Productivity of landowners and sharecroppers in the sertao of Northeast Brazil: implications for land redistribution

Item Type	text; Thesis-Reproduction (electronic)
Authors	Truran, James Arthur, 1945-
Publisher	The University of Arizona.
Rights	
Download date	13/08/2020 16:10:49
Link to Item	http://hdl.handle.net/10150/554927

PRODUCTIVITY OF LANDOWNERS AND SHARECROPPERS IN THE SERTAO OF NORTHEAST BRAZIL: IMPLICATIONS FOR LAND REDISTRIBUTION

by

James Arthur Truran

A Thesis Submitted to the Faculty of the

DEPARTMENT OF AGRICULTURAL ECONOMICS

In Partial Fulfillment of the Requirements
For the Degree of

MASTER OF SCIENCE

In the Graduate College

THE UNIVERSITY OF ARIZONA

1 9 7 5

STATEMENT BY AUTHOR

This thesis has been submitted in partial fulfillment of requirements for an advanced degree at The University of Arizona and is deposited in the University Library to be made available to borrowers under rules of the Library.

Brief quotations from this thesis are allowable without special permission, provided that accurate acknowledgment of source is made. Requests for permission for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the major department or the Dean of the Graduate College when in his judgment the proposed use of the material is in the interests of scholarship. In all other instances, however, permission must be obtained from the author.

SIGNED: James A. Nuran

APPROVAL BY THESIS DIRECTOR

This thesis has been approved on the date shown below:

Roger Fox
R. W. FOX
Professor of Agricultural Economics

Sept 22, 1975
Date

ACKNOWLEDGMENTS

I would like to thank the Department of Agricultural Economics, The University of Arizona for the support extended to me, both academic and financial. In particular, I wish to express my thanks to Dr. Roger Fox for his professional and personal encouragement and assistance.

Credit is also due to the wonderful people who typed portions of this paper: Edith Hallet, Charlotte Schmitz, Donna Moore, Debbie Hanneman and finally Paula Tripp who brought it all together in final form.

TABLE OF CONTENTS

TABLE OF CONTENTS--*continued*

LIST OF TABLES

LIST OF TABLES--continued

LIST OF ILLUSTRATIONS

ABSTRACT

The problem of improving agricultural productivity as a means of stimulating agricultural and economic development is becoming increasingly important. This work examines how two specific points, land tenure and farm size, affect agricultural productivities in Missao Velha, Ceara, Brazil. Using primary data obtained from various sized farm owner-operators and sharecroppers, a comparison is made of average input usage and the marginal productivities of inputs. The results of the analyses suggest that it would be economically possible to redistribute farm land from large size owners to small owners and sharecroppers. Such a land redistribution measure would, ceteris paribus, increase agricultural output.

CHAPTER 1

INTRODUCTION

Increasingly, the attention of those persons interested in the problems of the developing countries is turning from the question of industrialization to the problems of agriculture. Hayami and Ruttan (1971) treat this shift by focusing on the problem of how to transform traditional agriculture into a source of sustained growth, and the concomitant need for additional analysis of the agricultural development process.

The forces responsible for the agricultural development process, however, are often disputed, and attempts to explain them usually reflect biases of the individual researcher. Wharton (1969) presents a collection of articles focusing on the multidisciplinary aspect of the problem. In his book, the consensus developed by the contributing authors is that raising agricultural productivity must be the major concern of a developing economy. Suggested means for achieving this goal are varied and include, among other things, changes in health, education, transportation land reform, and the supply of inputs.

Recognizing the value of an integrated approach to the problem, this study will, nevertheless, focus on two specific points, namely on how land tenure and farm size affect agricultural productivity. In order to perform this examination, analyses of the productivities of property owners and sharecroppers in Missao Velha, Ceara, Brazil will be conducted. Figure 1 illustrates the location of Missao Velha in relation to the Northeast region and the rest of Brazil.

Justification for Research

Land reform, including redistribution of property rights, has been a popular prescription for the ills of Brazilian agriculture (C.I.D.A., 1966). The primary reason for this is the highly skewed distribution of land and the consequently skewed distribution of economic, social, and political power. Table 1 presents the numerical and percentage distribution of properties in 1960 for all of Brazil and for the Northeast Region. It is evident that although there is a large number of small farms, both in Brazil and the Northeast Region, their control of the land is extremely limited. The concentration of land, wealth, and power in the hands of few provides stimulus for social unrest and possible economic inefficiencies, conditions which a land reform measure are designed to remove.

An additional point illustrated in Table 1 is that the Northeast region contains an absolute majority (58 percent) of the farms in Brazil with less than ten hectares. This fact alone does not necessarily indicate problems, since in one area ten hectares might be adequate while in another 100 hectares would be too few. Nevertheless, the land resources of the Northeast are generally considered poor in relation to other parts of Brazil and the poverty of the region is well-documented (Schuh, 1970; Patrick, 1972; Hirschman, 1963). The existence of a large number of small farms coupled with a miniscule knowledge of the

Figure 1. Map of Brazil showing location of Northeast region and the study area.

Table 1. Distribution of farms by size, Brazil and the Northeast, 1960.

	Number	Percent	Area (1,000 ha.)	Percent
BRAZIL				
< 10 ha.	1,495,020	44.00	5,952	2.3
10 - 100	1,491,415	44.00	47,566	19.0
100 - 1,000	314,831	9.00	86,029	34.4
1,000 - 10,000	30,883	0.90	71,420	28.6
10,000 <	1,597	0.05	38,893	15.6
NORTHEAST				
< 10 ha.	873,124	62.00	2,746	4.3
10 - 100	421,183	30.00	13,744	21.8
100 - 1,000	105,388	7.00	27,544	43.7
1,000 - 10,000	7,483	.50	15,363	24.4
10,000 <	179	.01	3,592	5.7

Source: Paiva et al., 1973, pp. 298-299.

production relationships on these farms creates problems for both researcher and policymaker.

Compared with former years, however, knowledge of Brazilian agriculture is improving. Schuh, in his descriptive book, The Agricultural Development of Brazil (1970), provides an excellent starting point for background information on the structure of Brazilian agriculture. Other such general works are Paiva, Schattan and de Freitas (1973), the C.I.D.A. (1966) report on socioeconomic conditions in Brazilian agriculture, the U. S. Department of Agriculture's (1968) projections of agricultural supply and demand and Herrmann's (1972) study of production and productivity. Specific studies of agricultural productivity and input usage are somewhat more restricted in availability and often relate to agriculture in the more developed South of the country. For instance, the Land Tenure Center of the University of Wisconsin-Madison as well as the Department of Agricultural Economics at Ohio State University both have extensive publishing lists covering primarily the South of Brazil (e.g., see Land Tenure Center (1972) publications 18 and 19 on training and methods which pertain exclusively to the question of agrarian reform in Brazil).

Fortunately, information on Northeastern agriculture is not entirely lacking. Nicholls and Paiva (1966) include some observations from this region; the C.I.D.A. study (1966) on socioeconomic conditions of the tenure system has good descriptive work on the area; Patrick (1972) discusses the general development of agriculture; the U. S. Department of Agriculture (1968) study contains observations from Ceara and Pernambuco, and finally, Cline (1970) includes regional observations in his analysis. Except for Cline's work, these latter studies do not address the question of productivity differences between property owners and sharecroppers, who might become future owners after a land redistribution program.

In addition to increasing the sparse amount of information on existing small land holdings in the Northeast of Brazil, there exists a further reason for new information on agricultural productivity. The federal government, reacting in part to the social pressures, promotes, on paper at least, the concept of land reform. There exists a fairly complex law, O Estatuto da Terra, which calls for expropriation and redistribution of nonefficient large and small holdings. Currently this law, and similar programs such as PROTERRA are nearly dormant; however, if they were to be implemented they would restructure the agricultural sector. Consequently, for these reasons, additional knowledge of productivity in the agricultural sector is important.

Objectives and General Procedures

The basic objective of this work is to examine the possible consequences of a redistribution of agricultural land on farm productivity. Attention will be centered on two aspects of such a reorganization. First, does ownership status affect farm productivity; in other words, are there incentives to ownership? Secondly, do economies of size exist in the agricultural production process in Missao Velha? In order to answer these questions, two different techniques will be utilized. The first will be an examination of farm production data for classes of producers, both property owners and sharecroppers. This will be followed by a presentation and discussion of production functions estimated for each of the producer groups. The information developed by these two approaches will assist others to understand better the agricultural production process and the possible impacts of changing the current structure.

CHAPTER 2

THEORY, HYPOTHESES, AND DATA SOURCE

The primary purpose of this chapter is to identify and discuss, in a theoretical manner, how a redistribution of property rights will affect the agricultural sector. This discussion will be divided into two sections: societal benefits (which will not be analyzed in this study), and expected effects on agricultural productivity. Additionally, this chapter will present the hypotheses which will be tested in the subsequent analyses and describe the data to be used in these analyses.

Societal Benefits

Social equity as a result of land reform is important when considering the long run success of such a measure. It could help the society as a whole remove social pressures and promote political health. Increased equity will be the result of the transfer of land from the "haves" (e.g., in the case of Brazil, those 0.9 percent who control 44.2 percent of the land) to the "have-nots." The mechanism of this transfer might vary, and includes expropriation with or without payment. The transfer of wealth, however, is immediate through the recipient securing access to the future streams of income from the land.

The transfer of wealth should provide benefits for the society as a whole through a restructured effective demand for domestically produced industrial products. Barraclough and Domike (1966) report that the wealthy in the lesser developed countries tend to spend a considerable portion of their incomes on sumptuary consumption, including foreign travel and imported items. A redistribution of wealth through land reform would transfer purchasing power from these consumers to the new recipients, providing income with which they might purchase needed products from domestic industries. The industrial sector would be stimulated to meet this increased demand for both consumer and producer items, thus providing increased employment and investment opportunities. Indeed, as Adams (1970, p. 428) flatly states: "One of the major restraints on further industrial growth in Latin America is the lack of purchasing power in the hands of the rural poor." Mellor (1966) suggests that an additional benefit to society from this process would result from reaching underutilized talents that can contribute to economic growth.

A second form of social benefit resulting from a land reform is the absorption of previously unemployed and underemployed labor on the new farms. Gains to society should be twofold. First, as currently unemployed and underemployed individuals begin to contribute their labor to agriculture, output should increase. Industrial output has grown in the underdeveloped countries, but this growth has followed capital intensive lines and employment has not increased proportionally. Goodman and Cavalcanti de Albuquerque (1971) illustrate this point using data from Northeast Brazil. A casual observer of urban growth in these countries will note the larger influx of people migrating from the rural areas. Often, these new urban dwellers will have no employment, and may be worse off than before. A land redistribution creating opportunities in the rural areas will have a dual effect of increasing agricultural output and of slowing down the mass migrations to the urban centers. Dorner and Kanel (1971, p. 49) refer to this as a form of "farm financed social welfare."

Security of land tenure is a third societal benefit resulting from land reform. Tenure security is extremely important in influencing agricultural investments. Each investor, whether a landowner, a sharecropper, or a renter must feel secure that he will receive benefits from his investment over time. The relationships between tenure security, and agricultural investment is not entirely direct, however. Warriner (1964) points out that tenure security by itself will not cause investment, but it is a condition for it. There will still be a need for new social and economic support structures if investment potentials are to be reached.

A final benefit accruing to society from a land redistribution under sharecropper conditions concerns what is produced by the newly reformed agricultural sector. After reform, as the newly enfranchised farmers become free to select crops based on market and personal incentives, there might be a switch from export type crops to food crops of a higher nutritional quality than previously produced. Economists as early as Adam Smith (1937) have noted the quality differences between food consumed by the poor and that consumed by the rich. The redistribution of land and the concomitant redistribution of wealth could trigger such a change towards higher nutritional quality foods. This was precisely the case in the Egyptian and Bolivian land reform experiences (Warriner, 1964). The resultant gains could accrue to society from two sources. In the first case, the sharecropper, who would no longer have to turn over up to 50 percent of his product, would have more food available for personal consumption. His improved health and that of his family could influence future production and productivities. The second source of benefit would result from a larger number of farmers responding to market incentives for more food products (Mellor, 1966; Schultz, 1964), thus helping to feed a growing urban-industrial sector of the country.

Effects on Agricultural Productivity

Land redistribution can have either profound positive or negative effects on agricultural productivity; however, without increases in productivity, a redistribution of property rights will achieve only modest benefits for a society (Dorner, 1972). Even though social equity would be achieved, the full participation of the agricultural sector in the development process would still remain an elusive goal.

In general, the following effects of a land reform measure on agricultural productivity are expected.

First, decreases in productivity and output will be the expected response if there exist economies of size in agriculture, and the reform creates farms that are small relative to an optimal economic size. Figure 2 illustrates this concept. As output and farm size increases (measured along the horizontal axis) the per unit cost of production decreases (LRAC) until the curve flattens out as between output levels A and B. If large sized farms are, in fact, more efficient, then a land reform favoring the creation of small farms (to the left of point A in Figure 2) will merely be exchanging one form of poverty for another. Formerly, the peasant was a poor sharecropper; afterward, a poor

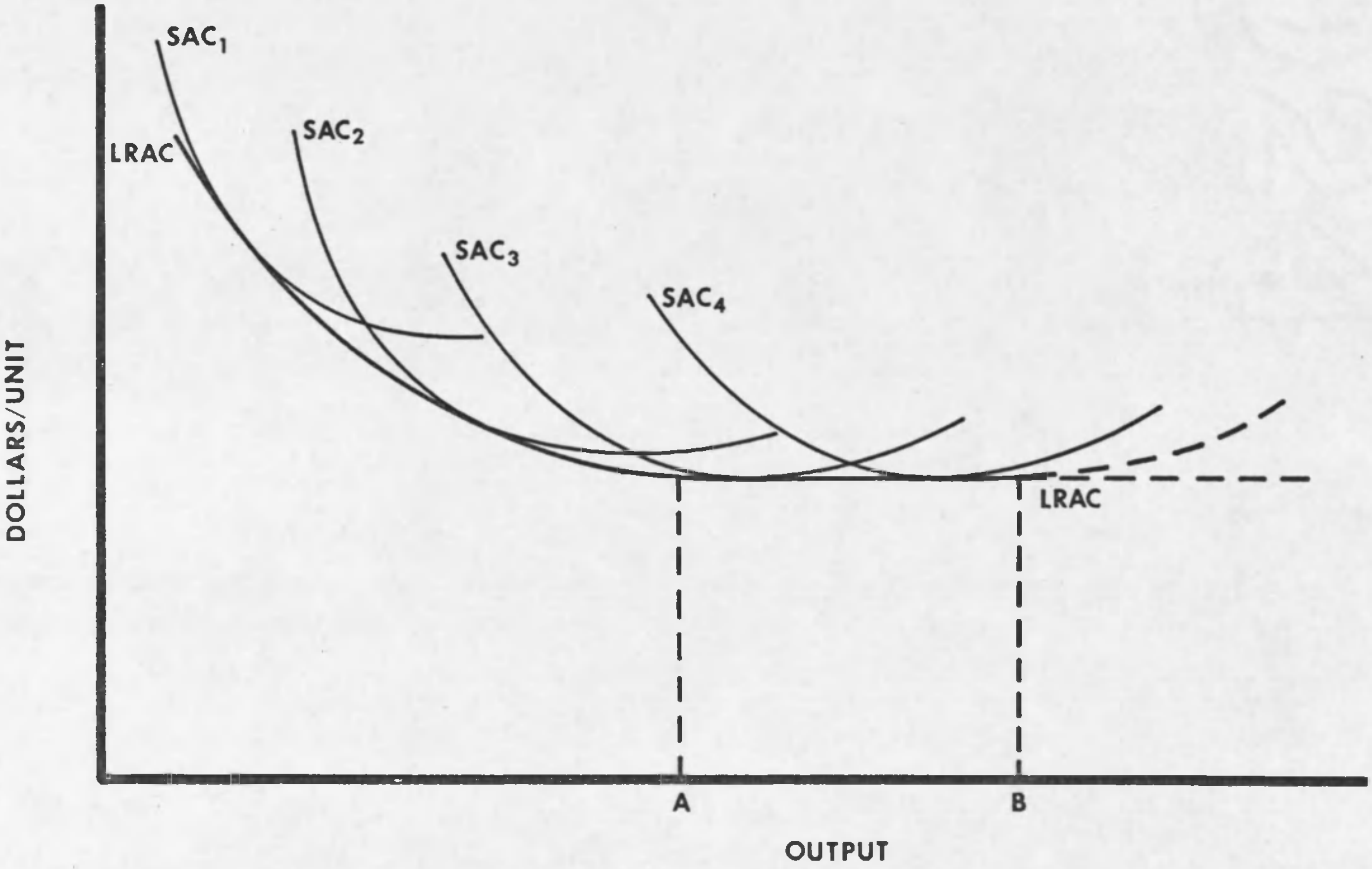

Figure 2. Economies of size.

landowner without enough land to support himself. The possible existence of size economies does not preclude reform. It would suggest, however, that a post-reform farm unit be within the economically optimum size range, perhaps through state or cooperative control.

Second, increases in agricultural productivity and total output are expected if the newly organized farms make more intensive use of the factors of production than do existing large farms. The creation of more small and medium farms will bring land into production that is currently held idle on the latifundi (large scale land holdings), thus opening new opportunities for currently underutilized labor resources.

Third, productivity within agriculture is expected to increase as the combinations of inputs on farms approach economic optimality. Imperfections currently exist in the markets for some factors of production (Warriner, 1964) and it is precisely these imperfections at which land reform is aimed (Dorner, 1971). Improved access to land and capital resources, currently closed to the peasant, will promote economically efficient factor usage.

Fourth, productivity would be expected to increase if there exist incentives to ownership. This is derived from the widely held belief that a farmer or any person would rather work for himself than for someone else.

These four general effects will be developed further in the next section.

Economies of Size

The question of the possible existence of size economies in the agricultural sector of the developing countries is crucial. Unfortunately, there is no clear point of a priori agreement on this question. While it is generally agreed that economies of size exist in industry and agriculture in the developed countries (Viner, 1952; Leftwich, 1970; Heady, 1961; Madden, 1967) there is a lack of consensus on this point when discussing the developing economies (Dorner, 1971). Reference to the theory inherent in the discussion will be helpful in understanding it.

Economies of size result in the case where per unit production costs are lower for larger sized producing units.[1] Size economies are generally discussed in terms of short run and long run situations. Short run economies generally are considered to arise from fuller utilization of the fixed resources of production (e.g., agricultural land) while in the long run all resources, including the previously fixed factors, can be changed. As illustrated in Figure 2 there are several (any number of) short run cost curves (SRAC) corresponding to different sized firms in the industry (e.g., farms). Their particular "u" shape is related to the law of diminishing returns. Up to a point, as output increases in the short run, costs decrease since fixed cost is spread over more units. After a minimum point, however, more and more inputs must be added to the fixed resource to produce greater output and costs rise. Connecting these various SRAC curves is an envelope curve, or the LRAC, reflecting

---

1. Although a distinction is sometimes made between "scale" and "size" in discussing economies and diseconomies (Madden, 1967, pp. 1-2), the terms will be used as synonymous in this study.

the assumption that all inputs including what had been fixed in the short run are now variable. See Viner (1952) for an amusing discussion of the shape of the envelope curve. If economies of size exist, then costs will decline until a minimum cost range between A and B in Figure 2 is reached; after output level B, no further benefits will accrue to larger sized firms. This condition might arise for one, or more, of several reasons both internal to the farm firm and external to it. Internal economies of size are those which arise from specific aspects of the farm itself and are not dependent on the agriculture sector as a whole. These might be either technical or pecuniary in origin. A technological internal economy is typified by factor indivisibilities. For example, a case of a technological economy might be a farm becoming large enough to fully employ a tractor or other large machine. A small farm could own the same equipment, however, the high cost associated with it might prohibit this. A pecuniary internal economy might result from the farm being large enough to receive quantity discounts in input purchases, or premium prices for sales of large lots of products. In the case of labor, a pecuniary economy of size might result from the farm being large enough to control the wage rate paid in the area.

In addition to these internal factors leading to economies of size, there exists the possibility of size economies resulting from conditions outside of the farm itself. The concentration of political power in the hands of large landowners, and the subsequent influence on legislation affecting agriculture is one example.

Up until now this discussion has focused on the declining portion of the LRAC and the minimum cost range. There yet remains the portion to the right of point B in Figure 2. This area, however, is of theoretical importance only. Traditional economic analysis suggests that rising costs, diseconomies of size, arise from managerial and administration problems (Ferguson, 1969). They might not occur, and indeed, it is hard to find convincing illustrations or empirical evidence (Viner, 1952; Madden, 1967).

The relevance of this discussion to the developing agricultural sectors is now clearer. If economies of size do exist for large producing units, then attempts to create a post reform farm smaller than A in Figure 2 will have the effect of increasing the average unit costs and decreasing the average agricultural productivities.

Intensity of Factor Use

Output from post-reform farms would be expected to increase to the extent that the factors of production, especially land, are used more intensively by small farmers. The incentives to use inputs more intensively appear to be inversely related to farm size (Dorner, 1971; Cline, 1970) since the producer feels more pressure when he is closer to subsistence. Several studies suggest that smaller farms have a higher output per area than do large farms (Dorner, 1971; C.I.D.A., 1966). Reasons for this are varied and Cline (1970) suggests seven possibilities.

1. Labor market dualism resulting from the coexistence of large scale modern farms paying the VMP and traditional farms paying an institutional wage greater than its marginal product.

2. Land held as a portfolio asset.

3. Land market imperfections due to lack of available small parcels of land.and credit.

4. Production on small farms for home consumption as well as for the market.

5. Monopsony power over labor by large landowners.

6. Land holding for prestige.

7. Poor land quality on large farms.

The specific causes of this inverse relationship will not be sought in this study; however, evidence of the phenomena itself will be looked for.

Factor Combinations in Agriculture

Economic theory states that optimum long run resource allocation within a firm will occur where the ratios of the prices of an input to the marginal physical product of those inputs is equal for all inputs used. In other words, where:

$$\frac{P_{x_1}}{MP_{x_1}} = \frac{P_{x_2}}{MP_{x_2}} = \ldots = \frac{P_{x_n}}{MP_{x_n}} = MC = P_y$$

(for conditions of pure competition). Any deviation from this would suggest that the farm is not operating at the optimum point, and that it could improve (Leftwich, 1970).

Failure to allocate resources in this manner could be the result of market imperfections (Warriner, 1964). The preceding section suggested some of the imperfections that could influence the use of land. It is precisely the removal of these imperfections at which land reform is aimed (Dorner, 1971).

Incentives to Ownership

There are three basic ways in which tenure forms (owner/operator, sharecropper, renter, squatter, administrator/operator) might influence incentives to ownership. First, ownership can be expected to increase the incentive to work. Under a tenure structure where a sharecropper is obliged to turn over fifth percent of his product, as was common in the study area, there is little incentive to assume greater risks and increase production.

A second incentive to ownership was described previously as security to make long-term investments. Obviously, investments in productive improvements will not be made unless the investor (farmer) feels secure that he will benefit from the investment.

The final incentive to ownership relates to the optimal use of inputs, as discussed in the preceding section. Under a tenure structure where the sharecropper pays for all of an improvement and receives only a portion of the product, investment will not reach an optimum level (Figure 3).

The optimum point of production should be at point A where the slope of the break-even line $\frac{P_x}{P_y}$ facing the producer is equal to the slope of the total physical product curve $\frac{\partial Y}{\partial X}$. Under the tenure structure mentioned above, where the sharecropper must assume all variable costs and turn over 50 percent of the product, the sharecropper would view his break-even line as being steeper (BE'). This would cause him to use less of the input and decrease output in order for him to maximize profit (point B). The difference between B and A would be attributed to incentives (or lack) of ownership.

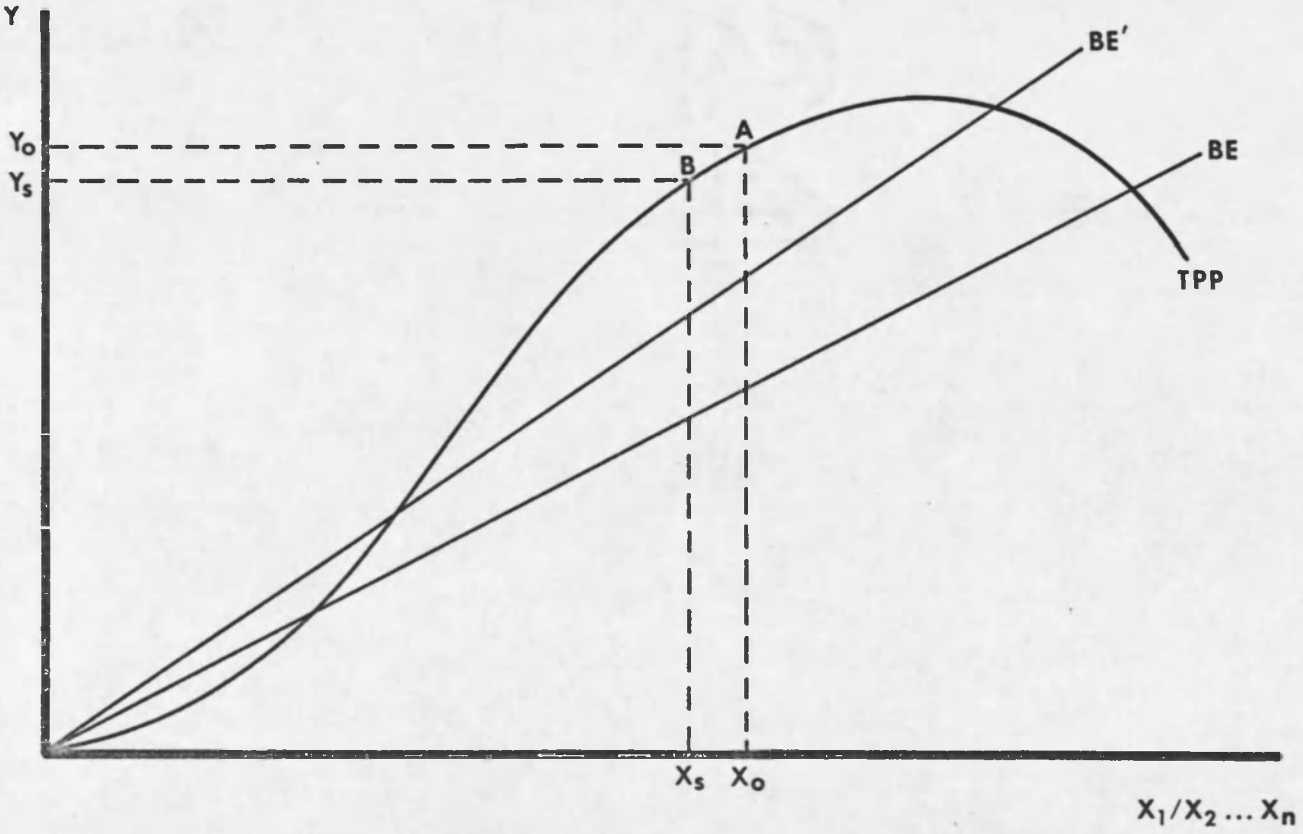

Figure 3. Incentives to ownership -- influence on input usage and resultant output.

This discussion, while theoretically correct, is rather simplistic. It assumes that, in general, any of the input variables might be varied. In the case of Brazilian sharecroppers, the only input that is really variable is capital. Land is controlled by the landowner and there is no alternative market for labor. The incentives to ownership question might, therefore, be more completely illustrated by the use of isoquants and price lines, as in Figure 4.

In this case, the price of labor is fixed, as at P_{L_1} while the price of capital becomes cheaper as P_{C_1} to P_{C_2}, corresponding to an easier access to capital, perhaps resulting from ownership of land. Output would increase from I_1 to I_2 as input use changes. This increase would, therefore, be attributed to incentives to ownership.

Hypotheses and Empirical Tests

In the preceding sections, the ways in which a land reform measure could affect agricultural productivity have been presented and discussed. Based on these, and in order to meet the stated objectives of this study, the following hypotheses are presented:

1. There are incentives to ownership vs. sharecropping, in that owner operators achieve a higher output per area than nonowners.

2. There are no economies of size in agricultural production as represented by farms in Missao Velha.

These hypotheses will be tested empirically using information from Missao Velha, Ceara, Brazil. Specifically the following questions concerning agricultural production will be investigated:

(a) Are there returns to scale in agriculture?

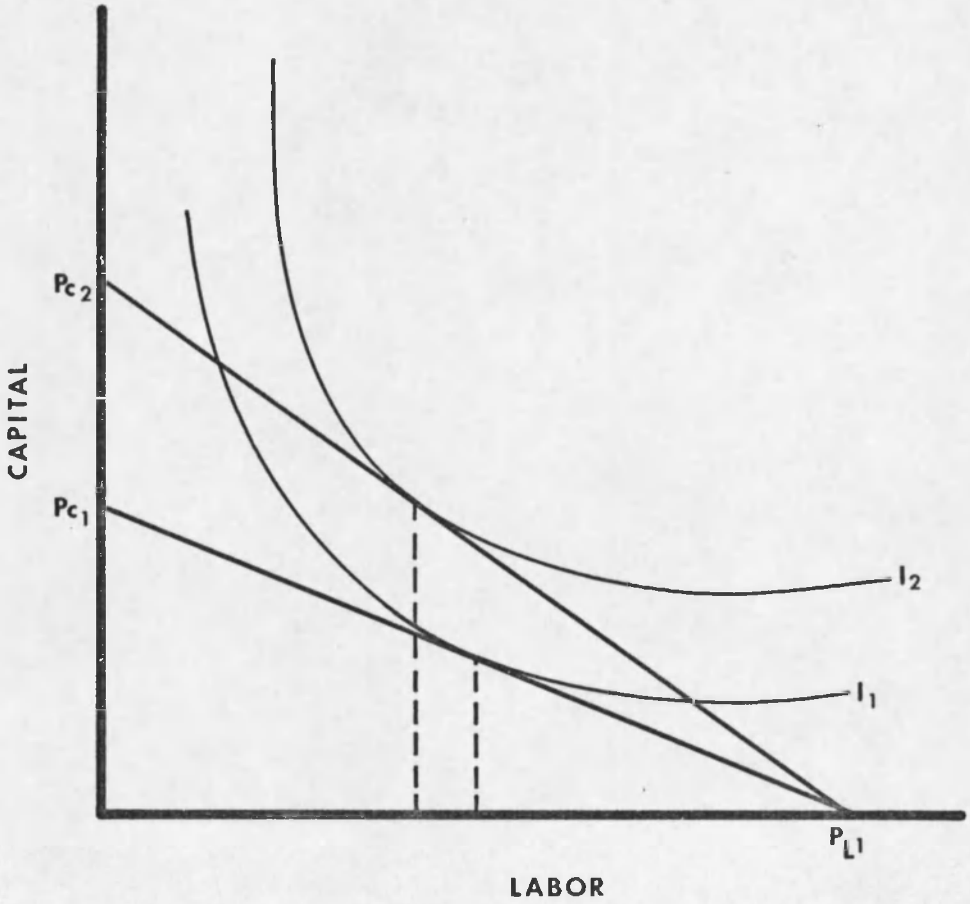

Figure 4. Incentives to ownership -- alternative explanation.

(b) Are owner-operated farms more productive than sharecropper plots?

(c) Do owner-operators use inputs more intensively than sharecroppers?

(d) Do small farms use inputs more intensively than large farms?

(e) Do small farms achieve higher output per area than large farms?

Issues raised in this chapter but which will not be investigated further are:

(a) Why do small farms use inputs more intensively?

(b) What is the optimum factor combination within agriculture?

(c) What are the changes in investment and demand resulting from land redistribution?

(d) What are equity effects on the society as a whole?

The procedures for investigating these hypotheses and questions will be twofold. First, a descriptive analysis of agricultural practices in Missao Velha will be presented. Through the use of productivity ratios, the tests of intensity of input usage and output will be conducted. The second procedure for testing the returns to size, will consist of production function analysis among size classes of landowners and between owners and sharecroppers. These production functions will also provide additional information concerning input use.

Data Collection and Selection

The information used in these analyses was developed as a portion of a much larger research project concerning cotton production in Ceara.

This study, the result of cooperation between the Ministry of Agriculture, the Bank of the Northeast of Brazil, and the Department of Agricultural Economics at the University of Ceara, represents a cross-sectional examination of production and factor use during the 1971-72 crop year.

Selection of sample units was based on the 1972 cadastral survey conducted by the National Institute of Colonization and Agrarian Reform (I.N.C.R.A.). The list of property owners has been stratified by size and the largest (over 800 hectares or 1,920 acres) and smallest (under 3 hectares or 7 acres) units were removed. Furthermore, all farms not producing cotton were eliminated from the list at this point. The remaining farms were placed in three categories: 25 hectares and less, 25.1 to 100 hectares, and 100.1 to 800 hectares. The choice of the size categories was based on the existence or not of sharecroppers. I.N.C.R.A. records indicated that those farms with less than 25 hectares did not have sharecroppers. As it developed in the field, one farm in Class I did have two sharecroppers present, however, this does not affect the remainder of the observations. The farms larger than 25 hectares were then divided arbitrarily at 100 hectares to reflect medium and large sized producers. An additional aspect of the selection process was the goal of having enough observations from each size class so as to permit statistical testing. Thus an equal number of sample units were drawn from each class. Unfortunately, it is not possible to present the actual distribution of properties in Missao Velha from which the sample was drawn. Biserra (1974), however, states that 92.6 percent of the farms in the country occupy 94.6 percent of the land.

In addition to property owners, selected as described above, the survey included interviews with sixty sharecroppers. These were selected on an arbitrary basis from the list of property owners interviewed. Although subsequent analysis will eliminate some of the property owners interviewed, all observations of sharecroppers will be included. This decision to include all sharecropper observations even though the particular owner had been eliminated is based on the finding that sharecropper characteristics (plot size, yields, etc.) were independent from the size of the owner's farms. The data were obtained through personal interviews conducted during November of 1972. Both the questionnaire and interviewers were used in a different region and were thus fully tested by the outset of the Missao Velha study.

Table 2 presents the distribution of the strata and the number of observations used in the subsequent analyses. There were two criteria used for the exclusion of the fourteen property owner samples. One was if the owner reported no crop area under his direct control (exploracao direta) which eliminated six. The second was if 30 percent of the crop area reported was devoted to sugar cane production. The justification for this criterion, which eliminated eight farms, was nonhomogeneity of land resources. Sugar cane was produced on irrigated, low land substantially different from the rest of the land in the municipio.

Table 2. Distribution of the strata.

Size	Property Owners		Sharecroppers	
Strata[a]	Interviewed	Analyzed	Interviewed	Analyzed
3-25 ha.	24	23	2	2
25.1-100 ha.	25	22	9	9
100.1-800 ha.	21	11	49	49
	70	56	60	60

a. The strata intervals are valid for property owners only. Subsequent analyses will show no significant difference between sharecroppers and size strata of owners.

CHAPTER 3

ORGANIZATION AND PRODUCTION IN AGRICULTURE IN MISSAO VELHA

The structure of the agricultural sector in Missao Velha is a reflection of that found in the rest of the Northeast and to an extent, the whole of Brazil. It is characterized by the coexistence of a few very large farms and a large number of small, sub-family sized farms. This latifundia-minifundia complex is a direct legacy of the colonization and history of Brazil (Prado, 1971). Several excellent studies discuss this type of agrarian structure and its ramifications on Brazilian agriculture and society. Among these are Furtado (1968), Freyre (1946), C.I.D.A. (1966), Nicholls and Paiva (1966), and Johnson (1971). This chapter will briefly describe the latifundia system as it exists in Missao Velha and how this structure is reflected in agricultural practices of both sharecroppers and landowners. Additionally, the examination of input usage among the study groups will serve to test the hypothesis that small farms use inputs more intensively and thus achieve higher outputs per hectare than do large farms.

Description of the Region

The municipio (county) of the Missao Velha forms a part of the Cariri region in the southern portion of the state of Ceara, Brazil. It is 556 kilometers (345 miles) from the state capital, Fortaleza, and is served by paved roads and a railroad. The primary commercial ties are with the nearby cities of Crato and Juazeiro do Norte which are the principal urban and commercial centers of the region and form the second largest urban concentration in the state. The _municipio_ thus has access to regional, national, and international markets for its products, as well as sources of credit and agricultural inputs.

The Cariri region has been described as an oasis in the desert because more favorable climatic conditions exist there than are found in the surrounding _sertao_ (semi-arid backlands). Rainfall is concentrated between December and May with a pronounced dry spell during the remainder of the year. Average rainfall is 750-1,000 millimeters per year (30 to 40 inches) (Convenio Governo Do Estado, 1973). The _municipio_ of Missao Velha occupies approximately twenty percent of the Cariri region, or 559 square kilometers (210 square miles). The population is still primarily rural with 72 percent of the 1970 population total of 30,000 so classified. The population density was rather high, 53.7 people per sq. kil., suggesting the existence of many small farms. Table 3 compares this density to that of the rest of Ceara, the Northeast, and the rest of Brazil.

The principal crops produced in Missao Velha and their contributions to the economy of the region are presented in Table 4. These crops are also important for the country, accounting for five of the six most important crops in 1966 (Schuh, 1970, pp. 104-105).

Organization of Agricultural Activities

The organization of agricultural activities in Missao Velha is structured along traditional lines. For the small farms and sharecroppers, this implies a farm organization where business and family consumption

Table 3. Population densities, 1970.

Area	Density[a]
Missao Velha	53.7
Ceara	30.6
Northeast	18.6
Brazil	11.8

a. Persons per square kilometer.

Sources: Biserra (1974) and Paiva et al. (1973).

Table 4. Principal crops produced in Missao Velha, and their contributions to the economy of the municipio, 1972.

Crop	Production (tons)	Percent of agricultural income
Cotton	200,000	34.9
Beans	26,500	18.0
Corn	82,500	11.2
Sugar Cane	90,000	10.2
Rice	18,000	4.8
Other	--	20.9

Source: Biserra (1974).

decisions are intermingled, and where the bulk of the labor force, management and capital come from the same household. For the large landowner, on the other hand, traditionalism dictates the entire fabric of the socioeconomic system. As Kanel (1971), speaking in general terms, describes it:

> The basic feature of this kind of organization is stability of agriculture technology over long periods of time. The active concern of landlords is not changes in farming practices and gains that might be achieved thereby, but the extraction of a surplus from the peasantry . . . Such tenure systems tend to be characterized by the personal dominance of the landlord (Kanel, 1971, p. 28).

In Brazil, the principal expression of traditionalism is found in the _latifundia-minifundia_ duality and the associated social, political, and economic structures. The C.I.D.A. (1966) study focused a major portion of its report on the conditions present under this agrarian structure in Brazil. They describe the Brazilian latifundia system as follows:

> Latifundismo is a system of power . . . What makes this power so distinctive is its near absoluteness . . . The final decisions on what and how much to plant, on what, when and where to sell rests with him (the landowner). The worker who lives on the farm and receives a plot of land to raise crops for subsistence or sale has usually a _limited_ range of freedom to decide what crops to plant . . . In most cases he can only plant annual crops and . . . he is prohibited from keeping animals on his plot . . . It is (also) interesting to note that on medium sized farms the organization is as complex, though on a smaller scale, and as autocratic as on the latifundios (C.I.D.A., 1966, pp. 413-439).

That these same conditions exist, and indeed are rather common, in Missao Velha will be illustrated in the following section. Information taken from interviews with the sixty sharecroppers will be used in this discussion. The complete extent of the _latifundia-minifundia_ complex and its consequent effects on agricultural performance in Missao Velha unfortunately cannot be presented here. It is possibly more prevalent than will be illustrated since the original sample excluded the very large (over 800 hectares) and the very small (less than 3.0 hectares) farms.

Characteristics of Sharecropping

The producing units in the sharecropping system are families. In this study there were fifty-nine nuclear family units and one nonfamily household. These sixty samples were arbitrarily selected from nineteen _fazendas_ included in the survey of property owners. ("In this part of the world, a _fazenda_ may be practically any land holding of more than a few hectares in size, regardless of its organization and operation," Johnson, 1971, pg. 2.) Although the property owners had been stratified by size (Table 3), this classification for sharecroppers is unnecessary. Sharecroppers form a relatively homogeneous population in that their agricultural activities are independent of the size _fazenda_ on which they work. This is the conclusion drawn from a series of statistical tests conducted for various measures of sharecropper performance. Productivity would be expected to differ only if large _fazendas_ supplied more inputs, in the form of land and capital, than do smaller _fazendas_, thus leading to significant differences among sharecropper performances. Tests for the significance of difference between means were conducted using information reported by sharecroppers on size Class I and II _fazendas_ as one group versus sharecroppers on Class III _fazendas_.

The various measures tested and the calculated "t" values are:[2]

1. Total area available to sharecropper -- (0.936)

2. Cultivated area -- (0.866)

3. Value fo crop sales -- (0.784)

4. Value of cotton sales -- (0.502)

5. Value of livestock sales and sale of animal production -- (0.795)

6. Value of production, Cr.$/total area -- (0.461)

7. Value of production, Cr.$/cultivated area -- (0.517)

8. Value of production, Cr.$/sharecropper -- (0.841)

The results of these tests support the decision to treat sharecroppers as a single unit, not dependent upon the size of the <u>fazenda</u> where they live.

Conditions reported by the sharecropper informants conform closely with the descriptions presented by Johnson (1971) and C.I.D.A. (1966). While there are sharecroppers in the study area who resemble modern tenants in that they have resided on the same farm for up to fifty years, they do not achieve their access to the land through a written contract.[3] In all cases, relations between the landowner and sharecropper and landowner were oral, with conditions favoring the owner. This conforms exactly to conditions reported by Johnson (1971) and C.I.D.A. (1966) for other areas of Ceara. Within the study group, specific obligations between sharecropper and owner varied greatly. The sixty respondents delineated thirty-one different share obligations towards the landowner.

---

2. The table "t" value at a 90 percent significance level and 59 degrees of freedom is 1.296.

3. Of course, a written contract means little if the sharecropper is illiterate, or if no laws exist to enforce it.

These generally required a fifty percent share of cotton produced, and some, usually lesser, percentage of the other crops produced. In no cases were cash rents paid. All payments were in kind, either as a percentage or an agreed upon quantity of product. In addition to crop obligations, thirty-one sharecroppers reported required "labor days" (dias de sujeicao for the owners benefit. Wages were paid for these labor days, however, at a rate lower than the prevailing wage rate. The distinction between sujeicao labor and wage labor was also noted by Johnson (1971, p. 79) and C.I.D.A. (1966, p. 423). In return for the above obligations, the landowner provided access to the land, and little else.

All of the sharecropper units reported some type of restriction placed on their agricultural activities. The primary ones reported, and the percentage of responses for each were:

1. The landowner, or his agent, specifying what type of cotton to plant -- (96.7 percent).

2. The owner, or agent, specifying the cotton seed to use -- (81.7 percent) and often supplying them -- (71.7 percent).

3. The owner specifying where planting will be done -- (68.3 percent).

4. The owner selecting the crops to be grown in association with cotton -- (23.3 percent).

5. The landowner not allowing cattle -- (63.3 percent).

These restrictions, which quantify the descriptions in C.I.D.A. (1966, pp. 133-146) further serve to illustrate the relative positions of the sharecroppers and the property owners. The provision of cotton seeds is essentially the only input, besides land, provided by the owner. The costs, and risks, of modernization are borne by the sharecroppers.

As might be expected, movement towards modernization is very limited. The sixty sharecroppers reported no mechanized equipment for production (either motor or animal) nor was any fertilizer use reported. Landowners reported a larger incidence of implement use, with three tractors and several animal powered tools. These, however, appear to be for the use of the landowner and were not available to sharecroppers. The primary tool available and used in agriculture was the hoe.

This seemingly unequal exchange is not entirely one way, however, for in return the sharecropper receives security for himself and his family. Johnson's (1971) entire description of sharecroppers in Ceara focuses on this security aspect. Land resources in the Northeast are poor and often unavailable for purchase. The weather is unpredictable, but has a distinct tendency toward dryness. Without the support of a patrao (landowner) a small farmer might perish in a bad year. The tendency to use techniques and inputs that will provide subsistence in a bad year and, perhaps, a small surplus in a good year is a result of the search for security. It is to improve this security at which land reform is aimed.

Agricultural Production in Missao Velha

Agricultural practices might be described most conveniently through an examination of the use of the basic factors of production: land, labor, and capital. In the subsequent discussion and analysis, information on each of these factors will be presented for the five producing groups in Missao Velha: Class I landowners (3.0 - 25 hectares), Class II landowners (25.1 - 100 hectares), Class III landowners (100.1 - 800 hectares), all landowners, and all sharecroppers.

Description of the Variables

The variables defined below will be used in the analyses in this and the following chapters. They were calculated for both landowners and sharecroppers from data extracted from the survey in Missao Velha. Table 5 presents the values obtained for the means, standard deviations, and coefficient of variation of these variables for landowners and sharecroppers. It is evident that considerable variation is present in the data, and that the mean is not a reliable measure of central tendency. Since the mean is highly influenced by extreme values, the use of mean values for prediction would tend to overstate the expected response to change. In most cases, as seen in Table 5, the mean is considerably higher than the median. This skewness, tending towards overestimating typical data, provides an additional impetus and justification for marginal analysis available from production functions. The definitions of the variables are:

Cultivated Area: This variable, expressed in hectares (1 hectare = 2.47 acres) measures total cultivated area reported by the respondents. In the case of landowners, it represents only those fields reported under the direct control (exploracao direta) of the owner. Thus, land cultivated by sharecroppers or rented to others is excluded.

Pasture Area: This land variable, also presented in hectares, represents land reported under three categories: uncleared land, natural pasture, and artificial pasture. As with the previous measure, the area

Table 5. Input and output data for landowners and sharecroppers, Missao Velha, 1972.

Variable Name	Mean	Standard Deviation	Coefficient of Variation	Median
CLASS I LANDOWNERS				
Cultivated Area (ha.)	8.1	5.1	0.630	6.5
Pasture Area (ha.)	2.9	2.9	1.000	1.9
Family Labor (man/days)	273.3	169.7	0.621	255.0
Hired Labor (man/days)	147.0	173.3	1.179	103.3
Fixed Capital (Cr. $)	5,471.6	4,985.5	0.911	4,509.2
Machine Capital (Cr. $)	935.0	2,756.0	2.948	76.0
Animal Capital (Cr. $)	2,671.5	3,672.3	1.375	1,053.1
Cash Production Costs (Cr. $)	715.7	1,749.4	2.444	77.0
Total Area (ha.)	13.8	7.0	0.507	--
Output this Year (Cr. $)	4,733.8	3,956.6	0.836	2,831.6
CLASS II LANDOWNERS				
Cultivated Area (ha.)	18.1	11.4	0.630	14.8
Pasture Area (ha.)	16.7	15.7	0.940	13.1
Family Labor (man/days)	248.3	202.8	0.817	237.5
Hired Labor (man/days)	532.5	529.0	0.993	419.7
Fixed Capital (Cr. $)	11,594.3	11,955.9	1.031	7,695.0
Machine Capital (Cr. $)	1,360.4	2,328.9	1.712	154.8
Animal Capital (Cr. $)	9,942.4	10,383.1	1.044	7,173.8
Cash Production Costs (Cr. $)	830.9	1,046.5	1.259	260.5
Total Area (ha.)	47.4	18.6	0.392	--
Output this Year (Cr. $)	9,499.1	6,400.8	0.674	8,767.0

Table 5. (continued)

Variable Name	Mean	Standard Deviation	Coefficient of Variation	Median
CLASS III LANDOWNERS				
Cultivated Area (ha.)	53.0	56.9	1.074	38.3
Pasture Area (ha.)	101.4	95.1	0.938	92.0
Family Labor (man/days)	433.5	377.0	0.870	303.8
Hired Labor (man/days)	1,805.8	1,771.7	0.981	1,413.3
Fixed Capital (Cr. $)	34,370.9	27,305.3	0.794	25,840.0
Machine Capital (Cr. $)	10,265.9	17,765.1	1.730	4,343.0
Animal Capital (Cr. $)	39,790.1	24,740.7	0.622	34,597.0
Cash Production Costs (Cr. $)	3,910.0	5,077.8	1.299	1,552.0
Total Area (ha.)	240.7	165.5	0.688	--
Output this Year (Cr. $)	33,818.2	22,011.2	0.651	29,810.1
TOTAL LANDOWNERS				
Cultivated Area (ha.)	20.9	30.5	0.685	13.1
Pasture Area (ha.)	27.6	56.0	2.029	7.9
Family Labor (man/days)	295.0	240.7	0.609	255.0
Hired Labor (man/days)	624.3	1,033.2	1.655	296.7
Fixed Capital (Cr. $)	13,553.6	17,765.2	1.311	7,407.5
Machine Capital (Cr. $)	2,935.0	8,712.3	2.968	101.7
Animal Capital (Cr. $)	12,819.1	18,700.5	1.459	5,515.0
Cash Production Costs (Cr. $)	1,388.4	2,813.5	2.026	249.0
Total Area (ha.)	71.6	111.8	1.561	--
Output this Year (Cr. $)	12,318.9	15,155.2	1.230	7,753.7

Table 5. (continued)

Variable Name	Mean	Standard Deviation	Coefficient of Variation	Median
SHARECROPPERS				
Cultivated Area (ha.)	4.400	4.3	0.977	3.400
Pasture Area (ha.)	0.047	0.3	6.383	.005
Family Labor (man/days)	207.600	131.0	0.631	176.200
Hired Labor (man/days)	32.500	78.4	2.412	2.000
Fixed Capital (Cr. $)	22.500	65.9	2.929	0.500
Machine Capital (Cr. $)	27.700	24.7	0.892	20.500
Animal Capital (Cr. $)	380.000	279.5	1.360	313.700
Cash Production Costs (Cr. $)	19.800	33.8	1.707	12.500
Total Area (ha.)	4.600	4.3	0.935	--
Output this Year (Cr. $)	2,056.800	2,621.1	1,274	1,461.700

reported for landowners represents pasture directly controlled by the owner. Sharecroppers reported almost zero pasture area (with two of sixty reporting a total of 2.8 hectares). This measure does not include the area of cultivated fields which, after harvest, are customarily used for supplemental grazing. It additionally omits the area reported as being under the control of the sharecropper but which also could be grazed by the landowner's livestock for a portion of the year. These omissions are due to the lack of specific information concerning the contribution of this grazing, and of the sharecroppers labor to livestock production. Studies such as Anderson and Rodrigues (1968) suggest that the contribution to livestock is substantial since the forage material is both nutritious and available at a time when natural forage is limited. It is recognized that these omissions will tend to underestimate the average and marginal productivities of labor, especially that of sharecroppers, while somewhat overestimating these same measures for the pasture area variable as a whole.

Family Labor: As measured in this study, this variable expresses the labor contributions of the farmer, either landowner or sharecropper, and his immediate family. In developing this measure, the mandays reported on the questionnaire were weighted according to the following criteria:

a. Adult male, 15 - 64 years = 1.00

b. Adult female, 15 - 64 years = .75

c. Adult over 65 = .60

d. Youth under 15 = .50

Although each producing unit reported this variable in similar terms, the qualitative composition varies. Large landowners would contribute considerably more managerial labor than would smaller farmers and sharecroppers. This will tend to overestimate the average productivities for landowners with sharecroppers.

Hired Labor: Measured in man-days, this variable includes contributions from several sources. These are:

a. Permanent labor force, representing usually specialized labor. In the case of sharecroppers, no permanent labor force was reported.

b. Unspecialized labor utilized anytime during the entire year. This component accounted for the bulk of this variable for both landowners and sharecroppers.

c. Sharecroppers labor os dias de sujeicao. This variable measures man-days labor performed by sharecroppers for the owner's benefit. This labor was paid for, but usually at a wage rate below the normal wage levels.

The values reported in the questionnaire were weighted on the same basis as family labor.

Fixed Capital: This variable, expressed in Cruzeiros (Cr. \$1.00 ≃ U. S. \$0.20 at the time of the study) aggregates the reported values for houses, sheds, warehouses, stables, silos, wells, farm roads, and other similar items "fixed" on the land. It represents the stock value of these items, and was calculated as the average of the beginning and ending values reported. The value reported by sharecroppers, Cr. \$22.5, should be considered with respect to their nonlandowning status. It cannot be expected that a sharecropper invests in fixed improvements in the land.

Machine Capital: This variable, also expressed in Cruzeiros presents the stock value of machinery and implements on hand during the 1971-72 agricultural year. It also was calculated as an average of beginning and ending reported values. Included in this measure, in addition to general farm machinery, are values reported for motor vehicles such as jeeps and pickup trucks. For sharecroppers, this measure represents only hand tools, and no mechanized implements.

Animal Capital: Aggregated in this variable are the values, in Cruzeiros, reported for work animals, cattle, poultry, swine, sheep, and goats. As with the previous capital measures, it was calculated as the average value on hand during the production year. This variable disguises a major difference in the composition of the available livestock. In the case of sharecroppers, almost no bovines or horses were reported, reflecting the general prohibition on cattle raising enforced by the landowner.

Cash Production Costs: Included as cash production costs are values reported for machine operating costs, machine rental, costs of inputs for animals and crops, marketing costs for cotton, and the value of all taxes and social security payments. For those landowners with motor vehicles, the primary component of this variable is the machine operating costs. There was almost no machine rental values reported, either by landowners or sharecroppers. (Interestingly, there was very little borrowing of machinery, apparently reflecting an aversion to be in someone's debt.) For sharecroppers and smaller property owners (Class I), this variable could serve as a measure of technical inputs into production. There was no reported use of fertilizer by anyone and very little use of insecticides. The primary "industrialized" input was improved seeds for cotton. The use of the term "improved seeds" did not always mean the same thing and ranged from seed selected by the gin operator from the previous year's crop to seed "certified" by state agencies.

Total Gross Product: This variable, expressed in Cruzeiros represents the aggregation of several reported categories. These are the value of crop production, the value of sales of animals and animal products, the value of home consumption of animals and animal products, plus the appreciated value of the livestock herd over the year. Crop production had been reported in physical terms and was converted to value measures with market prices reported by the local agricultural extension agent (ANCAR). Production was recorded as amount produced, regardless of its use -- e.g., home consumption, sales, rent, stock, and so forth. In the case of landowners, it represents only the production on the fields reported under direct control of the owner (see variable 1).

Various measures of performance based on these ten variables will be presented in the sections that follow.

Land

Land is one of the primary inputs into agricultural production in Missao Velha. Table 6 presents a description of land use practices of landowners and sharecroppers. Columns 1 and 2 present the mean values reported for total farm area and cultivated farm area, respectively. The intensity of land use, shown in Column 3, shows an inverse relation between total farm size and intensity of cultivation. This particular relation is slightly misleading, however, in quantitative terms only.

Table 6. Land use on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations	(1) Total Area ha.	(2) Cultivated Area ha.	(3) Cultivated Area[a] %	(4) Pasture Area ha.	(5) Pasture Area[b] %	(6) Producing Area[c] ha.	(7) Producing Area[d] %
Landowners							
I (23)	13.80	8.10	58.7	2.90	21.0	11.00	79.7
II (22)	47.40	18.10	37.3	16.70	35.2	34.40	72.6
III (11)	240.70	53.00	21.3	101.40	42.1	152.60	63.4
Total (56)	71.60	20.40	28.5	27.60	38.5	48.00	67.0
Share-croppers (60)	4.55	4.44	97.6	0.04	--	4.48	97.6

a. Column 2 ÷ 1 x 100

b. Column 4 ÷ 1 x 100

c. Column 2 + 4

d. Column 6 ÷ 1 x 100

The value reported forlandowners as cultivated area represents only the area under the direct control of the owner, and does not count the contribution of sharecroppers. When this additional area is included, the intensity of cultivation for Class II and Class III owners increses to 42 percent and 32.2 percent, respectively. These latter values, while still yielding the inverse relation between size and intensity, more accurately represent the land use practices of medium and large-sized landowners.

The value reported for intensity of cultivation by sharecroppers is also misleading. A landowner will only cede a sharecropper a fixed amount of land for crop purposes. Thus, the sharecropper will have very little, 2.4 percent, unused land. Because the sharecropper lacks direct control over the land, comparisons between cultivation intensities of landowners and sharecroppers are invalid.

Column 4, Table 6 presents the mean values reported for pasture area. The direct relation between pasture area and farm size reflects the tendency for large landowners to raise more livestock. This tendency has both economic and historic roots. Historically, the Northeast region was settled through large cattle ranches. Cattle ranching has remained socially preferable to crop production for those who possess the conditions for it. Economically, cattle ranching is a relatively low risk, low cost operation, requiring little labor input. It will provide some return and a store of wealth even in the periodic droughts that affect the Northeast.

Combining cultivated area and pasture area, Column 6 yields the same inverse relation as for cultivated area alone; that is, smaller landowners use their land resources more intensively than large landowners.

Labor

The second principal input in the agricultural production process is labor. For the convenience of later analyses, this input has been separated into categories of "family labor" and "hired labor." Patterns of labor use are presented in Tables 7, 8, and 9. Family labor use for property owners (Column 3, Table 7) is not related, in absolute terms, to farm size. The contributions in man-days labor are not significantly different between the three classes of property owners. The intensity of use of family labor (Columns 4-5, Table 7) does vary considerably with size. The smaller farms, Class I, use almost three times as much family labor, measured in man-days, per area as do medium and large size farms. The value reported for sharecroppers, 46.8 man-days/hectare, twice as much as the smallest property owner, illustrates the labor intensive practices employed. It is directly related to the limited access to land for sharecroppers.

Table 8 illustrates the use of hired labor by the various groups. The relation between size and use, in absolute terms, is direct. However, the intensity of hired labor/hectare, Column 4, does not indicate a clear trend. Hired labor per hectare increases from Class I to Class II, and then falls off. This probably results from the move towards livestock oriented farms and the consequent lower labor requirements per area. As expected, hired labor use by sharecroppers was minimal.

Table 7. Family labor use on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Family Labor (man/days)	(4) Intensity[a]	(5) Intensity[b]
Landowners						
I	(23)	11.00	13.80	273.3	24.8	19.8
II	(22)	34.40	47.40	248.3	7.2	5.2
III	(11)	152.60	240.70	433.5	2.8	1.8
TOTAL	(56)	48.00	71.60	295.0	6.1	4.1
Sharecroppers	(60)	4.44	4.55	207.6	46.8	45.6

a. Column 3 ÷ 1

b. Column 3 ÷ 2

Table 8. Hired labor use on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Hired Labor (man/days)	(4) Intensity[a]	(5) Intensity[b]
Landowners						
I	(23)	11.00	13.80	147.0	13.4	10.7
II	(22)	34.40	47.40	532.5	15.5	11.2
III	(11)	152.60	240.70	1,805.8	11.8	7.5
TOTAL	(56)	48.00	71.60	624.3	13.0	8.7
Sharecroppers	(60)	4.48	4.55	32.5	7.3	7.1

a. Column 3 ÷ 1

b. Column 3 ÷ 2

Table 9. Total labor use on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Total Labor (man/days)	(4) Intensity[a]	(5) Intensity[b]	(6) Percent Family
Landowners							
I	(23)	11.00	13.80	420.3	38.2	30.5	65.0
II	(22)	34.40	47.40	780.8	22.7	16.5	32.0
III	(11)	152.60	240.70	2,239.3	14.7	9.3	19.4
TOTAL	(56)	48.00	71.60	919.3	19.1	12.8	32.1
Sharecroppers	(60)	4.48	4.55	240.1	53.6	52.8	86.5

a. Column 3 ÷ 1

b. Column 3 ÷ 2

Table 9 reflects total labor usage. Once again the data show a direct relation between farm size and the absolute amount of labor used. On the other hand, as farm size increases, the intensity of use decreases, Column 4. Column 6 provides an interesting insight into the composition of the labor force as size and ownership change. The contribution of family labor by Class I owners and sharecroppers represents a considerably larger portion of total labor used on the farm than does this measure for medium and large landowners. This would suggest that although the total family labor contribution across groups is similar, the nature of this input changes. The smaller farmer is supplying a larger amount of physical labor, while the medium and large owners provide more administrative input.

Capital

Capital is the third general factor of production to be considered. For the purposes of this study, this measure has been divided into four categories. These are:

a. fixed capital, including the value of houses, buildings and various fixed improvements to the land;

b. machinery capital;

c. animal capital;

d. cash production expenses.

Fixed capital, as illustrated in Table 10, once again reflects the phenomenon of absolute value increasing directly with size while an intensity per hectare decreases with size, Columns 3 and 4. Note should be taken of the mean value reported by sharecroppers, Cr. \$22.5. The median value for this variable was only Cr. \$0.50, reflecting the fact

Table 10. Fixed capital use in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Fixed Capital (Cr. $)	(4) Intensity[a]	(5) Intensity[b]
Landowners						
I	(23)	11.00	13.80	5,471.60	497.4	396.5
II	(22)	34.40	47.40	11,594.30	337.0	244.6
III	(11)	152.60	240.70	34,370.90	225.2	142.8
TOTAL	(56)	48.00	71.60	13,553.60	282.4	189.3
Sharecroppers	(60)	4.44	4.55	22.45	5.1	4.9

a. Column 3 ÷ 1

b. Column 3 ÷ 2

that sharecroppers do not have the equity or the security of tenancy required to initiate capital improvements.

Machinery capital, Table 11, varies directly with farm size in absolute terms. The intensity of use, however, is somewhat misleading. Class I owners reported a mean value of Cr. $935.00. This value includes two farms who reported pickup trucks. The high values for these two units seriously distorts the mean value. Note that the median value is only Cr. $75.00. If the atypical cases were excluded, then equipment used per area would vary directly with farm size. By eliminating these two cases, average machine capital for Class I owners falls to Cr. $101.0.

Sharecroppers reported an average of Cr. $27.70 worth of equipment. This consisted entirely of hand tools, principally hoes, axes, and billhooks. Interestingly enough, this exact same figure was reported by Johnson (1971) in his study conducted five years earlier in a different region.

Total animal capital, Table 12, increases directly with size, corresponding to the previously mentioned tendency for large farmers to raise more livestock. There is a quality change within this increase as well. Sharecroppers and small farmers tend to have few cattle and more poultry, sheep, goats, pigs, and other small animals, while large landowners have relatively few small animals.

The final capital measure to be considered is cash production costs, Table 13. As with machinery capital, this measure is characterized by extreme variability for Class I owners. One of the components of this measure was machinery expense, and the two Class I owners reporting pickup trucks also reported abnormally high costs.

Table 11. Machinery use in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Machine Capital (Cr. $)	(4) Intensity[a]	(5) Intensity[b]
Landowners						
I	(23)	11.00	13.80	935.0	85.0	67.70
II	(22)	34.40	47.40	1,360.4	39.5	28.70
III	(11)	152.60	240.70	10,265.9	67.3	42.70
TOTAL	(56)	48.00	71.60	2,935.0	61.1	40.99
Sharecroppers	(60)	4.44	4.55	27.7	6.2	6.10

a. Column 3 ÷ 1

b. Column 3 ÷ 2

Table 12. Animal capital use on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Animal Capital (Cr. $)	(4) Intensity[a]	(5) Intensity[b]
Landowners						
I	(23)	11.00	13.80	2,671.5	242.8	193.6
II	(22)	34.40	47.40	9,942.4	289.0	209.8
III	(11)	152.60	240.70	39,790.0	260.7	165.3
TOTAL	(56)	48.00	71.60	12,819.1	267.1	179.0
Sharecroppers	(60)	4.44	4.55	380.0	85.6	83.5

a. Column 3 ÷ 1

b. Column 3 ÷ 2

Table 13. Cash production costs on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Production Costs (Cr. $)	(4) Intensity[a]	(5) Intensity[b]
Landowners						
I	(23)	11.00	13.80	715.7[c]	65.1	51.9
II	(22)	34.40	47.40	830.9	24.2	17.5
III	(11)	152.60	240.70	3,910.1	25.6	16.2
TOTAL	(56)	48.00	71.60	1,388.4	28.9	19.4
Sharecroppers	(60)	4.44	4.55	19.8	4.5	4.4

a. Column 3 ÷ 1

b. Column 3 ÷ 2

c. Median = 76

Finally, Table 14 presents a summary of the components of capital used in Missao Velha. The primary components are animal and fixed capital. Intensity of capital usage again illustrates the inverse relation with farm size.

All of the above measures of input use in agriculture do appear to be related to farm size. Specifically, cultivated area, exploited area, man-days labor per hectare, fixed capital, and total capital use per hectare are inversely related to farm size. The only measure that varies directly with farm size is machinery capital. Given the limited space and the relatively high population densities in Missao Velha, it is not surprising that smaller size farmers must use the limited land more fully than producers on large farms. Comparisons between sharecroppers and property owners are very misleading for all inputs used due to the lack of land and capital by sharecroppers. They are forced by circumstances to apply high levels of labor per hectare and to utilize a very high percentage of the land made available to them.

Based on the above measures of input usage, and recalling the problems associated within them identified in the text, we can state that a land reform, redistributing land from the large landowners to the small farms would encourage more intensive agricultural practices. The focus of our attention must now turn to the relationships between output and farm size.

Table 15 presents production data as reported during the agricultural year 1971-72. The area measurements, Columns 1-4, are reported in hectares, and are the same as reported in Table 6. Column 5 reports crop production during the year, and is presented in Cruzeiros.

Table 14. Total capital use on farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Producing Area (ha.)	(2) Total Area (ha.)	(3) Total Capital (Cr. $)	(4) Intensity[a]	(5) Intensity[b]	(6) Percent Fixed	(7) Percent Machinery	(8) Percent Capital	(9) Percent Cash Production
Landowners										
I	(23)	11.00	13.80	9,798.3	890.7	710.0	55.8	9.5	27.3	7.3
II	(22)	34.40	47.40	23,728.0	689.7	500.6	48.9	5.7	41.9	3.5
III	(11)	152.60	240.70	88,336.8	578.8	367.0	38.9	11.6	45.0	4.4
TOTAL	(56)	48.00	71.60	30,696.1	639.5	428.7	44.2	9.6	41.8	4.5
Sharecroppers	(60)	4.44	4.55	450.0	101.3	98.8	5.0	6.2	84.5	4.4

a. Column 3 ÷ 1

b. Column 3 ÷ 2

Table 15. Production and productivity of farms in Missao Velha, by producer groups, 1972.

Class and Number of Observations		(1) Crop Area (ha.)	(2) Pasture Area (ha.)	(3) Producing Area (ha.)	(4) Total Area (ha.)	(5) Crop Production (Cr. $)	(6) Livestock Production (Cr. $)	(7) Total Production[a] (Cr. $)	(8) Crop Yield[b] (Cr.$/ha)	(9) Livestock Yield[c] (Cr.$/ha)	(10) Production Per Producing Area[d] (Cr. $/ha)	(11) Production Per Total Area[e] (Cr. $/ha.)
Landowners												
I	(23)	8.10	2.9	11.00	13.80	3,007.6	1,757.5	4,765.1	371.3	606.0	433.2	345.3
II	(22)	17.70	16.7	34.40	47.40	5,120.1	4,914.5	10,034.6	289.3	294.3	291.7	211.7
III	(11)	51.20	101.4	152.60	240.70	18,950.6	14,867.6	33,818.2	370.1	146.6	221.6	140.5
TOTAL	(56)	20.40	27.6	48.00	71.60	6,969.2	5,572.96	12,542.2	341.6	201.9	261.3	175.2
Sharecroppers (60)		4.44	--	4.44	4.55	1,699.0	357.8	2,056.8	382.6	N.A.	463.2	452.0

a. Columns 5 + 6
b. Column 5 ÷ 1
c. Column 6 ÷ 2
d. Column 7 ÷ 3
e. Column 7 ÷ 4

Crop production in Missao Velha typically consists of several "associated" crops gorwn together in the same field. There are few isolated crops produced, sugar cane being the primary example. In order to avoid double counting of land used for production, the questionnaire sought to identify the area of plantings as a group. Hence, a cultivated area of 3.5 hectares (8.4 acres) might include some combination of cotton, corn, beans, rice, and manioc, and not 3.5 hectares of each individual crop. Data do not exist concerning the actual area occupied by a single crop within the associated field; consequently, it is necessary to discuss output in terms of cash value per hectare. Total production, Column 7, is the sum of crop and livestock values. Columns 8-11 report output per hectare in various manners. Column 8 shows crop value per cultivated area. This measure decreases considerably from Class I to Class II farms, and then increases by the same amount. The increase in production per hectare in Class II is due almost exclusively to the production of sugar cane. The production of sugar cane, which had previously eliminated eight of the Class III owners from the analysis provides gross returns per area far in excess of food crops and cotton. It is primarily a crop produced by the largest landowners on a different soil type, and clearly affects this productivity measure.

Livestock yield per pasture area is expressed in Column 9. As can be noted, it drops off considerably as farm size increases. The smaller farms reported a higher concentration of livestock on their small land base, 2.9 hectares, compared with the large pasture area reported by Class III owners, 101.4 hectares. While the value of livestock only increases seven times, the pasture area increases 30 times.

Total production per exploited area, Column 10, presents a measure of production efficiency. It presents a definite inverse relation between farm size and output per exploited area. The final column is a measure of farm efficiency since it considers total farm hectares. Since output per cultivated hectare showed an inverse relation with size, this measure also would be expected to show an inverse relation and indeed it does.

Summary and Conclusions

Agricultural production in Missao Velha is inversely proportional to farm size. Furthermore, intensity of input usage varies inversely with size. This result is significant in terms of estimating the effects on output that might be caused by a land redistribution. It implies that output should increase for two reasons. One, a more intensive use of the factors of production, especially land, and two, an increased output per hectare from smaller farms. The descriptions in this section additionally serve as a test of the hypothesis that there are incentives to ownership. Incentives to ownership might suggest that owners are more productive than sharecroppers. The results, however, do not support this hypothesis. Sharecroppers produce more per hectare than do property owners. This higher output per area appears to be due to the higher use of labor on the available land base. If incentives to ownership were measured in terms of output per labor unit, then the opposite conclusion is reached. Output for sharecroppers is Cr. \$8.6/man-day while for all landowners this figure is Cr. \$13.6/man-day. Thus it remains inconclusive whether, in fact, incentives to ownership exist. It is apparent, however, that output per hectare is greater on the smaller farms and decreases as size increases. Further insight into this question could be obtained by studying net returns for the various producer groups.

CHAPTER 4

FUNCTIONAL ANALYSIS OF AGRICULTURAL PRODUCTIVITY IN MISSAO VELHA

The hypothesis raised in Chapter 2, that no economies of size exist in the sample farms in Missao Velha, will be considered in this chapter. Additionally, further insight into agricultural production process in the study area will be provided. The structure of this chapter will consist of four parts: a general discussion of production function analysis, the empirical tests conducted, a further description of agriculture in Missao Velha, and finally the results and conclusions of the chapter.

Production Functions[4]

One of the most useful methods available to economists for the study of production relationships is the concept of the production function. A production function is a schedule, table, or mathematical formula which describes the relationship between inputs used in the production process and the resultant output. In general, a mathematical formula for a production function is expressed as:

$$Y = f\ (X_1,\ X_2,\ .\ .\ .\ X_n)$$

---

4. This discussion will extract relevant points from general production theory. For a complete discussion of production economies, see Carlson (1956) or Heady (1961). Agricultural products function analysis is covered quite well in Heady and Dillon (1963).

This equation represents an attempt to specify all of the factors of production (within the parentheses) which contribute to the magnitude of Y, or output. This general form for the production function, however, does not express the amount or direction that Y varies as inputs X_1, X_2, . . ., X_n are varied. In order to express quantitative relationships, the production function must be expressed in algebraic form. The algebraic form to be used in this analysis, the Cobb-Douglas or power function, will be discussed below.

Knowledge of the relationships expressed within production functions are useful to researchers, policymakers and laymen in many areas of study. Predictions of commodity supplies are often based on production function analysis, as are decisions regarding profit maximization within a firm. The allocation of scarce resources to their most productive uses is also facilitated by knowledge of production relations. This study proposes to use the information developed by empirical analysis of agricultural production for descriptive purposes. Attempts to understand the structural relationships of agricultural production in Missao Velha will help estimate output response to changes in input usage. Specifically, three important relationships are contained within the production function are useful in describing input-output relationships. These are the average product, the marginal product, and the elasticity of production.

The first of these measures, the average product or the average productivity, refers to an input. It is calculated by dividing the total product produced at a certain level of input use by the amount of that input, or Y/X_i where Y is total product and X_i is the amount of the "*ith*" input. In Table 15, for example, the average product of an hectare (2.4 acres) of cultivated land in Missao Velha was presented in Column 8. The second measure, marginal product or marginal productivity, also refers to input usage. In this case it measures the marginal or additional product resulting from the use of one more unit of input. It is measured as $\frac{\partial Y}{\partial X_i}$ or the change in Y caused by a change in X_1. The final measure included in this discussion is the elasticity of production, or production coefficient (E_p). As with any "elasticity" concept in economics, this measures sensitivities. In this case, it relates the response of output to changes in input use and is expressed as:

$$E_{p_i} = \frac{\partial Y}{\partial X_i} \cdot \frac{X_i}{Y} \quad \text{or} \quad \frac{MP_{xi}}{AP_{xi}}$$

The elasticity of production is useful for determining economies of size which exist in the production process. A production function with a sum of the individual elasticities of production, ΣE_{p_i}, equal to one exhibits constant returns to changes in inputs. A one percent increase in all inputs yields a one percent increase in output. Correspondingly, an elasticity of production of less than one implies decreasing returns to size, while an $\Sigma E_{p_i} > 1$ implies increasing returns to size. With this general understanding of production functions, discussion now turns towards the algebraic model used in this study.

The algebraic model of the production function chosen for use in the subsequent analysis is known as the Cobb-Douglas function, and is expressed in general form as:

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3} \dots X_n^{b_n}$$

where, as we have seen, Y refers to output and $X_1, X_2, \ldots X_n$ refers to the various inputs utilized. This function, while curvilinear in whole numbers, is linear in logarithmic form, and thus the technique of ordinary least squares regression analysis can be applied to estimate "a" and the various "b's." This function is useful for several reasons. It provides a compromise between: (a) adequate fit of the data; (b) compilational feasibility; and (c) sufficient degrees of freedom for statistical testing. Furthermore, the Cobb-Douglas function allows easy interpretation of the elasticity of production, making this function ideal for analysis of returns to scale. The exponents in the Cobb-Douglas production function are the elasticities of production for the individual inputs. This can be shown easily for the one variable case:

$$Y = aX^b \tag{1}$$

the marginal physical product of X_1 in this case is:

$$\frac{\partial Y}{\partial X} = baX^{b-1} = \frac{bax^b}{x} \tag{2}$$

When equation (2) is multiplied by the inverse of the average product, equation (3) is arrived at:

$$E_p = \frac{b(aX^b)}{X} \cdot \frac{X}{Y} \tag{3}$$

If we substitute the value of Y from equation (1) into equation (3), we have:

$$E_p = \frac{bY}{X} \cdot \frac{X}{Y} \tag{4}$$

Simplifying equation (4) leaves the elasticity of production equal to the exponent, "b."

Hypothesis Test and Results

The model used for testing the hypothesis of constant returns to scale in agricultural production in Missao Velha is:

$$Y = aX_1^{b_1} X_2^{b_2} X_3^{b_3}$$

The hypothesis to be tested is that the exponents in this equation, the elasticities of production, sum to one. If the "b's" sum to greater than one, then increasing returns to size are implied. This would suggest that a possible land reform create larger scale producing units. If the sum of the exponents is less than one, then decreasing returns to size are implied with the opposite implications for a land reform. Constant returns to size would imply that large and small farms are both economically efficient, under the existing technology. The hypothesis to be tested in this chapter is, formally, that the exponents sum to one (Knenta, 1971):

$$H_O: \sum_{i=1}^{3} b_i = 1$$ versus the alternative hypothesis,

$$H_A: \sum_{i=1}^{3} b_i \neq 1$$

An aggregated form of the production function was chosen for the analysis. The equation has one dependent variable, total gross output, and three independent variables: producing land, labor, and capital services. Land, X_1, is the sum of cultivated and pasture areas as defined in Chapter 3 of this study. Labor, X_2, is the sum of the reported values for family labor and hired labor, also defined in Chapter 3. The third independent variable, X_3, represents the contribution of several forms of capital to the production process. It is the sum of fixed capital, machine capital, animal capital, and cash production costs and is expressed in value terms. This aggregation of various capital measures is consistent with Heady and Dillon (1963, p. 629) and is approximately equal to "capital" in a conventional tripartite classification. Care is needed in the interpretation of these three variables, however, since they are all aggregated measures. Normally, an elasticity of production coefficient for an input, say land, indicates how much production will change due to a one percent increase in that variable, holding other inputs constant. In this case, all of the component parts of the input, e.g., cultivated and pasture land, would have to increase in exactly the same proportion, again, with the other inputs held constant.

During the preliminary analyses, several estimates of the production function were computed with various levels of input aggregation. The final form of the function used here was chosen over others for several reasons. One was the goodness of fit or R^2 of the equation. The R^2 statistic measures the percentage of the variation in the dependent variable, output, accounted for by the independent variables, land, labor, and capital. Although a high R^2 does not prove causality between independent and dependent variables, it is, nevertheless, a desirable characteristic of an equation. The significance level of the regression equation was a second criterion for selection of the aggregated model. A low significance level, as expressed in the F statistic, suggests that the equation is essentially no better than any other equation in clarifying the relationships embodied in the function. A third criterion for selection was the sign and significance levels of the coefficients of the independent variables. A negative value would suggest that the removal of that input from production, in this case a bundle of inputs, would increase output and, therefore, be rejected on a priori grounds. The significance level of the coefficient has precisely the same implications as the significance level of the equation. That is, if a coefficient is not significantly different from zero, then that input could effectively be removed from the production process without affecting the output. A fourth criterion for the selection of this aggregated function is consistency with other studies and personal observations as well as the ease of interpretation of the results. And finally, the aggregated form of the production function provides the maximum number of degrees of freedom for use in statistical tests.

The results of the least squares regression estimates of the production function for various producing groups in Missao Velha are presented in Table 16. All variables were converted to log base 10 for the computations. The first four columns present the values for the constant term, "a," (in log form) and the individual elasticities of production for land, b_1, labor, b_2, and capital services, b_3, with the respective standard errors of the estimates and the significance levels below. Column 5 is the sum of the individual elasticities of production. The hypothesis to be tested is that this figure be one, or not significantly different from one. A "t" test on the significance of difference between this sum and one that was conducted, and the figures in parentheses in Column 5 are the calculated "t" values. The R^2 and F values are presented in Columns 6 and 7. Estimates of the production function were developed for seven groups of producers. These are Class I landowners, Class II landowners, Class I and II landowners, Class II and III

Table 16. Production function estimates, by producer groups, Missao Velha, 1972.

Producer group and number of observations		Constant[a] (1)	Land[a] (2)	Labor[a] (3)	Capital[a] (4)	Σ b's (5)	R^2 (6)	F (7)
Landowners								
I	(23)	.62023	.19354	.46839	.40426	1.06619[b]	.7394	17.9646
		[.49570]	[.29379]	[.27578]	[.11189]	(.28720)[d]		
		(.226)	(.518)	(.106)	(.002)			
II	(22)	1.16330	.19237	.41015	.30710	.90962[b]	.6705	12.2083
		[.49337]	[.22588]	[.15399]	[.14973]	(.45340)[d]		
		(.030)	(.406)	(.016)	(.055)			
I + II	(45)	.85379	.19059	.40239	.38676	.97974[b]	.7658	44.6916
		[.27618]	[.12552]	[.12531]	[.08238]	(.12840)[d]		
		(.004)	(.137)	(.003)	(.000)			
II + III	(33)	1.11225	.23406	.17487	.45940	.86833[b]	.6264	16.2058
		[.50460]	[.18889]	[.18096]	[.17515]	(.97390)[d]		
		(.036)	(.225)	(.342)	(.014)			
TOTAL	(56)	1.04002	.21331	.23488	.44474	.89293[b]	.7571	54.0185
		[.29563]	[.12067]	[.13518]	[.09125]	(1.23060)[d]		
		(.001)	(.083)	(.088)	(.000)			
Sharecroppers	(60)	1.90533	.56929	.08683	.30009	.95621[b]	.6712	38.0966
		[.22935]	[.10902]	[.09563]	[.07458]	(.47900)[d]		
		(.000)	(.000)	(.368)	(.000)			
All Observations	(116)	1.79985	.31922	.26599	.21630	.80151[c]	.8002	149.5555
		[.17787]	[.08649]	[.08419]	[.04787]	(3.46590)[d]		
		(.000)	(.000)	(.002)	(.000)			

Table 16. (continued)

a. Figures in brackets are the standard errors of the coefficients. Figures in parentheses are the probability levels at which the coefficients would be accepted as significantly different from zero.

b. Not significantly different from one (1) at the 5% level.

c. Significantly different from one (1) at the 5% level.

d. Calculated t values.

landowners, all landowners, all sharecroppers, and finally all observations.

Initial examination of the seven functions presented in Table 16 is encouraging. The R^2, or coefficient of determination, is above .60 in all cases, and exceeds .75 in three instances. The regression coefficients all have, as expected, positive signs and are significant at the 90 percent level or above in most (67 percent) cases. The F statistic, expressing the significance of the regression equation, is also high in the majority of cases, ranging from 12.208 (df = 19) to 149.556 (df = 113). Thus the use of these estimates of the production function for agriculture is justified. The results and implications of these equations will be discussed below.

Returns to Scale

A primary reason for the use of the Cobb-Douglas form of the production function was the ease of interpretation of returns to scale. The hypothesis to be tested is that there are constant returns to scale among the sample units. The results of the hypothesis test are presented in Column 5, Table 16. In six of seven cases, the function coefficient was not significantly different from one at any common level of acceptance. The one case when the function coefficient was significantly different from one was with the function estimated for all 116 observations, when the sum was 0.80151. This value suggests decreasing returns to scale, a condition whereby the small farms are actually more efficient producers than the large farms. While this result does not confirm the hypothesis directly, it does serve to further the argument that small farms are an alternative to large farms. The hypothesis of constant returns to size is thus supported. This implies that a land reform could establish small scale producing units without a loss of technical efficiency.

The use of functional analysis of the production process allows an examination of aspects other than just the returns to scale question. The individual factor elasticities of production, the marginal productivities of the factors, and the average productivities of the factors may also be examined for additional insights into the structure and performance of the agricultural sector. These will be looked at individually below.

Elasticities of Production

An elasticity of production coefficient for an individual input expresses the percentage increase (decrease) in output that will result if the particular input is increased (decreased) by one percent, holding all other inputs constant. In the application of this concept to the data from Missao Velha, recall that each input is a package, and that an "increase" implies a proportional change of each component of the input.

The elasticity of production for land shows how production will vary as both cropland and pasture land are varied together. It is expected that agriculture dominated by crop production, as was typical on units farmed by sharecroppers, would show a larger response to changes in the land input than would agriculture dominated by extensive livestock production, e.g., Class II and III landowners. That this was the case in the present study is evident from Table 16, Column 2, where the Ep of land for sharecroppers is .569 versus an Ep of .234 for the larger landowners.

The elasticity of production for capital should show the opposite pattern, with a higher response in livestock enterprises. The explanation is that the more intensively the land is used, e.g., for crops, the smaller the expected response to "other services," or capital. Again, referring to the functions developed for sharecroppers and Class II and III landowners, this response is evident from the results of the Ep for capital.

The elasticity of production for the labor input does not show a pronounced pattern of response, either in theory or in the results of this study. An extremely low value for the Ep of labor vis-à-vis the Ep for land would suggest disguised unemployment and underemployment in agriculture (U. S. Department of Agriculture, 1968). This situation is exemplified in the case of sharecroppers. By doubling the cultivated area, holding labor and capital constant, output increases by more than 56 percent, while increased labor on the original land only increases output by 8 percent. Thus output could be increased by utilizing the same labor force on larger areas.

Marginal Productivities

The marginal productivity of an input measures the additional, or marginal, output resulting from the use of one more unit of the input, all other things held constant. In this study, it is expressed as marginal value product (MVP) since output is reported in monetary terms. In general, the MVP of an input depends on the level of that input already being used, and on the levels of the other factors of production utilized. In the Cobb-Douglas form of the production function, it is calculated at the geometric mean for all variables. If knowledge of the costs of each of the inputs is available, then an examination of production efficiency can be made, with the long-run optimum point being where:

$$\frac{\text{MVP labor}}{\text{MUC labor}} = \frac{\text{MVP land}}{\text{MUC land}} = \frac{\text{MVP capital}}{\text{MUC capital}} = 1$$

If the ratio between the marginal value product of an input to the marginal unit cost (MUC) of that input is less than one, it suggests that too much of the input is being used. If, conversely, the ratio is greater than one, too little of the resource is being utilized in the production process. With regard to the production functions developed for Missao Velha, this examination of efficiency can only be conducted on a general basis since accurate cost data are not available. Estimates of the prevailing wage rate as well as the opportunity costs of capital will allow a cursory examination of production efficiency with regard to these two inputs. Table 17 summarizes the MVP values for each of the producer groups.

Labor use by landowners appears to approach an economically efficient level. An approximation of the daily wage rate reported in the study was Cr. \$5.00, a value also reported by Biserra (1974). Class I and II landowners both closely approach this figure with their calculated marginal value products for labor of Cr. \$4.32 and Cr. \$5.34, respectively. The MVP of labor calculated for the larger farms, Cr. \$2.39, does not necessarily suggest disequilibrium labor usage. "Labor" for the larger

Table 17. Marginal value products, by producer groups, Missao Velha, 1972.

Producer group and number of observations		Land	Labor	Capital
		- - - - - - - - Cr. $[a] - - - - - - - -		
Landowners				
I	(23)	64.94	4.32	0.24
II	(22)	47.59	5.34	0.14
I + II	(45)	55.08	4.39	0.21
II + III	(33)	56.03	2.39	0.19
TOTAL	(56)	58.66	2.73	0.21
Sharecroppers	(60)	243.51	0.67	1.30
All Observations	(116)	110.34	2.51	0.33

a. At the time of the study, U. S. $1.00 equalled approximately Cr. $5.00.

farms includes contributions from three sources: family labor, hired labor, and sharecropper "labor days" (dias de sujeicao) which were compensated at a lower rate than the normal wage levels. Thus the average wage bill of the larger farms could well have been less than Cr. $5.00, although most probably not as low as the MVP of Cr. $2.39. In the case of landowners in Missao Velha, therefore, labor usage approximates economically rational levels.

The marginal value product for sharecropper's labor, Cr. $0.67, appears to fall far below the prevailing wage rate. This value suggests the Lewis (1954) and Ranis and Fei (1961) descriptions of agriculture under a surplus labor conditon, when the marginal product of labor is zero or near zero, and the superfluous workers could be theoretically transferred to the industrial sector without a production loss in agriculture. Given the aggregated nature of the labor input, however, as well as the omission of seasonal data, the surplus labor theory does not necessarily apply here. Mellor (1966, p. 159) suggests that problems of measurement and variability among observations, both present in the data from Missao Velha, does not allow normal statistical methods to "distinguish a labor productivity of zero from one near the wage rate" (Mellor, 1966, p. 159). In a further description of labor usage by farmers, he states:

> . . . families that control only small amounts of land are forced by subsistence pressures to move well out on the labor input function, gradually raising the average product of the stock of labor closer to the subsistence level. Concurrently, the marginal productivity of labor input is driven to a low level. In contrast, a family with control of a substantial amount of land per worker will be able to operate well back on the labor input schedule . . . Under these conditions, the

> marginal product of the last increment of labor will be well above zero (Mellor, 1966, p. 167).

The marginal value product of labor for sharecroppers in Missao Velha, while appearing to conform to the surplus labor hypothesis is most likely an example of the phenomenon described by Mellor (1966). Indeed, the questionnaire attempted to examine the labor situation, and shortages were reported by various producers during various seasons. This conforms with Johnson's (1971) observations of a sharecropping economy in another section of Ceara. Further implications of a possible labor shortage will be presented in the discussion of the marginal value product for land.

The marginal value product of capital appears to follow an opposite pattern than the MVP of labor. Sharecroppers appear to use capital efficiently, while property owners of all sizes exhibit irrational capital usage. Since the marginal value product of capital measures the additional output (in monetary terms) that is expected from the use of an additional unit of input (also in monetary terms) it is desirable for the MVP of capital to equal one plus the opportunity cost of capital -- e.g., what the capital could earn in the best alternative use. Assuming a bank interest rate of 6 percent to 10 percent in real terms, the MVP of capital would be expected to be somewhere in the neighborhood of Cr. $1.10 to Cr. $1.20. Although our measure of the marginal unit cost of capital is imprecise, it is clearly evident from Table 17 that in no case did the MVP capital for landowners exceed Cr. $0.24, while the same value for sharecroppers is Cr. $1.30, suggesting the use of too much of the input by landowners, and rational or slightly too little use by sharecroppers. Referring back to the definitions of the aggregated capital measure, however, this result is not at all unexpected. Capital for the sharecropper consists primarily of hand implements and small animals. It is unlikely that a sharecropper is going to invest in costly, long term forms of capital. This was not the case for property owners, however. The owners' capital measure included the value of houses for himself and his sharecroppers as well as some tools and machines that presumably supplied services to the sharecroppers in addition to the owner. The overcapitalization evidenced by landowners is also expected on the grounds of the conspicuous consumption argument.

The final marginal value productivity calculated is for the land input, more precisely cropland and pasture area. There are no accurate guides relative to the cost of land against which to compare the MVP of land, since in the study are there were almost no cash rentals. The results of the calculations of the marginal value productivities of land are presented in Table 17. It is clearly evident that while the property owners present a fairly consistent figure, ranging between Cr. \$47.6 and Cr. \$64.9, the value reported for sharecroppers is extremely high, Cr. \$243.5, in fact over five times as large as the smallest value. This extremely high MVP of land for sharecroppers suggests considerable gains could be forthcoming if the landowner permitted the sharecropper to use more land -- or to seek more sharecroppers. The specific reasons why this does not occur were not sought in this study but are, the author feels, intimately related to both the seasonal labor shortages discussed previously, and the techniques of agricultural production itself.

Crop production on the farm units in Missao Velha is labor intensive. The landowner or his administrator generally feels a need to supervise the activities of the laborers. Thus an increase in either the number of sharecroppers, or an increase in the cultivated area per sharecropper, requires additional supervision, creating perhaps a disutility or a diseconomy to size. This aspect could limit the land available to a sharecropper, even in light of the high MVP of land. Another important reason for this condition relates to the low technical level of production. Typically a field will be cleared and farmed intensively for about three years, less intensively for about two years more, then allowed to lie fallow for, hopefully, ten years (Nicholls and Paiva, 1966). Thus a sharecropper might be farming 5 hectares, but the landowner must allow 15 hectares, 5 in cultivation and 10 in various states of fallow or descanso. These two observations relate to the production aspect of the landowner-sharecropper system. There remain many noneconomic relationships that influence the production side and the resultant productivities and practices.

The patrao system is a system of exchanges. The sharecropper, as discussed in Chapter 3, receives security from the landowner. He returns, to the owner, security in the form of labor. A majority of the property owners responded that they have difficulty in securing adequate supplies of labor throughout the year. The landowner with the desire and conditions to support sharecroppers, will thus seek to have a basic resident labor force available throughout the year. In spite of the high MVP of sharecropper land, it may not be to the owner's benefit to cede additional land to the sharecropper for two reasons. First, the sharecropper would have less labor available for the landowner's benefit in the busy seasons. Secondly, if the sharecropper obtained an improved financial position in life, it is possible that he might migrate to either the South or to the newly opened areas in the Amazon, both realistic alternatives in Brazil. Thus the patrao, even in the face of the high potential gains from increasing the area farmed by sharecroppers, might rationally decide not to make available the extra land.[5]

The reasoning behind this digression includes one additional aspect of why a landowner might not desire additional sharecroppers, above the minimum amount necessary for his own needs. This is the cost associated with being a patrao. The landowner in the sertao does more than just provide land to the sharecropper. He must often act as godparent to a sharecropper's child, and in many cases raise the child in his own home. Medicines and medical help for the sharecropper's family are often made available either for free or as a loan from the landowner. The houses and repairs of sharecroppers' houses are provided at the owner's expense as is food in a time of need. These are provided so as to insure the minimum labor requirements during the busy season. These very real costs of being a patrao are partially captured in the survey and most likely contribute to the low MVP of capital for landowners.

Summary

This Chapter presented the mathematical formulation and results of the production functions utilized in the functional analyses of agriculture in Missao Velha. This discussion was followed by a test of the

5. In order to verify this argument, one additional important piece of information is needed, viz., the seasonal MVP's of labor used by landowners. Given this information and the appropriate input prices, the economic rationale of the argument could be tested.

second major hypothesis raised in Chapter 2. The hypothesis was that there are no economies of size in agriculture among the study farms. The results of the hypotheses tests clearly support the condition of constant returns to scale. Indeed, in one case, decreasing returns are implied. The possible effects on a land reform suggest that small farms could be created without loss of technical efficiency.

The analysis of marginal productivities conducted in this Chapter provided additional insight into agricultural and socioeconomic characteristics of the study area. Property owners appear to operate their production (exploracao direta) at near optimum levels for land and labor. The MVP calculated for labor was close to the approximate wage rate, while the MVP for land was fairly consistent across sizes. The marginal value product of capital for property owners appears to be quite low, suggesting too much capital usage. The apparent irrationality of capital usage includes an element of the cost of being a patrao. The owner finds it necessary to make considerable indirect investments in order to successfully operate with sharecroppers.

The sharecroppers, the other producer group analyzed, appears to be economically irrational in this usage of land and labor. Much of this, as has been shown, is beyond their control since the land is not theirs, and there are few alternative markets for their labor due to the constraints of the landowners "contracts." Capital use by sharecroppers appears to be rational, in that the marginal value product for capital is Cr. \$1.30 and it would be expected that the "cost" of this input should be Cr. \$1.10 to Cr. \$1.20. The MVP of sharecropper labor was extremely low, Cr. \$0.67, as would be expected. The low figure for labor MVP does not suggest the surplus labor hypothesis of Ranis and Fei (1961). Rather, it conforms to the seasonal labor shortage of Mellor (1966). As discussed in the Chapter, the seasonal labor shortage concept is further supported by the landowner's "irrational" capital usage. The final MVP figure discussed was for sharecropper land. This value, Cr. $243.5, suggests that considerable gains could be forthcoming if more land were used for production. Specific reasons for not allocating more land to sharecroppers were not sought in either the questionnaire nor the analysis. However, it was suggested that additional land was not allocated for two reasons. The first was related to the low technical levels of agricultural production. Because of the practice whereby a field is left fallow for up to 10 years, a landowner must base his allocation on an area three times as large as the cropped area. The second reason is related to the seasonal labor shortage condition. If the sharecropper is busy on his own fields, he won't have the labor required for the owner's field.

The entire agricultural structure, consisting of landowners and sharecroppers, appears to operate as a whole. Output gains from a land reform would be expected as returns on factors of production are equalized across farm sizes.

CHAPTER 5

SUMMARY AND IMPLICATIONS

The basic objective of this study was to examine the probable effects on agricultural output in Northeast Brazil that would be caused by a land reform measure. Attention was centered on quantifiable physical and economic characteristics of agriculture in Missao Velha, Ceara. Chapter II summarized the possible effects of a land redistribution predicated on four points. These are:

1. The relation between output and possible economies or diseconomies of scale in the agricultural sector.
2. The intensity of factor use between small and large farms.
3. The improved optimality of factor usage across farms.
4. The existence of incentives to ownership.

These four points led to the two hypotheses stated in Chapter II. The first hypothesis is that there are incentives to ownership; in other words, that landowners are more productive than sharecroppers. This hypothesis was tested through an examination of input/output ratios among the various producer groups. The second hypothesis is that there are constant returns to scale in agriculture in Missao Velha, Ceara. In order to test this hypothesis, least squares regression estimates of production functions for various producer groups were developed and tested for returns to size. These hypotheses tests were described in Chapters III and IV and results are summarized below.

Incentives to Ownership

The hypothesis of the existence of incentives to ownership implies that landowners will be more productive than sharecroppers. The results of the tests relating to this hypothesis are inconclusive and depend upon the variables selected. If incentives to ownership are defined as a higher average product for land, then sharecroppers showed higher productivity than did any class of landowner. The average product of capital also provides the same result. If, however, incentives to ownership are defined as the average product of labor, then landowners clearly are more productive than sharecroppers. Only one other study relative to Brazil attempts to estimate incentives to ownership of land; Cline (1970) also failed to confirm their existence. The failure to prove incentives to ownership does not preclude a possible land reform measure. Much of the higher average product of land for sharecroppers is due to the extremely high amount of labor per hectare resulting from a lack of alternatives. Higher total output and labor productivity is achieved on owner-operator farms.

Economies of Size

First, relative to economies of size, the production functions developed for seven producer groups all suggest either constant or decreasing returns to farm size. In only one case, Class I landowners, was the sum of the exponents of the Cobb-Douglas function greater than one, and this difference was not significant at normal acceptance levels. The implications of these results suggest that large farms are no more productive, and perhaps less productive, than smaller sized farms. A possible land reform which redistributes land from these extensive holdings to landless rural people and/or very small landholders will create technically viable producing units, given current production practices. The possible existence of economies of size is thus not a relevant argument against land reform involving farms greater than three hectares in the study area.

It is informative to compare this result with other studies relating to the world in general and Brazil in specific. Table 18, from Heady and Dillon (1963, p. 630), presents production functions for agriculture in various areas of the world. Although the production functions developed in this study are not crop specific as are those presented in Table 18, several comparisons may, nevertheless, be drawn. The first relates to the discovery of constant returns to scale in agriculture in Missao Velha. In the group of production functions from various countries, the sum of the production elasticities is nearly always close to one. Those few examples of increasing returns to size, i.e., with a sum of production elasticities significantly greater than one, are predominately in the developed countries, the United States, Japan, Norway, Australia, and the United Kingdom, while the lesser developed areas exhibit constant or decreasing returns to size. The existence of constant returns to size in the less developed countries is also noted by Dorner (1971) and Kanel (1967). A second comparison with the data from Heady and Dillon (1963) relates to the individual elasticities of production. Mention has been made that agriculture dominated by livestock production would tend to exhibit a lower elasticity of production for land, and a higher value for "other services," than an agricultural system dominated

Table 18. Production elasticities as estimated in 41 cross-sectional Cobb-Douglas production function studies.

Location of Sample	Function for	Elasticity of Production: Land Services	Labor Services	Other Services	Sum of Elasticities
United States, northern Iowa	corn	0.91	0.08	0.16	1.15
Japan, Honshu	sweet potatoes	0.85	0.29	0.00	1.14
Unites States, southern Iowa	corn	0.79	0.09	0.39	1.27
Japan, Hokkaido	rice	0.75	0.18	0.07	1.00
India, Andhra Pradesh	irrigated farms	0.57	0.14	-0.08	0.63
Japan, Honshu	rice	0.56	0.29	0.15	1.00
United States, Montana	wheat	0.50	0.04	0.58	1.12
India, Uttar Pradesh	wheat	0.50	-0.26	0.69	0.93
Norway, southeast	cereals	0.47	0.04	0.28	0.79
Taiwan, Tainan	cereals	0.44	0.33	0.31	1.08
New Zealand, Canterbury	sheep	0.42	0.15	0.54	1.11
United States, Alabama	crops	0.39	0.32	0.46	1.17
South Australia	dairy	0.39	0.25	0.54	1.19
Canada, Alberta	wheat, beef	0.39	0.20	0.34	0.93
India, Uttar Pradesh	sugar cane	0.37	0.69	0.03	1.09
Taiwan, Tainan	sugar cane	0.36	0.25	0.34	0.95
Sweden	mixed farms	0.35	0.05	0.57	0.97
India, Andhra Pradesh	dry farms	0.31	0.04	0.07	0.42
Japan, Honshu	tea	0.29	0.30	0.46	1.05
United States, Iowa-Illinois	crop-share	0.29	0.25	0.48	1.02
Australia, New South Wales	dairy	0.28	0.22	0.42	0.92
South Africa, Kalihari	cattle fattening	0.28	0.13	0.55	0.96
India, Uttar Pradesh	wheat, sugar cane	0.23	0.43	0.35	1.01

Table 18. (continued)

Location of Sample	Function for	Elasticity of Production			Sum of Elasticities
		Land Services	Labor Services	Other Services	
Norway, southeast	fodder	0.23	0.32	0.57	1.12
United States, Iowa-Illinois	livestock-share	0.23	0.18	0.53	0.95
Canada, Alberta	cattle ranches	0.20	0.37	0.39	0.97
South Africa, Kalihari	cow-calf ranches	0.19	0.19	0.52	0.90
India, Andhra Pradesh	mixed farms	0.14	0.26	0.13	0.53
Austria	mixed farming	0.13	0.26	0.61	1.00
Australia, New South Wales	sheep	0.10	0.59	0.55	1.24
United States, Iowa-Illinois	owners	0.09	0.17	0.73	0.99
Israel	mixed farms	0.03	0.25	0.80	1.08
Norway, southeast	beef cattle	--	0.42	0.79	1.21
United Kingdom, England	dairy	--	0.29	0.83	1.12
Western Australia	dairy	--	0.23	0.76	0.99
United States, Alabama	livestock	--	0.23	0.74	0.97
Norway, southeast	dairy	--	0.18	0.80	0.98
United States, southern Iowa	hogs, cattle	--	0.12	0.98	1.10
United States, Montana	cattle	--	0.08	0.94	1.02
United States, northern Iowa	hogs, cattle	--	0.08	0.91	0.99
Sweden	dairy	--	-0.05	1.23	1.18

Source: Heady and Dillon, 1963, p. 630.

by crop farms. This is precisely the case in Missao Velha if we compare sharecroppers versus Class II and III landowners. The results of this study are therefore comparable with general production functions for other areas of the world.

There are four studies relative to Brazil's Northeast with which this study will be compared. These are Nicholls and Paiva (1966), U. S. Department of Agriculture (1968), Cline (1970), and C.I.D.A. (1966). These four works range from the highly analytical studies by Cline and the U. S. Department of Agriculture, to the general descriptive investigations by C.I.D.A., and Nicholls and Paiva. With regards to economies of size in agricultural production, Cline, U. S. Department of Agriculture, and Nicholls and Paiva all discovered constant returns to scale in agricultural production. The C.I.D.A. study, which did not develop production functions, noted in Quixada, Ceara that the smallest farm was the most productive, followed by the largest. Note should be taken that only seven farms were sampled in the C.I.D.A. study, so generalizations from the results are questionable.

Cline (1970) estimated production functions for 18 combinations of states and products, and in only three cases were the sum of the elasticities significantly different from one. One case, Sao Paulo coffee, showed increasing returns to size while the other two, Sao Paulo cattle/general and Minas Gerais cattle, showed decreasing returns to size. The U. S. Department of Agriculture estimated Cobb-Douglas functions for total farm output, crops only and livestock only for Ceara and the rest of Brazil. Although they did not test for scale economies, an examination of the function coefficients shows them to be considerably distant from one only in the case of Ceara livestock, and this sum was .76, suggesting decreasing returns to size. The final estimate of production functions by Nicholls and Paiva (1966) was for the municipio of Crato, which is in the same region as Missao Velha. The results of their estimates also strongly support the hypothesis of constant returns to scale in agricultural production.

The production function estimates developed in this study appear to be compatible with other general and specific studies done both for the rest of the world and for Ceara. The results indicate that constant returns to size exist over a wide range of farm sizes in the agricultural sector of Missao Velha.

The marginal analysis of agricultural production, conducted in Chapter IV, provided interesting insights into socioeconomic conditions present in the study area. The seemingly inefficient economic performance of both landowners and sharecroppers appear to be more rational than just figures indicate. It is a response to a search for security with exchanges occurring between both sharecroppers and property owners. This finding is consistent with a seasonal labor shortage hypothesis as presented by Mellor (1966), as well as with descriptions by Johnson (1971) and C.I.D.A. (1966). Unfortunately, estimates of seasonal MVP's of labor are not available to permit vigorous testing of the hypothesis.

Implications

The objective of this work was to examine the performance of the agricultural sector with regards to a possible redistribution of agricultural land and the resultant effects on productivity. The results of this examination support a decision to redistribute land from the large latifundia to the landless peasants and sharecroppers as well as to small family-sized farms. Such a redistribution would have output increasing effects. Smaller owner-operated farms are more productive than larger farms with regards to use of land, labor, and capital.

This recommendation, however, is made with several important qualifications. First, this study has not determined the optimal size for a farm unit in Brazil or the Northeast. It only suggests that smaller farms, of the range of 3.0 to 25.0 hectares are more productive than are larger farms. Second, this work assumes a constant technology. If new conditions are present, which would affect the current levels of input usage, then these conditions might not hold. Third, there has been no effort in this study to answer the question of rural poverty. The creation of small farms will not, by itself, remove peasants from the ills of poverty. The acceptable level of poverty is a social and political question. Land reform will create an opportunity to reassess the conditions of the rural poor and provide a possible means for correcting current problems. It doesn't necessarily have to do this, and this study does not provide guidelines to follow in handling rural poverty problems.

The final qualification relates to the nature of a possible land reform. While output would be expected to increase after a land redistribution, this would only be the case if the new farmers have access to all of the necessary inputs to agricultural production, such as credit, information, seeds, as well as an organized marketing structure to absorb the production. All of these factors are being met, to some extent, under the current system. The long-run success of a land reform policy will be measured by the incremental changes in the delivery of needed inputs and the marketing of increased output. Agriculture has an important contribution to make to the overall development process of an economy. A land reform measure promoting increased optimality of resources can be the trigger to stimulate the contribution.

APPENDIX A

LISTING OF ALL OBSERVATIONS

	Cultivated Land	Pasture Land	Family Labor	Hired Labor	Fixed Capital	Machine Capital	Animal Capital	Cash Production Costs	Production
	(- - - hectares - - -)		(- -man-days - -)		(- - - - - - - - - - - - Cr. $[a] - - - - - - - - - - - - - -)				
CLASS I LANDOWNERS									
1	5.0	6.4	200.0	50.0	7535	149.0	1652.5	42	2452.9
2	10.2	4.3	100.0	167.5	4500	28.0	6717.5	622	6774.3
3	15.1	2.0	410.0	250.0	10000	80.0	2650.0	66	7807.4
4	4.0	1.0	146.0	20.0	4262	22.5	207.5	45	1231.3
5	11.9	4.4	210.0	300.0	1900	83.5	4215.0	165	5996.0
6	7.2	0.0	182.0	15.0	7280	17.5	526.0	827	2038.0
7	6.0	0.0	439.0	0.0	1700	47.0	645.0	28	2501.8
8	11.1	9.9	725.0	504.0	8140	140.0	11532.5	179	8147.7
9	8.5	0.0	387.5	135.0	6210	385.5	1500.0	250	4235.6
10	3.6	8.4	29.0	300.0	850	6.0	226.0	40	1055.3
11	14.0	0.0	482.5	232.5	21200	80.0	4830.0	183	4679.0
12	4.8	4.2	113.0	10.0	1050	37.5	419.0	71	2042.4
13	4.3	3.0	150.0	163.0	4775	15.0	160.0	53	2769.3
14	3.5	1.2	265.0	0.0	1950	18.0	785.0	19	1931.0
15	5.0	5.0	309.5	4.0	1750	147.0	436.5	76	1748.6
16	7.5	1.5	124.0	125.0	10000	6.0	185.0	52	1964.3
17	2.3	3.0	150.0	0.0	200	10.0	17.5	0	331.4
18	6.5	0.5	468.0	0.0	5600	225.0	1065.0	85	3285.9
19	3.5	1.5	60.0	99.0	100	75.0	37.5	56	829.3
20	11.0	7.0	470.0	200.0	2050	74.0	1297.5	728	13419.3
21	22.1	0.0	300.0	675.0	12950	9257.5	13375.0	5446	11743.0
22	3.5	0.4	280.0	40.0	9200	556.0	2765.0	546	11006.0
23	16.2	2.0	285.0	90.0	2645	10045.0	6200.0	6882	10888.0
CLASS II LANDOWNERS									
24	20.0	8.0	235.0	800.0	5500	18.0	4555.0	89	11409.6
25	29.5	21.0	280.0	987.0	11355	197.5	34040.0	1846	30697.2

	Cultivated Land	Pasture Land	Family Labor	Hired Labor	Fixed Capital	Machine Capital	Animal Capital	Cash Production Costs	Production
	(- - - hectares	- - -)	(- - man-days	- -)	(- - - - - - - -	- - - - - - Cr. $[a]	- - - - - - - -	- - - - - - - -	- - - - - - -)
26	6.5	21.7	260.0	266.0	4840	176.0	14100.0	239	5469.6
27	14.6	0.0	200.0	400.0	17890	5057.0	8560.0	3741	5763.0
28	25.4	12.1	938.0	412.0	18880	133.5	7800.0	523	8034.0
29	6.0	15.0	60.0	18.7	2050	32.5	86.0	33	614.3
30	34.3	9.0	297.5	560.0	13800	1795.0	3570.0	1354	10448.3
31	14.0	8.0	0.0	268.8	5400	77.5	920.0	240	4491.4
32	54.0	0.0	345.0	435.0	33320	1980.0	7047.5	170	7117.9
33	20.0	10.0	425.0	210.0	9150	5770.0	6805.0	3286	11191.4
34	15.0	12.0	300.0	556.0	3500	396.0	20375.5	1444	10102.6
35	18.0	26.0	382.5	650.0	8190	279.5	7300.0	198	4541.4
36	7.8	0.0	30.0	350.0	5300	75.0	4160.0	128	4822.4
37	14.5	16.5	227.5	1018.0	13500	51.5	30155.0	251	10713.6
38	11.2	20.5	240.0	427.5	10060	77.5	10586.0	209	10121.8
39	6.9	54.6	65.0	330.0	8750	6510.0	21850.0	1456	14269.0
40	12.2	6.0	120.0	100.0	7080	18.0	7430.0	164	7699.9
41	27.1	1.9	120.0	2510.0	7200	310.0	0.0	310	14736.0
42	7.8	14.0	18.0	57.5	4420	47.5	515.0	248	3542.2
43	7.3	14.0	320.0	24.0	4000	42.0	1027.0	356	4330.9
44	25.2	43.0	150.0	450.0	5710	120.0	0.0	270	9500.0
45	21.0	54.0	450.0	885.0	55180	6765.0	27850.0	1725	19362.6
CLASS III LANDOWNERS									
46	57.5	40.0	250.0	2400.0	86700	19315.0	50240.0	12252	64176.3
47	38.5	3.0	480.0	522.5	8450	735.5	14174.0	750	16614.0
48	51.0	99.0	325.0	328.0	12700	6.0	31310.0	695	32955.7
49	25.0	49.0	211.2	2015.0	14300	6716.5	19650.0	1084	1755.0
50	213.0	352.0	180.0	5650.0	58360	13300.0	62710.0	4566	61240.0
51	18.0	70.0	0.0	317.5	23600	37.5	13420.0	621	11995.3

	Cultivated Land	Pasture Land	Family Labor	Hired Labor	Fixed Capital	Machine Capital	Animal Capital	Cash Production Costs	Production
	(- - - hectares	- - -)	(- - man-days	- -)	(- - - - - - -	- - - - - - -	Cr. $[a] - - - - -	- - - - - - -	- - - - - - -)
52	3.5	12.0	320.0	150.0	3500	52.0	40575.0	228	18340.0
53	62.0	130.0	487.5	2050.0	40500	4960.0	33252.5	4541	60505.0
54	23.0	129.0	240.0	4262.0	15660	60335.0	91770.0	14864	21864.0
55	23.0	100.0	1255.0	700.0	49990	70.0	18945.0	120	32210.4
56	69.0	131.0	1020.0	1469.0	64320	7397.5	61645.0	3290	50344.3
SHARECROPPERS									
1	1.8	0.0	200.0	0.0	0	25.0	337.5	12	1159.5
2	3.7	0.0	244.5	0.0	0	35.0	175.0	14	1162.7
3	5.4	0.0	447.0	0.0	14	40.0	527.5	21	1724.1
4	7.8	0.0	422.5	10.0	0	27.0	330.0	12	2750.9
5	2.0	0.0	45.0	115.0	0	2.0	790.0	12	1575.0
6	3.7	0.0	98.0	37.5	360	20.0	208.0	12	1851.0
7	3.5	0.0	256.6	8.0	0	17.0	30.0	0	2002.6
8	4.3	0.0	72.0	0.0	0	5.0	515.0	20	1381.6
9	1.2	0.0	100.0	0.0	0	8.0	268.5	9	953.7
10	3.3	0.3	190.5	0.0	0	5.0	405.0	0	990.0
11	1.0	0.0	175.0	0.0	170	23.0	195.0	40	922.6
12	2.0	0.0	167.5	0.0	60	24.0	184.0	36	828.1
13	1.4	0.0	145.0	9.0	0	10.5	35.5	10	452.0
14	3.0	0.0	0.0	10.0	0	22.0	721.0	42	1777.3
15	1.8	0.0	49.8	0.0	40	26.0	260.0	30	691.4
16	9.0	0.0	325.0	48.0	0	13.0	420.0	38	2647.6
17	2.7	0.0	155.0	16.0	0	15.0	267.5	7	1868.0
18	1.2	0.0	165.0	0.0	0	13.0	150.0	0	633.9
19	1.3	0.0	80.0	0.0	70	14.0	160.0	3	940.6
20	1.2	0.0	105.0	4.0	0	20.0	175.0	4	2233.4
21	2.3	0.0	120.0	7.0	0	11.5	232.5	19	1510.1

	Cultivated Land	Pasture Land	Family Labor	Hired Labor	Fixed Capital	Machine Capital	Animal Capital	Cash Production Costs	Production
	(- - - hectares	- - -)	(- - man-days	- -)	(- - - - - -	- - - - - -	- - - Cr. $[a]	- - - - - -	- - - - - -)
22	7.0	0.0	367.5	30.0	0	20.0	520.0	13	2808.1
23	2.2	0.0	100.0	0.0	5	16.0	57.5	5	734.6
24	2.1	0.0	177.5	0.0	0	55.0	431.5	10	1717.8
25	5.2	0.0	300.0	0.0	0	24.0	652.5	36	3240.7
26	3.5	0.0	270.0	11.0	0	55.5	387.5	20	1276.4
27	3.6	0.0	377.5	0.0	20	62.5	297.5	21	1791.4
28	3.0	0.0	473.5	24.0	12	74.0	837.5	12	4005.7
29	4.8	0.0	305.0	110.0	2	27.5	282.5	22	3297.9
30	4.9	0.0	280.0	0.0	0	26.0	235.0	0	1435.4
31	3.7	0.0	328.5	48.0	18	42.5	405.0	8	820.0
32	2.3	0.0	130.0	80.0	0	11.0	200.0	0	508.0
33	3.8	0.0	197.5	30.0	43	60.0	1127.5	16	1644.3
34	1.5	0.0	28.8	0.0	0	0.0	22.5	13	530.3
35	1.2	0.0	248.0	0.0	0	5.5	287.0	11	726.9
36	3.1	0.0	150.0	12.0	62	6.0	182.5	4	760.0
37	4.1	0.0	120.0	17.0	0	4.0	450.0	22	849.0
38	6.5	0.0	110.0	20.0	0	50.0	493.0	255	4224.7
39	13.0	0.0	620.0	0.0	0	71.0	1035.0	20	2402.9
40	4.0	0.0	260.0	105.0	320	141.5	1253.0	20	2147.4
41	3.0	0.0	127.5	0.0	0	12.5	410.0	6	1364.7
42	4.8	0.0	206.0	20.0	20	15.5	365.0	14	2141.8
43	18.5	0.0	345.0	490.0	90	22.5	738.5	0	8546.4
44	5.0	0.0	325.0	27.0	0	30.0	199.0	5	928.0
45	3.2	0.0	172.5	36.0	16	16.5	752.5	8	2652.9
46	9.5	0.0	270.0	126.0	0	54.0	945.0	0	6908.3
47	2.2	0.0	80.0	0.0	0	18.0	155.5	12	750.9
48	2.1	0.0	112.5	0.0	10	13.5	100.0	14	485.1
49	2.0	0.0	80.0	0.0	0	13.5	0.0	0	269.0

	Cultivated Land	Pasture Land	Family Labor	Hired Labor	Fixed Capital	Machine Capital	Animal Capital	Cash Production Costs	Production
	(- - - hectares - - -)		(- - man-days - -)		(- - - - - - - - - - - - - Cr. $[a]				- - - - - - - - - - - - - -)
50	4.5	2.5	161.5	18.0	0	28.5	479.0	19	1345.1
51	2.9	0.0	80.0	0.0	0	15.0	200.0	34	1488.0
52	1.6	0.0	67.5	0.0	0	10.0	42.5	15	566.0
53	4.0	0.0	219.0	0.0	0	25.0	208.0	12	1396.2
54	5.9	0.0	318.0	0.0	10	87.5	335.0	38	1585.0
55	2.0	0.0	175.0	0.0	0	37.5	200.0	14	787.9
56	7.5	0.0	25.0	216.0	0	55.0	332.5	14	2432.1
57	6.6	0.0	367.5	0.0	5	9.5	405.0	58	3194.3
58	8.1	0.0	187.5	7.0	0	43.5	179.0	6	1596.3
59	2.4	0.0	207.0	0.0	0	5.0	667.5	8	1217.4
60	27.2	0.0	525.0	260.0	0	20.0	540.0	62	18776.7

a. At the time of the study, U. S. $1.00 equalled approximately Cr. $5.00.

LIST OF REFERENCES

Adams, Dale W. "Aid Agencies and Land Reform in Latin America: A Suggested Change in Policy," Land Economics, Vol. XLVI, No. 4, Nov. 1970, pp. 423-434.

Anderson, Ray and Sandoval Cavalcante Rodrigues. "Ups and Downs of Cattle Weights in Ceara, Brazil," Progressive Agriculture in Arizona, Vol. XX, No. 1, January-February, 1968, pp. 10-12.

Barraclough, S. and A. Domike. Agrarian Structure in Seven Latin American Countries. Madison: Land Tenure Center, University of Wisconsin-Madison. LTC Reprint No. 25, 1966.

Biserra, Jose Valdeci. "Uso e Impacto de Credito na Productivadade dos Insumos, e a Alococao dos Fatores de Producao na Agricultura," Municipio de Missao Velha (Ce.), 1971/72. Brasilia: Ministerio de Agricultura, SUPLAN, EAPA, 1974.

Carlson, Sune. A Study on the Pure Theory of Production. New York: Kelley and Millman, Inc., 1956.

C. I. D. A. Land Tenure Conditions and Socioeconomic Development of the Agricultural Sector of Brazil. Washington, D. C.: Pan American Union, 1966.

Cline, W. R. Economic Consequences of a Land Reform in Brazil. Amsterdam: North-Holland Publishing Co., 1970.

Convenio Governo Do Estado; Fundaca IBGE. Atlas Do Ceara. Rio de Janeiro: Instituto Brasileiro de Geogriafia, 1973.

Dorner, Peter. "Needed Redirections in Economic Analysis for Agricultural Development Policy" In Land Reform in Latin America, Issues and Cases, P. Dorner, ed. Madison: Land Tenure Center, University of Wisconsin-Madison, 1971, pp. 5-19.

Dorner, Peter. Land Reform and Economic Development. Baltimore: Penguin Books, 1972.

Dorner, P. and D. Kanel. "The Economic Case for Land Reform" in Land Reform in Latin America, Issues and Cases, P. Dorner, ed. Madison: Land Tenure Center, University of Wisconsin-Madison, 1971, pp. 41-56.

Ferguson, C. E. Microeconomic Theory. Homewood, Illinois: Richard D. Irwin, Inc., 1969.

Freyre, Gilberto. The Masters and the Slaves (Casa grande e senzala). Translated from the 4th edition by Samual Putnam. New York: Alfred A. Knopf, Inc., 1946.

Furtado, C. The Economic Growth of Brazil. Berkeley: University of California Press, 1968.

Goodman, David E. and Roberto Cavalcanti de Albuquerque. A Industrializacao do Nordeste. Vol. 1. A Economia Regional. Colecao Relatorios de Pesquisa, No. 6. Instituto de Planejamento Economico e Social. Ministerio de Planejamento e Coordenacao Geral. Rio de Janeior, Brazil, 1971.

Hayami, Y. and R. Ruttan. Agricultual Development: An International Perspective. Baltimore: The Johns Hopkins Press, 1971.

Heady, E. O. Economics of Agricultural Production and Resource Use. Englewood Cliffs: Prentice-Hall, 1961.

Heady, E. O. and J. L. Dillon. Agricultural Production Functions. Ames: Iowa State University Press, 1963.

Herrmann, Louis F. Changes in Agricultural Production in Brazil, 1947-65. Foreign Agricultural Economic Report No. 79. Washington, D. C.: U. S. Department of Agriculture, June 1972.

Hirschman, A. O. Journeys Towards Progress: Studies of Economic Policymaking in Latin America. New York: Twentieth Century Found., 1963.

Johnson, A. W. Sharecroppers of the Sertao. Economics and Dependence on a Brazilian Plantation. Stanford: Stanford University Press, 1971.

Kanel, D. "Size of Farm and Economic Development." Reprinted from Indian Journal of Agricultural Economics, Vol. 22, No. 2, April-June 1967. Madison: Land Tenure Center, University of Wisconsin, LTC Reprint #31, 1967.

Kanel, D. "Land Tenure Reform as a Policy Issue in the Modernization of Traditional Societies," In Land Reform in Latin America, Issues and Cases. P. Dorner, ed. Madison: Land Tenure Center, University of Wisconsin-Madison, 1971, pp. 23-35.

Knenta, J. Elements of Econometrics. New York: The MacMillan Co., 1971.

Land Tenure Center. Agrarian Reform in Brazil: A Bibliography, Part 1 and Part 2. Madison: Land Tenure Center, University of Wisconsin-Madison, Training and Methods Series #18 and #19, 1972.

Leftwich, R. H. The Price System and Resource Allocation. Hinsdale: The Dryden Press, 1970.

Lewis, W. A. "Economic Development with Unlimited Supplies of Labor," Manchester School of Economics and Social Studies, Vol. 22, May 1954, pp. 139-192.

Madden, J. P. Economies of Size in Farming. Washington, D. C.: Economic Research Service, United States Department of Agriculture, Agricultural Economic Report No. 107, 1967.

Mellor, J. W. The Economics of Agricultural Development. Ithaca: Cornell University Press, 1966.

Nicholls, W. H. and R. M. Paiva. Ninety-Nine Fazendas. The Structure and Productivity of Brazilian Agriculture, 1963, Chapter III, The Cariri Region of Ceara, Crato. Nashville: Graduate Center for Latin American Studies, Vanderbilt University, 1966.

Paiva, R. M., S. Schattan, C. F. T. de Freitas. Brazil's Agricultural Sector: Economic Behavior, Problems and Possibilities. Sao Paulo: XV International Conference of Agricultural Economists, 1973.

Patrick, G. F. Desenvolvimento Agricola do Nordeste. Relatorio de Pesquisa No. 11. Instituto de Planejamento Economico e Social. Ministerio de Planejamento e Coordenacao Geral., Rio de Janeiro, 1972.

Prado, C. The Colonial Background of Modern Brazil. Berkeley: University of California Press, 1971.

Ranis, G. and J. C. H. Fei. "A Theory of Economic Development," The American Economic Review, Vol. LI, No. 4, Sept. 1961, pp. 533-565.

Schuh, G. E. The Agricultural Development of Brazil. New York: Praeger Publishers, 1970.

Schultz, T. W. Transforming Traditional Agriculture. New Haven: Yale University Press, 1964.

Smith, A. The Wealth of Nations. New York: The Modern Library, 1937.

U. S. Department of Agriculture. Projections of Supply and Demand for Agricultural Products of Brazil. Published for U. S. D. A. by the Israel Program of Scientific Translations, Jerusalem, 1968.

Viner, J. "Cost Curves and Supply Curves," Readings in Price Theory, George J. Stigler and Kenneth E. Boulding, eds. Homewood, Illinois: Richard D. Irwin, Inc., 1952, pp. 155-176.

Warriner, D. "Land Reform and Economic Development" in Agriculture in Economic Development, C. K. Eicher and L. W. Witt, eds. New York: McGraw-Hill Book Co., 1964, pp. 272-298.

Wharton, C. R., ed. Subsistence Agriculture and Economic Growth. Chicago: Aldimore Publishing Co., 1969.