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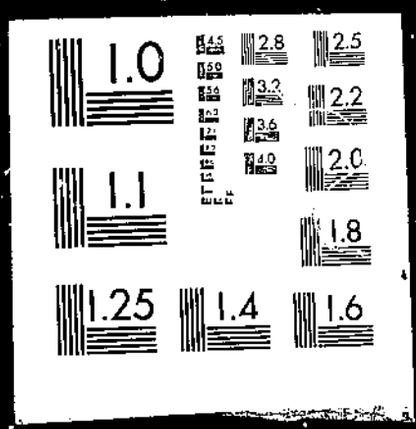
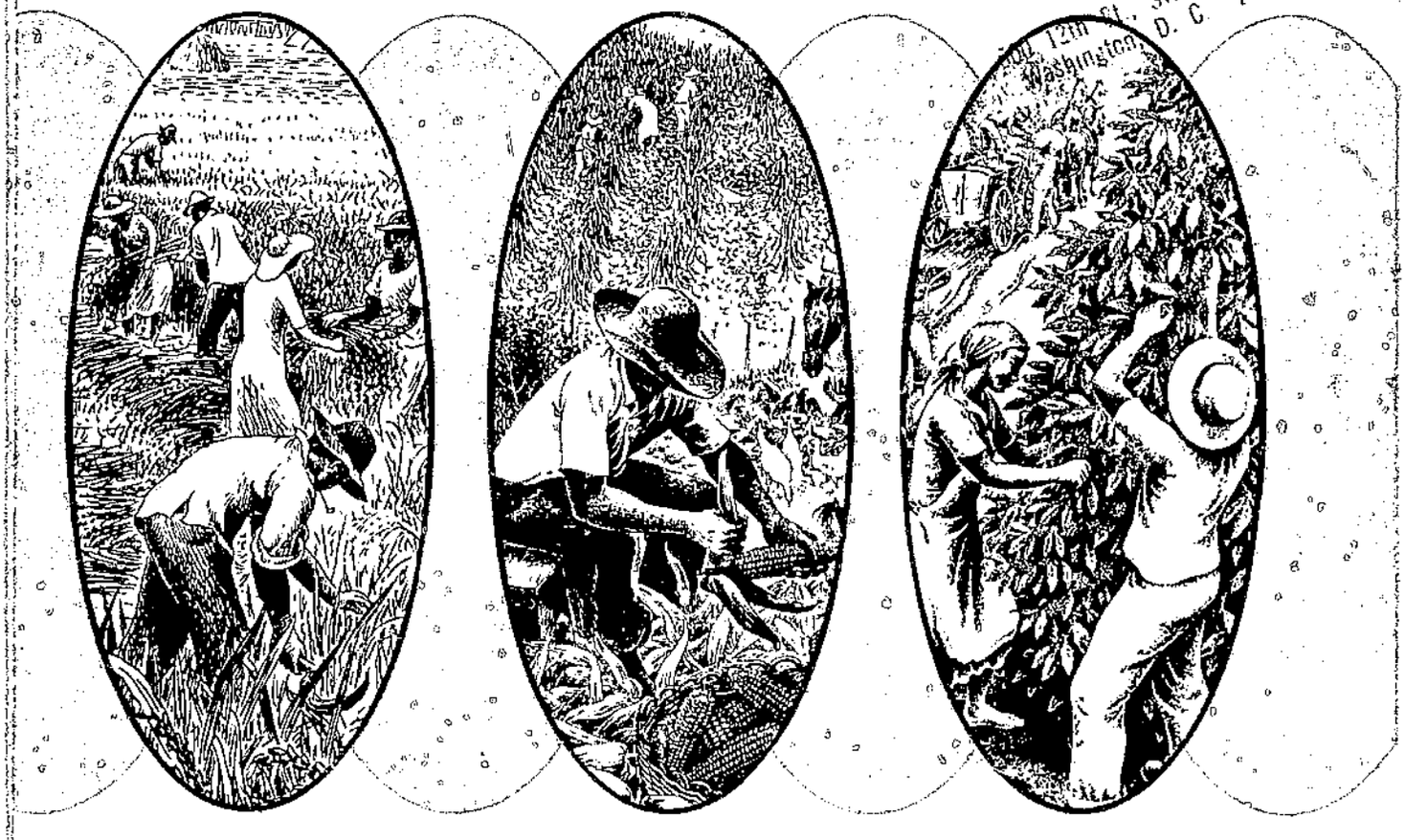


FOREIGN AGRICULTURAL ECONOMIC REPORT NO.79

Changes In Agricultural Production In Brazil, 1947-65



ECONOMIC RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE

ABSTRACT

Brazil increased agricultural output about 4.5 percent a year from 1947 to 1965, mainly by expanding the cultivated area, but it has the potential to double the area cultivated. Agricultural production grew more rapidly than population in the 1950's and 1960's, but crop yields remained low and traditional practices were followed with low levels of fertilization. Human labor is the only source of power on three-fourths of the farms. Agricultural output increased rapidly enough to meet rising demands for farm products resulting from population and income growth and to permit some exports. Agriculture has remained the principal economic activity and source of foreign exchange earnings in Brazil with coffee being the major export. The agricultural labor force rose about 2 percent a year, and output per farmworker rose almost as fast.

Keywords: Brazil, Economic growth and agriculture, Agricultural productivity, Technological progress.

CHANGES IN AGRICULTURAL PRODUCTION IN BRAZIL, 1947-65

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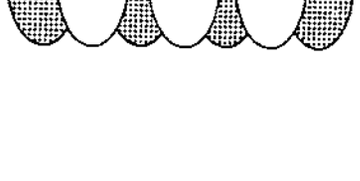

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U.S. DEPARTMENT OF AGRICULTURE
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FOREWORD

To provide better knowledge for planning and implementing country development programs, the Agency for International Development asked the Economic Research Service of the U.S. Department of Agriculture to conduct research on a project entitled "Factors Associated With Differences and Changes in Agricultural Production in Underdeveloped Countries."

The first phase of the research compared and analyzed rates of growth in agricultural output and factors affecting them. It was reported in ***Changes in Agriculture in 26 Developing Nations, 1948 to 1963,*** Foreign Agr. Econ. Rpt. No. 27, Economic Research Service, U.S. Department of Agriculture, November 1965. This was augmented by ***Growth of Crop and Livestock Output in Selected Developing Nations, 1948 to 1965,*** ERS-Foreign 226, Economic Research Service, U.S. Department of Agriculture, July 1968.

The second phase of the research, a part of which is reported here, involved a detailed analysis of the specific relationship between factors and processes of change in agricultural output in selected countries. Agricultural economists from the Economic Research Service, in cooperation with research organizations in each country, studied Greece, Taiwan, Mexico, Brazil, Colombia, India, and Nigeria. Their findings are summarized in ***Economic Progress in Agriculture in Developing Nations, 1950-68,*** Agr. Econ. Rpt. No. 59, Economic Research Service, U.S. Dept. Agr., May 1970.

Brazil's agricultural development is discussed in depth in this report with particular emphasis on the period 1947-65. Attention is focused on the relative contributions of area cropped, livestock numbers, and crop and livestock yields to the country's agricultural growth. From these analyses suggestions are made for facilitating further development. The significance of Brazil's experience to other countries is also evaluated.

Senior Agricultural Advisor
Bureau of Technical Assistance
Agency for International Development

PREFACE

This study considers factors related to changes in Brazil's agricultural output and productivity—the nation's great potential for expanding the area under cultivation, problems of soil fertility, conditions determining the balance between traditional and modern techniques, and general economic and cultural background. These aspects of Brazil's agriculture bear strongly on the country's future growth. Moreover, since many of these conditions prevail elsewhere in the world in varying degrees, the results of this study can also be used in planning agricultural and economic development programs in other developing countries, particularly those still having unused land for development.

Much of the work in Brazil was done under a memorandum of agreement between the Economic Research Service (ERS), the Getulio Vargas Foundation, the Ministry of Agriculture of Brazil, and the USAID Mission to Brazil.

The Getulio Vargas Foundation provided office space, professional and clerical assistance, and ready access to its accumulated knowledge of Brazilian agriculture. Special acknowledgment is due Julian Chacel, Director of the Brazilian Institute of Economics, Isaac Kerstenetsky, Director of Research, Sylvio Wanick Ribeiro, Chief of the Center for Agricultural Studies, and economists Ruy Miller Paiva and Mauro de Rezende Lopes, all of the Getulio Vargas Foundation. Economic assistants were Vera Maria Guido and Murilo de Gusmao. Pinto Lopes and Ida Prinzac compiled data and made various statistical analyses for the study.

University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, under contract with ERS, studied factors affecting productivity of the corn and hog enterprises in that State. Eli de Moraes Sousa, Head of the Department of Agricultural Economics, led the study. Alzemiro E. Sturm, rural sociologist, and Roger Johnson and Bernard Erven of the University of Wisconsin contract team at University of Rio Grande do Sul contributed importantly to the study's development and execution.

Rueben Buse, University of Wisconsin, under contract with ERS, carried out the statistical analysis of components of change in Brazil's agricultural output during 1947-55.

General guidance was provided by Raymond P. Christensen, formerly Director of the Foreign Development and Trade Division, ERS, and his predecessor in that position, Kenneth L. Bachman, under whose direction this work was carried out. Appreciation is extended also to L. Jay Atkinson, Chief of the Economic Development Branch; his predecessor, Wade F. Gregory; and the author's several colleagues in the overall project.

CONTENTS

TABLES

TABLES—Continued

FIGURES

SUMMARY

Brazil increased agricultural output during 1947-65 at the rate of 4.5 percent a year, mainly by expanding cultivated areas. Agricultural production grew faster than population, but crop yields were relatively stagnant and adoption of technology was slow. Human labor remained the only source of power on three-fourths of the nation's farms.

Agricultural output per capita increased about 1.5 percent a year, enough to meet rising demands for farm products resulting from population and income growth and to permit some exports. Products other than Brazil's traditional exports of coffee, cocoa, sugar, and cotton showed the greatest gains, especially in the 1960's.

Average yields of 24 crops increased 0.1 percent a year, but this average reflects the tendency of area planted to increase most where yields or prices or both tended to be above national averages. After adjustment for this tendency, average crop yield decreased 0.1 percent a year. Livestock output per animal unit showed a gross increase of 0.7 percent a year—1.4 percent after adjustment for changes in location and product patterns.

Production increased through more intensive use of farmland in States which had been settled longest, and through opening of new farms in frontier States. Value of agricultural output at 1957-59 prices doubled between 1947-49 and 1963-65. States which had been settled longest contributed 61 percent of the increase. Parana, the most important frontier State during this period, contributed 21 percent of the increase, and the remaining 18 percent was accounted for by the other frontier States. Their shares of output in 1947-49 were 86, 6, and 8 percent, respectively.

Increased crop areas and livestock numbers were made possible by average growth rates of 2 percent a year in the agricultural labor force, and 1.9 percent a year in labor productivity as measured by a composite of crop area and animal units per worker. Mechanization was a minor factor in the productivity increase—numbers of tractors and plows per 1,000 hectares of cropland averaging 2.2 and 35.9, respectively, in the last census in 1960.

Technological advancement has been slow in Brazil, although the rate of progress seemed to be increasing in the late 1960's. Fertilizer consumption remained essentially static from 1957 through 1966 at 9 to 10 kilograms of nutrients per hectare. For the most part, the profit margin from improved practices remained low, partly because production responses were generally low, and partly because of unfavorable price ratios. However, a number of technological innovations were introduced and spread rapidly. Soybean production, practically unknown in 1947, rose to 1 million tons in 1969, a growth rate of 21 percent a year from 1947 to 1965. New, improved varieties were becoming available and were also being adopted.

Brazil initiated or expanded a fairly complete list of public programs serving agriculture during the past two decades. But since these programs were on a relatively small scale or begun late in the period, their impact on output was relatively slight. Agricultural growth came largely from spontaneous efforts of the private sector, using the potential of virgin lands, private capital formation fully adequate for traditional technology, and a growing, mobile labor force. The resulting growth contributed relatively little to raising rural income in the older settled regions, especially among small farmers and landless workers.

CHAPTER I.—BACKGROUND

Brazil is slightly larger than the United States, excluding Alaska and Hawaii. It stretches 2,684 miles (4,320 kilometers) from north to south, and 2,689 miles (4,328 kilometers) from east to west. The southernmost point is as far below the Equator as Atlanta, Ga., is above it. The northernmost point is 5 degrees above the Equator. Brazil's 3.3 million square miles (8.5 million square kilometers) occupy almost half the area of the South American continent.

Natural Features

The principal physical features of Brazil are: (1) the littoral, a narrow strip about 20 to 40 miles wide along the coast from the border with Uruguay to the delta of the Amazon River, (2) the escarpment immediately back of the littoral, from which the land dips generally westward, (3) the Central Highlands, bounded sharply by the eastern escarpment and merging into the watersheds of the Amazon and the Paraguay-Parana Rivers, and (4) the Amazon Valley (fig. 1). Altitudes are generally below 3,000 feet (1,000 meters) except along the escarpment, and in some eastern portions of the Highlands. The highest point in the country is about 9,000 feet (2,890 meters) *(79)*.[1]

Topography of parts of the East and South is rough enough to put some limits on agriculture, even with traditional hand methods. Historically, the littoral and adjacent hill areas have supported commercial crops such as sugarcane, cocoa, and coffee; food crops were produced in rougher, marginal areas; and livestock production took place in the interior. In the future, as production methods shift from hand labor to machinery, rough topography may cause some land to be retired from crop production in the East and South. In the western portion of the Highlands and most of the Amazon Valley, topography is suitable for mechanized agriculture. However, there are bands of land along the Amazon and its tributaries where agricultural potential is low because of seasonal flooding.

Among Western Hemisphere countries, Brazil's crop yields tend to be average, or less (table 1). The soils of Brazil are mainly Latosols and Laterites, relatively low in natural fertility. Many are relatively unresponsive to known yield-increasing techniques (*113*, p. 415; *114*, p. 481). Limited areas of more fertile soils, notably in the States of Parana, Sao Paulo, and Rio Grande do Sul, are already developed agriculturally. According to a recently completed survey of the western portion of the Central Highlands and the Amazon Basin, most of this undeveloped area has good agricultural potential as far as soils, topography, and climate are concerned.

The climate of Brazil is generally tropical, but parts of the South are subtemperate, especially at higher altitudes. Rainfall over most of the country averages 40 inches or more annually. Rates of 30 inches or less are found in the area of the Northeast known as the Drought Polygon. The annual rainfall in the Drought Polygon is not only low, but irregular and unpredictable. During the past 20 years, there were at least two disastrous, widespread droughts in the Northeast, in 1951-53 and 1958.

[1] *Italicized* numbers in parentheses refer to Literature Cited, p.74.

Table 1.—Crop yields per hectare, Brazil and selected Western Hemisphere countries, 1965-67

Country	Rice (paddy)	Wheat	Corn	Beans	Cotton (lint)
			Kilos		
South America:					
Brazil	1,560	790	1,360	680	160
Argentina	3,660	1,260	2,100	1,010	260
Bolivia	1,650	760	1,210	680	---
Chile	2,760	1,550	3,400	1,090	---
Colombia	2,030	970	930	550	500
Ecuador	1,630	960	640	500	250
Paraguay	2,470	1,100	1,230	680	210
Peru	4,030	950	1,640	890	560
Uruguay	3,350	970	570	680	210
Venezuela	2,010	530	1,190	470	370
North America:					
Canada	---	1,580	5,160	1,450	---
Mexico	2,450	2,520	1,140	440	720
United States	4,900	1,770	4,700	1,370	540

Source: *(53)*.

Figure 1.—Map of Brazil.

Source: T. E. Weill, et al, Area Handbook for Brazil, 1970, prepared by Foreign Areas Studies, The American University, Washington, D.C., Superintendent of Documents, 1970.

The natural vegetation of Brazil is predominantly forest. Natural grasslands cover about three-fourths of the State of Rio Grande do Sul, and scattered small areas in the other southern States and Mato Grosso. Pine forests blanket much of Santa Catarina and Parana. Equatorial and tropical forests extend over the Amazon Valley and the littoral, the southern portions reaching inland from the littoral to the Parana River between and around the grasslands and pinelands. In the interior of the Northeast, the natural vegetation is a complex called caatinga—a mixture of drought-resistant small plants, brush, and scattered trees. Much of the Central Highland also has sparse vegetation called cerrado, consisting mainly of grass interspersed among brush and scattered trees *(23,* II, 11). The caatinga and cerrado are problem areas, the latter constituting, in a way, a barrier or hurdle to the western expansion of Brazil's agriculture *(36).*

Settlement and Population Growth

The Portuguese first reached Brazil in 1500, and settlement was begun in earnest in the 1530's *(120,* p. 84; *111,* p. 37). Thereafter, the population increased slowly in the face of numerous obstacles—an unfavorable natural environment, sometimes hostile natives, raids and incursions by pirates, and invasions by the Dutch and French. From an estimated 15,000 persons in 1550 to, at most, 300,000 in 1690, the population grew at a compound annual rate of 1.2 percent (*120,* p. 271). More than half the population were slaves through the following century. The population grew about 2 percent a year during the 18th and 19th centuries. With the end of slave trade around 1850, Brazil undertook to stimulate immigration from Europe *(111,* pp. 145-157, 187-195; *57,* pp. 149-154; *124,* ch. XVI). Approximately 1.5 million immigrants entered Brazil between 1884 and 1900, and about 2.6 million from 1901 to 1940. Some of the immigration was spontaneous—particularly settlers fleeing unsettled conditions in the Italian peninsula during the 1880's and 1890's. During the 19th century, however, the Brazilian Government and landholders actively recruited colonists. Organized colonization projects had a marked influence on the structure of agriculture in Rio Grande do Sul, Santa Catarina, and parts of Sao Paulo.

Brazil's population grew about 2.1 percent a year from 1872 to 1940, mainly under the influence of stepped-up immigration. Birth and death rates both declined slightly, and the rate of natural population increase rose a few hundredths of 1 percent. After 1940, death rates declined sharply. Brazil had 41 million inhabitants in 1940; by 1970, the population was about 95 million. The rate of population growth between 1950 and 1960 rose to 3.1 percent. Immigration dwindled to a trickle during World War II, rose to record levels in the early 1950's, then declined to relative insignificance.

The geographic center of population has remained close to the Atlantic coast throughout Brazil's history. Forays into the interior for slaves, gold, and precious stones in the early centuries of occupation left scattered settlements and established Brazil's claims to its present territory *(23,* Map I-2). But the geographic center of population was only about 150 miles inland in 1823. By 1960, it was little more than 300 miles inland, although it had moved about 300 miles southwesterly *(17,* p. 17). The geographic center of agricultural production remained somewhat closer to the coast, but reached farther south.

Diversity of Social and Economic Institutions

Brazil's population grew by adding varied national and ethnic groups to similarly varied indigenous influences. Differing degrees of physical isolation and cultural leads and lags had the result that, "Brazil presents one of the most extraordinary cultural diversities to be found anywhere in the world . . . Brazilians from one part of the immense nation are usually startled by the differences they observe as they visit other states and other regions, or even other portions of their own state." (*124,* p. 12; *125,* p. 33.) Economically important sociological phenomena are also diverse—the relationships of the people to the land, and to each other in the family, school, church, and government (*124, 56*).

Relationships of People to Land

A variety of settlement patterns are found in Brazil. On large estates, the "casa grande" (great house or manor), adjoined by the sugar mill (engenho) or coffee-drying terrace (terreiro) and homes of workers, produce village-like population groupings. But where holdings are small, either line-villages or scattered farmsteads predominate.

Property boundaries are oriented to natural features—streams, roads, or ridges. Property descriptions may be vague, and surveys indefinite, giving rise to confusion and insecurity of land titles and handicapping the administration of real estate taxes (*124,* pp. 257-282; *40,* p. 111; *13).*

The difficulties over property boundaries are complicated, if not overshadowed, by other aspects of land titles. Land in Brazil was claimed by the Portuguese Crown at the time of The Discovery in 1500 and granted to individuals in various ways up to the time the country became independent in 1822. Important land tenure legislation, passed in 1850, was superseded in 1892 by the Constitution of the Republic which gave the States title to all public lands within their boundaries and jurisdiction over land laws (*124,* pp. 283-292). Brazilian law has been lenient to squatters (*124,* pp. 268, 291; *127,* p. 16; *13*). Under recent agrarian reform laws, the Federal Government has taken a more active role in land development.

About half the land area of Brazil was privately owned rural property in 1967 (*17,* p. IX, and *25,* 1967,

p. 18). The remainder was government owned, unclaimed, or urban. Land ownership was widely diffused, with the total number of properties estimated at 3.8 million. About a third of these properties comprised less than 10 hectares each, and half were between 10 and 100 hectares. The total area of properties of less than 10 hectares was almost 2 percent of the total area of all properties, while properties of more than 100 hectares accounted for about 40 percent of the total (*17*, p. 94).

Tendencies toward large-sized properties—an outgrowth of the original land grants of the Portuguese Crown—were strengthened by an apparent preference for land ownership among the wealthy, and by economies of scale for certain enterprises, notably sugar and cattle raising. Of 3.3 million rural properties registered with the Institute of Agrarian Reform in 1965, more than 40,000 were 1,000 hectares or more, and 2,162 were at least 10,000 hectares (*17*, p. X).

In sharp contrast to the pattern of large holdings was the family-size unit adopted for colonization projects, public and private, of the past 100 years or so. These small properties are joined—probably much outnumbered—by others acquired by their owners through attrition of large estates, diffusion of ownership through inheritance, occasional financial failure, sale of small parcels, and the not inconsiderable losses of property rights to squatters (table 2) (*124*, pp. 337-342).

To further promote the ownership of small farms, the Government of Brazil in 1964 established the National Institute for Development of Agriculture (INDA) and the Brazilian Institute for Agrarian Reform (IBRA). These agencies undertook colonization projects on public lands in previously unsettled areas, as well as on land acquired by purchase or expropriation of large estates in areas already developed. They have since been replaced by the National Institute of Colonization and Agrarian Reform (INCRA).

Describing the land tenure situation in Brazil is a formidable undertaking. The spectrum of sizes of landholdings and the numerous types and gradations in arrangements between those who own the land and those who plant, cultivate, and harvest it preclude simple generalizations.[2]

Ownership was the predominating tenure form in 1960, with 66.7 percent of the farms and about 64 percent of the land owner operated. About 16 percent of the farms and 7 percent of the land were rented; 11 percent of the farms and 4 percent of the land were "occupied" (used without payment of rent, with or without the consent of the owner); and 5 percent of the farms with 25 percent of the land were operated by hired managers (table 3). About two-thirds of the rentals were share rents.

Many farm laborers are compensated in part by the privilege of using a piece of land for subsistence production. Their production may be as important as that of many of the smaller owners, renters, or "ocupantes," even though their scope for decisionmaking may be more restricted.

Further discussion of the structure of agriculture appears later in this report (pp. 61-62).

Family Patterns

Patterns and values of Brazilian family life are interwoven with the economic structure of the country. The Portuguese patriarchal system evolved into a typically Brazilian form, as thoroughly analyzed by Gilberto Freyre (*56*) and T. Lynn Smith (*125*). (Both works cited have extensive bibliographies.) The patriarchal family coincided with the large landed estate and tended to perpetuate family wealth and influence.

Patterns of family life were less rigid among the laborers than among the proprietors of estates. The workers were tied to the estates by jobs and the privilege of having a place to live and the use of a plot of ground for raising food. But these ties were none too strong, and rural Brazilians have been ready and frequent migrants (*124*, pp. 144-166). European colonists of the last 100 years introduced another family type, closely attached

[2] Wheeler, Richard G. *Notes on Measures of Concentration of Rights to Use of Agricultural Land in Brazil.* Econ. Res. Serv., U.S. Dept. Agr., 1968, 33 pp. (Typewritten.)

Table 2.—Basis of possession of rural properties, by size of holding and percentage of total, Brazil, 1966

Basis of possession	Properties		Area	
	Number	*Percent*	*1,000 ha.*	*Percent*
Purchase from private owner ..	1,773,341	53.0	138,155	45.0
Purchase of public land	115,547	3.4	20,205	6.6
Indirect transactions[1]	40,443	1.2	5,149	1.7
Inheritance and usufruct[2]	546,454	16.3	48,443	15.8
Occupation and default[3]	116,625	3.5	9,014	2.9
Undeclared	755,526	22.6	86,294	28.0
Total	3,347,936	100.0	307,260	100.0

[1] By exchange, settlement of debt, dowry. [2] Usufruct is, essentially, lifetime right to use. [3] "Ocupacao e usucapiao;" essentially, squatter's rights, adverse possession.

Source: (*17*, p. 96).

Table 3.—Farm numbers and area, by tenure status of operator and size of farm, Brazil, 1960

Farm size (hectares)	Number of farms by tenure status of operator				
	Owner	Renter	Occupier[1]	Manager	Total
	Thousands				
Less than 10	773	452	235	35	1,495
10-100	1,201	110	108	72	1,491
100-1,000	238	16	12	49	315
1,000-10,000	18	2	1	10	31
10,000 or more	1	([2])	([2])	1	2
Total	2,231	580	356	167	[3]3,338
	Area of farms by tenure status of operator				
	Owner	Renter	Occupier[1]	Manager	Total
	Million hectares				
Less than 10	3.5	1.6	0.7	0.2	6.0
10-100	38.9	2.8	3.1	2.8	47.6
100-1,000	62.5	4.3	3.3	15.9	86.0
1,000-10,000	42.0	3.9	1.7	23.8	71.4
10,000 or more	14.2	5.6	.3	18.8	38.9
Total	161.1	18.2	9.1	61.5	249.9

[1] Possession and use without title or payment of rent. [2] Less than 500. [3] Includes 4,023 establishments without declaration of size or operator's status.

Source: (*24*).

to small landholdings but sending many of its younger generation to the city or to develop new farms on the frontier.

Church

Like most Latin American countries, Brazil is predominantly Roman Catholic. Church-state relationships took a unique course in Brazil over the centuries following The Discovery. The two institutions are separated more than in other Latin American countries, but less than in the United States (*124*, pp. 407, 519; *120*, pp. 313-341; *94*, pp. 230-234). The influence of the parish priest and the bishop can be very effective in support of activities in the parish and diocese, including efforts to promote economic development.

Education

Until the 20th century, Brazil reflected the ascendency of partriarchal-aristocratic values. Education was primarily for the wealthy, and for men. In 1900, 34 percent of the population were literate. Fifty years later, of the age group which would have been of school age in the first decade of the century, 42 percent were literate (52 percent of the men and 33 percent of the women). The general level of literacy rose to 61 percent by 1960.

Two-thirds of all children between 7 and 14 attended elementary school in 1964. In urban areas, school attendance in this age range was more than 80 percent, but in rural areas only 51 percent. Rural areas in some States had only one out of three children of this age in school. Similar conditions exist at secondary school and higher education levels.

Educational problems at all levels go beyond the basic need for schoolrooms and teachers. Secondary education has mainly prepared students for the universities, leaving a deficiency in vocational education (agricultural studies, for instance). Universities, in turn, have trained chiefly for law, medicine, and letters.

Government

Allocation of functions and responsibilities among governmental entities has a direct bearing on the manner in which public action is brought to bear on agricultural problems. With new problems constantly arising, or with a new appreciation of old ones, government itself could not remain static. Federal Constitutions of 1892, 1934, 1937, 1946, and 1967 mark major steps in governmental structure. Other changes within the Constitution came by legislation or through other political responses to social and economic needs.

The smallest political unit in Brazil is the municipio, comprising one or more towns and the surrounding rural area. The municipio corresponds roughly to the county in the United States. Unlike the United States, however, the towns in Brazil's municipios are not incorporated separately from the rural area. The municipio is governed by an elected mayor (prefeito), and board (camara) of supervisors (vereadores). The fusion of rural and urban areas at the lowest level of government probably has subordinated rural welfare to urban interests (*139*, p. 297).

The municipio government is responsible for local services—roads, schools, sanitation, local courts, and civil registries. However, the taxing authority and, therefore, the resources at the disposal of local governments are limited (*39*, *40*). The costlier services—roads and schools—often are unmet. To solve this problem, the municipios are permitted to retain a part of the sales taxes which they collect as agents for the States. Also, municipios are allocated a share of Federal income tax revenues. The basis of allocation has reinforced a tendency toward proliferation of municipios, beyond the number warranted by economic and service criteria. There were 2,855 municipios in 1960, and 3,954 in 1968. More stringent criteria for establishment of new municipios were adopted in 1967 (Complementary Law No. 3, Dec. 7, 1967), (*35*), and 19 municipios were merged with others in 1968 (one in Sao Paulo and 18 in Acre).

The States of Brazil have long exercised considerable political autonomy. They supplement municipios in roads and schools, control public land, administer land laws, and promote colonization. Sao Paulo's Department of Agriculture has been a model in Latin America and a leader among the Brazilian States in agricultural research, extension, and education activities and in agricultural marketing services.

The Federal Government was relatively weak, politically, during the monarchy and the first 40 years or so of the Republic. Under President Getulio Vargas, powers of the States were curtailed. Some were restored with the Constitution of 1946, but Federal authority and Federal resources are being used increasingly to deal with problems such as those of agriculture. A reorganization of the Ministry of Agriculture in 1967 undertook to strengthen working relationships between the Federal Government and the States by decentralizing the Ministry and promoting regional meetings with local leaders to formulate agricultural programs.

The President and members of the Legislature are the elected Federal officials. The executive departments are the ministries and numerous institutes, or independent agencies, loosely subordinated to particular ministries.

The Ministry of Agriculture was established in 1909 in a combined Ministry of Agriculture, Industry, and Commerce. It was separated from Industry and Commerce in 1934. Its functions include only a few of the many governmental interests touching agriculture—chiefly, research, agricultural development, and agrarian reform (table 4). The Ministry's appropriation for 1968 made up 2.2 percent of the Federal budget. Commodity programs are administered by quasi-public institutes, the Coffee Institute and the Institute of Sugar and Alcohol being the largest. The list of governmental agencies related to agriculture is long (see appendix C). Since activities related to agriculture are widely dispersed throughout the Government (table 5), effective coordination is unlikely unless at the initiative of the President, or the Legislature.

Table 4.—Budget of the Brazilian Ministry of Agriculture, by principal activities, 1968

Activity	Appropriation
	Million NCr$[1]
Agricultural development[2], colonization, and agrarian reform	174.0
Price programs	13.1
Research	39.8
Protection and inspection of agricultural products	28.4
Information	2.0
Weather	4.8
Administration	38.6
Total	300.7

[1] The new cruzeiro (NCr$) became the official unit of currency on February 13, 1967, equal to 1,000 of the former, or "old" cruzeiros. The new cruzeiro had an exchange value of 36.8 cents, U.S. currency, or NCr$2.715 equal to 1 U.S. dollar on the date of the changeover, and remained at that rate until January 2, 1968. The rate of exchange rose steadily with Brazil's chronic inflation during the 1950's and 1960's. Cruzeiro amounts used in this report are based on 1957-59 prices, unless otherwise indicated. The exchange rate, in terms of new cruzeiros, averaged 0.1227 to the dollar in 1957-59. [2] Including forests and fisheries.

Source: *(34)*.

Cooperatives

Brazil has an active agricultural cooperative movement. In 1967, 2,319 associations were registered with the National Institute for Agricultural Development (INDA, now INCRA). Rio Grande do Sul was the leading State in number of associations (478), closely followed by Sao Paulo (419). In 1964, agricultural cooperatives had more than 800,000 members (*25*, 1966, p. 380; *139*, p. 441).

Cooperatives engage in a variety of activities. About two-thirds are classified as "mixed"; the remainder are specialized by commodities, chiefly milk, coffee, and grains. Credit cooperatives (not limited to agriculture) numbered 527 in 1966. Nearly two-fifths were located in the Northeast.

The National Cooperative Credit Bank (BNCC) was established for cooperatives in 1951. Lending increased rapidly in the 1960's, from about $10 million in 1964 to more than $40 million in 1968. Increasing amounts of technical assistance and training for officers and employees of cooperatives are being provided through INCRA and State departments of assistance to cooperatives.

Private Enterprise

Private enterprise has an important role in the Brazilian economy, alongside numerous autarchies—enterprises organized, financed, and directed by Government (*5*, p. 78; *60*, pp. 19-24; *61*, pp. 17-23; *41*). Agricultural marketing, industries using agricultural raw materials, and industries supplying tractors, fertilizers, and other agricultural inputs are all predominantly in private hands.

Table 5.--Brazilian budget allocations for agriculturally related activities, 1968

Ministry	Agriculture (Program category 130)	Colonization (Program category 170)	Other agriculturally oriented items (other program categories[1])	Total
	Million NCr$			
Presidency	([2])	([2])	([2])	([2])
Agriculture	240.3	51.4	8.8	300.5
Education and Culture	0	0	47.4	47.4
Army	([2])	0	0	([3])
Finance	2.4	0	30.0	32.7
Industry and Commerce	0	0	1.3	1.3
Interior	106.7	8.2	39.5	154.4
Foreign Relations	0	.6	0	.6
Health	0	0	96.1	96.1
Labor and Welfare	0	.5	0	.5
Total	349.6	60.7	223.4	633.7

[1] Principally for higher education, food distribution, control of droughts and floods, and epidemic diseases prevalent in rural areas. [2] Agriculturally related items are not separated in the budget, but are implicit in several activities under the Ministry of Planning and General Coordination. [3] Less than 0.5 million.

Source: Compiled from (34).

Transportation, Communication, and Electrification

Transportation

Distance influences agricultural production so strongly that it is not surprising to see Brazil's agriculture differentiated and growing according to the availability and efficiency of its transportation services. In this respect, Brazilian farmers were poorly served until well into the 20th century. Brazilian transport still has far to go to take care of many needs. Yet, the situation has changed so rapidly in the past two decades that it may take another 10 years for the country's agriculture to adjust fully to the possibilities created by highway construction and railway modernization since World War II.

Railway building began in Brazil in the mid-19th century starting from the major seaports. Rio de Janeiro was linked with the coffee-rich Paraiba Valley in the 1850's. Other railway enterprises up and down the coast penetrated relatively short distances into the interior. Belo Horizonte, capital of mineral-rich Minas Gerais and only about 200 airline miles from Rio de Janeiro, was reached by the railroad in 1911. The first train reached the new Federal Capital, Brasilia, in March 1967, and regular traffic was established a year later. The rail network totaled 31,333 kilometers in 1926, reached 37,967 kilometers in 1957, but declined to 32,054 kilometers by 1968 with abandonment of uneconomic lines. The lines penetrating inland were slow to become linked laterally, parallel to the coast; some links were still being completed in 1968 (*72*, p. 140). Lateral movement of freight by rail remains slow and costly. The principal gauge is 1 meter, but both wider and narrower gauges are in use. Thus, rolling stock cannot be used interchangeably on all lines, and shipments between some points have to be reloaded en route.

Highways have become increasingly important in Brazil. A nationwide network of highways connecting all parts of the country is under construction. Brasilia will eventually be linked directly to all State capitals. The road to Belem, Para, is completed; the road to Porto Velho on the western edge of Rondonia is open to fair-weather traffic; and by 1980 Brasilia should be connected with Manaus, Amazonas, and Porto Velho with Recife, Pernambuco (*77*, XV, No. 4, p. 57).

Highways increased from 193,000 kilometers in 1936 to 460,000 in 1955 and 940,000 in 1968 *(25)*. Only 4.5 percent of the distance was paved in 1968, although the length of paved road increased thirteenfold from 1955 to 1964. The number of cargo vehicles in use grew at the rate of 8.6 percent a year during 1947-67, reaching 570,000 by the end of 1967.

Highway investments were primarily in main truck routes, where a given investment serves the maximum ton-miles of traffic. Casual observation by a traveler on these highways discloses a high proportion of agriculturally related traffic—produce on its way to market, fertilizer and other supplies bound for the farm.

Off the main roads, signs of highway progress tend to disappear. In the 1966 survey of farm properties, each owner was asked how many days during the year the farm was inaccessible by road *(17)*. For the country as a whole, about 360,000 properties (11 percent of the total) were cut off by impassable roads for 60 days or more. In the State of Sao Paulo, the percentage of farms isolated for 60 days or more ranged by physiographic zones from two to 32.

Communication

In 1967, there were 1.5 million installed telephones in Brazil, compared with 0.8 million in 1955. Two-thirds of the sets were in Brasilia and the State capitals. Other large towns had many of the remainder, leaving strictly rural areas sparsely served. In 1967, 959 radio stations were in operation, in contrast to 527 in 1955. Many of these stations broadcast on shortwave and were capable of being received throughout the country.

An active publishing industry issued 155 million books in 1967, of which 871,765 were on agricultural subjects. Three years earlier, only 82,500 books dealt with agriculture from a total of 52 million. Thirty-five agricultural periodicals published 3.1 million copies in 1967.

Electrification

In 1968, 31.4 million kilowatt hours were consumed, compared with 11.3 million kilowatt hours in 1955—an annual compound growth rate of 8.2 percent. Of the 1968 total consumption, 0.6 billion kilowatt hours were used by rural consumers. The 1960 census found 115,796 farms with electricity, but about half were equipped with their own generators (*24*, p. 30).

Commodity History

Economic activity of the Portuguese in Brazil began about 1500 with the gathering of Brazilwood, a prized dyestuff. Sugar was first produced in 1532, and by midcentury, had become the main source of income. By 1600, sugar exports amounted to 20,000 to 35,000 tons a year. Thereafter, exports fluctuated in this range for two centuries, but price and values declined by four-fifths as sugar production increased in other parts of the world.

In the last half of the 18th century, gold mining dominated Brazil's economy, displacing sugar. Livestock were in demand for food and for transport between the coastal towns and the mines in the interior. Toward the end of the century, gold mining dwindled, releasing labor and capital for employment in a new wave of agricultural development.

Coffee became the 19th-century miracle of Brazil, after developing slowly during the 18th century. The first coffee plants were introduced in 1727. Exports began about 1780, and in the first decade after independence in 1822, coffee accounted for about 18 percent of the nation's exports. Thereafter, coffee's share in value of exports increased rapidly, averaging 40 percent in the 1830's, and 69 percent during 1892-96. After 1900, coffee exports declined, but the quantity fluctuated irregularly around 15 million bags annually. Falling prices and the growth of other exports, both agricultural and nonagricultural, accounted for the decline in coffee's share in the value of Brazil's exports (fig. 2). Coffee production continued rising until the early 1930's, subsided during World War II, and rose again to a new peak in the 1960's. The additional production went partly into increased domestic consumption and partly into a rising carryover.

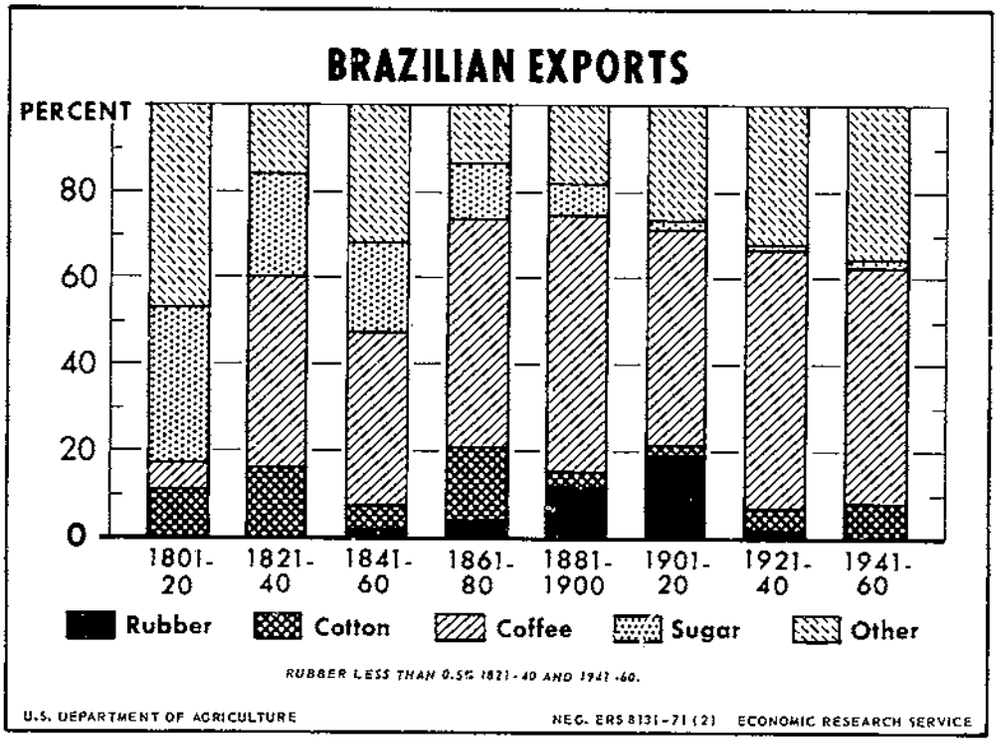

Figure 2

Coffee influenced the pattern of occupation of the country from 1860 to 1960, much as sugar and cattle had during colonial days. Coffee first became commercially important in the State of Rio de Janeiro. By the 1790's, plantations were being established in the valley of the Paraiba do Sul. This valley became the center of coffee production in the 1800's, and remained in the lead until late in the century (*126*). From the Paraiba Valley, the crop spread northwest into the eastern edge of Minas Gerais early in the 19th century and, after 1900, southwest into Sao Paulo. The peak of coffee output in Brazil in the 1930's coincided approximately with the final occupation and development of coffee production in the western part of Sao Paulo. After World War II, coffee production spilled over from Sao Paulo into western Parana (*83, 84*).

As the frontier of coffee production shifted west and south, older areas turned to livestock or other crops, or returned to forest. The abandonment of coffee in the older areas has been attributed to the inherent tendency for tropical soils in general, and the soils of this area in particular, to lose fertility rapidly. Coffee culture, itself, appears to deplete the soil more rapidly than many other crops. Agronomists believe that productivity can be maintained with fertilizers, and that the decline of coffee in older areas need not have been inevitable. Nevertheless, much of the effective agricultural development of Brazil coincided with the translocation of coffee production.

A number of products besides sugar, coffee, cattle, and transport animals were commercially important in particular localities and for limited periods. These included rubber, tobacco, cotton, rice, and cocoa, which were mainly exported, and products such as oilseeds and fibers other than cotton which grew along with industries using agricultural raw materials after World War II. Still other products were closely linked with the growth of population—corn, beans, mandioca[3], bananas, and wheat.

Rubber was a boom product in the Amazon region during the last half of the 19th century and the first two decades of the present century. At their peak, Brazil's exports of rubber were valued at half to two-thirds the value of coffee exports. Rubber production was greatly reduced after 1920, but it continues to be the principal product of the Amazon region, followed closely by jute. Rubber complements crop and livestock production, providing alternative employment for the agricultural laborers in some parts of the region. Recently, some rubber has been planted in Bahia as a complementary use of labor on cocoa plantations.

Tobacco production reached commercial importance in Brazil early in the 17th century. Tobacco was in strong demand in Europe, and for barter in the slave trade with Africa. It accounted for about 2 percent of the value of exports during the colonial period. In recent decades, tobacco has continued to account for about the same share of Brazil's exports. Important centers of tobacco production are in Bahia and in two southernmost States, Rio Grande do Sul and Santa Catarina.

Cotton, like rubber and tobacco, was native to Brazil, but its commercial development came later than that of tobacco. During the American Civil War, there was a cotton boom in Brazil. Another boom began in the 1930's, with exports rising to five to ten times the level of previous decades. During colonial times, cotton was mainly a product of the Northeast. After World War II, it figured prominently in the growth and changing patterns of agriculture in the States of Sao Paulo and Parana. In the 1960's, there was a resurgence in cotton production in the Northeast.

Cocoa has been a steady, relatively undramatic contributor to Brazil's exports. Production has centered in the southeastern part of the State of Bahia.

Not as much is known, quantitatively, about trends in food crops as in export crops. Because export crops earned foreign exchange and were the principal source of public revenue, data on exports were being compiled long before crop production reports were established. It may be presumed that production of staple crops—corn, mandioca, and beans—increased at about the same rate as total population. From time to time, there were variations in this trend, as in the early days of the gold era, when farming was neglected to the point that acute shortages of food occurred; or, in the Northeast, when crop yields were sharply reduced because of recurrent droughts. Commercial agriculture so dominated large areas that food was often scarce. "Monoculture" became anathema for want of effective distribution of domestic and imported food supplies.

Rice has always been among Brazil's most valuable domestic food crops. By the 1960's, it was vying with coffee and corn for first place. In colonial days, it was a leading crop of the North, principally in Maranhao, but most rice is now produced in the Southern region. In the 1960's, the Central West became increasingly important in rice production.

Brazil has always imported wheat in large amounts. Domestic production provided about one-fifth of the total quantity consumed (*70*, p. 110) until 1968 and 1969, when a surge of production brought the domestic supply up to one-third of the total (*93*). Most wheat is grown in the southernmost State, Rio Grande do Sul. The doctrine of import substitution as a guide to economic development was applied to agriculture in the 1950's in the wheat enterprise. Special incentives successfully stimulated production for a few years, but their effect was spent by 1958, and wheat acreage fell by nearly half in the next 6 years. Renewed incentives and some technological advances brought another spurt in the late 1960's.

Cattle production has always been an important agricultural activity in Brazil, supplying relatively cheap and plentiful meat for domestic markets. Nevertheless, it

[3] Manioc or cassava.

has not usually been adequate from the standpoint of quality, price, or supply to enable Brazil to compete on the world market. Dairying in eastern Sao Paulo and southeastern Minas Gerais supplies butter, cheese, fresh milk, and other dairy products for domestic consumption.

Forestry and Fisheries

Forestry, extractive products, and fisheries have been important economically throughout Brazil's history. About 2 percent of the labor force was engaged in these activities in 1968, and in 1963-65 they accounted for 5.5 percent of the gross value of output of the primary sector (table 6).

Table 6.—Output of agriculture, forestry, and fisheries, Brazil, 1963-65

Activity	Gross value of output	
	Billion NCr$[1]	*Percent*
Crops and livestock	5,103	94.5
Timber	127	2.4
Charcoal	14	.3
Plant extractives	82	1.5
Fisheries	72	1.3
Total primary sector (gross)	5,399	100.0

[1] The average rate of exchange during 1963-65 was NCr$1,436=$1.

Sources: (25) and (77, Vol. XXIII, No. 10, Oct. 1969).

Two extractive products, Brazilwood and rubber, have already been mentioned. The leading product in this class since World War II has been babassu, an oilseed obtained from palm trees found mainly in Maranhao. Rubber ranks second. Other products in this class include waxes, gums, fibers, oilseeds, tanning materials, foods, beverages, and drugs. Output of the group increased about 2 percent a year during 1960-67.

Forestry developed mainly to serve domestic needs for building materials and for fuel, since Brazil lacks coal and petroleum. Charcoal was used for producing more than a million tons of pig iron annually in the 1960's, but charcoal production declined at the rate of 4 percent a year during 1963-67. After forests in the older settled portions of the country were exhausted, replanting became necessary. Nearly a million hectares were reforested on farms in the South in 1960, about 10 percent of the total forested area. Forest products, particularly the pine of southern Brazil, constitute an important export. The Amazon Basin contains some 20 percent of the world's tropical rain forest, but remains relatively untouched. Although considerable development activity is underway in the Amazon, that area contributed only 1.3 percent of Brazil's timber harvest in 1967. Brazil's timber harvest increased about 4 percent a year during 1963-67.

The fisheries industry, like forestry, serves mainly the domestic market. About 90 percent of the catch comes from the ocean. Important fishing centers are Rio Grande do Sul, Santa Catarina, Sao Paulo, Guanabara, Rio de Janeiro, Bahia, Ceara, Maranhao, and Para. Relatively small exports of shrimp and lobster ($5 to $10 million annually during 1966-68) were more than offset by yearly imports of codfish amounting to $20 to $26 million. Output of fish increased about 7 percent a year from 1950 to 1968.

Succession of Dynamic Fronts

During four centuries of agricultural development, several major agricultural products have come to the fore in economic importance, and then receded. By the 1960's, Brazil's agriculture was more diversified than it had ever been, but it was still dynamic. (Recent changes will be discussed in more detail in later chapters.)

Agriculture in Brazil seems to have grown by steadily advancing, first on one front and then on another. As new products have come into prominence, established ones have seldom disappeared or even declined appreciably in absolute volume of output. This may continue to be the case while large areas of new land remain to be developed. Yet, historically, Brazilian farmers have been alert and responsive to their alternatives, shifting emphasis among agricultural enterprises as relationships among product prices and costs of production change. While such dynamics have brought prosperity to some, to others they have brought the pangs of retreat to alternatives that earlier were second best.

Agricultural Regions

Many of the factors discussed in the preceding pages have worked together to produce regional differences in the pattern of agricultural production. Such differences are described adequately for purposes of this report by comparing data for individual States or for the physiographic regions that were standard until 1968. (See fig. 1 and (*11*)). Some data were also available for the approximate 300 physiographic zones and 4,000 municipios (*17, 20, 21, 26, 27, 28, 37, 64, 65*).

Most of the analysis in this study followed the standard regions as previously defined (see tables 7 and 8). In 1968, the States of Sergipe and Bahia were shifted to the Northeast. Sao Paulo was combined with Minas Gerais, Espirito Santo, and Rio de Janeiro to form a new region, the Southeast. Thus, the former East was divided between the former Northeast and the new Southeast. The new South consists of Parana, Santa Catarina, and Rio Grande do Sul (*25*, 1968, p. 18).

State lines constitute acceptable boundaries of what might be called agro-economic regions where agriculture is sparse, as in the North and most of the Central West. Elsewhere, State boundaries occasionally split relatively homogeneous agricultural areas. The most important instance of this is the area comprising northwestern Parana, western Sao Paulo, the southwestern tip of

Minas Gerais (known as the Minas Triangle), and adjoining portions of Mato Grosso and Goias. Eastern Sao Paulo, southeastern Minas Gerais, and most of Rio de Janeiro, likewise, are relatively homogeneous, especially to the extent that the area is under a common urban-industrial influence.

Another geographic classification that helps to explain current dynamics of Brazilian agriculture distinguishes "old" and "new" (or frontier) areas. The "old" areas consist of States, or parts of States, in which a high proportion of the land was in farms by 1940, and a relatively high proportion was in crops. The Northeast, East, and South regions—less the States of Maranhao, Piaui, and Parana—make up the "old" area. The North and Central West, plus the States just named, constitute the new area, although the North region is still relatively inactive, agriculturally.

Brazilian agriculture has also been classified geographically according to level of technology and degree of productivity. Three classes are defined: extensive agriculture of new areas, extensive agriculture of old areas, and intensive agriculture in the vicinity of urban centers (*36*, pp. 53-55; *108*, pp. 8-10). Extensive agriculture is considered "traditional," and intensive, "modern." This classification represents recognizable type situations, but to be useful it requires more data than are presently available concerning technological characteristics of agriculture by geographic areas, and some common denominator of technological advancement. Studies of the frequency of use of specified techniques, both traditional and modern, have been made by Ruy Miller Paiva and William H. Nicholls (*109*), and by Eli Souza and associates.[4]

Recent Economic and Social Progress

Brazil made considerable economic progress during 1947-65. Industrialization was emphasized, and abundant land was utilized with increasing efficiency by a growing farm labor force. Industrial output quadrupled and agricultural output more than doubled between 1947 and 1966. Per capita income increased at an average annual compound rate of 2.8 percent.

During the mid-1960's, a number of social and economic problems brought some temporary setbacks. Economic measures were taken to curb an alarming rate of inflation, and industrial activity became virtually stationary from 1962 through 1965. Frosts and droughts in the important States of Sao Paulo and Parana brought temporary declines in agricultural output. But, by 1966, the economy resumed former rates of growth. In that year, per capita income reached a record high of $236.

Brazil is still in a transitional state of economic development. Industry supplies a wide range of consumer and capital goods for domestic needs, but it has yet to achieve an important export role. Agriculture continues to employ slightly more than half the labor force, and contributes between 25 and 30 percent of national income. Agriculture's share of national income remained steady between 25 and 30 percent. Industry's share rose from 22 to 28 percent, while that of services and government declined.

Agricultural products (raw materials, textiles, and food and beverages) made up 85 - 95 percent of Brazil's exports throughout the study period. The dollar value of agricultural exports remained relatively stable, but nonagricultural exports, chiefly minerals and manufactures, began to rise in the mid-1950's.

Brazil has progressed in such social fields as welfare, health, and education, although much remains to be done. The foundations of existing social legislation were laid in 1937 with the formation of "sindicatos," organizations of employees and employers. A social security system provides protection of job tenure, health benefits, old age pensions, and other benefits. Minimum wages under legislation dating from 1941 are the effective wages for many urban workers and for some farm labor (*63*). The minimum wage is adjusted periodically on the basis of changes in cost-of-living indexes.

Brazil shares with other tropical countries the health problems characteristic of warm climates. Infectious disesases and disorders of the digestive tract are the leading causes of death in most parts of the country. In the largest cities of the more temperate South, the causes of death assume patterns more characteristic of developed countries, with circulatory diseases and cancer tending to predominate (*25*). Nationally, mortality rates declined from 19.7 per 1,000 in the decade ending with 1950 to 15.0 per 1,000 by 1960 (*22*).

Birth rates averaged 44.0 per thousand in 1950-60, having remained practically constant since the last quarter of the 19th century *(22)*. Infant mortality rates vary widely throughout the country, but have dropped appreciably since 1950.

Literacy rates increased from 49 percent in 1950 to 61 percent in 1960. Students enrolled in primary schools at the beginning of the school year increased from 4.4 million in 1950 to 11.9 million in 1968. Attendance grew about 6 percent a year, while population growth averaged 3 percent. Approximately 65 percent of the primary-school-age children attended school in 1964 (*25*, 1965, p. 400).

[4] Souza, Eli de Moraes and others. *Investigation of Factors Related to Productivity in the Agricultural Sector of Two Municipios of the State of Rio Grande do Sul, Brazil.* Univ. of Rio Grande do Sul, Porto Alegre, 1968, 342 pp. (Typewritten.)

CHAPTER II.—GROWTH OF AGRICULTURAL OUTPUT

Gross Output—Overall Performance

Brazil's agricultural output is measured regularly by conventional index numbers, and by the agricultural component of the national income accounts (*25*, 1966, pp. 98 and 108; *131*, p. 5; *133*, pp. 12-13; *76*, index numbers 37-43; *66*, p. 4). The indexes differ in commodities included and methods of construction. Generally, they consist of a single national total for all products, or, at most, for a few product groups. For an analysis of the changes that have occurred, and for more precise projections of the effects likely to be achieved by specific efforts to stimulate production, more detailed measures of output are necessary. To meet this need, a more detailed set of production indexes has been constructed, suitable for measuring the contribution of various components to the total change in output.

Brazilian agricultural output approximately doubled between 1947 and 1965, growing at a compound annual rate of about 4½ percent a year (fig. 3). In 1966-69, production fell below the projection of the 1947-65 trend, and appeared to be slowing down.

Year-to-year variations in total output were relatively small, notwithstanding some occasions when bad weather affected broad regions. National output in two-thirds of the years from 1947 to 1965 fell within 4 percent of the trend line. In 1964, particularly unfavorable conditions in Parana and Sao Paulo caused output to drop 8 percent below the 1947-65 trend. This loss was more than overcome in 1965, when output took the largest year-to-year leap of the entire period and rose to 6 percent above the trend. Preliminary indications are that 1969 output was about 3 percent below an extrapolation of the 1947-65 trend (*70*).

Several measures of output, differing in commodity coverage, show slightly varying growth rates:

	Growth Rate 1947-65
	Percent
Index of real product, agriculture, national accounts[1]	4.5
Index of agricultural production, Conjuntura Economica[2]	4.6
Index of net agricultural production, USDA-ERS[3]	4.2
Value of output of 34 products at 1957-59 average prices[4]	4.6

[1] Based on data in (*77*, Sept. 1967, p. 119).
[2] Based on data in (*77*, index number 37).
[3] Based on data in (*133*). Covers period 1948-65.
[4] Compiled for this study.

Gross Output—34 Products

The index of output of 34 farm products[1] was computed especially for this study because the existing indexes did not permit adequate analysis of certain aspects of the growth of agriculture during the study period, 1947-65. The new index can be related to changes in the geographic and product composition of farm output throughout the period. Such analysis seemed necessary because Brazil's agriculture was both heterogeneous and dynamic during the period under study. The 34 products account for about 99 percent of the total value of agricultural products.

Basic data for the computations were the annual production estimates of the Production Statistics Service (SEP) of the Ministry of Agriculture.[2] For some products, no other source of data was available. Several sources were available for other products, but were not suitable for one or more of several reasons—they were not available by States or by years for the entire period, or they did not afford consistent area, quantity, and price series.

Census data suggest that annual estimates may be low for crop output, without substantial trend in the bias, and that livestock inventory numbers were biased upward, with a rising trend in the bias. The rate of growth, when adjusted for the indicated bias in livestock inventory, would be reduced about 0.1 percent.

Quantities of crops and livestock products were taken directly from SEP, as published in Brazil's Statistics Yearbook (*25*). Meat production, however, was estimated with several intermediate steps, incorporating allowances for inventory change and for an intermediate stage in beef production that took place in a State other than where the animals were raised.

Prices of crops and livestock products were taken directly from SEP. Meat prices were based on average values of livestock in inventory, since data on farm prices of slaughter animals were not available. This procedure tended to underestimate the value of marketings—relatively little (less than 10 percent) in States like Sao Paulo and Minas Gerais, where milking cattle and finishing of slaughter cattle were important, and substantially more—33 to 50 percent—in other States.

[1] See appendix A for list of products included.
[2] Production Statistics Service became Agricultural Statistics Technical Group of Brazilian Institute of Geography and Statistics (IBGE) in 1968.

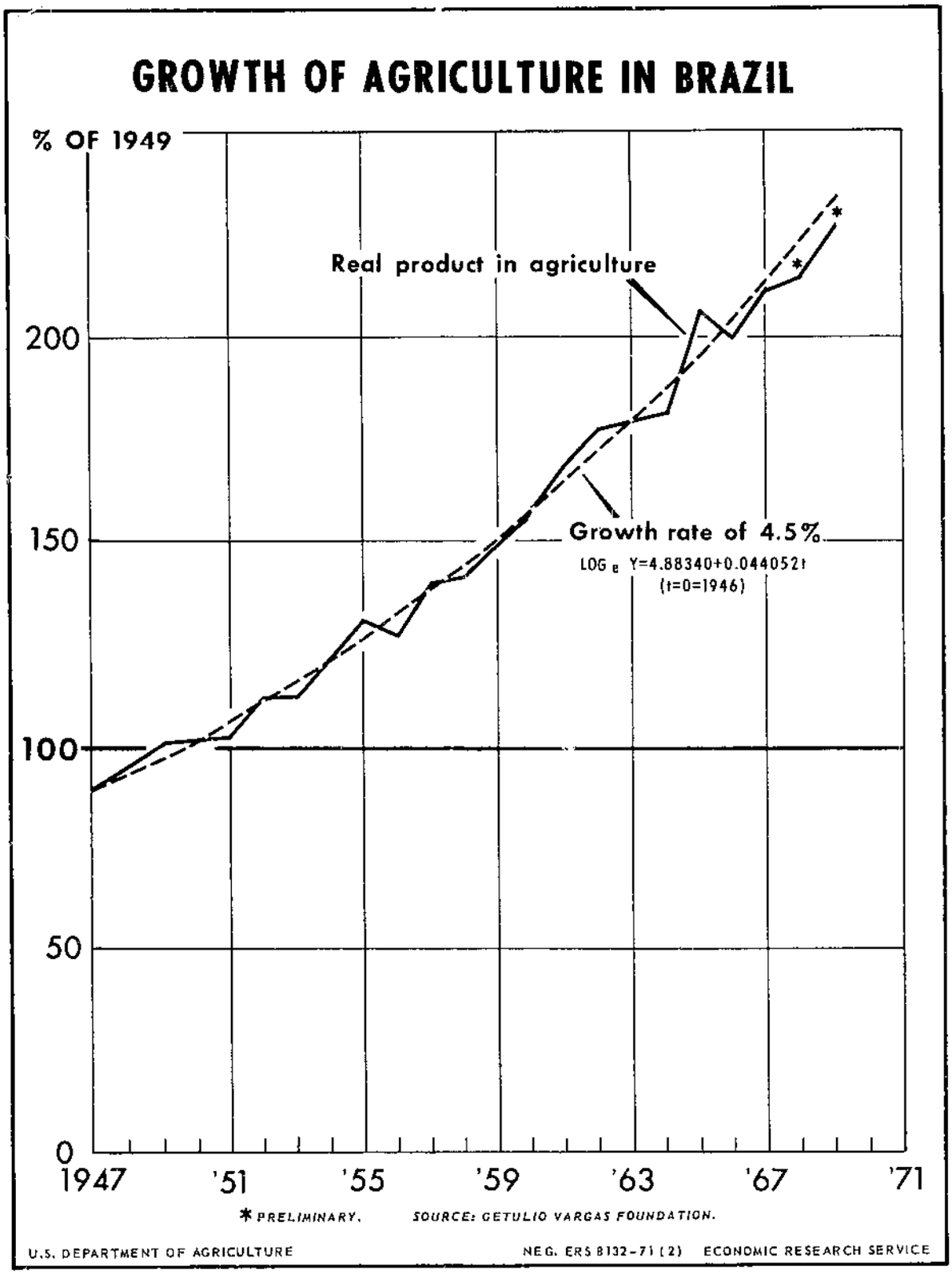
GROWTH OF AGRICULTURE IN BRAZIL
% OF 1949
Real product in agriculture
Growth rate of 4.5%
LOG e Y=4.88340+0.044052t
(t=0=1946)
200
150
100
50
0
1947
'51
'55
'59
'63
'67
'71
* PRELIMINARY.
SOURCE: GETULIO VARGAS FOUNDATION.
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8132-71 (2) ECONOMIC RESEARCH SERVICE

Figure 3

Total value of output of 34 products increased from 206 million new cruzeiros annually in 1947-49 to 412 million new cruzeiros in 1963-65[3] (table 7). Agricultural output increased more in some regions than in others.

Table 7.—Total value of output of 34 agricultural products, Brazil, by regions, annual averages, 1947-49 and 1963-65

Region	Value of output in 1957-59 prices				
	1947-49		1963-65		Increase 1947-49 to 1963-65
	Million NCr$[1]	*Pct.*	*Million NCr$*[1]	*Pct.*	*Million NCr$*[1]
North	4	2	7	2	3
Northeast	32	15	65	16	33
East	62	31	101	24	39
South	99	48	204	50	105
Central West	9	4	35	8	26
Brazil	206	100	412	100	206

[1] NCr$0.1227=US$1.

The Central West (Mato Grosso and Goias), for instance, nearly quadrupled its output, moving from 4 to 8 percent of the national total. Production in the East (principally Minas Gerais and Bahia) grew far more slowly than other regions and its share of the total fell from 30 to 24 percent. By regions, compound annual growth rates ranged from 3.2 to 8.4 percent (table 8).

Table 8.—Growth of output of 34 agricultural products, compound annual rates, Brazil, by regions, 1947-56, 1957-65, and 1947-65

Region	Growth rate[1]		
	1947-65	1947-56	1957-65
	Percent		
North	3.8	2.8	[2]5.5
Northeast	4.7	3.0	[2]8.1
East	3.2	2.8	2.6
South	4.8	5.0	4.0
Central West	8.4	9.4	9.3
Brazil	4.6	4.2	4.6

[1] Value of b in mathematically fitted least squares function $Y=ab^X$. [2] Difference from growth rate for 1947-56 is statistically significant by F-test at the 5-percent level.

Within regions, growth rates of agricultural output tended to vary considerably from State to State. In the Northeast, Maranhao had the most rapid rate of growth (7.9 percent), the fourth highest in Brazil, while in Rio Grande do Norte the rate was 3.6 percent. In the South, Parana grew at 10.8 percent a year, the highest rate of growth in the nation and more than twice that in any of the other three States of the region. Sao Paulo, on the other hand, had a growth rate of 3 percent a year. The important agricultural State of Minas Gerais had the lowest growth rate in the nation (2.8 percent), but growth rates in the East region were uniformly low (table 9).

Table 9.—Growth of output of 34 agricultural products, compound annual rates, by States, Brazil, 1947-65

State and region	Growth rate	State and region	Growth rate
	Percent		*Percent*
NORTH		EAST	
Rondonia	1.9	Sergipe	4.0
Acre	2.6	Bahia	3.5
Amazonas	6.3	Minas Gerais	2.8
Roraima	5.0	Espirito Santo	4.3
Para	3.6	Rio de Janeiro	3.5
Amapa	1.3	Guanabara	(1)
NORTHEAST		SOUTH	
Maranhao	7.9	Sao Paulo	3.0
Piaui	5.7	Parana	10.8
Ceara	4.8	Santa Catarina	4.2
Rio Grande do Norte	3.6	Rio Grande do Sul	4.0
Paraiba	4.8		
Pernambuco	3.8		
Alagoas	4.1	CENTRAL WEST	
		Mato Grosso	6.2
		Golas	8.7
		Distrito Federal	(1)

[1] Data incomplete.

As a group, the frontier States[4], with output valued at 29 million new cruzeiros in 1947-49, increased output by 81 million new cruzeiros, while the older settled areas, with output valued at 177 million new cruzeiros in 1947-49, increased output by 125 million new cruzeiros.

Crop Output

Average value of crop output increased from 155 million new cruzeiros to 298 million new cruzeiros between 1947-49 and 1963-65, at 1957-59 prices (table 10). Share of total output for crops declined slightly, partly because unfavorable production conditions in the South in 1963 and 1964 had more effect on crops than on livestock and partly because livestock output consistently grew at a slightly faster rate than crops (fig. 4).

Among major product groups, average growth rates for the entire period were generally uniform (table 11). Dividing the period into halves, however, brings out some contrasts. Output of each crop group (except "other nonfood crops") grew more rapidly in 1957-65 than in the preceding period[5]. Output of meat and

[3] Calculated with 1957-59 average prices. The free market exchange rate during that period was 0.1227 new cruzeiros to the U.S. dollar. The unit of currency used in this report is the new cruzeiro (NCr$), which was established in February 1967 at the rate of 1 new cruzeiro to 1,000 old cruzeiros.

[4] Parana, Mato Grosso, Goias, Maranhao, and States of the North region.

[5] Castorseed, cocoa, coffee, rubber, and tobacco comprise the other nonfood crops. Products included in each crop group are listed in appendix B.

livestock products, on the other hand, slowed after 1957.

Rates of growth in output of crops varied within groups as well as between the halves of the 1947-65 period. Wheat output increased much less than corn and rice over the entire period (table 12). Furthermore, wheat output declined in the latter half of the period, while rice and corn increased even more rapidly than earlier. Most food crops other than grains grew at near average rates, but exceptionally high rates were achieved by peanuts, soybeans, and tomatoes.

Table 10.—Total value of 34 agricultural products, by product groups, Brazil, annual averages, 1947-49 and 1963-65

Product	Value of output in 1957-59 prices			
	1947-49		1963-65	
	Million NCr$	*Percent*	*Million NCr$*	*Percent*
Crops	155	75	298	72
Livestock	51	25	114	28
Total[1]	206	100	412	100
Crops:				
Grains	47	30	96	32
Other food crops	52	34	113	38
Fibers	17	11	30	10
Other nonfood crops	39	25	59	20
Total	155	100	298	100
Livestock:				
Meat	31	61	59	52
Livestock products	20	39	55	48
Total[1]	51	100	114	100

[1] Totals and percentages from unrounded numbers.

Table 11.—Growth of output of 34 agricultural products, compound annual rates, by product groups, Brazil, 1947-65, 1947-56, and 1957-65

Product	Growth rate[1]		
	1947-65	1947-56	1957-65
	Percent		
Crops:			
Grains	4.4	3.8	[2]6.0
Food crops	4.7	4.1	[2]5.9
Fibers	4.0	2.3	[2]7.3
Other nonfood crops	3.9	1.7	[2]-.5
Total	4.5	3.3	4.6
Livestock:			
Meat	3.7	5.4	4.5
Livestock products	6.5	8.8	[2]4.9
Total	4.9	6.8	[2]4.7

[1] In this and subsequent tables showing growth rates for the entire period along with those for the two halves, the rate for the entire period was usually intermediate between the rates for the two halves. Sometimes, however, the rate for the entire period fell outside the range of rates for the two halves. This occurred if direction or rate of change between halves differed appreciably from the trends within halves. [2] Difference from growth rate for 1947-56 is statistically significant by F-test at the 5-percent level.

Of the fibers, cotton output increased at a less than average rate during 1947-65, but increased rapidly in the latter half of the period. Sisal and jute grew at exceptional rates (10.9 and 15 percent annually, respectively) over the entire period, but faster in the first half.

The most heterogeneous product group, in terms of growth rates, was "other nonfoods." Coffee and cocoa grew during the first half, and declined during the second half. The overall growth rate for coffee was about average (4.3 percent), reflecting mainly a rise from about 2 to 2.2 million tons a year in 1947-56 to around 3 to 4 million tons a year in 1957-65 (fig. 5).

Coffee was consistently Brazil's leading crop in value of output until 1961, valued at current prices or at 1957-59 average prices. After 1959, coffee production leveled out or declined, and other crops began to gain on coffee. Consequently, the value of coffee at 1957-59 prices dropped to second, after rice, in 1962; in 1964, it fell below both rice and corn. Valued at current prices, coffee was outranked by rice and corn in 1967, and by rice, corn, and sugarcane in 1966.

Change in pattern of crop output was probably one of the most significant features of Brazil's agricultural development between 1947 and 1965. This change is apparent from the differences among growth rates, coffee's declining rank in total crop output, and offsetting gains in other crops—rice, sugarcane, and a number of lesser crops, including oilseeds, tomatoes, and bananas (table 12). The seven leading crops accounted for 80.1 percent of the total value of 26 crops in 1947-49, and 78 percent in 1963-65 (table 13).

Livestock Output

Value of livestock output increased from 51 million new cruzeiros in 1947-49 to 114 million new cruzeiros in 1963-65 at 1957-59 prices (table 10). Like crops, growth in output of meat and animal products varied among products and in different periods (table 14). The meat group was dominated by beef, which accounted for two-thirds of total meat production. Beef output increased less rapidly than other meats. Growth rates for cattle, swine, and sheep were lower in 1957-65 than in the first 10 years, and higher for goats and poultry. Goats were important in the Northeast, and the trend in goat production probably reflects the general stimulation of demand by the regional development program, SUDENE.[6] Trends in poultry reflect the introduction and development of a broiler industry, and the resulting increase in poultry slaughter at packing plants. Since production estimates for poultry meat probably omit most of the supply purchased live but killed and dressed by retail butchers or consumers, the growth rate is doubtless inflated. The relative importance of poultry in the total meat supply is understated, however.

[6] SUDENE (Superintendency for Development of the Northeast).

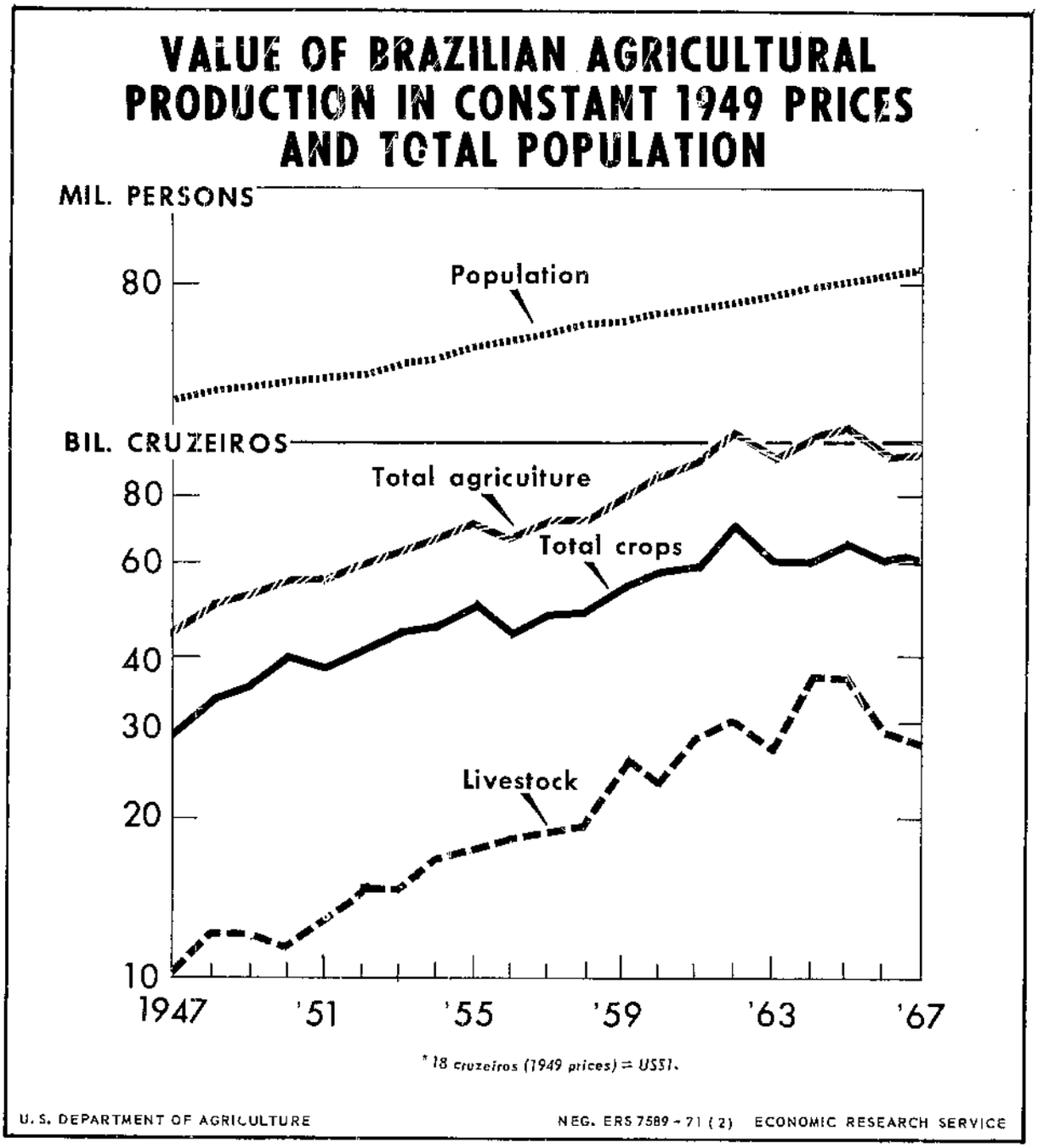
VALUE OF BRAZILIAN AGRICULTURAL PRODUCTION IN CONSTANT 1949 PRICES AND TOTAL POPULATION
MIL. PERSONS
80
Population
BIL. CRUZEIROS
80
60
40
30
20
10
Total agricuiture
Total crops
Livestock
1947
'51
'55
'59
'63
'67
* 18 cruzeiros (1949 prices) = US$1.
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Figure 4

Table 12.--Value of output of crops, by crop group, Brazil, annual averages, 1947-49 and 1963-65, and rates of growth, 1947-65, 1947-56, and 1957-65

Product	Value of output in 1957-59 prices				Growth rate		
	1947-49		1963-65		1947-65	1947-56	1957-65
	Million NCr$	*Percent*	*Million NCr$*	*Percent*	*Percent*	*Percent*	*Percent*
Rice	21.5	13.9	49.8	16.7	5.1	3.1	[1]7.8
Corn	21.8	14.1	41.1	13.8	4.0	2.5	[1]5.4
Wheat	3.7	2.4	5.0	1.7	1.5	12.8	[1]-3.0
Total grains	47.0	30.4	96.0	32.2	4.4	3.8	[1]6.0
Peanuts	.8	.5	4.3	1.4	12.8	9.3	14.6
Soybeans	.1	.1	1.8	.6	20.6	34.3	[1]18.7
Babassu	1.0	.6	2.1	.7	4.8	.8	[1]9.6
Total oilseeds[2]	1.8	1.2	8.2	2.7	14.1	13.2	15.6
Potatoes	3.6	2.3	6.9	2.3	4.3	5.6	[1]2.9
Sweetpotatoes	1.7	1.1	3.1	1.0	4.1	1.7	[1]6.5
Tomatoes	.7	.5	4.2	1.4	12.7	12.8	10.9
Onions	1.1	.7	2.6	.9	5.3	8.0	[1]3.4
Total vegetables	7.1	4.6	16.8	5.6	5.7	6.0	5.3
Bananas	3.6	2.3	9.1	3.1	5.8	6.3	[1]6.8
Oranges	3.2	2.1	5.9	2.0	3.7	1.8	[1]5.9
Pineapples	.4	.3	.8	.3	5.6	6.9	[1]3.5
Grapes	.9	.6	2.3	.8	6.1	8.0	[1]3.0
Total fruits	8.1	5.2	18.2	6.1	5.1	4.9	5.8
Beans	12.8	8.3	21.7	7.3	3.3	3.1	4.1
Mandioca	11.3	7.3	22.2	7.5	4.2	2.7	[1]7.0
Sugarcane	10.2	6.6	23.6	7.9	5.5	4.9	[1]5.4
Coconuts	1.0	.7	2.4	.8	5.7	3.8	[1]6.3
Total other foods	35.4	22.9	69.9	23.4	4.4	3.5	[1]5.5
Cotton	16.3	10.5	28.1	9.4	3.6	1.7	[1]7.0
Sisal	.2	.1	1.8	.6	15.0	23.8	[1]11.5
Jute	.1	.1	.6	.2	10.9	16.2	[1]8.2
Total fibers	16.6	10.7	30.4	10.2	4.0	2.3	7.3
Coffee	30.0	19.4	45.8	15.4	4.3	1.4	[1]-1.4
Tobacco	2.6	1.7	4.7	1.6	3.7	2.9	[1]6.6
Cocoa	3.5	2.3	4.6	1.5	1.7	4.2	[1]-1.4
Castorseed	1.2	.8	1.8	.6	2.2	-3.4	[1]8.0
Rubber	1.4	.9	1.8	.6	1.3	1.5	2.4
Total other nonfood	38.7	25.0	58.6	19.7	3.9	1.7	-0.5
Total, 26 crops	154.6	100.0	298.1	100.0	4.5	3.3	4.6

[1]Difference from growth rate for 1947-56 is statistically significant by F-test at the 5-percent level. [2]Babassu was unintentionally omitted from the growth rate computations for the oilseeds subgroup, and the food group.

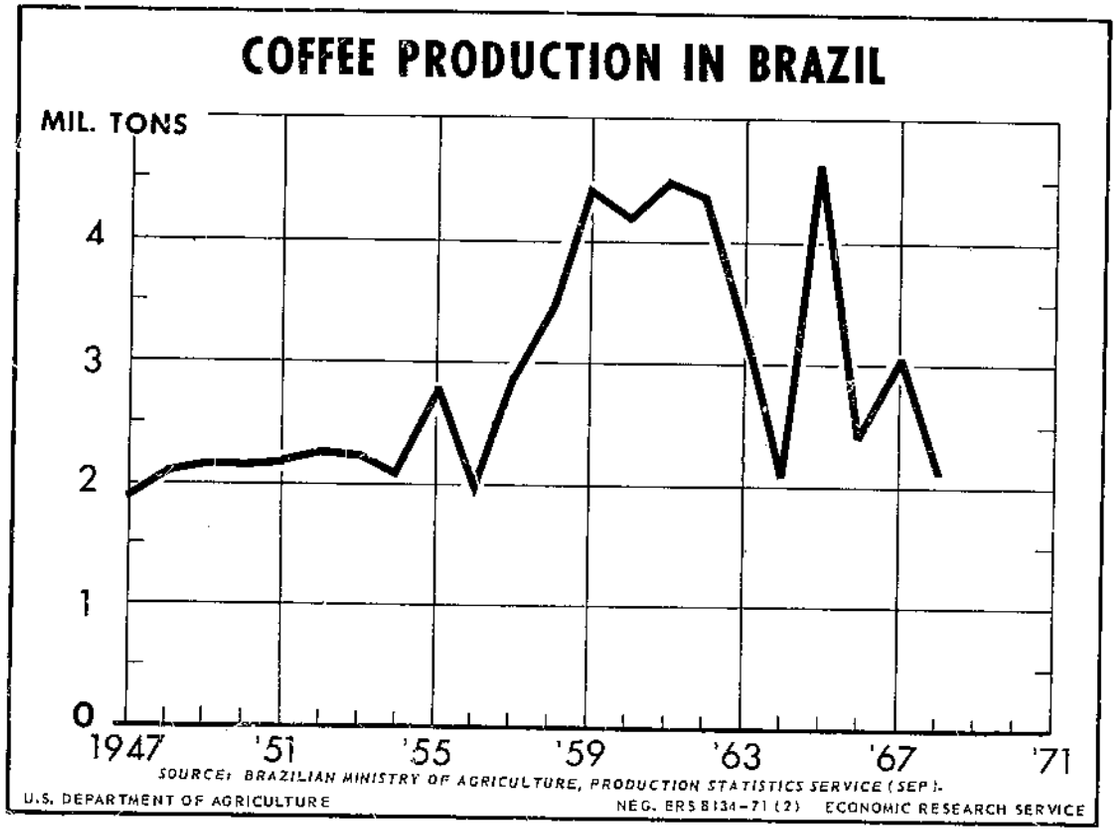


Figure 5

Table 13.—Value of output of 26 leading crops, Brazil, annual averages, 1947-49 and 1963-65, and rates of growth, 1947-65, 1947-56, and 1957-65

Product	Value of output in 1957-59 prices				Growth rate		
	1947-49		1963-65		1947-65	1947-56	1957-65
	Million NCr$	*Percent*	*Million NCr$*	*Percent*	*Percent*	*Percent*	*Percent*
Coffee	30.0	19	45.8	15	4.3	1.4	[1]-1.4
Corn	21.8	14	41.2	14	4.0	2.5	[1]5.4
Rice	21.5	14	49.8	17	5.1	3.1	[1]7.8
Cotton	16.3	11	28.1	10	3.6	1.7	[1]7.0
Beans	12.8	8	21.7	7	3.3	3.1	4.1
Mandioca	11.3	7	22.2	7	4.2	2.7	[1]7.0
Sugarcane	10.2	7	23.6	8	5.5	4.9	[1]5.4
19 other crops	30.7	20	65.7	22	---	---	---
Total 26 crops	154.6	100	298.1	100	4.5	3.3	4.6

[1] Difference from growth rate for 1947-56 is statistically significant by F-test at the 5-percent level.

Table 14.—Value of output of livestock and byproducts, Brazil, annual averages, 1947-49 and 1963-65, and rates of growth, 1947-65, 1947-56, and 1957-65

Item	Value of output in 1957-59 prices				Growth rate		
	1947-49		1963-65		1947-65	1947-56	1957-65
	Million NCr$	*Percent*	*Million NCr$*	*Percent*	*Percent*	*Percent*	*Percent*
Cattle	23.9	47	39.1	34	3.1	4.1	3.8
Swine	6.4	12	16.0	14	5.1	9.1	[1]4.7
Sheep	.2	([2])	1.0	1	5.3	21.5	13.7
Goats	.4	1	.7	1	3.9	2.0	7.6
Poultry	.4	1	1.9	2	8.8	12.4	[1]17.4
Total meat	31.3	61	58.8	52	3.7	5.4	4.5
Milk	12.4	24	36.3	32	6.9	9.5	[1]5.4
Eggs	5.8	12	16.0	14	6.5	8.3	[1]5.0
Wool	1.7	3	2.6	2	2.5	5.7	[1]-.7
Total livestock products	20.0	39	54.9	48	6.5	8.8	[1]4.9
Total livestock	51.3	100	113.6	100	4.9	6.8	[1]4.7

[1] Difference from growth rate for 1947-56 is statistically significant by F-test at the 5-percent level. [2] Less than 0.5 percent.

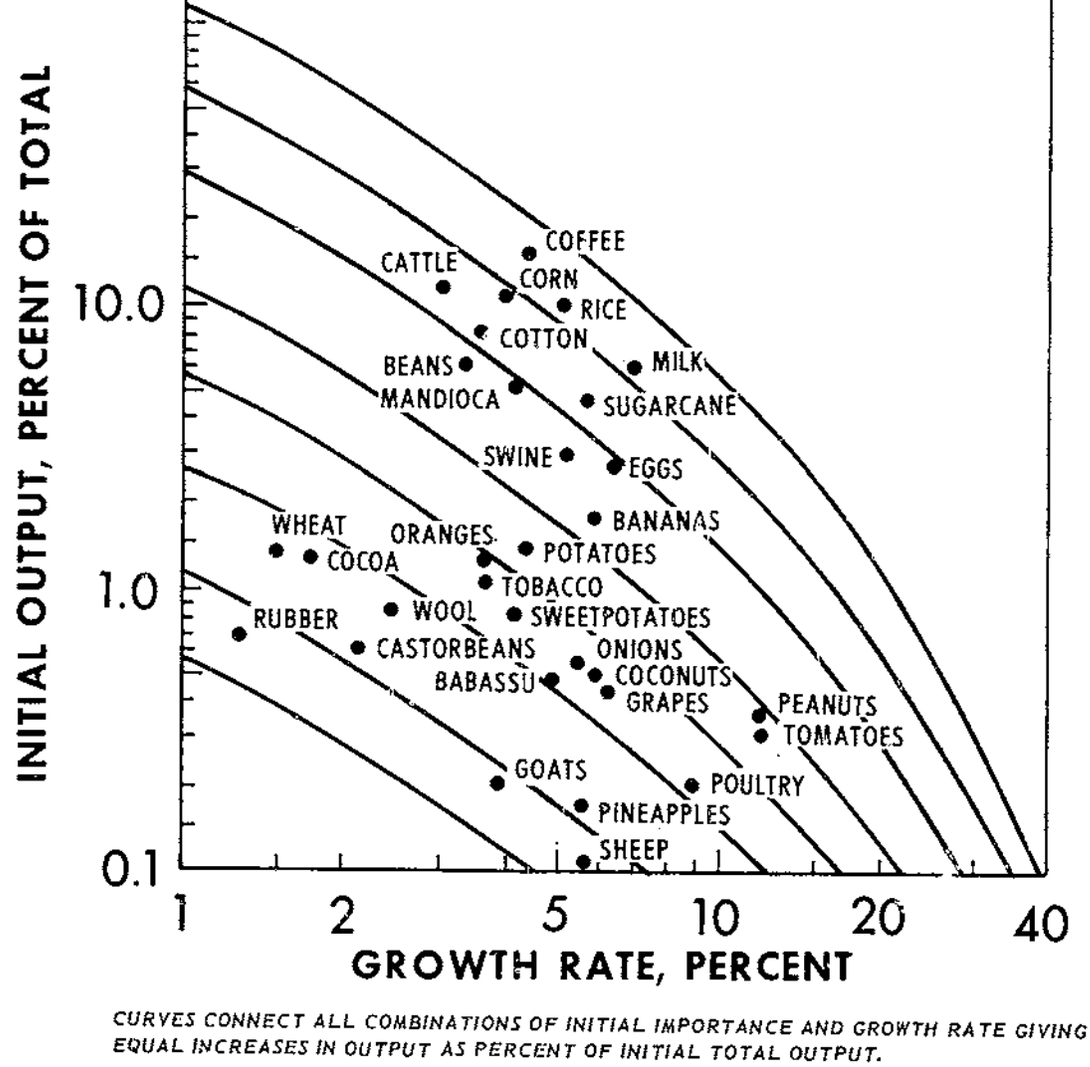
Output of milk and eggs grew rapidly over the entire period 1947-65, but at a slower rate in the second half. The rapid growth in output of milk and eggs accounted for the increase in all livestock output relative to crop output. Wool output increased steadily from 1947 to 1959, then dropped abruptly to a lower level from which it resumed its rise. Production of wool in 1966 still had not recovered all the decline that took place between 1959 and 1960.

Joint Role of Initial Importance and Growth Rate

Output of many of Brazil's more important products (coffee, corn, rice, and mandioca) grew at close to average rates between 1947 and 1965. These products contributed increased output in proportion to their initial importance (fig. 6). On the other hand, peanuts and tomatoes, because of high growth rates, contributed as much to increases in output as did potatoes and bananas, which were five to six times as important at the beginning of the period (1947-49). Products with low initial importance and low growth rates (rubber, goats, and sheep) contributed least to the overall increase in output.

Among States, rapidly growing Parana increased output as much as Sao Paulo between 1947-49 and 1963-65, although Parana's output was less than half Sao Paulo's at the start of the period (fig. 7). Mato Grosso and Goias, with high growth rates, each added as much to Brazil's total agricultural output as Bahia, and nearly as much as Minas Gerais or Rio Grande do Sul. Low initial importance and low growth rates in Acre and Rondonia resulted in small contributions to agricultural output. Amazonas, with a creditable growth rate of 6.3 percent, contributed relatively little to the total increase in output because of its initial low level.

INCREASE IN BRAZILIAN FARM OUTPUT FROM SPECIFIED PRODUCTS, 1947-49 TO 1963-65



CURVES CONNECT ALL COMBINATIONS OF INITIAL IMPORTANCE AND GROWTH RATE GIVING EQUAL INCREASES IN OUTPUT AS PERCENT OF INITIAL TOTAL OUTPUT.

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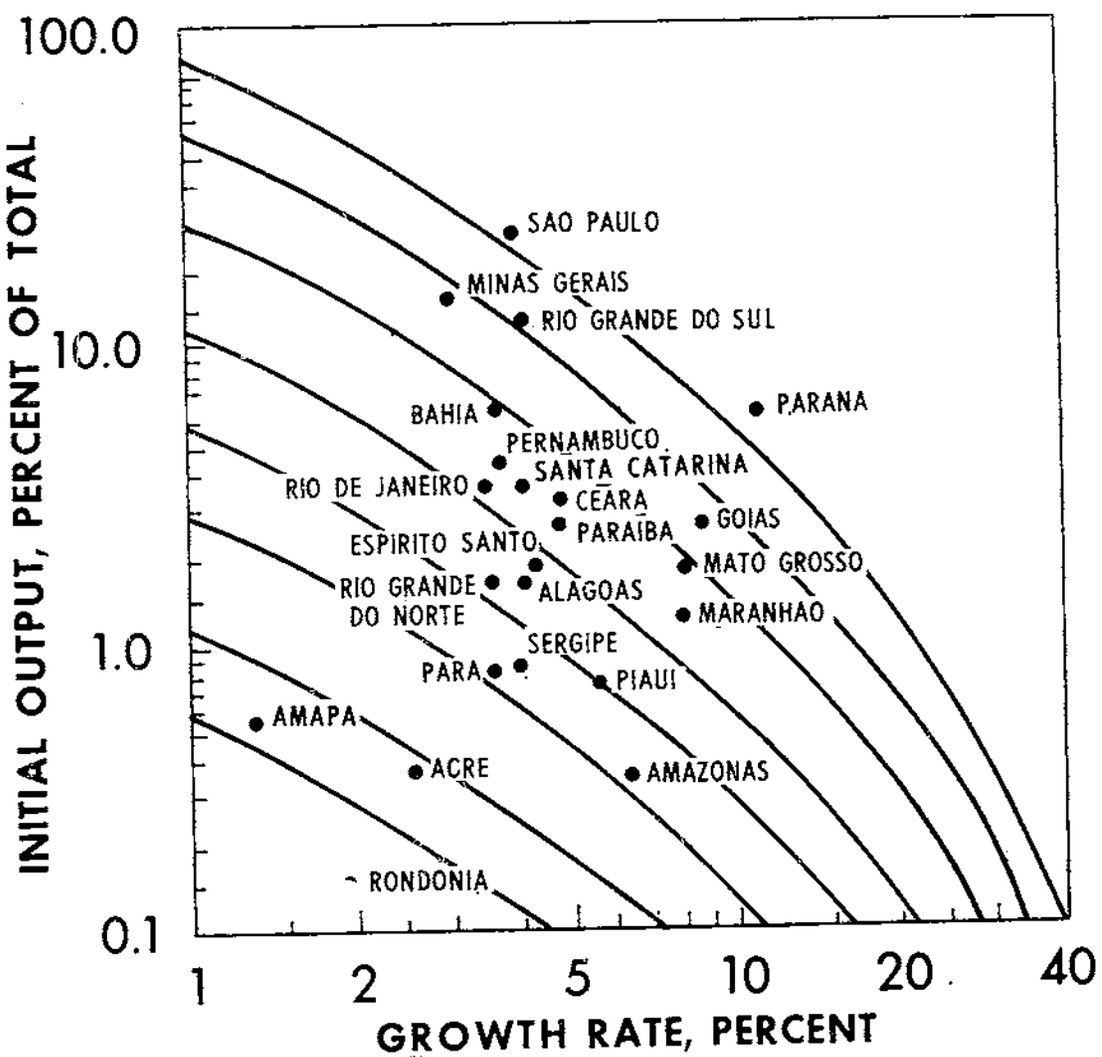
Figure 6

INCREASE IN BRAZILIAN FARM OUTPUT BY STATES, 1947-49 TO 1963-65



CURVES CONNECT ALL COMBINATIONS OF INITIAL IMPORTANCE AND GROWTH RATE GIVING EQUAL INCREASES IN OUTPUT AS PERCENT OF INITIAL TOTAL OUTPUT.
OUTPUT LESS THAN 0.1 PERCENT: RORAIMA. *DATA INCOMPLETE: GUANABARA, FEDERAL DISTRICT.*

U.S. DEPARTMENT OF AGRICULTURE NEG. ERS 8138-72 (2) ECONOMIC RESEARCH SERVICE

Figure 7

CHAPTER III.—CONTRIBUTIONS OF LAND AND LIVESTOCK NUMBERS AND PRODUCTIVITY

Land almost invariably leads the list of inputs contributing to agricultural output. In Brazil, changes in the amount of land under cultivation have accounted for an exceptionally high proportion of the total change in crop output (*132*, p. 19). Livestock output, on the other hand, is usually less highly correlated with land area. Hence, animal numbers are a more significant measure of livestock input than land used in livestock production. Given the dominant status of cropland and livestock numbers for explaining changes in crop and livestock output, it is convenient to express the collective effect of all other inputs in terms of yield per hectare of cropland, or per animal unit of livestock.

The following sections describe changes in cropland, pastureland, and livestock numbers in Brazil over the period 1947-65. These are followed by estimates and analyses of the contribution of these inputs to changes in agricultural output. Later chapters will consider other inputs and their effects.

Farmland

Because there is still much room for expansion in Brazil, land will continue to be an important source of increased agricultural output. Not only are there large areas which are publicly owned or unclaimed, but much potentially arable land is not yet under cultivation on existing farms. Moreover, most of the new areas can be cultivated with traditional techniques, although advanced techniques offer superior returns. Application of scientific methods for finding areas most likely to be productive—methods such as the Ministry of Agriculture is using for proposed colonization projects—would, of course, benefit spontaneous settlements as well as those developed under public programs.

Farmland occupied only 30 percent of the land area of Brazil in 1960 (table 15). Some of the remaining land suitable for farming was privately owned, but properties were not classified as farmland under census definitions unless crops or livestock were being produced. An enumeration of rural property in 1966 indicated that 36 percent of the total land area was privately owned (*17*, p. 40).

Some States have been occupied for many decades—Paraiba, Rio de Janeiro, and Rio Grande do Sul had more than 65 percent of their area in farms as early as 1920. In Sao Paulo, agriculture grew rapidly, with farmland constituting 56 percent of total area in 1920, and 75 percent in 1940. After Sao Paulo became fully settled, Parana began to absorb labor and capital in agriculture, and the percentage of land in farms rose from 40 percent to 59 percent between 1950 and 1960.

Percentage of land in farms remains lower in Bahia than in the other coastal States, because much of Bahia falls in the Drought Polygon, lacks transportation, and has low agricultural value. Other Northeastern States are also handicapped by generally unfavorable climate and topography. Elsewhere, low rates of occupancy result from difficulty of access or lack of local economic activity to generate demand for farm products.

Problems of access and lack of local economic activity are being solved. The longrun potential for agriculture, therefore, depends on how suitable the unoccupied areas may be for agriculture. Rainfall is generally adequate, and topography is more favorable to agriculture in the North and Central West than in the East and South. As much as 80 percent of land area in the North and Central West could be farmed, about the level of occupancy already attained in Sao Paulo and Rio Grande do Sul. Thus, some 260 million hectares of farmland might be added in the North, and 90 million hectares in the Central West, compared with the total of 250 million hectares of farmland in all of Brazil in 1960.

The quality of potential new farmland is good, if properly managed. The Ministry of Agriculture has rated the suitability of frontier lands at two levels of technology (table 16). Under traditional methods, agricultural potential of 93 percent of the area is relatively low. With the use of advanced known techniques, however, 63 percent of the area would have a relatively high potential.

Cropland

Cropland in Brazil increased from 19 million hectares in 1950 to 29 million hectares in 1960, and from 8 percent of land in farms to 11 percent. Intensity of cultivation, as measured by the proportion of farmland in crops, varied widely among States, but increased during the decade in all States except the urban State of Guanabara (table 17)

Cropping intensity under current Brazilian practices appears to have reached a maximum of about 25 percent of land in farms. Parana has exceeded this ratio, but several States which had 20-25 percent of farmland in crops by 1940 showed little further change by 1960. This apparent ceiling to cropping intensity reflects limits set by rough topography and low natural fertility and other soil characteristics that, under present technology, make continuous cropping unprofitable.

Table 15.—Land area and land in farms, and estimated potential future increase in farmland, by States, Brazil, 1960

State and region	Total land area of State	Total land in farms		Potential additional farmland[1]
		Area	Percentage of total land area of State	
	Million hectares	*Million hectares*	*Percent*	*Million hectares*
NORTH				
Rondonia	24.3	0.3	1	19.1
Acre	15.3	9.4	61	2.8
Amazonas	155.9	6.4	4	118.3
Roraima	23.0	.9	4	17.8
Para	122.8	5.3	4	92.9
Amapa	13.9	1.2	9	9.9
NORTHEAST				
Maranhao	32.5	8.2	25	17.8
Piaui	25.1	9.1	36	11.0
Ceara	14.7	10.9	75	1.0
Rio Grande do Norte	5.3	3.7	70	.6
Paraiba	5.6	4.1	72	.4
Pernambuco	9.8	5.9	60	1.9
Alagoas	2.8	1.9	69	.3
EAST				
Sergipe	2.2	1.5	67	.3
Bahia	56.0	17.7	32	27.1
Minas Gerais	58.3	38.3	67	7.4
Espirito Santo	4.6	2.9	63	.8
Rio de Janeiro	4.2	3.0	71	.4
Guanabara	.1	(2)	40	(2)
SOUTH				
Sao Paulo	24.7	19.3	78	.5
Parana	19.9	11.3	57	4.5
Santa Catarina	9.5	5.9	62	1.7
Rio Grande do Sul	26.8	21.7	81	-.3
CENTRAL WEST				
Mato Grosso	123.1	31.0	25	67.6
Goias	64.2	28.9	45	22.5
Distrito Federal	.6	.9	24	.3
REGIONAL SUMMARY				
North	355.4	23.5	7	260.8
Northeast	96.0	43.9	46	33.0
East	125.3	64.3	51	36.0
South	80.9	58.3	72	6.4
Central West	187.9	60.0	32	90.4
Brazil	845.7	249.9	30	426.6

[1] Based on the assumption that farmland reaches 80 percent of total land area in all States. [2] Less than 0.05 percent. Totals and percentages calculated from unrounded data.

Sources: (*24*) and (*25*, 1967, p. 18).

Table 16.—Suitability of land for agriculture, frontier region, Brazil[1]

Suitability class	Assumed traditional management		Assumed use of advanced known techniques	
	Mil. ha.	*Pct.*	*Mil. ha.*	*Pct.*
I	10.1	2	198.9	33
II	6.6	1	180.0	30
III	338.4	56	28.2	5
IV	221.0	37	169.0	28
Not determined	24.7	4	24.7	4
Total	600.8	100	600.8	100

[1] Compositive information collected over period of several years.

Source: Division of Pedology and Soil Fertility, Ministry of Agriculture.

Of the total area added to cropland in Brazil between 1950 and 1960, more than one-fifth was in Parana alone (table 17). The next largest increase was in Rio Grande do Sul. Five other States increased cropland more than Sao Paulo. The latter, as previously mentioned, had its most rapid agricultural expansion between 1920 and 1940. Between 1950 and 1960, Sao Paulo accounted for only 5 percent of Brazil's total increase in cropland.

States comprising the "old" agricultural region of Brazil (see p. 11) had 16.3 million hectares of cropland in 1950, about 85 percent of the total. Cropland occupied about 12.5 percent of the land in farms in this area. Between 1950 and 1960, area in cropland in the "old" States increased about 35 percent, compared with about 140 percent in the "new" States. The compound

Table 17.—Cropland, by States, Brazil, 1950 and 1960

State and region	Area		Percentage of farmland		Increase, 1950-60	
	1950	1960	1950	1960	Area	Percentage
	1,000 ha.	*1,000 ha.*	*Percent*	*Percent*	*1,000 ha.*	*Percent*
NORTH						
Rondonia	4	12	1	4	8	177
Acre	14	20	(1)	(1)	6	43
Amazonas	53	95	1	1	42	79
Roraima	1	2	(1)	(1)	1	204
Para	162	295	2	6	133	82
Amapa	1	9	(1)	1	8	1,196
NORTHEAST						
Maranhao	329	896	3	11	567	172
Piaui	225	464	3	5	239	106
Ceara	827	1,565	8	14	738	89
Rio Grande do Norte	444	621	12	17	177	40
Paraiba	661	1,012	18	25	351	53
Pernambuco	999	1,397	20	24	398	40
Alagoas	282	430	19	22	148	53
EAST						
Sergipe	136	179	12	12	43	32
Bahia	1,372	2,163	9	12	791	58
Minas Gerais[2]	2,992	3,599	8	9	607	20
Espirito Santo	588	738	23	26	150	25
Rio de Janeiro	588	598	19	20	10	2
Guanabara	22	24	53	50	2	8
SOUTH						
Sao Paulo	4,258	4,768	22	25	510	12
Parana	1,358	3,441	17	30	2,083	153
Santa Catarina	670	993	13	17	323	48
Rio Grande do Sul	2,503	3,710	11	17	1,207	48
CENTRAL WEST						
Mato Grosso	143	374	(1)	1	229	161
Golas	465	989	2	3	524	113
Distrito Federal	(3)	4	---	3	4	---
REGIONAL SUMMARY						
North	235	432	1	2	197	84
Northeast	3,766	6,386	9	15	2,620	70
East	5,698	7,616	10	12	1,918	34
South	8,788	12,912	16	22	4,124	47
Central West	608	1,366	1	2	758	125
Brazil	19,095	28,712	8	11	9,617	50

[1] Less than 0.5 percent. [2] Includes Serra dos Aimores, territory in litigation between Minas Gerais and Espirito Santo. Totals and percentages obtained from unrounded data. [3] Included in Golas in 1950.

Source: *(24)*.

annual rates of change were 3.1 and 9.1 percent, respectively.

Cropland may continue to increase in some of the old States, particularly where farming has been held back by transportation difficulties. However, some areas now being cropped are too steep or rocky for machine cultivation, and may be withdrawn as technology advances. In the frontier States, more than twice as much new land might be cropped as is now under cultivation in all of Brazil (table 18). Topography and rainfall in the frontier States would permit a much higher proportion of land in crops than presently prevails in the old States. However, the suitability of the frontier lands for cropping depends greatly on techniques and level of management. Under advanced management, as has already been noted, the agricultural potential of about two-thirds of the area is high.

Pastureland

A fairly close relationship exists between crop output and area used for crops. Livestock output, on the other hand, is less closely related to measure of land area. Yet, changes in the amount of land used for pasture do give some indication of changes in livestock output. Farther on in this report, livestock numbers are used as a measure of the principal physical input to the livestock sector of total agriculture, and for the measure of productivity in the livestock section.

Pastureland in Brazil increased from 108 million hectares in 1950 to 122 million hectares in 1960

(table 19). Pasture areas decreased in some of the northern States, but these declines may not be meaningful because data on farmland in this part of Brazil are more precarious than for the rest of the country. The decline in pastureland in Maranhao was accompanied by a large decrease in reported total farm area.

Large increases in pastureland in Bahia and Minas Gerais accompanied increases in total farmland and decreases in forest and idle land. Sao Paulo increased pastureland by 1.2 million hectares, compared with increases of 0.5 million hectares in cropland and 0.3 million hectares in total farmland. Forest land remained practically unchanged, but "idle and unproductive" land was reduced by 1.5 million hectares.

Table 18.—Cropland potentials, Brazil, 1960

Item	Unit	Settled States[1]	Frontier States[2]	Brazil
Total land area	Million ha.	247.8	600.9	845.7
Cropland	do.	25.6	3.1	28.7
Do.	Percent	10.3	.5	3.4
Potential cropland[3]	Million ha.	25.6	62.5	88.1

[1] Former South, East, and Northeast regions, less Maranhao and Piaui. [2] Former North and Central West regions, plus Maranhao and Piaui. [3] Assumes that cropland in the settled States remains at the 1960 level, and that cropland in the frontier reaches the same average percent of total area as in settled States.

Source: Compiled from (24).

Table 19.—Pastureland, by States, Brazil, 1950 and 1960[1]

State and region	1950	1960	Change	
	1,000 ha.	*1,000 ha.*	*1,000 ha.*	*Percent*
NORTH				
Rondonia	3	5	2	67
Acre	103	21	-82	-80
Amazonas	94	123	29	31
Roraima	508	708	200	39
Para	1,597	993	-604	-38
Amapa	128	371	243	190
NORTHEAST				
Maranhao	3,495	2,474	-1,021	-29
Piaui	2,101	2,615	514	24
Ceara	2,392	3,370	978	41
Rio Grande do Norte	1,315	1,840	525	40
Paraiba	1,343	1,875	532	40
Pernambuco	1,023	1,944	921	90
Alagoas	298	540	242	81
EAST				
Sergipe	405	735	330	81
Bahia	4,605	6,264	1,659	36
Minas Gerais	22,990	25,945	2,955	13
Espirito Santo	584	843	259	44
Rio de Janeiro	1,343	1,447	104	8
Guanabara	6	9	3	50
SOUTH				
Sao Paulo	8,648	9,872	1,234	14
Parana	2,249	2,694	445	20
Santa Catarina	1,878	1,993	115	61
Rio Grande do Sul	14,616	13,540	-1,076	-7
CENTRAL WEST				
Mato Grosso	20,379	22,598	2,219	11
Goias	15,583	19,168	3,585	23
Distrito Federal	([2])	85	85	---
REGIONAL SUMMARY				
North	2,432	2,220	-212	-9
Northeast	11,967	14,658	2,691	22
East	29,932	35,508	5,576	19
South	27,340	28,099	759	2
Central West	35,962	41,851	5,889	16
Brazil	107,633	122,335	14,702	14

[1] Totals from unrounded data. [2] Included in Goias in 1950.

Source: (24).

Pastureland declined by 1 million hectares in Rio Grande do Sul, where total farmland and unproductive land also declined. It will be recalled that cropland in Rio Grande do Sul increased by 1.2 million hectares between 1950 and 1960.

Increases in pastureland in Mato Grosso and Goias about matched the increase in total farmland in those States, and accounted for more than one-third of the total increase in pastureland in Brazil.

Livestock Numbers

Meat and milk from cattle accounted for more than two-thirds of the value of the eight livestock products considered in this study (table 14). Livestock numbers expressed in animal units also show the predominance of cattle (table 20). Changes in cattle numbers, therefore, explain a considerable part of the change in livestock output.

Estimates of cattle numbers made annually by the Production Statistics Service (SEP) rose more between 1940 and 1960 than cattle numbers enumerated in the respective censuses. The annual rates of increase were 3.4 percent and 1.7 percent, respectively. If the lower rate of change shown by the census were used for the inventory component of livestock output, the average annual rate of increase of total agricultural output would have been reduced about 0.1 percentage point.

About two-thirds of the cattle in Brazil are in the East and South regions (table 21). Rates of increase varied considerably among States within regions, as they did for cropland and pastureland. Cattle numbers increased most rapidly in the States of Parana and Mato Grosso. The absolute increase in number of cattle in Mato Grosso between the 1950 and 1960 censuses was larger than in any other State, although Mato Grosso remained behind Minas Gerais, Sao Paulo, and Rio Grande do Sul in total numbers. Cattle numbers, like cropland, increased relatively more in the principal frontier States of the 1947-65 period: Parana, Mato Grosso, and Maranhao.

Aggregate Input of Cropland and Livestock

Total land and livestock inputs to agricultural production increased at the average rate of 3.9 percent a year from 1947 to 1965 (table 22). Cropland increased somewhat more rapidly than livestock numbers, 4.0 percent and 3.9 percent, respectively.

In area devoted to crops, high growth rates were achieved in the two States of the Central West and in Parana, Maranhao, and Piaui. Parana also led the increases in livestock numbers.

High growth rates were achieved in some of the States and territories of the North, but the production base was small. This region still contributes relatively little to Brazil's total agricultural output.

Productivity

Output per unit of input (hectares of cropland plus equivalent animal units of livestock) in Brazil increased at an overall rate of about 0.6 percent a year between 1947 and 1965. The "productivity" expressed in this measure is a gross productivity composed of several elements in the calculation of total agricultural output. Only a small part of the overall change in productivity was attributable to such technological advances as improved crop varieties and heavier use of fertilizer. The following sections analyze and measure several components of the overall change in productivity: area (or livestock numbers), location of production, and product composition of total output.

Total agricultural output was measured for this study by multiplying the output of each product in each State by its 1957-59 average price in that State and summing the products. A shift of acreage (or livestock numbers) from one product to another or from one State to another may cause total output to change, although total inputs may remain the same. If total inputs remain the same, any change in output would be the result of change in crop pattern. Crop pattern, in turn, has two components, one arising from shifts in the proportions

Table 20.—Livestock numbers by species and animal units, Brazil, 1950 and 1960

Species	Number of head, Dec. 31				Animal units[1]	
	1950		1960		1950	1960
	SEP[2]	Census	SEP[2]	Census		
	Million					
Cattle	53	47	74	56	5.1	7.2
Swine	26	23	48	n.a.	1.0	1.8
Sheep	14	13	18	n.a.	.2	.2
Goats	9	7	11	n.a.	.1	.1
Chickens	59	74	106	n.a.	.1	.2
All poultry	111	78	184	n.a.	.2	.3
Total[3]	---	---	---	---	6.5	9.6

n.a.=not available.
[1] Area-equivalent animal units: each unit consists of the number of head producing the same value of output as 1 hectare of crops (average of 24 crops), calculated separately for each State. [2] Production Statistics Service. [3] Totals from unrounded data.

Table 21.—Cattle numbers, by States, Brazil, 1950 and 1960

State and region	Cattle numbers			
	July 1, 1950	Sept. 1, 1960	Change	
	Thousands	Thousands	Thousands	Percent
NORTH				
Rondonia	2	3	1	50
Acre	27	33	6	22
Amazonas	88	139	51	58
Roraima	141	166	25	18
Para	743	841	99	13
Amapa	31	46	15	48
NORTHEAST				
Maranhao	959	1,369	410	43
Piaui	1,039	1,126	87	8
Ceara	1,186	1,343	157	13
Rio Grande do Norte	480	491	11	2
Paraiba	701	760	59	8
Pernambuco	894	940	46	5
Alagoas	302	402	100	33
EAST				
Sergipe	415	494	79	19
Bahia	4,035	4,570	535	13
Minas Gerais	10,483	11,880	1,397	13
Espirito Santo	494	648	154	31
Rio de Janeiro	876	1,074	198	23
SOUTH				
Sao Paulo	5,880	7,155	1,275	22
Parana	806	1,630	824	102
Santa Catarina	1,004	1,196	192	19
Rio Grande do Sul	9,211	8,683	-528	-6
CENTRAL WEST				
Mato Grosso	3,511	5,631	2,120	60
Goias	3,530	[1] 4,864	1,334	38
REGIONAL SUMMARY[2]				
North	1,031	1,229	198	19
Northeast	5,561	6,424	863	16
East	16,357	18,880	2,523	15
South	16,901	18,664	1,763	10
Central West	7,041	10,495	3,454	49
Brazil	46,891	55,693	8,802	19

[1] Including Federal District. [2] Regional and national totals include areas in litigation.

Source: (*24*).

of total output produced at different locations and one arising from changes in the proportion of total output represented by individual products.

National average output per unit of input free of crop pattern effects (hereafter called pure yield) was calculated for each year of the 1947-65 period by averaging the percentage changes in yields of products by States. The base period averages of crop area were used as weights. The resulting series—pure yield without location or product components—increased at the rate of 0.2 percent a year, rather than the 0.6 percent indicated by the ratio of total output to total inputs (gross yield) (fig. 8), or the 0.3 percent indicated by a measure of yields weighted by the value of production in the base period.

Trends in productivity of individual products varied considerably around the overall national average. State, regional, and product group averages also diverged from the overall national average.

Gross rates of change in yield of individual products tended to be larger (in the positive direction) than pure rates (tables 23 and 24). The crop pattern component implicit in the difference between the gross and pure rates resulted from a tendency of area planted to increase most where yields or prices or both tended to be above national averages.

Coffee yields showed the widest discrepancy between rates of change in gross yield (0.5 percent) and pure yield (-0.8 percent). The difference resulted from changing location of production, particularly the shift to

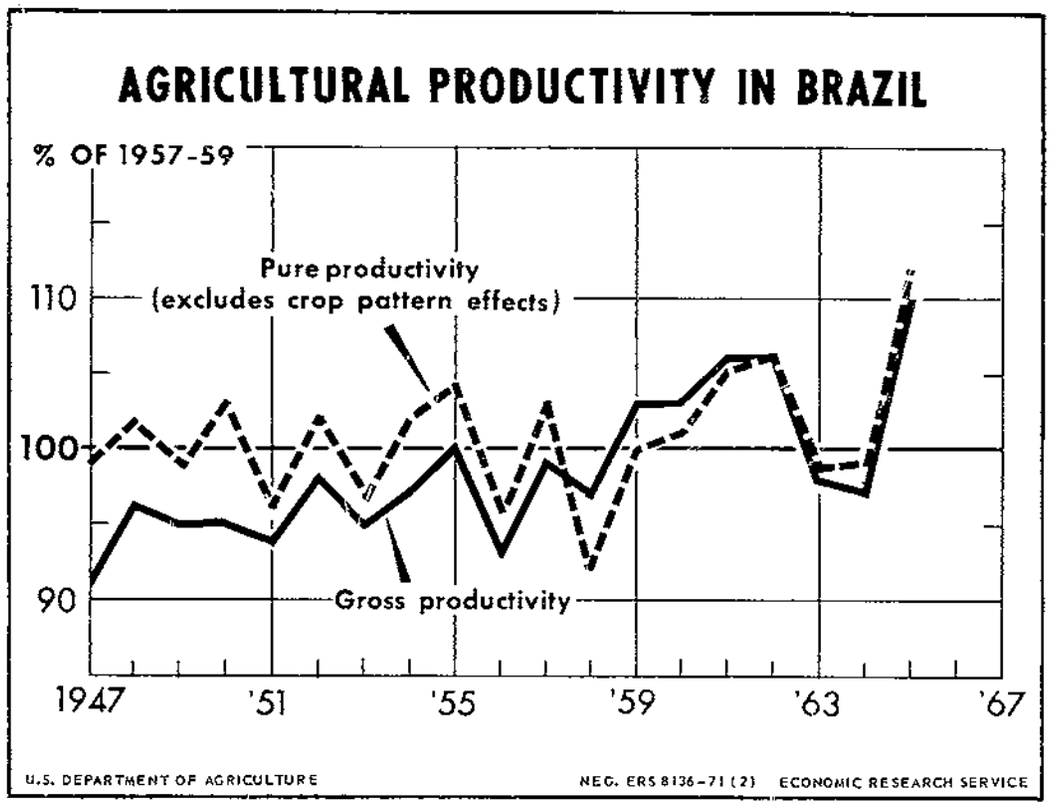


Figure 8

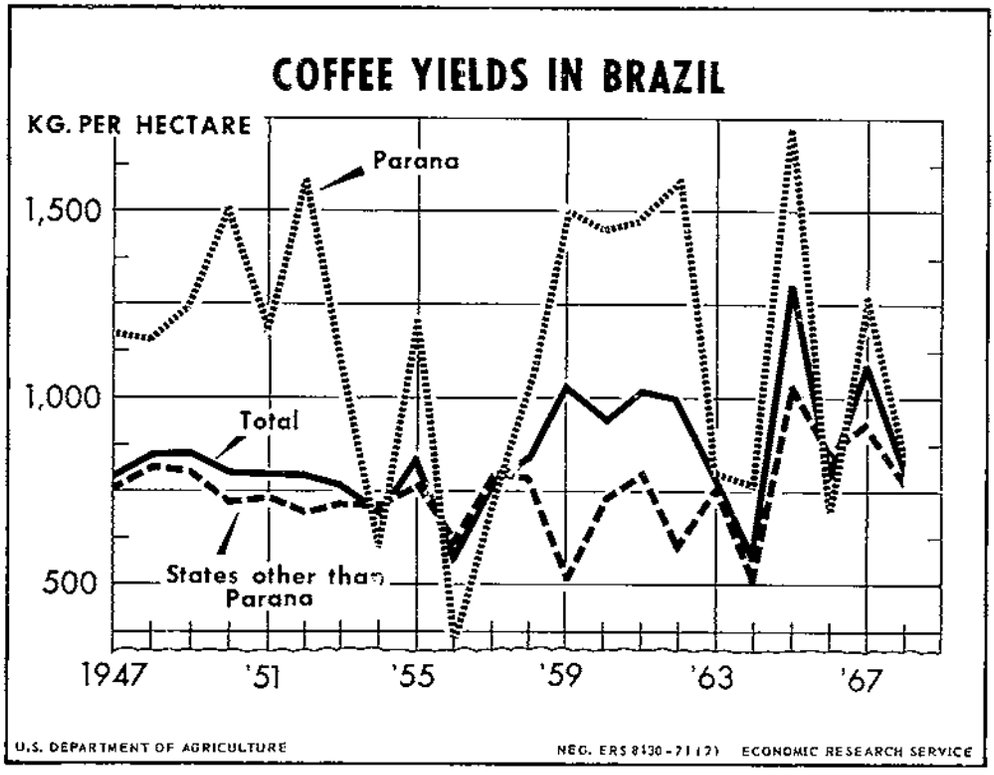


Figure 9

Table 22.—Rates of change in crop area and livestock numbers, 32 products, by States, Brazil, 1947-65

State and region	Crops	Livestock	Total[1]
	Percent		
NORTH			
Rondonia	24.0	4.8	12.9
Acre	2.2	3.9	2.7
Amazonas	8.3	5.6	7.0
Roraima	11.5	1.9	2.4
Para	4.4	2.4	3.6
Amapa	13.3	-.1	3.3
NORTHEAST			
Maranhao	9.0	4.5	7.8
Piaui	8.8	2.5	6.0
Ceara	4.8	1.1	4.2
Rio Grande do Norte	3.6	2.0	3.5
Paraiba	3.8	4.6	3.9
Pernambuco	4.2	2.5	4.0
Alagoas	4.3	5.5	4.5
EAST			
Sergipe	3.6	3.7	3.6
Bahia	4.7	3.5	4.3
Minas Gerais	2.5	3.6	2.8
Espirito Santo	3.7	4.5	3.8
Rio de Janeiro	2.7	2.6	2.7
Guanabara	—	—	—
SOUTH			
Sao Paulo	.9	3.8	1.4
Parana	8.7	8.6	8.7
Santa Catarina	3.4	4.1	3.6
Rio Grande do Sul	4.2	1.9	3.4
CENTRAL WEST			
Mato Grosso	11.8	7.4	8.5
Goias	10.4	4.5	7.4
Distrito Federal	—	—	—
REGIONAL SUMMARY			
North	5.0	2.8	4.0
Northeast	5.0	3.0	4.6
East	3.1	3.5	3.2
South	3.5	3.4	3.5
Central West	10.8	6.0	7.9
Brazil	4.0	3.8	3.9

[1] Livestock included on the basis of area-equivalent animal units. (Each unit consists of the number of animals whose 1957-59 average production, valued at 1957-59 prices, would equal the average value of crop output per hectare.) Number of animals comprising a unit was determined separately for each State.

Parana. Parana's share of Brazil's coffee area increased from 8 percent in 1947-49 to 35 percent in 1963-65, and yields were generally much above the average for the rest of Brazil (fig. 9). Coffee yields in both Parana and Sao Paulo declined about 0.5 percent a year from 1947 to 1965. In Minas Gerais, which ranked third in total area in 1963-65, coffee yields declined 1.7 percent a year over the 19 years.

Total livestock productivity (meat and livestock products) increased at the rate of 0.7 percent a year, gross basis, and 1.4 percent pure basis (table 24). In the meat subgroup, of which beef was the dominant item, gross and pure rates were practically identical. Considering the possible overstatement of the increase in cattle numbers (above p. 12), the trend in yield may, in fact, have been slightly upward, about 0.1 percent a year.

Milk output per head of cattle increased at a high rate, but the figures must be interpreted cautiously. Since annual estimates of milk cow numbers were not available, milk yield here is output per head of all cattle. Yields may reflect a rise in proportion of cows milked, rather than an increase in output per cow in the milking herd. The pure rate of change in milk yield was higher than the gross rate. The gross rate reflects the more rapid growth of cattle numbers in States producing relatively little milk.

Comparing gross and pure rates of change in yield by States and regions measures the effect of shifts among products. The pure rate of change in yield is calculated from State average yields weighted by base period inputs (hectares or animal units). Gross rates of change, being calculated from total output divided by total input of the given year, include the effect of change in the proportionate allocation of inputs among enterprises. Gross rates for regions also include effects of changes in the area allocated to a given enterprise among States.

Gross and pure rates of change in output per composite unit of land and livestock generally differed less in the State and regional averages than in the national averages for individual products (table 25). Gross yields again tended to increase more than pure yields, implying that within a State, yields tended to increase most for products having above-average values per hectare or per animal unit.

Trends in livestock output per animal unit showed greater variation among States than trends in crop yields, as shown in table 26.

Crop Yields and Expansion in New Areas

Differences in soil fertility between new and old areas are stressed in Brazil as reasons for expansion of farming into new areas. Parana is frequently cited as a new, rapidly growing area in which yields are much higher than in the adjoining older area, Sao Paulo. To obtain a perspective on the relation between fertility levels and rates of expansion of crop area, yields of eight leading crops in three "old" areas—Sao Paulo, Minas Gerais, and Ceara—were compared with yields in four adjacent "new" areas—Parana, Mato Grosso, Goias, and Maranhao (table 27). Rates of growth of total crop area in the old areas ranged from 0.9 to 4.8 percent a year, and from 8.7 to 11.8 percent in the new areas. The question considered was, "To what extent were higher yields of a given crop in the new areas associated with more rapid growth in area of that crop?"

Table 23.—Changes in crop yields, specified crops, Brazil, 1947-65

Product	Rate of change in yield		Product	Rate of change in yield	
	Gross	Pure		Gross	Pure
	Percent			*Percent*	
Rice	[1]0.2	[1]0.1	Beans	-0.2	-0.5
Corn	[1].2	[1].2	Mandioca	[1].4	[1].2
Wheat	[1]-1.2	[1]-1.2	Sugarcane	[1].9	[1].5
Grains	([1])([2])	---	Coconuts	[1]1.8	[1]1.5
			Other foods	[1].1	---
Peanuts	2.1	1.8	Total food crops	[1].3	([1])([2])
Soybeans	[1]-1.1	[1]-1.0			
Oilseeds	[1]1.2	---	Cotton	1.2	1.0
			Sisal	.3	1.8
Potatoes	[1]1.5	[1]1.3	Jute	1.3	1.1
Sweetpotatoes	1.7	1.3	Fibers	1.7	1.1
Tomatoes	2.9	2.2			
Onions	[1].9	[1].9	Coffee	.5	-.8
Vegetables	1.8	---	Tobacco	[1].4	-.1
			Cocoa	-2.4	-2.4
Bananas	([1])([2])	-.1	Castorseed	.1	[1]-.8
Oranges	[1]-.2	[1].3	Other nonfood	-.8	-.9
Pineapples	[1].6	.8	Total 24 crops	.1	-.1
Grapes	.8	.9			
Fruits	.4	---			

[1] Growth rates for 1947-56 and 1957-59 differed significantly by F-test at the 5-percent level. [2] Less than 0.05 percent.

Table 24.—Changes in productivity of livestock, Brazil, 1947-65

Product	Rate of change in yield		Product	Rate of change in yield	
	Gross	Pure		Gross	Pure
	Percent			*Percent*	
Cattle	-0.4	-0.5	Milk	[2]3.3	[2]4.4
Hogs	-.7	-1.3	Eggs	[2].8	[2].5
Sheep	4.0	([1])	Wool	[2].2	1.8
Goats	1.1	1.0			
Poultry	[2]3.5	[2]1.2	Total livestock products	2.5	[2]4.2
Total meat	-.7	-.6			
			Total livestock	.7	[2]1.4

[1] Not available. [2] Growth rates for 1947-56 and 1957-59 differed significantly by F-test at the 5-percent level.

Sao Paulo—Parana

Yields of coffee and beans in Parana exceeded yields in Sao Paulo by 36 and 28 percent, respectively (table 28)[1]. Coffee acreage had a growth rate of 5 percent higher than all crops in Parana, but beans grew less rapidly than all crops, falling behind by 2.6 percent.

Rice yield was 6 percent lower in Parana than in Sao Paulo, but rice area gained more rapidly than area in all crops. Mandioca, also, yielding 10 percent less than in Sao Paulo, increased in area more rapidly than all crops.

Yields of six of the eight crops averaged higher in Parana than in Sao Paulo, but the margin of yield of corn—second only to coffee in area—was just 3 percent. Corn area increased more slowly than total crop area.

Sao Paulo—Mato Grosso

Yields of coffee, bananas, and beans in Mato Grosso exceeded yields in Sao Paulo by 147, 75, and 41 percent, respectively, (table 29). Coffee area grew more rapidly than area of all crops in Mato Grosso by 2.6 percent, but area of bananas and beans grew less rapidly than area of crops.

Cotton yields were 1 percent lower in Mato Grosso than in Sao Paulo, but cotton area in Mato Grosso grew at an annual rate 9 percent higher than area of all crops.

Yields of sugarcane and mandioca were both lower in Mato Grosso than in Sao Paulo. Area of both crops

[1] Average of 9 years, 1947-49, 1955-57, and 1963-65. Selection of these years was based on convenience, since average yields for the three 3-year periods were already available when the analysis was undertaken.

Table 25.—Changes in State and regional average output per composite unit of land and livestock, compound annual rates, Brazil, 1947-65

State and region	Gross	Pure	State and region	Gross	Pure
	Percent			*Percent*	
NORTH			SOUTH		
Rondonia	-0.3	-0.3	Sao Paulo	0.9	0.7
Acre	1.1	.7	Parana	.1	.2
Amazonas	1.4	1.9	Santa Catarina	.4	.2
Roraima	1.2	([1])	Rio Grande do Sul	.4	.2
Para	.4	.3			
Amapa	-2.2	-2.7	CENTRAL WEST		
NORTHEAST			Mato Grosso	-1.1	-1.4
			Goias	.1	.5
Maranhao	.3	.5	Distrito Federal	---	---
Piaui	.1	.4			
Ceara	.7	.4	REGIONAL SUMMARY		
Rio Grande do Norte	.3	.1			
Paraiba	.7	.8	North	.6	.0
Pernambuco	-.2	-.4	Northeast	.2	.0
Alagoas	-.6	-1.0	East	.0	-.1
			South	.6	.5
EAST			Central West	-.4	-.4
Sergipe	-0.2	-0.5	Brazil	.3	.2
Bahia	-.5	-.4			
Minas Gerais	-.2	-.2			
Espirito Santo	.5	.5			
Rio de Janeiro	.8	-.2			
Guanabara	---	---			

[1] Valid calculations could not be made, owing to unusual changes in cattle numbers during the base period (1957-59).

Table 26.—Changes in crop yields and output per animal unit of livestock, gross basis, compound annual rates, by States and regions, Brazil, 1947-65

State and region	Gross rate of change in yield		State and region	Gross rate of change in yield	
	Crops	Livestock		Crops	Livestock
	Percent			*Percent*	
NORTH			SOUTH		
Rondonia	0.3	-0.8	Sao Paulo	0.8	[1] 1.3
Acre	[1] .5	1.7	Parana	-.1	1.0
Amazonas	[1] 1.1	12.0	Santa Catarina	.2	.7
Roraima	-.6	[1] -6.6	Rio Grande do Sul	[1] .1	1.4
Para	[1] -.2	1.3			
Amapa	[1] -3.1	7.8	CENTRAL WEST		
NORTHEAST			Mato Grosso	[1] -.2	-1.5
			Goias	-.5	1.2
Maranhao	1.5	-2.0	Distrito Federal	--	--
Piaui	.6	1.8			
Ceara	.5	-5.3	REGIONAL SUMMARY		
Rio Grande do Norte	([2])	.2			
Paraiba	.4	1.7	North	[1] .1	1.3
Pernambuco	[1] -.2	[1] -.2	Northeast	.2	.2
Alagoas	[1] -.5	-.9	East	-.4	.8
			South	.4	[1] 1.2
EAST			Central West	[1] -.4	-.4
Sergipe	-0.1	-0.4	Brazil	.1	.7
Bahia	-1.1	1.0			
Minas Gerais	-.5	.3			
Espirito Santo	[1] .3	1.0			
Rio de Janeiro	-.1	2.4			
Guanabara	--	--			

[1] Growth rates for 1947-56 and 1957-59 differed significantly by F-test at the 5-percent level. [2] Less than 0.05 percent.

Table 27.—Yields per hectare of selected crops in selected "old" and "new" States, Brazil, 9-year average, 1947-49, 1955-57, and 1963-65

Crops[1]	Sao Paulo (Old)	Parana (New)	Mato Grosso (New)	Minas Gerais (Old)	Goias (New)	Ceara (Old)	Maranhao (New)
	Kilograms						
Corn	1,381	1,428	1,412	1,295	1,564	850	700
Rice[2]	1,355	1,269	1,527	1,609	1,601	1,598	1,281
Coffee[3]	707	959	1,745	677	1,482	561	851
Cotton[4]	716	834	710	499	517	366	363
Beans	641	823	905	601	898	504	552
Mandioca	18,468	16,712	16,935	15,790	16,984	13,867	9,945
Sugarcane	48,813	56,669	45,289	32,699	40,835	42,872	26,666
Bananas	14,196	18,545	24,880	18,933	21,907	20,558	29,729

[1] Ranked on basis of total acreage, 1963-65. The first 7 crops led all others; bananas ranked 14th. [2] Rough rice. [3] Berries in the pulp. [4] Seed cotton.

Table 28.—Relation of yield level of selected crops to rate of increase in crop area, Sao Paulo and Parana, Brazil, 1947-65

Crop	Yield[1]	Increase in crop area[2]	
		Sao Paulo	Parana
	Percent		
Coffee	36	-1.2	5.3
Bananas	31	[3]4.8	[3].2
Beans	28	[3]-.5	-2.6
Cotton	16	-4.8	2.6
Sugarcane	16	7.5	[3].5
Corn	3	1.3	-3.4
Rice	-6	.1	2.0
Mandioca	-10	[3]5.1	.5

[1] Percentage by which average yield in new area (Parana) exceeded yield in old area (Sao Paulo), 9-year average, 1947-49, 1955-57, and 1963-65. [2] Growth rate of crop indicated, relative to rate of growth of total cultivated area, 1947-65. [3] Value of output of this crop ranked lower than 7th among all crops in the State on the basis of value of output in 1962-64.

Table 29.—Relation of yield level of selected crops to rate of increase in crop area, Sao Paulo and Mato Grosso, Brazil, 1947-65

Crop	Yield[1]	Increase in crop area[2]	
		Sao Paulo	Mato Grosso
	Percent		
Coffee	147	-1.2	2.6
Bananas	75	[3]4.8	[3]-8.1
Beans	41	[3]-.5	-1.3
Rice	13	.1	3.1
Corn	2	1.3	-1.9
Cotton	-1	-4.8	9.0
Sugarcane	-7	7.5	[3]-5.5
Mandioca	-8	[3]5.1	-4.5

[1] Percentage by which average yield in new area (Mato Grosso) exceeded yield in old area (Sao Paulo), 9-year average, 1947-49, 1955-57, and 1963-65. [2] Growth rate of crop indicated, relative to rate of growth of total cultivated area, 1947-65. [3] Value of output of this crop ranked lower than 7th among all crops in the State on the basis of value of output in 1962-64.

expanded in Mato Grosso, but more slowly than total crop area, falling behind at rates of 5.5 and 4.5 percent, respectively.

Table 30.—Relation of yield level of selected crops to rate of increase in crop area, Minas Gerais and Goias, Brazil, 1947-65

Crop	Yield[1]	Increase in crop area[2]	
		Minas Gerais	Goias
	Percent		
Coffee	119	-0.4	0
Beans	49	-1.1	[3]-3.1
Sugarcane	25	-.3	-3.4
Corn	21	.1	-.5
Bananas	16	[3]1.1	[3]-1.8
Mandioca	8	-.5	-2.5
Cotton	4	[3]5.9	-4.1
Rice	0	.3	2.0

[1] Percentage by which average yield in new area (Goias) exceeded yield in old area (Minas Gerais), 9-year average, 1947-49, 1955-57, and 1963-65. [2] Growth rate of crop indicated, relative to rate of growth of total cultivated area, 1947-65. [3] Value of output of this crop ranked lower than 7th among all crops in the State on the basis of value of output in 1962-64.

Minas Gerais—Goias

The most rapidly growing crop in Goias was rice, with yields identical to those in Minas Gerais (table 30). Coffee yields in Goias were more than double those in Minas Gerais, but the rate of growth of coffee area was only average for the State. Beans, which yielded 49 percent higher in Goias than in Minas Gerais, failed by 3.1 percent a year to expand area as rapidly as total crop area.

Yields of all eight crops were as high or higher in Goias as in Minas Gerais.

Ceara—Maranhao

Yields of five of the eight crops were lower in Maranhao than in Ceara (table 31). In Maranhao, the most rapidly growing crop of the eight was rice, with yields averaging 20 percent less than in Ceara. Coffee, yielding 52 percent more in Maranhao, also grew at a higher than average rate, but it was not a major crop in either State.

Table 31.—Relation of yield level of selected crops to rate of increase in crop area, Ceara and Maranhao, Brazil, 1947-65

Crop	Yield[1]	Increase in crop area[2]	
		Ceara	Maranhao
	Percent		
Coffee	52	[3]-3.6	[3]1.5
Bananas	45	3.5	-.5
Beans	9	.8	1.6
Cotton	-1	.6	-.1
Corn	-18	.0	-.3
Rice	-20	1.0	2.8
Mandioca	-29	-2.8	-2.0
Sugarcane	-38	-1.4	-1.0

[1] Percentage by which average yield in new area (Maranhao) exceeded yield in old area (Ceara), 9-year average, 1947-49, 1955-57, and 1963-65. [2] Growth rate of crop indicated, relative to rate of growth of total cultivated area, 1947-65. [3] Value of output of this crop ranked lower than 7th among all crops in the State on the basis of value of output in 1962-64.

Discussion

Crops with rapidly expanding areas in newly developed or developing States of Brazil include crops which yielded less than in neighboring older States as well as crops yielding more. The data confirm the general belief that yields tend to be higher in the new areas, but the exceptions make it evident that high yield was not a necessary condition for expansion of area in the newer States.

Differences in crop yields among States appeared to depend to an important degree on factors other than soil fertility. In none of the States did yields of all crops differ from yields of the same crops in any adjoining State by a uniform percentage. In several instances, factors that made it profitable to expand output of a crop apparently overcame a yield disadvantage.

The data help to place in quantitative perspective the extent to which soil exhaustion affects the agricultural competition between old and new areas. The midpoint of the 32 differences in yields in tables 28-31 is about 11 percent. This indicates the approximate yield advantage of new areas, insofar as an average may be meaningful. The national average rate of change in crop yield ("pure" rate, excluding effect of shifts in location) was -0.1 percent a year (table 23, p. 30). At this rate of soil exhaustion (assuming that no other factors, such as insects and disease, contributed to the decline in yields), a difference of 11 percent in level of yield would require about 100 years to develop.

Such a low rate of decline in soil fertility appears inconsistent with the common observation that soils may be cropped for only a few years after being cleared of forest, then left to pasture or to revert to brushland or forest. But such a process is really not inconsistent with a relatively stable average fertility, maintaining a relatively fixed proportion of farmland under crops. In the older areas, this proportion has remained relatively constant at about 1 hectare in 4. In the newer areas, such as Parana, the proportion of cropland that is being cultivated for the first time each year is not large enough to influence State average yields perceptibly.

Much of Brazil's cropland was brought under cultivation for the first time within the past 40 years. In Sao Paulo, area in crops more than doubled between 1920 and 1940. Therefore, it may be assumed that at least half the cropland in the State had been cropped less than 30 years by the beginning of the period covered in the present study. Consequently, the fertility level would have declined only between 1 and 2 percent. These data suggest that present differences in yields between new and old areas result more from differences in the inherent productivity of the virgin soils than from soil exhaustion.

Summary

Foregoing sections have described in some detail the growth of agricultural output in Brazil during 1947-65, and have analyzed the principal components of change—crop area, livestock numbers, and productivity of land and livestock. The latter was measured at two levels, one representing as nearly as possible purely physical performance, the other including changes in patterns of production.

Crop yields tended to be higher in new areas, but this was not true of all crops and all areas. Cropland expanded inevitably in frontier areas, given accessibility and a supply of labor. If yields were higher than in old areas, this was gratifying; but if other factors were favorable, lower yields were not invariably a deterrent to expansion of new areas.

Value of output of 32 agricultural products increased 204 million new cruzeiros from 1947-49 to 1963-65 (1957-59 prices) (table 32).[2] Pure change in inputs accounted for 85 percent of the increase, pure change in yields 11 percent, and various other effects (net effects of shifts in locational and product patterns of production) the remainder. In terms of growth rates, total output increased 4.6 percent a year, pure inputs 3.9 percent, and pure yields 0.2, leaving 0.5 percent to be accounted for by the net effects of pattern changes.

[2] Rubber and babassu were omitted. Since these products are harvested mainly from wild trees, no estimates of land area occupied were available.

Table 32.—Principal components of change in agricultural output, Brazil, 1947-49 to 1963-65

Components other than input and yield	Total change	Factor component		
		Input	Yield	Interaction
	Million new cruzeiros			
Gross	204.3	186.6	14.0	3.7
Pure	217.5	174.0	23.1	20.4
Crop pattern	-13.2	12.6	-9.1	-16.7
	Components of crop pattern			
Location	-16.5	-6.4	-4.7	-5.4
Product	2.0	5.5	-1.2	-2.3
Location X product interaction	1.3	13.5	-3.2	-9.0
Total crop pattern	-13.2	12.6	-9.1	-16.7
	Components of change expressed as percentage of total gross changes			
	Percent			
Gross	100	91	7	2
Pure	106	85	11	10
Crop pattern	-6	6	-4	-8
	Components of crop pattern			
Location	-8	-3	-2	-3
Product	1	3	-1	-1
Location X product interaction	1	6	-1	-4
Total crop pattern	-6	6	-4	-8

CHAPTER IV.—CONTRIBUTIONS OF FACTORS COMPLEMENTARY TO LAND

Traditional agriculture in Brazil requires little except labor and land to achieve its normal production potential. Even traditional agriculture, however, needs some capital, in the fundamental sense of labor applied to produce income in future years rather than in the current year. Growing crops by traditional methods requires housing for the farmworkers and minimum tools. Tree crops and cattle production, both important in Brazil, have long production cycles. Hence, labor and other inputs employed in establishing plantations and herds do not begin to produce until later. Modern techniques in all agricultural enterprises require relatively greater amounts of capital in more complex forms.

Labor has a double role in agricultural development, since it is both an input factor and a residual claimant to income. Incomes in agriculture depend strongly on labor productivity. But labor also figures importantly in such forms of capital formation as land clearing and improvement and establishment of tree crop enterprises. Application of modern techniques in agricultural production is, to some extent, an indirect substitution of nonfarm labor for farm labor. Thus, total labor embodied in farm output declines somewhat less than employment on farms as a result of mechanization and similar technological changes.

Production inputs from nonfarm sources are commonly considered capital inputs, although many of them produce their effects in the current production period. Fertilizer, probably the most important item of this class of inputs, has become a symbol of modern inputs, because deficiency of soil nutrients commonly limits crop yields, and high levels of fertilizer use are associated with high productivity of land. The relation between fertilizer input and crop output is direct, and the significance of the physical output-input ratio and the corresponding price ratios is widely recognized (*132*, pp. 51-54; *112*, p. 194; *48*, p. 95; *108*, p. 11).

Other forms of capital are less easily equated to output. A shift from animal power to mechanical power creates an extremely complex set of adjustments. Genetic modifications in plants which increase yields by using solar radiant energy more efficiently (*135*, p. 255) do not necessarily involve any additional priced input. Likewise, an improved technique may modify the sequence or timing of operations, influencing output without changing the quantity of inputs. Recognizing therefore, that technological improvements often go beyond changes measurable as capital, it is still useful and significant to consider changes in measurable capital inputs.

This chapter describes and analyzes developments in the use of labor and capital during the past two decades, and evaluates their contributions to increases in output.

Labor

Rapid population growth has been a strong stimulus for change in Brazil, as elsewhere in the world. A burden on one one hand—essential social services have to be expanded to meet the needs of the people—it brings land into production with labor and little else. The rural population provides workers for new farms, more intensive exploitation of existing farms, and for additions to the urban labor force. An understanding of the record of farm employment and farm labor productivity in recent years is essential for a valid appraisal of prospects for the coming generation.

Rural Population Movements

Brazil's population was two-thirds rural in 1950 (fig. 10). Most of the rural population was in the States that had been settled longest (the Northeast less Maranhao, the East, and the South less Parana). Differential natural growth rates plus internal migration changed this pattern significantly during the 1950's. By 1960, the rural population in the newer areas had increased 56 percent while that in the older areas rose only 10 percent.

Net migration from the older rural areas between 1950 and 1960 amounted to about 7 million persons. About 6 million moved into urban areas, and 1 million into the newer rural areas. Rural Parana alone appears to have absorbed about three-quarters of a million migrants. In keeping with its rapid agricultural growth, Parana increased farm employment 110 percent between 1950 and 1960, equivalent to an average annual compound rate of 7.7 percent.

Rural areas closest to industrial centers felt the competition of nonfarm employment opportunities keenly from 1950 to 1960. Rio de Janeiro suffered a reduction of 28 percent in numbers of farmworkers (table 33). Farm employment in Sao Paulo and Minas Gerais—States important both industrially and agriculturally—increased only 1 and 8 percent, respectively. Agriculture in the affected areas is being modified accordingly (*142*, p. 17).

Farm Employment, 1950-60

The agricultural census of 1950 counted 11 million farmworkers, but omitted many persons whose only

Table 33.—Persons employed in agriculture, by States, Brazil, 1950 and 1960

State and region	1950[1]	1960	Change		
			Number	Percentage[2]	
				Total	Annual rate
	Thousands	*Thousands*	*Thousands*	*Percent*	*Percent*
NORTH					
Rondonia	3	4	1	31	2.7
Acre	10	30	20	198	11.5
Amazonas	84	167	83	98	7.1
Roraima	4	3	-1	-23	-2.6
Para	230	335	105	46	3.9
Amapa	4	5	1	13	1.2
NORTHEAST					
Maranhao	491	952	461	94	6.8
Piaui	302	358	56	19	1.8
Ceara	675	801	126	19	1.8
Rio Grande do Norte	256	299	43	17	1.6
Paraiba	483	553	70	15	1.4
Pernambuco	947	1,263	316	33	2.9
Alagoas	301	363	62	20	1.8
EAST					
Sergipe	162	249	87	53	4.3
Bahia	1,495	1,820	325	22	2.0
Minas Gerais[3]	2,108	2,272	164	8	.8
Espirito Santo	288	285	-3	-1	-.1
Rio de Janeiro	337	244	-93	-28	-3.2
Guanabara	20	20	0	0	0
SOUTH					
Sao Paulo	1,708	1,727	19	1	.1
Parana	611	1,285	674	110	7.7
Santa Catarina	433	575	142	33	2.9
Rio Grande do Sul	1,136	1,334	198	17	1.6
CENTRAL WEST					
Mato Grosso	126	187	61	49	4.1
Goias	399	499	100	26	2.3
Distrito Federal	---	3	3	---	---
REGIONAL SUMMARY[4]					
North	335	544	209	62	4.9
Northeast	3,456	4,590	1,134	33	2.9
East	4,410	4,890	480	11	1.0
South	3,888	4,921	1,033	27	2.4
Central West	525	688	164	31	2.7
Brazil	12,614	15,634	3,020	24	2.2

[1] Adjusted for undernumeration. See p. 37.
[2] Totals and percentages from unrounded numbers.
[3] Includes Serra dos Aimores.
[4] Includes Federal District.

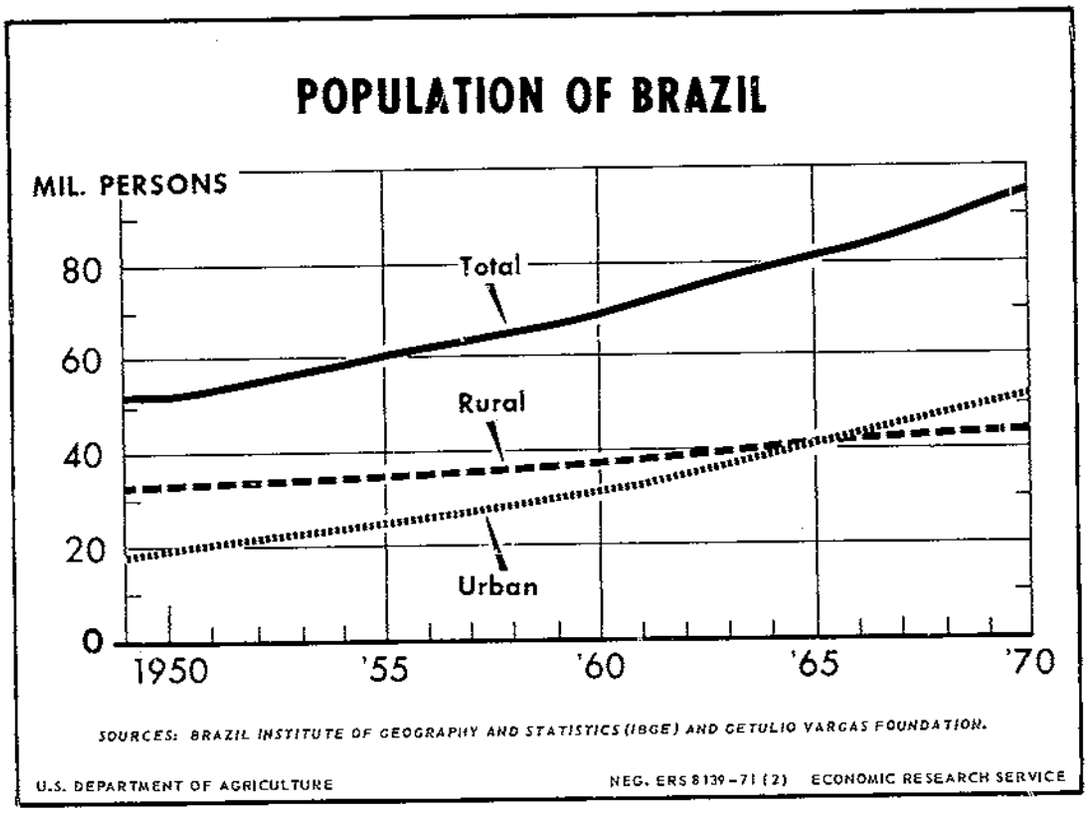


Figure 10

compensation was the right to use a plot of land. After adjustment for this undernumeration *(58, 59, 88,* p. 595, *127,* p. 3), the actual total number of persons working in agriculture was about 12.6 million. By 1960, the number of workers had risen to 15.6 million (table 34).

The composition of the agricultural labor force changed relatively little with respect to age or sex between 1950 and 1960—more so with respect to type of employment. The percentage of women and of workers under 15 years of age increased slightly—possibly reflecting superior opportunity for adult males in the urban labor market. Number of operators and unpaid family workers increased 18 percent, while share workers decreased 26 percent. The latter class, which included only 11 percent of all workers in 1950, is based on a definition involving the sharecropper's degree of control over his own activities. There is reason to question whether many who would have been placed in this class in 1950 might not have been classed as operators of share-rented farms in 1960. Numbers of share-rented farms were not tabulated in 1950, so this hypothesis cannot be tested with available data.

Farm Employment, 1960-68

Information about farm employment in the 1960's is provided by a survey of a national sample of households in 1968. The survey covered the Northeast, East, and South regions, but excluded the Central West and North. Definitions used were those of the demographic census, which had given lower counts of workers in agriculture in the 1950 and 1960 censuses. In the demographic census, women who may have worked in agriculture were commonly classified as housewives, and children attending school were classified as students, whether or not they also did farmwork. The household sample also enumerated only workers 14 years old and older, whereas the demographic census included persons 10 years old and older *(105).*

The demographic census of 1960 counted 11.7 million farmworkers. After adjusting the household sample results to comparable Brazil totals, agricultural workers by 1968 numbered between 12.6 and 13.4 million, giving a range of growth rates between 0.9 and 1.6 percent. The higher rate results from assigning all estimated 10-13-year-olds to agriculture, and is probably excessive. Thus, it seems clear that employment in agriculture grew less rapidly in the 1960's than in the preceding decade. In comparison, nonagricultural employment grew at annual rates of 4.2 percent between 1950 and 1960, and 6.8 percent between 1960 and 1968.

Regionally, the household sample data indicate that between 1960 and 1968 farm employment grew at

Table 34.—Persons employed in agriculture, selected classifications, Brazil, 1950 and 1960

Agricultural workers	1950		1960	
	Number[1]	*Percent*	*Number*[1]	*Percent*
Men	7,873,971	72	11,111,551	71
Women	3,122,863	28	4,522,434	29
Total	10,996,834	100	15,633,985	100
15(14) years and older[2]	9,102,556	83	12,653,563	81
Under 15(14) years[2]	1,894,278	17	2,980,422	19
Total	10,996,834	100	15,633,985	100
Operator and unpaid family	6,022,033	55	9,848,727	63
Wage workers	3,729,244	34	4,412,674	28
Share workers	1,245,557	11	916,039	6
Others[3]	---	---	456,545	3
Total	10,996,834	100	15,633,985	100
Adjustment for underenumeration	1,617,015			
Adjusted total	12,613,849			

[1] For details on the adjustment for underenumeration see (*58, 59, 88, 126,* p. 3). [2] Basis of classification shifted from 15 years in 1950 to 14 years in 1960. [3] Not enumerated in 1950. Apparently consists largely of workers whose compensation is the privilege of using a plot of land not qualifying as an agricultural establishment.

Source: (*24*).

annual rates of 0.1, -1.3, and 2.9 percent in the Northeast, East, and South, respectively.[1] Corresponding rates in the 1950's were 1.3, 1.5, and 1.9 percent. The heterogeneity of the South must be kept in mind. The agricultural labor force decreased in Sao Paulo while increasing enough elsewhere, especially in Parana, to give the region as a whole more rapid growth than either the East or Northeast.

Productivity of Farm Labor

The agricultural census data on farm employment leave little doubt that labor productivity increased substantially between 1950 and 1960, and 1968 data from the household sample survey indicate that the increase continued through the 1960's. Employment increased 2.2 percent a year, compared with the 3.9-percent increase in composite input of cropland and livestock numbers.

Number of workers relative to area of cropland dropped from 66 per 100 hectares in 1950 to 54 in 1960 (table 35). Farms in the South used the fewest workers per 100 hectares—44 in 1950 and 38 in 1960. Parana, which absorbed large numbers of agricultural workers during the decade, decreased its work force per 100 hectares of cropland at the same rate as other States in the South.

The influence of various factors that might account for a change in number of persons employed in agriculture per 100 hectares of cropland was calculated from State data for the census years 1950 and 1960. Proportion of cropland in labor intensive crops, livestock numbers per 100 hectares of cropland, proportion of livestock in the labor intensive class, ratio of firewood produced to area of cropland, and proportion of farms using only human power accounted for about 63 percent of the variation among States in numbers of persons employed per 100 hectares of cropland in 1950, and about 81 percent in 1960 (table 36).

Applying the 1950 regression coefficients to 1960 average values of the independent variables gives an estimate of 104 persons per 100 hectares of cropland. The average number in 1960 was 67.[2] With, in effect, 67 persons doing the work that would have required 104 persons at 1950 rates, the ratio of cropland to workers was about 55 percent greater in 1960 than in 1950.

Employment Prospects

Continued increases in agricultural employment may be expected. Brazil's population grew more rapidly than urban employment in the 1950's, although urban areas absorbed about six-sevenths of the population increase in older rural areas. Urban employment opportunities grew less rapidly than industrial production because of rising productivity per worker (*7*). A similar countercurrent apparently existed in Brazilian agriculture, but land was available to absorb labor freed by this process as well as that arising from the excess of natural increase of population over nonfarm employment. The rise in nonagricultural employment between 1960 and 1968, and the decline of farm employment in the East, suggest that agriculture may

[1] Regions as defined elsewhere in this report, except that here Bahia and Sergipe are included in the Northeast instead of the East (*105*).

[2] Unweighted average of the State averages. The figure of 54 persons per 100 hectares cited previously is a weighted average, reflecting the generally higher levels of labor productivity in the larger States.

soon have to compete more vigorously for its supply of labor. Older agricultural areas face continued restructuring of farming, as the labor market adjusts to trends in population, urban employment, and labor productivity.

Table 35.—Persons employed in agriculture, per 100 hectares of cropland, by States, Brazil, 1950 and 1960

State and region	1950[1]	1960
NORTH		
Rondonia	76	36
Acre	72	150
Amazonas	158	175
Roraima	559	152
Para	142	114
Amapa	648	56
NORTHEAST		
Maranhao	149	106
Piaui	134	77
Ceara	82	51
Rio Grande do Norte	58	48
Paraiba	73	55
Pernambuco	95	64
Alagoas	107	84
EAST		
Sergipe	120	139
Bahia	109	84
Minas Gerais	70	58
Espirito Santo	49	39
Rio de Janeiro	57	41
Guanabara	91	85
SOUTH		
Sao Paulo	40	36
Parana	45	37
Santa Catarina	65	58
Rio Grande do Sul	45	36
CENTRAL WEST		
Mato Grosso	88	50
Goias	86	50
Distrito Federal	---	70
REGIONAL SUMMARY		
North	143	126
Northeast	92	72
East	77	65
South	44	38
Central West	86	50
Brazil	66	54

[1] Based on adjusted number of persons employed. See p. 37.

Calculated from census data.

Wages of Agricultural Laborers

Monthly wages of common agricultural laborers averaged about NCr$76 ($20) a month at the end of 1968 (table 37) *(74)*. Wages were as much as NCr$106 in Rio Grande do Sul, and as low as NCr$53 in Paraiba. Managers and tractor drivers, the highest paid agricultural employees, earned NCr$139 and NCr$132, respectively. Wages of foremen were intermediate between those of common laborers and those of the highly paid groups. Differences in wages among States tended to correlate with differences in output per worker. Major exceptions were Rio Grande do Sul and Santa Catarina, where wages were far above the predominant relationship to output per worker, and the five States from Alagoas to Rio Grande do Norte, where they were low.

Table 36.—Factors influencing number of persons employed per 100 hectares of cropland, 1950 and 1960[1]

Variable	Unit	Regression coefficient	
		1950	1960
Crop intensity[2]	Percent	0.528	0.758
Number of livestock	Animal units	.019	-.039*
Livestock intensity[3]	Percent	.665	-1.588**
Timber production	M^3/hectare	5.653*	7.111**
Farms using human power only	Percent	.797**	.674**
Average number of persons employed per 100 hectares of cropland[4]	Number	88.0	67.2
R^2	---	.631**	.808**
Standard error of estimate	Number	25.2	16.7

* Significant at 5-percent level. ** Significant at 1-percent level. [1] All data for 1950, and all except timber in 1960, from the respective censuses of agriculture. Timber in 1960 from *(25)*. Some of the smaller States and territories were combined with larger ones as follows: Rondonia, Acre, and Roraima with Amazonas; Amapa with Para; Guanabara with Rio de Janeiro; and Federal District with Goias. [2] Ratio of total area of sugarcane, bananas, potatoes, oranges, tobacco, cocoa, and sisal to total area of 16 crops, including rice, corn, mandioca, peanuts, wheat, beans, soybeans, and perennial cotton. [3] Ratio of animal units of milk cows, hogs, sheep, goats, and poultry to total animal units. Numbers of milk cows for 1960 estimated from data on milk production, and unpublished estimates of milk cow numbers in 1964. [4] Arithmetic average of State averages.

Fertilizers

Productivity of land and labor may be explained largely on the basis of greater use of complementary inputs—fertilizers, plant protection materials, and machinery—which come increasingly from nonfarm sources.

Apparent consumption of fertilizers in Brazil increased from 74,000 metric tons (nutrient basis) in 1950 to 602,000 metric tons in 1968 (table 38). After reaching a peak of 248,000 metric tons in 1958, there was relatively little further change through 1966. The 1958 level of consumption per hectare was exceeded only once until 1967 (table 39).

Phosphates, of which Brazil has domestic supplies, accounted for about half the total consumption of fertilizers throughout the period, although their share of the total tended to decline. Nitrogen and potash consumption both rose relative to phosphates. Potash tonnage consistently exceeded that of nitrogen *(1, 2)*.

Geographic differences in consumption of fertilizers in Brazil were extreme (table 40). Nearly 90 percent of the nutrients were used in the South *(3)*. Total nutrients per hectare in Sao Paulo-Parana in 1959-61 were more

Table 37.—Wages of agricultural employees, by selected States, Brazil, July 1-December 31, 1968

State and region[1]	Manager	Foreman	Tractor operator	Laborer	Minimum[2]
	NCr$ per month[3]				
NORTHEAST					
Maranhao	95	89	96	72	79
Ceara	113	73	101	56	79
Rio Grande do Norte	107	76	103	60	79
Paraiba	102	73	81	53	79
Pernambuco	95	73	92	58	84
Alagoas	112	58	85	54	79
EAST					
Sergipe	103	90	118	70	79
Bahia	125	89	133	70	79
Espirito Santo	134	107	131	75	101
Rio de Janeiro	160	133	147	94	118
SOUTH					
Parana	162	119	119	88	101
Santa Catarina	187	161	175	97	125
Rio Grande do Sul	275	161	128	106	142
CENTRAL WEST					
Mato Grosso	220	148	157	85	120
Golas	163	143	227	85	120
Brazil	139	101	132	76	

[1] Data not reported for States not listed. [2] Some States are divided into two regions, with different minimums. In such instances, the lower minimum is given here, since the higher rates usually reflect urban employment conditions. [3] The new cruzeiro (NCr$) was exchanged at the rate of NCr$3.83 for US $1 in December 1968.

Sources: (*25*, 1968, p. 432) and (*74*).

Table 38.—Apparent consumption of fertilizers, Brazil, 1950-68

Year	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Total[1]
	1,000 metric tons	*1,000 metric tons*	*1,000 metric tons*	*1,000 metric tons*
1950	13.6	38.7	22.1	74.4
1951	17.9	59.2	27.4	104.5
1952	10.3	38.5	14.5	63.3
1953	21.0	56.4	30.7	108.2
1954	18.7	67.1	27.9	113.7
1955	23.6	74.2	48.8	146.6
1956	27.1	94.1	41.6	162.9
1957	26.8	115.1	60.2	202.1
1958	45.3	137.8	65.1	248.2
1959	60.8	121.8	57.4	240.1
1960	89.6	126.9	106.2	322.7
1961	55.1	118.8	70.7	244.6
1962	50.3	119.8	68.2	238.2
1963	62.1	153.4	91.8	307.2
1964	50.8	135.1	69.6	255.4
1965	70.6	120.1	99.7	290.4
1966	71.1	116.6	93.3	281.1
1967	106.4	204.6	136.9	447.9
1968	144.3	273.1	184.3	601.7

[1] Totals from unrounded data.

Sources: (*22*) and (*25*).

Table 39.—Fertilizer used per hectare, Brazil, 1950-68

Year	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Total[1]
	Kilograms	*Kilograms*	*Kilograms*	*Kilograms*
1950	0.8	2.2	1.2	4.2
1951	1.0	3.3	1.5	5.9
1952	.5	2.1	.8	3.4
1953	1.1	2.9	1.6	5.6
1954	.9	3.3	1.4	5.5
1955	1.1	3.5	2.3	6.8
1956	1.2	4.3	1.9	7.4
1957	1.2	5.0	2.6	8.8
1958	2.0	5.9	2.8	10.7
1959	2.5	5.0	2.4	9.9
1960	3.5	4.9	4.1	12.5
1961	2.1	4.4	2.6	9.1
1962	1.8	4.3	2.4	8.6
1963	2.1	5.2	3.1	10.4
1964	1.7	4.5	2.3	8.5
1965	2.2	3.8	3.1	9.1
1966	2.3	3.7	3.0	9.0
1967	3.3	6.4	4.3	14.0
1968	4.4	8.3	5.6	18.3

[1] Totals from unrounded data.

Table 40.—Fertilizer consumption, by regions, Brazil, annual averages, 1959-61

Region	Nitrogen N	Phosphate P_2O_5	Potash K_2O	Total
	1,000 metric tons			
North[1]	1.8	12.6	5.3	22.7
Central[2]	4.0	2.5	1.8	8.3
Central South[3]	51.7	74.0	60.5	186.2
South[4]	8.0	33.4	10.5	51.9
Total	68.5	122.5	78.1	269.1
	Kilograms per hectare			
North[1]	0.7	1.8	0.7	3.2
Central[2]	1.3	.8	.6	2.7
Central South[3]	4.6	6.5	5.3	16.4
South[4]	2.0	8.3	2.6	12.9

[1] Area served by ports of Belem, Macau, Recife, Maceio, and Salvador. [2] Area served by ports of Guanabara and Angra dos Reis. [3] Area served by ports of Santos, Paranagua, and Sao Francisco do Sul. [4] Area served by ports of Porto Alegre and Rio Grande.

Sources: Based on (22) and Report of Brazilian Work Group on the Fertilizer Situation in Brazil, Agri Research, Inc., 43 pp., Sept., 1963. (Typewritten.)

than five times the level of average usage in States to the north.

Most of the fertilizer used in the Northeast was applied to sugarcane (table 41). In Rio Grande do Sul, the bulk of the consumption was shared by rice and wheat. Sao Paulo had several crops—coffee, sugarcane, cotton, and vegetables—on which substantial quantities of fertilizer were used *(42)*.

Principal factors influencing the use of fertilizers are the physical production responses and product price ratios. Prices of fertilizers in Brazil are higher than in many other countries (*36*, pp. 53, 62; *105*, p. 118; *45*). Nitrogen, for example, cost the farmer from $0.36 to $0.89 a kilogram in 1967, depending on the State where it was purchased. Prices were lowest in States where usage was highest. The extremely high cost of fertilizer in low-usage States constitutes a formidable barrier to increased usage. The wholesale price per kilogram of nitrogen in calcium nitrate in Sao Paulo was $0.36, compared with $0.18 to $0.27 in other countries *(54*, p. 47). Consequently, relatively high crop response ratios were required to cover fertilizer costs (table 42). Ratios were generally most favorable in Sao Paulo. Neighboring Parana had higher fertilizer prices and lower crop prices than Sao Paulo; hence, higher response ratios would be needed to make fertilizer use profitable. Fertilizer prices reached their highest levels in real terms in 1965, and then declined (table 43).

Table 41.—Approximate utilization of fertilizers, by crops, selected regions, Brazil, 1967

Crop	Sao Paulo		Northeast		Rio Grande do Sul	
	Percentage of total consumed in region	Percentage of crop fertilized	Percentage of total consumed in region	Percentage of crop fertilized	Percentage of total consumed in region	Percentage of of crop fertilized
	Percent					
Coffee	15	25	---	---	---	---
Sugarcane	20	40	80	30	---	---
Cotton	10	35	---	---	---	---
Vegetables	25	90	1	15	---	70
Citrus	5	25	---	15	---	15
Bananas	5	25	---	15	---	---
Others	20	10	12	---	5	---
Tomatoes	---	---	5	90	---	---
Coconuts	---	---	3	10	---	---
Tobacco	---	---	---	50	15	75
Pasture, etc.	---	---	---	5	---	15
Rice	---	---	---	---	40	80
Wheat (rotation with soybeans and corn)	---	---	---	---	40	90
Grapes	---	---	---	---	---	15

Source: *(43)*.

Table 42.—Prices of fertilizer nutrients and selected farm products, Sao Paulo and Parana, Brazil, 1967

Item	Price per kg.		Kgs. of product to equal 1 kg. of fertilizer nutrient		
			N	P_2O_5	K_2O
	SAO PAULO				
	NCr$	*Dollars*[1]	*Kilograms*	*Kilograms*	*Kilograms*
Fertilizer:					
Nitrogen (N)	0.968	0.358			
Phosphate (P_2O_5)	.555	.205			
Potash (K_2O)	.380	.140			
Rice	.329	.122	2.9	1.7	1.1
Corn	.144	.042	8.5	4.9	3.3
Beans	.309	.114	3.1	1.8	1.2
Coffee (in the berry)	.279	.103	3.5	2.0	1.4
	PARANA				
Fertilizer:					
Nitrogen (N)	1.600	0.592			
Phosphate (P_2O_5)	.682	.252			
Potash (K_2O)	.508	.188			
Rice	.306	.113	5.2	2.2	1.7
Corn	.083	.031	19.1	8.1	6.1
Beans	.262	.097	6.1	2.6	1.9
Coffee	.281	.104	5.9	2.4	1.8
Wheat	.268	.099	6.0	2.5	1.9

[1] At rate of NCr$2.70 to US $1.

Sources: *(72 and 75)*.

Table 43.—Farm prices per metric ton of selected fertilizers, Rio Grande do Sul, Brazil, 1960-69

Year	Ammonium sulphate	Simple superphosphate	Potassium chloride
	NCr$ (current price)		
1960	8.55	6.21	8.39
1961	15.12	7.91	13.20
1962	29.86	17.79	32.78
1963	48.94	30.04	53.04
1964	117.27	72.90	121.36
1965	202.50	125.00	197.50
1966	225.00	129.30	215.00
1967	250.00	164.00	234.00
1968	231.80	190.00	222.30
1969[1]	300.00	240.00	305.00
	NCr$ (adjusted to 1969 price level)		
1960	224	162	219
1961	286	150	250
1962	360	214	395
1963	349	215	378
1964	469	289	485
1965	555	342	541
1966	408	235	390
1967	356	234	333
1968	290	237	278
1969[1]	300	240	305

[1] July-August. The average rate of exchange of the new cruzeiro was NCr$4.125=US$1.

Sources: Current prices from *(86)*. Adjusted prices calculated on basis of index of wholesale prices of farm products (excluding coffee). Index No. 48 from *(77)*. Index for 1969 based on change in new series, Conjuntura Economica No. 275.

Fertilizer response ratios in Brazil tend to be low. Extensive trials with coffee obtained yields of 2.27 kg. of coffee (in the berry) per kg. of nutrients in mixed fertilizer (20-10-20) (*82*, p. 248). At 1967 prices, a return of 2.33 kg. of coffee per kg. of fertilizer would have been required in Sao Paulo (table 42). In Parana, it would have been 3.36 kg.

Reports of a series of studies on fertilization of beans indicate the uncertainty of crop responses. Occasional trials were successful, but in more than half, yields on plots treated with nitrogen, phosphate, or potash were not significantly different than yields on plots receiving no treatment. Responses averaged 3.9 kilograms of beans per kilogram of nitrogen (N), 2.6 kilograms of beans per kilogram of phosphate (P_2O_5) and 0.9 kilograms of beans per kilogram of nutrients in a complete fertilizer (*95, 96, 97, 98, 99, 100*). Similar variability of responses, measured in terms of statistical significance, not to mention tests of profitability, were reported by workers in programs supported by USAID (*129*).

Somewhat more favorable ratios were reallized in experiments on rice in Rio Grande do Sul (*4*). Phosphate fertilizer gave 7.3 kilograms of rice per kilogram of nutrient. An economic analysis of experiments with fertilizer on wheat and soybeans in Rio Grande do Sul disclosed average returns only slightly above the margin of profitability at normal prices.[3]

[3] Lanzer, Edgar A. *Analise Economica de Alguns Experimentos de Fertilizantes e Correcao de Solo Com os Cultivos de Soja e Trigo.* M. S. thesis, Univ. of Rio Grande do Sul, 1969.

Robert Cate, of the International Soil Testing Project, estimated that Brazilian farmers might profitably have used 700,000 tons of fertilizer nutrients in 1964, compared with the 255,400 tons actually used *(42)*. Thus, there appeared to remain some unexploited opportunities for profitable use of fertilizer. But considering jointly the prices of the various crops and the response to fertilizer, only about one-sixth of the cropland could have been fertilized profitably. On about one-fourth the area which could have been fertilized, the recommended rate would have been only about 75 kg. per hectare.

Lime, although found to improve fertilizer responses on some soils, is costly also. Soil analysis assists greatly in predicting which soils will respond to a particular nutrient. Soils laboratories tested about 100,000 samples in 1968. It is possible that these technological improvements contributed appreciably to the 1967-68 upturn in fertilizer consumption, and that further knowledge will be developed to extend the gains.

Expenditures on fertilizer made up about 3 percent of total farm expenses in 1950 (*18*, p. 14). Comparable data from the 1960 census were still unpublished in 1968. A survey of farms by the Getulio Vargas Foundation in 1962-63 found "intermediate consumption" amounted to 10.9 percent of the value of production (*47*, p. 21). Thus, it appears that expenditures on fertilizers, as a percentage of the total, were not greatly changed from 1950.

Plant Protection

Plant protection materials rank next to fertilizer as indicators of technological progress. Total domestic production of pesticides and fungicides plus imports of materials in this category increased two- to three-fold from the mid-1950's to the mid-1960's (table 44).

Table 44.—Supply of pesticides and fungicides, Brazil, 1953-68

Year	Pesticides and fungicides	Year	Pesticides and fungicides
	1,000 metric tons		*1,000 metric tons*
1953	5.6	1961	16.2
1954	11.8	1962	18.4
1955	11.4	1963	12.4
1956	9.9	1964	10.0
1957	6.3	1965	20.1
1958	6.5	1966	22.9
1959	9.8	1967	23.6
1960	19.4	1968	22.5

Source: Compiled from *(25)*.

Domestic production of these materials commenced in the late 1950's and by 1967, about half the total supply was being produced in Brazil. The extent to which the supply was used in nonfarm activities is not known.

Seeds

In 1966, nearly 200 public and private agencies (*52*) distributed about 130,000 tons of improved seed, 98 percent of which was domestically produced. However, since improved seed amounted to only 1 percent of the total quantity of seeds planted in that year, most farmers apparently used their own production or obtained supplies from neighbors.

Power

Use of power in agriculture has both an engineering and an economic significance. In agriculture, as in industry, the worker's output rises proportionately with the amount of power at his disposal (*54*, pp. 93-97). Brazil ranks relatively low in amount of farmwork done with power from other than human sources. This phenomenon has been long recognized in Brazil; however, no effective way to solve the problem has been found (*124*, ch. XV; *147*).

Reliance on hand methods was one of the practices referred to by an observer in 1858 who complained, "The soil is cultivated with the methods and instruments of 300 years ago."[4] To help overcome this deficiency, northern Europeans were encouraged to immigrate to Brazil in the mid-19th century, since they were more skilled in the use of animal power than the original Portuguese settlers. Again, when Southern planters from the United States migrated to Brazil after the Civil War, they were expected to implant a higher level of machine technology. In both cases, indigenous practices persisted.

The relatively slow adoption of power in agriculture may be attributed in part to the inherent power requirement for performing a given operation in Brazilian soils. Weaver showed how a difference in power requirements between two soil types common in one district of India determined which method of rice culture—broadcast or transplant—was more profitable (*101*, pp. 196-201). Low yields may further inhibit more extensive use of power. In the simplest terms, the additional area that can be cultivated with supplemental power may produce too small a margin over the production required to maintain work animals. It has been observed that nations with high crop yields tend to use more power (*54*, p. 94), but it does not follow that more power could always be used profitably where yields are very low. Efficiency of animal power may be impaired under tropical conditions. Animals eat less as environmental temperatures rise above the optimum; at high temperatures, energy intake may drop below maintenance requirements (*89*, p. 322). As environmental temperature rises, the animal's maintenance energy requirements increase also to maintain thermal equilibrium (*128*). Energy balances such as this determine optimum agricultural systems (*106*).

[4] Furquim de Almeida. Cited by Stanley J. Stein (*126*, p. 50).

Three out of four farms in Brazil reported using human power only in 1960, approximately the same ratio as 10 years earlier (table 45). Reliance on human power alone declined slightly with increase in farm size, but even among the 415 farms reporting 1,000 hectares or more of cropland, a quarter used no animal or mechanical power. While farms using some mechanical power increased rapidly during the decade—from about 6,000 in 1950 to 46,000 in 1960—it is evident that these numbers are still too small to figure importantly in Brazil's more than 3 million farms. Even among farms with between 100 and 1,000 hectares of cropland in 1960, less than half used mechanical power.

Other indications of use of power are given by numbers of tractors (63,000 in 1960, up from 8,000 in 1950) and numbers of plows (1,032,000 and 714,000, respectively). Sao Paulo and Rio Grande do Sul had 71 percent of Brazil's tractors and plows in 1960.

Domestic production of tractors began in 1960, but demand has been weak, and factories have been producing at considerably less than capacity. The peak supply of 14,000 tractors in 1960 (all imported) was not exceeded through 1967 (table 46). Assuming a 10-year life for a tractor, imports plus indigenous production between 1960 and 1967 were little more than enough to maintain the number of tractors on farms at the level reached in 1960.

Prices of five brands of tractors averaged $4,480 per unit in 1965 (*117*). The increase in price of tractors from 1961 to 1965 was somewhat less than the increase in wholesale prices of agricultural products including coffee.

The extent to which power is used varies sharply by regions (table 47) (*146*). Such striking differences within a country whose people have been fairly mobile (*124*), *139*, p. 32) indicates significant differences in physical and economic factors. Such differences in adoption of machine technology are commonly considered inherent in people rather than in environments, but there is growing evidence that traditional practices are usually soundly related to environment, changing rapidly when new and profitable adaptations become available (*137*, p. 36).

Irrigation

In 1960, 461,460 hectares of Brazil's 28.7 million hectares of cropland were irrigated. More than half the irrigated area was riceland in Rio Grande do Sul. The Northeast has small areas under irrigation, notwithstanding the large expanse of arid land in this region. The National Department for Works Against Drought has been active in the Northeast since the latter part of the 19th century, building dams which serve mainly for watering livestock and for household and urban needs. A regional development program for the Upper Sao Francisco Valley is contemplated for the irrigation of possibly one-quarter of a million hectares (*141*).

Table 45.—Distribution of Brazilian farms by source of power used in farmwork, 1950 and 1960, and by area in crops per farm, 1960

Source of power used in farmwork	Farms			
	1950		1960	
	Number	*Percent*	*Number*	*Percent*
Human labor only	1,504,124	72.9	2,380,364	75.6
Animal	554,441	26.8	721,767	23.0
Mechanical	593	(1)	16,304	.5
Animal and mechanical	5,484	.3	29,735	.9
Total	2,064,642	100.0	3,148,168	100.0

Source of power used in farmwork	Area in crops per farm, 1960				Total
	Less than 10 hectares	10-99 hectares	100-999 hectares	1,000 hectares and over	
	Farms				
Human labor only	2,029,829	340,738	9,688	109	2,380,364
Animal	470,855	244,945	5,916	51	721,767
Mechanical	4,566	8,658	3,007	73	16,304
Animal and mechanical	4,302	18,133	7,116	182	29,735
Total	2,509,552	612,474	25,727	415	3,148,168

[1] Less than 0.05 percent.

Source: (*24*, table 8).

Table 46.—Supply of tractors, Brazil, 1950-68

Year	Tractors, all types			Year	Tractors, all types		
	Produced	Imported	Total		Produced	Imported	Total
	Thousand				*Thousand*		
1950	---	5.8	5.8	1959	---	5.0	5.0
1951	---	12.3	12.3	1960	(1)	14.0	14.0
1952	---	8.1	8.1	1961	1.7	7.4	9.1
1953	---	3.3	3.3	1962	7.6	4.1	11.7
1954	---	15.0	15.0	1963	9.9	3.2	13.1
1955	---	5.9	5.9	1964	11.5	2.4	13.9
1956	---	4.7	4.7	1965	8.1	1.4	9.5
1957	---	8.1	8.1	1966	9.1	2.5	11.6
1958	---	8.2	8.2	1967	6.3	1.4	7.7
				1968	6.8	3.3	10.1

[1] Production began in December. Less than 50 produced.

Source: (*25*).

Table 47.—Indicators of power use on farms, by regions, Brazil, 1960

Item	North	North-east	East	South	Central West	Brazil
	Percent					
Farms by source of power used:						
Human only	100	96	90	44	90	76
Animal	(1)	4	10	53	8	22
Mechanical	(1)	(1)	(1)	1	1	1
Animal and mechanical	(1)	(1)	(1)	2	1	1
Total	100	100	100	100	100	100
	Number					
Items per 1,000 hectares of cropland:						
Tractors	0.6	0.4	1.0	3.9	1.7	2.2
Plows	.7	2.8	15.0	69.0	8.7	35.9

[1] Less than 0.5 percent.

Source: Compiled from *(24)*.

Nonfarm Component of Farm Expenses

A collective measure of capital goods inputs in Brazilian agriculture is obtained from 1950 census data on farm expenses *(18)*, and results of a farm survey carried out by the Getulio Vargas Foundation in 1963 *(46, 47)*, (table 48). Inputs other than labor and rent

Table 48.—Farm expenses, by type, Brazil, 1950, and 1962-63

Type of farm expense	1950	1962-63
	Percent	
Labor	56	46
Other inputs	36	38
Rent	4	16
Taxes	4	(1)
Total	100	100

[1] Not enumerated.

Sources: 1950 based on *(18*, table 12); 1962-63 based on *(47*, table V).

remained about the same proportion of the total in both periods (36 and 38 percent, respectively). This is consistent with the comparatively restricted role of nonfarm inputs indicated by the preceding discussion. Brazilian farmers spent about the same proportion of their gross income on capital inputs as farmers in other countries, but used fewer farm-produced and more purchased nonfarm inputs (table 49).

Capital Formation

Total investment in Brazil's agriculture in 1965 was about $16 billion (table 50). Value of land (including tree crops) accounted for just under 50 percent of the total, and livestock about 35 percent. Buildings, equipment, and work animals made up the rest.

By 1965, total agricultural investment had about doubled from 1950. Investment in machinery and equipment increased more than tenfold, while other assets grew more modestly. Compound annual rates of growth represented by these values ranged from 1 percent for buildings to 18 percent for machinery and equipment.

These estimates, which give a summary impression of capital inputs, are more useful in explaining the change in productivity per worker than the spotty evidence on numbers of tractors, plows, and farms using various sources of power. On the basis of the annual rates in table 50, capital formation for 1964 amounted to Cr$1.19 billion. Agricultural output was valued at Cr$4.4 billion. Thus, capital formation in agriculture (approximately the same as savings from income of the sector) was about 27 percent of income.[5]

On the basis of the growth rate for the index of real product in agriculture in the national accounts, and value of agricultural output in 1964 at current prices, the increment of income was Cr$0.19 billion. The gross incremental capital-output ratio, therefore, was 6.5 and the marginal productivity of capital 0.16. Even making considerable allowances for the tentative nature of these estimates, it appears that productivity of capital in agriculture was low, compared with other countries *(132*, p. 79).

Implications of Changes in Factors Complementary to Land

Chapter III presented data on productivity in terms of output per unit of land, or per head of livestock. Changes were shown to be slight, although crop yields rose appreciably in Sao Paulo, where more yield-raising

[5] Using other data, Chacel estimated farm investment at 18.4 percent of gross farm production in 1962-63 *(46)*.

Table 49.—Estimates of the percentage distribution of inputs used in farm production, selected countries and selected periods

Input	Brazil, 1962-63[1]	Punjab of India[2]	Taiwan, 1961-65[3]	Colombia[4]	Japan, 1955-59[5]	United States, 1967
	Percent					
Land	35	44	41	36	17	15
Labor	29	21	27	31	42	18
Capital, total	36	35	32	33	41	67
Farm-produced	10	27	10	21	--	7
Purchased nonfarm	26	8	22	12	--	60
Total	100	100	100	100	100	100

[1] Calculated from data in (*47*), assigning to land the difference between all other expenses and value of production. [2] B. Sen, Capital Input in Punjab Agriculture: 1950/51 to 1964/65 (unpublished report). [3] (*49*). [4] (*4*). [5] (*147*).

Table 50.—Investment in agriculture, Brazil, 1950 and 1965

Item	Investment				Annual rate of increase
	1950[1]		1965		
	Billion NCr$	*Billion dollars*[2 3]	*Billion NCr$*	*Billion dollars*[2 3]	*Percent*
Land[4]	7.2	3.79	13.4	7.05	4
Buildings	1.2	.64	1.5	.77	1
Machinery and equipment	.5	.28	6.0	3.17	38
Livestock (except work animals)	5.8	3.06	10.3	5.40	4
Total[2]	14.8	7.77	31.2	16.39	5

[1] Adjusted to 1965 price level. [2] Growth rates, dollar values, and totals computed from unrounded data. [3] Exchange rate of NCr$ 1.904 per dollar. [4] Includes investment in tree crops.

Sources: IBRA (*17*), table 55 for 1965 data, except animals. SEP data for animals in both years, 1950 values being essentially the 1950 inventory priced at average values per head prevailing in 1965. Land, buildings, and machinery and equipment values for 1950 from Census of Agriculture (*18*), table 11, adjusted to 1965 price levels by use of appropriate indexes from Conjuntura Economica (*77*).

inputs are used than in other States. This chapter has already described patterns and trends in the use of inputs complementary to land—labor and capital inputs. The following section discusses the apparent relationships between productivity and complementary inputs.

Labor input per hectare of cropland in Brazil decreased between 1950 and 1960. If other inputs remained constant, such a decline would have implied a decrease in output per hectare. This observation indicates that the relative importance of the various factors of production shifted considerably over the decade. It was not within the scope of this project to seek out possible explanations of the change. Production functions derived from farm survey data by the Getulio Vargas Foundation indicated that output increased 0.16 percent from a 1-percent increase in labor input in 1962-63 (*70*, p. 70). Production function analysis holds other factors "constant." Census data reflect substitution among factors.

The foregoing discussion treats labor as a variable input to land. The implicit assumption is that output per unit of land is and should be the chief consideration. As a policy criterion, this assumption and premise is probably less valid in Brazil than anywhere in the world in this decade. Both labor and capital are more limiting than land to Brazil's agricultural output. Standards of success of development efforts in Brazil probably should give precedence to output per worker. Increases in the amount of land used per worker, the reciprocal of workers per 100 hectares shown in table 35, almost dictate an increase in capital per worker (apart from possible technical innovations which may be capital saving). They also imply a redistribution of income among the factors of production; returns to land fall as returns to labor rise.

Where the land-man ratio is raised by withdrawal of labor (as in the immediate hinterland of the Sao Paulo-Rio de Janeiro-Belo Horizonte industrial complex), a tendency toward more land-extensive

enterprises would be expected. To some extent, rising consumer demand for perishable foods—vegetables, fruits, milk, and eggs—favors some land-intensive enterprises which may differentiate land values more steeply in parts of the hinterland without offsetting the decline for the hinterland as a whole. One of the stresses of agricultural development in Brazil, therefore, may be generated by declining returns to land. Such development generates demand for yield-increasing innovations which will counter the decline in income to, and capitalized value of, land.

Output effects from fertilizer are more easily and directly evaluated than were changes in labor. Fertilizer consumption increased a little over 200,000 tons from 1950 to 1966. At 8 kilograms of rice for 1 kilogram of fertilizer, output would have amounted to 1.6 million tons of rice. Valued at the 1957-59 prices used in output measures in this study, the hypothetical rice output attributed to fertilizer would amount to about 6 percent of the increase in total output of 34 principal farm products, equivalent to a growth rate of about 0.4 percent a year. Crop yields alone did not show this much response. The South used four to five times as much fertilizer per hectare as the rest of Brazil, but, except for Sao Paulo, yield changes were well within the range of variation experienced in the North.

Part of the effect of fertilizer went to offset an apparent decline in natural fertility. Some inferences about trends in natural fertility may be drawn from data for States (except Sao Paulo and Rio Grande do Sul) which used negligible quantities of fertilizers. About half the States had declining yields during 1947-65—0.5 percent or more per year in five States; -1.1 percent in Bahia. However, these trends are not attributable exclusively to declining fertility. Other factors which could have caused declining yields include: aging of stands of tree crops, increasing incidence of diseases and pests, more extensive labor practices, and extension of cultivation onto inherently poorer soils.

Interpreting the role of capital in Brazilian agriculture is difficult because of conflicting evidence. The upward trend in labor productivity would indicate that the ratio of capital to labor had been increasing. On the other hand, such nonfarm inputs as fertilizers, plant protection materials, and tractors are still used at low rates. The capital-output ratio indicates a low rate of return on investment in agriculture. It is possible that the various indicators of capital inputs seem to diverge because of inaccuracies in the data. This suggests a need for improved aggregative data on the use of capital in Brazilian agriculture. Studies at the farm level would aid in the interpretation of aggregate data, and would help to solve problems resulting from the apparently low physical and biological efficiency of many capital inputs in Brazil.

CHAPTER V.—FACTORS EXTERNAL TO THE FARM

Brazilian agriculture has come a long way from the self-sufficiency that characterized the "sertao" (backlands, or interior) of colonial and empire days. It is largely a commercial agriculture, with more than a third of its inputs coming from off the farm (above, p. 46), and most of its output entering commercial channels. The frontier, "traditional" as its agriculture may be, makes itself felt in urban markets through the supplies it generates (*107*, p. 117; *70*, p. 12). The future evolution of Brazilian agriculture will be conditioned increasingly by the commercial demand—domestic and foreign—for its products. In turn, Brazilian agriculture will demand an increasing volume and variety of services from sources external to the farm.

In addition to the growing demand for commercial services supplying nonfarm inputs and channeling the flow of output to market, Brazil's agricultural progress will require increasing amounts of other public and private services: research, education, and credit; services facilitating, guiding, and assisting land settlement; marketing services such as information on prices, market receipts, and storage holdings; and a wider government role in the use of grades and standards for farm products in domestic trade.

Domestic Demand

Characteristics of the domestic demand for agricultural products have been studied extensively by the Getulio Vargas Foundation as a basis for projecting supply and demand for agricultural products through 1975 *(70)*, and in connection with an analysis of Brazil's food industry *(62)*. Other reports are available on selected marketing problems, providing an increasing fund of information on the subject.

A relatively high rate of population growth, increasing urbanization, and rising per capita incomes have been the chief elements of Brazil's domestic food demand. Both urbanization and income factors contributed to a changing pattern of consumption (*70*, pp. 29-62). Consumption of fresh beef, milk, and wheat flour increases fairly rapidly with rising income—more so in urban than in rural households—and consumption of such historic staples as dried beef, rice, beans and mandioca flour changes little, or declines (table 51).

Total agricultural output comfortably accommodated the combined effects of increases in population and income. Food crop output increased 4.7 percent and livestock output 4.9 percent, while total food demand increased 4.3 percent annually from 1947 to 1965.[1]

Table 51.—Income elasticity, selected foods, urban and rural areas, Brazil, 1962-63

Product	Urban	Rural
Beef, fresh	0.72	0.50
Milk, fresh	.76	.50
Wheat flour	.51	.43
Oranges	.74	.47
Bananas	.64	.18
Beef, dried	.15	-.25
Rice	.21	.33
Dry beans	.04	.04
Mandioca flour	-.06	-.01

Source: (*70*, pp. 47-48).

Food prices rose steadily, relative to other prices, until 1962, even while inflation raised the general price level. Government controls—more effective on prices of nonfood items such as rents than on food—contributed to this tendency (*76*, p. 50; *62*, p. 134). Eventually, more fundamental steps were taken to control inflation. At the same time, price controls were relaxed and relationships between the index of food prices and the index of all prices in the cost of living began to reflect the fundamentally favorable food supply situation (fig. 11).

Whether farmers benefited from the rise in food prices is not clear. An index of producer prices rose less rapidly than either retail or wholesale food prices (fig. 12). The index of producer prices, based on national average prices implicit in the production estimates of the Production Statistics Service (SEP), is biased downward by the increasing weight implicitly given to production on the frontier. For example, Parana, which had phenomenal growth in output during the period, experienced a relative decline in the prices of eight representative commodities from 104 percent of the national average in 1955-57 to 90 percent in 1963-65 (table 52). The national wholesale price index is probably more useful for measuring agriculture's relative position until an unbiased national index of producer prices becomes available.

The geographic structure of prices changed sharply in several respects during 1947-65 (table 52). Agricultural prices in the Northeast, from Sergipe to Rio Grande do Norte, rose more than 30 percent relative to the national

[1] Based on population growth rate of 3.12 percent between 1950 and 1960 (*25*, 1947, p. 35), growing real per capita income at the annual rate of 2.4 percent, and coefficient of income elasticity of demand of 0.47 (*70*, pp. 47-48, weighted by 1960 urban and rural population).

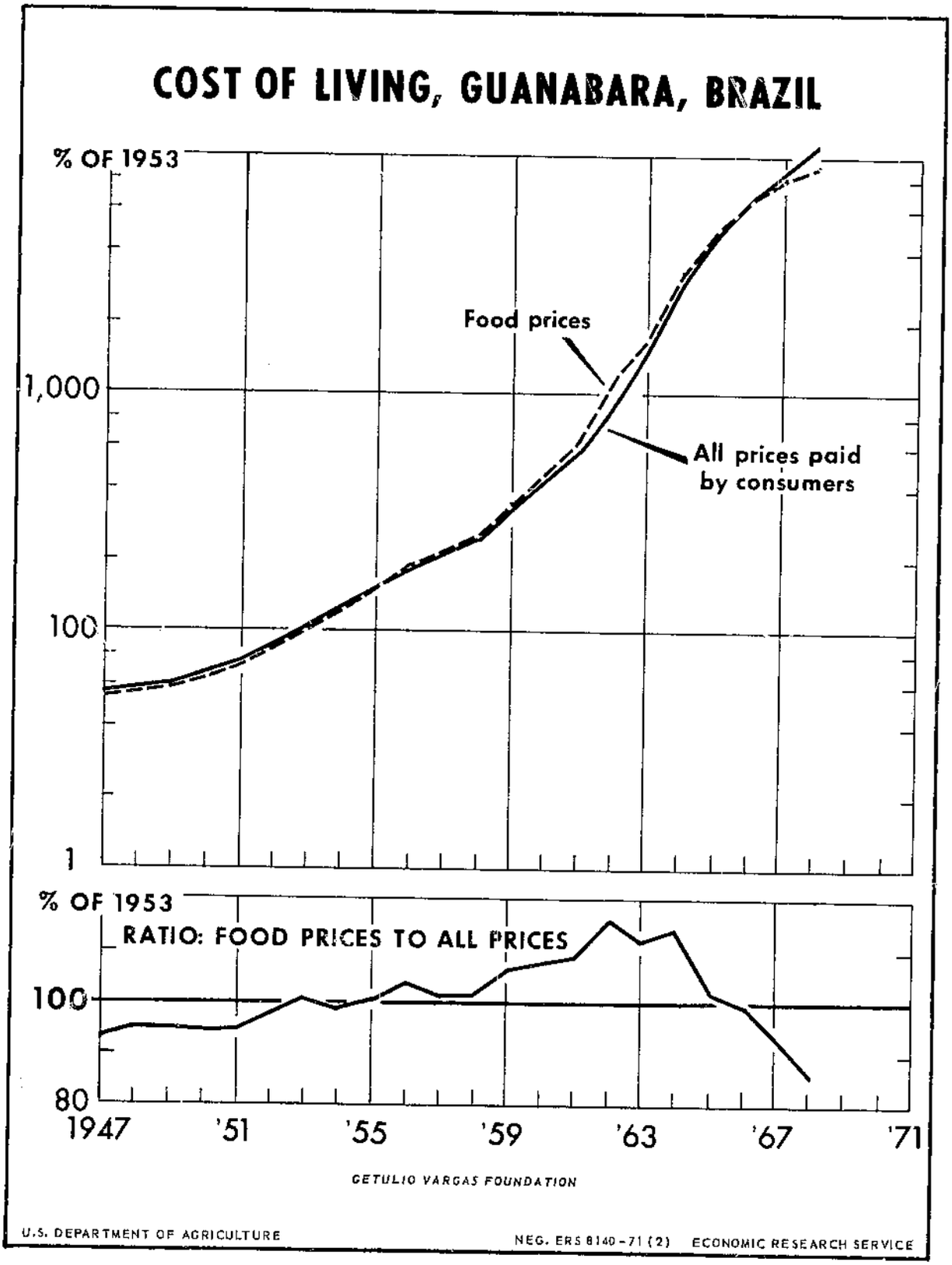

COST OF LIVING, GUANABARA, BRAZIL
% OF 1953
1,000
100
1
Food prices
All prices paid by consumers
% OF 1953
RATIO: FOOD PRICES TO ALL PRICES
100
80
1947
'51
'55
'59
'63
'67
'71
GETULIO VARGAS FOUNDATION
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8140-71 (2) ECONOMIC RESEARCH SERVICE

Figure 11

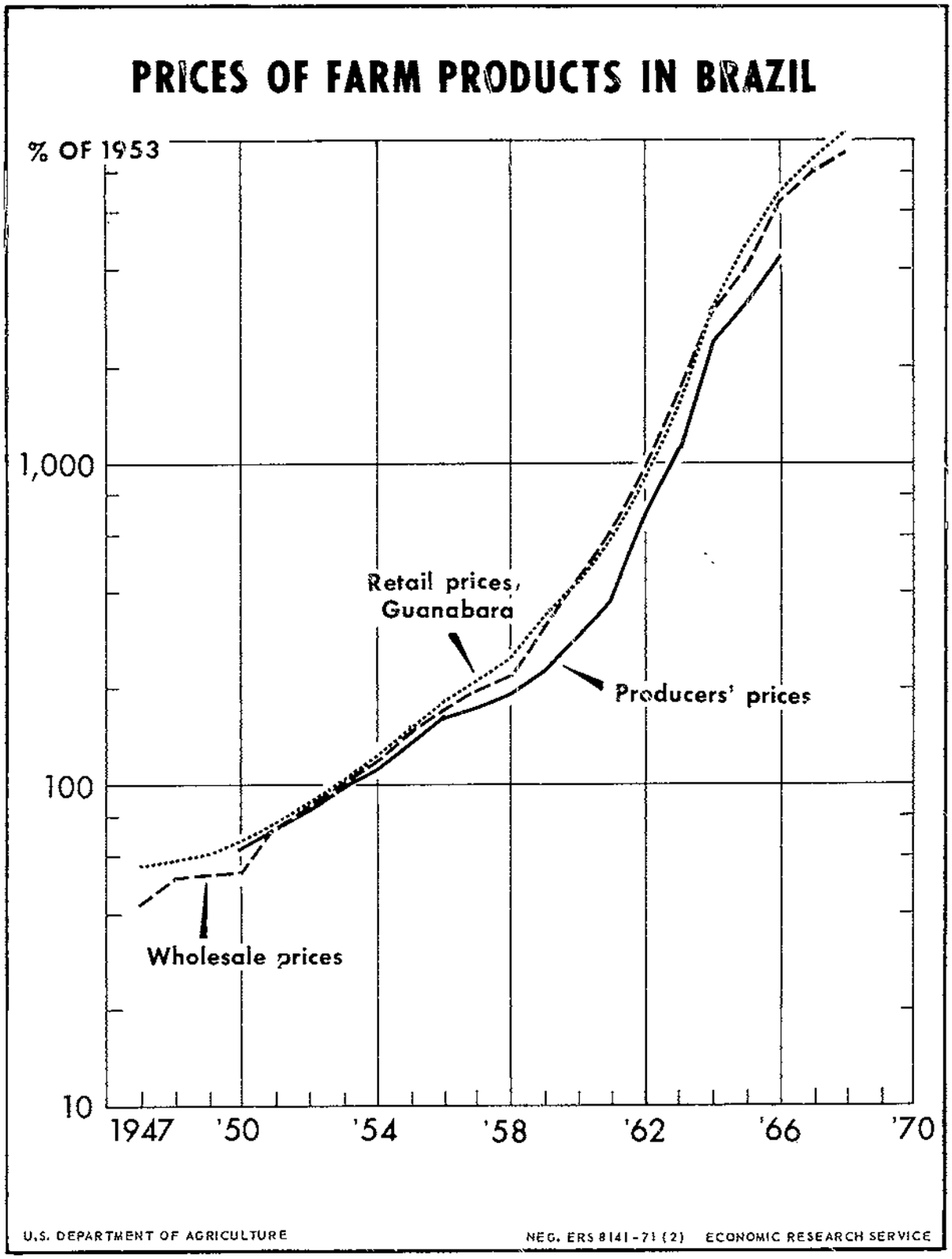

PRICES OF FARM PRODUCTS IN BRAZIL
% OF 1953
1,000
100
10
1947
'50
'54
'58
'62
'66
'70
Retail prices, Guanabara
Producers' prices
Wholesale prices
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8141-71 (2) ECONOMIC RESEARCH SERVICE

Figure 12

Table 52.—Geographic pattern of farm prices, Brazil, selected periods

(National average=100)[1]

State and region	1947-49	1955-57	1963-65	1966-68
NORTH				
Rondonia	188	104	123	161
Acre	151	113	122	129
Amazonas	128	118	100	98
Roraima	161	183	184	128
Para	85	87	88	83
Amapa	136	141	155	131
NORTHEAST				
Maranhao	67	67	78	86
Piaui	71	61	73	83
Ceara	81	84	94	94
Rio Grande do Norte	97	110	138	127
Paraiba	93	102	134	116
Pernambuco	98	103	124	112
Alagoas	91	112	130	110
EAST				
Sergipe	93	106	123	106
Bahia	85	87	97	112
Minas Gerais	104	97	95	98
Espirito Santo	97	91	90	95
Rio de Janeiro	105	116	101	107
SOUTH				
Sao Paulo	117	119	110	109
Parana	99	104	90	97
Santa Catarina	85	88	76	74
Rio Grande do Sul	98	99	96	93
CENTRAL WEST				
Mato Grosso	88	90	84	90
Goias	88	84	83	90

[1] Prices of each of 8 commodities, expressed as a percentage of the national average price, and the resulting price relatives averaged for the State. Commodities included: rice, corn, coffee, cotton, sugarcane, mandioca, beans, and cattle. In 1947-49, prices of mandioca were excluded in Parana and Mato Grosso, cattle in Santa Catarina, and sugarcane in Mato Grosso because they differed excessively from relative prices of other products in those States. In 1955-57, mandioca in Mato Grosso was excluded for the same reason.

average. The rise probably resulted from increases in consumer purchasing power generated by activities of the regional economic development authority (SUDENE) (*115*).[2] The necessary offsetting declines occurred in the areas closest to the urban centers of the South. Prices in the States in which agricultural output expanded most rapidly did not change uniformly.

Prices declined more in Parana than in neighboring Sao Paulo. In Mato Grosso and Goias, prices declined relative to the national average, but less, proportionately, than in Sao Paulo. Maranhao, sharing some of the general tendency for prices to rise in the Northeast, improved its position considerably between 1955-57 and 1963-65. Frontier prices may be weighted toward a retail level of trading initially, shifting toward a commercial farm assembly type of transaction as output rises. Such developments may account for the drastic changes in relative prices in territories of the North.

[2] Zombek, John J. *Regional Inequality and Economic Development in Brazil.* M.S. thesis, Univ. of Arizona, 102 pp., 1966. (Typewritten.)

Derived Demand at Farm Level—The Transportation Factor

Transportation costs are a major factor in the geographic pattern of prices. Comparative scarcity of local supplies in relation to local demand in important consuming centers determines the location of peaks in the price surface. From these centers, farm prices decline with distance. In this context, changes in the efficiency of transportation over time may offset effects of lengthening supply lines. Highway transport in Brazil has become increasingly efficient during the past two decades. Total length of paved highways increased from 3,133 kilometers in 1955 to 42,378 in 1968 (*25*). In 1968 alone, paving was completed on 3,350 kilometers of Federal and State highways—more than the entire length of paved road in the country 13 years earlier (*73*).

Highways of all types per 1,000 square kilometers of land surface averaged between 300 and 400 kilometers in Brazil's more fully developed States in 1965. Yet even these States have inadequate farm-to-market access. In the advanced State of Sao Paulo, with 714 kilometers of road per 1,000 square kilometers, 32 percent of rural property owners in some sections reported roads impassable for 60 days or more a year in 1965

(*18*). Rapidly growing Parana built more roads from 1955 to 1965 than any other State (one-fourth of the national total) and raised its ratio of road length to land area from 180 to 350. Other frontier States are still seriously deficient in roads—Goias with 54 kilometers of road per 1,000 square kilometers, Mato Grosso with 21, and Maranhao with 77.

Highways are probably the most important transport medium affecting the geographic structure of farm prices, but rail transport is significant also and is being improved. In 1968, a major relocation of the railway line connecting Porto Alegre and Sao Paulo was completed, shortening the distance by 700 kilometers (*73*).

What these physical indicators of improved transport may mean for farm prices depends on rate structures. Freight rates appear to have increased about 25 percent in 1968, a year when wholesale prices of farm products rose only about 15 percent (*73*). It must be noted, however, that rail transport is heavily subsidized, receipts averaging about half of expenses in 1966-68.

It is commonly thought that agriculture cannot continue expanding into new areas at the rate of the past two decades, because of the lengthening distance of the frontier from consuming centers and seaports. At present, neither highway nor railroad facilities are adequate for low-cost transportation of bulk freight. But U.S. experience suggests that when Brazil has time to install adequate transport facilities, distance may be less of a barrier than it seemed in the early 1960's. Brazil's most rapidly growing geographic area during 1947-65 was the western part of the State of Parana, an airline distance of about 300 miles from Sao Paulo, Brazil's largest city. This is comparable to the distance from New York City to Pittsburgh, Pa. In the 1960's, Campo Grande, in the State of Mato Grosso, was on the frontier of expanding crop production. Campo Grande is about 500 miles from Sao Paulo, or about the distance from New York to Toledo, Ohio. Today, Porto Velho, Rondonia, is the most distant point reached by highway westward from Sao Paulo. This is equivalent to the distance from New York to the western edge of the U.S. Wheat Belt in the Plains States. As farming spreads northward and westward in Brazil, and as planned highways are built to the Amazon River, the latter may become as important to Brazil as the Missouri, Mississippi, and Great Lakes waterways are to the U.S. Midwest (*68*).

Minimum Prices

The Brazilian Government initiated a program in 1951 to protect producers against the hazard of undue price declines. There is considerable fluctuation in output, and, therefore, in prices among important farm products (table 53). To counter this instability, minimum prices for various products were announced from time to time, and the Government undertook to purchase these products, or to lend money to producers for products in storage. Effectiveness of the program varied, and generally was slight until 1967. By harvesttime in most years, endemic inflation had eroded the economic significance of the minimum prices announced at the start of the crop season. Also, the terms of the programs tended to be conservative, and measures to inform producers about the programs and how to use them were not adequate. Originally, the programs emphasized direct purchases rather than loans. The emphasis was reversed in 1967, and that change, along with changes in other aspects of the program, made it substantially more effective (*92, 121*).

Table 53.—Variability in output and prices of selected crops, Brazil, 1947-65

Crop	Coefficient of variation[1]	
	Output[2]	Price[3]
	Percent	
Rice	9	26
Coffee	27	37
Corn	7	20
Cotton	14	28
Sugarcane	3	25
Mandioca	7	17
Beans	7	22
Bananas	4	20
Wheat	36	32
Peanuts	27	30
Oranges	7	23
Tobacco	9	14
Cocoa	14	38

[1] Standard errors of estimate of the logarithms of output and price, expressed as percentages. [2] Output series for 1947-65. [3] Price series for 1944-65.

Food Processing

Growing domestic demand for food requires a growing food processing industry. Estimates of food demand based on population, incomes, and income elasticities of demand indicated an excess of demand over supply of processed foods between 1950 and 1960 (*62*, p. 63). The food industry grew at the rate of 5.7 percent a year in that decade, but declined during 1960-65. From 1965 to 1968, the growth rate rose to 6.2 percent a year (fig. 13). Output of the food industry increased much less than all industry, but paralleled the growth of total agricultural output.

Although the foregoing indicators imply that the food industry expanded less rapidly than expected, it should be noted that more than half the firms in the industry in 1960 came into existence after World War II (*62*, p. 67). Food manufacturing firms surveyed in 1965 disclosed that underutilization of capacity was a major problem (*62*, p. 123). A dynamic economy in which sources of raw materials are shifting may have difficulty achieving full utilization of existing capacity. Improvements in transportation further complicate the problem, since plants located at different points may experience radical changes in their ability to compete for raw materials as new routes are opened (*122*).[3] Some investments may

[3] Smith, Gordon W. *Agricultural Marketing in Southern Brazil.* Ph.D. thesis, Harvard Univ., Cambridge, Mass., 1965.

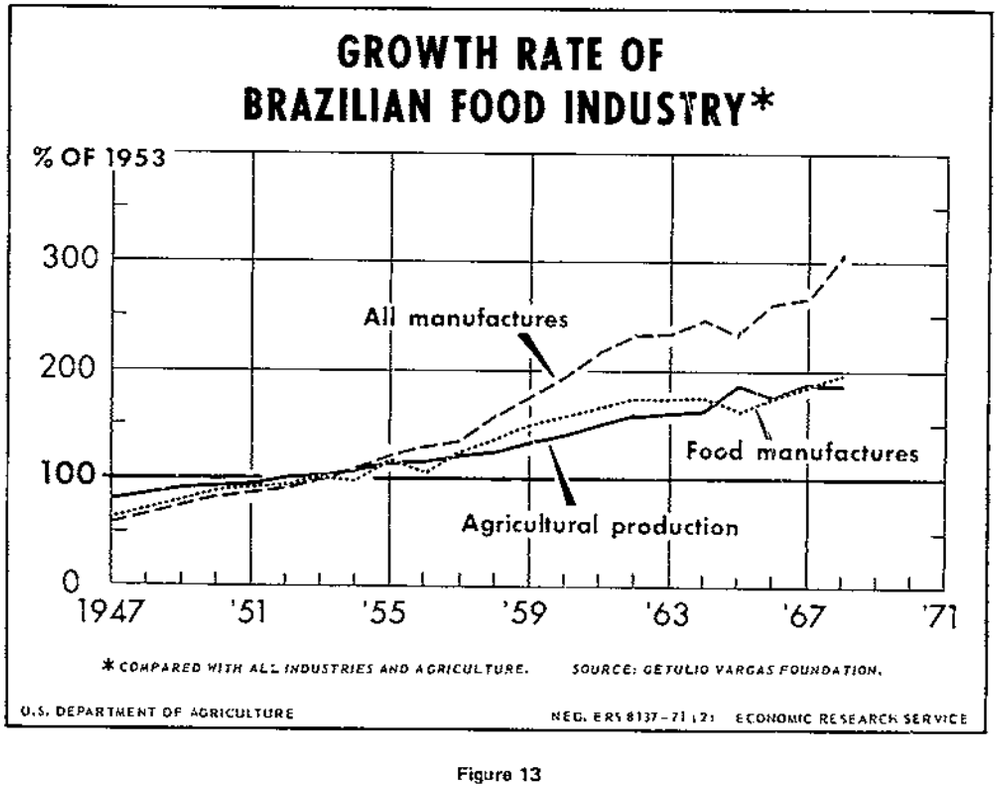


Figure 13

be misplaced because of failure to anticipate correctly the locations at which the need would arise. This seems to have happened with some Government grain storage facilities (*135*, appendix A).

Foreign Demand

Brazil has depended on agricultural exports for foreign exchange earnings throughout its history. Since 1946, agricultural exports have not been less than 82 percent of all exports, and in some years they were as high as 95 percent. Coffee dominated Brazil's export lists for more than a century. Even at the peak of the rubber boom in 1910, coffee retained a slight lead. From 1945 to 1965, coffee's share of total exports averaged 56 percent. Cotton and sugar, the next most important exports with about 10 and 2 percent, respectively, of the total, became increasingly important during the latter part of the period. In the 1960's, cocoa, sisal, tobacco, and vegetable oils each contributed 1 to 2 percent.

Total agricultural exports increased in quantity fairly steadily from 1947 to 1968 (*19*). Values declined from 1951 to 1959 because of declining prices. In the 1960's, however, unit values remained steady and total value of agricultural exports increased at the compound annual rate of 4.4 percent between 1960 and 1968. The share contributed by products other than coffee was stable at about 40 percent in 1960-64, but rose after 1964 (fig. 14).

If Brazil's agricultural production significantly exceeds domestic demand, foreign outlets will doubtless be sought for the added output. The potential of foreign markets to absorb added supplies from Brazil is, therefore, critical for Brazil's economic development. Experience to date affords no clear insight into such a contingency, since output and domestic demand remained fairly balanced during the 1950's and 1960's.

The form in which added productive capacity expressed itself would be crucial. More coffee is not needed, and output would have to be immobilized, as substantial portions of the total output have been for nearly half a century. World markets for sugar are so restricted that sugar production has been controlled in Brazil, and presumably these controls will continue. The position of Brazilian cocoa, which has substantial competition from developing countries in Africa, appears to have weakened because of declining yields.

Brazil has several products—rice, corn, soybeans, and peanuts—whose potential competitive strength in international markets appears more promising. Markets for these crops are somewhat less restricted, and successful competition may be closely related to technological and commercial efficiency.[4] Beef might be added to this group, except that experience of the past

[4] An analysis and projection of production possibilities for rice and corn in Brazil by Richard G. Wheeler provides detailed information on these two grains (*145*).

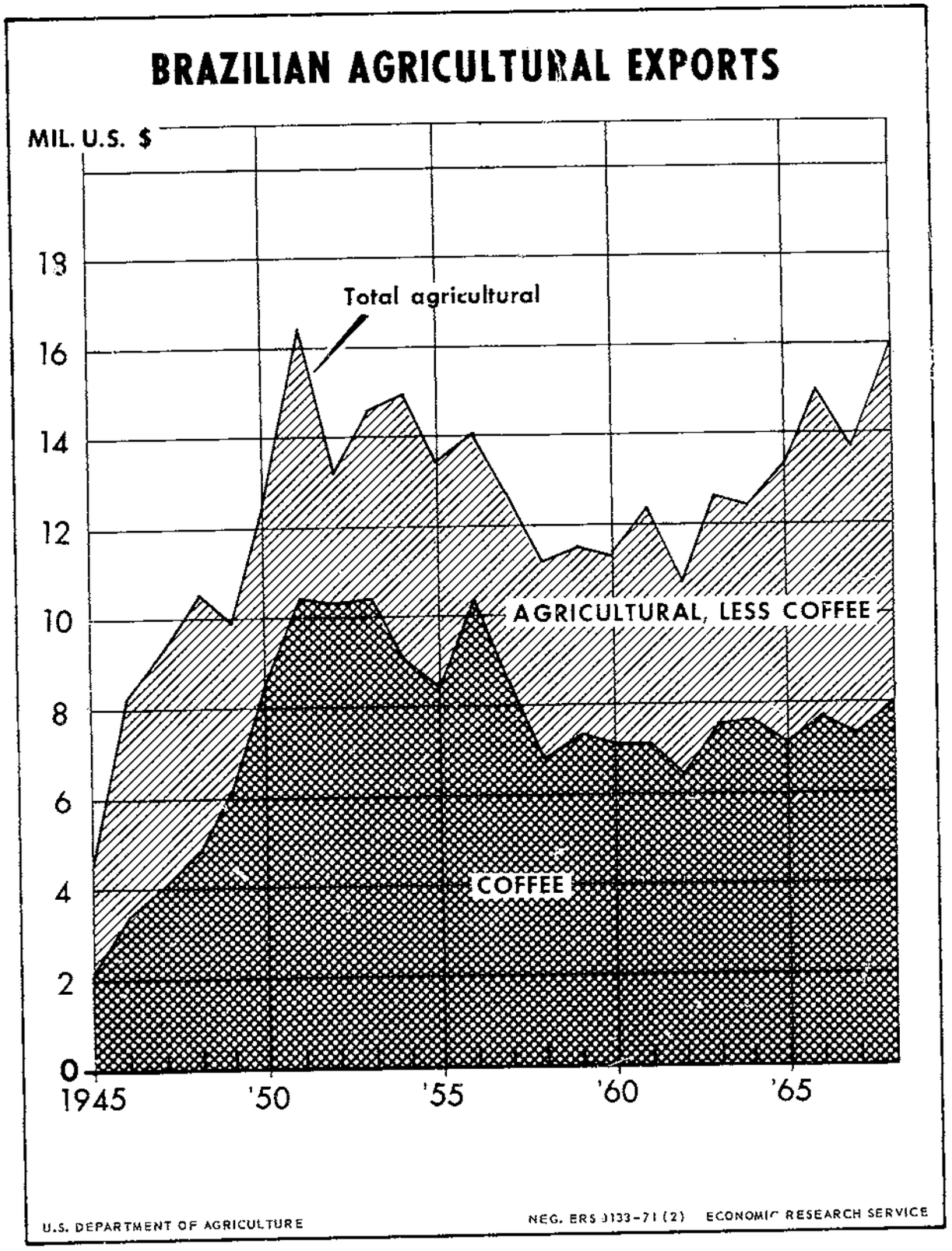

BRAZILIAN AGRICULTURAL EXPORTS
MIL. U.S. $
18
16
14
12
10
8
6
4
2
0
1945
'50
'55
'60
'65
Total agricultural
AGRICULTURAL, LESS COFFEE
COFFEE
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 3133-71 (2) ECONOMIC RESEARCH SERVICE

Figure 14

two decades gives less assurance that an exportable surplus might be imminent. Projected domestic demand seems likely to absorb all the beef that Brazil can produce through 1975 (*70*).

Rice and corn already occupy about 40 percent of the cropland in Brazil, and have grown at rates approximating the average of all crops. Both commodities have been exported sporadically—corn in increasing amounts, about 1.2 million tons in 1968, or nearly double the previous record (*108*, pp. 25-26). Soybeans and peanuts are relatively new crops, but have been expanding very rapidly. The potential area suitable for peanuts may be limited. Soybeans, on the other hand, have a much less restricted potential area, because their ecological requirements are similar to corn.

Given the variability of output noted previously (above, p. 53), and, on the average, a balance between output and domestic demand, it would be expected that exports of rice and corn would be sporadic, and highly variable from year to year. This has, in fact, been the case (*108*, pp. 25-26). Such instability of exports carries with it several handicaps: exporting firms are burdened by excess capacity in years when exportable supplies are low; price discounts must be taken to compete with more dependable suppliers; and traders have to take wider margins to offset the risks associated with year-to-year variability in volume. Even at relatively low levels of exports during the early 1960's, port facilities were occasionally overtaxed, and many were technologically obsolete or obsolescent.

If exports of rice and corn rise, it will be because technological progress and increased efficiency make them attractive even at some decline in relative price, or because the flow of labor and capital into agriculture continues unchecked by superior real alternatives elsewhere in the economy. Labor and capital tend to seek and find employment, even with declining returns. Again, since agriculture is a classically competitive activity to the extent that new entrants accept lower prices and returns, older areas will experience declining income unless efficiency can be increased. It is important to Brazil for world trade in these commodities to remain relatively free and unrestricted. Otherwise, successful efforts to raise agricultural productivity may create distress in domestic markets.

Agricultural Finance

Capital and credit have shared importantly in the development of Brazilian agriculture, although their roles have not been clearly evident or generally recognized. Since a well-defined agricultural credit system has existed only since 1937 and much of the agriculture of the country is considered "traditional," it is implied that capital's contribution to this development has been minor. The nature and extent of capital formation in agriculture has received virtually no explicit attention. Nevertheless, the internal savings, investment, and capital formation within the agricultural sector have been substantial. An agricultural credit system is evolving, and agriculture, agricultural trade, and agriculturally based industries have obtained part of their financing from the general credit system.

The existing stock of capital in Brazilian agriculture comes mainly from savings of the agricultural sector itself. A comparison of the value of livestock assets with total bank loans for livestock production in any recent year establishes this proposition. During 1965, the increase in value of livestock, calculated at values per head prevailing at the beginning of the year, was more than 500 billion cruzeiros, while total livestock loans by banks of Brazil amounted to about 65 billion cruzeiros. Since most of the bank loans were for short terms, it is evident that the increment in livestock value alone was substantially greater than the net increase in total farm assets attributed to borrowings. At the end of 1965, balances of all loans to agriculture by the Agricultural and Industrial Credit Department (CREAI) of the Bank of Brazil (See p. 57 ff.) were about 80 billion cruzeiros higher than at the beginning of the year. Thus, the increase in institutional credit to agriculture was almost infinitesimal in relation to the increase in total value of agricultural assets. The chief role of credit, therefore, has been to provide short-term operating capital.

Savings in agriculture not only appear to account for most of the increase in farm assets, but they are considered by some observers to have contributed an important share of the savings that have gone into Brazil's industrial expansion since World War II. Baer suggests "that the agricultural distributors, who capture most of the increment of the national product going to agriculture via higher terms of trade, tend to invest their savings in the nonagricultural sector, construction and industry." (*5*, p. 162). However, some large landowners in Sao Paulo and Minas Gerais are reported to be investing in farms in Mato Grosso and Goias.

The structure of Brazilian wealth is such that it might be difficult to trace the origin of any particular portion of the national total to any one producing sector. Land—the most important agricultural asset—is often owned by absentee landlords. Many of these owners follow nonagricultural occupations—professions, trade, or industry. Consequently, it is difficult to assess which part of their savings should be attributed to agriculture, and which part to nonagricultural pursuits. Some savings are reinvested in agriculture, the landlord generally being responsible for fixed assets: buildings, fences, and plantations of tree crops. Some purely nonagricultural savings may be invested directly in agriculture also. It is said, for example, that some of the modern, mechanized production of wheat, corn, and soybeans in Rio Grande do Sul on areas formerly devoted to grazing represents the initiative of urban investors—doctors, lawyers, and

merchants, who previously may or may not have been receiving some income directly from land.

Resident owners and operators need not have large incomes to have some savings or accumulation of capital. Indeed, the 1½ million farms of less than 100 hectares each in 1960 (440,000 more than in 1950) represent a sizable increment of capital during the preceding decade (equity in housing alone is substantial). Subdivision of large farms or development of new areas—whether by spontaneous settlement or planned colonization—all require investment and production of goods to be used as a source of future incomes.

It is popular to deprecate the meager and primitive traditional productive facilities and housing that are common on the frontier and on many small farms in the older agricultural areas. A survey of small farms in Rio Grande do Sul used several asset scales representing humble forms of capital formation, including composition of windows in the home (glass or wooden shutters) and number and kind of timepieces owned by the farmer.[5] "Modern" or not, such capital comes from savings and investment and contributes to increased total output, whether or not it raises productivity (yield per acre).

The Agricultural Credit System

Inadequacy of Brazil's agricultural credit system has been of concern for decades. Much discussion and several abortive attempts to enact agricultural credit laws from 1888 to 1934 left little impression on the existing system.[6] Private lenders, merchants, and lending agents were virtually the only sources of farm credit. Commercial banks made few agricultural loans. The terms and conditions of loans followed the norms of trade, rather than the conditions of agricultural production.

Even now, virtually nothing is known about the volume of credit from nonbank sources. It is believed that in the early 1960's banks were providing about 80 percent of rural credit. This was largely the result of the establishment of rural credit facilities by the Federal Government during 1937-45, and the expansion of these facilities during the 1950's and early 1960's.

CREAI—Agricultural and Industrial Credit Department of the Bank of Brazil—was established in 1937 (Law No. 454). Although its first loan was made in 1938, CREAI remained relatively unimportant until the 1950's. The National Cooperative Credit Bank (BNCC) was added to the system in 1943 (Law No. 5893) and a program of loans and purchases, financed through the Bank of Brazil, was begun in 1951 (Law No. 1506). By the mid-1960's, these were the major governmental sources of credit and were believed to be supplying half or more of all credit used by farmers.

In 1965, rural credit legislation was consolidated in a general revision of the banking laws (Bank Reform, Law No. 4595, Dec. 31, 1964). The Central Bank of Brazil (BCR) and the National Monetary Council (CMN) were established at this time, becoming the most important agencies regulating the total credit available and its application. Principal institutional lenders loaned about US $500 million in 1965. About 70 percent was loaned by Federal banks, and the rest by State and private banks (table 54).

Table 54.—Rural loans by banks, 1965

Lending institution	Amount		Percentage of total
	Billion cruzeiros	*Million dollars*	*Percent*
Bank of Brazil	608	322	64
National Cooperative Credit Bank	47	25	5
Other Federal banks	43	23	17
Total Federal Banks	698	370	74
State banks	161	86	17
Private banks	81	43	8
Total	942	499	100

Sources: Based on mimeographed tabulation from CREAI; also, data from (*25*, 1966, pp. 275 and 277).

Approximately two-thirds of the institutional credit to agriculture is extended through CREAI, whose operations afford a good view of the credit services available to, and used by, Brazilian farmers. CREAI maintains separate accounts for production of crops and livestock. "Other agricultural" loans by CREAI are divided about equally between loans to cooperatives and price support loans (table 55).

Table 55.—Loans of the Agricultural and Industrial Credit Department (CREAI), Bank of Brazil, by purpose, 1965

Purpose of loan	Amount		Percentage of total	
	Billion cruzeiros	*Million dollars*	*Percent*	*Percent*
Production:				
Crops	475	252	78	62
Livestock	64	34	11	8
Other agricultural uses[1]	68	36	11	9
Total, agricultural	608	322	100	79
Industrial	159	85	--	21
Total, CREAI	767	407		100

[1] Principally loans to cooperatives and for price support.

Source: (*25*, 1966, p. 274, a; p. 275, b and c; p. 276, d).

[5] See footnote [4] p. 11.

[6] See Luiz Bartholomeu (*12*) and Camillo Nogueira da Gama (*50*), whose writings include summaries of early attempts to improve the credit system. Stanley Stein gives a documented account of the credit system in the heyday of coffee in the Paraiba Valley of Rio de Janeiro (*126*).

CREAI agricultural loans are further classified as to use in current production or investment purposes. Overall, and for crop production, the largest share in 1965 went to current expenses, but for livestock production, most went to investment (table 56).

Loans for current expenses are generally made for less than 1 year, although for some purposes the time may be extended to 2 years. Other loans, including loans secured by farm real estate, may mature in a maximum of 15 years, although most are limited by law to 3 to 5 years. In practice, few loans in any class are made for the maximum allowable maturity for that class.

A third criterion by which CREAI classifies loans is by size of producer. The Bank of Brazil made special provisions for loans to small producers in May 1961 (*87*, p. 112). The collateral requirements for small producers were made more liberal than for other producers (table 57).

Loans by CREAI during 1962-64 were distributed geographically in fairly close relation to the regional value of agricultural production (table 58). The ratio of loans to value of output was somewhat higher than average in the South, and correspondingly less in other regions.

The interest rates and maturities offered by CREAI and its collateral requirements have generally been more favorable for agricultural production than those available previously. Maturities of CREAI loans in 1965-66 were two to three times as long as commercial loans. Commercial loans for crop production, for example, had an average maturity of 4 to 5 months, while CREAI loans in this category ran about 10 months. In livestock production, commercial loans matured in about 80 days, and CREAI loans in about 11 to 13 months. Loans of the general credit department of the Bank of Brazil for nonagricultural purposes averaged about 75 to 80 days.

Borrowers from CREAI paid 8 percent per year for the loan, of which 1 percent was for service charges and notary fees (*87*, p. 111). Ordinary loans from other sources may have cost the borrower 3 percent a month or more. (Three percent a month equals 42½ percent per annum.) An anti-usury law in Brazil, passed in 1933 (*50*, p. 15), fixed maximum legal rates of interest at 10, 8, and 6 percent per annum, the lowest rate applying to loans for agricultural purposes. But loans may provide for "monetary correction" to offset the decline in purchasing power of money. For example, a loan may

Table 56.—Loans for current expenses and investment, Agricultural and Industrial Credit Department (CREAI), Bank of Brazil, 1965

Loan classification	Purpose of loan					
	Current expenses	Investment	Total	Current expenses	Investment	Total
	Bil. cr.	*Bil. cr.*	*Bil. cr.*	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*
Production:						
Crops	372	103	475	197	55	252
Livestock	12	52	64	7	27	34
Other agricultural use	62	5	69	33	3	36
Total	447	160	608	237	85	322
		Percent				
Share of total	74	26	100			

Sources: (*25*, 1966, p. 275, c); (*10*, anexos, 5, 8, 9).

Table 57.—Loans to small producers, and total loans, Agricultural and Industrial Credit Department (CREAI), Bank of Brazil, 1965

Loan classification	Small producers	Other producers	Total	Small producers	Other producers	Total
	Bil. cr.	*Bil. cr.*	*Bil. cr.*	*Mil. dol.*	*Mil. dol.*	*Mil. dol.*
Production:						
Crops	25	450	475	13	239	252
Livestock	2	62	65	1	33	34
Total	27	512	540	14	272	286
		Percent				
Share of total	5	95	100			

Source: (*10*, anexos 10, 11).

Table 58.—Distribution of agricultural loans, Agricultural and Industrial Credit Department (CREAI), Bank of Brazil, and value of farm output, by region, 1962-64

Region	Loans		Farm output[1]		Loans as percentage of value of farm output
	Billion Cr$[2]	*Percent*	*Billion Cr$*[2]	*Percent*	*Percent*
North	8	1	91	1	9
Northeast	129	14	1,339	17	10
East	160	17	2,029	25	8
South	555	59	3,893	48	14
Central West	85	9	76	9	11
Total	937	100	8,113	100	12

[1] Value of 27 major crops and 8 items of livestock and animal products. [2] Average rate of exchange for 1962-64 was NCr$0.987=US$1.

Sources: Loan data compiled from reports of Bank of Brazil *(9)*. Value of crops compiled from reports of SEP *(25)*. Value of livestock output estimated from SEP data.

specify that the principal amount of the loan to be repaid shall be scaled upward in proportion to the change in the general index of wholesale prices. This index increased 30 percent or more in 9 out of 22 years between 1944 and 1966, and between 10 and 30 percent in 10 of the remaining 13 years. The increase at a compound annual rate between 1947-49 and 1964-66 was 26 percent a year.

Besides the effect of inflation, high interest rates for agricultural loans may still reflect imperfections in capital markets. Competition provided by the Bank of Brazil has not yet corrected this deficiency.

Because of the high rate of inflation and the low interest rate at which CREAI makes agricultural loans, demand for credit has been greater than the Bank could supply (*9*, p. 36). The Bank's resources are limited by what it can raise through deposits and sale of securities in the country's capital market, or by borrowing abroad. Lending power of the Bank is also restricted by national credit policy. To contain inflationary pressures, limits have been set on the total amount that the Bank can lend. The lending power of the Bank of Brazil is allocated between agricultural and nonagricultural functions.

The agricultural portion, in turn, is further allocated among classes of borrowers. The Bank's operating budget containing these allocations has been subject to approval by a Government board. Since 1965, this board has been the National Monetary Council (CMN). Previously, it was the Superintendency of Money and Credit (SUMOC). By this means, the Bank's activities are made to conform to the overall monetary and credit policy of the Government. Thus, Bank of Brazil loans to agriculture reflect a purposeful control of the supply of credit to agriculture as part of the effort to check the continued high rate of inflation and in recognition of the heavy demand for credit from all sectors of the economy (*6*).

Financing Agricultural Marketing

Marketing of agricultural products creates a substantial demand for credit in Brazil. Financing of stored products, inventories in trade channels, and investments in marketing facilities accounted for half again as much lending as loans for agricultural production in 1965-66 (table 59). Both the Agricultural and Industrial Credit Department (CREAI) and the General Credit Department (CREGE) of the Bank of Brazil were engaged in this kind of financing. CREGE accounted for most agricultural marketing loans, while CREAI was responsible for somewhat more than half the loans for agricultural production (table 60).

Trends in Lending by CREAI, 1947-68

CREAI may have been a fairly significant factor contributing to increases in Brazil's supply of agricultural credit up to about 1952 (fig. 15). CREAI loans in relation to agricultural income increased steadily, from 3.4 percent in 1941 to 10.4 percent in 1952. Thereafter, through 1967, year-to-year increases in CREAI loans did little more than keep up with inflation.

Loans for crop production remained the major component of total CREAI loans throughout the 1947-66 period, or roughly 80 percent of all agricultural loans. Livestock loans increased proportionally through the early 1950's, then decreased. "Other" loans consisted mainly of loans to cooperatives until the late

Table 59.—Financing granted to the private sector, Bank of Brazil, 1965-66

Purpose of loan	1965		1966	
	Billion cruzeiros[1]	*Percent*	*Billion cruzeiros*[2]	*Percent*
Agriculture:				
Production	939	24	1,676	27
Marketing	1,378	35	1,978	32
Total agriculture	2,317	59	3,654	59
Other than agriculture	1,622	41	2,556	41
Total	3,939	100	6,210	100

[1] The average rate of exchange in 1965 was NCr$1.899=US$1. [2] The average rate of exchange in 1966 was NCr$2.220=US$1.

Source: (9), 1965, 1966). Compiled from data in tables on pp. 234-235 of Report for 1965, and pp. 246-247 of Report for 1966.

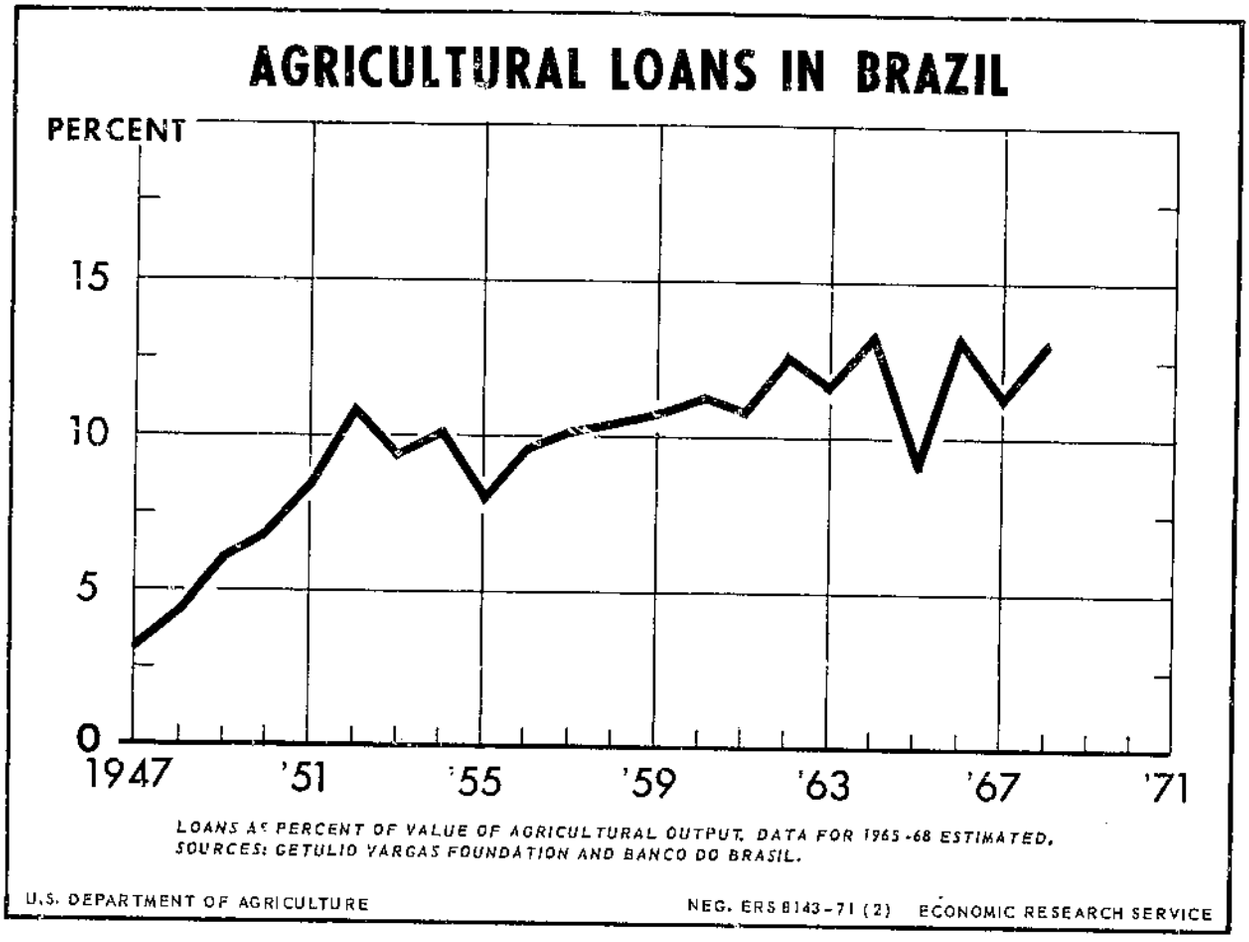


Figure 15

Table 60.—Financing granted to the private sector by General Credit Department (CREGE) and Agricultural and Industrial Credit Department (CREAI), Bank of Brazil, 1965-66

Department and purpose of loan	1965		1966	
	Billion cruzeiros	*Percent*	*Billion cruzeiros*	*Percent*
CREGE:				
Agriculture:				
Production	399	12	706	14
Marketing	1,237	39	1,777	36
Nonagricultural use	1,570	49	2,505	50
Total	3,206	100	4,988	100
CREAI:				
Agriculture:				
Production	540	74	970	80
Marketing	141	19	201	16
Nonagricultural use	52	7	51	4
Total	733	100	1,222	100

Source: (*9*, 1965, 1966). Compiled from data in tables on pp. 234-235 of Report for 1965, and pp. 246-247 of Report for 1966.

1950's. From 1962 on, cooperatives and minimum prices received about equal amounts.

Loans for livestock production during 1947-66 were much less than proportionate to the contribution of livestock to total agricultural income. Conservatism in lending for livestock production may have been partly a reaction to a speculative boom in the livestock industry that lasted from 1940 to 1946. Total CREAI loans for livestock during this period exceeded the value of CREAI loans for crop production. In 1947, CREAI livestock loans fell to less than 5 percent of the amount loaned for this purpose in the previous year. When the boom (mainly in purebred zebu stock) came to an end, there was widespread bankruptcy among cattlemen. In 1952, special legislation was passed to relieve their financial distress (*50*).

From time to time, various aspects of Brazil's agriculture have been singled out for special attention by the Government, and the Bank of Brazil has been the instrument for applying the credit elements of such programs. Rice, wheat, sugar, and coffee have been helped through programs to increase production, to stockpile surpluses, to eradicate or renovate unproductive plantings, or to build storage or processing facilities. In 1966, a program was established to subsidize the consumption of fertilizers (FUNFERTIL). Initially, the subsidy was limited to interest and banking expenses of loans to farmers for purchase of fertilizer, but other forms of subsidy were authorized. Earlier, a special fund was established to encourage more active lending to agriculture by private banks (FUNAGRI). Brazilian Government funds for these programs have been supplemented by loans from the U.S. Agency for International Development (USAID). Such efforts may have had strategic influence on the particular activity at which they were aimed, but it does not appear that the total value of agricultural loans changed significantly relative to agricultural income between 1952 and 1967.

A new agricultural credit law became effective in 1967. One of its requirements was that banks invest 10 percent of their deposits in rural loans, or make these funds available to the Central Bank for agricultural credit (*67*). Agricultural loans discounted by the Central Bank increased from NCr$84 million in 1965 to NCr$222 million in 1967. In 1968, the Bank of Brazil increased its loans for crop and livestock production by about 40 percent over the previous year. Loans by CREAI appear to have neared 15 percent of the value of agricultural output, up sharply from the 10-12 percent range that had prevailed from 1952 to 1967.

Credit and the Structure of Agriculture

An important credit function, barely touched by banking services available in Brazil until recently, is that of facilitating the restructuring made necessary by changing technology. Economies of scale and efficiency are likely to require many farms to become larger as technology evolves, although this expansion may conflict with some welfare criteria.

Brazil has a highly diversified agrarian structure and apparently there are large numbers of farms too large or too small to satisfy either production or welfare criteria (*17, 88, 102, 103, 104, 124, 145*). Some estates are actually larger than some of the world's smaller nations. Registration of properties in 1967 found 83 estates of at least 100,000 hectares (386 square miles) out of a total of more than 3½ million properties. At the other extreme, large parts of the South were settled in a family farm pattern, and the median size farm in the 1960 census was in the range of 10 to 20 hectares. The smallest median size farm by States was in the 2-to 5-hectare class in Maranhao, Pernambuco, Alagoas, and Sergipe; the largest was in the 50-to-100-hectare class in Goias.

Concentration of farmland by size of farms varies considerably among States. Distribution depends to an important extent on original settlement patterns (fig. 16),

influenced further by recent trends toward more rapid proliferation of farms in the smaller sizes (fig. 17).

Two-thirds of the farms and farmland were owner operated in 1960 (table 61). Among rented properties, cash rent is more common than share rent. Many farm laborers receive the use of a plot of ground as payment for performing a certain amount of work for the landowners. The majority of these plots are small, but they may produce as much as rented properties in the lower end of the size scale. Some laborers are paid in shares of the crop they produce. The census makes an effort to distinguish those with some autonomy as "operators." Rentals are highest among small farms (less than 50 hectares) and very large farms (more than 2,000 hectares).

Brazil has enough land to absorb even more people in agriculture, but the supply of capital could be a limiting factor. Cropland per person employed in agriculture increased from 1.5 hectares in 1950 to 1.8 hectares in 1960, and could be increased further, with beneficial effects on agricultural incomes. Many existing farms, particularly in the South and Northeast, are already too small and need to be consolidated. A supply of long-term farm mortgage credit would speed the process of consolidation. Farms to be established in newly developing areas will need more capital if they are to accommodate expected technological advances.

Large estates have been a conspicuous feature of the tenure structure of Brazil throughout the history of the country, although land has usually been available for those who wanted it sufficiently. Due to lack of a suitable credit system, however, the acquisition process has been relatively inefficient. Small farms available to meet this need have often been isolated or located on poorer soils, and consequently less capable of yielding adequate incomes. But they have done much to relieve pressure for land reforms (*5*, p. 161).

Steps to meet remaining land tenure needs more adequately were taken in 1965 with the establishment of the Brazilian Agrarian Reform Institute (IBRA), now the National Institute of Colonization and Agrarian Reform (INCRA). INCRA has broad authority to procure land (by expropriation, with compensation, if necessary), and is moving to develop colonies in frontier areas. A major obstacle to a more rapid evolution of the agrarian structure toward greater equality in sizes of farms has been the lack of a good source of institutional farm mortgage credit. Such a source of mortgage credit would facilitate the subdivision of overly large properties and lessen the tendency for fragmentation of properties that are already too small. Lack of sufficient credit of this type may tend to keep farm sizes in the new settlements smaller than would be in the best longrun interests of the settlers. A long-term credit program (5-to 12-year loans) was initiated in 1967, and may take care of this need.

Table 61.—Farms and farmland, by tenure status of the operator, Brazil, 1950 and 1960

Tenure	1950			
	Farms		Farmland	
	Number	*Percent*	*Million ha.*	*Percent*
Owner	1,553,349	75	154.5	66
Renter	186,949	9	12.9	6
Occupant[1]	208,657	10	9.9	4
Manager	115,512	6	54.9	24
Total[2]	2,064,642	100	232.2	100
	1960			
	Farms		Farmland	
	Number	*Percent*	*Million ha.*	*Percent*
Owner	2,234,960	66	161.1	64
Renter:				
Cash rent	327,136	10	13.1	5
Share rent	252,833	8	5.1	2
Occupant[1]	356,502	11	9.1	4
Manager	166,236	5	61.5	25
Total[3]	3,337,769	100	249.9	100

[1] Possession and use without title or payment of rent. [2] Includes 175 establishments and 18,582 hectares with tenure status not declared. [3] Includes 92 establishments and 13,716 hectares with tenure status not declared.

Sources: *(18)* and *(24)*.

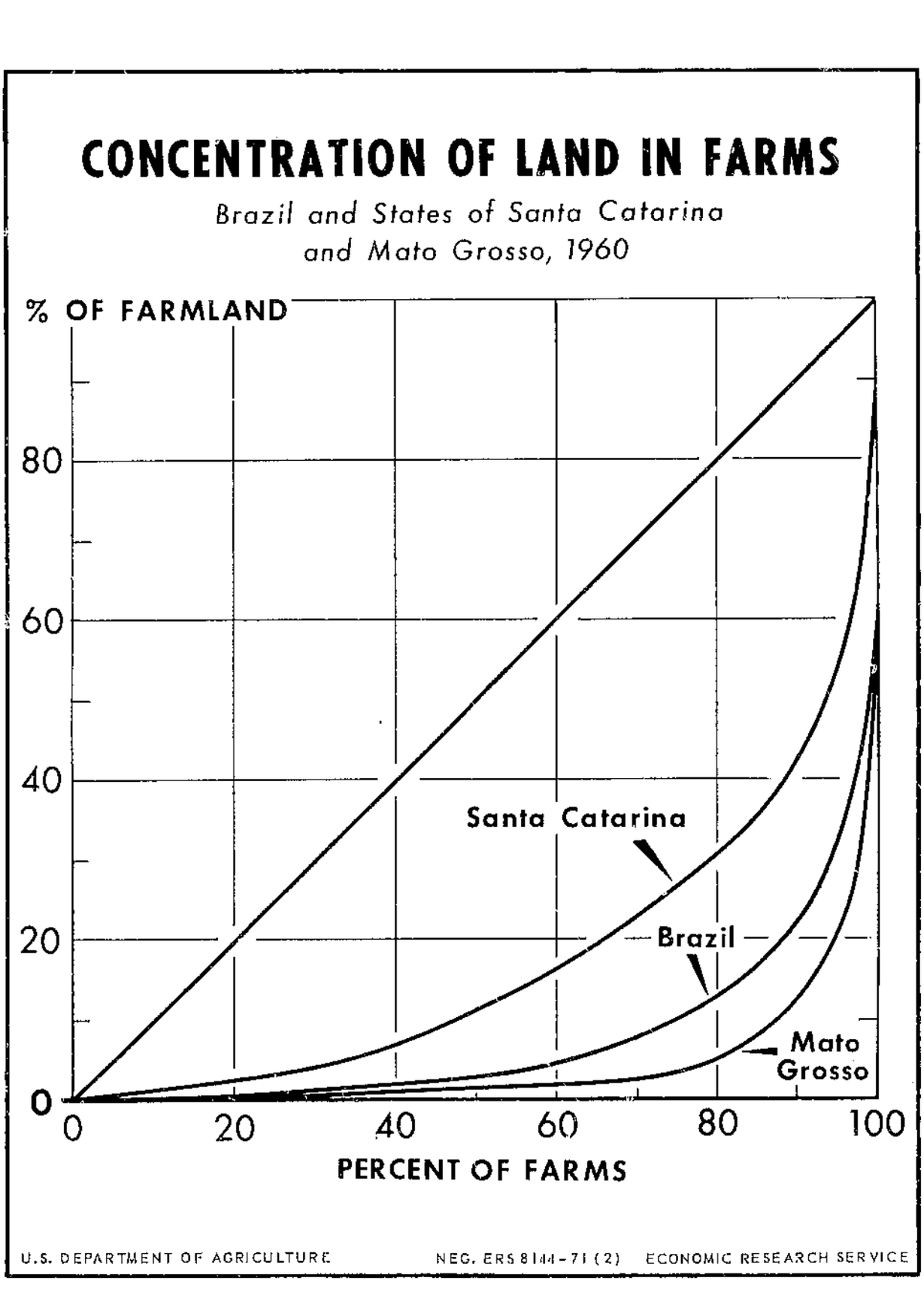

CONCENTRATION OF LAND IN FARMS
Brazil and States of Santa Catarina and Mato Grosso, 1960
% OF FARMLAND
80
60
40
20
0
Santa Catarina
Brazil
Mato Grosso
0
20
40
60
80
100
PERCENT OF FARMS
U.S. DEPARTMENT OF AGRICULTURE
NEG. ERS 8144-71 (2)
ECONOMIC RESEARCH SERVICE

Figure 16

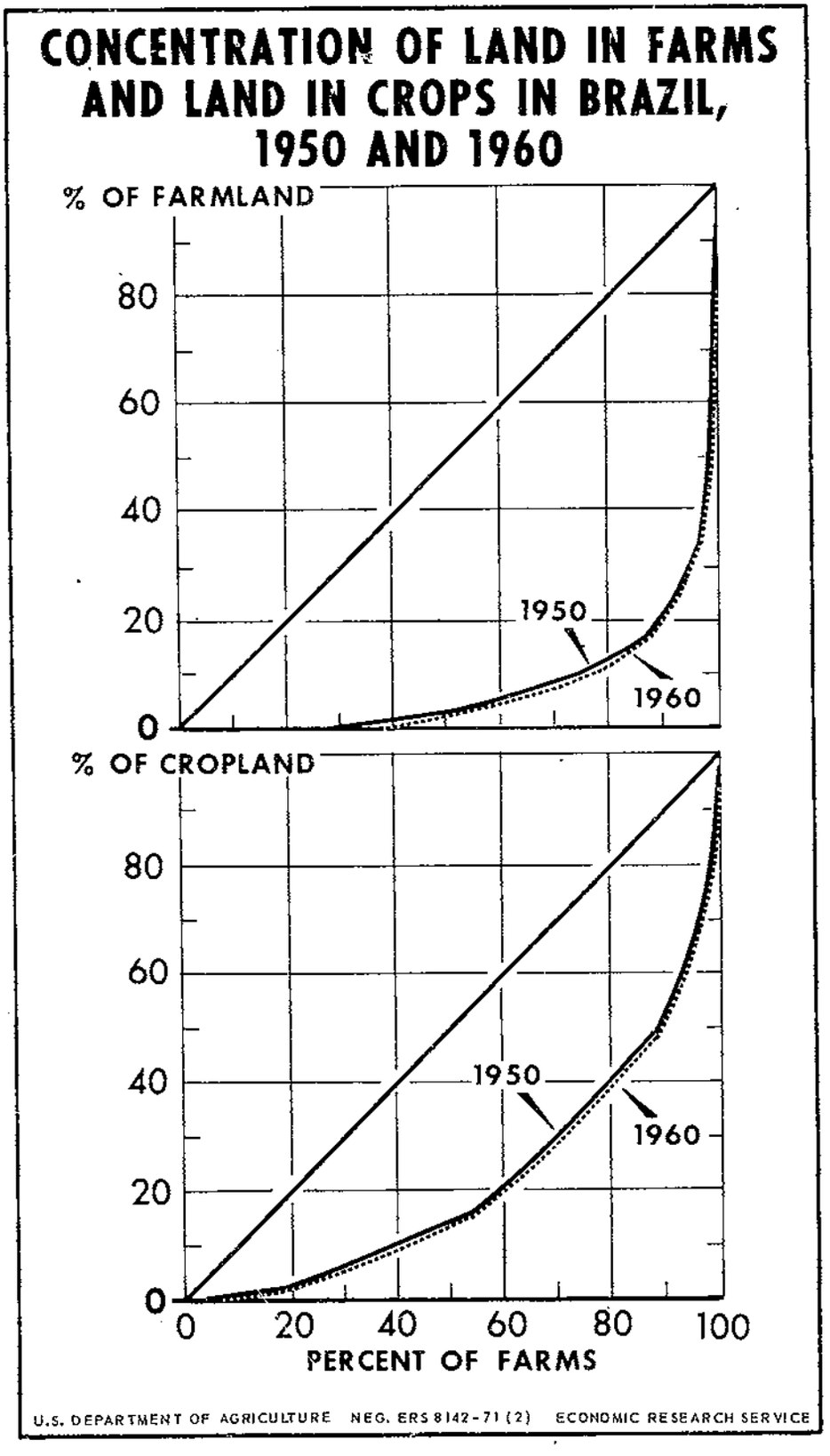

CONCENTRATION OF LAND IN FARMS AND LAND IN CROPS IN BRAZIL, 1950 AND 1960
% OF FARMLAND
80
60
40
20
0
1950
1960
% OF CROPLAND
80
60
40
20
0
1950
1960
0
20
40
60
80
100
PERCENT OF FARMS
U.S. DEPARTMENT OF AGRICULTURE NEG. ERS 8142-71 (2) ECONOMIC RESEARCH SERVICE

Figure 17

Organized Land Development

Early in the 19th century, Brazil began to locate groups of settlers on family-sized farms in an organized pattern.[7] Such formal settlement enterprises were largely Government-sponsored, but varied widely as to kind and extent of Government participation. At one extreme, some were heavily subsidized: ocean passage was paid for by the Government, and public works were undertaken primarily to provide employment and income for the settlers until their own production could be brought up to a subsistence level. At the other extreme, little was provided except the service of marking property boundaries.

By the beginning of the 20th century, colonists were seeking land, and private colonization ventures were being undertaken as profitmaking enterprises. One of the largest and most successful of these was Companhia de Terras do Norte Parana, leader in the fabulous development of northwestern Parana. Initially British, this company founded Londrina in 1925, built a railroad, and bought large tracts of land which were subdivided and sold to settlers. By World War II, Brazilian interests were able to purchase the British equity in the enterprise, and the original capital was repatriated to Britain. Private development activity continued in the 1960's, some of it by unscrupulous speculators exploiting foreign investors (*140*). One of the outstandingly successful colonies established following World War II was Holambra, founded in Sao Paulo by Dutch colonists. Several Japanese colonies also were established prior to and following World War II.

The Brazilian Government maintained an interest in organized colonization efforts, even after private projects became the principal form. In the 1930's, steps were taken to integrate settlers of foreign origin more firmly into Brazilian culture. Basic legislation in 1941 and 1964 provided for creation and regulation of settlements, both public and private. IBRA and the National Agricultural Development Institute (INDA) administered the laws until 1969, when sole responsibility for colonization was vested in IBRA, (now INCRA). Instructions issued under these laws specify in considerable detail how settlements are to be planned and administered (*14*). In 1960, 31 colonies were operating in 15 States. As each colony becomes economically advanced, that is, when a majority of colonists achieve full ownership and the community is fully viable economically, it is "emancipated" and becomes integrated into the normal political life of the county (municipio) in which it is located.

Provisions for colonization under current agrarian reform legislation are important symbols of intent to help farm laborers acquire farms of their own. Yet, the number of persons benefiting from such projects is apt to be small. Not only are the formalities of organized colonization burdensome, compared with the relative ease of informal spontaneous settlement, but financing of land and facilities to meet formal standards of adequacy is likely to be an additional limiting condition. While formal private colonization is also provided for under INCRA's regulations, independent, spontaneous settlement will doubtless continue to have a significant but unobtrusive role in the formation of new farms.

The success of farm settlement projects has varied widely during the past century and a half. Not all development enterprises have been as highly successful as those in Parana. Many settlements failed because they did not pay sufficient attention to the need for access to markets, and to the amount and quality of resources required to provide each settler an adequate income (*144*). Guidelines for settlement under INCRA's regulations indicate that these factors will receive more attention in future projects (*14*).

Research and Education

Agricultural research in Brazil employed about 900 technicians in 1967—about one per 3,700 farmers.[8] The oldest experiment station was founded in 1887. By 1966, there were about 50 main research centers and 70 substations (*29*). Research gave the country improved selections of coffee varieties (beginning in the 1930's) (*82*, p. 196), improved citrus stock, and corn hybrids widely used in Sao Paulo (*85*). A massive wheat breeding campaign, jointly supported by national and international agencies, public and private, was begun in 1968 (*93*).

Brazil apparently has had no accomplishments in breeding new crop varieties comparable to the IR-8 rice and Mexican wheats. Tests of varieties developed elsewhere have not shown results in Brazil comparable to the improvements shown in some other locations. Varietal tests and genetic research already constitute a major part of research under way, but considerable obstacles impede interpretation of results and formulation of valid recommendations for their practical application. Much remains to be done to determine and fully exploit possible interactions between crop varieties and environment (*143*).

Varietal trials proved a substantial superiority of selected strains of Novo Mundo coffee over other varieties (*82*, p. 197). Yet, the most recent variety survey, in Minas Gerais, found that plantings of Novo Mundo were a minor percentage of the total (*69*).

Agricultural education is provided on a limited scale. Only half the children 7 to 14 years old in rural areas attended school in 1964, although total primary

[7] This section draws on material from a number of sources (*23*, III-6); (*25*, 1908-12); (*57*, ch. XXII); (*124*, ch. 16).

[8] Haynes, James L. *Status Summary of Brazilian Agricultural Research.* IRI, DEPEA, Ministry of Agriculture, Rio de Janeiro, n.d. (about 1967), 2pp. (Typewritten.)

school enrollment increased 170 percent from 1950 to 1964. Curricula are largely designed to prepare students to enter universities for careers in the humanities or nonagricultural professions. Of 1,626 secondary schools in 1966, only nine were classified as agricultural (*25*, 1967, p. 605). At the junior high school level, 121 schools offered agricultural courses, and at the senior high school level, 41 (*25*, 1967, p. 669).

University enrollment in agricultural and veterinary science curricula in 1968 was 8,015 out of a total of 258,303 (*25*, 1968, p. 528). In the preceding year, of 27,490 graduates in all fields, 1,511 students specialized in agriculture and veterinary science. Several Brazilian universities, with help from USAID and American universities, have greatly expanded and improved their teaching and research activities in the field of agriculture (*119*, pp. 205-226).

Following World War II, agricultural extension work was initiated with a program of rural missions (*125*, p. 559). The program was formalized in Minas Gerais in 1949 as the Association for Credit and Rural Assistance (ACAR). Other States followed, and the Federal agency, ABCAR, was created in 1956 (*51*). Local offices of the system served nearly 1,300 municipios from a total of 3,300 in the 18 States where the program was in operation in 1967. The number of extension specialists rose from 990 in 1964 to 2,151 in 1967. Federal support and coordination is given through the National Institute for Agricultural Development (INDA), an agency of the Ministry of Agriculture.

Brazilian farmers apparently have no serious cultural or temperamental objections to adopting any truly profitable technological innovations. This is borne out by historical shifts in response to changing alternatives (above, p. 10), by rapid expansion of output of several crops, and by results of recent studies of supply responses (*15*, *16*, *70*, *123*).

Two municipios in Rio Grande do Sul were studied to learn what factors were associated with differences in productivity between the municipios, and among farmers within municipios.[9] Levels of productivity were measured for corn and hog enterprises. Farms were small family holdings (averaging 15 and 25 hectares, respectively) in the municipios of Estrela and Frederico Westphalen. The list of recommended production practices, compiled with the advice of agronomists and animal husbandmen, contained 30 items, 10 pertaining to crop production (especially corn) and 20 to hog production. The survey found that six practices were practically ignored (used by less than 5 percent of the 220 farmers interviewed) and one was used almost universally (95 percent). After deleting several other practices considered unsuitable for scoring, 15 practices remained in one municipio and 17 in the other which could be used to score farmers according to their innovativeness. From these final lists, it was found that 43 farmers were using 10 or more recommended practices, 141 were using from four to nine practices each, and 39 farmers were using less than four. While the results demonstrate that Brazilian farmers will adopt innovations, it is evident that much remains to be done to raise the level of technology in terms of known techniques. Farmers in the municipio of Estrela used an average of 7.2 recommended practices per farm, out of a possible 15. In Frederico Westphalen, the average was 6.2 out of 17.

Differences in innovativeness among municipios were related to a highly complex set of factors. Low productivity was found associated with lack of resources (livestock and equipment) complementary to labor, and relatively low scores for adoption of recommended production practices. Sociological factors significantly correlated with high adoption scores could be summed up by the term "contact." Producers in closest touch with the community around them, with urban areas, and with sources of information (radio, reading matter, and agricultural technicians) adopted more practices than their neighbors who were more isolated, voluntarily or involuntarily.

Foreign Aid

U.S. Government and international agencies provided about $4 billion in loans and grants to Brazil during 1946-67 (table 62). About $0.7 billion consisted of surplus agricultural commodities, mainly wheat, from the United States under Public Law 480 programs. The total value of these imports during 1964-67 was equivalent to about 2 percent of the total value of domestic agricultural production.

AID loans for agricultural projects in 1965-68 amounted to $60 million from a total of $827 million (*131*). Projects included importation of fertilizers, construction of a fertilizer manufacturing plant and a forest products plant, and expansion and improvement of agricultural research.

AID technical assistance, amounting to $58 million, was more heavily weighted toward agriculture than the loans. About one-fifth of the U.S. technicians in Brazil were concerned with food and agriculture. Major technical assistance efforts in agriculture included: (1) A multidisciplinary group from the U.S. Department of Agriculture, numbering more than 20 persons in Brazil at its peak in 1965-67; (2) Contracts with four U.S. universities to help Brazilian universities strengthen their work in agriculture; (3) Assistance to the research departments of the Ministry of Agriculture; and (4) Establishment of a national soil testing service.

In addition to USAID and P.L. 480 programs, Brazil received significant foreign assistance from U.S. foundations, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Program (UNDP), and several development banks.

[9] See footnote 4, p. 11.

Table 62.—U.S. and international economic assistance loans and grants to Brazil, 1946-67

Year	AID and predecessor agencies	Food for Freedom (P.L. 480)	Other[1]	U.S. total	International organizations[2]
	Million dollars	*Million dollars*	*Million dollars*	*Million dollars*	*Million dollars*
1946-48	---	---	73.9	73.9	---
1949-52	2.6	---	109.5	112.1	117.6
1953-57	17.3	148.4	684.8	850.5	55.8
1958	5.8	3.6	17.5	26.9	18.0
1959	8.9	3.0	122.2	134.1	90.6
1960	11.9	1.8	6.8	20.5	1.1
1961	7.0	84.7	188.3	280.0	17.7
1962	84.5	74.2	47.9	206.6	27.6
1963	86.3	48.6	7.4	142.3	23.1
1964	178.6	160.3	6.5	345.4	30.7
1965	230.7	24.9	17.3	272.9	164.2
1966	241.7	114.1	23.4	379.2	153.0
1967	212.6	22.0	34.8	269.4	252.8
Total, 1946-67	1,088.0	685.5	1,340.3	3,113.8	952.2

[1] Includes Social Progress Trust Fund, $62.1 million; Export-Import Bank long-term loans, $1,212.2 million; Surplus Property Credits, $22.5 million; and Defense Mobilization Development, $16.4 million. [2] Includes International Bank for Reconstruction and Development (IBRD), International Finance Corporation (IFC), Interamerican Development Bank (IDB), United Nations Development Program (UNDP), and European Economic Community (EEC).

Source: (*130*).

Foreign assistance programs to Brazil were coordinated in part by the Agricultural Technical Office (Escritorio Tecnico de Agricultura or ETA), which grew out of the Joint Brazil U.S. Economic Development Commission established in 1950. As conceived, ETA was to have broad responsibilities for deciding which projects would receive foreign support, and which foreign agency would be asked to assist a particular project. Finally, ETA would monitor the projects to see that support was used in accordance with the plan. In the course of time, ETA came to serve mainly as a disbursing channel for AID funds and the Brazilian counterpart funds to AID-supported projects. Some planning and coordination came to be exercised by the Planning Ministry and a planning group in the Ministry of Agriculture, but the implementation was largely left to bilateral arrangements between the Brazilian agency directly responsible for a project and the foreign agency contributing to its support. Thus, foreign assistance programs exhibited some of the dispersion that characterized other activities related to agriculture (p. 6).

CHAPTER VI.--IMPLICATIONS FOR AGRICULTURAL DEVELOPMENT

Agricultural development planning increasingly calls for quantitative statements about relationships among factors of production and output and subsectors of agriculture, and between agriculture and external sectors (the rest of the domestic economy and world markets). Formulating the econometric model that may ultimately be needed in Brazil is beyond the scope of this project. But Brazil's agricultural output is considered quantitatively, and information is provided about relationships that would form important parts of such a model. Special attention is given to the large area of land available for development, complex and perplexing problems of biological and economic productivity, and agriculture's relationship to the rest of the economy.

Full Use of Land

As in other low-income countries, more of Brazil's lowest incomes are concentrated in agriculture than in any other sector of the economy. But unlike many of these countries, Brazil has abundant land and can continue expanding its cultivated cropland at present rates for most of this century. Thus, a major agricultural issue consists of finding ways to make the land resource contribute more toward raising national and per capita incomes.

Occupying its territory more fully is one of Brazil's overriding goals. Settlement to confirm the nation's right to the land it claims has always been inherent in Brazil's land policy. In the past, this factor sometimes led to the establishment of colonies lacking conditions essential for economic viability. Either the undertaking failed or the settlers were forced to lead a life of deprivation (*144*). This experience leads some to reject the policy of settling additional land. At the very least, the experience emphasizes the need for careful attention to conditions essential for successful settlement.

Objectives other than simple occupation of territory have figured in Brazil's long history of formal settlement or colonization projects, public and private. Some projects, like those which contributed to the development of Parana, were commercially oriented. Others have stressed social aims or relief for landless workers unable to escape from crowded areas offering insufficient and low-paid employment. Building on this experience, provisions for planned settlements became a part of agrarian reform and agricultural development programs initiated in the 1960's.

Productivity

Despite its extensive land area, Brazil still shares a problem of productivity with countries less abundantly endowed. Parts of Brazil are densely settled. Total income in these areas may be achieved through increased output per hectare. But higher income per person may be achieved through higher productivity per worker, shifting to production patterns which use more land per worker, and not necessarily increasing total income of the area. This alternative implies migration of some workers to other areas, and consolidation of some of the smaller farms. It also implies some decline in land values in the areas now most densely settled. Since this alternative has some unattractive features, it is understandable that many would prefer to increase yields through improved technology.

Evidence in chapters III and IV supports an overall impression of low physical and biological productivity of practically all inputs used in farm production in Brazil under traditional methods, and of still unsolved problems impeding effective use of presently available modern techniques. Such low productivity has discouraged trends away from traditional technology. Changes in techniques have been further inhibited by a tendency for prices of nonfarm inputs to be high, compared with prices in other countries. Thus, growth of agricultural output between 1947 and 1965 was characterized by dramatic expansion in Parana and other frontier areas, and by displacement of coffee by rice and corn in value of output. Increases in cropland and livestock numbers accounted for 85 percent of the increase in output, the remainder reflecting changes in yields and crop patterns.

Crop yields in general increased during the study period, but the gain was small—0.1 percent a year, against an overall increase in crop output of 4.5 percent. Furthermore, most of the apparent increase in yield resulted from the increasing volume of production in frontier areas, where yields tended to be higher than average. Trend in output per animal unit of livestock, on the other hand, was biased downward by the increasing proportion of livestock production in frontier areas. Yields of major crops in the frontier States ranged from 38 percent lower to 147 percent higher than in neighboring older States, the median yield being about 11 percent higher in the frontier States. Exhaustion of soils from years of cropping in the older States did not appear to be a major factor in yield differences among States.

Analyses of output per hectare of crops and per animal unit of livestock indicate that little change in output could be attributed to other inputs. Labor productivity increased during the study period. Between 1950 and 1960, the agricultural labor force increased about one-fourth, while real product in the agricultural sector increased more than half. The agricultural frontier absorbed large numbers of migrants from older States, while urban employment drew heavily from rural areas close to industrial centers. Sao Paulo and Minas Gerais, both close to frontier States and containing large industrial centers, were drained of most of their rural labor surpluses, but the Northeast, despite migration to both rural and urban areas, increased agricultural employment by one-third.

Nonfarm inputs, such as fertilizer and machinery, made up less than two-fifths of farm expenses in the 2 years for which data were available, 1950 and 1962-63. Fertilizer consumption remained static at relatively low levels between 1958 and 1966, turning upward sharply in 1967 under stimulus of a special credit program and improved knowledge of how to use fertilizers more effectively under Brazilian conditions. High prices of fertilizer and generally low response ratios held consumption in check, although opportunities for profitable use of fertilizer appear not to have been exploited fully.

Farms using only human muscle for power—three-quarters of the total—remained virtually unchanged from 1950 to 1960. This constraint on labor productivity has been recognized, but unresolved, for a century or more.

Agriculture and the Rest of the Economy

Linkages between agriculture and the rest of the economy may be grouped into those composing the market demand for farm products, those affecting the competition between farm and nonfarm sectors for resources, and those involving savings, investment, money, and finance (*44*). Of these, the most obvious is probably the market demand for Brazilian farm products, since it implies price constraints on increased production.

Domestic Markets

Most of Brazil's agricultural production is consumed domestically. About 70 percent of total cropland in 1963-65 was used for crops other than the six chief export crops. Expanding domestic demand compounded of a growing population, rising per capita real income, and increasing urbanization absorbed much of the growth in agricultural output, and will continue to do so. Shifts in the geographic pattern of farm prices showed the influence of urban demand, as well as the effects of steady improvement in transport facilities. Other favorable facets of domestic demand included the Government's minimum price program and a growing food processing industry. If supplies of domestic products grow faster than population and personal incomes, prices tend to fall. It then becomes profitable to shift land to export crops. This mechanism regulates the growth rate of products that cannot be readily exported (*108*).

Exports

Brazil leads the world in coffee production and ranks third in cocoa. World prices of these products are influenced significantly by production or marketings from Brazil so increases in production quickly become unprofitable if they exceed rates approximating the growth in world demand.

Brazil now exports small but increasing quantities of a few crops—rice, corn, and soybeans—whose prices on world markets would be little affected, even if Brazil's production and exports were to increase substantially. If prices of domestic products tended to fall relative to prices of these export commodities, production for export would tend to rise. Similarly, an increase in efficiency of agricultural production would tend toward higher production of export products.

Resource Markets

Another important linkage between farm and nonfarm sectors is through the resource market. Land, labor, nonagricultural inputs (such as fertilizers, machinery, and other industrial materials), and commercial, technical, scientific, and social services constitute resources needed for agricultural production, and agriculture competes with nonagricultural uses for these resources.

The quantity of land available for agriculture in Brazil is virtually unaffected by competition from nonagricultural uses. Cities, highways, and other uses of land may have important local effects on land values, but they occupy relatively little space. The most significant factors affecting the quantity of land used for farming, grazing, or forestry in Brazil are the investment required to develop land and to provide access to market, and the relationship of residual income to marginal land relative to the expected rate of return on alternative investments. Some of the necessary investments, like highway construction and cadastral surveys for security of title (or equitable and effective tax assessment), are eminently fields for public action.

Labor is the next most important agricultural input after land (if, indeed, any priority can be established between these two factors). The farm-nonfarm distribution of labor constitutes a distinctive feature of interest in developing economies. Detailed theory has been worked out for the case where the marginal productivity of agricultural labor is null or negative (*91*). The theory obviously does not fit Brazil, where abundant land and an expanding and improving transportation network assure a virtually constant if not secularly rising marginal productivity of labor, even with

traditional techniques (*110*). Urban employment continues to preempt the labor supply it needs in Brazil, but part of the residual rural population moves on to occupy new land. Mechanization, which tends to raise the land-man ratio, may accelerate the rural-rural migration, accounting for the high growth rate in agricultural output of such States as Parana, Mato Grosso, Goias, and Maranhao. Mechanization also serves to fill the farm labor vacuum that tends to develop in the immediate hinterlands of the cities of Sao Paulo, Rio de Janeiro, and other industrial centers.

Labor, like land, may vary in quality and is subject to improvement. Knowledge and skill can be cultivated, at a cost, and represent both private and public investment opportunities. The wage differential between tractor operators and common agricultural labor in Brazil affords an indication of the income potential of one teachable skill.

Apart from its role as a production input, agricultural labor is an important factor in Brazil's social goals, since members of the farm labor force constitute a disproportionately large component of the low-income group. Consumption patterns of farmers, and their preferences for disposing of additional income, may have important implications for national economic development policy as domestic industry begins to saturate the demand of urban middle and upper income classes.

Nonfarm inputs become increasingly important as newer techniques invade traditional agriculture. In the developed nations, value of nonfarm inputs used by farmers may be greater than the personal income of the farm population from farm sources (*138*, 1967, pp. 574 and 575). This linkage between farm and nonfarm sectors is reciprocal. As farmers seek increased efficiency, they demand more nonfarm inputs. On the other hand, as the supplying industries compete to boost sales of their products on the basis of more efficient production, pricing, and selling, they may also raise the efficiency of farm production (*8*).

Nonfarm inputs can be supplied from domestic production, or they can be imported. Which is preferable depends on such factors as the size of the domestic market and the efficiency of the industrial sector in general.

In addition to physical inputs from nonfarm sources, agriculture requires public (governmental) services. Education, research, extension, marketing services, and regulatory activities must expand as modern farming and farm marketing methods displace traditional methods.

Most services—education, research, and extension—needed by a modern agriculture have been available in Brazil since World War II. Yet, the supply of these services is far from sufficient. In 1964, for example, half the rural children aged 7 to 14 did not attend school, and extension services provided an average of only one specialist for every 1,400 farmers.

Agriculture has important indirect relationships to the rest of the economy through fiscal and monetary channels. Since agricultural exports are the main source of foreign exchange earnings in Brazil, as in most developing countries, agricultural progress can contribute importantly to the country's capacity to pay for imports of capital goods needed for development, and to attract foreign investment to supplement domestic savings. Financing of agricultural production and marketing can absorb substantial amounts of institutional credit. Because the total supply of credit is limited, the demand from agriculture can affect the availability of credit for other sectors. Savings and investment in the agricultural sector may show positive or negative balances, thus contributing to, or restricting, the supply of funds available for nonagricultural investment.

Brazilian farmers have a substantial investment in production facilities, notwithstanding the limited use of advanced technology. Investment in land clearing, buildings, tree crops, and livestock from 1947 to 1965 appear to have been financed largely from the farmers' own savings. Approximately one-fourth of the gross value of each year's agricultural output went into agricultural capital formation. Although institutional credit was available, it was utilized almost exclusively for short-term financing. Loans amounted to about 10 percent of the value of agricultural output during most of the past two decades.

The linkages described above may be considered a rough model of the role of agriculture in economic development. They involve land, labor, and capital at every level from the research laboratory and experimental plot through the microeconomic and macroeconomic phenomena to the most complex national development models. These linkages reflect significant heterogeneities in the country's natural endowment of physical resources. They are influenced by social and political institutions and values, modifying the manner and extent to which new wants and new ways take their place among those transmitted from the past, or displace them.

Future Development

Past progress of Brazilian agriculture is summed up compactly in the 4.5-percent growth rate of the primary sector component of gross national product. To project future development, however, and guide it toward desired objectives requires consideration of separate components of the overall growth, many of which have exhibited diverging trends. Forces bearing on one component tend to differ in kind or strength from those affecting another, as well as in the extent to which they may be influenced by public action. Thus, to be able to specify a development program adequately, it is necessary to consider components of output and related forces at lower levels of aggregation than the primary sector as a whole.

The literature of agricultural economic development suggests many pertinent forms of disaggregation—dichotomies are common: subsistence versus commercial sectors, minifundia versus latifundia, domestic versus export crops, traditional versus modern, new areas and old areas, supply and demand. There is growing interest in the production function approach, in which the classical production factors—land, labor, and capital—may be further subdivided, both at macroeconomic and microeconomic levels.

In the present study, agricultural growth was disaggregated in four categories: factors of production (land, labor, and capital, with some further consideration to major categories of capital inputs); commodities; geographic area; and supplies and services external to the farm. Analysis along these lines of disaggregation provides important information toward formulation of an agricultural development policy.[1]

Land will almost certainly contribute more than any other factor toward increasing agricultural output in Brazil during what remains of the 20th century. Total crop area would be more than trebled if area cropped in the frontier States were raised to the same percentage of total area as in the older settled States. Suitability ratings are high for nearly two-thirds of the frontier area, assuming the use of improved management and presently known techniques.

The principal resistance to be overcome in expanding area under cultivation is that of providing adequate transportation. The frontier region still lacks a network of highways and railroads, but a basic highway network is planned for completion during the next decade (*77*, April 1968). Secondary roads, in the aggregate, may present a greater problem. The frontier area averaged 19 kilometers of roads per 1,000 square kilometers in 1965. To bring this up to Parana's 1965 average of 350 kilometers would require construction of 2 million kilometers of roads—the equivalent of 60 years' work at the average rate of construction from 1955 to 1965.[2]

Other community facilities will be needed in the new areas, but from the standpoint of the economy as a whole, these needs would be essentially the same whether the growing population spread into the new areas or remained in the older ones. Existing educational facilities, for example, are still inadequate for full-time schooling of all children in the older areas.

Expanding agricultural production into new areas involves substantial investment in land clearing and development. Traditional techniques sufficing for this purpose depend mainly on human labor. The work can be done during seasons when little or no alternative productive employment is available. Investment of this sort requires little prior savings or credit. How much development can be accomplished with such methods depends on the hypothesized availability of seasonal labor lacking alternative opportunities to perform useful work.

Modern techniques and large-scale land clearing and development, on the other hand, require prior savings. These forms of agricultural development may become sufficiently competitive to attract private financial investment. Investment funds are required also for off-farm facilities such as those used in marketing. These generally cannot be obtained directly with labor alone, even in their traditional forms.

The pace of agricultural development in Brazil will probably be set fundamentally by the growth rate of the agricultural labor force. The elements of this calculation vary in predictability—the natural increase in population is more predictable than trends in urban employment or rural-urban migration, for example. The Getulio Vargas Foundation projected an economically active population in agriculture of 19.2 million by 1975, a growth rate of 1.5 percent (*70*, p. 81). Labor productivity was expected to increase at the rate of 2.4 percent a year. Therefore, the effective employment of the labor force would require about a 4-percent annual increase in cropland. Actual increases in cropland might be greater or less than this estimate, depending on trends in relative profitability of labor intensive and labor extensive farm enterprises, and the extent to which technological advances impinge on labor-land input ratios. More rapid growth of cropland than labor force would imply increasing labor productivity, essential for rising income and social welfare.

The regional distribution of the agricultural labor force will probably continue to shift as it did between 1950 and 1960. This would give rise to substantial migration from the Northeast and the small farm areas of the South to new farming areas on the frontier, and continued draining of rural people into urban occupations around industrial centers *(110)*.

Capital was the third item considered in the factor line of disaggregation in this study. The available evidence shows that the forms of capital identified with advancing technology—largely nonfarm inputs—were used too little to account for much agricultural output, and even sizeable rates of increase would have little effect on the aggregate output of the sector. That price ratios for such inputs were unfavorable was recognized in Brazil. But a more fundamental difficulty seems to have been the tendency of physical and biological efficiencies to be low.

Returns from money spent for agricultural research are far less predictable than returns from a given investment in roads and land development. Yet, in aggregates on a scale that would be appropriate for Brazil, there is reason to expect good returns from research *(118)*. "Science policy or the management of research and development are much younger arts than agriculture, but they are already beginning to get results

[1] Shuh and Alves also identified a wide variety of factors affecting agricultural progress in Brazil (*119*).

[2] An efficient system of 400 kilometers of road per 1,000 sqare kilometers on level land would provide a road within 1¼ kilometers of any point. Such a system would serve 30-hectare holdings having average frontages of ¼ kilometer per holding.

which justify the assumption of some degree of rationality" (*55*, p. 464).

Significant gains in productivity remain to be achieved by more widespread adoption of known improved techniques—developed locally or transferred from abroad—since, as was found in the study of factors associated with differences in productivity among farmers in two municipios in Rio Grande do Sul, few Brazilian farmers are now using all the practices considered superior. Yet, there are several reasons for believing that presently known techniques do not promise output increases anywhere near those obtainable from increases in crop areas. Rate of adoption of innovations is a function of time, and some "improved" practices (use of fertilizer, for example) have long been advocated in Brazil. Consequently, failure to adopt such practices implies some justifiable reason such as unfavorable price or physical productivity. Environmental factors may sharply restrict the transferability of technology, especially new plant varieties, and this limitation applies to transfers among areas within Brazil as well as to transfers from abroad. Brazil has far to go to provide its farmers with an array of plant varieties fully adapted to the ecological diversity of the nation's vast length and breadth. Finally, some of the fundamental problems of tropical agriculture—photoperiodism, soil management, and animal reproduction, growth, and maintenance—may block effective use in Brazil of some techniques that succeed in temperate climates. For these reasons, Brazil is warranted in expanding its research investment considerably, in concurrence with efforts to exploit the momentum of frontier development.

The commodity line of disaggregation in this study disclosed large changes in the commodity pattern of agricultural output in Brazil between the late 1940's and the mid-1960's. Cocoa and rubber output grew less than 2 percent a year over the period as a whole, and coffee and cocoa output trended downward during 1957-65. In total value of output, coffee surrendered first place to rice in 1962, and trailed rice, corn, and sugar in 1966 on the basis of current prices. Coffee's share in value of output of 26 crops declined from 19 percent in 1947-49 to 15 percent in 1963-65. Exceptionally high rates of growth—10 to 20 percent—were achieved by soybeans, sisal, peanuts, tomatoes, and jute. Milk and eggs increased more than 6 percent a year, accounting for the livestock subsector's increase in share of total output from 25 percent in 1947-49 to 28 percent in 1963-65. A significant implication of these trends is that Brazilian farmers were not bound to traditional patterns so firmly that they were unresponsive to economic alternatives over a span of time appropriate for development planning.

The Brazilian economy absorbed the increased agricultural output during the past 20 years without serious pressure on the level of agricultural prices. The 3-percent growth rate of population and 2.8-percent growth rate of per capita income were apparently well balanced with the 4.5-percent growth rate in agricultural output. Successful efforts to stimulate agricultural output through increased productivity of land or labor, or both, might burden the absorptive capacity of the domestic market. In that event, Brazil might enter world markets with some products that do not now figure importantly on its export list—rice, corn, and soybeans are the most likely candidates for such expansion. Although Brazil alone is unlikely to export enough of these products to depress world markets, these commodities are promising items for expansion in other countries, both developed and less developed. Constant attention will be required for Brazil to assess its competitive position accurately with respect to exports, and to assist farmers in maintaining appropriate choices of enterprises and levels of output.

Geographic disaggregation provided information on the current status of frontier versus settled agriculture in Brazil. A generation ago the State of Sao Paulo epitomized this dichotomy. During 1947-65, Parana was the outstanding new area, both in terms of rate of growth and total increase in output. Mato Grosso, Goias, and Maranhao also had high rates of growth, but contributed much less to total increase in output. Now that opportunities for opening up new land are coming to an end in Parana, the frontier of the next decade will be mainly in Mato Grosso and Goias, with tentacles of penetration along the highway network extending into Rondonia, Acre, Para, and Amazonas.

Although its rate of growth in earlier years may have resembled that of Parana in recent years, Sao Paulo attained only a 3-percent growth rate during 1947-65. About one-third of Sao Paulo's increase in output was accounted for by increase in yield, a much higher proportion than in any other State. In fact, yields declined in many of the older settled States. These results agree with the general evidence of progressiveness in Sao Paulo's agriculture. On the other hand, Sao Paulo's performance in raising productivity would have to be surpassed many times if land productivity were to become a satisfactory source of increased agricultural output in Brazil.

Geographic disaggregation places in bold relief what may be the chief obstacle to Brazil's agricultural development—the relatively easy, cheap, and certain increments of agricultural output provided by the frontier. Older settled areas, with few exceptions, are under continuing pressure to adjust to a structure in which land rents and land values take a smaller share of net farm income, and enterprises offering higher returns to labor are favored. However, these pressures may be offset or minimized by developing and applying new yield-increasing techniques. The restructuring of agriculture necessitated by evolving technology will also be facilitated if increased amounts of institutional credit are supplied.

Past agricultural development in Brazil was left largely to private initiative. While the Government provided a fairly complete array of aids to agriculture, much of this

assistance was on such a small scale and instituted so recently, its impact on agricultural output has been relatively minor. The past performance of Brazil's agriculture, therefore, reflects primarily the spontaneous accommodation of several million farmers to their economic environment—adaptation to a changing structure of prices, a shifting supply of labor, access to a frontier, and a virtually static array of technical possibilities.

About 40 percent of the increase in output between 1947-49 and 1963-65 came from frontier States, which at the beginning of the period accounted for 14 percent of Brazil's agricultural output, and at the end, 27 percent. This growth represented mainly the strength of spontaneous forces. For Government to play a larger, more effective role requires a better understanding of these forces and of governmental efforts which might catalyze, guide, and supplement them, remove obstacles, minimize the chances of failure, and open avenues to a more prosperous agriculture. Increasing effort was applied to agricultural planning in the 1960's (*31, 32, 38*), but the focus remained on land already in farms (*33*, p. 65).

Significance of Brazil's Experience to Other Countries[3]

Brazil's experience demonstrates the effectiveness of spontaneous growth factors when limiting or inhibiting physical or technological conditions are not unduly restrictive. The principal spontaneous growth factors in Brazil were the labor force, availability of land for crop expansion (both in areas long settled and in areas being taken out of forest for the first time), a substantial capacity for capital formation (even though largely in the form of traditional inputs), and sufficient managerial initiative to combine the resources productively (again, mainly, though not exclusively, in traditional patterns).

Serious inhibiting conditions in Brazil were chiefly the relatively low levels of physical and biological productivity afforded by nonfarm produced inputs under Brazilian conditions. Where technologically superior innovations appeared, such as soybeans, they spread rapidly.

Brazil has been unable to effect much improvement in the level or distribution of incomes. Clearly, increasing output alone, while necessary, is not sufficient to achieve all the objectives of economic development.

Brazil's growth has been atomistic, depending mainly on responses at the level of the individual farm enterprise. While approaches requiring more highly organized effort have been made—research, extension, credit institutions, and irrigation projects, for example—they accounted for little actual development during the period under study. Countries lacking some of the relatively easy sources of growth that sufficed in Brazil would have to rely more heavily on organized efforts. Planning is essential to identify constraints on growth and prescribe remedies, and action programs are required to provide a continuing flow of improved alternatives and the means to exploit them.

[3] Detailed comparisons between Brazil and other countries may be found in the summary report (*137*) and other reports of research done under this project (*4, 49, 78, 80, 81, 116, 132*).

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APPENDIX A

Alphabetic List of Products

English-Portuguese		Portuguese-English	
Babassu	Babacu	Abacaxi	Pineapples
Bananas	Banana	Algodão	Cotton
Beans	Feijão	Amendoim	Peanuts
Castorbeans	Mamona	Arroz	Rice
Cattle	Bovinos	Aves	Poultry
Cocoa	Cacau	Babacu	Babassu
Coconuts	Coco da Bahia	Banana	Bananas
Coffee	Café	Batata doce	Sweetpotatoes
Corn	Milho	Batata inglesa	Potatoes
Cotton	Algodão	Borracha	Rubber
Eggs	Ovos	Bovinos	Cattle
Goats	Caprinos	Cacau	Cocoa
Grapes	Uva	Café	Coffee
Jute	Juta	Cana de acucar	Sugarcane
Manioc (cassava)	Mandioca	Caprinos	Goats
Milk	Leite	Cebola	Onions
Onions	Cebola	Coco da Bahia	Coconuts
Oranges	Laranja	Feijão	Beans
Peanuts	Amendoim	Fumo	Tobacco
Pineapples	Abacaxi	Juta	Jute
Potatoes	Batata inglesa	Lã	Wool
Poultry	Aves	Larenja	Oranges
Rice	Arroz	Leite	Milk
Rubber	Borracha	Mamona	Castorbeans
Sheep	Ovinos	Mandioca	Manioc (cassava)
Sisal	Sisal	Milho	Corn
Soybeans	Soja	Ovinos	Sheep
Sugarcane	Cana de acucar	Ovos	Eggs
Sweetpotatoes	Batata doce	Sisal	Sisal
Swine	Suinos	Soja	Soybeans
Tobacco	Fumo	Suinos	Swine
Tomatoes	Tomato	Tomate	Tomatoes
Wheat	Trigo	Trigo	Wheat
Wool	Lã	Uva	Grapes

APPENDIX B

Products Making Up Specified Product Groups

Domestic crops

Rice
Corn
Sugarcane
Beans
Mandioca
Bananas
Wheat
Potatoes
Peanuts
Oranges
Tomatoes
Sweetpotatoes
Coconuts
Soybeans
Pineapples
Onions
Grapes
Jute
Babassu

Export crops

Coffee
Cotton
Tobacco
Cocoa
Sisal
Castorseed
Rubber

Food Crops

Grains

Rice	Corn	Wheat

Oilseeds

Peanuts	Soybeans	Babassu

Vegetables

Potatoes	Sweetpotatoes
Tomatoes	Onions

Fruits

Bananas	Pineapples
Oranges	Grapes

Other Foods

Beans	Sugarcane
Mandioca	Coconuts

Fiber crops

Sisal	Cotton	Jute

Crops other than food or fiber

Coffee	Tobacco	Cocoa
Castorseed	Rubber	

Subsistence crops

Corn	Beans	Mandioca
Bananas		

Market crops

All crops not classified as subsistence crops

Permanent crops

Coffee	Oranges	Sisal
Grapes	Bananas	Cocoa

Temporary crops

Rice	Mandioca	Tomatoes
Corn	Wheat	Sweetpotatoes
Sugarcane	Potatoes	Soybeans
Cotton	Peanuts	Castorseed
Beans	Tobacco	Pineapples
Onions	Jute	

Extractive crops

Rubber	Babassu

Meat animals

Cattle	Sheep	Goats
Poultry	Hogs	

Animal products

Milk	Eggs	Wool

APPENDIX C

Public agencies related to agriculture in Brazil, 1968

Agencies

Office of the Presidency:

Ministry of Planning and General Coordination
Technical Cooperation Council of the Alliance for Progress (CONTAP)
Brazilian Government Secretariat for Coordination of the Program of Technical Assistance
Brazilian Institute of Georgraphy and Statistics (IBGE)
Institute of Applied Economic-Social Research (IPEA)

Ministry of Agriculture:

Department of Agricultural Promotion
Research (2 departments, 6 regional institutes, and two commodity institutes) (IPEAN, etc.)
Department of Protection and Inspection
National Institute of Agricultural Development (INDA)
Brazilian Institute of Agrarian Reform (IBRA)
National Superintendency of Supply (SUNAB)
Commission for Financing Production (CFP)
Superintendency for Development of Fisheries (SUDEP)
Brazilian Institute for Development of Forestry
Federal Agricultural Fund
Agricultural Information Service
Weather Service

Ministry of Interior:

Regional development agencies (SUDENE, SUDAM, SUVALE, SUDESUL[1])
Federal Territories (Amapa, Rondonia, Roraima)
National Department of Works Against Drought (DNOCS)

Ministry of Education and Culture:

Directorate of Agricultural Instruction
Agricultural Schools and Universities (6)
National School Lunch Campaign

Ministry of Finance:

Food Service of Social Welfare (SAPS)
Secretary of Agriculture of the Federal District

Ministry of Health:

National Department of Rural Endemic Diseases

Financial Institutions:

Central Bank of the Republic (BCR)
National Development Bank (BNDE)
Bank of Brazil (BB)
National Cooperative Credit Bank (BNCC)
National Agricultural Insurance Company

Other Agencies:

National Cold Storages (FRINASA)
Brazilian Warehouse Company (CIBRAZEM)
Brazilian Food Company (COBAL)
Brazilian Coffee Institute (IBC)
Sugar and Alcohol Institute (IAA)
Brazilian Association for Credit and Rural Assistance (ABCAR) (and State affiliates)
Rice Institute of Rio Grande (IRGA)

[1] Until 1967 was SPVRFS.

INDEX

USDA/FAER-79

CHANGES IN AGRICULTURAL PRODUCTION IN BRAZIL, 1947-65. (Foreign Agricultural Economic Report). / Louis F. Herrmann. Washington, DC: Economic Research Service, Jun. 1972.

2 OF 2
USDA
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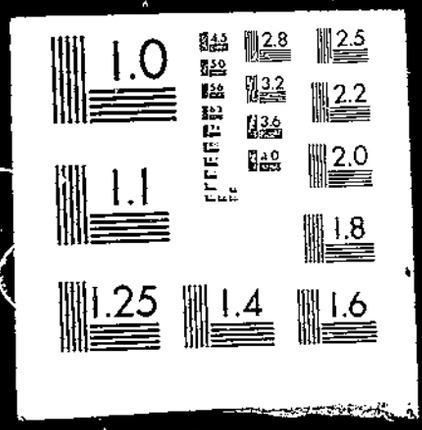

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