(2) Land	.6977	1.0000					
(3) Labor	.7141	.6374	1.0000				
(4) Education	.3093	.2547	.2061	1.0000			
(5) Modern Inputs	.6967	.5776	.5385	.2659	1.0000		
(6) Dummy 1	-.1813	-.0845	-.2113	-.0100	-.0227	1.0000	
(7) Dummy 2	.1642	.0714	.0382	.0334	.1854	-.4005	1.0000

Table C.4.--Simple correlations among the variables of estimated function for corn-beans combination in Table 4.4.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) Output	1.0000						
(2) Land	.6678	1.0000					
(3) Labor	.6421	.5627	1.0000				
(4) Education	.2185	.2228	.1345	1.0000			
(5) Modern Inputs	.6352	.5607	.4597	.2228	1.0000		
(6) Dummy 1	-.1263	-.0613	-.2890	-.0891	.0692	1.0000	
(7) Dummy 2	.0069	-.0321	-.0937	.0603	-.0850	-.3918	1.0000

APPENDIX D

FARMING SYSTEMS RESEARCH

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FARMING SYSTEMS RESEARCH

In this study, especially in Chapter III, the objective was to relate all components of the farming system in order to verify the process of income determination in the study area. As defined by Dillon et al.,

A farming system (or farm system or whole-farm system) is not simply a collection of crops and animals to which one can apply this input or that and expect immediate results. Rather, it is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences with the strands held and manipulated by a person called farmer who, given his preferences and aspirations, attempts to produce output from the inputs and technology available to him. It is the farmer's unique understanding of his immediate environment, both natural and socioeconomic, that results in his farming system.¹

The conceptual framework used in this research is in some way related to a schematic representation of some determinants of the farming system presented by Norman² (Figure D.1). According to Norman, the total environment can be divided into two elements: technical and human. Technical elements include the actual and potential livestock and crop enterprises, physical and biological factors that have been modified by man--often through technology development.

Two types of factors characterize the human element: exogenous and endogenous. The exogenous factors are outside the control of the

¹John L. Dillon, Donald L. Plucknett, and Guy J. Vallaeyes, "Farming Systems Research and International Agricultural Research Centers" (Armidale: The University of New England, Sept. 1978), p. 8. (Mimeographed.)

²Norman, op. cit., pp. 3-5.

individual farmer, and they include (a) community structures, norms, and beliefs; (b) external institutions, such as extension services, institutional credit, and price policies; and (c) miscellaneous influences, such as population density and location. The endogenous factors, on the other hand, are controlled by the farmer himself, "who ultimately decides on the farming system that will emerge, given the constraints imposed by the technical element and exogenous factors."¹

In Chapter III some of the determinants of the farming system of the study area are analyzed, especially interaction of human and technical elements determining levels of income of five different groups of farmers.

¹Ibid., p. 3.

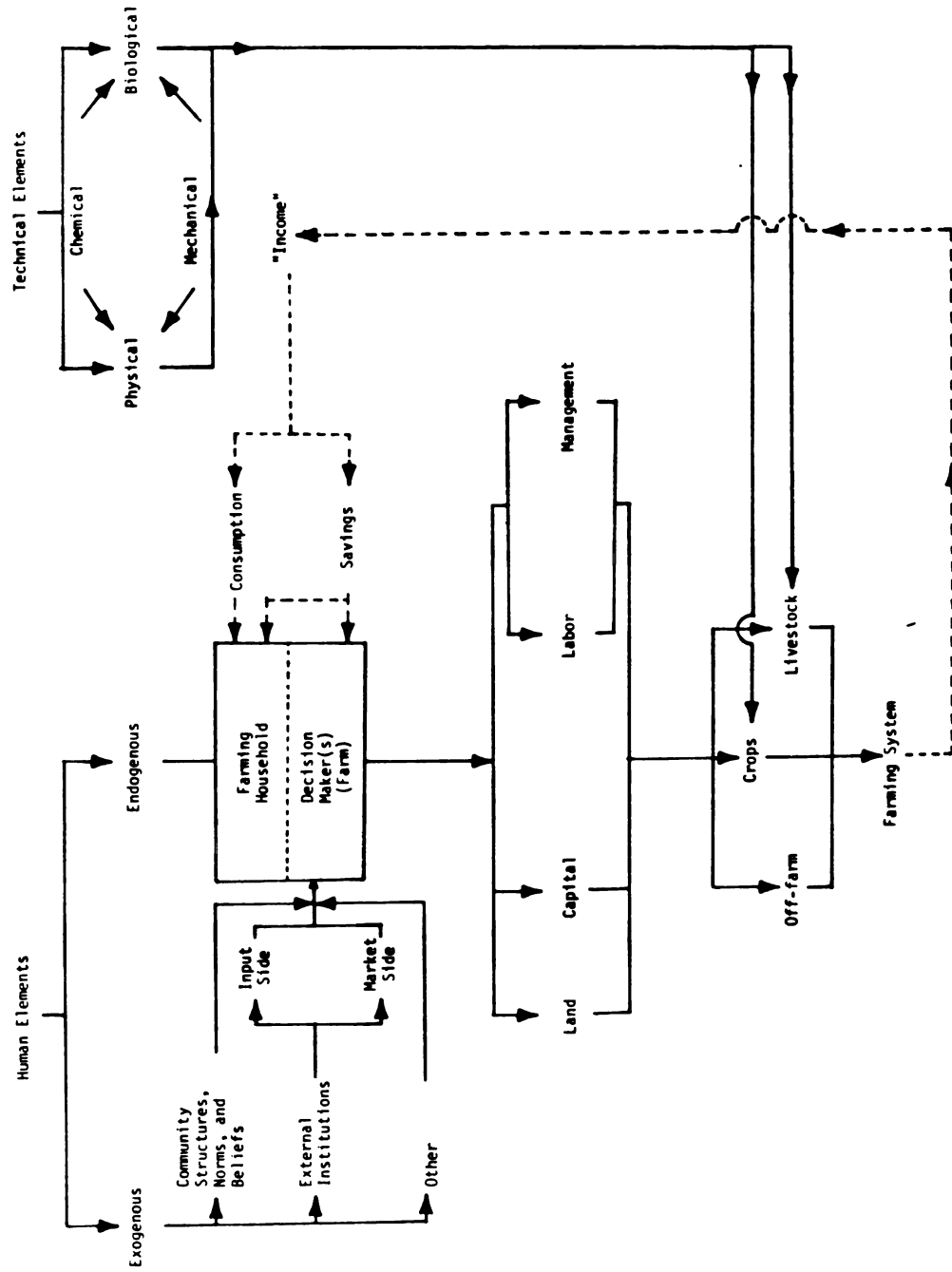


Figure D.1.--Schematic representation of some determinants of the farming system (from Norman, op. cit., p. 4). Broken lines represent results of farming system.

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